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Inheritance of Some Important Characters to Improve Sweet Melon (*Cucumis melo* L.) Fruits

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ABSTRACT: The present investigation was carried out during three years of 2012, 2013 and 2014. These experiments were done at Sabaheya Horticultural Research Station, Alexandria, and Fowa area, Kafer El- Sheikh, Egypt. Type of gene action, correlation coefficient and path analysis among all combinations of some important characteristics of sweet melon were studied. A 5X5 half-diallel cross was performed among five pure lines of sweet melon. Additive gene effects were found to be significant for plant length, number of branches / plant, flowering date, maturity date and flesh thickness indicating that the additive gene action played the main role in the inheritance of these traits. The evaluated characteristics of fruit netting, fruit shape index, total soluble solids % and moisture content exhibited insignificant values for the additive gene action. The dominant gene effect was found to be significant for plant length, number of branches per plant, maturity date, fruit netting degree, Total soluble solids % and moisture content indicating the importance of dominant gene effect in the inheritance of this characters. Total yield per plant, phenotypically, correlated with plant length, average fruit number and average fruit weight. Hence, a lot of attention for such relationships in the improvement program of such characters of sweet melon through selection.
Key words: *Cucumis melo*, gene action, correlation coefficients, path analysis

INTRODUCTION

Sweet melon (*Cucumis melo* L.) is one of the most important economic species of the family Cucurbitaceae. Among the different parts of a melon plant, fruits have the highest diversity in size, form, external ornamentation, and internal and external color (Kirkbride, 1993). Further, Kirkbride (1993) and Goldman (2002) reported that, fruits as short as 4 cm long (*C. melo,* L. var *agrestis*) and as long as 200 cm (*C. melo*, L. var. *flexuosus*) and attaining weights between 50 g and more than 15 kg . Plant breeding programs are aim to improve the characteristics of plant so that they become more desirable agronomically and economically higher yield and improved quality. High yield, early maturity and uniform fruit shape and size, as well as, excellent quality, are important objectives for melon breeding programs (Zalapa *et al.* 2006). Several researchers had match attention with the family Cucurbitaceae to study the influence of gene action; such as, Zalapa *et al.* (2006), Feyzian *et al. (*2009), Pornsuriya *et al.* (2009) and Abu Arak (2013), they all declared that the additive genes effects were the key regulator factor for most melon traits. They, also, showed that all three types of epistatic effects were significant for fruit width (additive x additive, additive x dominance and dominance x dominance) effected in the inheritance of melon traits.

The objectives of the present study were: (1) to generate genetic information such as, the nature of gene action (additive, dominant, and epistasis gene action) controlling the studied characters and (2) calculating the correlation coefficient (r) for different pairs of some important characters of sweet melon to be used in the improvement programs of melon.

MATERIALS AND METHODS

1. Experimental materials

The genetic material were consisted of five parental lines obtained from the breeding program of the project of improvement the Cucurbitaceae vegetables, Horticultural Research Institute. Five genotypes are (line $_{Kooz\ Assal}$ (P_1), Line $_{Matrouh}$ (P_2), line $_{orange}$ (P_3), line $_{green}$ (P_4) and line $_{Ideal}$ (P_5)). A 5X5 half diallel cross was performed, in the green house at the first of February in 2012, among the five lines of sweet melon, to get 10 F1 hybrid combinations. At the first of august 2012, the F1 of each of the ten hybrids was selfed and backcrossed to both parents to get 10 F2 and 20 backcross populations which were sown on 15th of March, 2013 and 20th of March, 2014.

2. Field experiments and the experimental design

The seeds of the 5 parents, 10 F1′ s, 10 F2′ s and 20 backcrosses generations, as well as, the seeds of the commercial cultivar "Gallia" were sown for the evaluation on 15th and 20th of March 2013 and 2014; respectively, in Fowa area, Kafer El- Sheikh Governorate, Egypt. A randomized complete blocks design with three replicates was used. Each plot consisted of three rows; each row was 4 m long and 1 meter wide having an area 12 m^2 for each plot.

3. Statistical analysis and estimation of genetic parameters

The recorded data for the six populations; i.e., P_1, P_2, F_1, F_2, $BC_1$and BC_2 for each cross were, statistically, analyzed and the combined analysis over two seasons were done as outlined by Allard (1960). Types of gene action were calculated using relationships given by Hayman (1958) and Gamble (1962). Simple correlation coefficient (r) was calculated for different pairs of the studied characters as shown by Dospekhove (1984).

RESULTS AND DISCUSSION

Data of Table (1 and 2) revealed that there were significant genotypic differences among the tested populations for all the studied characters. This result indicating that the evaluated populations differed in their genetic potential with respect to these traits. The environmental factor (year effects) showed significant and highly significant effects on plant height, number of branches per plant, flowering date, maturity date, fruit flesh thickness, netting degree and moisture content. The results indicated that there were fluctuations in the environmental conditions from year to another throughout both experiments of this investigation affecting these characters. The interaction between the genetically and environmental factors (genotype X year) had pronounced effects for the two traits flowering date and T.S.S %, suggested that the relative performance of the evaluated population was essentially the same, when grown under individual environments, as illustrated by Anne *et al.* (2011).

The mean values of the vegetative characters are shown in Table (3). Results of plant height trait showed that most of the F_1′s crosses had the highest mean values. The hybrid 2×4 and 3×4 led to the tallest plant but the shortest plant was given by BC_1P_1 in the hybrid 2×4.According to number of branches per plant trait. Results showed, generally, that the F_1′s plants recorded high values where it ranged between (4- 4.66). The crosses 1×3, 1×5

and 3×5 recorded the lowest mean values for flowering date characters, so these genotypes might be elected for producing early fruits. On the other hand, the genotypes P_1, 2×4, 2×5 and Gallia 1 might be elected for producing late fruit, where they all gave values ranged between 40 to51 days from planting to flowering stage. For maturity date the results showed that the hybrids 1×3, 1×2, 1×5, 3×5, 2×3 and 4×5 recorded the lowest value for the days to maturity.

Table(1):Combined analysis of variance for the studied vegetative characters; flowering date, maturity date and yield and its components of 5 parents, 10 F_1 ,10 F2,10 BC1P1 and 10 BC1P2 sweet melon crosses (over two years of 2013 and 2014)

S.O.V.	D.F.	Plant height (cm)	No. of branches per plant	Flowering date (day)	Maturity date (day)	Fruits No. per plant	Average fruit weight (kg)	Total fruit yield per plant (kg)
Blocks	2	3728.38*	1.65*	3.15	7.95	0.72	0.096	0.311
Genotypes	44	3254.67**	1.15**	82.61**	354.79**	0.70**	0.232**	1.122**
Years	1	4670.84*	2.70*	31.33**	6.69**	0.18	0.183	4.206
G x Y	44	671.35	0.40	11.00**	79.01	0.41	0.074	0.240
Error	178	1037.64	0.19	3.46	2.42	0.42	0.091	0.248

*, ** Significant and highly significant at the 0.05 and 0.01 level of probability, respectively.

Table(2):Combined analysis of variance for the studied fruit characteristics of 5 parents, 10 F_1, 10 F2, 10 BC1P1 and 10 BC1P2 sweet melon crosses (over two years of 2013 and 2014)

S.O.V.	D.F.	Fruit flesh Thickness (%)	Fruit shape index	Fruit netting degree	T.S.S (%)	Moisture Content (%)
Blocks	2	184.058**	0.025	4.959**	2.718	12.873*
Genotypes	44	39.161**	0.085**	3.168**	7.607**	7.547**
Seasons	1	273.330**	0.019	0.003	11.408*	25.330*
G x S	44	19.052	0.008	0.700	2.841*	3.841
Error	178	21.612	0.010	0.985	1.845	3.890

*, ** Significant and highly significant at the 0.05 and 0.01 level of probability, respectively.

The mean performances for yield and yield component character are presented in Table (4). The highest average for the fruit number per plant recorded by the P_2 (line green) followed by the F_1 plants for the hybrids 1×2, 1×3, 1×4, 2×4, 2×5, 3×4 and 3×5. Results indicated that the lowest fruit number was obtained by the parent P_1 (line kooz Assal). For average of fruit weight per plant character results clearly showed that the genotype BC_1 P_1 in cross 1×4

recorded the highest fruit weight value followed by the genotype BC_1 P2 in the cross 2×3. The highest F_1 values for the fruit weight character were recorded by the hybrids 1×3, 1×4 and 2×4. The highest recorded value for the total fruit yield per plant trait was obtained by the genotype BC_1 P_1 in the cross 1×4, while the highest F_1 values were given by the hybrids 1×2, 1×5, 2×4, 2×5, 3×4 and 3×5.

Mean performances of sweet melon fruit characteristics are presented in Table (5).The mean values of fruit flesh thickness showed that the F_1 plants (cross 3×5) gave the highest value, followed by the commercial cultivar "Gallia 1" compared with other evaluated genotypes. Regarding the fruit shape index character, the parent P_1 (line kooz Assal) seemed to have an oblong fruit shape where it gave the highest value; the F_1 crosses seemed to be round where values ranged between 0.90 and 1.27. The lowest value was given by "Gallia 1" cv., where it recorded 0.90 for this trait. Most of the F_1 crosses getting the highest values in addition to the check cultivar "Gallia 1", but the lowest values were recorded with BC_1P_2 in the cross 2×4.

The total soluble solids character (T.S.S) for the F1 crosses ranged from 12.83% (the hybrid 1×4) to 16.86% for the cross 1×5; while the lowest mean value was recorded by the P_1(line kooz Assal). The cultivar "Gallia 1" recorded moderate percentage in this respect. The parent P_1(line kooz Assal) gave the highest percentage value (93.77%) for the fruit moisture content trait; while all the F_1 crosses ranged from 89.54% (the hybrid 2×3) to 92.27% for the hybrid 4×5.The P3(line orange) recorded the lowest value (83.72%) for the fruit moisture content trait.

Chamnan *et al.* (2006) in Thai Slicing melon reported that, F_1 generation had the best performance considered from fruit number per plant, followed by that of BC_2, whereas, the poorest performance was P_1. Zalapa *et al. (*2006) in melon found that, for most traits, F_1 generation means were higher than the mid-parent value, and at AR the mean of the F_1 surpassed the mean of the high parent for fruit number per plant, fruit weight per plant and days to anthesis. Also, they found that the F_1 generation was intermediate to parental lines for primary branch number at both AR (5.7) and HCK (5.6), and performed equal to/or better than both parents for fruit number per plant (5.9, AR and 1.7, HCK), fruit weight per plant (6.2 kg, AR and 2.4 kg, HCK) and average weight per fruit (1.1 kg, AR and 1.5 kg, HCK). BC_1P_1 and BC_1P_2 progeny resembled their respective recurrent parent with respect to growth habit and fruiting characteristics, and F2 individuals varied dramatically for the yield-related characteristics examined.

Table (3): Mean performances of 5 parents, 10 F_1 ,10 F2 ,10 BC1P1, 10 BC1P2 sweet melon crosses and a check cultivar for the studied vegetative characters, flowering date and maturity date (over two years of 2013 and 2014)

genotypes	Plant height (cm)	No. of branches per plant	Flowering Date (day)	Maturity date (day)	Plant height (cm)	No. of branches per plant	Flowering date (day)	Maturity date (day)
	Cross 1 (1x 2)				Cross 6 (2x 4)			
P_1	225.50^{bc*}	4.66^{a}	43.00^{b}	79.00^{e}	236.60^{b}	3.83^{a}	35.50^{g}	79.50^{c}
P_2	236.60^{ab}	3.83^{b}	35.50^{g}	79.50^{d}	230.20^{bc}	4.33^{a}	37.50^{f}	79.50^{c}
F_1	263.50^{a}	4.66^{a}	36.00^{f}	70.00^{g}	279.50^{a}	4.00^{a}	40.00^{d}	78.50^{e}
F_2	198.80^{c}	3.83^{b}	39.00^{e}	75.00^{f}	192.20^{c}	4.50^{a}	39.50^{e}	79.00^{d}
BC_1	224.60^{bc}	4.16^{ab}	41.00^{d}	86.50^{b}	191.30^{c}	4.00^{a}	40.50^{c}	78.00^{f}
BC_2	223.50^{bc}	4.50^{ab}	41.50^{c}	81.00^{c}	207.00^{bc}	3.83^{a}	44.50^{b}	91.00^{b}
Gallia1	209.00^{bc}	3.83^{b}	51.00^{a}	92.00^{a}	209.00^{bc}	3.83^{a}	51.00^{a}	92.00^{a}
	Cross 2 (1x 3)				Cross 7 (2x 5)			
P_1	225.50^{ab}	4.66^{ab}	43.00^{b}	79.00^{c}	236.60^{ab}	3.83^{ab}	35.50^{g}	79.50^{e}
P_2	234.10^{ab}	4.33^{ab}	38.50^{d}	76.00^{e}	214.00^{bc}	3.50^{ab}	37.00^{e}	80.00^{d}
F_1	270.10^{a}	4.66^{ab}	34.50^{g}	69.50^{g}	261.30^{a}	4.00^{a}	40.00^{d}	80.50^{c}
F_2	212.50^{b}	3.83^{b}	37.50^{e}	81.50^{b}	186.30^{c}	3.66^{ab}	36.00^{f}	79.00^{f}
BC_1	227.8^{0ab}	4.33^{ab}	40.50^{c}	77.50^{d}	216.30^{bc}	3.66^{ab}	48.50^{b}	87.00^{b}
BC_2	219.30^{b}	4.83^{a}	37.00^{f}	73.00^{f}	233.00^{ab}	3.16^{b}	41.50^{c}	76.00^{g}
Gallia1	209.00^{b}	3.83^{b}	51.00^{a}	92.00^{a}	209.00^{bc}	3.83^{ab}	51.00^{a}	92.00^{a}
	Cross 3 (1x 4)				Cross 8 (3x 4)			
P_1	225.50^{ab}	4.66^{a}	43.00^{c}	79.00^{d}	234.20^{b}	4.33^{a}	38.50^{f}	76.00^{g}
P_2	230.20^{ab}	4.33^{a}	37.50^{e}	79.50^{c}	230.10^{b}	4.33^{a}	37.50^{g}	79.50^{f}
F_1	259.60^{a}	4.00^{a}	35.50^{f}	78.50^{e}	279.50^{a}	4.16^{a}	39.50^{d}	88.00^{e}
F_2	207.60^{b}	3.00^{b}	35.00^{g}	75.50^{g}	207.00^{b}	4.16^{a}	39.00^{e}	91.50^{c}
BC_1	246.50^{ab}	4.83^{a}	43.50^{b}	77.00^{f}	220.80^{b}	3.83^{a}	41.00^{c}	89.00^{d}
BC_2	218.30^{ab}	4.83^{a}	40.00^{d}	84.00^{b}	222.50^{b}	3.66^{a}	44.50^{b}	93.50^{a}
Gallia1	209.00^{b}	3.83^{ab}	51.00^{a}	92.00^{a}	209.00^{b}	3.83^{a}	51.00^{a}	92.00^{b}
	Cross 4 (1x 5)				Cross 9 (3x 5)			
P_1	225.50^{abc}	4.66^{a}	43.00^{b}	79.00^{f}	237.50^{ab}	4.33^{ab}	38.50^{e}	76.00^{f}
P_2	214.00^{abc}	3.50^{b}	37.00^{f}	80.00^{e}	214.00^{b}	3.50^{c}	37.00^{f}	80.00^{e}
F_1	251.30^{a}	4.33^{ab}	36.00^{g}	74.50^{g}	259.80^{a}	4.66^{a}	34.00^{g}	74.50^{g}
F_2	199.30^{c}	4.33^{ab}	37.50^{e}	94.00^{a}	217.30^{b}	3.66^{bc}	41.00^{d}	82.00^{d}
BC_1	213.20^{abc}	4.50^{ab}	40.50^{c}	92.50^{c}	217.20^{b}	4.33^{ab}	42.00^{c}	84.00^{c}
BC_2	241.00^{ab}	4.00^{ab}	38.50^{d}	93.50^{b}	207.60^{b}	4.16^{abc}	48.50^{b}	89.00^{b}
Gallia1	209.00^{bc}	3.83^{ab}	51.00^{a}	92.00^{d}	209.00^{b}	3.83^{bc}	51.00a	92.00^{a}
	Cross 5 (2x3)				Cross 10 (4x5)			
P_1	236.60^{a}	3.83^{a}	35.50^{d}	79.50^{e}	230.20^{ab}	4.33^{a}	37.50^{f}	79.50^{d}
P_2	234.20^{a}	4.33^{a}	38.50^{c}	76.00^{f}	214.00^{b}	3.50^{bc}	37.00^{g}	80.00^{c}
F_1	239.30^{a}	4.16^{a}	36.00^{d}	75.00^{g}	256.30^{a}	4.16^{ab}	39.00^{d}	75.50^{f}
F_2	216.50^{a}	4.16^{a}	39.00^{c}	96.50^{a}	213.20^{b}	3.16^{c}	38.50^{e}	79.00^{e}
BC_1	232.00^{a}	4.50^{a}	41.50^{b}	81.00^{d}	209.00^{b}	4.00^{ab}	43.50^{b}	84.50^{b}
BC_2	249.30^{a}	3.83^{a}	41.50^{b}	82.50^{c}	222.80^{ab}	4.00^{ab}	43.00^{c}	79.00^{e}
Gallia1	209.00^{b}	3.83^{a}	51.00^{a}	92.00^{b}	209.00^{b}	3.83^{abc}	51.00^{a}	92.00^{a}

* Means with different superscripts in a column are significantly different at (P<0.05), using Duncan's Multiple Rang Test.

Table (4): Mean performances of 5 parents, 10 F_1 ,10 F_2 ,10 BC_1P_1, 10 BC_1P_2 sweet melon crosses and a check cultivar for the studied yield and yield components (over two years of 2013 and 2014)

genotypes	Fruits No. per Plant	Average fruit weight (kg)	Total fruit yield per plant (kg)	Fruits No. per Plant	Average fruit weight (kg)	Total fruit yield per plant (kg)
	Cross 1 (1x 2)			Cross 6 (2x4)		
P_1	1.83 ^{c*}	1.180 ^{a}	2.140 ^{ab}	2.83 ^{a}	0.765 ^{abc}	2.150 ^{b}
P_2	2.83 ^{ab}	0.765 ^{c}	2.150 ^{ab}	3.17 ^{a}	0.739 ^{bc}	2.307 ^{b}
F_1	3.00 ^{a}	0.831 ^{bc}	2.473 ^{a}	3.00 ^{a}	1.029 ^{ab}	2.854 ^{a}
F_2	2.16 ^{bc}	0.755 ^{c}	1.370 ^{c}	2.00 ^{b}	1.111 ^{a}	1.825 ^{b}
BC_1	2.83 ^{ab}	0.648 ^{c}	1.751 ^{bc}	2.50 ^{ab}	0.762 ^{abc}	1.893 ^{b}
BC_2	2.33 ^{abc}	1.051 ^{ab}	2.320 ^{a}	1.83 ^{b}	0.651 ^{c}	1.161 ^{c}
Gallia1	2.33 ^{abc}	0.872 ^{bc}	2.008 ^{ab}	2.33 ^{ab}	0.871 ^{abc}	2.008 ^{b}
	Cross 2 (1x 3)			Cross 7(2x5)		
P_1	1.83 ^{b}	1.225 ^{a}	2.148 ^{ab}	2.83 ^{ab}	0.765 ^{ab}	2.150 ^{a}
P_2	2.50 ^{ab}	0.983 ^{a}	2.171 ^{ab}	2.50 ^{b}	0.728 ^{b}	1.820 ^{a}
F_1	2.16 ^{ab}	1.100 ^{a}	2.205 ^{ab}	3.33 ^{a}	0.718 ^{b}	2.280 ^{a}
F_2	2.33 ^{ab}	0.910 ^{a}	1.918 ^{b}	2.33 ^{b}	1.015 ^{a}	2.280 ^{a}
BC_1	3.00 ^{a}	1.085 ^{a}	2.735 ^{a}	2.50 ^{b}	0.645 ^{b}	1.610 ^{a}
BC_2	2.33 ^{ab}	1.105 ^{a}	2.455 ^{ab}	2.50 ^{b}	0.853 ^{ab}	2.080 ^{a}
Gallia1	2.33 ^{ab}	0.871 ^{a}	2.008 ^{b}	2.33 ^{b}	0.872 ^{ab}	2.020 ^{a}
	Cross 3(1x 4)			Cross 8 (3x 4)		
P_1	1.83 ^{c}	1.353 ^{ab}	2.148 ^{bc}	2.50 ^{b}	0.983 ^{a}	2.171 ^{ab}
P_2	3.16 ^{a}	0.739 ^{c}	2.307 ^{bc}	3.16 ^{a}	0.739 ^{a}	2.307 ^{ab}
F_1	2.66 ^{ab}	1.093 ^{bc}	2.526 ^{ab}	2.66 ^{ab}	0.974 ^{a}	2.546 ^{a}
F_2	2.33 ^{bc}	0.793 ^{c}	1.626 ^{c}	2.33 ^{b}	0.846 ^{a}	2.085 ^{ab}
BC_1	2.16 ^{bc}	1.602 ^{a}	3.029 ^{a}	2.50 ^{b}	0.710 ^{a}	1.744 ^{b}
BC_2	2.66 ^{ab}	0.794 ^{c}	2.159 ^{bc}	2.16 ^{b}	0.876 ^{a}	1.780 ^{b}
Gallia1	2.33 ^{bc}	0.871 ^{bc}	2.023 ^{bc}	2.33 ^{b}	0.871 ^{a}	2.008 ^{ab}
	Cross 4 (1x 5)			Cross 9 (3x 5)		
P_1	1.83 ^{b}	1.180 ^{a}	2.148 ^{b}	2.5 ^{ab}	0.983 ^{a}	2.171 ^{ab}
1.819 ^{bc}	0.713 ^{b}	2.5 ^{ab}	1.819 ^{bc}	0.732 ^{b}	2.50 ^{ab}	P_2
2.406 ^{a}	0.776 ^{ab}	3.16 ^{a}	2.860 ^{a}	0.933^{ab}	3.16 ^{a}	F_1
1.763 ^{bc}	0.695 ^{b}	2.66 ^{ab}	1.943 ^{bc}	0.926 ^{ab}	2.33 ^{b}	F_2
1.598 ^{c}	0.658 ^{b}	2.50 ^{ab}	1.546 ^{c}	0.774 ^{b}	2.00 ^{b}	BC_1
1.568 ^{c}	0.686 ^{b}	2.33 ^{b}	1.541 ^{c}	0.672 ^{b}	2.33 ^{b}	BC_2
2.008 ^{abc}	0.871 ^{ab}	2.33 ^{b}	2.008 ^{bc}	0.871 ^{b}	2.33 ^{b}	Gallia1
	Cross 10 (4x 5)			Cross 5 (2 x 3)		
2.307 ^{ab}	0.739 ^{b}	3.16 ^{a}	2.150 ^{ab}	0.765 ^{b}	2.83 ^{a}	P_1
1.819 ^{ab}	0.713 ^{b}	2.50 ^{a}	2.171 ^{ab}	0.983 ^{ab}	2.50 ^{a}	P_2
2.213 ^{ab}	0.925 ^{ab}	2.50 ^{a}	1.666 ^{b}	0.716 ^{b}	2.33 ^{a}	F_1
2.438 ^{a}	1.067 ^{a}	2.33 ^{a}	1.605 ^{b}	0.790 ^{b}	2.33 ^{a}	F_2
2.154 ^{ab}	0.879 ^{ab}	2.66 ^{a}	2.172 ^{ab}	1.027 ^{ab}	2.15 ^{a}	BC_1
1.690 ^{b}	0.716 ^{b}	2.50 ^{a}	2.811 ^{a}	1.250 ^{a}	2.33 ^{a}	BC_2
2.008 ^{ab}	0.871 ^{ab}	2.33 ^{a}	2.008 ^{b}	0.871 ^{ab}	2.33 ^{a}	Gallia1

* Means with different superscripts in a column are significantly different at (P<0.05), using Duncan's Multiple Rang Test.

Table (5): Mean performances of 5 parents, 10 F_1, 10 F_2, 10 BC_1P_1 and 10 BC_1P_2 sweet melon crosses and a check cultivar for the studied fruit characteristics (over two years of 2013 and 2014)

Moisture content (%)	T.S.S (%)	Fruit netting degree	Fruit shape index	Fruit flesh thickness (%)	genotypes
			Cross 1(1x2)		
93.77 ^{a}	12.16 ^{c}	7.66 ^{b}	1.54 ^{a}	58.46 ^{c*}	P_1
91.70 ^{ab}	14.33^{ab}	9.33 ^{ab}	1.04 ^{c}	62.39 ^{bc}	P_2
91.58 ^{ab}	14.66 ^{ab}	10.00 ^{a}	0.99 ^{cd}	64.32 ^{ab}	F_1
91.42^{abc}	14.06 ^{ab}	8.33 ^{ab}	1.21 ^{b}	68.58 ^{ab}	F_2
90.34 ^{bc}	14.58 ^{ab}	9.66 ^{a}	1.06 ^{c}	66.58 ^{ab}	BC_1
88.23 ^{c}	15.26 ^{a}	8.16 ^{ab}	1.06 ^{c}	67.37 ^{ab}	BC_2
90.33 ^{bc}	13.66 ^{b}	9.66 ^{a}	0.90 ^{d}	69.20 ^{a}	Gallia1
			Cross 2 (1x3)		
93.77 ^{a}	12.16 ^{c}	7.66 ^{b}	1.54 ^{a}	58.46 ^{c}	P_1
92.72 ^{ab}	14.58 ^{ab}	9.50 ^{a}	1.11 ^{b}	63.64 ^{b}	P_2
91.22 ^{ab}	15.03 ^{a}	10.00 ^{a}	1.27 ^{b}	64.53 ^{ab}	F_1
91.81 ^{ab}	14.6 ^{ab}	9.33 ^{a}	1.24 ^{b}	64.74 ^{ab}	F_2
91.36 ^{ab}	13.08 ^{bc}	9.16 ^{a}	1.18 ^{b}	67.77 ^{ab}	BC_1
91.05 ^{b}	13.83 ^{ab}	8.66 ^{ab}	1.13 ^{b}	65.67 ^{ab}	BC_2
90.33 ^{b}	13.66 ^{ab}	10.00 ^{a}	0.90 ^{c}	69.20 ^{a}	Gallia1
			Cross 3 (1x4)		
93.77 ^{a}	12.16 ^{d}	7.66 ^{b}	1.54 ^{a}	58.63 ^{c}	P_1
90.50^{bcd}	14.01 ^{bc}	10.00 ^{a}	0.97 ^{c}	63.28 ^{b}	P_2
91.06 ^{bc}	12.83 ^{cd}	10.00 ^{a}	1.06 ^{b}	66.65 ^{ab}	F_1
88.17 ^{d}	16.13 ^{a}	9.83 ^{a}	1.01 ^{bc}	66.03 ^{ab}	F_2
88.89 ^{cd}	14.61 ^{ab}	10.00 ^{a}	0.95 ^{c}	66.50 ^{ab}	BC_1
91.52 ^{b}	15.96 ^{a}	9.83 ^{a}	0.94 ^{c}	66.81 ^{ab}	BC_2
90.33^{bcd}	13.66^{bcd}	10.00 ^{a}	0.90 ^{c}	69.20 ^{a}	Gallia1
			Cross 4 (1x5)		
93.77 ^{a}	12.16 ^{d}	7.66 ^{c}	1.54 ^{a}	58.63 ^{b}	P_1
89.90 ^{c}	14.66 ^{bc}	9.33 ^{ab}	0.93^{cd}	64.34 ^{ab}	P_2
91.36 ^{bc}	16.86 ^{a}	9.83 ^{a}	1.09 ^{b}	67.65 ^{a}	F_1
89.50 ^{c}	16.91 ^{a}	9.83 ^{a}	1.05 ^{bc}	65.72 ^{a}	F_2
92.32 ^{ab}	13.43 ^{cd}	7.66 ^{c}	1.00 ^{bcd}	68.98 ^{ab}	BC_1
90.52 ^{bc}	15.55 ^{ab}	8.16 ^{bc}	1.01 ^{bcd}	63.96 ^{ab}	BC_2
90.33 ^{bc}	13.66 ^{cd}	10.00 ^{a}	0.90 ^{d}	69.20 ^{a}	Gallia1
			Cross 5 (2x3)		
91.71 ^{ab}	14.33 ^{bc}	9.33 ^{a}	1.04 ^{bc}	62.39 ^{c}	P_1
92.73 ^{a}	14.58^{abc}	9.50 ^{a}	1.11 ^{b}	63.64 ^{bc}	P_2
89.54 ^{b}	15.09 ^{ab}	9.33 ^{a}	0.93 ^{c}	65.14 ^{abc}	F_1
89.91 ^{ab}	16.33 ^{a}	10.00 ^{a}	1.01 ^{bc}	65.98 ^{abc}	F_2
91.93 ^{ab}	13.13 ^{c}	9.66 ^{a}	0.96 ^{c}	64.45 ^{bc}	BC_1
90.72 ^{ab}	12.83 ^{c}	9.66 ^{a}	1.25 ^{a}	68.19 ^{ab}	BC_2
91.84 ^{ab}	13.67 ^{bc}	10.00 ^{a}	0.90 ^{c}	69.20 ^{a}	Gallia1

* Means with different superscripts in a column are significantly different at ($P<0.05$), using Duncan's Multiple Rang Test.

To be Conted…

Table (5) Cont'

Moisture content %	T.S.S %	Fruit netting degree	Fruit shape index	Fruit flesh thickness %	genotypes
			Cross 6 (2x4)		
91.71 ab	14.33 ab	9.33 ab	1.04 ab	62.39 bc*	P_1
90.51 ab	14.02 abc	10.00 a	0.97 abc	63.28 bc	P_2
91.50 ab	14.97 ab	10.00 a	1.08 a	67.28 ab	F_1
89.15 b	15.28 a	10.00 a	1.03 abc	67.03 ab	F_2
91.17 ab	15.32 a	9.16 b	1.03 abc	62.62 bc	BC_1
92.36 a	12.77 c	7.16 c	0.89 c	61.36 c	BC_2
91.84 ab	13.67 bc	10.00 a	0.90 bc	69.20 a	Gallia1
			Cross 7 (2x5)		
91.71 a	14.33 a	9.33 a	1.04 a	62.39 bc	P_1
89.90 a	14.67 a	9.33 a	0.93 c	66.84 abc	P_2
90.71 a	13.53 a	9.67 a	0.94 bc	68.17 ab	F_1
91.66 a	13.50 a	9.83 a	1.03 ab	68.20 ab	F_2
89.90 a	13.80 a	9.67 a	0.92 c	60.94 c	BC_1
91.90 a	12.82 a	9.50 a	1.09 a	66.22 abc	BC_2
91.84 a	13.67 a	10.00 a	0.90 c	69.20 a	Gallia1
			Cross 8 (3x4)		
83.72 b	14.58 ab	9.50 ab	1.11 a	63.64 bc	P_1
90.41 a	14.01 b	10.00 a	0.96 bc	63.28 bc	P_2
90.51 a	15.71 a	10.00 a	1.06 ab	63.02 bc	F_1
90.53 a	13.91 b	10.00 a	0.96 bc	66.43 ab	F_2
90.50 a	15.66 a	8.66 b	0.95 bc	63.22 bc	BC_1
90.67 a	15.68 a	9.50 ab	0.94 c	60.68 c	BC_2
90.33 a	13.66 b	10.00 a	0.90 c	68.20 a	Gallia1
			Cross 9 (3x5)		
92.72 a	14.58 a	9.5 ab	1.11 a	63.64 bc	P_1
89.90 b	14.66 a	9.33 ab	0.93 a	65.34 abc	P_2
91.72 ab	14.41 a	10.00 a	1.00 a	70.00 a	F_1
90.15 ab	15.11 a	9.00 b	0.97 a	62.47 c	F_2
90.81 ab	15.13 a	9.83 a	0.99 a	65.22 abc	BC_1
89.19 b	14.38 a	10.00 a	0.98 a	66.11 abc	BC_2
90.33 ab	13.66 a	10.00 a	0.90 a	68.20 ab	Gallia1
			Cross 10 (4x5)		
90.50 ab	14.01 ab	10.00 a	0.97 b	63.28 ab	P_1
89.90 b	14.66 ab	9.33 b	0.93 b	65.34 ab	P_2
92.27 a	15.50 a	9.83 a	0.93 b	61.97 b	F_1
91.49 ab	14.60 ab	9.83 a	1.15 a	62.22 b	F_2
92.32 a	14.26 ab	9.66 a	1.09 a	63.95 ab	BC_1
90.10 b	15.16 ab	8.66 b	0.97 b	61.93 b	BC_2
90.33 ab	13.66 b	10.00 a	0.90 b	68.87 a	Gallia1

* Means with different superscripts in a column are significantly different at (P<0.05), using Duncan's Multiple Rang Test.

Genetical parameters

Type of gene action

The data of the genetic analysis which give estimation on population mean values (m), additive gene action (a), dominance gene action (d) and the three epistatic effect ; i.e. additive x additive (aa), additive x dominance (dd) and dominance x dominance for the tested characters are presented in Tables (6,7 and 8).

The data of plant height showed significant variation for all the crosses; therefore, to improve this trait, selection in the advanced selfed generation on the basis of family mean performance would be effective. With this respect, the crosses 1x3, 1x4, 3x4 and 3x5 gave, highly, significant values for the additive gene effects indicating that, selection for the longest plant would be effective in these crosses. The dominance effects were found to be highly significant with positive values for all the hybrids except of the hybrid 4x5, these result indicated that, the dominance gene effect was important in the inheritance of this characters. The additive x additive interaction found to be highly significant with positive values for all the crosses except of importance of the crosses 3x5 and 4x5 indicating the importance of additive x additive gene action in the inheritance of this trait. The additive x dominance interaction was found to be highly significant for all the crosses with positive values for the crosses 1x3, 1x4, 3x4 and 3x5 and negative value for the crosses 1x2, 1x5, 2x3, 2x4, 2x5 and 4x5. This results indicating that, the selection for this trait in the early generation would be not effective. The dominance x dominance was found to be highly significant for all the crosses with positive values for the crosses 1x3, 2x4, 3x4, 3x5 and 4x5 and negative values for crosses 1x2, 1x4, 1x5, 2x3 and 2x5, this results indicating that the dominance gene For the number of branches per plant character, the additive gene effect exhibited insignificant values for all the crosses. The results showed that, the dominance x dominance epistatic were recorded significant and highly significant values for all the crosses.

The data presented in Table (6) for the no. of branches per plant trait revealed that the additive gene effect exhibited insignificant values for all the crosses. The results showed that, the mean value of the fruit maturity date character recorded highly significant and significant only for the two hybrids 1x5 and 2x3, respectively, indicating that, the population mean values might be effective as indicator for selection for this trait. while the dominance gene effect was significant with positive values for the crosses 1x2, 1x4, 1x5, 2x4, 2x5, 3x4, 3x5 and 4x5 indicating that the dominance gene effect had the main role in the inheritance of this character. The additive x additive (aa) epistatic found to be significant and highly significant with positive values for the crosses 1x2, 1x4, 2x4, 2x5 and 4x5.The dominance x dominance epistatic was found to be significant an highly significant with positive values for the crosses 1x3 and 2x3 , while the crosses 1x2, 1x4, 1x5, 2x4, 2x5, 3x4, 3x5 and 4x5 exhibited highly significant with negative value. These results showed that the dominance effect have the main role in the inheritance of this character. Dominance x dominance epistatic were recorded significant and highly significant values for all the crosses.

Table (6): Gene action of 5 parents, 10 F_1, 10 F_2, 10 BC_1P_1 and 10 BC_1P_2 sweet melon crosses for the studied vegetative characters, flowering date and maturity date

Maturity date (day)	Flowering date (day)	No. of branches per plant	Plant height (cm)	Maturity date (day)	Flowering date (day)	No. of branches per plant	Plant height (cm)	*Gene action*
Cross 6 (2x 4)				Cross 1 (1x 2)				
80.33	39.83	4.50	198.5**	73.33	41.00	3.83	199.3**	*m*
-15.33	-2.27	0.17	-10.17**	4.83	-0.5	-0.33	-14.33**	*a*
14.83**	8.20**	-2.42*	59.08**	20.58**	-3.65	2.44	111.25**	*d*
17.33**	5.86**	-2.33*	18.33**	29.33**	-1.00**	2.02	82.67**	*aa*
-14.83	-1.43*	0.42	-11.25**	6.92*	-3.85	-0.75	-13.58**	*ad*
-9.67**	-21.07**	2.83**	154.50**	-71.50**	-15.37**	-1.50*	-0.50**	*dd*
Cross 7 (2x 5)				Cross 2 (1x 3)				
80.33	38.0	3.67	190.83**	81.17	38.83	3.83	217.67**	*m*
15.17	5.00	0.50	-23.33**	5.17	2.67	-0.50	8.33**	*a*
15.75**	28.0**	-0.76	160.58**	-34.67**	-5.83**	3.17	71.70**	*d*
15.66**	24**	-1.00	134.66**	-27.67**	0.67**	3.00	38.67**	*aa*
15.58	5.50	0.33	-27.92**	3.00	0.67	-0.67	7.47**	*ad*
-31.50**	-48.88**	2.67*	-91.17**	25.33**	-7.00**	-3.00	16.60**	*dd*
Cross 8 (3x 4)				Cross 3 (1x 4)				
90.83	40.67	4.17	211.67**	76.50	37.00	3.00	212.33**	*m*
-4.67	-2.50	0.17	1.67**	-6.67	2.83	-0.33	14.50**	*a*
6.75**	9.33**	-1.50	90.67**	15.50*	13.58*	6.17	81.67**	*d*
-2.00**	7.66**	-1.66	96.66**	16.67*	17.67*	6.67	58.33**	*aa*
-3.08*	-3.17	0.17	2.17**	-6.50	0.42	-0.50	14.17**	*ad*
-8.83**	23.33**	4.33*	45.33**	-23.67*	-31.83**	-8.33*	-18.67**	*dd*
Cross 9 (3x 5)				Cross 4 (1x 5)				
84.33	40.67	3.67	221.67**	88.33**	38.83	4.33	207.83**	*m*
-6.33	-8.33	0.17	7.67**	-0.50	1.33	0.50	-33.0**	*a*
10.17*	12.58*	3.08	12.17**	6.17**	-0.17**	-0.08	130.17**	*d*
14.00	16.00*	2.33	-20.66**	11.67**	4.00**	-0.33	89.33**	*aa*
-4.17	-8.42	-0.25	4.67**	0.50	-1.50	-0.08	-36.83**	*ad*
-57.67*	-50.50**	-2.017*	103.67**	-69.0**	-9.67**	0.17*	-41.67**	*dd*
Cross 10 (4x5)				Cross 5 (2x3)				
80.33	38.50	3.50	220.17**	94.50*	41.00	4.17	221.17**	*m*
4.50	1.17	0.17	-11.67**	0.17	0.17	0.67	-22.13**	*a*
3.25**	12.75	2.55	-1.33**	-58.42**	-1.67**	0.08	73.58**	*d*
7.66**	11.00	2.33	26.00**	-54.33**	0.33**	0.00	70.00**	*aa*
5.08	1.25	-0.25	-15.17**	-1.25	1.67	0.92	-23.92**	*ad*
-23.83**	-22.17	-2.57*	106.00**	30.83**	-18.00**	-0.17	-115.8**	*dd*

*, ** Significant and highly significant at the 0.05 and 0.01 level of probability, respectively.
(*m, a, d, aa, ad* and *dd* = population mean, additive, dominant, additive x additive, additive x dominant and dominant x dominant gene action, respectively).

The data of the flowering date character appeared that the additive gene effect exhibited insignificant for all the crosses indicating that the role of the additive gene effect was negligible in the inheritance of this character. The dominance gene effect exhibited significant and highly significant positive value

for the crosses 1x4, 2x4, 2x5, 3x4 and 3x5. The additive x additive epistatic gene effects (*aa*) were found to be significant with the positive value for all the crosses, indicating that the additive x additive interaction was important in the inheritance of this trait.

The type of gene action for fruit yield per plant and yield components (No. of fruits per plant and average fruit weight) are presented in Table (7). The mean values of these characters were found to be insignificant for all the tested crosses indicating that the population mean may be not effective as an indicator for selection for these traits. The tabulated data of the No. of fruits per plant showed that the dominance effect exhibited significant values only for the crosses 1x3, 2x3 and 2x4.The dominance x dominance interaction was found to be significant for all the crosses except for the crosses 1x2 and 2x5. These results indicating that the dominance x dominance interaction was more important in the inheritance of this character.

The data of average fruit weight per plant character are presented in Table (8). the additive and dominance effects showed insignificant values for all crosses indicating that the additive and dominance effects might be not effective in the inheritance of this characters, the additive x additive interaction showed insignificant values for all the crosses except for the cross 2x4 which gave significant with negative value. The additive x dominance interaction was found to be insignificant for all the crosses except of the cross 1x4 which gave significant negative value.

For total fruit yield per plant characters, the recorded data showed that the additive and dominance effects were found to be insignificant for all the crosses except for the cross 2x5 which gave significant value for the dominance effect. The additive x additive interaction was found to be insignificant for all the crosses except for the 2x5 and 3x4, the dominance x dominance interaction was found to be significant for the crosses 1x4, 2x3, 2x4 and 3x4 indicating the importance of the dominance epistatic in the inheritance of this character for the tested crosses.

Fruit quality characteristics

Data presented in Table (8) declare these characters of gene action for fruit fresh thickness, the mean values was found to be significant and highly significant for the crosses 1x3, 1x4, 1x5, 2x5 and 4x5 indicating that improvement of such a character might be effective depending upon the population mean in the breeding selection. The additive gene action was significant and highly significant for all the tested crosses except for the hybrids 1x3, 1x4, 2x3 and 3x5. Concerning the dominant gene effect; results showed high significant for the tested crosses with highly magnitude values, which may be emphasize that the dominant gene effect was important in the inheritance of this trait. The additive x additive interaction

Table (7):Gene action of 5 parents, 10 F_1, 10 F_2, 10 BC_1P_1, and 10 BC_1P_2 sweet melon crosses for the studied yield and yield components characters

Total fruit yield per plant (kg)	Average fruit weight (kg)	Fruits No. per plant	Total fruit yield per plant (kg)	Average fruit weight (kg)	Fruits No. per plant	Gene action
Cross 6 (2x 4)			Cross 1 (1x 2)			
1.830	1.100	2.00	1.610	0.758	2.17	*m*
0.73	-0.04	0.76	-0.568	-0.40	0.50	*a*
-0.43	-1.81	1.00*	2.027	0.229	2.33	*d*
-1.18	-1.91*	0.66*	1.704	0.369	1.67	*aa*
0.81	-0.22	0.83	-0.568	-0.612	1.00	*ad*
5.51**	3.28	3.33*	0.602	-0.161	-1.33	*dd*
Cross 7 (2x 5)			Cross 2 (1x 3)			
2.280	1.020	2.33	1.780	0.900	2.17	*m*
0.47	-0.21	0.00	0.28	-0.02	0.67	*a*
0.70*	-1.09	0.83	3.23	0.81	2.00*	*d*
-1.73*	-1.06	0.66	3.27	0.80	2.00	*aa*
-0.63	-0.23	-0.17	0.38	-0.12	1.00	*ad*
2.36	0.99	3.30	-4.73	-0.81	-4.00*	*dd*
Cross 8 (3x 4)			Cross 3 (1x 4)			
1.590	0.680	2.33	1.630	0.790	2.33	*m*
0.92	-0.17	0.33	0.89	0.81	-0.50	*a*
3.02	0.40	-0.17	4.29	1.61	0.50	*d*
2.80*	0.45	0.00	3.90	1.63	0.33	*aa*
0.89	-0.29	0.67	0.97	0.59	0.17	*ad*
-2.19**	-0.29	1.67*	-4.61*	-2.63*	0.33*	*dd*
Cross 9 (3x 5)			Cross 4 (1x 5)			
1.760	0.700	2.67	1.890	0.93	2.17	*m*
0.03	-0.03	0.17	0.01	0.10	-0.33	*a*
-0.39	-0.16	-0.33	-0.38	-0.85	1.00	*d*
0.72	-0.09	-1.00	-1.25	-0.84	0.00	*aa*
-0.23	-0.16	0.17	-0.25	-0.13	0.00	*ad*
3.42	0.66	2.67*	4.77	1.71	2.00*	*dd*
Cross 10 (4x 5)			Cross 5 (2 x 3)			
2.440	1.070	2.33	1.600	0.790	2.33	*m*
0.46	0.16	0.17	-0.69	-0.22	-0.17	*a*
-1.58	-0.88	0.33	2.96	1.24	-0.67*	*d*
-2.06	-1.08	0.33	3.55	1.39	-0.33	*aa*
0.22	0.15	-0.17	-0.54	-0.11	-0.33	*ad*
3.60	1.19	1.33**	-5.70*	-2.77	1.33*	*dd*

*, ** Significant and highly significant at the 0.05 and 0.01 level of probability, respectively.
(*m, a, d, aa, ad* and *dd* = population mean, additive, dominant, additive x additive, additive x dominant and dominant x dominant gene action, respectively).

showed highly positive and negative magnitude values with highly significant values in most of the tested crosses except for the cross 2x3, indicating that the duplicate additive epistatic was more important in the inheritance of this character. Concerning the interaction additive x dominant the results showed significant and highly significant values for all the crosses except for the crosses 2x3 and 3x5. The non-allelic interaction dominant x dominant was found to be significant and highly significant with positive values for the crosses 1x5, 2x4, 2x5 and 3x4.

For fruit shape index trait, all the evaluated crosses exhibited insignificant values for the six parameters; i.e., mean values, additive gene effect, dominant gene effect, additive x additive, additive x dominant and dominant x dominant. These results suggesting that the improvement of this character in the early generation would be not effective. The data of fruit netting degree showed the additive gene effect was found to be insignificant for all the evaluated crosses, while the dominant gene effect showed highly significant positive value only for the crosses 1x2, 1x3 and 2x3. The additive x additive interaction showed significant and highly significant only for the crosses 1x2, 1x3 and 2x3. Dominance duplicate epistatic was found to be significant and highly significant with negative value for the crosses 1x3 and 2x3 while the crosses 1x5, 2x4, 2x5, 3x4 and 4x5 exhibited positive significant and highly significant values. The non- allelic interaction additive x additive showed significant and highly significant values for all the crosses except for the cross 1x5, 2x5 and 3x5.

The total soluble solids character showed that the additive gene action exhibited non- significant values for all the evaluated crosses; while the dominance gene action gave significant and highly significant values for most of the tested crosses except for the hybrid 2x4. These results indicated that the dominance gene effect was more important than the additive gene effect in the inheritance of this character. Concerning the duplicate additive epistatic, the data showed that the crosses 1x4 1x5 2x3, 2x5, 3x4, 3x5 and 4x5 showed significant and highly significant values. On the other hand, the dominance duplicate interaction was found to be highly significant for most of the tested crosses, except for the hybrid 3x5.

The mean values of the fruit moisture content trait was found to be insignificant for most of the tested crosses, except for the cross 3x4 where it gave significant value. The dominant gene action exhibited highly significant with high magnitude values for all the crosses indicating that the dominant gene action was more important than the additive gene effect in the improvement of this character. As for the duplication additive interaction, the results showed that all the crosses exhibited highly significant positive and negative values except for the cross 2x4 which gave, significantly, positive value. The dominant x dominant interaction showed highly significant values for all the tested crosses. Similar results were reported by Fernaindez *et al. (*2009) and Reddy *et al.* (2013`).

Table (8): Gene action of 5 parents, 10 F_1, 10 F_2, 10 BC_1P_1, and 10 BC_1P_2 sweet melon crosses for the studied fruit characteristics

Moisture content (%)	T.S.S (%)	Fruit netting degree	Fruit shape index	Fruit flesh thickness (%)	Gene action
Cross 1 (1x2)					
91.43	14.07	8.33	1.22	66.67	*m*
0.58	-0.35	1.50	0.01	0.53**	*a*
-6.79**	4.15*	2.63**	-0.94	7.45**	*d*
-5.63**	2.77	2.33**	-0.64	4.27**	*aa*
-0.45	0.77	1.79*	-0.24	1.45**	*ad*
14.23**	-5.90*	-1.25	0.98	-26.10**	*dd*
Cross 2 (1x3)					
91.81	14.60	8.67	1.25	65.80**	*m*
0.32	-0.74	0.50	0.05	0.30	*a*
-4.40**	-2.92*	1.75**	-0.41	11.58**	*d*
-2.37**	-4.57	1.00**	0.36	5.27**	*aa*
-0.21	0.47	1.42	-0.16	2.05*	*ad*
0.45**	7.58**	-0.83**	0.93	-15.17*	*dd*
Cross 3 (1x4)					
88.14	14.80	10.00	1.02	66.13*	*m*
-2.63	-1.35	0.17	0.01	1.00	*a*
7.17**	3.14**	0.67	-0.45	9.48**	*d*
8.28**	1.97**	-0.33	-0.25	3.33**	*aa*
-4.26	-0.42	1.33	-0.28	2.15*	*ad*
-2.76**	-8.42**	-2.00	1.08	-15.37**	*dd*
Cross 4 (1x5)					
89.50	15.72	9.83	1.06	66.00*	*m*
1.69	-1.28	-0.50	-0.01	2.37**	*a*
7.47**	0.22**	-6.33	-0.33	-1.57**	*d*
7.93**	-3.23*	-7.67	-0.19	-7.67**	*aa*
-0.26	0.03	0.33	-0.32	6.07**	*ad*
-7.48**	4.17**	2.67**	0.81	17.27**	*dd*
Cross 5 (2x3)					
89.93	16.10	9.33	1.02	66.07	*m*
1.21*	0.30	0.00	-0.25	-4.43	*a*
2.92**	-11.84**	1.92*	0.30	3.75**	*d*
5.95**	-12.46**	1.33*	0.44	1.53	*aa*
1.72*	0.42	0.08	-0.21	-3.65	*ad*
-7.37**	19.62**	-1.17*	-0.93	-13.37**	*dd*

*, ** Significant and highly significant at the 0.05 and 0.01 level of probability, respectively. (*m, a, d, aa, ad* and *dd* = population mean, additive, dominant, additive x additive, additive x dominant and dominant x dominant gene action, respectively).

To be Contd.

Table (8) Cont'

Moisture content (%)	T.S.S (%)	Fruit netting degree	Fruit shape index	Fruit flesh thickness (%)	Gene action
Cross 6 (2x4)					
89.53	15.28	10.00	1.03	67.13	*m*
-1.35	2.55	2.00	0.15	1.50**	*a*
-7.81**	-3.13	-7.00	-0.21	-14.95**	*d*
9.97*	-4.96	-7.33	-0.28	-20.86**	*aa*
-1.95	2.39	2.33	0.11	1.72**	*ad*
-47.84**	9.18**	14.00*	0.61	32.30**	*dd*
Cross 7 (2x5)					
91.64	13.5	9.83	1.03	68.13*	*m*
2.00	0.98	0.17	-0.16	-5.40**	*a*
-3.00**	-1.73**	-0.76	-0.13	-11.23**	*d*
-2.97**	-0.76**	-1.00	-0.08	-15.20**	*aa*
-2.85	1.15	0.17	-0.22	-2.63**	*ad*
2.28**	0.63**	0.67*	-0.09	23.27**	*dd*
Cross 8 (3x4)					
90.54*	13.92	9.83	0.96	66.20	*m*
-0.15	0.02	-0.83	0.01	1.57**	*a*
-0.92**	8.45**	-1.34	-0.04	-12.10**	*d*
0.18**	7.03**	-3.00	-0.06	-12.46**	*aa*
-1.26	-0.30	0.82	-0.06	1.00**	*ad*
1.76**	-9.70**	3.35*	0.48	11.27**	*dd*
Cross 9 (3x5)					
90.14	15.62	9.00	1.06	61.20	*m*
1.62	0.12	-0.17	0.01	-1.33	*a*
-0.07**	-4.34*	4.25	-0.27	20.95**	*d*
-0.54**	-3.76*	3.66	0.26	16.13**	*aa*
0.21	0.16	-0.25	-0.09	0.65	*ad*
6.49**	2.42	-4.50	0.36	-6.83	*dd*
Cross 10 (4x5)					
91.53	14.60	9.83	1.15	62.07*	*m*
2.22	-0.90	1.00	0.13	-0.40**	*a*
0.90**	1.64*	-2.50	-0.47	1.78**	*d*
-1.21**	0.47*	-2.67	-0.45	7.07**	*aa*
1.90	-0.58	0.67	0.10	2.15**	*ad*
1.32**	0.38**	5.00**	0.06	-8.63**	*dd*

*, ** Significant and highly significant at the 0.05 and 0.01 level of probability, respectively (*m, a, d, aa, ad* and *dd* = population mean, additive, dominant, additive x additive, additive x dominant and dominant x dominant gene action, respectively).

Correlation coefficient and path analysis

Correlation coefficient values are presented in Table (9). Values of the correlation coefficient were positive and significant or highly significant among the following characters: plant length with each of average fruit weight / plant and total yield / plant. Flowering date with maturity (days). Maturity (days) with the netting degree. Average fruit number with each of total yield /plant and netting degree. Average fruit weight with each of total yield / plant, fruit shape index. Total yield / plant with each of netting degree, TSS. TSS with moisture

content. Negative and significant or highly significant correlation values were found among maturity date with of No. of branches per plant.

Table (9): Correlation coefficient values (r) for each pair of characters of the studied traits of sweet melon (over the two years of 2013 and 2014)

TSS	N	FSH I	FTH%	TY/P	AFW/P	AFN/P	MD	FD	NB	PL	**Traits**
										0.10	NB
									-0.67*	0.40	FD
								0.66*	-0.68*	0.35	MD
							0.07	0.20	0.04	0.17	AFN/P
						-0.21	-0.02	0.09	0.06	0.60*	AFW/P
					0.60*	0.62*	0.14	0.28	-0.09	0.56*	TY/P
				0.05	-0.19	0.30	-0.11	-0.31	0.05	-0.05	FTH%
			0.19	0.29	0.81**	-0.34	-0.24	-0.31	0.37	0.46	F SH I
		-0.10	0.24	0.66*	0.18	0.59*	0.64*	0.43	-0.39	0.43	N
	0.21	0.29	-0.32	0.53*	0.54	0.12	0.06	0.18	-0.10	0.09	TSS
-0.10	0.11	0.01	-0.11	0.32	0.12	0.38	-0.38	-0.19	0.49	0.06	MC%

*, ** Significant at 5% and 1% levels of probability, respectively.

PL = plant height N = Branches number. FD = Flowering (days).
MD = Maturity (days). AFN = Average fruit number. AFW = Average fruit weight
TY = Total yield / plant FTH% = Flesh thickness. N = Netting degree.
FSH I = Fruit shape index. TSS%=Total soluble solids MC = Moisture content%

It could be concluded from results, listed in Table (9), that the characters plant length, number branches / plant and average fruit weight were good determinates of total yield / plant. These results suggesting that selection should be practiced for high yield production based on the plants which recorded highest values respecting to these three characters. Similar trend, more or less, of these results were found by Ibrahim and Ramadan (2013) who found highly significant positive correlation among total yield / plant with each of plant length and average fruit weight. The results of Wahba (2004) on some local cultivars and hybrids of sweet melon showed a positive correlation between flesh thickness and fruit diameter and among fruit weight and each of fruit length, fruit diameter and seed cavity diameter. The negative association was detected between flesh thickness and seed cavity / fruit diameter.

The Direct and indirect effects of average fruit number, average fruit weight (kg), plant length (cm), branches number and fruit shape index on total yield / plant (kg) were tabulated in Table (10). It could be noted from the data of path coefficient analysis that the direct effect was positive and highly in magnitude for fruit number per plant, plant length and fruit shape index. So, selection for these characters may be effective in improving the total yield per plant (kg). The Indirect effect was highly positive for the average fruit weight through its relation with fruit flesh thickness (0.5761), So, selection for high fruit flesh thickness may be effective in improving total yield through its relation with average fruit weight. Similar results were found by Feyzian *et al*. (2009) and Abou kamer (2011) on melon, they found direct positive effect for average fruit

number on total yield / plant and indirect positive effect for branches number through its relation with average fruit number / plant on total yield.

Table (10): Direct and indirect effects of some characters (Average No. of fruit per plant, average fruit weight per plant, plant length, No. of branches per plant and fruit flesh thickness) on total yield per plant

Total effect	FTH	BN	PL	FW	FN	traits
0.6200	-0.2418	-0.0082	0.1000	0.0341	0.7359	FN
0.6000	0.5761	-0.0122	0.3529	-0.1622	-0.1545	FW
0.5600	-0.0356	-0.0204	0.5882	-0.0973	0.1251	PL
0.0900	0.0356	-0.2041	0.0588	-0.0097	0.0294	BN
0.2900	0.7112	-0.0102	-0.294	-0.1314	-0.2502	FTH

R.E= 0.2950405

AFN = Average fruit number.
AFW = Average fruit weight (kg).
PL = plant height.
BN = Branches number.
FTH% = Flesh thickness.

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الملخص العربي

توريث بعض الصفات الهامة لتحسين جودة ثمار الشمام

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أجريت هذه الدراسة خلال ثلاثة أعوام متتالية ٢٠١٢، ٢٠١٣ و٢٠١٤ ، حيث تم تنفيذ التجربة في محطة بحوث البساتين–الصبحية –الإسكندرية بالإضافة لمنطقة فوه – محافظة كفر الشيخ– جمهورية مصر العربية، لدراسة نوع الفعل الجيني و معامل الارتباط بين أزواج الصفات المدروسة ومعامل المرور .

أجريت كل التهجينات الممكنة بين خمسة سلالات من الشمام في أتجاه واحد، أظهرت صفات طول النبات وعدد الفروع لكل نبات ،ميعاد الإزهار و ميعاد النضج و سمك اللحم تأثراً معنوياً تجاه الفعل الجيني المضيف ، مما يوضح أهمية الفعل الجيني المضيف في وراثة هذه الصفات. أظهرت صفات درجة الشبكية ، دليل شكل الثمرة ، نسبة المواد الصلبة الذائبة الكلية و المحتوي الرطوبي عدم وجود معنوية تجاه الفعل الجيني المضيف. وكان الفعل الجيني السيادي معنوياً لصفات طول النبات ، عدد الفروع لكل نبات ، ميعاد النضج، درجة الشبكية ، نسبة المواد الصلبة الذائبة الكلية و المحتوي الرطوبي مما يوضح أهمية الفعل الجيني السيادي في وراثة هذه الصفات . أظهرت صفة المحصول الكلي لكل نبات أرتباطاً مظهرياً مع صفات طول النبات، عدد الثمار لكل نبات ومتوسط وزن الثمرة لكل نبات وبالتالي يجب الاهتمام بهذه العلاقات في برامج تحسين الشمام من خلال الانتخاب. أظهرت النتائج إمكانية الانتخاب لصفة المحصول الثمرى للنبات مباشرة من خلا الانتخاب لصفة متوسط وزن الثمرة ، وأيضا يمكن الانتخاب لصفة المحصول الثمرى بطريقة غير مباشرة من خلال الانتخاب لصفة سمك لحم الثمرة والتي بدورها تؤثر على صفة متوسط وزن الثمرة والتي بدورها تؤثر على صفة المحصول الثمرى.

Combining Ability of wheat yield and Some yield Attributes Under Normal and Water Stress Conditions

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ABSTRACT: A half diallel cross among six parents of wheat (*Triticum aestivum* L.) was achieved for combining ability under recommended irrigation and water stress at Etay EL-Baroud Agricultural Research Station, Agricultural Research Center, Egypt, during 2009/2010 and 2010/2011 seasons in RCBD with three replications. Data were recorded from F_1 generation for days to heading, days to physiological maturity, plant height, flag leaf area, spike length, number of spikelets spike^{-1}, number of kernels spike^{-1}, number of spikes plant^{-1}, 1000-kernel weight and grain yield plant^{-1}. Mean squares for genotypes, parents, crosses and parent vs. crosses were significant for all the studied traits in both irrigation treatments. General combining ability (GCA) and specific combining ability (SCA) mean squares were significant for all the studied traits in both irrigation treatments. High GCA/SCA ratios which largely exceeded the unity were detected for all studied traits, except for grain yieldplant^{-1} under the study in both conditions. Wheat genotype Line 1 (P_6) showed the maximum desirable GCA values for days to heading, days to physiological maturity, flag leaf area, spike length, under water stress, number of kernels spike^{-1}and 1000-kernel weight under both conditions. For shortness, the cultivar Sakha 93 (P_2) proved to be the best general combiner for plant height under both environments. Meanwhile, Sham 6 under normal conditions and Sahel 1 under water stress conditions were the best combiners for plant height concerning breeding for tallness. The cultivar Gemmeiza 9 proved to be a good general combiner for number of spikelets spike^{-1} under both conditions. The cultivar Misr 1 found to be the best general combiner for number of spikes plant^{-1} and grain yield plant^{-1} under normal condition, while the cultivar Sakha 93 found to be the best general combiner for number of spikes plant^{-1} and grain yield plant^{-1} under water stress condition. The cross (Sahel 1 x Sham 6) showed the maximum desirable SCA values for days to heading and days to physiological maturity under both water regime treatments. The cross (Misr 1 x Line 1) exhibited the maximum SCA for plant height under normal conditions, while (Sahel 1 x Gemmeiza 9) showed the maximum SCA for plant height under water stress condition. The cross (Sahel 1 x Misr 1) showed maximum SCA value for flag leaf area under both environments. The cross (Sham 6 x Line 1) was the best specific combiners for spike length under normal conditions, while (Sahel 1 x Sham 6) was the best for spike length under stress conditions. The best specific combiner for kernels spike^{-1} under both conditions was the cross (Misr 1 x Line 1). The cross (Sakha 93 x Misr 1) showed the best SCA for number of spikes plant^{-1} under normal conditions while the cross (Sakha 93 x Line 1) was the best one under water stress conditions. For 1000-kernel weight the cross (Gemmeiza 9 x Misr 1) was the best specific combiner under both irrigation conditions. The cross (Sakha 93 x Line 1) exhibited the maximum SCA for grain yield plant^{-1} under normal conditions while the cross (Sakha 93 x Gemmeiza 9) was the best one under water stress conditions. The crosses (Sakha 93 x Gemmeiza 9), (Sakha 93 x Line 1) and (Misr 1 x Line 1) were prospective in wheat breeding programs since they expressed significant and desirable ($\hat{s}_{ij}$) effects for most traits.

Keywords: Bread wheat, General combining ability (GCA), Specific combining ability (SCA), Normal irrigation, Water stress.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important cereal crop in Egypt as well as in most countries over the world. Egypt's strategy is to minimize the food gap of this crop particular throughout vertical improvement and horizontal expansion. Although the cultivated area is restricted, enormous activities in new land reclamation

and cultivation succeeded to add more land for food production. But, the limited water resources put limitations. Moreover, drought is a worldwide issue that impacts seriously on the security of food production and the global climate change makes this even worse (Elisabeth *et al.,* 2009). Therefore, breeding and correct cultivation of cultivars having high yield potentialities are the main way to produce wheat crop to fill the gap between production and increased population.

Breeders should concentrate on development of productive wheat varieties by crossing good general combining lines for grain yield and selecting transgressive segregates from the resulting hybrids. Information regarding general and specific combining ability of wheat genotypes is a prerequisite to launch a successful wheat breeding program. Diallel mating design has been extensively used to analyze the combining ability effects of wheat genotypes and also to provide information regarding genetic mechanisms controlling grain yield and other traits.

Significant differences due to GCA and SCA were observed for the studied traits (Pang *et al*., 2010). Saeed *et al.* (2010) observed significant differences among genotypic mean in all of the traits under both conditions, they reported that; GCA and SCA differences were significant for all the traits under study except spike density and 100-grain weight in both conditions. Khan *et al.* (2007) found that, the additive gene effects were operating in plant height, biomass plant^{-1}, number of grains spike^{-1} and grain yield plant^{-1}, while number of tillers plant^{-1} and 1000-grain weight were controlled by non-additive gene effects. Golparvar (2013) found that GCA to SCA mean square ratio was significant for non of traits, indicating that non additive effects of genes were more important than additive effect for all studied traits.

The objectives of the present investigation were to assess the variations among wheat genotypes and available crosses for water stress tolerance characteristics, find out the good general combining genotypes for sound breeding program and to select high yielding combiners for the development of productive wheat varieties and mark crosses with better specific combining ability for yield related traits by employing diallel cross technique and to determine suitable measurements for drought resistance in wheat genotypes.

MATERIALS AND METHODS

The present investigation was carried out at Etay EL-Baroud Agricultural Research Station, Agricultural Research Center, Egypt, during the successive wheat-growing seasons, 2009/2010 and 2010/2011. Six common wheat genotypes (*Triticum aestivum* L. em Thell) representing a wide divergent were selected to establish the experimental materials for this study. The names, pedigree and origin of these varieties and/or lines are presented in Table (1).

Table (1): Code number, names, pedigree and origin of six parents of bread wheat

No.	Name	Pedigree	Origin
P1	Sahel 1	NS.732/PIMA/VEERY"S" SD735-4SD-1SD-1SD-0SD	Egypt
P2	Sakha 93	Sakha 92 / TR 810328 S8871-1S-2S-1S- 0S	Egypt
P3	Gemmeiza 9	Ald "S"/ Huac// Cmh74A .630/ Sx CGM4583 -5GM-1GM- 0GM	Egypt
P4	Misr 1	OASIS/SKAUZ//4*BCN/3/2*PASTOR CMSS00Y01881T-050M-030Y-030M- 030WGY-33M-0Y-0S.	Egypt
P5	Sham 6	W-3918-A/JUPATECO-73 CM-39992-8M-7Y-0M-0AP-0SYR	Syria
P6	Line# 1	KAUZ/PASTOR CMSSB0025S-48Y-010M-010Y-010M-9Y-0M	CIMMYT

In 2009/2010 season, grains for each of the parental genotypes were sown at various dates at 7 days interval for 4 weeks to provide synchronized flowering among the genotypes. All possible cross combinations excluding reciprocals were made among the six genotypes to produce their fifteen F_1 crosses. Hybridization was made by hand for enough number of spikes on main stems of each parent after 2-5 days from hand emasculation according to weather conditions.

In 2010/2011 wheat growing season, the six parents and their fifteen F_1 hybrid seeds were sown on 1st of December in two experiments. The twenty one (21) entries were evaluated in two separate irrigation regime experiments. The first experiment was given one surface-irrigation 29 days after the establishment one at the tillering stage (water stress conditions, S). The second experiment was irrigated four times after sowing irrigation (normal conditions, N). In each experiment, the genotypes were grown in a randomized complete block design (RCBD) with three replicates. Each replicate consisted of 36 rows, 3 m long and 30 cm apart with 20 cm between plants. Sixteen grains were sown in each row and manually drilled in the rows. Each experiment was surrounded by a wide border (12m) to minimize the underground water permeability. All other cultural practices, except irrigation, were applied as recommended for wheat cultivation. The two outside rows of the two external rows in each plot were discarded to eliminate the border effect.

Ten guarded plants for each parent and cross were tagged at random from each replication and data were recorded on heading date, maturity date, plant height, flag leaf area, spike length, number of spikelets per spike, number of spikes per plant number of the kernels for the highest spike, 1000 kernel weight and grain yield per

plant. Monthly average temperature and amount of rainfall and mechanical and chemical analysis of experimental soil are shown in Tables (2) and (3).

Table (2): Meteorological data at Etay EL-Baroud location during 2010/11 growing season

Month	Air temperature (C°)				RH %	Rain fall (mm)	Mean soil temperature (C°)		
	Mean		Extreme				5 cm depth	10 cm depth	20cm depth
	Max.	Min.	Max.	Min.					
Oct.	31	20.2	33	17	52.32	0	23.61	23.35	24.27
Nov.	27.8	16.9	30	14	53.77	0	21.55	21.52	21.58
Dec.	21.9	11.1	25	9	54.1	12	15.08	16.13	19.1
Jan.	19.55	9.74	21	8	53.84	10	13.92	14.05	19.24
Feb.	19.07	9.5	21	8	53.1	8	14.09	14.02	18.88
Mar.	20.64	10.4	23	9	52.19	6	15.13	15.34	20.35
Apr.	23.07	12.2	30	10	51.03	3	17.78	17.87	22.22
May	25.42	13.5	29	12	49.6	0	19.13	19.34	22.4

Table (3): Mechanical and chemical analysis of experimental soil in 2010/11 season at Etay EL-Baroud Research Station

Mechanical analysis	
Clay %	52.6
Silt %	26
Sand %	21.4
Textural class	Clay
Chemical analysis	
Available N mg/kg	58.6
Available P mg/kg	7.8
Available K mg/kg	214

The recorded data were subjected to the analysis of variance technique following Steel *et al.* (1997) to determine the significant differences among crosses and parents. General and specific combining ability estimates were estimated according to Griffing (1956) diallel cross analysis designated as method 2 model 1 for each experiment where genotypic differences were found significant.

REASULTES AND DISCUSSION

Analysis of variance and mean performance

Analysis of variance for all studied traits for each of normal and stress environments are presented in Table (4).

Mean squares for genotypes, parents, crosses and parents vs. crosses were found to be significant for the ten measurements in both irrigation treatments indicating wide diversity between the parental genotypes used in the present study for these traits. Significant variations among genotypes for grain yield and related traits in different varieties of wheat were also reported by Ahmadi *et al.* (2003); Joshi *et al.* (2004); Hakim *et al.* (2007); Mohammadi *et al.* (2007); Seboka *et al.* (2009) and Saeed *et al.* (2010).

The mean performances of six wheat parental genotypes and their F1 at normal and stress irrigation conditions are presented in Table (5). The water stress treatment decreased the mean of days to heading and days to physiological maturity for parents and their hybrids. Line 1 (P_6) followed by Sakha 93 (P_2) were the earliest under the two irrigation conditions, while the parental genotype Sham 6 (P_5) was the latest one. The two crosses (P_2 x P_6) and (P_1 x P_6) were the earliest in days to heading under both irrigation conditions. Meanwhile, the latest ones were the cross (P_1 x P_3) under normal conditions, (P_3 x P_4) and (P_3 x P_5) under stress conditions. These results indicated that the parental genotype Line 1 (P_6) possessed gene (s) controlling earliness of days to heading, while parental genotypes Sham 6 (P_5) and Gemmeiza 9 (P_3) have gene (s) for lateness.

Regarding days to physiological maturity, among parents, the earliest in maturity were Line 1 (P_6) and Misr 1 (P_4) under both irrigation conditions, while Sham 6 (P_5) was the latest one for this trait under the two irrigation conditions. Concerning crosses, three crosses (P_4 x P_6), (P_1 x P_6) and (P_1 x P_4) showed the lowest values (desirable) under both irrigation conditions.

For plant height, Sham 6 (P_5) was the tallest stature followed by Sahel 1 (P_1) and Gemmeiza 9 (P_3). However, Sakha 93 (P_2) was the shortest under the two irrigation conditions. Regarding crosses, two crosses (P_1 x P_2) and (P_2 x P_4) had the shortest plants under both irrigation conditions. However, crosses (P_3 x P_5), (P_5 x P_6) and (P_3 x P_6) had the highest mean values under normal irrigation meanwhile, crosses (P_1 x P_3), (P_1 x P_5), (P_1 x P_6) and (P_3 x P_6) showed the same performance under stress conditions. The reduction in plant height of stressed plants may be due to the reduction in internodes length and/or due to the reduction in moisture absorption, nutrient uptake and photosynthesis under drought stress condition.

The parents and crosses stressed for water had mean value of flag leaf area lower than plants under normal condition. For the parents, Line 1 (P_6) and Sham 6 (P_5) were the highest for flag leaf area under both irrigation conditions. Concerning crosses, the three crosses (P_5 x P_6), (P_4 x P_6) and (P_3 x P_5) had the highest value under normal conditions, meanwhile crosses (P_4 x P_6) and (P_5 x P_6) were the highest under water stress conditions. Cross (P_3 x P_4) had the lowest value of flag leaf area under both irrigation conditions.

Table (4): Mean squares for the studied traits under each of normal (N) and water stress (S) conditions

		Days to heading		Days to physiological maturity		Plant height		Flag leaf area		Spike length	
S.O.V.	d.f	N	S	N	S	N	S	N	S	N	S
Rep.	2	1. 63	1.02	0.49	0.91	2.44	1.62	0.46	2.11	0.85	0.74
Genotypes	20	58.74**	43.76**	24.85**	35.71**	151.45**	107.26**	403.12**	409.31**	7.70**	5.89**
Parents	5	148.46**	113.07**	58.23**	49.96**	271.73**	146.97**	760.44**	836.91**	13.57**	13.73**
Crosses	14	20.63**	12.60**	13.99**	31.75**	100.14**	76.10**	293.40**	213.46**	5.86**	3.32**
P vs. C	1	143.81**	133.49**	9.91**	19.91**	268.51**	344.90**	152.57**	1013.33**	4.20**	2.65**
Error	40	0.68	0.73	0.33	1.03	3.08	2.23	1.21	3.17	1.22	1.12

** indicate significance at 0.01 levels of probability.

Table (4): Cont.…

		Number of spikelets/spike		Number of kernels/spike		Number of spikes/ plant		1000-kernel weight		Grain yield/plant	
S.O.V.	d.f	N	S	N	S	N	S	N	S	N	S
Rep.	2	0.15	0.26	1.84	4.06	0.83	0.89	0.9	0.68	4.09	3.37
Genotypes	20	3.17**	2.84**	516.37**	502.77**	49.13**	30.47**	59.34**	90.36**	226.65**	142.01**
Parents	5	6.28**	4.24**	731.68**	631.59**	69.18**	35.08**	97.01**	128.94**	254.12**	14.52
Crosses	14	2.19**	2.46**	467.92**	485.97**	37.82**	28.23**	28.22**	63.08**	62.23**	127.01**
P vs. C	1	1.33**	1.18*	118.27**	93.92**	107.13**	38.90**	306.67**	279.36**	2391.17**	989.48**
Error	40	0.39	0.48	3.74	5.45	1.29	1.27	1.03	0.45	10.02	10.5

* and ** indicate significance at 0.05 and 0.01 levels of probability, respectively.

Regarding spike length, Line 1 (P_6) had the tallest spike under the two irrigation conditions. Cross (P_5 x P_6) had the tallest spike under normal conditions followed by four crosses i.e. (P_3 x P_6), P_4 x P_6), (P_2 x P_6) and (P_2 x P_3). Meanwhile crosses (P_4 x P_6), (P_2 x P_6), (P_3 x P_6) and (P_1 x P_6), respectively had the tallest spike under stress conditions, cross (P_3 x P_4) showed the lowest value for this trait under both conditions.

For number of spikelets per spike, Gemmeiza 9 (P_3) followed by Sahel 1 (P_1) and Line 1 (P_6) were the highest among parents under both irrigation conditions. Crosses (P_1 x P_3) and (P_3 x P_6) had the highest number of spikelets per spike under normal conditions. On the other hand, crosses (P_1 x P_3), (P_1 x P_6), (P_2 x P_3), (P_3 x P_5) and (P_3 x P_6) exhibited the highest one under stress conditions.

Concerning number of grains per spike, Line 1 (P_6) ranked the first under both irrigation conditions; the two crosses (P_1 x P_6 & P_4 x P_6) ranked the first and the second respectively, under both irrigation conditions followed by (P_5 x P_6) and (P_2 x P_6) under normal conditions. The high number of grains per spike in these crosses cold be attributed to superiority of the parent Line 1 (P_6) in this trait. It is clear from the data that water stress treatment decreased the mean of number of grains per spike for parents and their hybrids. This reduction may be due to the effect of water deficit on pollination and fertilization processes, which lead to decreasing number of grains per spike.

Concerning number of spikes per plant, the two parents Shame 6 (P_5) and Misr 1 (P_4) owned the highest number under both irrigation conditions. Meanwhile, the parent Line 1 (P_6) owned the fewest number of spikes per plant. Under normal conditions cross (P_2 x P_4) owned the highest number followed by cross (P_1 x P_2).

For 1000-kernel weight, the parental genotype Line 1 (P_6) was the superior parent under both irrigation conditions. All the five crosses that contain the parent Line 1 (P_6) in addition to the two crosses (P_3 x P_4 and P_2 x P_4) exhibited the highest values for this trait under normal conditions, cross (P_3 x P_6) ranked the first under both conditions. It's clear that the parental genotype Line 1 (P_6) possess gene (s) controlling high kernel weight. The high 1000-kernel weight in this parent could be attributed to its high flag leaf area.

Concerning grain yield per plant, the parent Misr 1 (P_4) showed the highest value of grain yield per plant under normal conditions. Meanwhile, the parent Sham 6 (P_5) had the highest value of grain yield per plant under stress conditions. Under normal conditions crosses (P_1 x P_3) and (P_3 x P_6) ranked first and second respectively, followed by the two crosses (P_2 x P_3) and (P_2 x P_6) under both irrigation conditions.

Table (5): The genotypes mean performance for the studied characters under normal (N) and water stress (S) conditions

Genotypes	Days to heading (days)		Days to physiological maturity (days)		Plant height (cm)		Flag leaf area (cm^2)		Spike length (cm)	
	N	S	N	S	N	S	N	S	N	S
Sahel 1 (P_1)	102.00	95.33	152.33	140.00	107.10	97.58	59.97	48.20	13.43	12.42
Sakha 93 (P_2)	93.00	90.67	151.33	143.67	84.42	79.58	68.15	62.53	13.67	12.94
Gemmeiza 9 (P_3)	104.33	99.00	151.33	143.33	105.79	94.30	51.11	35.54	15.02	13.53
Misr 1 (P_4)	96.33	93.00	147.00	137.00	97.17	88.82	59.94	44.85	13.13	12.63
Sham 6 (P_5)	106.00	103.67	153.33	144.33	110.70	98.67	88.05	62.13	15.15	14.50
Line 1 (P_6)	88.00	86.33	141.67	134.33	97.73	91.89	89.53	82.67	18.87	18.11
1 x 2	93.67	90.00	151.67	142.67	94.30	89.43	70.32	68.67	14.69	13.86
1 x 3	100.67	93.33	149.67	141.33	106.88	105.08	56.05	54.55	15.02	13.92
1 x 4	95.67	89.67	147.33	135.67	103.11	96.00	76.60	67.70	14.50	13.80
1 x 5	95.00	89.00	148.67	137.67	104.90	103.00	72.64	72.19	14.65	14.82
1 x 6	92.67	88.67	146.00	135.00	106.20	102.36	71.99	51.95	16.40	15.56
2 x 3	93.00	91.67	149.67	144.33	100.00	93.00	69.80	67.50	14.50	14.03
2 x 4	93.67	91.67	150.67	137.33	97.00	88.10	71.91	60.30	13.59	13.11
2 x 5	95.67	91.67	150.33	144.00	100.00	94.35	76.12	67.78	14.80	14.15
2 x 6	90.33	88.33	146.67	142.00	100.35	94.23	79.00	71.79	16.89	16.10
3 x 4	97.67	94.67	148.33	139.00	107.87	93.00	56.66	47.00	13.97	12.90
3 x 5	97.67	94.67	152.33	140.33	113.23	98.40	81.05	63.15	15.50	13.85
3 x 6	95.67	93.33	147.33	137.67	111.30	102.30	66.23	64.60	17.41	15.85
4 x 5	97.00	92.67	149.33	137.33	109.58	99.25	66.74	64.31	14.57	14.10
4 x 6	92.33	90.67	145.00	133.67	108.30	99.39	83.73	77.00	17.00	16.27
5 x 6	93.33	91.67	146.33	140.00	112.82	96.90	94.72	74.50	18.29	14.85
Mean of parents	98.28	94.67	149.50	140.44	100.49	91.81	69.46	55.99	14.88	14.02
Mean of crosses	94.93	91.44	148.62	139.20	105.06	96.99	72.90	64.87	15.45	14.48
Mean of genotypes	95.89	92.37	148.87	139.56	103.75	95.51	71.92	62.33	15.29	14.35
L.S.D. at 5%	1.36	1.41	0.94	1.67	2.90	2.46	1.81	2.94	0.56	0.57
L.S.D. at 1%	1.82	1.89	1.26	2.24	3.88	3.29	2.43	3.93	0.75	0.77

Table (5): Cont….

Genotypes	Number of spikelets/spike		Number of kernels/spike		Number of spikes/plant		1000-kernel weight (g)		Grain yield/plant (g)	
	N	S	N	S	N	S	N	S	N	S
Sahel 1 (P_1)	26.31	24.21	95.67	89.67	12.92	10.42	40.48	37.22	38.89	32.09
Sakha 93 (P_2)	24.48	23.70	80.44	75.80	13.78	11.77	43.93	37.37	37.77	34.50
Gemmeiza 9 (P_3)	28.00	26.36	95.29	81.18	13.31	9.33	45.63	43.35	48.02	30.85
Misr 1 (P_4)	24.20	22.97	85.83	79.22	17.14	13.10	43.80	38.97	58.77	33.05
Sham 6 (P_5)	24.80	24.31	84.29	78.00	17.75	13.33	46.67	39.37	48.00	36.22
Line 1 (P_6)	26.22	25.21	123.50	114.33	4.33	4.11	57.04	54.37	33.58	30.50
1 x 2	26.24	24.90	89.42	83.91	20.30	14.95	47.75	39.80	56.50	45.40
1 x 3	27.87	25.94	92.38	81.80	17.00	13.75	49.15	45.25	65.00	41.00
1 x 4	24.96	24.35	85.98	78.00	17.68	15.35	48.85	45.10	57.35	49.14
1 x 5	24.93	24.22	82.07	86.21	17.75	15.35	47.35	42.50	57.53	46.09
1 x 6	26.70	25.92	117.50	113.67	10.33	8.01	51.40	49.30	59.70	46.67
2 x 3	26.30	25.81	90.37	80.00	17.67	15.33	49.65	46.25	61.73	50.10
2 x 4	24.93	22.90	77.03	67.67	23.50	13.68	51.05	41.35	57.26	42.73
2 x 5	25.03	24.22	78.18	73.16	16.00	12.75	49.45	41.70	45.25	39.00
2 x 6	26.38	25.04	99.56	90.00	13.52	12.10	56.50	49.25	60.00	49.47
3 x 4	25.87	24.50	80.34	69.69	15.55	13.76	53.80	51.59	52.00	37.90
3 x 5	26.11	25.56	89.62	77.00	17.62	10.48	50.85	42.62	59.53	33.50
3 x 6	27.14	25.50	89.50	85.72	13.50	7.45	58.35	56.40	62.07	31.00
4 x 5	25.54	23.40	77.57	73.56	17.73	13.21	49.50	45.40	57.95	38.09
4 x 6	26.13	24.89	110.97	107.00	10.30	7.65	52.05	50.40	57.75	44.00
5 x 6	25.70	24.30	106.56	87.57	12.94	7.45	51.45	49.60	57.50	30.50
Mean of parents	25.67	24.46	94.17	86.37	13.21	10.35	46.26	41.77	44.17	32.87
Mean of crosses	25.99	24.76	91.14	83.66	16.09	12.08	51.14	46.43	57.81	41.64
Mean of genotypes	25.90	24.68	92.00	84.44	15.27	11.59	49.75	45.10	53.91	39.13
L.S.D. at 5%	1.87	1.86	3.19	3.85	1.87	1.86	1.67	1.11	5.22	5.35
L.S.D. at 1%	2.51	2.48	4.27	5.15	2.51	2.48	2.24	1.49	6.99	7.15

Combining ability

Analysis of variance for combining ability in normal and stress conditions is presented in Table (6).Mean squares associated with general combining ability (GCA) and specific combing ability (SCA) were found to be significant for all studied measurements in both irrigation conditions. It is evident that additive type of gene action was more important part of the total genetic variability for these traits in both normal and stress irrigation conditions. High GCA/SCA ratios which largely exceeded the unity were detected for all traits, except for grain yield/plant under the study in both irrigation treatments, such results indicated the predominance of additive and additive x additive types of gene action in the inheritance of such traits. These results are in agreement with those found by Abd Elnour (2005). Significant differences due to general combining ability and specific combining ability were observed for the studied traits (Pang *et al.*, 2010).

General combining ability effects:

General combining ability effects ($\hat{g}_i$) for individual parental line and/or cultivar for all studied measurements at normal and stress irrigation conditions are presented in Table (7). Such results are being used to compare the average performance of each parent with other genotype and facilitate selection of parents for further improvement to drought resistance. High positive values would be of interest for all measurements in question except days to heading and days to physiological maturity where high negative effects would be useful from the breeder point of view.

The two parental genotypes Misr 1 (P_4) and Line 1 (P_6) expressed significant negative ($\hat{g}_i$) effects for days to heading and days to physiological maturity under both normal and stress conditions, indicating that both parental genotypes could be considered as a good combiners for developing early genotypes.

For plant height, under the two irrigation conditions significant negative ($\hat{g}_i$) effects were detected for Sakha 93 (P_2) and Misr 1 (P_4) respectively, revealing the possibility of utilizing these parents to release short stature varieties. On the other hand, considerable significant or highly significant positive values were detected for the other parents under the two irrigation conditions, except Sahel 1 (P_1) at normal irrigation conditions, showing that these genotypes are suitable in breeding programs towards releasing varieties for higher plant height under the previous conditions. Yet releasing cultivars with short plants may be of special interest for such purpose.

Regarding flag leaf area, highly significant positive GCA effects were detected by Sham 6 (P_5) and Line 1 (P_6) at both conditions and Sakha 93 (P_2) under normal condition for showing that these parents appeared to be good combiners for this trait at the previous conditions. The other four parents gave significant negative or in significant ($\hat{g}_i$) effects for this trait.

Table (6): Mean squares of general and specific combining ability from diallel cross analysis for all studied traits under normal (N) and water stress (S) conditions

S.O.V.	d.f	Days to heading		Days to physiological maturity		Plant height		Flag leaf area		Spike length	
		N	S	N	S	N	S	N	S	N	S
Geno.	20	58.74**	43.76**	24.85**	35.71**	151.45**	107.26**	403.12**	409.31**	7.70**	5.89**
GCA	5	57.30**	35.09**	28.26**	38.05**	157.94**	98.49**	408.46**	311.65**	9.56**	6.63**
SCA	15	7.01**	7.75**	1.62**	3.19**	14.67**	14.84**	43.01**	78.03**	0.24**	0.41**
GCA/SCS		8.17	4.53	17.4	11.93	10.77	6.64	9.5	3.99	40.51	16.19
Error term	40	0.23	0.24	0.11	0.34	1.03	0.74	0.4	1.06	0.04	0.04

Table (6): Cont….

S.O.V.	d.f	Number of spikelets/spike		Number of kernels/spike		Number of spikes/plant		1000-kernel weight		Grain yield/plant	
		N	S	N	S	N	S	N	S	N	S
Geno.	20	3.17**	2.84**	516.37**	502.77**	49.13**	30.47**	59.34**	90.36**	226.65**	142.01**
GCA	5	3.48**	3.08**	555.08**	543.49**	45.47**	29.84**	47.84**	90.09**	37.75**	37.95**
SCA	15	0.25**	0.24**	44.47**	42.29**	6.68**	3.60**	10.43**	10.13**	88.15**	50.46**
GCA/SCA		13.93	12.96	12.48	12.85	6.81	8.3	4.59	8.89	0.43	0.75
Error term	40	0.03	0.06	1.25	1.82	0.43	0.42	0.34	0.15	3.34	3.5

** indicate significance at 0.01 levels of probability.
GCA refers to general combining ability.
SCA refers to specific combining ability.

Concerning spike length, only two parents i.e. Sham 6 (P_5) and Line 1 (P_6) exhibited highly significant and significant positive ($\hat{g}_i$) effects under normal irrigation conditions only. Meanwhile, the other parents gave highly significant negative or in significant ($\hat{g}_i$) effects for this trait.

For number of spikelets/spike, under both normal and water stress conditions, the parental genotypes Gemmeiza 9 (P_3) and Line 1 (P_6) gave the desirable ($\hat{g}_i$) effects. Meanwhile, the parent Sahel 1 (P_1) showed the same result under normal irrigation condition only. The other parental genotypes gave undesirable ($\hat{g}_i$) effect under both irrigation conditions for this trait.

Regarding number of grains/spike, the parental Line 1 (P_6) was the best combiner of number of grains/spike, it gave the highest significant positive ($\hat{g}_i$) effects under the two irrigation conditions followed by the parental genotype Sahel 1 (P_1). Therefore, they could be considered as the best combiners for this trait.

Regarding number of spikes/plant, the parental Sakha 93 (P_2), Misr 1 (P_4) and Sham 6 (P_5) showed the desirable ($\hat{g}_i$) effects under normal conditions, in addition to the previous parents the parent Sahel 1 (P_1) showed the desirable ($\hat{g}_i$) effects under stress conditions. The parental Line 1 (P_6) was the inferior for this trait and appeared to be bad combiner for this trait at the previous conditions.

For 1000- kernel weight, two parental genotypes i.e. Gemmeiza 9 (P_3) and Line 1 (P_6) expressed highly significant positive ($\hat{g}_i$) effects under both irrigation conditions. However, Line 1 (P_6) was the superior one indicating that these genotypes could be considered as good combiners for this trait. While, Sahel 1 (P_1), Sakha 93 (P_2), Misr 1 (P_4) and Sham 6 (P_5) showed highly significant negative effects in both irrigation conditions, suggesting that these genotypes could not be considered as good combiners for developing this trait.

The estimates of GCA effects for grain yield per plant are highly significant and positive in Gemmeiza 9 (P_3) and Misr 1 (P_4) under normal irrigation conditions. It could be noticed that Sahel 1 (P_1) and Sakha 93 (P_2) indicted desirable ($\hat{g}_i$) under water stress conditions. Negative and significant estimates of GCA effects were obtained for Line 1 (P_6) under the two irrigation conditions. These results are partially in harmony with Sultan *et al.,* (2011) who pointed to the importance of additive gene effects in the inheritance of plant height and spikes number plant^{-1}, while, additive, dominance and epistasis were the important in the inheritance of grains number spike^{-1}, 100-grain weight and grain yield plant^{-1} at most cases under both normal and water stress conditions. Moreover, additive genetic variance played the greatest and the important role in the inheritance of plant height, spikes number plant^{-1} and grain

Table (7): Estimation of general combining ability (GCA) effects for studied parents under normal (N) and water stress (S) conditions

Traits	Days to heading		Days to physiological maturity		Plant height		Flag leaf area		Spike length	
Parents	N	S	N	S	N	S	N	S	N	S
P1 (Sahel 1)	1.31**	-0.65**	0.74**	-0.57**	0.42	2.81**	-4.49**	-3.11**	-0.61**	-0.46**
P2 (Sakha 93)	-2.36**	-1.49**	1.19**	2.60**	-8.22**	-6.28**	0.00	3.10**	-0.65**	-0.41**
P3 (Gemmeiza 9)	2.76**	2.39**	0.99**	1.56**	3.08**	1.48**	-8.93**	-8.55**	-0.07	-0.35**
P4 (Misr 1)	-0.28**	-0.15	-0.93**	-2.49**	-0.76*	-1.90**	-3.49**	-3.79**	-0.89**	-0.62**
P5 (Sham 6)	2.43**	2.56**	1.44**	1.39**	4.46**	2.59**	7.99**	3.73**	0.14*	0.04
P6 (Line 1)	-3.86**	-2.65**	-3.43**	-2.49**	1.02**	1.30**	8.91**	8.61**	2.09**	1.80**
LSD $(g_i)_{0.05}$	0.31	0.32	0.21	0.38	0.66	0.56	0.41	0.67	0.13	0.13
LSD $(g_i)_{0.01}$	0.42	0.43	0.29	0.51	0.88	0.75	0.55	0.9	0.17	0.17
LSD $(g_i\text{-}g_j)_{0.05}$	0.48	0.5	0.33	0.59	1.02	0.87	0.64	1.04	0.2	0.2
LSD $(g_i\text{-}g_j)_{0.01}$	0.64	0.67	0.45	0.79	1.37	1.16	0.86	1.39	0.26	0.27

Table (7): Cont….

Traits	Number of spikelets/spike		Number of kernels/spike		Number of spikes/plant		1000-kernel weight		Grain yield/plant	
Parents	N	S	N	S	N	S	N	S	N	S
P1 (Sahel 1)	0.26**	0.13	1.83**	3.98**	0.25	0.89**	-2.85**	-2.42**	-0.44	2.32**
P2 (Sakha 93)	-0.43**	-0.31**	-6.07**	-5.59**	1.46**	1.41**	-0.75**	-2.83**	-2.64**	2.72**
P3 (Gemmeiza 9)	1.00**	0.91**	-1.40**	-4.31**	0.13	-0.21	0.60**	1.64**	2.37**	-2.34**
P4 (Misr 1)	-0.68**	-0.85**	-5.06**	-4.59**	1.52**	1.09**	-0.67**	-0.49**	2.81**	0.5
P5 (Sham 6)	-0.55**	-0.30**	-5.18**	-4.69**	1.33**	0.60**	-0.79**	-1.90**	-0.45	-1.79**
P6 (Line 1)	0.40**	0.42**	15.88**	15.20**	-4.70**	-3.78**	4.45**	6.00**	-1.65**	-1.41*
LSD $(g_i)_{0.05}$	0.11	0.16	0.73	0.88	0.43	0.42	0.38	0.25	1.19	1.22
LSD $(g_i)_{0.01}$	0.15	0.22	0.97	1.18	0.57	0.57	0.51	0.34	1.6	1.63
LSD $(g_i\text{-}g_j)_{0.05}$	0.18	0.25	1.13	1.36	0.66	0.66	0.59	0.39	1.85	1.89
LSD $(g_i\text{-}g_j)_{0.01}$	0.24	0.33	1.51	1.82	0.89	0.88	0.79	0.53	2.47	2.53

* and ** indicate significance at 0.05 and 0.01 levels of probability, respectively.

yield plant^{-1} at most cases under both water conditions. On the other hand, dominance genetic variance was the greatest and the important in the inheritance of grains number spike^{-1} and 100-grain weight at most cases under both water conditions. Kulshreshtha and Singh (2011) indicated that both additive and non-additive gene action were found to be important in the inheritance of yield and yield attributes under normal as well as saline irrigation conditions. On the other hand, Iqbal and Khan (2006) found that general combining ability effects were significant for spike length, number of spikelets per spike, number of grains per spike, spike density and grain yield. They added that the specific combining ability (SCA) variances were greater than general combining ability (GCA) variances, which showed the predominance of non-additive gene effects.

Specific combining ability effects:

Specific combining ability effects ($\hat{s}_{ij}$) of the parental combinations computed for all the studied measurements under normal and stress irrigation conditions are shown in Table (8). Seven and six crosses exhibited significant and negative (SCA) effects for days to heading in normal and stress irrigation conditions, respectively. Such results indicate that cross (Sahel 1 x Sham 6) followed by cross (Gemmeiza 9 x Sham 6) could be considered as good crosses for developing line to early heading date.

Under normal irrigation conditions, six crosses exhibited negative and significant ($\hat{s}_{ij}$) effects for days to physiological maturity, two crosses out of them didn't gave significant negative ($\hat{s}_{ij}$) effects for days to heading. Five crosses exhibited significant ($\hat{s}_{ij}$) effects for days to physiological maturity under water stress conditions, also two crosses out of them didn't gave significant ($\hat{s}_{ij}$) effects for days to heading. Such results confirm the viewpoint that it is not necessary that the genotype that have early heading date, have early maturity date also. Hence, maturity date could be reliable as a selection criterion for earliness than heading date. Earliness if found in wheat is favorable for escaping injuries by stress conditions (especially drought) and for intensive production.

Concerning plant height, among fifteen crosses, four crosses viz. (Sakha 93 x Line 1), (Gemmeiza 9 x Line 1), (Misr 1 x Sham 6) and (Misr 1 x Line 1) showed significant positive ($\hat{s}_{ij}$) effects at stress and normal irrigation conditions. The cross Misr 1 x Line 1 followed by Gemmeiza 9 x Line 1 and Sakha 93 x Line 1 showed highest significant positive ($\hat{s}_{ij}$) under both irrigation conditions.

The most desirable ($\hat{s}_{ij}$) effects were recorded by the crosses (Sahel 1 x Misr1), (Sakha 93 x Gemmeiza 9), (Gemmeiza 9 x Sham 6) and (Misr 1 x Line 1) under both normal and stress irrigation conditions for flag leaf area showing that these crosses appeared to be the best crosses for this trait.

Table (8): Estimate of specific combining ability effects "$\hat{s}_{ij}$" for the studied fifteen crosses under normal (N) and Stress irrigation (S) treatments for the traits studied.

Crosses \ Traits	Days to heading		Days to physio. maturity		Plant height		Flag leaf area		Spike length	
	N	S	N	S	N	S	N	S	N	S
Sahel 1 x Sakha 93	-1.17**	-0.23	0.86**	1.08*	-1.65	-2.60**	2.89**	6.35**	0.66**	0.38*
Sahel 1 x Gemmeiza 9	0.71	-0.77	-0.93**	0.79	-0.36	5.29**	-2.45**	3.88**	0.41*	0.38*
Sahel 1 x Misr 1	-1.25**	-1.89**	-1.35**	-0.83	-0.30	-0.42	12.66**	12.26**	0.71**	0.53**
Sahel 1 x Sham 6	-4.63**	-5.27**	-2.39**	-2.71**	-3.73**	2.10**	-2.78**	9.23**	-0.16	0.88**
Sahel 1 x Line 1	-0.67	-0.39	-0.18	-1.50**	1.01	2.74**	-4.36**	-15.88**	-0.37*	-0.14
Sakha 93 x Gemmeiza 9	-3.29**	-1.60**	-1.39**	0.63	1.39	2.30**	6.81**	10.62**	-0.07	0.45*
Sakha 93 x Misr 1	0.42	0.94*	1.53**	-2.33**	2.23*	0.77	3.48**	-1.34	-0.16	-0.20
Sakha 93 x Sham 6	-0.29	-1.77**	-1.18**	0.46	0.01	2.54**	-3.79**	-1.38	0.03	0.17
Sakha 93 x Line 1	0.67	0.11	0.03	2.33**	3.80**	3.70**	-1.83**	-2.25*	0.16	0.36*
Gemmeiza 9 x Misr 1	-0.71	0.07	-0.60*	0.37	1.80	-2.09**	-2.84**	-2.99**	-0.36*	-0.47*
Gemmeiza 9 x Sham 6	-3.42**	-2.64**	1.03**	-2.17**	1.94*	-1.17	10.07**	5.64**	0.15	-0.19
Gemmeiza 9 x Line 1	0.88*	1.23**	0.90**	-0.96	3.45**	4.01**	-5.67**	2.21*	0.10	0.05
Misr 1 x Sham 6	-1.04*	-2.10**	-0.05	-1.13*	2.13*	3.05**	-9.68**	2.03*	0.03	0.33
Misr 1 x Line 1	0.58	1.11*	0.49	-0.92	4.28**	4.48**	6.39**	9.85**	0.51**	0.74**
Sham 6 x Line 1	-1.13*	-0.60	-0.55	1.54**	3.59**	-2.49**	5.90**	-0.17	0.78**	-1.34**
LSD(S_{ij})0.05	0.85	0.89	0.59	1.05	1.82	1.54	1.14	1.84	0.35	0.36
LSD(S_{ij})0.01	1.14	1.18	0.79	1.40	2.43	2.06	1.52	2.47	0.47	0.48
LSD(S_{ii})0.05	0.70	0.73	0.49	0.87	1.50	1.27	0.94	1.52	0.29	0.30
LSD(S_{ii})0.01	0.94	0.98	0.65	1.16	2.01	1.70	1.26	2.04	0.39	0.40
LSD(S_{ii}-S_{jj})0.05	0.96	1.00	0.67	1.18	2.05	1.74	1.28	2.08	0.40	0.40
LSD(S_{ii}-S_{jj})0.01	1.29	1.34	0.89	1.58	2.74	2.33	1.72	2.78	0.53	0.54
LSD(S_{ij}-S_{ik})0.05	1.27	1.32	0.88	1.56	2.71	2.30	1.70	2.75	0.52	0.53
LSD(S_{ij}-S_{ik})0.01	1.70	1.77	1.18	2.09	3.63	3.08	2.27	3.68	0.70	0.72
LSD(S_{ij}-S_{kl})0.05	1.18	1.22	0.82	1.45	2.51	2.13	1.57	2.55	0.48	0.50
LSD(S_{ij}-S_{kl})0.01	1.58	1.64	1.09	1.94	3.36	2.85	2.10	3.41	0.65	0.66

* and ** indicate significance at 0.05 and 0.01 levels of probability, respectively.

Table (8): Cont.…

Crosses \ Traits	Number of spikelets/spike		Number of kernels/spike		Number of spikes/plant		1000 kernel weight		Grain yield/plant	
	N	S	N	S	N	S	N	S	N	S
Sahel 1 x Sakha 93	0.52**	0.40	1.66	1.08	3.32**	1.06	1.59**	-0.06	5.67**	1.23
Sahel 1 x Gemmeiza 9	0.72**	0.22	-0.05	-2.31	1.34*	1.48*	1.64**	0.93**	9.15**	1.89
Sahel 1 x Misr 1	-0.51**	0.39	-2.80**	-5.83**	0.64	1.78**	2.62**	2.91**	1.07	7.19**
Sahel 1 x Sham 6	-0.68**	-0.28	-6.59**	2.48*	0.90	2.27**	1.24*	1.71**	4.51**	6.43**
Sahel 1 x Line 1	0.15	0.70**	7.78**	10.05**	-0.49	-0.69	0.05	0.62	7.88**	6.63**
Sakha 93 x Gemmeiza 9	-0.17	0.53*	5.84**	5.46**	0.81	2.55**	0.04	2.34**	8.08**	10.59**
Sakha 93 x Misr 1	0.14	-0.62**	-3.84**	-6.59**	5.25**	-0.40	2.72**	-0.43	3.18	0.37
Sakha 93 x Sham 6	0.11	0.15	-2.57*	-0.99	-2.06**	-0.84	1.24*	1.32**	-5.57**	-1.06
Sakha 93 x Line 1	0.51**	0.25	-2.25*	-4.04**	1.50*	2.89	3.05**	0.98**	10.38**	9.03**
Gemmeiza 9 x Misr 1	-0.35*	-0.24	-5.20**	-5.85**	-1.37*	1.29*	4.12**	5.34**	-7.09**	0.61
Gemmeiza 9 x Sham 6	-0.24	0.27	-4.20**	1.57	0.88	-1.50*	1.29*	-2.23**	3.70*	-1.50
Gemmeiza 9 x Line 1	-0.16	-0.50*	16.98**	-9.60**	2.80**	-0.15	3.55**	3.67**	7.43**	-4.38*
Misr 1 x Sham 6	0.87**	-0.13	-4.19**	-1.59	-0.39	-0.07	1.21*	2.69**	1.68	0.24
Misr 1 x Line 1	0.51**	0.64**	8.14**	11.95**	-1.79**	-1.25*	-1.47**	-0.21	2.68	5.78**
Sham 6 x Line 1	-0.05	-0.49*	3.85**	-7.37**	1.04	-0.96	-1.96**	0.40	5.69**	-5.43**
LSD(S_{ij})0.05	0.32	0.44	2.00	2.41	1.17	1.16	1.05	0.70	3.27	3.35
LSD(S_{ij})0.01	0.42	0.59	2.68	3.23	1.57	1.56	1.40	0.93	4.38	4.48
LSD(S_{ii})0.05	0.26	0.36	1.65	1.99	0.97	0.96	0.87	0.58	2.70	2.77
LSD(S_{ii})0.01	0.35	0.49	2.21	2.67	1.30	1.29	1.16	0.77	3.62	3.70
LSD(S_{ii}-S_{jj})0.05	0.36	0.50	2.26	2.72	1.33	1.31	1.18	0.79	3.69	3.78
LSD(S_{ii}-S_{jj})0.01	0.48	0.67	3.02	3.64	1.77	1.76	1.58	1.05	4.94	5.06
LSD(S_{ij}-S_{ik})0.05	0.47	0.66	2.99	3.60	1.75	1.74	1.57	1.04	4.89	5.00
LSD(S_{ij}-S_{ik})0.01	0.63	0.88	4.00	4.82	2.35	2.32	2.09	1.39	6.54	6.69
LSD(S_{ij}-S_{kl})0.05	0.44	0.61	2.77	3.34	1.62	1.61	1.45	0.96	4.52	4.63
LSD(S_{ij}-S_{kl})0.01	0.58	0.82	3.70	4.46	2.17	2.15	1.94	1.29	6.05	6.20

* and ** indicate significance at 0.05 and 0.01 levels of probability, respectively.

Four crosses i.e. (Sahel 1 x Sakha 93), (Sahel 1 x Gemmeiza 9). (Sahel 1 x Misr 1) and (Misr 1 x Line 1) had significantly positive ($\hat{s}_{ij}$) effects for spike length under normal and water stress conditions. The cross (Sahel 1 x Sham 6) expressed the highest ($\hat{s}_{ij}$) effects for spike length under water stress conditions.

Regarding number of spikelets/spike, five crosses out of the fifteen crosses exhibited significant desirable ($\hat{s}_{ij}$) effects under normal irrigation conditions. Meanwhile, three out of the fifteen crosses exhibited significant desirable ($\hat{s}_{ij}$) effects under stress conditions, only the cross (Misr 1 x Line 1) exhibited significant desirable ($\hat{s}_{ij}$) effects for this trait under both normal and stress irrigation conditions.

From the same Table (8), it could be noticed that the three crosses; (Sahel 1 x Line 1), (Sakha 93 x Gemmeiza 9) and (Misr 1 x Line 1) under normal and water stress conditions are considered to be promising hybrids for improving number of kernels/spike, as they showed highly significant positive ($\hat{s}_{ij}$) effects. The cross (Gemmeiza 9 x Line 1) was the worst cross for this trait under both irrigation conditions.

Regarding number of spikes/plant, four crosses exhibited significant positive ($\hat{s}_{ij}$) effects under normal irrigation conditions, the cross (Sakha 93 x Misr 1) had the highest ($\hat{s}_{ij}$) effect. Meanwhile, under water stress conditions five crosses exhibited significant positive ($\hat{s}_{ij}$) effects, the cross (Sahel 1 x Gemmeiza 9) was the only cross which expressed significant positive ($\hat{s}_{ij}$) effects for number of spikes/plant under both normal and water stress conditions.

Eight crosses exhibited significant positive ($\hat{s}_{ij}$) for 1000-kernel weight under both normal and water stress conditions. The crosses (Gemmeiza 9 x Misr 1) and (Gemmeiza 9 x Line 1) could be considered as the best crosses for this trait.

Concerning grain yield/plant, nine parental combinations showed significant positive ($\hat{s}_{ij}$) effects under normal irrigation conditions. Also six crosses showed desirable ($\hat{s}_{ij}$) effects under water stress conditions. The two crosses (Sakha 93 x Gemmeiza 9) and (Sakha 93 x Line 1) seemed to be the best combinations for this trait under both normal and stress conditions.

CONCLUSION

The results revealed that there was significant genotypic variation among the genotypes for the studied traits. The genotype Line 1 (P_6) could be used as donor parent for the improvement of days to heading, days to physiological maturity, flag leaf area, spike length, number of kernels/spike and 1000-kernel weight for normal and water stress conditions. The cultivar Misr 1 (P_4), showed potential for the improvement of grain yield/plant under both irrigation conditions, and grain yield/plant under water stress conditions. The crosses (Sakha 93 x Gemmeiza 9) and (Sakha 93 x Line 1) have potential for the improvement of number of spikes/plant and grain yield/plant for water stress conditions. The cross (Sahel 1 x Misr 1) holds a promise for yielding better segregates with improving flag leaf area.

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الملخص العربى

القدرة على الإئتلاف لمحصول القمح وبعض مكوناته تحت الظروف العادية وظروف الإجهاد المائى

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أجريت هذه الدراسة بمزرعة محطة البحوث الزراعية بإيتاى البارود خلال موسمي ٢٠٠٩/٢٠١٠ و٢٠١٠/٢٠١١ وتهدف الدراسة إلي تقييم بعض التراكيب الوراثية لقمح الخبز في تجربتين الأولي تحت ظروف الري الطبيعي والثانية تحت ظروف الإجهاد المائي (ريه واحده خلاف رية الزراعة) واستخدم تصميم قطاعات كاملة العشوائية في ثلاث مكررات وكانت الصفات المدروسة هي: عدد الأيام حتى طرد السنابل، عدد الأيام حتى النضج، مساحة ورقة العلم،ارتفاع النبات، عدد السنابل/نبات، طول السنبلة، عدد السنيبلات/سنبلة، عدد حبوب السنبلة، وزن ألف حبة ومحصول الحبوب/نبات.

وتشير النتائج إلى أن التباين الراجع للتراكيب الورثية، الهجن والتفاعل بين الآباء والهجن كان معنويا لغالبية الصفات تحت ظروف الري الطبيعي والإجهاد المائى. ووجد أن التباين الراجع للقدرة العامة (GCA) والخاصة علي الإئتلاف (SCA) كان معنويا في الصفات تحت الدراسة. كانت النسبة بين القدرة العامة/القدرة الخاصة علي الإئتلاف أعلي من الوحدة لكل الصفات المدروسة فيما عدا صفة محصول الحبوب/نبات حيث كانت النسبة أقل من الوحدة تحت ظروف الري الطبيعي و الإجهاد المائي. أظهرت السلالة الأبوية سلالة ١ (P_6) أعلى قدرة عامة على التآلف معنوية ومرغوبة لصفات عدد الأيام حتى طرد السنابل، عدد الأيام حتى النضج، مساحة ورقة العلم وطول السنبلة تحت ظروف الإجهاد المائى وصفتى عدد حبوب السنبلة و وزن ألف حبة تحت كل من ظروف الري الطبيعي و ظروف الإجهاد المائي.

فيما يتعلق بصفة ارتفاع النبات عند الرغبة للتربية للقصرفإن الصنف سخا ٩٣ (P_2) أظهر أعلى قدرة عامة على التآلف معنوية سالبة ومرغوبة فى كلا البيئتين (الرى الطبيعى والإجهاد المائى)، أما فى حال الرغبة للتربية للطول فإن الأباء شام ٦ (P_5) و ساحل ١ (P_1) قد أظهرا أعلى قدرة عامة على التآلف حيث كانت موجبة و معنوية تحت كل من ظروف الري الطبيعي و ظروف الإجهاد المائي على التوالى. أظهر الصنف مصر ١ (P_4) أعلى قدرة عامة على التآلف موجبة و معنوية لصفتى عدد السنابل/نبات ومحصول الحبوب/نبات تحت ظروف الري الطبيعي، بينما أظهر الصنف سخا ٩٣ (P_2) أعلى قدرة عامة على التآلف موجبة و معنوية لنفس الصفتين تحت ظروف الإجهاد المائى.

أظهر الهجين (ساحل ١ x شام ٦) أعلى قدرة خاصة على الإئتلاف سالبة ومعنوية (مرغوبة) لصفتى عدد الأيام حتى طرد السنابل وعدد الأيام حتى النضج فى كلا البيئتين (الرى الطبيعى والإجهاد المائى). الهجين (مصر ١ x سلالة ١) أظهر أعلى

قدرة خاصة على التآلف موجبة ومعنوية لصفة ارتفاع النبات تحت ظروف الرى الطبيعى، فى حين أنه تحت ظروف الإجهاد المائى كان الهجين (ساحل ١ x جميزة ٩) هو الأعلى لصفة ارتفاع النبات. أظهر الهجين (ساحل ١ x مصر ١) أعلى قدرة خاصة على التآلف موجبة ومعنوية لصفة مساحة ورقة العلم. أظهر الهجين (شام ٦ x سلالة ١) أعلى قدرة خاصة على التآلف موجبة ومعنوية لصفة طول السنبلة تحت ظروف الرى الطبيعى، فى حين أن الهجين (ساحل ١ x شام ٦) كان هو الأعلى لصفة طول السنبلة تحت ظروف الإجهاد المائى. أما الهجين (مصر ١ x سلالة ١) كان أفضل الهجن فيما يخص القدرة الخاصة على التآلف لصفة عدد حبوب السنبلة وذلك تحت كل من ظروف الرى الطبيعى وظروف الإجهاد المائى. أما فيما يخص عدد السنابل/نبات فقد أظهر الهجين (سخا ٩٣ x مصر ١) أعلى قدرة خاصة على التآلف معنوية ومرغوبة تحت ظروف الرى الطبيعي بينما تفوق الهجين (سخا ٩٣ x سلالة ١) تحت ظروف الإجهاد المائى لصفة عدد السنابل/نبات.

أظهر الهجين (جميزة ٩ x مصر ١) أعلى قدرة خاصة على التآلف موجبة ومعنوية لصفة وزن ألف حبة تحت ظروف الرى الطبيعى والإجهاد المائى. أظهر الهجين (سخا ٩٣ x مصر ١) أعلى قدرة خاصة على التآلف موجبة ومعنوية لصفة عدد السنابل/نبات تحت ظروف الرى الطبيعى، فى حين أن الهجين (سخا ٩٣ x جميزة ٩) كان هو المتفوق لصفة وزن الألف حبة تحت ظروف الإجهاد المائى. مما سبق يمكن التوصية باستخدام الهجن (سخا ٩٣ x جميزة ٩)، (سخا ٩٣ x سلالة ١) و (مصر١ x سلالة ١) فى برامج التربية للقمح تحت ظروف الإجهاد المائى حيث أنها لها قدره خاصه معنوية ومرغوبة على التآلف فى معظم الصفات تحت الدراسة .

Evaluating Different types of Irrigation Water and Their Impact on Soil and Date Palm in AL- Hassa Oasis, KSA

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ABSTRACT: The present study was conducted to evaluate different types of irrigation water and their impact on heavy metals content in soil and date palm grown in Al-Hassa Oasis, Saudi Arabia. The investigated irrigation water included groundwater (GW), mixture of groundwater and drainage water (GW+DW), mixture of groundwater and tertiary treated wastewater (GW+TTWW) and mixture of groundwater, drainage water and tertiary treated wastewater (GW+DW+TTWW). The results of this study indicate that the water types used may cause one problem or another according to the water type. By applying the criteria used for interpreting water quality for irrigation, the most domain problems are salinity hazard and potential salinity. Therefore, it is expected that continuous irrigation without good water management (leaching requirements) can led to severe problems from the salinity point of view. The mixed waters (GW+DW +TTWW) have the highest effect on elemental composition of plants and soil followed by (GW+TTWW), (GW+DW) and then (GW). Generally, a significant difference in heavy metals concentrations for both treated soil and plants was found. The contents of the heavy metals in both soil samples and plants are compared with the worldwide standards. Based on these comparisons, the results concluded that the heavy metals in the soil and plants were in acceptable range.

Keywords: Al Hassa Oasis, Water Quality, Heavy metals, Sodium hazard, Potential salinity, leaf mineral composition.

INTRODUCTION

Water insufficiency is one of the most critical problems that confront the world particularly in the arid and semi arid regions. The water policy of any country is to use all water resources for adding more land to increase agriculture production for the people demands. The limiting factor for reclaiming the arable land is the availability of good quality water. Using the treated wastewater for irrigation purposes becomes inevitable alternative to reduce the request of freshwater resources in the world, especially in arid and semiarid areas (Duan and Fedler, 2007).

The sources of irrigation water in Al-Hassa Oasis, Saudi Arabia are drainage water, tertiary treated wastewater and groundwater individually or mixed. Before using any source of water that mentioned before, it should be tested to find out its effect on soil chemical, physical, fertility and toxicity properties. Also, the effects on plant growth, yield and elemental analysis must be calibrated. Heavy metals are components of the biosphere, occurring naturally in soils and plants, but as a consequence of industrialization. Heavy metals from various sources such as fossil fuel combustion, sewage sludge, industrial waste and fertilizer, contaminate the environment. Plants growing on polluted soils may contain elevated levels of heavy metals (Gallego *et al*., 2002; Zornoza *et al*., 2002). Heavy metal ions such as zinc, manganese and nickel are essential micronutrients for plants, but when present in excess, these, and non-essential heavy metals such as cadmium, can accumulate in plant parts used for human or animal nutrition to undesirably high contents. At even higher levels, they can become toxic to the plant (Williams *et al*.,

2000). The growing urbanization increases domestic water use while supplying wastewater that can be used for non-potable purposes, such as agricultural irrigation. The costs associated to wastewater source are low compared with those of other water sources (Bahri, 1999).

In developing countries agricultural sector, the predominant trend is reuse of treated wastewater in irrigation (Smith, 1996; Haruvy, 1997; Bahri, 1999,; Nicholson *et al*., 2003). In contrast, most developing countries such as Mexico, Peru, Chile and Argentina rely on raw wastewater for agricultural irrigation (Siebe and Cifuentes, 1995; Peasey *et al*., 2000). Some researches on the effects of treated wastewater on soil and plant have been done in the past years. Abedi-Koupai *et al*. (2006) reported that the accumulation of Pb, Mn, Ni, and Co in the soil significantly increased after wastewater land application, and such an accumulation decreased with the depth. Hussein (1991) found that sewage and drainage water significantly increased Fe, Mn, Cu and Zn in sandy clay loam soil, sandy soil and calcareous soil. These results are in harmony with those obtained by Hussein *et al.* (2008) and Al-Dakheel (2011). They reported that groundwater; drainage water and tertiary treated wastewater have the highest effect on Fe, Mn, Cu, Zn, Cd, Co and Ni content of soil followed by groundwater and tertiary treated wastewater, groundwater and drainage water and then groundwater. Pereira *et al*. (2012) found that, using reclaimed wastewater (RWW) leads to increase (P, Mg, B, Fe, Mn, Zn, Ni, Cu, Co, Cd, Cr, and Pb) in soil compared with well water irrigation. Gonca and Gokhan (2012) reported that, soil nutrient elements (Mn, Cu, Zn, and Fe), and heavy metals (Cd, Cr, Ni, and Pb) were higher in soil treated with wastewater than in control soil. On contrast, there was no significant difference in the concentrations of heavy metals in soils irrigated with reclaimed water and with ground water or tap water in different years (Yang *et al*., 2011). Keser and Buyuk (2012) reported that, plant nutrient contents (Zn, Ca, Mg and Na) and heavy metals (Cd and Pb) in parsley plant increased with wastewater irrigation. In addition, the wastewater-irrigated plants showed a significant accumulation of heavy metals (Pb, Cd, Cr, and Cu) in their edible parts and roots (Keser, 2013).

The present study aimed to evaluate different types of irrigation water and their impact on some of heavy metals content in soil and date palm grown in the Al-Hassa Oasis, Saudi Arabia.

MATERIALS AND METHODS

The investigated irrigation waters include groundwater (GW), mixture of groundwater and drainage water (GW+DW), mixture of groundwater and tertiary treated wastewater (GW+TTWW) and mixture of groundwater, drainage water and tertiary treated wastewater (GW+DW+TTWW). Characteristics of irrigation water quality used for irrigating the investigated soil are illustrated in (Table, 1).

Quality of the irrigation water was determined according to the following parameters (Wilcox, 1958 and FAO, 1973& 1976):

1. The soluble salts concentration of water, which can be expressed in terms of electrical conductivity (EC_{iw}, dS/m).
2. The chemical composition of water, by determining the concentrations of cations (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+} and anions (CO_3^{2-}, HCO_3^{-}, Cl^{-} and SO_4^{2-} ions).

The quality parameters were calculated as follows:

a. Sodium Hazard:

Can be expressed in terms of Sodium Adsorption Ratio (SAR) or Soluble Sodium Percentage (SSP, %).

$$SAR = \frac{Na^{+}}{\sqrt{(Ca^{2+} + Mg^{2+})/2}}$$

$$SSP = \frac{Na^{+}}{\sum Cations} \times 100$$

(The concentration of cations was expressed in me/L).

b. Magnesium hazard (SMgP):

It can be expressed by the value of Soluble Magnesium Percentage (SMgP, %),

$$SMgP = \frac{[Mg^{2+}]}{[Ca^{2+} + Mg^{2+}]} \times 100$$

c. Bicarbonate hazard:

It can be expressed by the value of Residual Sodium Carbonate (RSC, me/L):

$$RSC = \left[CO_3^{2-} + HCO_3^{-}\right] - \left[Ca^{2+} + Mg^{2+}\right]$$

(The concentration of ions was expressed in me/l.)

The concentration of toxic compounds can be expressed by the values of:

a. Potential Salinity (PS):

$$PS(me/l) = Cl^{-} + 0.5 \times SO_4^{2-}$$

b. The nitrate concentration (NO_3^{-}, mg/l).

c. The boron concentration (B, mg/L).

Table (1). Chemical characteristics of the irrigation waters used in the present study

Irrigation waters	EC, dS/m	pH	Soluble cations				soluble anions			NO_3^{-}	B
			Na^{+}	K^{+}	Ca^{2+}	Mg^{2+}	CL^{-}	HCO_3^{-}	$SO_4^{=}$		
			meq/l							mg/l	
GW	2.07	7.24	9.13	0.41	6.64	3.69	11.60	3.60	4.67	7.78	0.33
GW+DW	2.62	7.31	12.78	0.63	7.11	4.76	12.36	5.10	7.83	15.73	0.54
GW+TTWW	3.54	7.22	18.52	0.75	10.05	5.84	20.59	7.31	7.26	12.76	0.61
GW+DW+TTWW	4.43	7.14	20.61	0.57	12.86	9.85	24.00	4.64	15.25	21.11	0.48

Four farms in Al-Hassa Oasis were selected according to the irrigation water quality (One farm for each irrigation type) and approximately similar in soil texture. Four locations were selected in each farm. Four palm trees were selected to represent each location in the farms (16 palm trees for each farm). The palm trees were selected as uniform as possible in growth and vigor and subjected to the same cultural practices commonly adopted in the farm. From each date palm tree, five pinnate leaf samples were collected from the middle of the third leaf (from top) in all directions, i.e. 20 pinnate per each date palm tree. Leaf samples were washed with tap water, distilled water, air-dried, oven dried at 65Cº for 72 hrs, and then ground in a stainless steel mill and the powder stored for elemental analysis. The ground material (plant powder) was digested with concentrated Sulphuric acid + 30% hydrogen peroxide according to the method of Wolf (1982). In the digest, Fe, Mn, Cu, Zn, Cd, Co and Ni were determined by inductively coupled plasma optical emission spectrometer (Carter, 1993).

Four soil samples were collected from each farm, one for each location, from the surface (0 – 30 cm) depth for chemical analysis. All the collected soil samples were air dried, grounded and sieved through a 2mm sieve and kept for analysis. Mechanical analysis was carried out according to the international hydrometer method using sodium hexametaphosphate as a dispersing agent (Richards, 1972). pH and total soluble salts were measured in the soil paste extract (Jackson, 1973). The contents of Fe, Mn, Cu, Zn, Cd, Co and Ni in the soil were determined by inductively coupled plasma optical emission spectrometer (Carter, 1993) after extraction with DTPA extracting solution. Some physical and chemical properties of the soil samples are presented in (Table, 2).

The experiment was arranged in randomized complete block design, (four treatments or water quality) with four replications, represented by 4 locations with 4 trees for each location). The obtained results were subjected to statistical analysis of variance using SAS Software (SAS Institute Inc., 1996).

Table (2). Some physical and chemical characteristics of the experimental soil as affected by the different irrigation waters

Irrigation Water	Particle Size Distribution				pH	ECe (dS/m)	Soluble Cations				Soluble Anions		
	Sand %	Silt%	clay %	Texture			meq/l						
	%	%	%				Na^+	K^+	Ca^{2+}	Mg^{2+}	CL^-	HCO_3^-	$SO_4^=$
GW	87.9	2.0	10.1	LS		1.69	4.62	0.28	7.17	4.32	4.43	2.82	9.14
GW+DW	86.9	4.0	9.1	LS	7.62	2.15	7.84	0.35	8.49	5.56	9.04	3.63	9.57
GW+TTWW	82.8	6.1	11.1	LS	7.37	2.63	9.55	0.63	9.66	7.13	9.21	3.64	14.11
GW+DW+TTWW	87.9	4.0	8.1	LS	7.50	3.25	12.58	0.47	11.65	8.79	12.31	3.25	17.92

LS Loamy sand

RESULTS AND DISCUSSION

1. Quality of irrigation water

The water quality parameters for the all investigated water types are presented in Table (3). From these data, it appears that for all types of water, the EC_{iw} ranged from 2.07 to 4.43 dS/m. The critical level of EC_{iw} to cause severe salinity problems is 3 dS/m as reported by FAO (1976). The values of EC_{iw} for

(GW) and (GW+DW) are less than the critical limit and no problems of using these types of irrigation water. On the other hand, the (GW+TTWW) and (GW+ DW+TTWW) have EC_{iw} values more than the critical level. It could be considered as high salinity and may cause severe salinity problems. Therefore, it is expected that continuous irrigation without good water management (leaching requirements) can led to severe problems from the salinity point of view.

The data presented in Table (3) also revealed that the SAR value of all water sources is relatively low in comparing with the critical level of sodium hazard (less than 10) as reported by Richards (1972). With respect to the SSP as indicator for sodium hazard, the values of SSP for all types of water were ranged from 45.94 to 52.67%. The data revealed that all values of SSP were less than the critical limit (< 60%) as reported by Wilcox (1958).

Magnesium hazard is one of the criteria for suitability of water for irrigation. In this respect, the values of SMgP tabulated in Table (3) indicated that all types of water have a values ranged from 35.72 to 43.37%. The values are below the harmful level (> 50%). This means no problem of Magnesium hazard. The magnesium salts have toxic effects on the plant and the toxicity of Mg ion is higher than the toxicity of Na ion having the same concentrations.

The RSC value evaluates the tendency of irrigation water to form carbonates and to dissolve or to precipitate the calcium and to a less degree, the magnesium carbonates. The precipitation of poorly soluble carbonates increases the sodium hazard of irrigation water and as a result increases the sodicity of irrigated soils. The present values of RSC have a negative values, this means that Ca^{2+} + Mg^{2+} is more than the CO_3^{2-} + HCO^-_3 resulted in no problem of sodium hazard. Potential salinity (PS) for all water types used was ranged from 13.94 to 31.63 me/l. The high values of PS over the critical level (5 me/l) as reported by Richards (1972) may be due to high chloride and sulphate content in the irrigation water. The concentration of B for all the water types in the present study is < 1 mg/l. The palm trees are considered as semi-tolerant to Boron, which the limit of boron in irrigation water is from 1 to 2 mg/l (Wilcox, 1958). This would put these waters in the range of no problem of toxicity with respect to palm trees.

Table (3). Water quality parameters used for comparing the different irrigation waters

Irrigation water	EC_w dS/m	SAR	SSP (%)	Mg Hazard (%)	RSC me/L	Potential salinity (me/l)	B mg/l	NO_3^- mg/l
GW	2.07	4.02	45.94	35.72	-6.73	13.94	0.33	7.78
GW+DW	2.62	5.25	50.56	40.11	-6.77	16.27	0.54	15.73
GW+TTWW	3.54	6.57	52.67	36.76	-8.58	24.22	0.61	12.76
GW+DW+TTWW	4.43	6.12	46.95	43.37	-18.07	31.63	0.48	21.11

The nitrate contents (NO_3^-) in this water varied from type to another, but it is not exceeding the critical limit (45 mg/l) that cause nitrate poisoning (Wilcox, 1958).

Generally, from the presented data, it appears that the water types used in this work may cause one problem or another according to the water type. By applying the criteria used for interpreting water quality for irrigation, the most domain problems are salinity hazard and potential salinity. These results are in harmony with those obtained by Hussein *et al*. (2008) and Al-Dakheel (2011).

2. Leaf elemental composition

Crops can be characterized by typical chemical composition of growing or developed tissues. Chemical analysis of plant parts is often used for diagnostic purpose in determining fertilizer needs. Poor fertility level, excessive concentration of available nutrients, or high salinity in the root zone is reflected in lower or higher concentrations of certain elements in plant tissues in comparison with the optimum range (Feigin, 1985).

Table (4) shows the leaf elemental composition of palm irrigated by the different types of irrigation waters. The results revealed that (GW+DW), (GW+TTWW) and (GW, DW+TTWW) significantly increased Fe, Mn, Cu, Zn, Cd, Co and Ni contents in leaves of palm as compared with ground water (GW). It is observed that (GW+DW+TTWW) have the highest effect on elemental composition of plants followed by (GW+TTWW), (GW+DW) and then (GW). Campbell *et al.* (1983) obtained similar results; they showed that Fe, Cu, Zn, Pb, Ni and Cd contents in alfalfa, sweet corn and wheat crops were below hazardous levels. These results are in agreement with those obtained by Samia *et al*. (1989), they reported that the application of different treated wastewater effluents to three soils in Egypt (sandy, calcareous and clay) increased the concentration of heavy metals (Cd, Cu, Fe, Mn, Ni and Zn) in leaves of corn and wheat. In addition, Hussein (1991) reported that drainage and sewage water significantly increased Fe, Mn, Cu and Zn in corn, sugar beet and cotton plants. Moreover, Shahin and Hussein (2005) reported that the effect of different types of irrigation water on Cd content in cucumber, lettuce and tomato plants in the following order (GW+DW+TTWW)>(GW+TTWW) >(GW+DW) >(GW). Also, these results are in harmony with those obtained by Hussein *et al*. (2008). They found that (GW+DW+TTWW) have the highest effect on micronutrient contents of palm followed by (GW+TTWW), (GW+DW) and then (GW). On contrary, these results are in contrast with the results obtained by Abdel-Nasser et al. (2000), they found that the leaf micronutrient contents (Fe, Mn, Cu, Zn and B) in olive plants significantly decreased with increasing the salinity of irrigation water.

Referring to the nutrition criteria, the concentration of Fe in the plants of palm were more than the normal range found in plants (30-150 ppm), but generally these excesses concentrations are not toxic to plants (Hausenbuiller, 1985). The concentration of Mn in palm are within the normal range (15-100 ppm) (Hausenbuiller, 1985) except Mn concentrations in palm trees irrigated with (GW) were less than this range. The levels of Zn in the plants are much less than the general toxic limit (100 mg kg^{-1}) for plants given by Leeber (1972). The values of Cu concentration in the date palm were within the normal range found in plants (5-15ppm) (Hausenbuiller, 1985). Typical amount of risk elements (Cd, Co and Ni) in

plant are 0.1-1, 0.05-0.5 and 0.1-5 mg/kg for Cd, Co and Ni, respectively, Vecera *et al*.(1999). According to Vecera *et al*. (1999) the concentrations of Cd, Co and Ni in leaves of date palm were within the normal range.

Table (4). The leaf elemental composition (mg/kg) of Palm irrigated by different irrigation water types

Irrigation water	Fe	Mn	Cu	Zn	Cd	Co	Ni
	mg/kg						
GW	122.48	11.47	4.01	9.41	0.19	0.24	2.24
GW+DW	153.64	16.70	6.14	13.51	0.28	0.32	2.65
GW+TTWW	194.58	27.60	8.96	16.68	0.33	0.47	3.07
GW+DW+TTWW	249.48	42.44	10.23	18.92	0.38	0.59	4.34
LSD (0.05)	4.23**	1.35**	0.88**	1.01**	0.05**	0.05**	0.19**

** Significant at 1% probability level

3. Soil elemental analysis

Table (5) illustrates the effect of different types of irrigation water quality on the chemical properties of soil cultivated with date palm. The results indicated that (GW+DW), (GW+TTWW) and (GW+ DW+TTWW) significantly increased available Fe, Mn, Cu, Zn, Cd, Co and Ni of the soil as compared with ground water (GW). It is noticed that the effect of different types of irrigation water quality on the elemental contents of soil are in the following order (GW+ DW+TTWW) > (GW+TTWW) > (GW+DW) > (GW). Also, the data showed that there were a positive significant correlation between soil contents of Fe, Mn, Cu, Zn, Cd, Co and Ni and plants elemental contents of Fe, Mn, Cu, Zn, Cd, Co and Ni. The correlation coefficients were 0.99, 0.93, 0.98, 0.99, 0.98, 0.99 and 0.92, respectively. The obtained results are in close agreement with those found by Hussein (1991), Hussein *et al.* (2008) and Al-Dakheel (2011). Also, these results are in agreement with those obtained by Abdel-Nasser *et al.* (2000), they found that available soil micronutrients (Fe, Mn, Cu and Zn) significantly increased with increasing the salinity of irrigation water. Moreover, these results are in harmony with those obtained by Shahin and Hussein (2005), they reported that (GW+DW+TTWW) have the highest effect on Cd content of soil followed by (GW+TTWW), (GW+DW) and then (GW).

Table (5). The elemental contents of soil irrigated by different irrigation water types

Irrigation water	Fe	Mn	Cu	Zn	Cd	Co	Ni
	mg/kg						
GW	1.79	2.61	0.48	1.05	0.16	0.35	0.33
GW+DW	2.72	5.94	0.66	2.78	0.21	0.47	0.42
GW+TTWW	4.18	8.03	0.98	4.02	0.27	0.59	0.52
GW+DW+TTWW	6.44	9.68	1.25	5.11	0.31	0.72	0.71
LSD (0.05)	0.47**	0.23**	0.11**	0.15**	0.05**	0.08**	0.05**

** Significant at 1% probability level

According to Follett and Lindsay (1970), the data in Table (6) illustrate that the concentration of Fe in soil irrigated with (GW+DW+TTWW) was adequate. The

concentration of Fe in soil irrigated with (GW+DW) and (GW+TTWW) was marginal while, the concentration of Fe in soil irrigated with (GW) was deficient. The concentrations of Mn, Cu and Zn in the soil irrigated with different types of irrigation water were adequate. Typical amount of risk element (Cd, Co and Ni) in non-polluted soil are 0.01-3, 1- 40 and 10-1000 mg/kg for Cd, Co and Ni, respectively, Vecera *et al*. (1999). According to Vecera *et al*. (1999), the concentration of Cd, Co, Ni and Pb in soil treated with different types of irrigation water were within the normal range.

Table (6). Critical levels of DTPA- extractable micronutrients for sensitive crops (mg/kg)

Nutrient	Deficient	Marginal	Adequate
Zn	< 0.5	0.5 -1.0	> 1.0
Fe	< 2.5	2.5 4.5	> 4.5
Mn	< 1.0		> 1.0
Cu	< 0.2		> 0.2

Source: Follett and Lindsay (1970)

CONCLUSION

It can be concluded that the water types used in the present study may cause one problem or another according to the water type. By applying the criteria used for interpreting water quality for irrigation, the most domain problems are salinity hazard and potential salinity. Therefore, it is expected that continuous irrigation without good water management (leaching requirements) can led to severe problems from the salinity point of view. The mixture of (GW+DW+TTWW) have the highest effect on elemental composition of plants and soil followed by (GW+TTWW), (GW+DW) and then (GW). The results concluded that the heavy metals in the soil and plants were in acceptable range.

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الملخص العربي

تقييم أنواع مختلفة من مياه الري وتأثيرها على التربة ونخيل التمرفي واحة الإحساء بالمملكة العربية السعودية

يوسف بن عبد العزيز الملحم

مركز الدراسات المائية– جامعة الملك فيصل– المملكة العربية السعودية

أجريت هذه الدراسة لبحث تأثير نوعيات مختلفة من مياه الري على التربة ونخيل التمر النامي في واحة الإحساء بالمملكة العربية السعودية. وقد كانت نوعيات المياه التي استخدمت في هذه الدراسة هي مياه جوفية ومياه ري مخلوطة من (المياه الجوفية + مياه الصرف الزراعي) ومياه ري مخلوطة من (المياه الجوفية + مياه الصرف الصحي المعالجة ثلاثيا) ومياه ري مخلوطة من (المياه الجوفية + مياه الصرف الزراعي + مياه الصرف الصحي المعالجة ثلاثيا). وقد أوضحت النتائج انه بتطبيق المعايير المناسبة لتحديد مدى صلاحية المياه للري نجد ان خطورة نوعيات مياه الري المستخدمة في الدراسة تنحصر في الضرر الملحي وجهد الملوحة. لذلك فأن الاحتياجات الغسيلية يجب أخذها في الاعتبار مع هذه الظروف لإزالة الأملاح الزائدة من محلول التربة. كما أوضحت النتائج أن هناك فروق معنوية في تركيز العناصر الثقيلة التي تم تقديرها في كلا من التربة واوراق نخيل التمر وأن (المياه الجوفية + مياه الصرف الزراعي + مياه الصرف الصحي المعالجة ثلاثيا) كانت أكثر تأثير في محتوى التربة والنبات من العناصر الثقيلة يليها (المياه الجوفية + مياه الصرف الصحي المعالجة ثلاثيا) ثم (المياه الجوفية + مياه الصرف الزراعي) وبعد ذلك المياه الجوفية. أوضحت النتائج أيضا ان محتوى العناصر الثقيلة في التربة ونخيل التمركانت داخل الحدود المسموح بها.

Effect of Kaolin Application with Well-Irrigated and Water-Stress on Some Growth Parameters, Yield and Fruit Quality of "Le Conte" Pear Trees

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ABSTRACT: This experiment carried out during 2012 and 2013experimental seasons on "Le-Conte" pear trees. The Kaolin was applied on the canopy surface of trees in well-irrigated and water stress conditions at the beginning of growth, after fruit set and 4 weeks before the commercial harvest as follows: Well-Irrigated Control (WIC), Well-Irrigated + 1% Kaolin (WI1K), Well-Irrigated + 3% Kaolin (WI3K), Well-Irrigated + 5% Kaolin (WI5K), Well-Irrigated + 7% Kaolin (WI7K), Stress-Irrigated Control (SIC), Stress-Irrigated + 1% Kaolin (SI1K), Stress-Irrigated + 3% Kaolin (SI3K), Stress-Irrigated + 5% Kaolin (SI5K) and Stress-Irrigated + 7% Kaolin (SI7K). Data indicated that all well and stress irrigation treatments plus spraying Kaolin tended to increase shoot length as compared with controls (WIC and SIC). Moreover, SI5K and SI3K treatments gave the highest significant value for the shoot thickness. WI3K, WI5K and SI5K treatments gave the highest significant value in leaf area. Also, SI5K, SI3K and SI7Ktreatments significantly increased fruit set percentage and decreased fruit drop percent compared to all well treatments, SI1K and the two controls (WIC and SIC) during both growing seasons. Furthermore, all well irrigation water with kaolin treatments increased average fruit weight as compared with stress irrigation water treatments, while all stress irrigation water with kaolin treatments increased number of fruits per tree as compared with well irrigation water treatments as well as control treatments during both seasons of the study. Also, SIC treatment gave the highest significant T.S.S percent compared with well irrigation treatments and WIC. Stress irrigation treatments decreased acidity percent fruit content as compared with well irrigation treatments, while all kaolin concentrations showed no effect on it. At the meantime, all stress treatments especially, SI7K increased vitamin content, as compared with WIC and SIC. Also, it was found that well irrigated increased N, P and K percentages in “Le-conte” pear leaf as compared with stress water treatments.

Keywords: pear, well and stress irrigated, kaolin, vegetative growth, yield and fruit composition.

INTRODUCTION

Regulated deficit irrigation (RDI) is the practice of using irrigation to maintain plant water status within prescribed limits of deficit with respect to maximum water potential for a prescribed part or parts of the seasonal cycle of plant development (Kriedemann and Goodwin, 2003). RDI results in higher canopy light transmission (Shellie, 2006) that may lead to undesirable fruit exposure and sunburn in warm production regions with high solar radiation (Tarara*et al*., 2008 and Wample, 1996). The conventional way of reducing plant water deficits is irrigation, as Le Conte pear trees are grown extensively with poor supplies of water during a drought; extensive irrigation is not only uneconomical but also impracticable.

Dropping of fruits during June month and before harvesting due to water deficits and high temperature considers a serious problem and the losses are usually of a very high magnitude. Therefore, during a drought the only means of reducing plant water deficits in trees is by using antitranspirants (Davenport *et al*., 1972).

The great benefits of various antitranspirants for flowering, checking fruit drop as well as improving the yield quantitively and qualitatively of different fruit trees have fascinated pomologists and promoted much of the modern researches in this direction (Abou- Khaled*et al.*, 1970; Davenport *et al.*, 1974; Yang, 1995; Glenn *et al.*, 2001; Layne *et al.*, 2002; Green *et al.*, 2003; Glenn *et al.*, 2003; Jifon and Syvertsen, 2003; Abd El- Kader *et al.*, 2006; Salehand El-Ashry, 2006; Wand *et al.*, 2006; and Aly*et al.*, 2010). Environmental dusts and particular coverings on plants generally reduce photosynthesis and productivity due to leaf shading and interference with stomata activity. A wide range of minerals are available but kaolin offer low cost, safety profile, low absorption, particle size, dispensability in water and general commercial availability needed for agriculture use (Rosati*et al.*, 2006). Kaolin cools tissues and protects plants from extreme heat and ultraviolet radiation by increasing leaf reflectance and reducing transpiration rate (Nakano and Uehara, 1996 and Glenn *et al.*, 2010).

It appears that applying a reflective coating to plants under water stress provides more benefit in reducing the heat load than reduction in potential photosynthesis. Also, it was expected that net radiation was reduced, suggesting a potential reduction in transpiration and water use (Glenn *et al.*, 2001). Most of the early work in this area has been found to improve yield, fruit color and size, as well as the instantaneous rate of net photosynthesis of leaves (Glenn *et al.*, 1999; Showler, 2002; Thomas *et al.*, 2004 and Rosati*et al.*, 2006). Furthermore, kaolin improved net photosynthesis and stomatal conductance in citrus at midday but not in the morning (Jifon and Syvertsen, 2003) whereas no effect was found on pecan (Lombardini*et al.*, 2004). There have been reports of delayed maturation in some trials (Glenn *et al.*, 2001). However, at high temperature, rate of net photosynthesis may be more limited by the heat stress than by low light so that the reduction in leaf temperature, induced by the kaolin film, could more than compensate for the negative effect of reduced light (Glenn*et al.*, 2003). It can be expected that, the kaolin applications reduced leaf temperature, reduced the water require for trees under stressed- water apple trees (saving water irrigation), may be increased the yield and improve the quality of fruits and prolonged the shelf life of fruits after harvesting.

The objective of the present study was to investigate the effect of kaolin film applications in well and stress water on Le-Conte pear trees on vegetative growth, fruit setting, yield and yield components. So the results can be used to develop a pear irrigation guide to conserve water usage in a semi-arid climate.

MATERIALS AND METHODS

This experiment was carried out during two consecutive seasons at 2012 and 2013 on "Le-Conte" pear trees (*Pyrus communis*x *Pyrus serotinia* L.). The trees were 8 years old, budded on *Pyrus commun is* rootstock spaced at 5 x 4 and grown on sandy loam soil in a private orchardat Al- Nubaria region, Behira government. Trees were trainedto the central leader system.Soil samples were, randomly, taken from two depths (0-30 cm and 30-60 cm) prior to initiating of the experiment and analyzed for physical and chemical properties**.** A randomized complete block design was used in this trial using five trees for

each treatment.Pear orchard was divided into well-irrigated as required in the area and the other was done under water stress treatments.

The treatment of well-irrigated was irrigated with fertigated system carried out in the farm (Well irrigation), while the treatment of water stress was provided an amount of supplemental water that met either100% of estimated crop evapotranspiration(ETc) throughout the growing season then reduced percentage of ETc beginning shortly in spring irrigated at 70% from the practical irrigation (Stress irrigation). The two water irrigation regimes were equivalent to 100%and 70% of crop evaporation respiration (ET_c) were determined by using the Penman Monteith model according to Allen *et al.* (1998) equation:

Crop evapotranspiration (ET_c), mm /day = ET_o x K_c

Which ET_o: Potential evapotranspiration

K_c: Crop coefficient

Fifty trees nearly uniform as possible in growth vigor and productivity were chosen for each water treatments.The trees were subjected to fertigation system used in the practical field. Other cultural practices were applied in a manner consistent with those of commercial pear with orchards. Four rates of kaolin were applied for both water irrigation systems with an air- blast sprayer and control treatment.The reflective films applied on the canopy surface of trees in well-irrigated andwater stress conditions are as follows:

1- Well-Irrigated Control (WIC).
2- Well-Irrigated + 1% Kaolin clay (WI1K).
3- Well-Irrigated + 3% Kaolin clay (WI3K).
4- Well-Irrigated + 5% Kaolin clay (WI5K).
5- Well-Irrigated + 7% Kaolin clay (WI7K).
6- Stress-Irrigated Control (SIC).
7- Stress-Irrigated + 1% Kaolin clay (SI1K).
8- Stress-Irrigated + 3% Kaolin clay (SI3K).
9- Stress-Irrigated + 5% Kaolin clay (SI5K).
10- Stress-Irrigated + 7% Kaolin clay (SI7K).

Reflective film (Kaolin) was applied at the beginning of growth, after fruit set and 4 weeks before the commercial harvest date using Tween 20 (1%) as a surfactant.Soil analysis was carried prior and the end of experiment in different depths (Table 1). Water quality used in experimental study is presented in Table (2).

Table (1): Physical and chemical properties of experimental orchard soil

Depths (cm)	Sand	Silt	Clay	pH	EC (ds/m)	Anions (meq / L)			Cations (meq / L)				
	%	%	%			HC^{-}_{3}	CL^{-}	SO^{-}_{4}	NH_4^+	Ca^{++}	Mg^{++}	Na^+	K^+
0 – 30	70.3	10.1	18.6	7.6	0.78	12.9	4.2	4.27	0.06	5.75	4.0	6.7	0.220
30 – 60	68.2	11.5	17.7	7.7	0.91	13.2	4.3	3.59	0.09	4.43	3.29	6.04	0.042

Table (2): Water quality used in experimental study

SAR	pH	EC (ds/m)	Anions (meq / L)			Cations (meq / L)				
			HCO^{-}_{3}	CL^{-}	SO^{-}_{4}	NH_4^+	Ca^{++}	Mg^+	Na^+	K^+
10.10	7.1	5.62	12.20	75.14	4.27	0.06	5.75	8.0	2.0	0.22

The following parameters were measured:

Shoot length (cm): In the spring of each season, 20 non –fruiting shoots of spring cycle were tagged at constant height and at all direction of each tree. In October, the average length of tagged shoots was measured.

Shoot diameter (cm): At late October in both seasons, shoot thickness for twenty shoots was measured by hand caliber.

Leaf area (cm2): Leaf area was examined during the second half of August on fully developed mature leaves by portable area meter LI .COR model LI-3000 A.

Fruit set and drop percentages: In the spring, four branches were chosen from each tree and marked. The number of flowers, number of fruits on these branches and the remained fruits on these branches were counted then the fruit set and fruit drop percentages were calculated according to the equation. Sixty days after flowering, fruit set percentage was calculated in the same sequence mentioned above for the initial fruit set percentage according to this formula:

$$\text{Fruit set (\%)} = \frac{\text{No. of fruit lets}}{\text{No. of opened flowers}} \times 100$$

Fruit drop (%): was calculated by counting the number of dropping fruits from the middle of June till the commercial harvesting time under experimental conditions (Middle of August), then expressed as a percentage from the whole number of fruits remained on the tree at the middle of June according to this formula:

$$\text{Fruit drop (\%)} = \frac{\text{No. of dropped fruits}}{\text{No. of set fruit lets}} \times 100$$

Average fruit weight (g/ fruit), fruit samples were weighted and the average fruit weight for each replicate was calculated.

No. fruits/tree, Weight of fruits/tree: At harvest time, yield of each treatment was recorded as yield weight/tree by the multiplying number of fruits × average weight of fruit.

Fruit firmness: was expressed as (pound / $Inch^2$) according to (Magness and Taylor, 1925). Flesh firmness was measured in two opposite sides of the fruit using Magness Taylor pressure tester.

Regarding chemical fruit characteristics, samples of 10 fruits from each replicate tree i.e. 30 fruits for each of the applied treatment was picked randomly at harvest to determine the following parameters:
Total soluble solids of fruit juice (TSS %) was used to determine the percentage of TSS by hand refractometer**.**

The percentage of total acidity was determined in fruit juice according to the A.O.A.C. (1985) by titration with 0.1N sodium hydroxide using phenolphthalein as an indicator and expressed as grams malic acid / 100 milliliters.

Vitamin C (Ascorbic acid): The ascorbic acid content of the juice was determined by titration with 2, 6 dichloro phenol-indo-phenol (A.O.A.C., 1985) and calculated as milli-grams per 100 ml of juice.

Leaf elemental compositions: At the end of July of both seasons, samples of 40 leaves /tree were taken at random from the previously tagged shoots, the leaf samples were washed with tap water and distilled water, and then oven dried at 70°C to constant weight and then ground. To determine the leaf elemental contents, ground material of each sample was digested with sulphoric acid and hydrogen peroxide according to Evenhuis and Dewaard (1980).

In the digested material, total nitrogen and phosphorus were determined colorimetrically according to Evenhuis (1976) and Murphy and Riley (1962), respectively and potassium was determined by flame photometer. The concentrations of N, P and K were expressed as percent.

Statistical analysis

Results of the measured parameters were subjected to computerized statistical analysis using MSTAT package for analysis of variance (ANOVA) and means of treatments were compared using L.S.D. at 0.05 according to Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Vegetative growth:

The data for both experimental seasons, regarding the effect of different treatments of well and stress irrigation and kaolin spraying on the shoot length of "Le-conte" pear trees are shown in Table (3). Data indicated that, in general well irrigated treatments increased the shoot length as compared with stress irrigation treatments. Statistical analysis showed that, WI5K and WI7K treatments caused the highest significant length in the two seasons and SIC had the lowest significant value in both experimental seasons. Furthermore, data showed that, for both experimental seasons, all well and stress irrigation treatments plus spraying Kaolin in any rates tended to increasing shoot length as compared with control treatment (WIC and SIC). No significant difference was found among SI1K, SI5K and SI7K in both seasons.

Results of the effect of different treatments on shoot thickness of "Le-conte" pear trees clearly indicated that, in spite of all well irrigation with kaolin treatments under the study increased the shoot thickness of "Le-conte" pear trees during 2012 and 2013 seasons as compared with well irrigation (control) and the difference was not big enough to be significant, except WI7K in the first season, but the stress irrigation with kaolin spraying treatments generally increased the shoot thickness as compared with well irrigation with kaolin treatments as well as control treatments in both seasons. SI5K and SI3K treatments gave the highest significant value for the shoot thickness as compared with other treatments in both seasons (Table 3).

With regard to leaf area, data indicated that WI3K, WI5K and SI5K treatments gave the highest significant value in leaf area meanwhile, control treatments (WIC and SIC) tended to decrease leaf area of "Le-conte" pear trees in both seasons (Table 3).

The same results were reported by several authors**,** Heron *et al.* (2002) on pear found that sprays of prohexadione-Ca under water regime condition reduced shoot growth and Glenn *et al.* (2010) on grape vines (*Vitis vinif*era L. cvs.'Cabernet Sauvignon', 'Merlot', and 'Viognier') using a particle film treatment (PFT) under varying levels of applied water. Boland et *al.* (2000a&b) have shown in peach that deficit irrigation can restrict root volume and that was associated with a reduction in vegetative growth and canopy transpiration demand. Cooley *et al.* (2004) reported, up to 17% reduction in leaf area and 40% reduction in shoot growth in 'Cabernet Sauvignon' under deficit irrigation and Shellie (2006) reported that, an increase in 'Merlot' canopy light transmission under deficit irrigated. The reduction in g_s observed in this study under deficit irrigation regimes was most likely the result of negative feedback of low plant water status. Plant water status, at any point in time, is influenced by prior water status conditions that may have altered root capacity for water uptake, xylem hydraulic conductivity, non-hydraulic signals (Soar *et al.*, 2004), and/or the ratio of shoot to root transpiration demand.

Table (3): Effect of kaolin applications at well and stress irrigated pear trees on some growth parameters in 2012 and 2013 seasons

Treatments	Shoot lengt (cm)		Shoot diameter (cm)		Leaf area (cm^2)	
	2012	2013	2012	2013	2012	2013
WIC	41.36^{c}	40.86^{cd}	0.38^{c}	0.39^{c}	22.36^{ab}	22.98^{b}
WI1K	43.23^{c}	44.65^{bc}	0.39^{c}	0.41^{c}	23.12^{ab}	23.23^{b}
WI3K	45.12^{bc}	46.13^{b}	0.39^{c}	0.42^{c}	25.23^{a}	26.12^{a}
WI5K	52.23^{a}	50.33^{a}	0.42^{bc}	0.43^{c}	25.23^{a}	26.85^{b}
WI7K	48.13^{b}	49.74^{a}	0.45^{ab}	0.46^{bc}	24.12^{ab}	25.25^{ab}
SIC	38.25^{d}	39.22^{d}	0.46^{ab}	0.52^{ab}	21.86^{b}	22.82^{b}
SI1K	42.12^{c}	43.86^{bc}	0.47^{ab}	0.53^{ab}	23.01^{ab}	23.20^{b}
SI3K	43.23^{c}	41.29^{cd}	0.49^{a}	0.56^{a}	24.02^{ab}	23.23^{b}
SI5K	45.12^{bc}	42.92^{bcd}	0.50^{a}	0.58^{a}	25.28^{a}	26.36^{a}
SI7K	44.32^{bc}	42.83^{bcd}	0.48^{a}	0.51^{ab}	24.98^{a}	24.55^{ab}

Means followed by the same letter(s) within a separate column are not significantly different at 0.05 level of probability.

Fruit set and drop percentages:

The data concerning the effect of well and stress irrigation plus spraying kaolin on the percentage of fruit set and drop of "Le-conte" pear trees during 2012 and 2013 seasons are presented in Table (4).The results showed that, spraying the trees, in general stress irrigation treatments and kaolin applied increased the percentage of fruit set and decreased the percentage of fruit drop. Statistical analysis showed that, SI5K, SI3K and SI7Ktreatments significantly increased fruit set percentage and decreased fruit drop percent compared to all well irrigated treatments, SI1K and the two controls (WIC and SIC) during both growing seasons. No significant difference was found between SI5K and SI7K in the first season for fruit set percent. The lowest significant values were obtained by WIC and WI7K in the two seasons. While, the lowest significant percent of fruit drop obtained by SI5K and SI7K and the highest significant value was obtained by WIC and WI7K in the two experimental seasons. The data also showed that, stress irrigation without applied kaolin (SIC) gave fruit set % more than well irrigation without applied kaolin (WIC), while the reverse was true for fruit drop % in both seasons.

The beneficial of these antitranspirants on increasing plant water potential and accelerating cell division can enhance growth characters and prevent the formation of abscission zone by increasing calcium in the proximal and distal sides of the abscission zone of the fruits was mainly attributed to their positive action on standing the various stresses surrounded the trees such as water stress and high temperature (Davenport*et al.*,1972 and 1974). In the meantime, Masoud (2012) found that foliar application of the three antitranspirants namely Vapor gard, Kaolin and green miracle at 1.0 to 4.0 % considerably declined preharvest fruit dropping on Hamawy apricot trees.The promoting effect of these antitranspirants on growth (Davenport *et al.*, 1972) as well as their positive action on reducing preharvest fruit dropping surely

reflected on enhancing the yield as number of fruits and weight (kg.) . These results are in agreement with those obtained by Glenn *et al.* (2001); Green *et al.*(2003) and Aly *et al.* (2010) on apple and Masoud (2012) on apricot.

Table (4): Effect of kaolin applications at well and stress irrigated pear trees on fruit set and drop percent in 2012 and 2013 seasons

Treatments	Fruit set %		Fruit drop %	
	2012	2013	2012	2013
WIC	8.43 ^{e}	8.63^{e}	91.57^{a}	91.37^{b}
WI1K	9.23 ^{d}	9.21^{d}	90.77^{b}	90.79^{cd}
WI3K	9.85^{c}	9.58^{c}	90.15^{c}	90.45^{d}
WI5K	10.12^{c}	9.23^{d}	89.88^{c}	90.77^{cd}
WI7K	8.21 ^{e}	8.23^{f}	91.79^{a}	91.77^{a}
SIC	9.48 ^{d}	8.96^{d}	90.52^{ab}	91.04^{bc}
SI1K	10.12^{c}	9.23^{d}	89.88^{c}	90.77^{cd}
SI3K	11.28^{b}	11.85^{b}	89.72^{d}	88.15^{e}
SI5K	12.03^{a}	12.23^{a}	87.97^{e}	87.77^{e}
SI7K	12.07^{a}	11.99^{b}	87.93^{e}	88.01^{e}

Means followed by the same letter(s) within a separate column are not significantly different at 0.05 level of probability.

Physical properties:

Concerning the applying well or stress irrigation water with kaolin on the average fruit weight (g/ fruit) of “Le-conte” pear trees in 2012 and 2013 seasons, results revealed that all well irrigation water with kaolin(which show an increase in average fruit weight (g/ fruit) as compared with WIC and SIC in both seasons) treatments increased average fruit weight as compared with stress irrigation water treatment as well as control treatments during both seasons of the study, and that increase in fruit weight is big enough to be significant. It was noticed that WI5K treatment gave the highest average fruit weight (g/ fruit) of “Le-conte” pear trees in 2012 and 2013 seasons, meanwhile, the SIC treatments gave the lowest value of average fruit weight (g/ fruit) of “Le-conte” pear trees in both seasons (Table 5).

Regarding the number of fruits per tree, data revealed that all stress irrigation water with kaolin treatments increased number of fruits per tree as compared with well irrigation water treatment as well as control treatments during both seasons of the study. It was noticed that SI5K treatment gave the highest significant average fruit weight (g/ fruit) of “Le-conte” pear trees then SI7K and SI3K in 2012 and 2013 seasons, meanwhile, the WIC and SIC treatments (control) gave the lowest significant values of the number of fruits per tree of “Le-conte” pear in both seasons (Table 5).

As for weight of fruits/tree (kg), it was found that, all well irrigation and stress irrigation with kaolin treatments showed an improvement in average of weight of fruits/ tree(kg) as compared with well and stress irrigation controls in

both seasons. Statistical analysis showed that, the highest significant value was obtained by WI5K in both seasons and followed by SI3K and SI5k and no significant difference was found between WI5K and SI5K in the second season. The lowest significant value was obtained by WIC and SIC in both seasons.

Regarding the influence of irrigation and kaolin treatments on fruit firmness of “Le- conte” pear trees during the both seasons, data showed that, all well irrigation plus kaolin tended to decreased fruit firmness of “Le- conte” pear trees during both seasons as compared with WIC. Moreover, it was noticed that increasing kaolin concentrations in well irrigated treatments led to decreased fruit firmness of “Le- conte” pear trees during the both seasons. At the same time, all stress water irrigation plus kaolin treatments increased fruit firmness of “Le- conte” pear trees during the both seasons. Generally, no significant differences were noticed among WIC, WI1K and WI3K also, no significant differences were noticed among SI3K, SI5K and SI7K treatments for effected on fruit firmness of “Le- conte” pear trees during the both seasons (Table 5).
Song *et al.* (2012) found that the largest berry fresh weight of grape in both years, when used water regime (35–70% ETc or 35% ETc treatments) and the data showed a significant decrease in berry fresh weight by 23–29% in the 2 years.

The effect of antitranspirants on increasing calcium in the proximal and distal sides of the abscission zone of the fruits was mainly attributed to their positive action on standing the various stresses surrounded the trees such as water stress and higher temperature (Davenport *et al.*, 1972).David *et al.* (2003) in pear, there was a significant negative correlation where flesh firmness decreased as SSC increased. When data were pooled across cultivars in 1999 and regression analysis was conducted, a significant linear relationship existed between flesh firmness and SSC for both the control and film treatments, respectively. Moreover, Glenn *et al.* (2003) in apple found that, the kaolin applications reduced leaf temperature, reduced the water require for trees under stressed- water apple trees (saving water irrigation), may be increased the yield and improve the quality of fruits and prolonged the shelf life of fruits after harvesting. Also, Rosati*et al.* (2006) showed that Kaolin applications have been used to mitigate the negative effects of water and heat stress on plant physiology and productivity with variable results, ranging from increased to decreased yields and photosynthetic rates. The mechanisms of action of kaolin applications are not clear: although the increased albedo reduces leaf temperature and the consequent heat stress, it also reduces the light available for photosynthesis, possibly offsetting benefits of lower temperature. Abd El-Rhman (2010) found that all studied treatments (controlled irrigation, bagging, zinc sulphate and kaolin) had no effect on yield / tree (kg) but seeds% (grains)/fruit weight were reduced significantly when trees were treated with controlled irrigation, bagging, zinc sulphate and kaolin sprays.

Table (5): Effect of kaolin applications at well and stresses irrigated pear trees on some fruit parameters in 2012 and 2013 seasons

Treatments	Average fruit weight (g)		No fruits/tree		Weight of fruits/tree (kg)		Fruit firmness (pound /inch^2)	
	2012	2013	2012	2013	2012	2013	2012	2013
WIC	139.23^{d}	137.82^{c}	189.24^{h}	178.21^{f}	26.30^{g}	24.84^{e}	16.23^{cd}	16.25^{bc}
WI1K	141.22^{c}	144.32^{b}	192.11^{g}	188.98^{e}	27.05^{e}	27.38^{c}	16.03^{de}	16.12^{cd}
WI3K	143.56^{b}	143.36^{b}	196.32^{f}	195.24^{d}	28.18^{d}	28.03^{b}	16.02^{de}	16.11^{cd}
WI5K	148.21^{a}	146.52^{a}	209.23^{e}	199.53^{c}	31.00^{a}	29.25^{a}	15.96^{de}	15.99^{d}
WI7K	140.45^{c}	138.36^{c}	188.36^{h}	193.23^{d}	26.66^{f}	26.89^{c}	15.89^{e}	15.45^{e}
SIC	129.23^{i}	131.23^{f}	189.23^{h}	193.24^{d}	24.66^{h}	25.36^{d}	16.70^{a}	16.55^{a}
SI1K	136.25^{f}	133.23^{e}	211.21^{d}	201.32^{c}	28.81^{c}	26.88^{c}	16.63^{ab}	16.50^{a}
SI3K	137.89^{e}	135.21^{d}	212.32^{c}	208.87^{b}	29.27^{b}	28.24^{b}	16.35^{c}	16.41^{ab}
SI5K	133.25^{g}	136.23^{d}	218.24^{a}	213.89^{a}	29.09^{bc}	29.18^{a}	16.40^{bc}	16.33^{ab}
SI7K	130.23^{h}	132.22^{ef}	214.22^{b}	211.23^{b}	27.91^{d}	28.06^{b}	16.41^{bc}	16.35^{ab}

Means followed by the same letter(s) within a separate column are not significantly different at 0.05 level of probability.

Chemical properties of fruits:

Data of Table (6) revealed that, increasing rates of kaolin, gradually, decreased the content of fruits from T.S.S % in both seasons. At the same time, in general, stress irrigation treatments increased T.S.S percentage as compared with well irrigation treatments. It was found that, SIC treatment gave the highest significant T.S.S percent compared with well irrigation treatments and WIC, while the differences among the rest treatments (stress irrigation with kaolin) were not big enough to be significant, except for SI7K in the first season. In the meantime, the lowest significant values were found in WI5K and WI7K, in the second season.

As for ,the effect of well and stress water irrigation with or without kaolin treatments , it was found that, in general, stress irrigation treatments decreased acidity percent fruit content as compared with well irrigation treatments, while all kaolin concentrations showed no effect on it. Statistical analysis of the data showed that, the highest significant value was obtained by WI1K in the first season and WIC in the second season. Meanwhile, the lowest value of acidity percent was obtained by SI7K in the first season. It is cleared from the data that, no significant differences were found among the stress irrigation treatments in the second season.

Furthermore, the data as for the effect of irrigation plus kaolin on vitamin C content in “Le-conte” pear fruits during 2012 and 2013 seasons showed that, stress treatments in general led to increase Vitamin content, in the meantime all kaolin concentra tions in well as well as stress irrigation treatments in both seasons, increased fruit vitamin C content as compared with WIC and SIC. While, SI7K gave the highest significant value in the two seasons. Masoud

(2012) found that, there was a gradual promotion on fruit weight and vitamin C with increasing concentrations of each antitranspirants.

Regulated deficit irrigation is a significant improvement in water management for horticultural crops because it reduces irrigation water inputs while improving crop quality (Glenn *et al.*, 2010), also it has been used with peach and pear to shift photo assimilate sinks from vegetative to reproductive growth and increase yield, fruit quality and water use efficiency (Boland *et al.*, 1993; Chalmers *et al.*, 1981; Johnson *et al.*,1992; Mitchell and Chalmers 1982; Mitchell *et al.*, 1989; Moiana *et al.*, 2003). On the other hand, regulated deficit irrigation in wine grapes is commonly applied during two periods to increase berry quality, water deficits early in the season, from fruit set to veraison , control berry size and reduce vine vigor (McCarthy *et al.*, 2002 and Keller, 2005). Water deficit early in the season or after veraison and during fruit ripening can reduce yield and vegetative development compared to full irrigation (Kriedemann and Goodwin, 2003) and can benefit berry and wine quality in different ways (McCarthy *et al.* 2002; Cortell *et al.* 2005 and Romero *et al.*, 2010) Plant water relations were more impacted by irrigation regime than by particle film; however, vines with kaolin- particle film had the coolest leaf and canopy temperature (Glenn *et al.*, 2010). Trees under deficit irrigation had the warmest leaf and canopy temperature.

Song *et al.* (2012) found that the lowest total soluble solids, highest titratable acidity, and lowest pH in both years of grape, when used water regime (35–70% ETc or 35% ETc treatments) and the data showed a significant decrease in berry fresh weight by 23–29% in the 2 years.

Higher total soluble solids in grapes under water deficit could be related to the indirect effects of water stress (Koundouras *et al.*, 2009). Also, David *et al.* (2003) showed that, there was a significant negative correlation where flesh firmness decreased while, total soluble solids increased in pear. Glenn *et al.* (2003) in apple, expected that, the kaolin applications reduced leaf temperature, reduced the water require for trees under stressed- water apple trees (saving water irrigation), may be increased the yield and improve the quality of fruits and prolonged the shelf life of fruits after harvesting. Rosati *et al.* (2006) showed that Kaolin applications have been used to mitigate the negative effects of water and heat stress on plant physiology and productivity with variable results, ranging from increased to decreased yields and photosynthetic rates. Abd El-Rhman (2010) found that, in pomegranate, total soluble solids, total sugar and reducing sugars and other physical and chemical measurements were increased as influenced by foliar spraying with all treatments (controlled irrigation, bagging, zinc sulphate and kaolin) in both studied seasons. Masoud (2012) worked on Hamawy apricot trees, were subjected twice to three antitranspirants namely Vapor gard, Kaolin and green miracle each at 1.0, 2.0 and 4.0 % in addition, to the control treatment, and the data showed that foliar application of the three antitranspirants declined preharvest fruit dropping and total acidity percentage and improved the yield, calcium pectate % on distal and proximal sides of the abscission zone, fruit weight, total soluble solids %, total and reducing sugars, sucrose % and ascorbic acid comparing with the check treatment.

Table (6): Effect of kaolin applications at well and stresses irrigated pear treeson some chemical fruit parameters in 2012 and 2013 seasons

Treatments	TSS %		Acidity %		Vitamin C (mg/100 ml juice)	
	2012	2013	2012	2013	2012	2013
WIC	12.23^{bcd}	12.36^{bc}	0.49^{ab}	0.51^{a}	19.10^{e}	19.21^{d}
WI1K	12.11^{cd}	12.20^{cd}	0.50^{a}	0.49^{ab}	20.19^{d}	20.11^{c}
WI3K	12.02^{cd}	12.13^{d}	0.48^{ab}	0.47^{b}	21.21^{c}	21.02^{b}
WI5K	11.87^{d}	11.92^{e}	0.47^{b}	0.46^{b}	21.22^{c}	21.32^{b}
WI7K	11.99^{cd}	11.86^{e}	0.48^{ab}	0.47^{b}	20.11^{d}	21.01^{b}
SIC	12.66^{a}	12.65^{a}	0.40^{cd}	0.39^{c}	20.21^{d}	21.21^{b}
SI1K	12.54^{ab}	12.52^{ab}	0.42^{c}	0.41^{c}	21.63^{bc}	21.33^{b}
SI3K	12.32^{abc}	12.55^{ab}	0.40^{cd}	0.42^{c}	21.99^{b}	21.54^{b}
SI5K	12.31^{abc}	12.41^{abc}	0.41^{cd}	0.40^{c}	22.23^{b}	22.45^{a}
SI7K	12.23^{bcd}	12.40^{abc}	0.39^{d}	0.39^{c}	22.85^{a}	22.98^{a}

Means followed by the same letter(s) within a separate column are not significantly different at 0.05 level of probability.

Leaf elemental content:

Table (7) represents the effect of well and stress water irrigation plus kaolin spraying treatments on N, P and K in leaves of “Le-conte” pear trees in 2012 and 2013 seasons. It was obvious from the obtained results that, in general it was found that well irrigated increased N, P and K percentage in “Le-conte” pear leaf as compared with stress water treatment. Moreover, the usage of kaolin either with well irrigation or stress irrigation gradually increased N, P and K percentage as compared with WIC and SIC, also it was found that increasing kaolin concentrations in the two seasons in both well and stress irrigation treatments decreased the N,P and K percentage leaf content. As for nitrogen content, statistical analysis showed that, the highest significant value was obtained by WI1K treatment and the lowest significant value was obtained by SIC in the first season and SI1K in the second season. The differences between WI3K and WI5K also, between SI5K and SI7K were not big enough to be significant in both experimental seasons.

Concerning phosphorus and potassium, the same trend was found, data cleared that, the differences among the treatments (well irrigated with kaolin) WI1K, WI3K, WI5K andWI7K were not big enough to be significant. The lowest value was obtained by SIC in the two minerals for two seasons.

The same trend was found by Glenn *et al.* (2001), they reported that application of particle films increased the foliage reflectivity and influence on leaf physiology. Romero *et al.* (2010) found that, The linear relationships between $K_{root\text{-}stem}$ and K_{plant}, and Ψs suggest that plant hydraulic conductance and root water uptake were progressively reduced during water stress in grapevines, they also found that, the significant decrease in leaf nitrogen observed in regulated deficit irrigation not during the well-irrigated period and reduced N uptake in deficit- irrigated treatments as a consequence

of soil water deficit .Also, Stanley (1998) and Schupp *et al.* (2002), found that increasing the concentrations of kaolin or silica gel decreased the concentrations of N, P and K contents in leaf and fruit apple.

It was concluded from the previous data that, stress irrigation with kaolin treatments improved fruit set and fruit quality, while well irrigation with kaolin increased average fruit weight and N, P and K percentages.

Table (7): Effect of kaolin applications at well and stress irrigated pear trees on NPK leaf content in 2012 and 2013 seasons

Treatments	N (%)		P (%)		K (%)	
	2012	2013	2012	2013	2012	2013
WIC	1.92^{cd}	1.99^{c}	0.42^{b}	0.42^{ab}	1.39^{b}	1.36^{b}
WI1K	2.22^{a}	2.25^{a}	0.48^{a}	0.46^{a}	1.46^{a}	1.43^{a}
WI3K	2.01^{b}	2.14^{b}	0.48^{a}	0.45^{a}	1.45^{a}	1.43^{a}
WI5K	1.99^{bc}	2.14^{b}	0.46^{a}	0.45^{a}	1.43^{a}	1.39^{ab}
WI7K	1.92^{cd}	2.11^{b}	0.45^{a}	0.42^{ab}	1.44^{a}	1.39^{ab}
SIC	1.72^{f}	1.94^{d}	0.30^{d}	0.33^{d}	1.30^{b}	1.29^{c}
SI1K	2.02^{b}	1.91^{d}	0.38^{c}	0.39^{bc}	1.36^{b}	1.36^{b}
SI3K	1.92^{cd}	2.11^{b}	0.36^{c}	0.39^{bc}	1.36^{b}	1.35^{b}
SI5K	1.85^{de}	2.01^{c}	0.36^{c}	0.38^{bc}	1.32^{b}	1.30^{c}
SI7K	1.82^{e}	2.02^{c}	0.32^{d}	0.36^{c}	1.30^{b}	1.30^{c}

Means followed by the same letter(s) within a separate column are not significantly different at 0.05 level of probability.

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الملخص العربي

تأثير إضافة الكاولين مع الري الجيد والاجهاد المائي على بعض قياسات النمو، المحصول وجودة الثمار في أشجار الكمثرى صنف ليكونت

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أجريت هذه التجربة خلال موسمي ٢٠١٢ و٢٠١٣ على اشجار الكمثرى صنف ليكونت. وقد تم إضافة الكاولين رشا على الأشجار المنزرعة تحت ظروف الري الجيد وتحت الإجهاد المائي وذلك عند بداية النمو، بعد عقد الثمار وقبل ٤ أسابيع من الجمع وذلك كالتالي: معاملة المقارنة (الري الجيد)، الري الجيد+١% كاولين، الري الجيد+ ٣% كاولين، الري الجيد+ ٥% كاولين، الري الجيد+٧% كاولين، معاملة المقارنة (الإجهاد المائي)، الإجهاد المائي + ١% كاولين، الإجهاد المائي + ٣% كاولين، الإجهاد المائي + ٥% كاولين، الإجهاد المائي + ٧% كاولين. وقد أظهرت النتائج أن كل معاملات الري الجيد والإجهاد المائي المضاف لها كاولين أدت الى زيادة طول النمو وذلك بالمقارنة بمعاملتي الكونترول. وقد أعطت معاملتيالإجهاد المائي + ٣% كاولين، الإجهاد المائي + ٥% كاولين أعلى قيم معنويا بالنسبة للمساحة الورقية. وقد أظهرت معاملات الإجهاد المائي عند ٣،٥ و٧% رشا بالكاولين زيادة معنوية في النسبة المئوية لعقد الثمار كما أدت الى خفض النسبة المئوية لتساقط الثمار وذلك مقارنة بكل من معاملات الري الجيد ومعاملة الاجهاد المائي عند ١% كاولين وكلا معاملتي المقارنة خلال موسمي الدراسة. أيضا أظهرت النتائج ان كل معاملات الري الجيد المضاف له كاولين أدت الى زيادة متوسط وزن الثمار وذلك مقارنة بمعاملات الاجهاد المائي التي أدت الى زيادة عدد الثمار/شجرة مقارنة بمعاملات الري الجيد ومعاملتي المقارنة خلال موسمي الدراسة. وقد أظهرت معاملة المقارنة للاجهاد المائي أعلى معنويه بالنسبه للمواد الصلبه الكليه مقارنة بمعاملات الرى الجيد و معاملة المقارنه. كل معاملات الاجهاد المائى ادت الى خفض النسبه المئويه للحموضه فى الثمار مقارنة بمعاملات الرى الجيد بينما كل تركيزات الكاولين لم تؤثر عليها. فى نفس الوقت، كل معاملات الاجهاد المائى خاصة المضاف لها ٧ % كاولين أدت الى زيادة محتوى الثمار من فيتامين ج و ذلك مقارنة بمعاملتى الكونترول. أيضا وجد ان معاملات الرى الجيد ادت الى زيادة محتوى أوراق أشجار الكمثرى صنف ليكونت من النسبه المئويه لكل من النيتروجين و الفسفور و البوتاسيوم و ذلك مقارنة بمعاملات الاجهاد المائى.

Comparative Toxicity of Some Conventional Insecticides Against *Culex Pipiens* L. Mosquito Larvae from Different Districts in Egypt

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ABSTRACT: The susceptibility of *Culex pipiens* larvae to some insecticides commonly used in mosquito control programs [cypermethrin (Sparkill®), deltamethrin (Embrator®), temephos (Temepest®) and spinosad (Tracer®)] was investigated, also variations in esterases and glutathione S- transferases (GST) activities among three field populations (Abou homoss, Nadi El Said, Montaza) were measured and compared with a laboratory susceptible strain (S). The highest level of resistance against the tested insecticides was found in Abouhomoss strain (27.3, 22.2 and 24.8- fold) and the lowest level of resistance was recorded in Montaza strain (12.75, 15.17 and 8.17-fold) towards cypermethrin, deltamethrin and temephos, respectively. On the other hand, all strains recorded no resistance against spinosad (Tracer®). All field strains revealed significantly higher levels of GST and esterases activities compared with the laboratory susceptible strain. The results of the present study suggest that esterases and glutathione S- transferases enzymes have major role in *Culex pipiens* resistance to the evaluated insecticides.

Keywords: *Culex pipiens*, estrases, glutathione S-transferases, cypermethrin, deltamethrin, temephos, spinosad.

INTRODUCTION

Mosquitoes are the most important arthropod disease vectors, transmitting nine dreadful human diseases in over 100 countries, causing mortality of nearly two million people every year (Knudsen and Slooff, 1992; Klempner *et al*., 2007), therefore, the mosquito control continues to be an important strategy in preventing the mosquito-borne diseases (Nauen , 2007; Billingsley *et al* ., 2008; Midega *et al*., 2010). Mosquito control relies mainly on the chemical control using organophosphate, carbamate and pyrethroid insecticides. The extensive and indiscriminate applications of synthetic chemical insecticides lead to widespread development of resistance by mosquitoes and unwarranted toxic or lethal effects on non-target organisms (Roberts and Andre, 1994; Nauen , 2007) .

Insecticide resistance is a complex evolutionary phenomenon, which can potentially cause large problems in the control of agricultural insect pests and disease vectors, and it is an increasing problem for mosquito control in different parts of the world (Canyon and Hii, 1999; Katyal *et al*., 2001; Saleh *et al*., 2003; Nazny *et al*., 2005; Tawatsin *et al*., 2007). It is necessary, from time to time, to monitor the susceptibility status of local mosquito vectors to the insecticides used in the control programs. Documentation of insecticide resistance will identify insecticides that are no longer effective and is a critical first step towards developing resistance management programs (Panlawat *et al*., 2005).

The more efficient detoxification mechanisms, also known as metabolic resistance mainly occurs due to an increase in the expression or activity of three major enzyme families: esterases (EST), glutathione-S-transferases and the cytochrome P450 superfamily of enzymes (Li *et al*., 2007; Braga and Valle 2007; Russell *et al*., 2011).

Measuring the activity of these enzymes in natural populations is an important step in monitoring insecticide resistance mechanisms worldwide and should be conducted together with the surveillance of control efficacy to prevent significant changes in susceptibility to the insecticides being used (Coleman and Hemingway, 2007; Polson *et al*., 2011). Metabolic-based resistance mechanisms are important in conferring insecticide resistance. Detoxifying enzymes, primarily esterases, glutathione-S- transferases and monooxygenases , may be qualitatively or quantitatively changed to confer resistance (Cui, *et al*., 2007) . Glutathione-S-transferase enzymes (GST) play an important role in detoxification of xenobiotic compounds including insecticides. GSTs can produce resistance to a range of insecticides by conjugating reduced glutathion (GSH) to the insecticide or by its primary toxic metabolic products (Hemingway, 2000; Enayati *et al*., 2005). There is limited information on susceptibility levels of mosquito vectors to insecticides in Alexandria and Bouherra. So the objective was to determine the current susceptibility status of *Culex pipiens* larvae, the primary vector of filariasis, to some insecticides commonly used in mosquito control programs. Moreover, activities of esterases and glutathione S- transferases (GST) activities among three field populations (Abou homoss, Nadi El Said, Montaza) with a laboratory susceptible strain to investigate the role of these enzymes in *C. pipiens* resistance to the commonly used insecticides.

MATERIALS AND METHODS

Insect strains: A *Culex pipiens* L. (Diptra: Culicidea) colony maintained in the laboratory of Medical and Veterinary Insects, Department of Economic Entomology, for more than 10 years was used as susceptible strain (S). The field strains were collected from different ponds from Abou Homouss (El-Bouherra governorate), Montaza and Nadi El Said districts (Alexandria governorate). Larvae were cultured in the laboratory for one generation. Mosquitoes were reared at 27±1 ℃, 70±5% RH, and a photo regime of 14: 10 hr (light: dark). adults were provided with a 10 % sucrose solution as food source. A pigeon was introduced twice a week to the adults for blood feeding. Larvae were reared in dechlorinated water under the same temperature and light conditions and were fed daily with baby fish food.

Insecticides used: Cypermethrin (Sparkill® 25% EC) was provided by Anchor Co. Egypt, deltamethrin (Embrator®) 2.5% EC was supplied by KZ CO. Egypt, temephos (Temepest®) 50% EC was obtained from Kalyanyi industries, India and spinosad (Tracer®) 24% SC was provided by Dow Agrosciences CO.

Larvicidal bioassay: The larval susceptibility test was conducted according to WHO guidelines (WHO, 1975 and 1981) using early fourth instar larvae. Sufficient numbers of larvae were kept in the same breeding water till the test was carried out. Series of each tested insecticide concentrations were prepared in addition to control were replicated four times. Lots of 25 larvae

were used for all the experiments that have been conducted at 27± 1 ℃ and 75± 5 RH. Mortality counts were carried out after 24hr of treatment. Mortality percentages were calculated and corrected according to Abbott (1925). Values of LC_{50}, confidence limits and slop functions were calculated and ascertained using probit analysis according to Finney (1971).

Biochemical analysis:

Sample preparation: Batches of 200 mg early fourth instar larvae, from each mosquito strain, were homogenized in 2ml of 0.1 M phosphate buffer pH 7.4 using a glass homogenizer immersed in ice cubes. The homogenates were centrifuged for 30 min at 10.000 xg at 4℃ using Cryofuge 20-3, Heraeus Christ Centrifuge. The supernatant was used as crude enzyme extract for enzymes assay.

Protein measurements: The protein concentration of enzyme extract was determined by the method of Bradford (1976). Absorbance at 595 nm was carried out. Each sample was replicated three times and the protein concentration extrapolated from a standard curve using bovine serum albumin.

Glutathione S- transferases assay: GST activity was measured according to the method of Asaoka and Takahashi (1983). Results were presented as a specific activity ±SD.

Esterases assay: Esterase activity was measured according to He (2003) using α- naphthyl acetate as a substrate. Production of α- naphthol was monitored with a spectrophotometer at 320 nm. All assays were done in triplicate at 37℃. The reaction mixture (1 ml) contained 50 mM sodium phosphate (PH 7.0) , 10 mM $MgCl_2$, 50 mM substrate and 100 µl crude esterase homogenate. The enzyme blank reference cuvette was used without the protein as a control.

Statistical analysis: Data was subjected to analysis of variance (ANOVA) (CoStat Statistical Software, 1990). The standard deviation (SD) of four replications was calculated. Means were compared with each other using Student- Newman Keuls (SNK) test (LSD at $P < 0.05$).

RESULTS AND DISCUSSION

Toxicity of the tested insecticides against four strains of *C. pipiens*:

Toxic effect of the selected insecticides against *Culex pipiens* 4^{th} instar larvae of the laboratory and field strains, collected from different locations was evaluated. The probit analysis of the obtained data illustrated the insecticidal activity of the selected insecticides as LC_{50} values (Table 1). Data showed that the 4^{th} instar larvae of the field strains demonstrated varied levels of resistance to the tested insecticides. It is clear that Abou homoss strain has the highest levels of resistance against the tested insecticides with resistance ratios of 27.3 , 22.2 and 24.8 – fold towards the evaluated insecticides cypermethrin (Sparkill®), deltamethrin (Embrator®) and temephos (Temepest®) , respectively. This high level of resistance may be due to the intensive use of insecticides in surrounding agricultural areas. Regarding Nadi El Said strain,

the resistance ratios were 15.6, 17.6 and 10.7 – fold towards cypermethrin (Sparkill®), deltamethrin (Embrator®), and temephos (Temepest®), respectively. Montaza strain recorded the lowest resistance ratios against the tested insecticides (12.75, 15.17 and 8.17-fold towards cypermethrin, deltamethrin and Temephos, respectively). The present results clearly suggest the differential resistance ratio of the three *Culex pipiens* field strains to cypermethrin, deltamethrin and temephos when they were compared with the lab. strain. The strategy for the control of vector population with the restricted group of insecticides is very crucial and facing challenge nowadays. Rotational use of different groups of insecticide rather than the use of different members of same group of insecticides is more effective to reduce and deal with the resistance problem. Carbamates and organophosphates must be used in rotation in order to maintain the pyrethroids susceptibility (Nauen, 2007). . Resistance against 5% deltamethrin was reported in *Culex quinquefasciatus* from Lahore, Pakistan (Tahir *et al.*, 2009). On the other hand, all strains recorded no resistance against spinosad (Tracer®), therefore, Tracer® can be used as a good alternative for mosquito control. This result agreed to a large extent with the findings of Darriet *et al*. (2005) who found that spinosad was significantly more effective against *An. gambiae* than against the other two mosquito species (*Cx. quinquefasciatus* and *Ae. aegypti)*, and was more effective against *Cx. quinquefasciatus* than against *Ae. aegypti*. No significant difference was noted between the susceptible and resistant strains of each mosquito species. Currently, mosquito control depends on chemical or biological insecticides that cause as small toxic effect as possible against man and the environment. In this regard, spinosad proved to be a valid alternative for eliminating the larvae of many culicid species because it is a mixture of two natural compounds produced during the fermentation of spinosad and it has LC_{50} of 5000mg/kg for rats (Tomlin, 2000). This larvicide, which has been noted for its successful use for control of *Ae. aegypti* and *An. albimanus* larvae in Mexico (Bond *et al.* 2004), merits detailed evaluation with other mosquito species, especially because the absence of cross-resistance with common insecticides (pyrethroids, carbamates, and organophosphates) which makes spinosad a potential candidate for disease vector control, particularly in areas which where mosquitoes are resistant to insecticides. Perez *et al.* (2007) concluded that spinosad was as effective as temephos granules in eliminating the immature stages of *Aedes* spp.The present results also agreed with Jones (2012) who found that the susceptibility of *Culex quinquefasciatus* to spinosad did not differ between the laboratory reference strain (Sebring-S) and field collected mosquitoes.

Table (1): Median lethal concentrations of some evaluated insecticides against three field strains of *Culex pipiens* compared to the laboratory strain.

insecticide	Mosquitostrain	LC_{50} (mg/l)	Lower limit (mg/l)	Upper limit (mg/l)	RR*	Slope ± S.E
	Lab	0.0016	0.0007	0.0039	1.0	1.35 ± 0.109
Cypermethrin	Abou homoss	0.04368	0.06	0.090	27.3	1.5 ± 0.125
(Sparkill®) 25%EC	Nadi El Said	0.0249	0.0171	0.081	15.56	1.35 ± 0.112
	montaza	0.0204	0.0192	0.029	12.75	1.41 ± 0.113
	Lab	0.0006	0.0005	0.0007	1	1.45 ± 0.150
Deltamethrin	Abou homoss	0.0133	0.0155	0.024	22.16	1.5 ± 0.162
(Embrator®)2.5%EC	Nadi El Said	0.0106	0.007	0.024	17.6	1.41 ± 0.152
	montaza	0.0091	0.01	0.0153	15.1	1.48 ± 0.158
	Lab	0.0006	0.0004	0.0009	1	1.63 ± 0.131
Temephos	Abou homoss	0.0149	0.0199	0.027	24.83	1.78 ± 0.147
(Temepest®)50%EC	Nadi El Said	0.0064	0.0053	0.0117	10.66	1.66 ± 0.136
	montaza	0.0049	0.0049	0.006	8.16	1.67 ± 0.135
	Lab	0.14	0.103	0.277	1	2.04 ± 0.190
Spinosad	Abou homoss	0.714	0.678	1.3005	5.1	2.9 ± 0.250
(Tracer®) 24% SC	Nadi El Said	0.336	0.2505	0.5808	2.4	2.68 ± 0.238
	montaza	0.49	0.385	0.875	3.5	2.28 ± 0.217

*RR=Resistance Ratio

Activity of glutathione S-transferase (GST) and esterases in the tested strains of *Culex pipiens* :

GST and esterases activities in the susceptible laboratory strain and three field strains are shown in Fig. (1). Activities of GST and esterases were found to be significantly higher in all field strains compared to the activities of the susceptible one. The GST activities in the field strains (Abou homoss , Nadi El Said and montaza strains) were 2.57, 2.00 and 1.65 - fold , respectively, of that of the laboratory strain Abou homoss strain recorded the highest esterases activity (2.26- fold) compared with that of the laboratory strain, while Nadi El Said and montaza strains esterases activities were 2.11 and 1.83-fold of the laboratory strain esterases activities. There was a significant correlation between all enzyme activity levels and insecticide resistance phenotype by populations. The most probable reason for this, as explained by Ahmed and Wilkins (2002), when an insecticide enters an organism, before reaching its target site, it could meet with different enzyme and protein obstacles and as a result of interactions with these enzymes the insecticide is degraded. The latter results agreed to a large extent with the findings of Bisset *et al.* (2011) who recorded high levels of resistance in all tested strains of the mosquito *Aedes aegypti* and also they found that resistance ratios were highly correlated with esterase activity (P = 0.00001). On the contrary, the present finding of the correlation between the GST activities and the resistance ratio was disagreed with Bisset *et al.* (2011) who reported that neither GST nor monooxygenases were associated with the increase in *Aedes aegypti* resistance to temephos.

The increased detoxification is a common mechanism of resistance to pesticides (Openoorth, 1985). In *Culex pipiens*, such a mechanism is often involved in resistance to organophosphates . However, the low levels of

organophosphate and pyrethroid resistance could be conferred by either the elevated esterase or monooxygenase enzymes (Penilla *et al*., 1998).

Several earlier workers stated that pyrethroids do not serve as substrates for GST (Reidy *et al*., 1990; Grant and Matsumura , 1989) . So, other enzymes systems have been proposed as being responsible for conferring metabolic detoxification of pyrethroids. However , induction of GST activity has been reported not only after exposure to organophophates and organochlorides but also against pyrethroid (Yu and Nguyen , 1996; Kostarpoulos *et al*., 2001). Reidy *et al*. (1990) and Grant and Matsumura (1989) reported that there were correlation between the elevated levels of GST and resistance to pyrethroids for *Tribolium castaneum* and *Aedes aegypti*, respectively. Therefore, the significantly higher level of GST activity might play a role in pyrethroid resistance in *Culex pipiens* along with esterase activity.

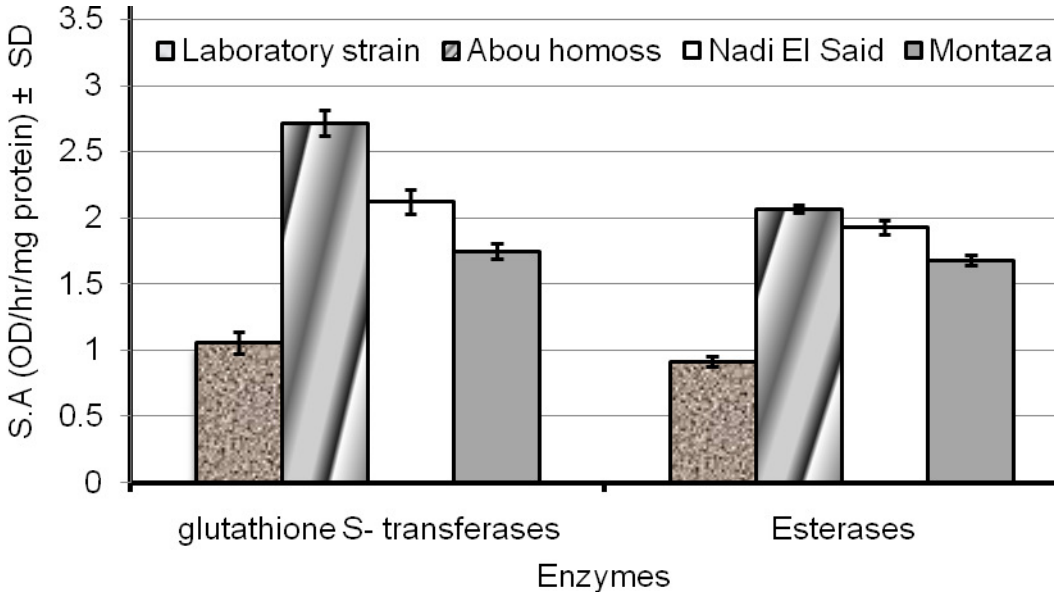

Figure 1: Activity of gluatthione S- transferases and esterases in the field and laboratory strains of *Culex pipiens* .

The results of the present study showed that the field populations have highest levels of esterases and glutathione S-transferases activities and resistance to the tested insecticides. These results suggest that esterases and glutathione S-transferases enzymes have major role in metabolic resistance to the used insecticide.

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الملخص العربي

مقارنة سمية بعض المبيدات الحشرية التقليدية ضد يرقات بعوض الكيولكس بيبينز من مناطق مختلفة في مصر

حسام الدين مجدى زهران

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تم دراسة حساسية العمر اليرقي الرابع لبعوض الكيولكس بيبينز لأربعة من المبيدات المعتاد إستخدامها ضمن برامج مكافحة البعوض و هي سيبرمثرين (سباركل®)، دلتامثرين (إمبراطور®)، تيميفوس (تيمبست®) و الإسبينوساد (تريسر®). كذلك تم دراسة الإختلاف فى النشاط النوعى لإنزيمات الإستيريز و الجلوتاثيون – إس ترانسيفيريز فى ثلاثة سلالات حقلية [أبو حُمص (محافظة البحيرة) ونادى الصيد والمنتزه (محافظة الأسكندرية)] ومقارنتها بالسلالة المعملية الحساسة وذلك لمعرفة الدور الذى تلعبه هذه الإنزيمات فى تطور ظهور المقاومة فى البعوض تجاه تلك المبيدات المختبرة. وقد وجد أن أعلى مستوى مقاومة للمبيدات المختبرة كان فى سلالة أبو حمص بمقدار ٢٧.٣ ، ٢٢.٢ ، ٢٤.٨ ضعف. أقل مستوى مقاومة كان فى سلالة المنتزه بمقدار ١٢.٧٥ ، ١٥.١٧ ، ٨.١٧ ضعف تجاه المبيدات المختبرة سيبرمثرين (سباركل®)، دلتامثرين (إمبراطور®)، تيميفوس (تيمبست®) على الترتيب. على الجانب الآخر، وجد أن جميع السلالات المختبرة لم تسجل أي مقاومة تجاه المبيد سبينوساد (التريسر®). هذا وقد أظهرت جميع السلالات الحقلية المختبرة زيادة معنوية فى النشاط النوعى لإنزيمات الإستيريز و الجلوتاثيون – إس ترانسيفيريز مقارنة بالسلالة المعملية الحساسة .

وقد اتضح من خلال نتائج الدراسة الحالية أن لإنزيمات الإستيريز و الجلوتاثيون – إس ترانسيفيريز لها دور أساسي فى تطور ظهور المقاومة فى بعوض الكيولكس بيبينز تجاه المبيدات المختبرة .

Biosafety of Stevia Extract Employing a Variety of Short-Term Genotoxic Bioassays

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ABSTRACT: Current work was carried out to assess the possible genotoxic effect of the natural sweetener Stevia in causing DNA damage, in order to achieve such a purpose, the genetic material of mice (*Mus musculus*, 2n=40) and human (*Homo sapiens*, 2n = 46) were chosen and used employing the following short-term genotoxic bioassays recommended by Environmental Protection Agency (EPA-USA): 1- Analysis of chromosomal abnormalities in mice bone-marrow cells; 2-Analysis of mice primary spermatocytes 3-Analysis of micronucleated polychromatic erythrocytes in mice; and 4- Chromosomal aberrations in human lymphocyte culture. The obtained results clearly showed that Stevia extractwas proven to be negative in causing DNA damage, which gave a strong evidence, at the level of the present study, that Stevia extract is recommended to be suitable for human usage.
Keywords: Stevia Extract, Biosafety, Short-Term, Genotoxic Bioassays.

INTRODUCTION

Stevia rebaudiana (Bertoni) is a small perennial shrub that has been used for centuries as a bio sweetener and for other medicinal uses such as to Lower Blood Sugar, Weight Loss, Microorganism inhibitor, oral tonic digestive aid and skin care. Its white crystalline compound (stevioside) is the natural herbal sweetener with no calories and is over 70-400 times sweeter than that of white sugar (Bharat *et al*., 2013).

In 1970, the Japanese food manufacturers began to use Stevia extracts as a natural sweetener. Now, about 40% of the sweetener Japanese market is Stevia based. Also, the use of products and extracts of Stevia are widespread throughout a lot of countries, such as China; Taiwan; Thailand; South Korea; Brazil; Malaysia; Indonesia; Argentina; Paraguay; Philippines; and Vietnam (Soejarto *et. al.,* 1982).

In 1994, Egypt has registered Stevia as a natural sweetener for use in food. The products in which Stevia has been used include soft drink; ice cream; cookies; chewing gum; tea and skin care products. In addition, Stevia and its extract are very important in weight-loss programs for their ability to reduce craving sweet and fatty foods. This plant has also been used to treat some diseases such as diabetes; high blood pressure; skin abrasions and inhibiting growth and reproduction of bacteria-like plaque (Tomita *et al.,* 1997). The gap between sugar production and consumption in Egypt is widening. In October 2013 Egypt had produced about 2012 Thousand Metric Tonnes (TMT) of sugar and imported 1208 TMT (GAIN Report, 2013/2014).

At the same time, five grams of stevioside can substitute one kilogram of table sugar. Thus, the cultivation of Stevia in Egypt as a main natural sweetener may reduce the gap between sugar production and consumption. Moreover, water requirements for the growth of sugarcane plants are relatively quite high, Sugarcane plant needs three times the water amount compared with Stevia, which requires approximately 300 m^3 water/feddan. Also, Stevia can grow under different climatic conditions and in different type of soils (Jia, 1984). So, there is a great interest on the strategical agriculture plan for Stevia cultivation in the new land reclamation projects to meet the demands of the Egyptian

markets and generate income for the growers.

Furthermore, stevia extracts can increase the palatability and attractiveness (enjoyment) of food through enhancement of flavors and odors (Ikan *et al*., 1993). Moreover, Stevia combines with other sweeteners to enhance their nutritive values (Shibata *et al.,* 1991).

Genotoxins are agents that specifically producing genetic alterations at sub-toxic exposure levels which result in organisms with altered hereditary characteristics. Depending upon the developmental stage of an individual, a genotoxin can exert teratogenic effect or cause mutations not only in somatic cells but also in germinal ones (Brusick, 2003).

In the last few years, several investigators reported that no acute toxicity for stevioside was achieved in doses as large as 15 g/body weight/day (Medon *et al.,* 1982; Krejci and Koechel, 1992 and Toskulkao *et al.,* 1997). It seems that no acute toxicity for stevioside but several question of concern were raised regarding the specifications of the stevia extract that had been tested, questionable chronic toxicity and carcinogenicity studies and possible effects on the male reproductive system that could affect fertility.

There are many systems to test mutagenicity using Drosophila as a genetic model to detect different genetic end points such as dominant lethal mutations (W**ü**rgler *et al.,* 1986); Bacteria (Terai *et al.,* 2002) and Saccharomyces cerevisiae (Badawy *et al.,* 2004).

The present investigation was carried out to study the biosafety of stevia extract employing a variety of short-term genotoxic bioassays. To achieve such a purpose the genetic materials of mice (somatic & germinal) and of human genomes were used.

MATERIALS AND METHODS

The present study aims to assess the possible genotoxity of Stevia extract (biosafty) employing mice (*Mus musculus*, 2n = 40) and Human (*Homo sapiens*, 2n = 46) genomes.

Stevia rebaudiana (Bertoni); Stevia 1108 and Stevia 9B-11 were imported from USA through the Faculty of Agriculture, Alexandria University, Egypt. An additional stevia variety namely Sponti was obtained from Sugar Crops Research Institute (SCRI), Agricultural Research Center (ARC), Ministry of Agriculture, Egypt.

Stevia rebaudiana (Bertoni) seeds were cultivated in pots (Bitmos : sand : clay) (1:1:1) at green house at Sabahia Agricultural Research Station in December 2013. The plants were harvested in mature stage before flowering.

Albino Swiss mice, Webster strain, weighting of 20±2 g were purchased from Faculty of Medicine, Alexandria University, Alexandria, Egypt. Animals were housed in cages in a room kept at 21℃ with a 12 h light/dark cycle, and given food and water *ad libitum* the local committee approved the design of the experiments, and the protocol conforms to the guidelines of the National Institutes of Health (NIH).

Heparinized human blood samples were taken from healthy volunteers 20-22 years old. They were non-smokers, non-subjected to any medical treatment.

Preparation of aqueous extract of Stevia leaves

Extraction of Stevia sweeteners has been carried out with water for each genome (Mondal *et al.,* 2012). Fresh leaves of Stevia washed thoroughly tap water then were dried in an electric oven (E. Schulz & Co. Inh. Franz. Skorezewsh KG). The dry leaves were ground into coarse powder by a hammer mill, then sieved through 60 mesh sieve, and finally stored in polyethylene bags until used. About 10 g of the ground leaves were extracted with 1.0 liter of hot water (80℃ ± 5℃) in a thermostatically controlled water bath for 2 hrs and then filtered through filter paper (Whatman No.4). The filtrate was freeze-dried using lyophilizer into powder and stored at 4℃. Stevia sweetener extract was determined through HPLC (high-performance liquid chromatography) as given by Kolb *et al.* (2001) Figure (1).

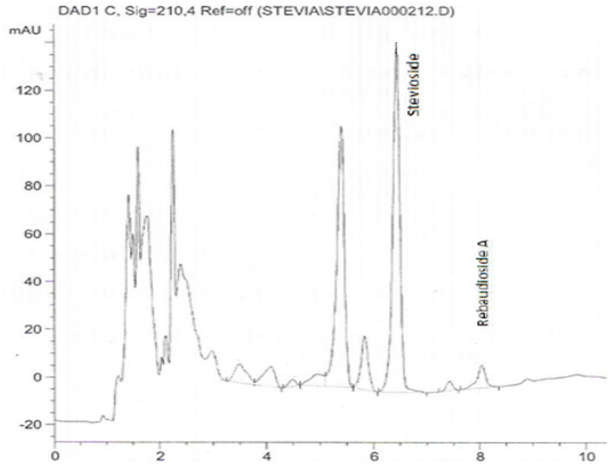

Figure (1): Chromatogram of Stevia sweetener from Sponti extract

(HPLC system Linear gradient 84 to 55% CH_3CN/H_2O, H_3PO_4, pH = 5), over 20 min, detection at λ = 210 nm, Agilent 1200 PDA detector, Eclipse plus C_{18} column (3.5 µm 4.6x250 mm); flow rate 2.0 mL/min.)

Experimental design

Treatments were divided into three groups as follow: Group I (as negative control), the animals received distilled water, Group II (as a positive control), each animal was given 1 ml of indoxan (cyclophosphamide) two times daily for 10 days (25 mg/kg b. wt.), while Ethyl methane sulfonate (EMS) with a concentration of 0.02M was used as a positive control in human lymphocyte, and the animals in groups III were obtained one ml of Stevia extract two times daily which contains 500 mg of Stevia sweeteners, for a month, while in the primary spermatocytes treatment, the dose was orally given three times daily which contains 750 mg of Stevia sweeteners, for a week. Four mice were used for Stevia extract treatment including the negative and positive control as well.

The following genotoxic bioassays were chosen and used:

1- Analysis of chromosomal abnormalities in mice bone-marrow cells,
2- Analysis of mice primary spermatocytes,
3- Analysis of micronucleated polychromatic erythrocytes in mice, and

4- Chromosomal aberration in human lymphocyte cultures.

1. Analysis of chromosome behavior in mice bone marrow cells

The treated animals were killed by decapitation 24 hrs after the last dose. Three hours prior to killing, the animals were injected with 0.6 mg/kg of colchicine. After killing, the adhering soft tissues and epiphyses of both tibiae were removed. The marrow was aspirated from the bone, transferred to phosphate buffer saline, centrifuged at 1200 rpm for 5 minutes and the pellet resuspended in 0.075 M KCl. Centrifugation was repeated and the pellet was resuspended in fixative solution (methanol: acetic acid, 3:1). The fixative was changed after 2 hours and the cell suspension was left overnight (in a refrigerator).

Slide preparation and staining

Cells in fixative were dropped on a very clean glass slide and air-dried. Spreads were stained with 10 % Giemsa at PH 6.8 for 5 min.

Screening of slides

Slides were coded and scored for chromosomal aberrations e.g., gaps, deletion, fragment, break, stickiness and hyperploidy. A mitotic index based on at least 1000 counted cells was recorded. For chromosomal abnormalities, at least 200 metaphase cells per dose were recorded. The comparison between treatments and control groups were statistically done.

2. Analysis of mice primary spermatocytes

Four male mice were used for each treatment. The dose was orally given three times daily which contains 750 mg of Stevia sweeteners, for a week. Ten days after the last dose, animals were killed by cervical dislocation. The used procedure follows basically the description given by Oud *et al*. (1979); Adler (1984); Seehy and Osman (1989) and Seehy (2007).

Tissue sampling: The testes were removed by making an incision into the scrotum and fat tissue was cleaned. The tunica were removed, transferred the tubules to a small Petri dish containing a piece of fly mesh and 3-4 ml of 2.2 % tri-sodium citrate. The tubules were cut up with forceps several times, and then they were mashed on the fly mesh with flat-top forceps. The fluid containing the cells was transferred to 12 X 100 mm round-bottom centrifuge tubes, centrifuged at 1000 rpm for 5 min. supernatant was completely discarded. The hypotonic solution (1 % trisodoum citrate) was slowly added and centrifuged, after 15-20 min, and then the cells were fixed in (methanol: glacial acetic acid, 3:1). The fixative was changed twice after 10 min for each by centrifugation between changes.

Staining

The slides were stained for at least 10 min using 10 % Giemsa (**P**H = 6.8), washed and air-dried.

3. Micronucleus test in mice

Male and female of strain Swiss albino, from randomly bred colony were used in the micronucleus assay. Four animals were used for each treatment. Each animal was received the proper dose of Stevia extract. The animals of the negative and positive control groups were received the proper volume of deionized water and cyclophosphamide, respectively.

Extraction of bone-marrow

Animals were killed after 24 hrs of the treatment time. The adhering soft tissue and epiphyses of both tibiae were removed. The marrow was aspirated from the bone, transferred to centrifuge tubes containing 5 ml fetal calf serum (one tube for each animal).

Preparation of the smears

Bone-marrow smear was made according to Schmid (1975). The tubes were centrifuged at 1200 rpm for 5 min., the supernatant was removed and a small drop of the viscous pellet was transferred on the end of a slide and spread by a cover glass held at an angle of about 45degrees. The preparation was then air-dried.

Staining

The preparations were stained in ordinary vertical staining jar according to method described by Gollapudi and Kamara (1979). The slides were fixed in absolute methanol for 5 min., rinsed twice in deionized distilled water, stained for 10 min. in Giemsa (1:6 Gurr's R-66 Giemsa in deionized water), rinsed again thoroughly in deionized distilled water, air-dried, cleaned in xylene for 3 min and mounted.

Screening of slides

A thousand polychromatic erythrocytes per animal (4000 per treatment) were scored using a special hand counter. The frequency of micronucleated cells was expressed as percent of micronucleated cells based on the total polychromatic erythrocytes percent.

In this part of study, only polychromatic erythrocytes were scored according to Brusick (1986). Micronuclei were identified as dark-blue staining bodies in the cytoplasm of polychromatic erythrocytes. The data obtained from this study were analyzed according to Hart and Pederson (1983).

4. Analysis of chromosomal abnormalities in human lymphocytes

In order to investigate the possible activity of the extract in causing chromosomal abnormalities in human chromosomes, the same procedure as that described by Seehy and Osman (1989) was used. Ethyl methane sulfonate (EMS) with a concentration of 0.02M was used as a positive control. At 70 hrs. of incubation at 37ºC colcemid was added to each tube. At 72 hrs. after initiation of the cultures, harvest the cells and prepared slides and stained by Giemsa 10%.Chromosomes were investigated for deletion, gaps, and fragment. …etc.

RESULTS

As mentioned before, this work was carried out to detect the possible genotoxic effect (Macro DNA damage) of *Stevia rebaudiana* (Bertoni) employing Mice (*Mus musculus,* 2n = 40) and Human (*Homo sapiens*, 2n = 46).

The data obtained from the analysis of mice bone marrow after treatment with the variety Sponti and two American Genotypes Stevia 1108 and Stevia 9B-11 in addition to the negative as well as positive control were summarized in Table (1).

As shown in Figure (2) total percentages of aberrant metaphases were 21.5% and 81% for the negative and positive control, respectively. However,

they were 30.5%, 18.5%, and 15% for the genotypes Sponti, 1108 and 9B-11.

Table (1): Percentage of chromosomal abnormalities in mice bone marrow cells after treatment with tested Stevia extract (Sponti, 1108 and 9B-11), negative control and positive control

Genotype and treatment	Type of aberrations					Total aberrant	Percentage of total aberrant metaphases
	Stickiness	Deletion	Fragment	RCF	Ring chromosome		
Sponti	13	12	10	3	20	61	30.5
1108	12	4	10	3	8	37	18.5
9B-11	11	8	3	2	6	30	15
NC	9	-	30	1	3	43	21.5
PC	44	40	48	9	21	162	81

NC: Negative Control.
PC: Positive Control.
200 cells were counted.

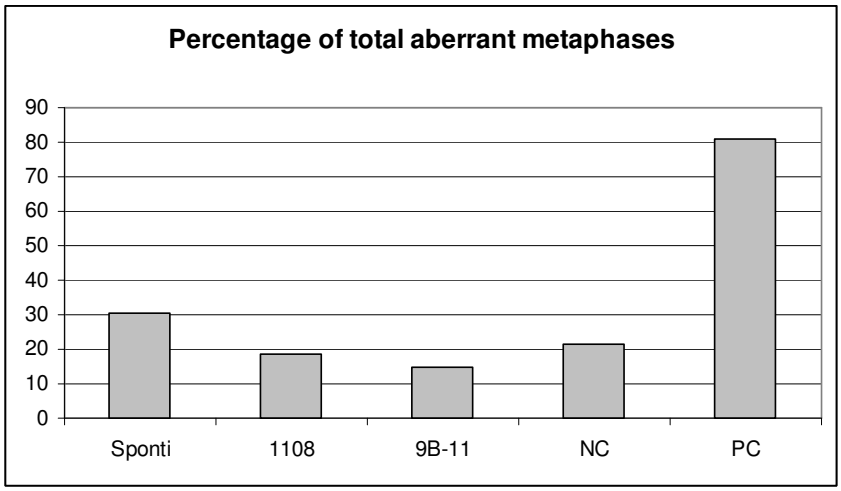

Figure (2): Percentage of total aberrant metaphases in mice bone-marrow cells after treatment with Stevia extract (Sponti, 1108 and 9B-11), negative and positive control.

Statistical analysis in Table (2) shows that all tested varieties of Stevia were found to be not significant.

Table (2): Statistical analysis (Chi square x^2) of chromosomal abnormalities in mice bone marrow cells after treatment with tested Stevia extract (Sponti, 1108 and 9B-11), negative control and positive control

Genotypes	Obs.	Exp.	(Obs.-Exp.)^2 /Exp.	Chi square tabulated
Sponti	61	52	1.6	df=1 at 0.05=3.841
1108	37	40	0.225	
9B-11	30	36.5	1.16	
NC	43	0	0	
PC	162	102.5	34.5	

Table (3) and Figure (3) show comparison between Sponti variety and the American ones in addition to the negative as well as positive control. All varieties were proven to be negative in causing significant aberration in mice primary spermatocytes. Total percentages of aberrant diakinesis were 14.5% and 77% for the negative and positive control respectively. However, they were 5.5%, 13%, and 9.5% for the varieties Sponti, 1108 and 9B-11.

Table (3): Percentage of abnormalities in mice primary spermatocytes after treatment with Stevia extract (Sponti, 1108 and 9B-11), negative and positive control

Genotype and treatment	Type of aberrations							Total aberrant diakinesis	Percentage of total aberrant diakinesis
	Polyploidy	RCF	Bi-nucleate	Stickiness	Ring chromosome	Micro nuclei	Fragment		
Sponti	1	-	3	4	2	1	-	11	5.5
1108	-	2	4	10	3	1	6	26	13
9B-11	-	1	8	4	3	1	2	19	9.5
NC	-	-	8	16	2	2	1	29	14.5
PC	-	11	7	66	26	2	42	154	77

NC: Negative Control.
PC: Positive Control.
200 cells were counted.
RCF: Robertsonian Centric Fusion

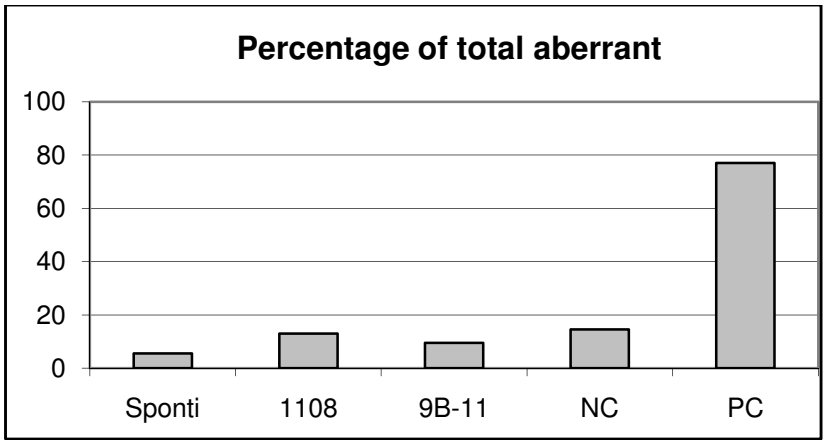

Figure (3): Percentage of abnormalities in mice primary spermatocyte cells after treatment with tested Stevia extract (Sponti, 1108 and 9B-11), negative control and positive control.

Table (4) revealed that, there was a significant increase in aberrations after treatment with positive control while negative control and all tested genotypes of Stevia were found to be not significant.

Table (4): Statistical analysis (Chi square x^2) of abnormalities in mice primary spermatocyte after treatment with tested Stevia extract (Sponti, 1108 and 9B-11), negative control and positive control

Treatments	Obs.	Exp.	(Obs.-Exp.)^2 /Exp.	Chi square tabulated
Sponti	11	20	4.05	
1108	26	27.5	0.08	**df=1 at 0.05=3.841**
9B-11	19	24	1.04	
NC	29	0	0	
PC	154	91.5	42.7	

Table (5) and Figure (4) show the effect of Stevia extract upon the induction of micronucleated polychromatic erythrocyte (MNPE). Positive control gave 1.75%, while negative control gave 0.25%. This percentage ranged from 0.5 to 1.25% for genotypes Sponti and 9B-11, respectively.

Table (5): Micronucleated polychromatic erythrocyte (MNPE) in mice bone-marrow cells after treatment with tested Stevia Extract

Treatment and genotypes	No. of MNPE	MNPE%
Sponti	20	0.50
1108	40	1.00
9B-11	50	1.25
N.C	10	0.25
P. C	70	1.75

Number of examined cells = 4000 cells

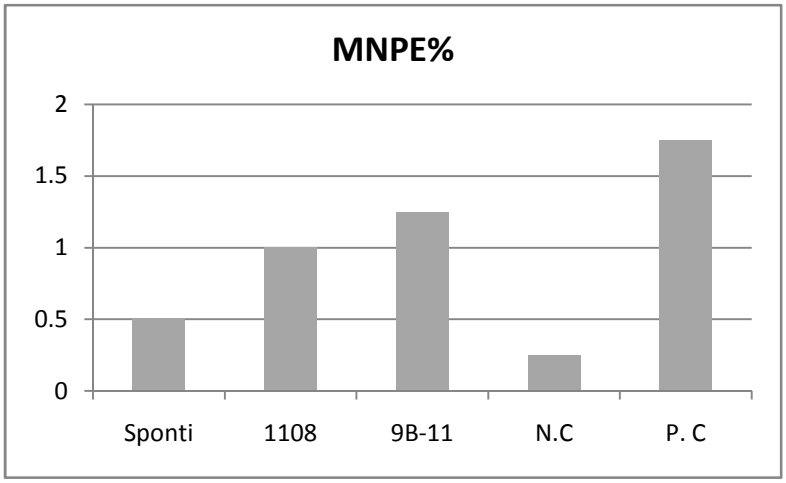

Figure (4): Micronucleated polychromatic erythrocyte (MNPE) in mice bone-marrow cells after treatment with Stevia Extract.

Figures 5 – 24 illustrate the effect of Stevia extract upon mice genome compared with the positive control. Figures 25 – 29 show the effect upon human chromosomes.

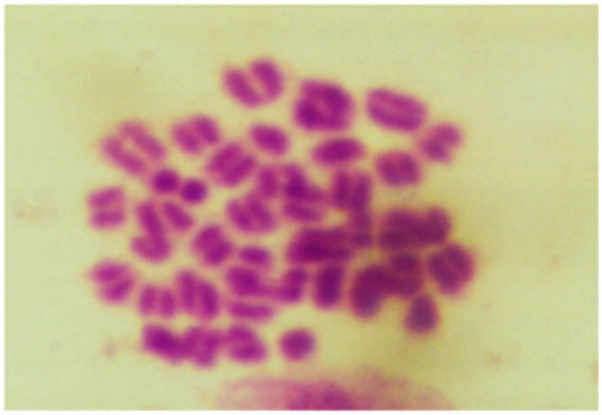

Figure (5): Photomicrograph showing spearmatogonial cell with polyploidy of mice treated with Sponti variety extract.

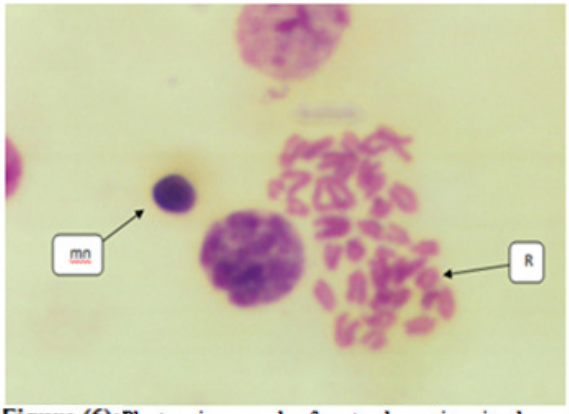

Figure (6): Photomicrograph of metaphases in mice bone marrow showing Ring chromosome (R) and Micronucleus (mn) after treatment with variety (1108) extract.

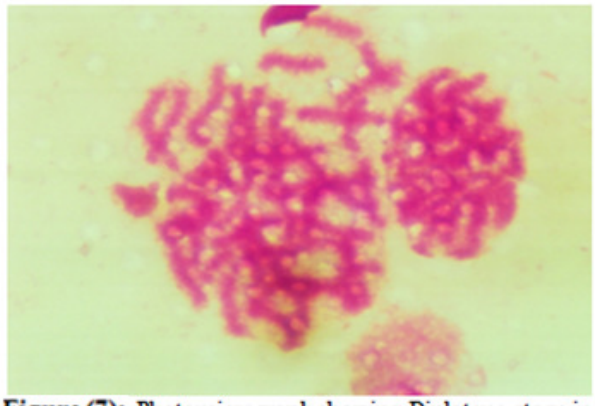

Figure (7): Photomicrograph showing Diplotene stage in mice primary spermatocytes after treatment with variety (1108) extract.

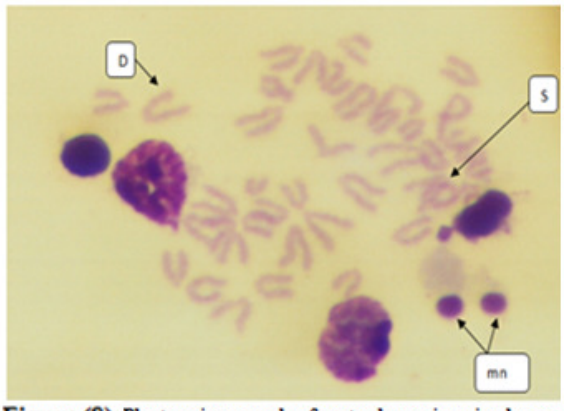

Figure (8): Photomicrograph of metaphases in mice bone marrow chromatide deletion (D) and Stickiness (S) and Micronucleus (mn) after treatment with variety (9B-11) extract.

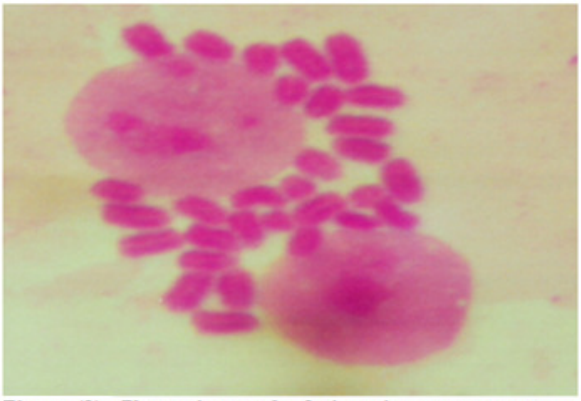

Figure (9): Photomicrograph of mice primary spermatocytes showing Spearmatogonial cell after treatment with varietv (9B-11) extract.

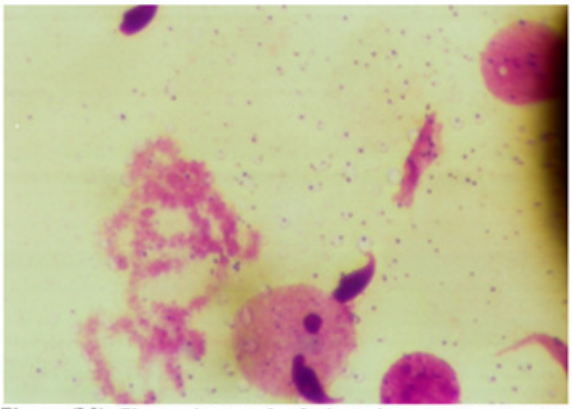

Figure (10): Photomicrograph of mice primary spermatocytes showing sperm heads after treatment with variety (9B-11) extract.

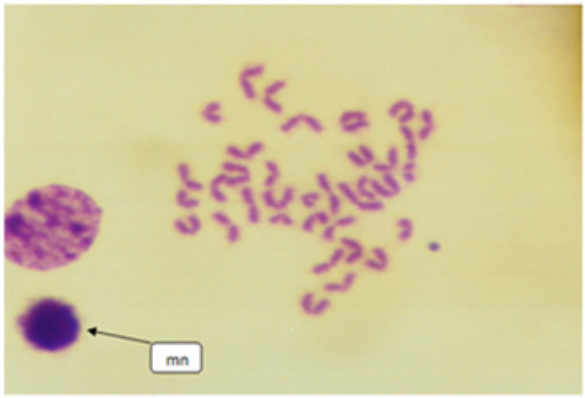

Figure (11): Photomicrograph of metaphases in mice bone marrow showing normal chromosomes and micronucleus (**negative control**).

Figure (12): Photomicrograph showing normal Diplotene stage of mice primary spermatocytes and normal sperm head (**negative control**).

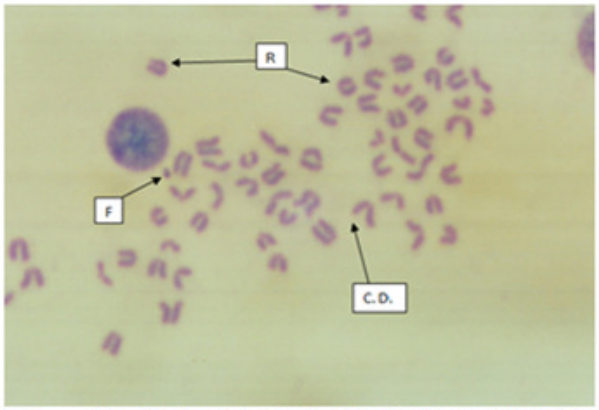

Figure (13): Photomicrograph of metaphases in mice bone marrow showing polyploidy, chromatid deletion (cd), fragment (F) and ring chromosome (R) after treatment with cyclophosphamide.

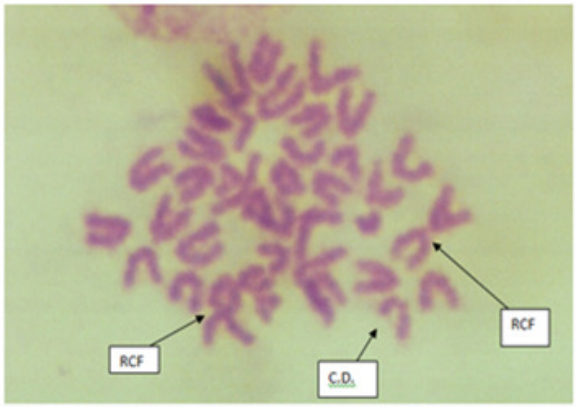

Figure (14): Photomicrograph of metaphases in mice bone marrow showing chromatid deletion (cd) and Robertsonian Centric Fusion (RCF) after treatment with cyclophosphamide.

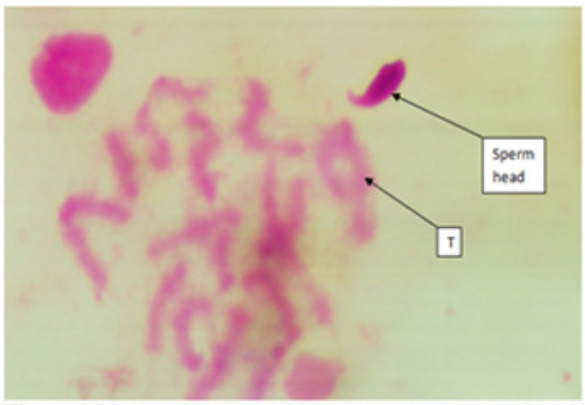

Figure (15): Photomicrograph showing Diplotene stage in mice primary spermatocytes after treatment with cyclophosphamide. Note heterozygous reciprocal translocation (T).

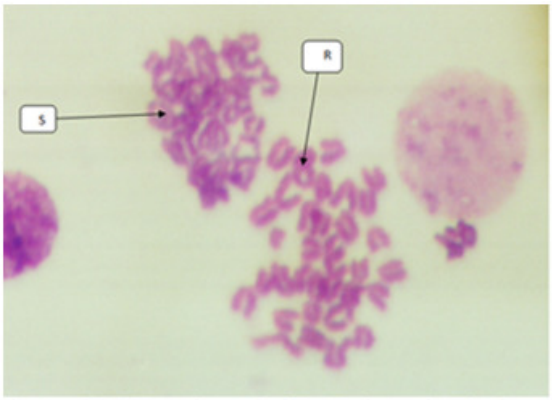

Figure (16): Photomicrograph of metaphases in mice bone marrow showing polyploidy with Ring chromosome (R) and high degree of stickiness (S) after treatment with cyclophosphamide.

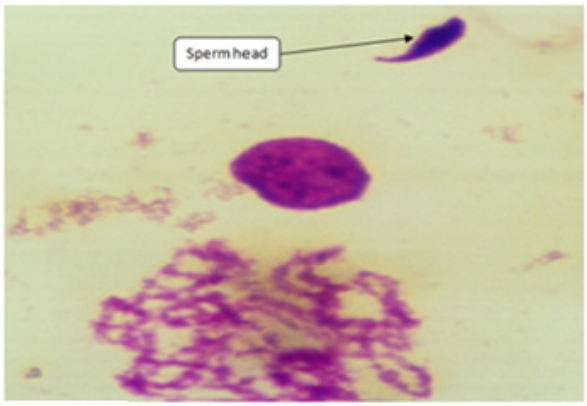

Figure (17): Photomicrograph of mice primary spermatocytes showing sperm head and inversion after treatment with cyclophosphamide.

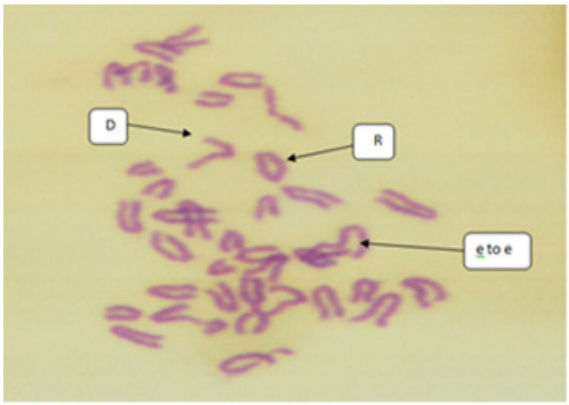

Figure (18): Photomicrograph of metaphases in mice bone marrow showing Ring chromosome (R), Chromatide deletion (D) and end to end association (e to e) after treatment with cyclophosphamide.

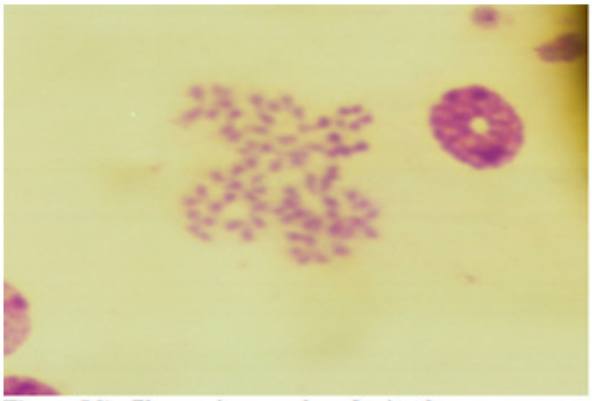

Figure (19): Photomicrograph of mice bone marrow showing chromosome degradation induced after treatment with Cyclophosphamide (positive control).

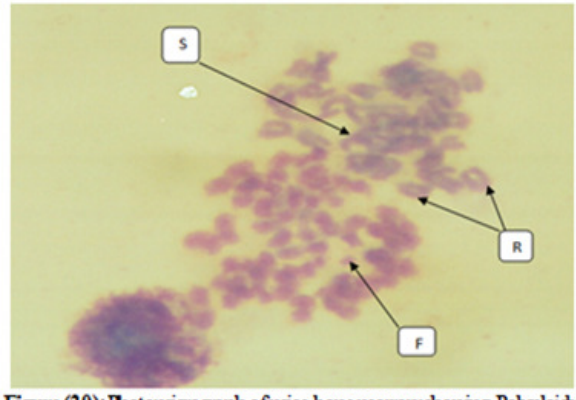

Figure (20): Photomicrograph of mice bone marrow showing Polyploidy with Ring shromosome(R), Chromosome fragment and Stickiness induced after treatment with Cyclophosphamide (**positive control**).

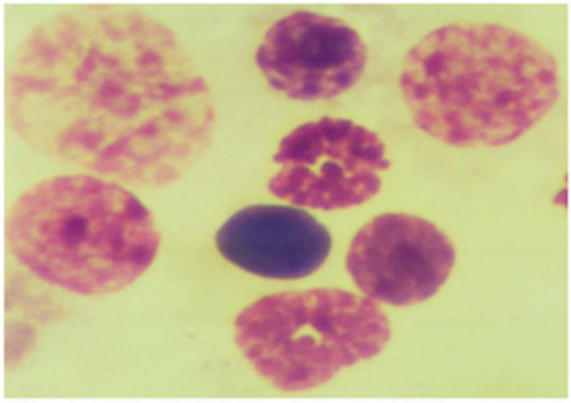

Figure (21): Photomicrograph of mice bone marrow showing binucleate induced after treatment with Cyclophosphamide (positive control).

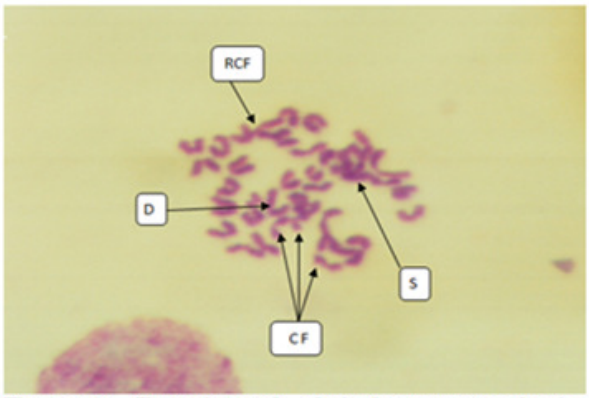

Figure (22): Photomicrograph of mice bone marrow showing Chromosome fragment (CF), Stickiness (S) Chromatide deletion (D) and Robertsonian Centric Fusion (RCF) induced after treatment with Cyclophosphamide (positive control).

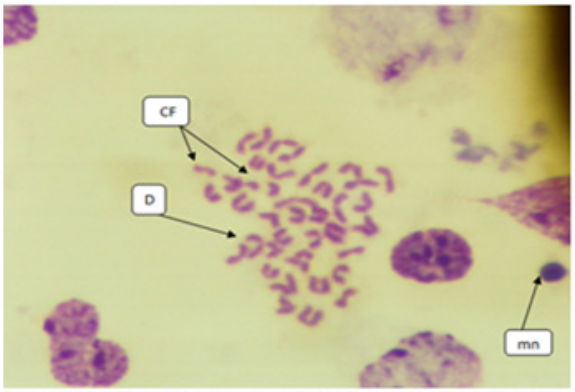

Figure (23): Photomicrograph of mice bone marrow showing Chromosome fragment, and chromatide deletion (D) induced after treatment with Cyclophosphamide (positive control).

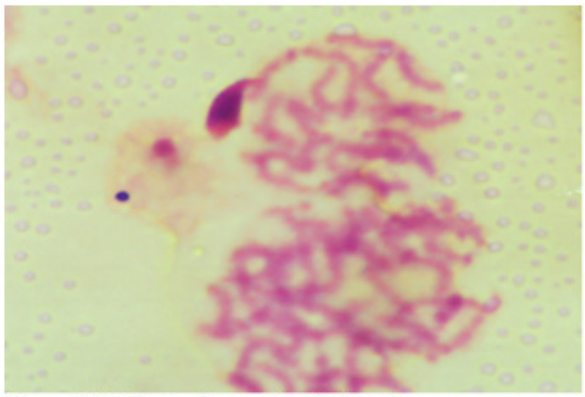

Figure (24): Photomicrograph of mice primary spermatocytes showing Polyploidy and Inversion induced after treatment with Cyclophosphamide (positive control).

Analysis of human lymphocyte cultures after treatment with the tested verities of Stevia extract proved that: 1. No significant increase in aberration and 2. This extract is negative and was not capable in causing Primary DNA damage.

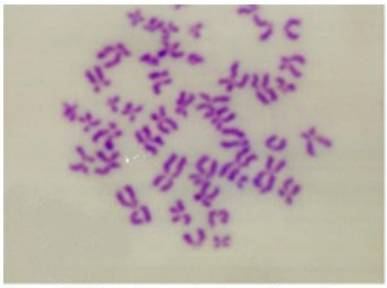

Figure (25): Photomicrograph of normal metaphase stage in human lymphocytes after treatment with Sponti variety extract.

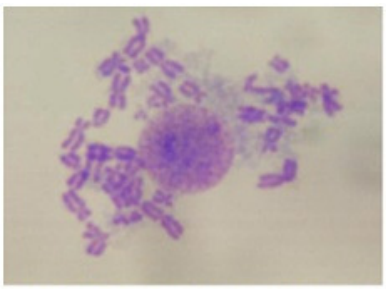

Figure (26): Photomicrograph of normal metaphase stage in human lymphocytes after treatment with variety (1108) extract.

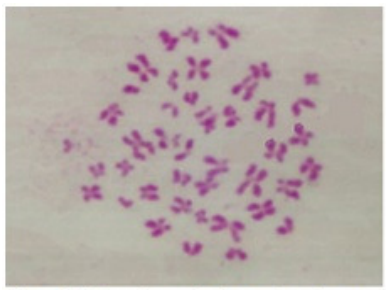

Figure (27): Photomicrograph of normal metaphase stage in human lymphocytes after treatment with variety (9B-11) extract.

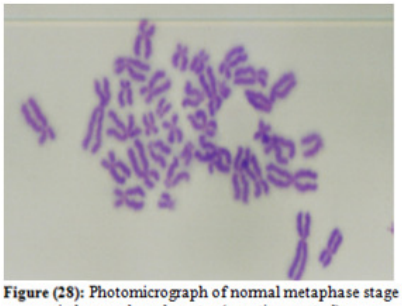

Figure (28): Photomicrograph of normal metaphase stage in human lymphocytes (negative control).

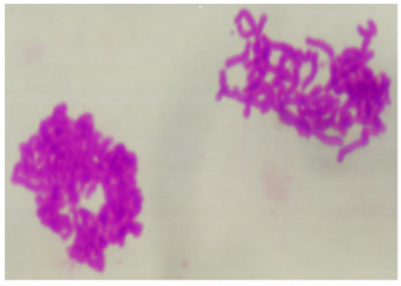

Figure (29): Photomicrograph of metaphase stage in human lymphocytes showing high degree of Stickiness induced by (EMS 0.02 M). positive control.

DISCUSSION

The history of Stevia as a safe sweetener is very inconsistent. There has been controversial debate over its use from the date it entered the human foods. Also, the research that has been done to approve its safety for human consumption or confirm its deleterious effects has provided inconsistent results. For example, Stevia extract was evaluated for its genotoxic potential using the comet assay. This showed that Stevia extract and steviol do not have DNA-damaging activity in cultured cells and mouse organs (Sekihashi *et. al*., 2002). In contrast, in vitro Ames test was used to test the mutagenic effect of stevioside and steviol using Salmonella typhimurium TA 98 and TA 100 as the tester strains. Stevioside and steviol at the concentrations up to 50 mg and 2 mg per plate respectively showed no mutagenic effect on both tester strains either in the presence or absence of metabolic activating system. However, at the high concentration both stevioside and steviol showed some toxic effects on both tester strains. While, the toxic effect was decreased in the presence of the metabolic activating system (Klongpanichpak *et. al*., 1997). Stevioside and steviol did not show any significant chromosomal effect in cultured human lymphocytes. This indicates that stevioside and steviol are neither mutagenic nor clastogenic in vitro at the used doses. However, in vivo genotoxic tests and long-term effects of stevioside and steviol are yet to be investigated (Suttajit *et. al*., 1993). Steviol was found to induce mutations at the guanine phosphoribosyltransferase gene (gpt) of Salmonella typhimurium TM677 wit metabolic activation. However, it is completely negative in the reverse mutation assays using E. coli WP2uvrA/pKM101 or S. typhimurium TA strains (Matsui *et. al*., 1996). Steviol was found to be mutagenic after metabolic activation in the forward mutation assay using Salmonella typhimurium TM677 (TM677). The results of obtained from such a research are in a harmony with those obtained by W**ü**rgler *et al.,* (1986) on Drosophila; Matsui *et al.* (1989) on Salmonella typhimurium TA 100, TA98, TA102 and TA97 and Badawy *et al.* (2004) on Saccharomyces cerevisiae using different strains.

The present work revealed that Stevia as assessed by the short-term genotoxic bioassays carried out on Mice (Bone-marrow – micronucleus – and primary spermatocytes) was proven to be negative in inducing Macro DNA damage. On the other hand, it was found to be negative in causing primary DNA damage, such a result reflects the biosafty of Stevia usage for Human as a natural sweetener. These results are in agreement with those reported by Abdel-Tawab *et al.* (2004) who investigated the capability of stevioside to induce clastogenic effect in mice bone marrow. They found that no significant numerical or structural chromosomal aberrations observed in treated group or their offsprings. Roberts and Renwick (2008) examined the toxicokinetics and metabolism of rebaudioside A, stevioside, and steviol in rats for comparative purposes to determine whether toxicological studies conducted previously with stevioside would be applicable to the structurally-related glycoside, rebaudioside A. Overall, the data on toxicokinetics and metabolism indicated that rebaudioside A and stevioside are handled in an almost identical manner. These studies support the use of toxicological safety studies conducted with stevioside for the safety assessment of rebaudioside A (Roberts and Renwick, 2008).

Genetic toxicology was simplified for the purposes of regulatory toxicology safety testing. Most agencies expect to see a limited test battery consisting of tests for gene mutation and chromosome aberrations. The International Conference on Harmonization (ICH) core battery of tests is the best example of this approach, and this battery is expected to become the international standard for most testing requirements (Pugsley *et al.,* 2008).

In conclusion, at the level of this study the use of *Stevia rebaudiana* (Bertoni) as a natural sweetener for human usage is recommended.

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الملخص العربي

الامان الحيوى لمستخلص نبات الاستيفيا بتوظيف مجموعة من اختبارات السمية الوراثية قصيره المدى

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يهدف هذا البحث الى تقييم الأثر الضار وراثياً لمستخلص نبات الاستيفيا. ولتحقيق هذا الهدف تم عمل اختبارات السمية الوراثية قصيرة المدى على الفئران والانسان كالتالى:

١- تحليل كروموسومات خلايا نخاع العظام فى الفئران.

٢- تحليل الخلايا الاولية للحيوانات المنوية فى الفئران.

٣- قياس الانوية الصغيره بخلايا الدم الحمراء غير الناضجة فى الفئران.

٤- تحليل الشذوذ الكروموسومى فى مزارع الخلايا الليمفاوية فى الانسان.

أوضحت النتائج المتحصل عليها عدم حدوث اى ضرر وراثى من استخدام مستخلص الاستيفيا على مستوى الدراسة الحالية . وهذا بدوره يعطى دليلا قويا بالتوصية على إستخدام هذا المستخلص .

In Vitro Propagation of Croton (*Codiaeum Variegatum* Gold Dust.) using Nodal Explants from Field Grown Plants

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ABSTRACT: This study was carried out in the tissue culture laboratory , the Faculty of Agriculture, Saba basha, Alexandria University, Egypt during the period from 2012 to 2014 . An efficient and reliable protocol for *in vitro* propagation of croton (*Codiaeum variegatum* Gold Dust.) was optimized. However, nodal explants from field grown of Croton (*Codiaeum variegatum* Gold Dust.) were used during *in vitro* culture study for induction of multiple shoots. Nodal explants were inoculated on various initiation or establishment media with different combinations of NAA and BA and the neoformed shoots were cultured on proliferation (multiplication) media for the development of multiple shoots, and the elongation media to elongate of the neoformed shoot. The subsequent elongated shoots were rooted, and acclimatized *ex vitro,* successfully. The best medium for shoot initiation was WPM medium supplemented with 1.0 mg/l BA. The favourable medium for multiplication was the tested medium augmented with 2.0 mg/l BA and 0.50 mg/l NAA. In addition, the most effective medium for elongation was the used medium enriched with 1.0 mg/l NAA. Furthermore, th *in vitro* shoots showed healthy root development when the tested medium was supplemented with combination of 2.0 mg/l IBA and 0.50 mg/l NAA (rooting stage).The combination of sand: peat moss (4:1) was used as substratum for the hardening of the in vitro plantlets, as a potting mix, was the best suited mix for the acclimatization of plantlets.

Key words: *In vitro* culture, *Codiaeum variegatum*, nodal explants, initiation, multiplication, rhizogenesis, acclimatization

INTRODUCTION

Garden croton grows naturally in southern Asia, Indonesia, and other Eastern Pacific islands where it grows in open forests and scrub. It is an evergreen shrub growing up to 6 m in height but usually maintained at 60 to 90 cm and grows well in areas having humid climate. The family *Euphorbiaceae* comprises nearly 322 genera and 8910 species (Bingtao *et al*., 2008) many of which have their own economic value and hence contribute to the floristic wealth of tropical and subtropical countries of the world. The family comprises a number of endemic and endangered taxa. However the in vitro studies are confined only on a few genera of aesthetic, medicinal, timber yielding, rubber yielding, dye yielding, cottage industries, ornamental and food crops like *Acalypha, Baliospermum, Codiaeum*, *Cleistanthus, Croton,Euphorbia,Emblica, Eryngium, Excoecaria, Givotia, Glochidion, Hevea, Jatropha, Mallotus, Manihot,Phyllanthus, Putranjiva, Ricinus, Sapium and Uapaca* (Rajesh-Kondamudi *et al.,* 2009). In addition to its aesthetic value as an indoor plant, crotons are also well known for its medicinal value. The plant is also well reputed for the production of valuable secondary metabolites of alkaloids, terpenes and flavanoids in nature (Puebla *et al.,* 2003; Maciel *et al.,*1998; Martins *et al.,* 2002). Generally, crotons are multiplied vegetatively by averages of cuttings and air layering. These processes are slow in response and requires large number of mother/stock plants. Despite its slow rate of conventional

multiplication, the plant is very high in demand (Deepa and Shanthi,2013) . Hence, micropropagation is an alternative averages of propagation, to meet its high demand in relatively shorter time. For instance, from shoot tip cuttings, one mother/stock plant can yield only 20 plants per year (Nasib et al.,2008; Mulabagal and Tsay,2004). Micropropagation is a relatively new technology and application of innovative method that have served to overcome barriers to progress in the multiplication of elite species and further improvements are anticipated (Nasib *et al*.,2008 ; Ashish and Sharma, 2011) . *In-vitro* growth and development is considerably influenced by several factors like genotype, the age and size of mother plant and explants, the season, growth conditions, media composition, and various other physiological factors (Ashish and Sharma, 2011). Also, as a averages of securing pathogen free plants, culture of shoot apical meristem is ideal. Other advantages in this method include rapid multiplication of plants within shorter period of time irrespective of the season (Mulabagal and Tsay, 2004). Keeping the above points in mind, chosen croton was for micropropagation due to its rare success in conventional breeding and also due to the meager availability of data for *in-vitro* production (Shibata *et al*., 1996; Orlikowska *et al*., 2000). An improved and enhanced method was established for the *in-vitro* propagation of croton. Croton is an evergreen shrub with alternate, simple leaves mottled with white, yellow, or red flower. Flowers are small, long, axillary, usually unisexual racemes antiamoebic, and anticancerous activities (Kupchan *et al.,* 1976). The plant may change colour as it matures (Ogunwenmo *et al.,* 2007). Fruits are globular capsules and 3 to 8 mm in diameter.Hence, this species has been selected for the different morphology and color combination of leaves, with contrasting veins. The leaves are alternate, non-serrated but sometimes lobed. The leaf extracts of crotons are reported to have many medicinal properties including purgative, sedative, antifungal, Croton (*Codiaeum variegatum* ,Gold Dust) with its amazing colors and leathery leaves is regarded as a beautiful foliage plant commonly known as croton and sometimes called Joseph's Coat orvariegated croton (Nasib *et al.,* 2008).Propagation of croton by rooting of softwood cuttings has been a good development. Some authors have investigated how different compounds of the substrate can improve root induction (Tillmann *et al* .,1994; Chen *et al*., 2000 ;Dai- Bisheng, 2007). The present study was aimed to establish an efficient and reliable protocol for *in vitro* propagation with focusing on rhizegenesis of this hard –to- root species.

MATERIALS AND METHODS

Plant material and explants sterilization

The plant material was collected from shrubs grown in garden of Ornamental and landscape, of the Research Department of EL-Montazh, Alexandria, Egypt. The plants were sprayed with the fungicide and insecticide 2-3 week prior to start initiation and over head watering was strictly avoided. Freshly grown shoot tips, with two to three nodes , were selected as explants' source in August. The collected material was brought to the plant tissue culture laboratory of the Plant Production Department of the Faculty of Agriculture ,Saba Basha, Alexandria University during 2012-2014 seasons and washed, thoroughly, with running tap water for 30 minutes to remove the dust or sand particles. The shoot tips were cut to nodal segments (single node) as an

explants source (Bhattatacharya *et al*., 1990).The excised explants were dipped in 70% ethanol for 60 sec. After treatment with ethanol the explants were rinsed with double distilled water twice, so as to lower the toxic effect of ethanol. The nodal segment's surfaces were sterilized using 20% of sodium hypochlorite for 20 minutes and 1.5 mg/l mercuric chloride for 5 min. Few drops of Tween-20 , also, were added as a surfactant to sterilized water with sterile gentle shaking under sterile conditions . After 20 minutes the plant material was washed three times with sterilized water and became ready for culture.

Microprogation stages

1-Intiation stage

The explants were cultured on solidified woody plant medium coined as WPM (Lloyd and McCown, 1980) which contained different concentrations of the cytokinin benzyl adenine (BA) at four concentrations:0.0(nil), 0.5,1.0 and 1.5 mg/l,in combinations with the auxin Naphthalene acetic acid (NAA) at four concentrations: 0.0(nil) ,1.0, 2.0 and 3.0 mg/l.Three explants were cultured in each jar which containing 30ml of medium and were placed, vertically. Each treatment was replicated three times and each has 3 explants (i.e.9 explants /treatment).The jars were capped with aluminum foil closures. The cultured jars were incubated in growth chamber at 25$\pm 1^{\circ}$ C temperature under 16 hr daily light and 8hr darkness illumination by a florescent light intensity of 2880 Lux (40μ mol $m^{-2}S^{-1}$ PPF).

2-Multiplication stage

The neoformed propagule of the initiation stage was sectioned into single leaflet node. The excised nodal cutting explants of the different positions were cultured onto the multiplication medium which was woody plant medium (WPM) supplemented with BA at four concentrations: 0.0(nil), 1.0, 2.0 and 3.0 mg/l, in combinations with NAA at four concentrations:0.0(nil) ,0.25, 0.50 and 0.75 mg/l.

3-Rooting (rhizogenesis) stage

The obtained shoots of croton from the multiplication stages were, individually separated and cultured on a rooting medium for rhizogenesis to achieve this stage ,two types of auxins were used as Indole butyric acid (IBA) at four concentrations: 0.00(nil),1.00, 2.00 and 3.00 mg/l , in combinations with NAA at five concentrations:0.00 ,0.25 ,0.50 ,0.75 and1.00 mg/l. Generally, the data were recorded per propagule at initiation, multiplication and rooting stages after 35 days in culture. The tested characters were as follows:

-Average shoot length(cm)/propagule.
-Average number of shoots formed/ propagule.
-Average number of leaflets formed/ propagule.
-Average number of nodes formed/ propagule.
-Average number of roots formed/ propagule.
-Average root length(cm)/ propagule.(at rooting stage)
-Average rooting time / propagule. (at rooting stage)

4-Acclimatization stage

The neoformed plantlets (rooted shoots) were then transferred to the greenhouse for hardening. The potting mix used in this study comprised of sand and peat moss (4:1) .The transferred plants were monitored weekly for at least 6 weeks.

Statistical analysis

A completely randomized design was used for all the experiments (Gomez and Gomez, 1984).Recorded data were analyzed, statistically, using analysis of variance technique (ANOVA) and averages were compared by Duncan's multiple range test (Steel *et al.*,1997) and significance was determined at $p \leq 0.05$.

RESULTS AND DISCUSSION

Achievement of optimal and reliable system for micropropagation of croton (*Codiaeum variegatum* Gold Dust) was urgent and in focus. Therefore, a set of experiments was conducted, and the obtained results were presented and discussed in the following section as follows:

1-Initiation stage

Data presented in Table (1) and Fig. (1) exhibit that both applied growth regulators' levels and their combinations exerted highly significant effects on the initiation stage's characters of croton ,where single nodal explants were grown *in vitro* for 35 days . Respecting the main effect of BA, the highest average value of shoot length (2.78 and 2.75 cm) was recorded at the absence of BA or its existence in the culture medium at 0.50mg/l. While, supporting the culture medium with NAA at 2.00 mg/l, gave rise to the highest average value (3.65 cm). Regarding the average number of shoots that formed per propagule, the obtained results of BA manifested that BA at 1.0 mg/l gave the highest number of shoots (1.51) which expressed, significantly, the highest average value comparing to the other treatments .In this respect, BA levels consider as in favour of stimulation cell division , morphogenesis (shoot initiation/bud formation) in tissue culture, and break of apical dominance and release growth of lateral buds (Raven,1992;Salisbury and Ross,1992;Davies,1995) and their combinations exerted highly significant effects on the initiation stage's characters of croton ,where singles nodal explants were grown *in vitro* for 35 days).

Table (1). Effect of different levels of BA and NAA (mg/l) and their combinations on the initiation stage of croton cultured *in vitro* for 35 days.

Characters	NAA levels (mg/l)	BA levels (mg/l) 0.00	0.50	1.00	1.50	Average NAA	Significance BA	NAA	BA X NAA
(a)Average shoot length (cm)/ propagule:									
	0.00	1.26	2.57	2.61	2.26	2.18	**	**	**
	1.00	4.37	3.47	3.23	3.53	3.65			
	2.00	3.44	2.78	2.45	2.43	2.77			
	3.00	2.05	2.19	1.78	1.98	2.00			
Average (AB)		2.78	2.75	2.52	2.55				
L.S.D.(0.05)							0.11	0.11	0.22
(b)Average number of shoots formed/propagule:									
	0.00	0.33	1.11	1.33	1.16	0.98	**	**	**
	1.00	0.60	1.88	2.33	1.49	1.58			
	2.00	1.11	0.76	0.88	1.33	1.02			
	3.00	0.55	0.66	1.72	0.83	0.94			
Average(BA)		0.65	1.16	1.51	1.20				
L.S.D.(0.05)							0.27	0.27	0.55
(c)Average number of leaflets formed/propagule:									
	0.00	2.55	4.61	5.66	6.00	4.70		**	**
	1.00	6.50	5.88	5.78	5.27	5.86			
	2.00	6.27	6.27	5.11	5.66	5.83			
	3.00	5.72	5.61	4.55	4.33	5.05			
Average(BA)		5.26	5.59	5.27	5.31				
L.S.D(0.05)							0.32	0.32	0.65
(d)Average number of nodes formed/propagule:									
	0.00	1.44	2.78	2.72	2.83	2.44		**	**
	1.00	5.50	4.44	4.39	5.50	4.95			
	2.00	5.05	4.27	3.99	3.77	4.27			
	3.00	3.50	3.55	4.16	4.16	3.84			
Average (BA)		3.87	3.76	3.81	4.06				
L.S.D.(0.05)							0.24	0.24	0.48
(e)Average number of roots formed/propaglue:									
	0.00	0.22	2.33	0.00	0.00	0.63		**	**
	1.00	3.72	2.99	1.66	0.36	2.18			
	2.00	5.11	3.55	3.33	3.77	3.94			
	3.00	2.33	1.33	0.66	0.00	1.08			
Average (BA)		2.84	2.55	1.41	1.03				
L.S.D.(0.05)							0.50	0.50	1.00

L.S.D.(0.05)=Least significant difference teast at 0.05 level of probability

*,**:Significant or highly significant.

With regared to the number of leaflets formed, the obtained data disclosure that BA at 0.50 mg/l, brought about the highest average value (5.59). On the other hand, augmenting the WPM with NAA at either 1.00 or 2.00 mg/l led to the highest average values (5.86 or 5.83, orderly) comparing to the other treatments. Meanwhile, the interaction between nil level(0.00 mg/l) and 1.00 mg/l BA and NAA, respectively, gave the highest average value (6.50 leaflets/explants). As for the average number of nodes formed /propagule, the obtained results showed that BA at 1.50 mg/l, led to the highest average value (4.06). On the other side, supplemented the tested medium with NAA at1.00 mg/l, gave the highest average value (4.95) comparing to the other treatments.

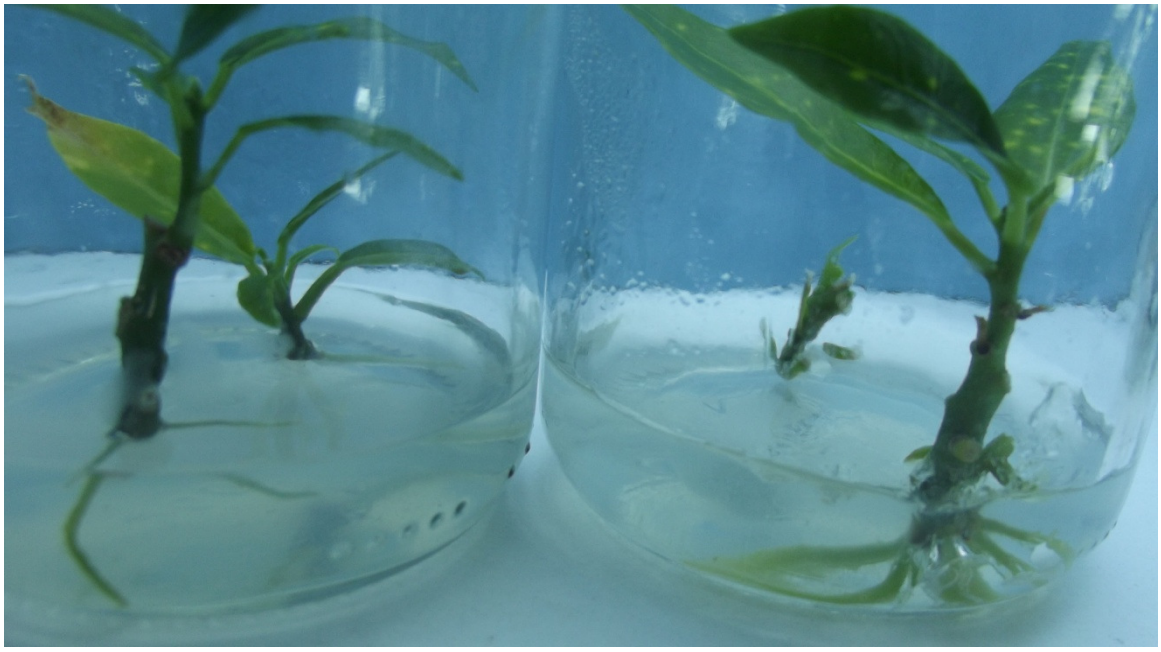

Figure (1): Initiation stage of croton nodal explants cultured on WPM +1mg/l NAA only.

On the other hand, the main effect of NAA, the obtaind data declared that NAA at 1.0 mg/l, resulted in the highest average values of the most studies characters except rooting trait. As regarded to the average number of roots/ propagule, the obtained results expressed that BA at either nil (0.00 mg/l) or 0.50 mg/l, led to the highest average values (2.84 or 2.55, consecutively).While BA at 2.00 mg/l , at 2.00 mg /l, gave the highest average value (3.94).The interaction between BA at 0.00 and NAA at 2.00 mg /l, resulted in formation the highest rooting mass (5.11). Decreseasing the average values of the studied characters (length of shoot and number of roots) were concomitant with increasing BA. WPM This finding could be due to accumulation supra-optimal level of cytokinin within tissues which exerts adverse effects on growth performance (Murashige,1974;Tomas,1987;George *et al*.,2008).Hence , medium without BA resulted in the highest average value of shoot length was taken place. This finding could be attributed to the mode of action of auxin NAA within cultured tissues which is capable of controlling various distinctive processes such as cell growth and elongation (George and herrington,1984;Georrge *et* al.,2008).On the other hand, extreme the lowest

concentration of NAA used, affected well the initiation stage of croton *in vitro.*This might be owing to the reason that higher concentration of NAA, which is usually ineffective against shoot proliferation (Vijaya *et al*.,1991;Waseem *et al*.,2011).Furthermore, it is known the role and mode of action of auxin for their abilities to enhance root formation, as stated by research workers(Chen *et al.,*1985; Liu *et al*.,1994;George *et al*.,2008;Waseem *et al*.,2011). Silva *et al.,* (2013) reported that the longest shoots on croton production being produced on medium supplemented with 1.0 mg/l NAA, and the combination of NAA and IBA at a ratio of 1:1mg/l of BA and NAA ,respectively led to the production of both number of leaves and longest shoots after a 60 days of subculture period , successfully, especially when cultures were initiated from explants taken from sprouted shoots of croton (*Codiaeum vareiegatum* , L.). The establishment and multiplication stages were possible when 1mg/l BA or 1mg/l IAA and 3 mg/l 2ip were added to the selected cultivar, respectively (Radice, 2010). Chitra and Madhusoodanan (2005)who studied the influence of auxins in direct *in vitro* morphogenesis of *Euphorbiaceae.* Rout *et al.* (2006) reviewed critically on present scenario and future prospects of tissue culture. However Indole butyric acid (IBA) induced the rooting very effectively and various studied characted plants established in the soil. (Ahn *et al*., 2007).

2-Multiplication stage

Results presented in (Table 2) and Fig. (2) revealed that both applied growth regulators and their combinations affected highly singinficantly the studied characters of multiplication stage .However, regarding the average shoot length (cm) / propagule, BA was in adverse relationship in the given trait; whereas BA level increased, the studied trait decreased ,therefor the nil level (0.00 mg/l) gave the highest average value (2.17).On the contrary, NAA levels were in proportional relationship, where, as the levels increased the highest average values increased, especially at 0.50 or 0.75 mg/l, which gave the highest average values (2.42 or 2.49, consecutively).Meanwhile, the interaction between BA at nil level and NAA at 0.50 mg/l ,recorded the highest average value (2.76).As for the average number of shoots formed / propagule, the main effect of BA showed that augmenting the culture medium with BA at 2.00 mg/l, led to the highest average value (3.06).On the other hand, providing the culture medium with either 0.50 or 0.75 mg/l of NAA, resulted in the highest average values (2.73 or 2.65,each in turn)

Meanwhile, the combination of BA and NAA at 2.00 and 0.50 mg/l, respectively led to the highest average value (3.89).With reference to the average number of leaflets formed/ propagule, fortifying the tested medium with either 1.00 or 2.00 mg/l of BA, resulted in the highest average values of the given trait (7.51 or 7.59,each in turn), comparing to the other treatments. On the other hand ,as NAA added to the culture media increased the gained values increased , especially at either 0.50 or 0.75mg/l, led to the highest average values (7.87 or 7.88, consecutively) of the given trait. But the interaction between BA and NAA at 2.00 and 0.50mg/l , in series resulted in the highest average value (7.22) of the tested trait .

Table (2). Effect of different levels of BA and NAA (mg/l) and their combinations on the multiplication stage of croton cultured *in vitro* for 35 days.

Characters	NAA levels (mg/l)	BA levels (mg/l) 0.00	1.00	2.00	3.00	Average NAA	Significance BA	NAA	BA X NAA
(a)Average shoot length(cm/propaglue:									
	0.00	1.01	1.67	1.39	1.01	1.27	**	**	**
	0.25	2.33	2.16	1.69	2.13	2.08			
	0.50	2.76	2.32	2.61	2.00	2.42			
	0.75	2.57	2.11	2.61	2.66	2.49			
Average(BA)		2.17	2.07	2.07	1.95				
L.S.D.(0.05)							0.09	0.09	0.18
(b)Average number of shoots formed/ propagule:									
	0.00	0.33	1.66	2.61	1.33	1.48	**	**	**
	0.25	0.72	2.27	2.60	1.05	1.66			
	0.50	1.44	3.22	3.89	2.38	2.73			
	0.75	1.72	3.11	3.16	2.61	2.65			
Average(BA)		1.05	2.56	3.06	1.84				
L.S.D.(0.05)							0.30	0.30	0.61
(c)Average number of leaflets formed/ propaglue:									
	0.00	3.44	5.55	6.00	5.88	5.22	**	**	**
	0.25	6.55	6.99	6.39	8.00	6.98			
	0.50	7.89	8.27	8.66	6.66	7.87			
	0.75	7.11	9.22	9.33	5.89	7.88			
Average(BA)		6.25	7.51	7.59	6.61				
L.S.D.(0.05)							0.40	0.40	0.80
(d)Average number of nodes formed/ propaglue:									
	0.00	2.44	5.89	5.16	2.00	3.87	**	**	**
	0.25	3.89	5.11	6.27	6.05	5.33			
	0.50	4.16	4.50	7.22	7.22	5.77			
	0.75	5.44	5.33	6.33	7.05	6.04			
Average(BA)		3.98	5.20	6.24	5.58				
L.S.D.(0.05)							0.49	0.49	0.99
(e)Average number of roots formed/ propaglue:									
	0.00	0.29	0.94	0.33	0.00	0.38	**	**	**
	0.25	3.66	3.50	0.72	1.39	2.31			
	0.50	5.00	1.78	3.44	2.00	3.05			
	0.75	6.28	3.55	3.38	4.11	4.33			
Average(BA)		3.80	2.44	1.97	1.87				
L.S.D.(0.05)							0.55	0.55	1.11

L.S.D.(0.05)=Least significant difference test at 0.05 level of probability
*,**:Significant or highly significant.

Figure (2): Multiplication stage neoformed croton shoot of initiation stage culture on WPM+ 2.0mg/lBA+0.50 mg/l NAA.

Respecting the average number of roots formed / propagule , the obtained results, divulged that the absence of BA from the culture medium, brought the highest average value of the tested trait (3.80),then as the BA levels increased the given results decreased . For NAA levels, the highest average value of the given trait (4.33) was recorded due to augmenting the culture medium with NAA at 0.75 mg/l., comparing to the other treatments. In general , these results could be brought about to the mode's action of cytokinins on stimulation both cell division and promotion growth of axillary shoots in plant tissues culture as, also, found by Tomas(1987),Triginano and Gray(2000) and George *et al*. (2008). Nasib *et al*. (2008) grew the shoot tip explants of *Codiaeum variegatum* on MS + BAP (0.5mg/l) + peptone (25mg/l). Sana (2012) reported that enhanced shoots and buds proliferation formation can be achieved by using the MS media with 2 mg/l of both KIN and BA. The higher concentration of these hormones (5mg/l each) resulted in shoot formation of various cultivars of *Codieaum variegatum* (L.). Martin *et al*. (2005) reported the influence of auxins in direct *in vitro* morphogenesis of mesophyll cells of *Euphorbia nivulia*, where the KIN reduced the rate of morphogenesis, whereas BAP induced somatic embryogenesis. The combination of BA with NAA and IAA had positive effect on morphogenesis. The shoot tips of *Glochidion multiloculaire* produced multiple shoots when cultured on MS + BA (1.0 mg/l) and IAA (1.0 mg/l). Callus was derived from the leaf and stem explants on a medium containing 2,4-D (0.5-2.0

mg/l),and produced shoot buds when transferred to MS+ BA (1.0-2.0 mg/l) + CM (Coconut milk, 10% v/v)(Yamuna *et al*., 1995). Bhot *et al.* (2010) concluded that nodal explants from field grown plants of *Codiaeum variegatum* (L.) Blume when inoculated on B5 medium fortitified with NAA (0.1mg/l), BAP (2.0 mg/l) and phloroglucinol (100 mg/l), showed the highest number of shoot bud development and proliferation in var. Undulatum while with spermidine (0.1mg/l), BAP(2.0 mg/l) and phloroglucinol (100mg/l) showed shoot bud development and proliferation in var. *Norwood Beauty* and *Punctat aureum.* With reference to the rooting mass per propagule, this finding might be taken place due to the well-known role of auxins in inducing of root formation (Tomas, 1987 and George *et al*.,2008).

3-Rooting (rhizogenesis) stage

Results in Table (3) and Fig. (3) showed that the applied both auxin levels and their combination exerted, significant effects on the studied characters of croton, except, the average number of node formed /propagule, whereas, However the interaction between IBA at 2.00 mg/l and NAA at 0.50mg/l. gave the highest nmber of root and root length per propagule (11.78, 3.96),respectively and also gave the high level of shoot length (4.02) which may equal at the same average the highest shoot length(4.08) was produced when medium supplemented with NAA at1.00 mg/l and IBA at nil(0.0).The data showed significant effect on the number of shoots characters when applied both growth regulators,using NAA at 0.75 gave the highest average effect (1.27).While using IBA at 2.00 mg/l gave high average effect comber to anther concentration of IBA (0.94) .On other hand ,the interaction between IBA and NAA gave the highest average number of shoots per propagule (1.72).But the lowest average of rooting time produced with IBA at 3.00 mg/l and NAA at1.00 mg/l (10.27).As for the average number of leaflets formed/ propagule ,the main effect of IBA and NAA showed that augmenting the culture medium with IBA at 2.00 mg/l and NAA at 0.25 gave the highest average value(8.89).

This results coud be explaind on the bases that auxin induced number of responses which involved cell division, cell enlargement, protein and nucleic acids synthesis which are concomitants of auxin-induced growth and changes in wall plasticity of plant cell and increase the apical dominance as there are essential and rapid processes involved in growth and elongation (Wilkins,1989).Our results were further confirmed by the previous findings of Komalavalli and Rao (2000); Sarker and Shaheen(2001); Munshi *et al*.(2004);Awal *et al*.(2005);Rajani and Patil(2009); Waseem *et al*.(2011) who suggested IBA as the best auxin for root induction and development. Nasib *et al*. (2008) grew the shoot *Codiaeum variegatum* which enhanced the rooting was induced on MS+ IBA (2.0mg/l) medium, and they were acclimatized with 95% survival rate. Chitra and Madhusoodanan (2005) studied the influence of auxins in direct *in vitro* morphogenesis of Euphorbiaceae. Rout *et al.* (2006) reviewed critically on present scenario and future prospects of tissue culture of some *Euphorbiaceae* members. While Indole butyric acid (IBA) induced the rooting very effectively .

Table(3).Effect of different levels of IBA and NAA (mg/l) and their combinations on the rooting stage of croton cultured *in vitro* for 35 days.

Characters	NAA levels (mg/l)	BA levels (mg/l) 0.00	1.00	2.00	3.00	Average NAA	IBA	Significance NAA	IBA	IBA X NAA
(a)Average shoot length(cm)/ propagule:										
	0.00	1.01	2.06	2.48	2.24	1.94		**	**	**
	0.25	2.94	3.34	2.47	2.23	2.74				
	0.50	3.04	3.12	4.02	3.89	3.52				
	0.75	3.56	3.31	2.71	2.22	2.95				
	1.00	4.08	3.49	2.97	2.86	3.30				
Average(IBA)		2.92	3.06	2.93	2.65					
L.S.D.(0.05)								0.19	0.21	0.42
(b)Average number of shoots formed/propagule:										
	0.00	0.00	0.00	0.83	0.00	0.20		**	**	**
	0.25	1.16	0.66	0.55	1.33	0.93				
	0.50	1.00	0.88	1.61	1.33	1.20				
	0.75	1.11	1.00	1.72	1.27	1.27				
	1.00	0.00	0.00	0.00	0.00	0.00				
(IBA)		0.65	0.50	0.94	0.78					
L.S.D.(0.05)								0.16	0.17	0.35
(c)Average number of leaflets formed/propagule :										
	0.00	2.38	5.78	5.66	6.00	4.95		ns	**	**
	0.25	7.22	5.55	8.89	4.89	6.46				
	0.50	6.89	7.00	6.00	6.11	6.50				
	0.75	8.44	7.11	5.72	5.94	7.05				
	1.00	7.33	4.83	5.89	5.00	5.76				
Average(IBA)		6.45	6.05	6.43	5.78					
L.S.D.(0.05)								0.39	0.43	0.87
(d)Average number of nodes formed/propogule:										
	0.00	2.00	3.39	3.27	2.72	2.84		**	**	**
	0.25	3.55	3.11	3.11	4.66	3.61				
	0.50	3.11	4.49	3.78	3.33	3.68				
	0.75	4.22	3.33	3.77	3.94	3.81				
	1.00	4.22	3.88	3.89	3.00	3.75				
Average(IBA)		3.42	3.64	3.56	3.53					
L.S.D.(0.05)								0.34	0.34	0.68
(e)Average number of roots formed/propaglue:										
	0.00	0.44	4.55	4.94	5.44	3.84		**	**	**
	0.25	5.77	6.72	7.38	9.44	7.33				
	0.50	7.38	7.33	11.78	7.50	8.50				
	0.75	7.33	7.33	5.77	7.11	6.88				
	1.00	5.16	6.55	7.22	6.44	6.34				
Average(IBA)		5.22	6.49	7.42	7.18					
L.S.D.(0.05)								0.42	0.47	0.94

To be Continued..

Table (3) Continued..

(f)Average root length(cm)/propagule:								
0.00	0.23	1.20	1.43	1.80	1.16	**	**	**
0.25	1.43	2.28	1.63	1.50	1.71			
0.50	1.61	3.10	3.96	3.33	3.00			
0.75	2.33	2.56	2.70	2.60	2.55			
1.00	2.83	2.33	2.26	2.13	2.39			
Average(IB)	1.68	2.29	2.40	2.27				
L.S.D.(0.05)						0.19	0.21	0.43
(g)Average rooting time/ propagule:								
0.00	35.00	31.83	32.16	28.22	31.80	**	**	**
0.25	34.00	34.11	20.99	19.33	27.11			
0.50	18.22	20.50	16.78	15.27	17.69			
0.75	31.38	21.54	18.89	24.22	24.01			
1.00	17.27	19.33	11.94	10.27	14.70			
Average(IBA)	27.17	25.64	20.15	19.46				
L.S.D.(0.05)						0.89	0.99	1.99

L.S.D.(0.05)=Least significant difference test at 0.05 level of probability *,**:Significant or highly significant.

Figure (3):Rhizogenesis of neoformed croton shoot of multiplication stage grown on WPM+2.0 mg/l

4-The fourth stage (acclimatization)

Acclimatization of *in vitro* grown plants is an important step in micropropagation (Smart, 2008; Rout *et al.*,2006).The *In vitro* grown plantlets with at least two to three roots were transferred to the greenhouse for the acclimatization *ex vitro*. The potting mix (sand and peat moss,4:1), routinely

used in the nursery of our institute, was found suitable for the hardening of the plants. The survival rate of the *In vitro* grown plants was 90% as shown in Fig. (4).

Figure (4):Acclimatized croton tissue culture plants derived plants *ex vitro*.

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الملخص العربي

الاكثار المعملى الدقيق لنبات الكروتن باستخدام اجزاء العقل الساقية للنباتات النامية حقليا

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*** قسم الزهور و نباتات الزينة و تنسيق الحدائق – كلية الزراعة –الشاطبى– جامعة الأسكندرية

اجريت هزه الدراسه في معمل زراعة الانسجه - قسم الانتاج النباتى– كلية الزراعه – سابا باشا- جامعة لاسكندريه خلال السنوات ما بين ٢٠١٢- ٢٠١٤ لتطوير أو إيجاد بروتوكول فعال للأكثار المعملى الدقيق لنباتات الكروتن"جولد دست" . ولقد تم أستخدام عقل ساقية من نباتات الكروتن النامية بحدائق قسم بحوث الزينه بقصر المنتزه (النباتات الأم) خلال دراسة معملية لأستحثاث اكثار (تضاعف) المجاميع الخضرية . تم زراعة الأجزاء النباتية العقدية على بيئات مغذية للتدشين او البدء باستخدام توليفات مختلفة من الأوكسين (NAA) والسيتوكينين (BA)، و تمت زراعة المجاميع الخضرية المتكونة خلال مرحلة البدء او التدشين علي بيئات مختلفة للتضاعف او الأكثار للحصول على اعداد كبيرة (متضاعفه) من تلك المجاميع الخضرية ، ثم أستطالتها و كذلك تجذيرها ، هذا بالأضافة الى اقلمة تلك النبيتات خارج المعمل ، بنجاح . كانت افضل بيئة لتدشين او بدء المجاميع الخضرية تحت الظروف المعملية هى بيئة أكثار النباتات الخشبية (WPM) المزودة بالسيتوكنين BA بتركيز ١ ملليجرام/

لتر . و كانت بيئة التضاعف او الاكثار هى نفس البيئة المزودة ٢ ملليجرام/لتر من السيتوكنين بالأضافة الى ٥,. مللجرام/ لتر من الاوكسين NAA . و كانت أفضل بيئة للأستطالة هى نفس البيئة المزودة بالأوكسين NAA عند تركيز ١مللجرام/لتر . و الأكثر من ذلك، عند تعريض تلك المجاميع الخضرية النامية معمليا لتراكيز مختلفة من الأوكسين NAA و كذلك IBA اظهرت مجاميع جذرية قوية و سليمة ، خاصة عند تزويد البيئة بالأوكسين IBA عند تركيز ٢ مللجرام/ لتر ، والأوكسين NAA عند تركيز ٥,. مللجرام/لتر (مرحلة التجذير) كما ان الخلطة من الرمل : البيتموس (١:٤) لأقلمة تلك النباتات ناتج زراعة الأنسجة كانت الأفضل في هذا الصدد .

Integrated Best Management for *Tuta Absoluta* (Lepidoptera:Gelechiidae) Infesting Tomato Plants in Egypt

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ABSTRACT: Tomato plants were sprayed three times (at 15 days intervals) with different evaluated insecticidal treatments during two following growing seasons of 2012 and 2013 in an approach to achieve efficient control against the tomato leafminer (borer) *Tuta absoluta*. During the first season of 2102, the treatment of emamectin benzoate+Kz oil was more effective and reduced the number of larvae and increased their reduction percentages up to 40.9% as compared with the other performed treatments of the 1st spray. After the 2nd spray, the treatment of chlorantraniliprole+Mineral oil was the most potent one and recorded the highest general mean of reduction over 10 days of inspection (89.9%) followed by chlorantraniliprole (alone) (81.3%). Furthermore, post- 3rd spray the mixture of metaflumizone+Kz oil® was proved to be the utmost superior treatment and achieved complete reduction (100%) all over the adopted inspection periods (5, 7, and 10 days). The same trend of results was gained during the second season of 2013. The addition of the mineral oil (Kz oil®) increased the efficiency of the evaluated insecticides :emamectin benzoate, chlorantraniliprole and metaflumizone; therefore it is recommended to admix mineral oil with each of these effective evaluated insecticides. So, they could be used in IPM programs for achieving potent control of *Tuta absoluta*.

Keywords: Tomato plants, the tomato leafminer *Tuta absoluta*, insecticidal treatments, mineral oil, reduction percentage

INTRODUCTION

Tomato crop (*Solanum lycopersicum* L.) is affected by many insects and fungal diseases, among which, the insects *Trialeurodes vaporariorum* and *Tuta absoluta*, and the fungi *Alternaria* spp. and *Botrytis cinerea* are of great incidence **(Bue *et al.,* 2012)**. The tomato leafminer (tomato borer) *Tuta absoluta* Povolny, native to western South America, is an extremely devastating insect-pest in planted tomato crops in most of South America, Europe and Africa (North of the Sahel). It causes yield losses up to 100% and decreases fruit quality in open field and greenhouse crops if control methods are not applied **(Bueno *et al.*, 2012)**. This insect- pest has spread rapidly throughout the Mediterranean area, and has also reached the countries of northern Europe. In 2009, *Tuta absoluta* has been found in the UK and the Netherlands travelling on Spanish tomato imports **(Miniermotte, 2010)**. It was also first observed in the year of 2010 damaging the tomato plants in different countries; Egypt **(Mohammed, 2010)**, Israel **(Seplyarsky *et al.*, 2010)**, Turkey (**Unlu, 2012 and Klc, 2010**), Montenegro, Italy (**Hrncic and Radonjic, 2011**), Iran (**Baniameri and Cheraghian, 2012**), Russia (**Izhevsky *et al.*, 2011**), Greece (**Roditakis *et al.*, 2010**) and Khartoum State, Sudan (**Mohamed *et al.*, 2012)**. The pest occurs throughout the entire growing cycle of tomatoes both for fresh market and processing, and larval feeding can cause losses up to 100% (**Desneux *et al.*, 2010**)

Because of its characteristic biology and behavior, *T. absoluta* is a challenging insect-pest to control. *T. absoluta* has been controlled with synthetic insecticides. Organophosphates and pyrethroids were used during the 1970's

and 1980's. New products (abamectin, spinosad, tebufonzide and chlorfenpyr) were introduced in the 1990's **(Lietti *et al.,* 2005)**. At least 12 classes of insecticides are being used for controlling *T. absoluta* **(IRAC, 2009a and 2009b)**. Control failures had been noted with Organophosphates and pyrethroids in South America (**Salazar and Araya, 2001**) prompted research on the resistance status of *T. absoluta* (**Lietti *et al.,* 2005; Siqueira *et al.,* 2000a, 2000b**). However, newer classes of insecticides provided good control of this pest (**IRAC, 2009a**). Indoxacarb, spinosad, imidacloprid, deltamethrin, and *Bacillus thuringiensis* var. *kurstaki* were applied for the control of larval infestations in Spain (**FERA, 2009; Russell, 2009**). Chlorpyrifos and pyrethrins were used in Italy (**Garzia *et al.,* 2009**). Abamectin, indoxacarb, spinosad, imidacloprid, thiacloprid, lufenuron, and *Bacillus thuringiensis* (*Bt*) were recommended for infestation outbreaks in Malta (**Mallia, 2009**). In Brazil, abamectin, cartap, chlorfenapyr, phenthoate, methamidophos, spinosad, and indoxacarb were recommended for use in the South, Southeastern, and Savannah tomato-growing regions, while chlorfenapyr, phenthoate, and spinosad were recommended for use in the Northeastern region (**IRAC, 2007**). In Argentina, *Bt* and triflumuron were recommended for the control of *T. absoluta* larvae as part of an IPM program that also included parasitoids (**Riquelme, 2006)**.

In Egypt, *T. absoluta* is newly reported and until now there are two registered insecticides (Dipel-2X® and Proclaim®) for controlling this insect. However, in Egypt there are going on evaluation of some insecticides under registration and few studies describing the efficiency of some insecticides for the control of *T. absoluta* (**Derbalah *el al.,* 2012; Shalaby *et al.,* 2012; Hanafy and El-Sayed 2013; Soliman *et al.,* 2013; Ramadan, 2014**). Therefore, certain insecticidal treatments compatible with IPM programmes were evaluated for their efficiency against *T. absoluta* infesting tomato plants in Egypt.

MATERIALS AND METHODS

Field experiment

Field trials were carried out in El-Sabahia Agricultural Research Center during June of 2012 (summer season) and the farm of Faculty of Agricultural (Saba Basha), Alex. Univ. at Abis 10th village, Alexandria Governorate during March of 2013 (winter season). The planted area was of approximately 3-5 Kerat. The selected experimental areas were divided into longitudinal blocks separated by buffer paths of 1 m^2 wide between every plot (180 m^2) to prevent insecticides drift. Transplanted tomato seedlings (Variety Malika) were grown all over the different blocks. The recommended agricultural practices were followed during both seasons according to recommendations of the Egyptian Ministry of Agriculture.

The presence of *T. absoluta* was confirmed by inspecting the occurring symptoms of morphological changes in tested plants of the collected specimens from the field.

Two sticky pheromone traps (Pherodis®) all over the growing season were used and they were replaced within that plot treated with detergent (Masrol®). The used trap with the pheromone (yellow) (1 lure) is specific for *T. absoluta* and it is produced by Koppert Biological System.

Insecticidal treatments

In both seasons of 2012 and 2013, each block of planted tomato contained three replicates / treatment. The plants of untreated check (control) were chosen to be a little far away from those treated plants to avoid any contamination or interference of spray drift.

Four different insecticidal treatments were evaluated; each treatment was applied at three consequent sprays (1st, 2nd and 3rd) in addition to a 5th treatment which has been used as untreated check (control) . The adopted 1st treatment of first spray included trap+detergent, emamectin benzoate, emamectin benzoate+Kz-oil and Engeo® (thiamethoxam + lambda-cyhalothrin). The treatment of second (2nd) spray included trap+detergent, chlorantraniliprole (Coragen®), chlorantraniliprole+Kz-oil and chlorfenapy+ spinotoram. The third (3rd) spray also included each of trap+detergent, metaflumizone, metaflumizone+Kz-oil and methomyl+ indoxacarb. All sprayed plants in the performed treatments were compared with the untreated check plants (Table 1).

In the second season of 2013, the aforementioned four insecticidal treatments (plus the control one) in each consequent 1st, 2nd and 3rd sprays were identically carried out as that done in the first season of 2012. The insecticidal applications were done when the plants were at the age of 2 months using a Knapsack sprayer (20 liters), at the rate of 200 liters / fed at 15 day intervals.

Table (1): The rate, trade and common names of the evaluated pesticides

Trade name	Common name	Rate/Fed. (ml)
Alferdy®	Metaflumizone	200
Avaunt®	Indoxacarb	50
Coragen20®%SC	Chlorantraniliprole	60
Masrole®	Detergent	1000
Engeo®	14.1% thiamethoxam +10.6% lambda-cyhalothrin	100
Kz oil®	Mineral oil	1000
Lannate®	Methomyl	300 g
Proclaim® 5%EC	Emamectin benzoate	120 g
Radiant®12%SC	Spinotoram	100
Chalenger®	Chlorfenapy	100

Sampling technique and inspection of the *Tuta absoluta*

The infestation rate was recorded after 5, 7 and 10 days post- spraying taking into account the mean number of larvae / 8sampled plants /replicate in

each treatment compared with control. Percentages of infestation reduction were also calculated. The estimated infestation rate in treatments was determined pre- and after 5, 7 and 10 days from insecticidal applications and the percentages of infestation reduction were calculated using **Henderson and Tilton (1955)** equation as follows:

$$\text{Reduction \%} = 1 - \left[\frac{A}{B} \times \frac{C}{D} \right] \times 100$$ where,

A: number of larvae in treatment after treatment.
B: number of larvae in treatment before treatment.
C: number of larvae in the check before treatment.
D: number of larvae in the check after treatment.

Statistical analysis

Data of the present study were subjected to the analysis of variance ANOVA using ″F″ Test following the randomized complete block design (RCBD). The least significant differences (L.S.D) at the 0.05 probabilty level were determined according to computer program (**COSTAT software, 1988**) and **Steel and Torrie (1981)** to compare the average mean numbers of the different treatments and control.

RESULTS AND DISCUSSION

During the first season of 2012, four insecticidal treatments were evaluated against the tomato leafminer (tomato borer) *Tuta absoluta* compared with the untreated check after the first spray. The residual effect of each of these treatments on the mean number of detected larvae on tomato plants and calculated reduction percentages are presented in Table 2. It could be seen that the mean numbers of larvae are going to be decreased till the 10^{th} day post-treatment. Meanwhile, the calculated percentage of reduction of each treatment was found to have, merely, the same trend. Considering the general mean (%) of reduction caused by the application of the different performed insecticdes, it is noticed that the treatment of emamectin benzoate+Kz oil was effective for reducing the number of larvae and increased their reduction percentages up to 40.9%, followed by the treatment of trap+ Detergent that gave a reduction percentage of 35.6. The addition of Kz oil to emamectin benzoate increased its efficacy; showed the highest reduction percentage of inspected larvae as compared with emamectin benzoate alone which recorded the least reduction percentage of 23.6 (Table 2).

The second spray included three different insecticidal treatments with the previously used treatment of trap+ Detergent and the untreated check (Table 3). Before the application of the evaluated treatments of the second spray, it was noticed that the number of the detected larvae increased. Nevertheless, the three tested treatments (chlorantraniliprole, chlorantraniliprole**+**Mineral oil and chlorfenapyr+spinetoram) were so effective in reducing the number of inspected larvae and increasing the calculated reduction percentages. The results revealed that the treatment of chlorantraniliprole**+**Mineral oil was the most potent one; recording the highest general mean of reduction of 89.9% over 10

days of inspection, followed by the treatment of chlorantraniliprole alone (81.3%). Herein, the addition of the mineral oil increased the efficiency of chlorantraniliprole when they were admixed and presented a promising efficient chemical mixture for controlling *Tuta absoluta*; that mixture would be included within IPM programs. The effective treatment of the mixture of chlorantraniliprole**+** spinetoram (78.1%) was less potentthan that mixture of chlorantraniliprole**+**Mineral oil in reducing the larval occurrence. A possibility for reducing pesticide applications in tomato fields is the use of integrating management methods such as proper plant spacing within the row (**Guedes *et al*., 1994**), and use of mineral oil in the insecticide mixtures (**Guedes *et al*., 1995)** as well as improved production systems (**Picanco *et al*., 1995**).

The effect of certain applied treatmentsin the 3rd spray against the tomato leafminer, *Tuta absoluta* in 2012 season is shown in Table 4. It could be seen again that the addition of the mineral oil to an insecticide is increasing its toxicological activity. The mixture of metaflumizone+Kz oil was proved to be the superior achieving complete reduction (100%) all over the inspection periods post-spraying. The addition of the mineral oil to metaflumizone was found to double its activity. These results are in agreements with those reported by **Guedes *et al*. (1995)**. It could be also seen that the effect of metaflumizone alone was merely equal to that mixture of methomyl+indoxacarb, whereas the general means of reduction percentages were 59.1 and 52.6, respectively). Therefore, the application of metaflumizone alone within IPM programs would be more useful than the use of the less effective mixture of methomyl+indoxacarb (Table 4).

During the second season of 2013, the applied 1st spray involved four insecticidal treatments as those of the 1st spray of the 1st season of 2012 evaluated against the tomato leafminer *Tuta absoluta* compared with the untreated check (Table 5). The results obtained ascertained again that the mixture of emamectin benzoate +Kz oil was the most effective treatment against the tomato leafminer, *Tuta absoluta* giving the highest general reduction of 48.4.9%, whereas emamectin benzoate alone recorded a lower general mean of reduction comprised 25.4%. The treatment of Engeo® (a mixture of 14.1%thiamethoxam +10.6% lambda-cyhalothrin) came in the second rank giving a general mean of reduction amounted to 35.8%. Again, the addition of the mineral oil to emamectin benzoate has increased its residual effect and the efficacy of the applied mixture.

Moreover, the deduced mean number of inspected *Tuta absoluta* larvae and calculated reduction percentages due to the applications of different evaluated insecticidal after 5, 7 and 10 days in the 2nd spray are shown in Table 6. In this concern, the calculated mean of general reduction is being used for evaluating the residual effect and to determine the efficacy of each of evaluated treatments. The results revealed that the applied mixture of chlorantraniliprole**+** Kz mineral oil was the most potent treatment that reduced the number of *Tuta absoluta* larvae and gave a high general mean of reduction percentage of 94.2, followed by chlorantraniliprole (alone) (91.1%) and chlorfenapyr + spinetoram (71.4%).

The treatment of using a trap+ detergent (as a spray) was the least efficient one, whereas the number of larvae were increased all over the adopted periods of inspection (Table 6); therefore the calculated general mean of reduction was as low as 4.6%.

Table (2): Effect of certain tested insecticidal treatments against the tomato leafminer, *Tuta absoluta* infesting tomato plants in 2012 season (1st spray)

Treatments	1st season (2012)									
	Pre-spray	Average No. of larvae/8 plants (A) and % infestation reduction (R) after 1 st spray at different intervals (days)						L.S.D 0.05	General Average	
		5		7		10				
	A**	A	R	A	R	A	R		A	R(%)
Trap+Detergent	16.0[a]*	14.0[b]	12.5	12.0[c]	35.5	9.0[d]	58.8	1.5	11.6	35.6
Emamectin benzoate	19.0[a]	17.0[b]	10.5	18.0[ab]	18.1	15.0[c]	42.3	1.1	16.6	23.6
Emamectin benzoate + Kz oil	19.0[a]	16.0[b]	15.7	12.0[c]	45.4	10.0[d]	61.5	1.4	12.6	40.9
Engeo®	19.0[a]	17.0[b]	10.5	17.0[b]	22.7	12.0[c]	53.8	1.2	15.3	29.0
Untreated check	19.0[c]	19.0[c]	-	22.0[b]	-	26.0[a]	-	1.0	22.3	-

*Means followed with the same letter(s) within the same row are not significantly different at 0.05 probability level.

** A= Average number of larvae and R= Infestation reduction percentage

Table (3): Effect of the evaluated insecticidal treatments against the tomato leafminer, *Tuta absoluta* infesting tomato plants in 2012 season (2nd spray)

Treatments	1st season (2012)									
	Pre-spray	Average No. of larvae/8 plants (A) and % infestation reduction (R) after 2nd spray at different intervals (days)						L.S.D 0.05	General Average	
		5		7		10				
	A	A	R	A	R	A	R		A	R(%)
Trap+Detergent	70.0[d]*	80.0[c]	-1.1	85.0[b]	-6.0	87.0[a]	-7.1	0.538	84.0	-2.9
Chlorantraniliprole	36.0[a]	12.0[b]	70.5	5.0[c]	87.8	6.0[c]	85.6	2.013	7.6	81.3
Chlorantraniliprole +Mineral oil	32.0[a]	8.0[b]	77.8	3.0[c]	91.8	0.1[d]	100.0	2.599	3.7	89.9
Chlorfenapyr + Spinetoram	43.0[a]	20.0[b]	58.8	6.0[b]	87.8	6.0[c]	87.9	1.837	10.6	78.1
Untreated check	69.0[c]	78.0[b]	-	79.0[a]	-	80.0[d]	-	1.591	79.0	-

*Means followed with the same letter(s) within the same row are not significantly different at 0.05 probability level.

** A= Average number of larvae and R= Infestation reduction percentage.

Table (4): Effect of the applied insecticidal treatments against the tomato leafminer, *Tuta absoluta* infesting tomato plants in 2012 season (3rd spray)

Treatments	1st season (2012)									
	Pre-spray	Average No. of larvae/8 plants (A) and % infestation reduction (R) after 3rd spray at different intervals (days)						L.S.D 0.05	General Average	
		5		7		10				
	A	A	R	A	R	A	R		A	R(%)
Trap+Detergent	22.0[b]	21.0[c]	13.6	25.0[a]	-13.6	19.0[d]	-2.5	1.033	21.6	-2.5
Metaflumizone	8.0[a]	5.0[.0b]	43.4	4.0[bc]	50.0	2.0[c]	70.3	3.183	3.6	59.1
Metaflumizone+ Kz oil	3.0	0.0	100	0.0	100.0	0.0	100.0	----	0.0	100.0
Methomyl + Indoxacarb	8.0[a]	4.0[b]	54.7	3.0[b]	62.5	4.0[b]	40.6	2.599	3.6	52.6
Untreatedcheck	19.0[b]	21.0[a]	-	19.0[b]	-	16.0[c]	-	1.125	18.6	-

*Means followed with the same letter(s) within the same row are not significantly different at 0.05 probability level.

** A= Average number of larvae and R= Infestation reduction percentage.

Table (5): Effect of the performed insecticidal treatments against the tomato leafminer, *Tuta absoluta* infesting tomato plants in 2013 season (1st spray)

Treatments	2nd season (2013)									
	Pre-spray	Average No. of larvae/8 plants (A) and % infestation reduction (R) after 1st spray at different intervals (days)						L.S.D 0.05	General Average	
		5		7		10				
	A	A	R	A	R	A	R		A	R(%)
Trap+Detergent	12.0[a]	10.0b[c]	16.6	11.0[ab]	20.5	9.0[c]	42.6	1.500	10.0	26.6
Emamectin benzoate	13.0[a]	12.0[ab]	7.6	10.0[c]	33.3	11.0[bc]	35.2	1.423	11.0	25.4
Emamectin benzoate + Kz oil	14.0[a]	11.0[b]	21.4	7.0[c]	56.6	6.0[c]	67.2	1.837	8.0	48.4
Engeo®	13.0[a]	11.0[b]	15.3	10.0[b]	33.3	7.0[c]	58.8	1.701	9.3	35.8
Untreated check	13.0[c]	13.0[c]	-	15.0[b]	-	17.0[a]	-	1.248	15.0	-

*Means followed with the same letter(s) within the same row are not significantly different at 0.05 probability level.

** A= Average number of larvae and R= Infestation reduction percentage.

The addition of the mineral oil (Kz oil) to chlorantraniliprole gave a highly effective mixture that reduced the incidence of *Tuta absoluta* larvae. In this concept, **Bassi *et al.* (2012)** reported that Chlorantraniliprole (Rynaxypyr®, Coragen® and Altacor®) is a novel diamide insecticide by DuPont with

outstanding performance on *Tuta absoluta* and has an extremely low mammalian toxicity profile. This compound was tested on *T. absoluta* since 2002 in Brasil at the DuPont R&D Station in Paulinia; the early results indicated a new standard of *T. absoluta* control, even on insecticide-resistant populations.

The obtained results regarding the effect of the evaluated insecticidal treatments of carried out 3rd spray during the season of 2013 against the tomato leafminer are presented in Table 7. The treatment of metaflumizone+Kz oil was also the most effective treatment that rather reduced the infestation rate of *Tuta absoluta* after 10 daysof spraying and pronounced the highest general mean of reduction percentage of 74.4. Again, it is also noticed that metaflumizone (alone) was merely as effective as the mixture of methomyl+indoxacarb (a mixture of two carbamate insecticides) and therefore it is better to apply metaflumizone alone or with a mineral oil to increase the toxic efficacy of the applied compound against the insect-pest. **Garzia *et al.* (2009)** reported that the most effective insecticides for controlling *Tuta absoluta* in Sicily (Italy) are some chlorpyrifosand/or some pyrethrin products plus mineral oils.
As a conclusion, the addition of the mineral oil (Kz oil®) increased the efficiency of the evaluated insecticides :emamectin benzoate, chlorantraniliprole and metaflumizone; therefore it is recommended to admix mineral oil with each of thees effective evaluated insecticides. So, they could be used in IPM programs for achieving potent control of *Tuta absoluta*.

Table (6): Effect of the evaluated insecticidal treatments against the tomato leafminer, *Tuta absoluta* infesting tomato plants in 2013 season (2nd spray)

Treatments	2nd season (2013)									
	Pre-spray	Average No. of larvae/8 plants (A) and % infestation reduction (R) after 2nd spray at different intervals (days)						L.S.D 0.05	General Average	
		5		7		10				
	A**	A	R	A	R	A	R		A	R(%)
Trap+Detergent	26.0[d]	27.0[c]	14.6	31.0[b]	2.0	36.0[a]	-2.7	0.88	31.3	4.6
Chlorantraniliprole	24.0[a]	6.0[b]	79.4	0.1[c]	100.0	2.0[c]	93.8	3.18	2.7	91.1
Chlorantraniliprole +Mineral oil	19.0[a]	4.0[b]	82.7	0.1[c]	100.0	0.1[c]	100.0	2.25	1.4	94.2
Chlorfenapyr + Spinetoram	15.0[a]	8.0[b]	56.1	4.0[c]	78.0	4.0[c]	80.2	2.25	5.3	71.4
Untreated check	23.0[c]	28.0[b]	-	28.0[b]	-	31.0[a]	-	0.90	29.0	

*Means followed with the same letter(s) within the same row are not significantly different at 0.05 probability level.

** A= Average number of larvae and R= Infestation reduction percentage.

Table (7): Effect of applied insecticdal treatments against the tomato leafminer, *Tuta absoluta* infesting tomato plants in 2013 season (3rd spray)

Treatments	2nd season (2013)									
	Pre-spray	Mean No. of larvae/8 plants (A) and % infestation reduction (R) after 3rd spray at different intervals (days)						L.S.D 0.05	General mean (%)	
		5		7		10				
	A**	A	R	A	R	A	R		A	R
Trap+Detergent	15.0^{bc*}	17.0^{a}	7.2	16.0^{ab}	-6.6	14.0^{c}	6.6	1.20	15.6	7.2
Metaflumizone	6.0^{a}	4.0^{ab}	45.4	3.0^{b}	50.0	2.0^{b}	66.6	3.18	3.0	54.0
Metaflumizone+ Kz oil	1.9^{a}	0.7^{a}	99.3	0.7^{a}	62.0	0.7^{a}	62.0	4.50	0.7	74.4
Methomyl + Indoxacarb	6.0^{a}	3.0^{b}	59.0	2.0^{b}	66.6	3.0^{b}	50.0	3.18	2.6	58.5
Untreated check	9.0^{b}	11.0^{a}	-	9.0^{b}	-	9.0^{b}	-	1.50	9.6	-

*Means followed with the same letter(s) within the same row are not significantly different.

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الملـخـص الـعـربـي

المكافحة المتكاملة للتوتا أبسليوتا التي تصيب نباتات الطماطم في مصر

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تم رش نباتات الطماطم ٣ رشات تم فيها تقييم معاملات كيميائية مختلفة خلال موسمي ٢٠١٢ و ٢٠١٣ لمكافحة نافقة أوراق الطماطم التوتا أبسيليوتا في فترات بينية (١٥ يوم بين الرشة والأخري). أوضحت النتائج خلال الموسم الأول أن المعاملة المكونة من مبيد إيمامكتين بنزوات وزيت Kz أظهرت كفاءة عالية في خفض الإصابة والتي وصلت إلي ٤٠,٩ % بالمقارنة بالمعاملات الأخري في الرشة الأولي.

كما أظهرت النتائج أن أن المعاملة المكونة من خليط الزيت المعدني ومركب كلورانترانيليبرول كانت أكفأ المعاملات المختبرة وسجلت أعلي متوسط عام لخفض الإصابة الذي تم حسابه خلال عشرة أيام من الفحص حيث بلغ هذا الخفض ٨١,٣% بعد الرشة الثانية. أما بعد الرشة الثالثة والتي أُستعمل فيها خليط الزيت المعدني مع مبيد ميتافلوميزون أظهر هذا الخليط أيضاً كفاءة عالية محققاً الخفض الكامل لأعداد الحشرة في النباتات المعاملة وذلك بعد الرشة الثالثة .

كما أوضحت النتائج المتحصل عليها في الموسم الثاني (٢٠١٣) تأكيد نفس الإتجاه في النتائج المتحصل عليها في الموسم الأول حيث أظهرت النتائج أيضاً أن إضافة الزيت المعدني Kz أدي إلي زيادة كفاءة المبيدات المختبرة والتي تم خلطها معه (إيمامكتين بنزوات ، كلورانترانيليبرول ، ميتافلوميزون) ولهذا يمكن إضافة الزيت المعدني للمبيدات الفعالة والمستخدمة ضمن برامج المكافحة المتكاملة لحشرة التوتا أبسيليوتا.

Control of *Lavandula Dentata* Root Rot with Leaves Extracts of *Lawsonia Inermis* and *Eucalyptus Camaldulensis*

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ABSTRACT: A pot experiment was conducted during 2012 and 2013 seasons in the Experimental Field of the Medicinal and Aromatic Plants Department at Dokky, Giza, to investigate the effect of aqueous extracts of powdered dried henna (*Lawsonia inermis*) and camphor *(Eucalyptus camaldulensis*) leaves separately on Lavender (*Lavandula dentata*) root rot disease, vegetative growth, volatile oil percentage, volatile oil component analysis (GLC). The results were summarized as follow: in all cuts in the two seasons, treatment inoculated with the tested fungus alone all plants died (control). The plants sprayed with *Lawsonia inermis* aqueous extract at high concentration (100g/L) had a highest significant antimicrobial activity against root rot disease, *Lawsonia inermis* aqueous extract showed good inhibitory effect against the tested fungus. As for vegetative growth and volatile oil percentage the application of *Lawsonia inermis* aqueous extract at (100g/L) significantly increased plant height, number of branches , herb fresh and dry weights and volatile oil percentage in most cases in both seasons. Followed by the application of *Eucalyptus camaldulensis* aqueous extract at (100g/L). The lowest values were recorded when the plants were treated with *Eucalyptus camaldulensis* aqueous extract at (50g/L) in the first and second seasons. Regarding GLC analysis, the highest percentage of 1,8-Cineol (the main component of the volatile oil) was produced with *Lawsonia inermis* aqueous extract at (100g/L).

Keywords *Lavandula dentata* root rot disease, *Lawsonia inermis* and *Eucalyptus camaldulensis* leaves aqueous extracts.

INTRODUCTION

The intensive and indiscriminate use of fungicides in agriculture has caused many problems to the environment such as water, soil, animals and food contamination, poisoning of farmers elimination of non target organisms and selection of phytopathogens, pest and weed insensitive to certain active ingredients(Strangarlin *et al*., 1999).To minimize the negative effects of fungicides alternative developed methods to control plant diseases are being used. These methods include the biological control, the induction of resistance and the use of natural products with induction of resistance and or with direct antimicrobial activities (Schwan and Strangarlin, 2005).

The biological control is defined as the use of antagonistic organisms for the control of microorganisms, reducing the amount of inoculum that determines the extent of disease (Cook and Baker, 1983).The induction of resistance promotes the activation of the latent plant defense systems, which manifests itself when it comes into contact with a biotic (Felipini and Di Piero, 2009) on apple and (Strangarlin *et al.,* 2010) on soybean or abiotic elicitor carre and (Barretti *et al.,* 2010) on tomato. The expression resistance of induction both can be used to denote local protection, this is, the induction of a resistance only in the tissues in which it was applied the treatment with the inducing agent, also

can indicate a systemic resistance that manifest far from the tissue where the elicitor was applied (Moraes, 1992).

Henna (*Lawsonia inermis*) belongs to family Lythraceae is small shrub cultivated in many tropical countries and warm temperate reign. It has been used for coloring palms of hands, soles of feed an finger nails and also for personal adornment (Bhuvane and Kuruvilia, 2002). *Lawsonia inermis* plant constituent are made up tannic acid, mucilage and gallic acid, but the main bioactive constituent is 2-hyrooxynaphthoquinon (lawsone). (Singh and Singh, 2001) powdered leaves of this plant in paste form have been used as cosmetic and as remedy in skin diseases and used as external application in headache. *Lawsonia inermis* aqueous extract has been used as natural fungicide (Dahankhar *et al*., 2000). Also, *Lawsonia inermis* aqueous extract has a high antimicrobial activity against potato dry rot disease caused by *Fusarium solani* (Bhardwaj, 2012). Spraying *Lawsonia inermis* aqueous extract is the safe method to control powdery mildew disease of *Zinnia elegans* (Hegazi and El-Kot, 2010).

Some components in *Lawsonia inermis* leaves according to (Duke , 1992)

- **Lawsone (10 ppm)**
  1.4 Naphaquinone
- **Flavonoid glucosde**
  Apigenin-4- glucoside
  Luteolin-3- glucoside
  Luteolin-7-0- glucoside
- **Tannins (50-100 ppm)**
- **Phenolic acid**
  Gallic acid
- **Terpenes**
  Beta- sitosterol
  Mannitol
- **Coumarins(12.7-21.4 ppm)**
- **Sugars**
  Pentosan

Camphor (*Eucalyptus camaldulensis*) belongs to family Myrtaceae, is one of the reputed fast growing trees of the world. It's oil is acrid, bitter, astringent and insect repellent,(Babu *et al*., 2008).

Some components in *Eucalyptus camaldulensis* leaves according to (Duke, 1992)

- **Terpens and their derivatives**
  Beta-Bisabolol, Beta-Elemene, Beta-Pinene
  Borneol, Cadinadiene, Cadinenol, Cadineol
  1-8Cineole(24-48ppm), Geraniol, Eugenol
  &-Terpineol- Citronellol, Camphene
  Cuminalcohol, Cuminaldehyde, Camphor
  Eucalyptol
- **Phenolic acidsglocosid**

lavender (*Lavandula dentata*) belongs to family Lamiaceae. *Lavandula dentata* is one of the most useful medicinal and aromatic plants. Commercially, it is an important source of essential oil that is widely used in fragrance industry including soaps, colognes, perfumes, skin lotions and other cosmetics (Paul *et al.,* 2004). In food manufacturing, lavender essential oil is employed in flavoring beverages, ice –cream, candy, baked goods and chewing gum (Kim and Lee, 2002) . Recently, aromatherapy is becoming increasingly popular and *Lavandula dentata* is used in aromatherapy as a relaxant (Lis –Balchin and Hart, 1999).Several therapeutic effects of *Lavandula dentata*, such as sedative, antiviral and antimicrobial activities have been reported (Gamez *et al.,* 1990 ; Buchbauer *et al.,* 1991).

Lavandula dentata essential oil are advocated for their use as antibacterial agent in both early and modern aromatherapy texts (Lawless,1992; Gattefosse,1995). *Lavandula dentata* is exposed to many diseases and root rot is one of the *Botryodiplodia theobromae* (Pat.) Griff. and Maubl. (Syn: *Lasiodiplidia theobromae* Pat.) and its asexual state, *Botryosphaeria rhodina* (Berk and M.A. Curtis) Arx are fungal pathogens of great economic importance.It is a cosmopolitan fungus causing both field and storage diseases on more than 280 plant species including crops, fruits, and cash fruit trees .*B. theobromae* is an opportunistic plant pathogen that causes different types of plant diseases within tropical and subtropical regions (Faber *et al*., 2007). It has a wide host range estimated to be more than 280 plant species (Domsch *et al*., 2007;Khanzada *et al*., 2006; Sutton 1980) although with varied pathological effects on its hosts. The fungus is known to cause tuber rots in yam, root rot in cassava, collar rot in peanuts, crown rot in banana, stem end rot in mango fruits, stem rot in pawpaw and leaf spot in citrus (Sangeetha *et al.,* 2011; Rossel *et al.,* 2008; Khanzada *et al.,* 2004). Rots caused by the fungus, particularly in the root and tuber crops often occur underground and so diagnosis of the disease is usually delayed or under repaired. Moreover, the wider host range (Crammer, 1979) and the host non- specificity of *B. theobromae* makes control and management of the disease very difficult.

Nawadays synthetic fungicides are used as primary tools for the control of plant diseases. However, the alternative control methods are needed because of the negative public perceptions about using synthetic chemicals, resistance to fungicide among fungal pathogens, and high development cost of new chemicals. The uses of plant-derived products as disease control agents have been studied, since they tend to have low mammalian toxicity, less environmental effects and wide public acceptance (Lee *et al.,* 2007; Katooli *et al*., 2011).

The aim of this research was to examin the antifungal activity of aqueous extracts of *Lawsonia inermis* and *Eucalyptus camaldulensis* leaves separately to control of *Lavandula dentata* plants root rot disease .

MATERIALS AND METHODS

This experiment was conducted at the Experimental Field of the Medicinal and Aromatic Plants Department at Dokky, Giza, Egypt, in two successive seasons 2012 and 2013.

1. Preparation of Plant extracts

Lawsonia inermis and *Eucalyptus camaldulensis* aqueous extracts were prepared by soaking (100g) of powdered dried leaves in tap water for 24 hours and then they were filtered. Each extract was concentrated at (50 and 100g/L) (Babu *et al.,* 2008).*Lavandula dentata* plants were sprayed four times with aqueous extracts of *Lawsonia inermis* and *Eucalyptus camaldulensis* separately. The first spray was conducted after planting, the second was done three weeks there after, the third was applied after the 1st cut and the fourth was added three weeks after the third one.

2.Experimental procedure

2.1.Isolation and identification of causal pathogen (*Botryodiplodia theobromae*)

Naturally infected plants showed root rot disease symptoms, collected from El –Ekhlas Farm at Giza ,were cut into pieces 5mm long .These pieces were surface sterilized for 3min. with 3% sodium hypochlorite and rinsed in 4 successive changes of sterile distilled water then left to dry on Whatman No. 1 filter paper .The surface sterilized pieces were transformed to potato dextrose agar (PDA) medium in petri dishes and incubated at 27± 2ºC for 5 days . Pure cultures, made by single spore technique, was identified using cultural, morphological and microscopical characters according to (Barnett and Hunter, 1981).

2.2.Soil infestation with the pathogenic fungus

Isolated pathogen *Botryodiplodia theobromae* was grown on sand –corn medium(1:1w:w and 40% water) for 15 days at 25± 2ºC.Pots (30cm diameter) containing sterilized sandy loam soil were artificially infested separately with prepared fungal inoculum at the rate 3% of soil weight .The inoculum was mixed thoroughly with the upper layer of the soil then irrigated every other day and left for 7 days to ensure the distribution of the inoculum. Each treatment was replicated three times every replicate consisted of nine pots (1 plant / pot) and nine ones left without infestation to serve as control. Root rot percentage was recorded 45 days after planting.

2.3 Source of cutting

Lavandula dentata cutting (15-20) cm in height were obtained from El-Ekhlas Farm at Giza and planted in plastic pots (30cm diameter) on 25th February, 2012 and 2013 in the first and second seasons, respectively.

3. Experiment layout

The experiment layout was designed in complete randomized blocks included five treatments each treatment was replicated three times and every replicate consisted of nine pots (1plant /pot), the recorded data were statistically analyzed according to Snedecor and Conchran (1968), using L.S.D at 5% .

4. Chemical fertilization

The sources of chemical fertilizers (NPK) were ammonium sulphate (20.6%N), calcium superphosphate (15.5% P_2O_5) and potassium sulphate (48%K_2O). (NPK) fertilizers were added at the recommended level in five doses, the 1st was for all phosphorous amount which was added during soil preparation, the rest (NK) were applied in two equal doses for each cut, on 8 th April and 10 th May for the1stcut and on 10 th June (after the1st cut) and 9 th July for the 2ed one in the two seasons. The plants were harvested twice, the first cut was conducted on 7th June and the second one on 8 th August in both seasons.

5.Treatments

1.Control (*Botryodiplodia theobromae* fungus all plants died and were not subject to statistical analysis) .
2.*Botryodiplodia theobromae* fungus+ *Lawsonia inermis* aqueous extract at (50g/L).
3.*Botryodiplodia theobromae* fungus +*Eucalyptus camaldulensis* aqueous extract at (50g/L).
4.*Botryodiplodia theobromae* fungus + *Lawsonia inermis* aqueous extract at (100g/L).
5.*Botryodiplodia theobromae* fungus +*Eucalyptus camaldulensis* aqueous extract at (100g/L).

6.Data recorded

The following data were recorded

1. Identification of causal pathogen (*Botryodiplodia theobromae*)
2.Percentage of root rot.
3.Plant height and number of branches /plant.
4.Herb fresh and dry weights (g/plant).
5.Volatile oil percentage in fresh herb according to (British Pharmacopeia, ,1963).

7.Volatile oil component

Sample taken from the oil obtained in the first cut of the first season were analyzed using gas liquid chromatography (GLC), to determine their main constituents. The use of GLC in the quantitative determinations was performed using the methods described by (Bunzen *et al.,* 1969; Hoftman, 1967).

RESULTS AND DISCUSSION

1. Identification of causal pathogen

Associated with root rot symptoms was a fungus that had the following morphology: solitary pycnidia, pyriform, black, 150–175 X190–210 mm, glabrous, with an apical ostiole, stromatic wall, composed of several layers of dark brown, thick-walled cells; conidia ellipsoidal, one-celled, hyaline when immature becoming dark brown, striate and didymospore with age ,22.0–28.5 X12.5–14.0 mm. The fungus fits the description of *Botryodiplodia theobromae* (Pat.) Griffon & Maubl. (Punithalingam, 1976 ; Barnett and Hunter, 1981).

2. Percentage of root rot

Aqueous extracts of *Lawsonia inermis* and *Eucalyptus camaldulensis* were tested for their antifungal ability to control root rot disease of *Lavandula dentata* caused by the pathogenic fungus *Botryodiplodia theobromae* . Data in Table (1) clearly emphasized that, *Lawsonia inermis* and *Eucalyptus camaldulensis* aqueous extracts separately control root rot disease . It is obvious that resistance agents significantly decreased the incidence of root rot disease, *Lavandula dentata* plants were protected by aqueous extracts of *Lawsonia inermis* and *Eucalyptus camaldulensis* separately. The most effective treatment was aqueous extract of *Lawsonia inermis* at 100g / L in both seasons. This result may be due to medicinal and aromatic plants represent a rich source of antimicrobial agents (Mahesh and Satish, 2008). Plants generally produce many secondary metabolites, fungicides and many pharmaceutical agents used in traditional medicine (Ibrahim, 1997; Ogundipe *et al.,* 1998).Medicinal and aromatic plants are the sources of natural fungicides that make excellent leads for new fungicides development (Arokiyara *et al.,* 2008; Brindha *et al*., 2009). Also Medicinal and aromatic plants have limitless ability to synthesize aromatic secondary metabolites, most of which are phenols or their oxygen subatituted derivatives (Geissman, 1963). Important subciasses in this group of compounds include phenols, phenolic acids, quinones, flavones, flavonoids, tannins, coumarins and essential oils. These groups of compounds show antimicrobial effect and serves as plant defense mechanisms against pathogenic microorganisms. Simple phenols and phenolic acid are bioactive phytochemicals consisting a single substituted phenolic ring. Phenolic toxicity to microorganisms is due to the sites and number of hydroxyl groups present in the phenolic compound(Scalbert, 1991; Urs and Dunteavy, 1975).Quinones are characteristically highly reactive, colored compounds. These results were in accordance to (Bambawale *et al.,* 1995) on cotton found that, *Lawsonia inermis* aqueous extract inhibited spore germination and mycelial growth *of Myrothecium roridum*. Also, (Bakeer *et al.,* 2005) on *Pelargonium graveolens* reported that, garlic (*Allium sativum*) and onion (*Allium cepa*) extracts significantly decreased the incidence of *Pelargonium graveolens* root rot disease. (Sharma *et al.,* 2010) on kinnow fruits observed that, *Allium sativum* aqueous extract inhibited 100%of mycelial growth of *Botryodiplodia theobromae* followed by aqueous extract of *Lawsonia inermis* which reduced 73.64% of rot incidence.

Table 1. Effect of *Lawsonia inermis* and *Eucalyptus camaldulensis* leaves extracts on percentage of root rot of *Lavandula dentata* plants during 2012 and 2013 seasons

Treatments	% root rot			
	Season 2012	Efficacy %	Season 2013	Efficacy %
Control(*Botryodiplodia theobromae* fungus)	100.00	0.0	100.00	0.0
Botryodiplodia theobromae fungus +*Lawsonia inermis* extract (50g/L)	41.60	53.70	38.90	56.70
Botryodiplodia theobromae fungus +*Eucalyptus camaldulensis* extract (50g/L)	46.60	48.20	44.40	50.60
Botryodiplodia theobromae fungus +*Lawsonia inermis* extract (100g/L)	27.50	69.10	25.50	72.20
Botryodiplodia theobromae fungus +*Eucalyptus camaldulensis* extract(100g/L)	39.60	56.00	36.60	59.30
LSD at 5%	15.40	-	14.60	-

The same results were obtained by (Hegazi and El-Kot, 2010) found that, spraying *Zinnia elegans* plants with *Lawsonia inermis* aqueous extract inhabited powdery mildew caused by *Erysiphe cichoracearum* fungus. In the same way, (Tariqu *et al.,* 2010) on *Gladiolus grandiflorus* stated that, spraying both aqueous extracts of *Allium sativum* and *Allium cepa* reduced incidence of corm rot disease caused by *Fusarium oxysporium* fungus.

3.Vegetative growth

3.1.Plant height and number of branches/ plant

Data in Table (2) indicated that, treatment inoculated with *Botryodiplodia theobromae* fungus alone all plants died (control), also both aqueous extracts of *Lawsonia inermis* and *Eucalyptus camaldulensis* had a significant increased in plant height and number of branches / plant in the two seasons. The tallest plants in the first and second seasons at the two cuts were recorded by the plants were treated with aqueous extract of *Lawsonia inermis* and *Eucalyptus camaldulensis* separately at 100g/L which gave (36.36, 34.77cm) and (29.16, 27.36 cm) at first and second cuts in the first season, respectively. The same trend was observed in the second season giving (32.50, 31.77 cm) and (26.97,25.30 cm). The shortest plants in the two cuts of the first and second season were treated with aqueous extract of *Eucalyptus camaldulensis* at 50 g / L as shown in Table (2).The same trend was observed in the case of number of branches. The application of *Lawsonia inermis* aqueous extract also had a significant effect on number of branches/plant, the highest number of branches was recorded when plants were sprayed with *Lawsonia inermis* aqueous extract at 100g/L giving 9.35 and 10.07 at first and second cuts, respectively, while in the second season the recorded data were 12.01 and 13.15 at first and second cuts, respectively. The lowest values were recorded when the plants were sprayed with *Eucalyptus camaldulensis* aqueous extract at 50g/L in the first and second cuts at the first season giving (7.46 and 8.90).The same trend was observed in the second season giving (9.60, 10.96) at the first and second cuts. These results may be due to *Lawsonia inermis* aqueous extract contains lawsone ($C_{10}H_6O_3$),the active
ingrediend and naturally occurring naphthoquinone (Habbal *et al.,* 2007) and the presence of eucalyplol in *Eucalyptus camaldulensis* aqueous extract (Babu *et al.,* 2008).These results are in agreement with that obtained by (Tariqu *et al.,* 2010) on *Gladiolus grandiflorus***.**

3.2.Herb fresh and dry weights (g/ plant)

Data in Table (3) revealed that, treatment applied with the tested fungus alone all plants died (control). Spraying aqueous extracts of *Lawsonia inermis* and *Eucalyptus camaldulensis* separately had a significant effect on herb fresh and dry weights in most cases in the two seasons. The best results were obtained from *Lawsonia inermis* aqueous extract. The highest fresh and dry weights /plant were recorded when *Lavandula dentata* plants were sprayed with *Lawsonia inermis* aqueous extract at 100g/L giving 37.15, 39.31 g /plant and 41.43, 48.44 g/plant fresh weight and 15.47, 19.88 g/plant and 28.09,37.12 g/plant dry weight in the first and second seasons respectively.

Table 2. Effect of *Lawsonia inermis* and *Eucalyptus camaldulensis* leaves extracts on plant height and number of branches of *lavandula dentata* plants during 2012 and 2013 seasons

Plant height				
	1st season		2 ed season	
Treatments	1st cut	2 ed cut	1st cut	2 ed cut
Control(*Botryodiplodia theobromae* fungus)	0.0	0.0	0.0	0.0
Botryodiplodia theobromae fungus +*Lawsonia inermis* extract (50g/L)	23.81	22.05	21.80	20.15
Botryodiplodia theobromae fungus +*Eucalyptus camaldulensis* extract (50g/L)	23.23	20.42	20.17	19.67
Botryodiplodia theobromae fungus +*Lawsonia inermis* extract (100g/L)	36.36	34.77	32.50	31.77
Botryodiplodia theobromae fungus +*Eucalyptus camaldulensis* extract(100g/L)	29.16	27.36	26.97	25.30
LSD at5%	3.326	3.664	4.044	4.962
Number of branches				
Control(*Botryodiplodia theobromae* fungus)	0.0	0.0	0.0	0.0
Botryodiplodia theobromae fungus +*Lawsonia inermis* extract (50g/L)	8.56	9.43	9.99	11.33
Botryodiplodia theobromae fungus +*Eucalyptus camaldulensis* extract(50g/L	7.46	8.90	9.60	10.96
Botryodiplodia theobromae fungus +*Lawsonia inermis* extract (100g/L)	9.35	10.07	12.01	13.15
Botryodiplodia theobromae fungus +*Eucalyptus camaldulensis* extract(100g/L)	9.07	9.94	11.00	12.18
LSD at 5%	1.028	0.955	0.686	0.784

These results may due to the presence of the secondary metabolites, flavonoids, tannins, phenols and anthraquinones in *Lawsonia inermis* aqueous extract, the plant extracts may be considered as good sources of natural antioxidants for medicine uses (Arulpriya and Lalitha, 2012). These results are in harmony with (Muhammed, 2005; Tariqu *et al.*, 2010).

4.Volatile oil percentage

Data in Table (4) showed that, all plants died when they were treated with the pathogenic fungus alone (control). Essential oil percentage of *Lavandula dentata* fresh herb were significantly responded to plant extracts (natural fungicides) in the first season at the two cuts . The high concentration of *Lawsonia inermis* aqueous extract (100g/L) had a highest fungitoxic activity against *Lavandula dentata* root rot, which gave the highest oil percentage the values were 0.367 and 0.427% at the first and second cuts in the first season respectively. While in the second season the differences between the treatments were not significant. The lowest volatile oil percentage was obtained when the plants were sprayed with *Eucalyptus camaldulensis* aqueous extract at 50 g/L in the two seasons.The increment in volatile oil percentage may be due to medicinal and aromatic plants are the sources of natural fungicides because plants produce secondary metabolites such as phenols, phenolic acids, quinones, flavones, flavonoids, flavonols, tannins, coumarins and essential oils. These groups have antimicrobial effect against pathogenic microorganisms (Das *et al.,* 2010).

5. GLC analysis of essential oil

The GLC analysis were carried out on the essential oil of *Lavandula dentata* plants of two treatments in the first cut of first season, *Eucalyptus camaldulensis* aqueous extract (50g/L) and *Lawsonia inermis* aqueous extract (100 g / L). Data were recorded in Table (5) and Figures (1-2) revealed that, 1,8- Cineol was the main component. It was observed that content of 1,8-Cineol tended to increase up to 46.48 % in case of *Lawsonia inermis* aqueous extract (100g/L).

Table 3. Effect of *Lawsonia inermis* and *Eucalyptus camaldulensis* leaves extracts on herb fresh and dry weights /plant (g) of *Lavandula dentata* plants during 2012 and 2013 seasons

Treatments	1st season		2 ed season	
herb fresh weight /plant(g)				
	1st cut	2 ed cut	1st cut	2 ed cut
Control(*Botryodiplodia theobromae* fungus)	0.0	0.0	0.0	0.0
Botryodiplodia theobromae fungus +*Lawsonia inermis* extract (50g/L)	34.61	36.07	36.94	44.17
Botryodiplodia theobromae fungus +*Eucalyptus camaldulensis* extract(50g/L	33.60	34.42	34.97	42.72
Botryodiplodia theobromae fungus +*Lawsonia inermis* extract (100g/L)	37.15	39.31	41.43	48.44
Botryodiplodia theobromae fungus +*Eucalyptus camaldulensis* extract(100g/L)	35.07	38.33	40.78	47.52
LSD at 5%	3.189	NS	5.428	4.927
herb dry weight /plant(g)				
Control(*Botryodiplodia theobromae* fungus)	0.0	0.0	0.0	0.0
Botryodiplodia theobromae fungus +*Lawsonia inermis* extract (50g/L)	10.94	17.47	24.64	34.47
Botryodiplodia theobromae fungus +*Eucalyptus camaldulensis* extract(50g/L	8.75	16.08	20.27	30.48
Botryodiplodia theobromae fungus +*Lawsonia inermis* extract (100g/L)	15.47	19.88	28.09	37.12
Botryodiplodia theobromae fungus +*Eucalyptus camaldulensis* extract(100g/L)	13.13	18.03	26.25	35.33
LSD at 5%	2.612	3.517	4.255	3.831

Table 4. Effect of *Lawsonia inermis* and *Eucalyptus camaldulensis* leaves extracts on volatile oil percentage of *Lavandula dentata* plants during 2012 and 2013 seasons

Volatile oil percentage (in fresh herb)				
	1st season		2 ed season	
Treatments	1st cut	2 ed cut	1st cut	2 ed cut
Control(*Botryodiplodia theobromae* fungus)	0.0	0.0	0.0	0.0
Botryodiplodia theobromae fungus +*Lawsonia inermis* extract (50g/L)	0.220	0.407	0.453	0.500
Botryodiplodia theobromae fungus +*Eucalyptus camaldulensis* extract (50g/L	0.200	0.373	0.447	0.493
Botryodiplodia theobromae fungus +*Lawsonia inermis* extract (100g/L)	0.367	0.427	0.460	0.520
Botryodiplodia theobromae fungus +*Eucalyptus camaldulensis* extract(100g/L)	0.273	0.413	0.454	0.513
LSD at 5%	0.086	0.031	NS	NS

Table 5. Effect of *Lawsonia inermis* and *Eucalyptus camaldulensis* leaves extracts on volatile oil components % of *Lavandula dentata* plants in the 1St Season (1St cut).

Treatments / Volatile oil components	*Eucalyptus camaldulensis* aqueous extract (50g/L) %	*Lawsonia inermis* aqueous extract (100g/L) %
α-Pinene	4.15	4.20
1,8- Cineol	45.25	46.48
Sabinene	15.89	15.96
Linalool	9.91	9.94
Bicyclo(3,1) Hexan -3Ol,4 Methylene	7.76	7.78
Bicyclo(3,1,1) Heptan-2-One, 6,6-Dimethyl	4.36	4.39
αCampholene Aldehyde	0.92	0.95
p-Cymene	0.46	0.47
Camphene	0.99	1.00
Verbenone	1.02	1.11

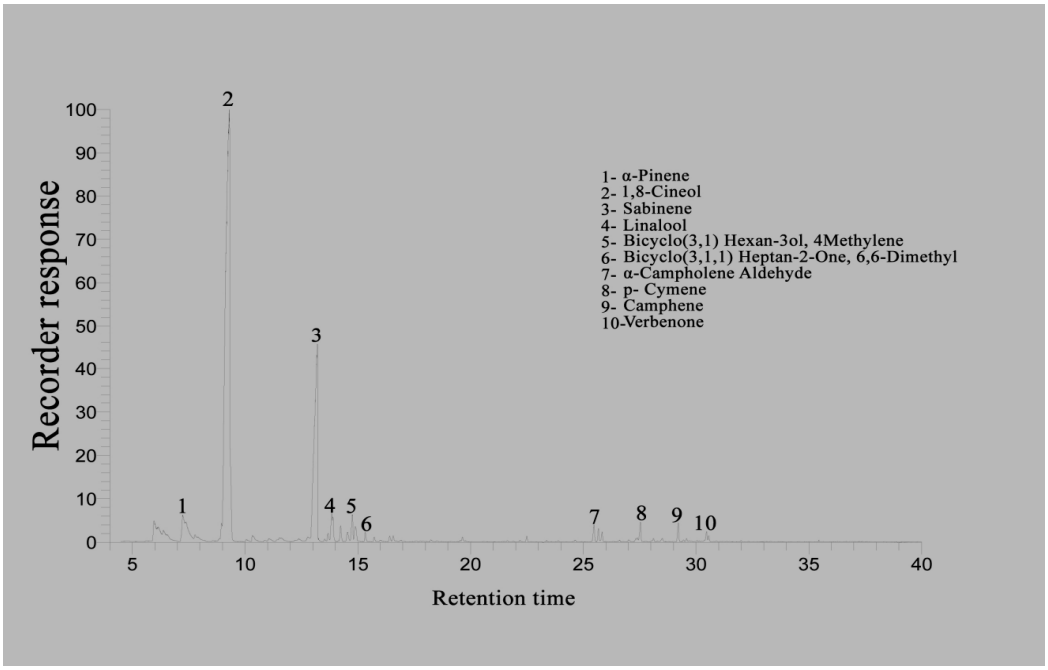

Figure 1. Chromatogram of *Lavandula dentata* volatile oil distilled from plants sprayed with *Eucalyptus camaldulensis* leaves aqueous extract at (50g/L)

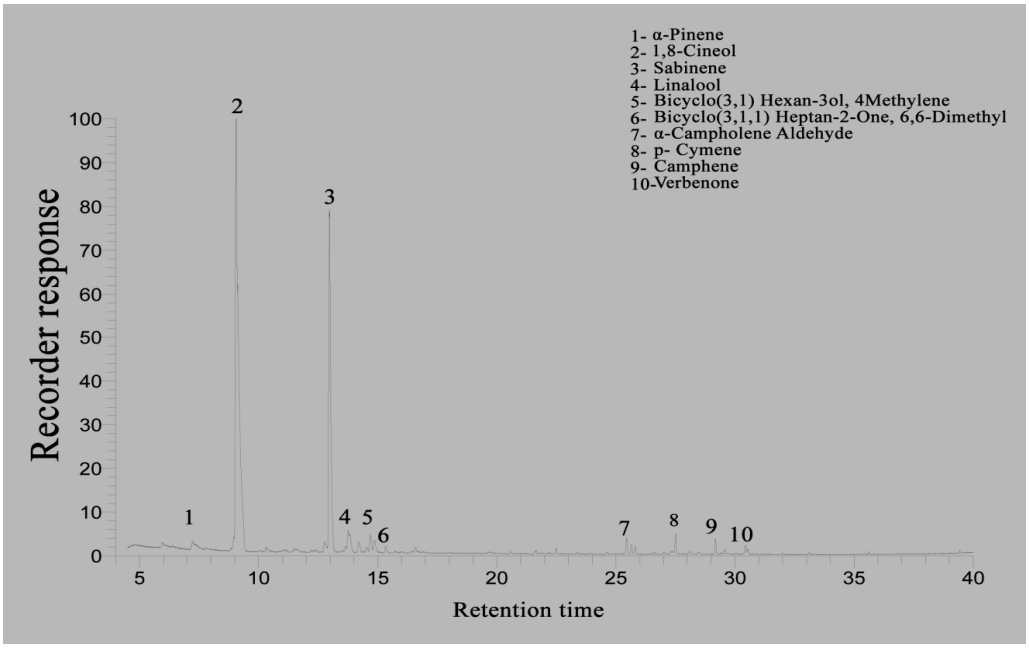

Figure 2. Chromatogram of *Lavandula dentata* volatile oil distilled from plants sprayed with *Lawsonia inermis* leaves aqueous extract at (100g/L).

CONCLUSION

It could be concluded that *Lawsonia inermis* aqueous extract at high concentration (100g/L) had a highest (natural fungicide) fungitoxic activity against *Lavandula dentata* root rot disease and it had a positive effects on vegetative growth and volatile oil percentage.

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الملخص العربي

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اجريت هذه التجربة فى مزرعة قسم بحوث النباتات الطبية والعطرية بالدقى خلال موسمى ٢٠١٣/٢٠١٢ بهدف دراسة تأثير الرش بالمستخلص المائى لكلا من الحناء والكافور منفردين بتركيز (١٠٠,٥٠ جرام /لتر). على مرض عفن الجذور فى نبات اللافندر وكذلك النمو الخضري ونسبة الزيت ومكونات الزيت وكانت اهم النتائج كما يلى:ادي رش نباتات اللافندر بالمستخلص المائى للحناء بتركيز ١٠٠جرام / لتر الى اعاقه نمو ونشاط الفطر المسبب للمرض وكذلك ادي الى زيادة النمو الخضري ونسبة الزيت زيادة معنوية وذلك فى اغلب الحالات فى كلا الموسمين. وقد سجلت النباتات التى عوملت بالمستخلص المائى للكافور بتركيز ٥٠جرام/ لتر اقل قيم وذلك فى كلا الموسمين . اما بالنسبة لتحليل مكونات الزيت فقد ادى الرش بالمستخلص المائى للحناء بتركيز. ١٠٠جرام / لترالى الحصول على اعلى نسبة للمكون الرئيسى فى الزيت (السنيول).

Biological Control of *Mentha Viridis* Root Rot Caused by *Fusarium Solani* by Using Mycorrhizal Fungi and Silicate Dissolving Bacterium

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ABSTRACT: This work was carried out in Experimental Farm of (PPRI) during the season of 2012 and 2013.The aim of the study was to investigate the effect of the inoculation of spearmint (*Mentha viridis*) plants with silicate dissolving bacterium *(Microbacterium trichotecenolyticum*) and or vesicular arbuscular mycorrhizal fungi (VAM) on the incidence of root rot disease, plant growth and volatile oil percentage. The obtained results are summarized as follows: in all cuts in the two seasons, treatment applied with pathogenic fungus alone all plants died (control) . The inoculation with silicate dissolving bacterium plus mycorrhizal fungi reduced growth of tested fungus and at same time spearmint plants were significantly taller than other treatments in both seasons. The same trend was observed in the branching of spearmint plants except in the second cut of the first season, the differences between treatments were not significant. The combination between silicate dissolving bacterium and mycorrhizal fungi (VAM) significantly increased dry weight/ plant in the second cut at the first season, also the highest volatile oil percentage was achieved with this treatment. In addition GLC analysis revealed that the highest percentage of carvone (the main component of the volatile oil) was produced with that exact treatment.

Keywords: Biological control, *Mentha viridis* root rot disease, *Fusarium solani*, Mycorrhizal fungi, Silicate dissolving bacterium.

INTRODUCTION

Spearmint (*Mentha viridis*,L.) belongs to family Lamiaceae (Labiatae).It is one of the most important medicinal and aromatic crops in many parts of world as well as in Egypt for local use and exportation (Bakeer *et al*., 2005). It is used in various medicinal and aromatic industries, such as the flavoring of pharmaceutical and other preparation such as tooth paste, mouth washes and perfumes (Mahran,1967).Spearmint volatile oil is characterized by a high carvone content for (60-70)% (Lee and Fred,1998; Elmasta *et al.,* 2006). Spearmint volatile oil is used as carminative, antimicrobial, also it is added to diarrheal drugs to prevent colics (Hikal and Omer,1993).

The complex disease, root rot caused by (*Fusarium oxysporium* , *Rhizoctonia solani, Macrophomina phaseolina* (Bakeer *et at.,* 2005) are considered as one of the most destructive soil borne disease attacking crops.

Arbuscular mycorrhizal fungi (VAM) are ubiquitous soil fungi that form obligate associations with plants roots. The potential benefit of mycorrhizal to agriculture is more apparent than even before because of the need to increase food, fiber and fuel production to keep pace with the increase in world population is crucial, especially in the lesser developed areas of the world. Hypotheses proposed to explain VAM fungal effects on soil borne plant pathogens generally have been considered to have either a physical or

physiological basis. It is already known that VAM fungi have been shown to affect root growth, nutrient absorption and host physiological responses to environmental stresses. However, VAM fungi have not been shown to interact directly with pathogens through antagonism, antibiosis or predation. The indirectly effect of the host-pathogen relationship by physiologically altering the host or by competing for space or host resources (Kulkarni *et al*., 1997).

Silicon (Si) is known as a beneficial element for plants the direct and indirect benefits of the element for crops (especially grasses) are related to resistance to diseases, pest and drought. The importance of Si on plant nutrition is set greater in the case of organic farming, since the use of biocides (insecticide, fungicides, nematicides, etc.) (Buck *et al*., 2008).

Supplying Si through fertilization can contribute for the increase in production and protection of organically grown crops. (Epstein, 2001) cited some scientifically proven examples of beneficial effects that Si promotes in the plants, such as resistance to plant pathogen attack, better structure of plant architecture, resistance to herbivore of insects, mitigation of heavy metal phytotoxicity. Traditionally it is suggested that an accumulation of Si in the epidermal tissue of the plant main mechanism which provide defense against insect and fungal attacks. Steel slag was considered as an adequate source of Si and registered in 1955 in Japan as a fertilizer (Kingston, 2008).Numerous studies demonstrated the high agronomic benefits of steel slag mainly due to it is high soluble Si (Ferreirex *et al*.,2008).

MATERIALS AND METHODS

This study was carried out at Experimental Farm of Mycology Research & Diseases Survey Dept., PPRI, ARC, in two successive seasons 2012 and 2013.The aim of this study was to investigate the effect of applying VAM fungi and / or silicate dissolving bacterium on the incidence of spearmint plants root rot.

1.Source of the pathogenic fungus and plant material

Pathogenic fungal isolate of *Fusarium solani*, the causal agent of spearmint root rot disease, was obtained from Mycology Research & Diseases Survey Dept., PPRI , ARC. This isolate proved to be aggressive in previous studies.VAM fungi inoculum containing spores of *Glomus mosseae*, *Glomus intraradices, G.faculatum* and *Gigaspora* sp. was also obtained from Mycology Research & Plant Diseases Survey Dept, PPRI, ARC. It was applied at the rate 10 g / kg soil (consisted of soil, extra material hyphal fragments and infected sudan grass root fragments).

2.Source of silicate dissolving bacterium

Domestic isolate was kindly provided by Department of Microbiology/ SWERI / ARC.

3.Experimental procedures

A pathogenic isolate of *Fusarium solani* was grown on sand –corn medium (1:1W:W and 40% water) for 15 days at 25 ± 2 ºC. Pots (30 cm diameter) containing sterilized sandy loam soil were artificially infested separately with prepared fungal inoculum at the rate of 3% of soil weight. The inoculum was mixed thoroughly with the upper layer of the soil then irrigated every other day

and left for 7 days to ensure the distribution of the inoculum. Each treatment was replicated three times every replicate consisted of nine pots (1 plant / pot) and nine ones left without infestation to serve as control. Prior to cultivation, electric furnace steel slag (by product of Ezz –Dekheilah steel company)was air dried, ground at < 60 mesh and mixed in the soil pots at rate equivalent to 250 kg/fed. At planting date and 15 days later, strain of silicate dissolving bacterium was applied in liquid form to the steel slag treated soil at rates equivalent to 5 L / fed. Spearmint rhizomes (12-15 cm in length) were obtained from the Farm of El Kanater El- Khairia and planted in the inoculated plastic pots (30 cm diameter) on 15 th February, 2012 and 2013 in the first and second seasons, respectively.

4. Experiment layout

The experiment layout was designed in complete randomized blocks included five treatments each treatment was replicated three times and every replicate consisted of nine pots (1plant /pot), the recorded data were statistically analyzed according to Snedecor and Conchran (1968), using L.S.D at 5% .

5.Chemical fertilization

The sources of chemical fertilizers (NPK) were ammonium sulphate (20.6 % N), calcium superphosphate (15.5% P_2O_5 and potassium sulphate 48% K_2O). (NPK) fertilizers were added at the recommended level in five doses, the 1st was for all phosphorous amount which was added during soil preparation, the rest (NK) were applied in two equal doses for each cut, on 29 th March and 28 th April for the1st cut and on 20 th May (after the1st cut) and 22 th June for the 2^{ed}one in the two seasons. The plants were harvested twice, the first cut was conducted on 17 th May and the second one on 18 th July in both seasons.

6.Treatments

1.(Control) *Fusarium solani* (all plants died and were not subject to statistical analysis) .
2.*Fusarium solani* + Mycorrhizal fungi (VAM).
3.*Fusarium solani* +.silicate dissolving bacterium
4.*Fusarium solani*+ + Mycorrhizal fungi (VAM) + silicate dissolving bacterium.
5.Spearmint plants without any infection (normal).

7.Data recorded

The following data were recorded:
1.Incidence of root rot disease
2.Plant height and number of branches/ plant.
3.Herb fresh and dry weights (g/ plant).
4.Volatile oil percentage in dry herb according to British Pharmacopeia (1963).

8.Volatile oil components

Samples taken from the oil obtained in the first cut of the first season were analyzed using gas liquid chromatography (GLC), to determine their main constituents. The use of GLC in the quantitative determinations was performed using the methods described by (Bunzen *et al*., 1969 and Hoftman, 1967).

RESULS AND DISCUSSION

1. Incidence of root rot disease

Results presented in Table (1) showed that spearmint plants response to inoculation with the tested bio agents (VAM and silicate dissolving bacterium) . It is obvious that they significantly decreased the incidence of root rot disease. Spearmint plants were protected from early infection with *Fusarium solani* .The best results were obtained from inoculation with silicate dissolving bacterium + Mycorrhizal fungi (VAM) in the first and second season respectively. Such effect may be due to that Si deposited on the tissue surface act as physical barrier .It prevents physical penetration and /or makes the plant cells less susceptible to enzymatic degradation by fungal pathogens. This mechanism is supported by the positive correlation between the Si content and the degree of suppression of diseases and pests. Also, Si function as a signal to induce the production of phytoalexin (Cherif *et al*.,1994).Si application to cucumber resulted in the stimulation of the chitinase activity and rapid activation of peroxidases and polyphenoloxidases after infection with *Pythium* spp. Glycosidically bound phenolics extracted from Si treated plant when subjected to acid or beta glucosidase hydrolysis displayed a strong fungistatic activity. However, in oat attacked by *Blumeria yraminis*, Si deficiency promoted the synthesis of phenolic compounds(Carver *et al*.,1998).The phenylalanine ammonia – lyase activity was enhanced by Si deficiency.(Harlpur *et al*., 1990) showed that simultaneous inoculation of VAM fungi with the pathogen reduced the incidence of disease caused by *Sclerotium rolfsii* [*Corticium rolfsii*] on wheat in pot trials. Also (Rabie, 1998) revealed the effectiveness of *G. mosseae* against *Botrytis faba* of broad bean. It was suggested that mycorrhizal fungi increase the resistance of plants against pathogen attack by increasing the nutritional needs of plants, and other factors that cause the unavailability of nutrients for the pathogen, reducing environmental stress on plants and soil microorganisms in improving rhizosphere. Mycorrhizal infection may alter the host plant metabolism through certain chemical, physiological and morphological inductions (Mosse, 1973)..Mycorrhizal fungi (VAM) inoculated plants have higher levels of orginine that is inhibitory to chlamydospores of disease causing pathogen (Amarantus, 2001) reported that VAM can cause unavailability of nutrients for pathogen, that claim is supported by (Turk *et al*., 2006) who said that arbuscular ,vesicles and the network of intracellular hyphae cause the unavailability of space to colonize and reduce pathogens carbohydrate supply in the plant roots .Mycorrhizal fungi (VAM) may improve response in the root system of plants root against pathogens. It is speculated that mycorrhizal chickpea seedlings that survived might have benefited from some or all of these modifications. These results are in harmony with those obtained by (Harplur *et al*.,1990) on wheat, (Liu *et al*., 1995) on cotton , (Rabie, 1998) on broad bean and (Moussa and Daoud, 2013) on corn.

Table 1. Effect of mycorrhizal fungi and silicate dissolving bacterium on incidence of root rot disease of spearmint plants during 2012 and 2013 seasons

Treatments	% root rot	
	1 st season(2012)	2 ed season (2013)
Control (*Fusarium solani*)	100.00	100.00
F.solani+VAM	66.67	33.33
F.solani + silicate dissolving bacterium	50.00	50.00
F.solani+ silicate dissolving bacterium+ VAM	16.67	0.00
Spearmint plants without any infection (normal)	50.00	50.00
LSD at 5%	40.63	23.48

VAM =mycorrhizal fungi

2.Vegetative growth

2.1. Plant height and number of branches/ plant

From data in Table (2) it can be noticed that inoculation of the plants with mycorrhizal fungi (VAM) and or silicate dissolving bacterium significantly increased plant height in both seasons. The tallest plants in the first and second seasons at the two cuts were recorded when the plants inoculated with silicate dissolving bacterium + Mycorrhizal fungi (VAM) giving 54.78 and 47.09 cm at first and second cuts, respectively. The same trend was observed in the second season giving 46.56 and 37.88 cm. Regarding the effect of resistance agents on number of branches, data showed that all studied parameters in Table (2) significantly increased except in the second cut of the first season. The most effective treatment was *Fusarium solani* +silicate dissolving bacterium + Mycorrhizal fungi (VAM), which recorded 42.69 and 32.65 at first and second cuts, respectively. The same trend was observed in the second season giving 28.17 and 24.17. These results are in agreement with that obtained by (Rabie,1998) on broad bean.

2.2. Herb fresh and dry weights (g /plant)

Data in Table (3) indicated that there were insignificant differences in herb fresh weight / plant due to all treatments in concerning the effect of antistress agents. As for herb dry weight, inoculation of spearmint plants with silicate dissolving bacterium+ Mycorrhizal fungi (VAM) had no significant effect on herb dry weight in the two season except in the second cut of the first season. The inoculation of spearmint plants with silicate dissolving bacterium+ Mycorrhizal fungi (VAM) gave the highest dry weight /plant in the first season at the second cut (50.45 g / plant).These results are in harmony with those obtained by (Harlpur *et al.,* 1990) on wheat, (Cherif *et al.,* 1994) on cucumber and (Rabie, 1998) on broad bean. This behavior may be due to the positive role of silicate dissolving bacterium which dissolving Si from steel slag by product protect plants from unfavorable conditions and biotic stresses (Ferreirex *et al*.,2008).

Table 2. Effect of mycorrhizal fungi and silicate dissolving bacterium on plant height and number of branches of spearmint plants during 2012 and 2013 seasons

Plant height				
	1st season		2ed season	
Treatments	**1 st cut**	**2 ed cut**	**1 st cut**	**2 ed cut**
Control (*Fusarium solani*)	0.0	0.0	0.0	0.0
F.solani+ VAM	46.00	42.67	35.78	30.78
F.solani+silicate dissolving bacterium	49.11	44.02	37.67	33.56
F.solani+ silicate dissolving bacterium+ VAM	54.78	47.09	46.56	37.88
spearmint without any infection (normal)	52.22	50.03	42.11	35.90
LSD at5%	4.20	4.02	2.95	3.97
Number of branches				
Control (*Fusarium solani*)	0.0	0.0	0.0	0.0
F.solani+VAM	27.50	21.77	18.00	15.10
F.solani+ silicate dissolving bacterium	29.83	23.77	23.72	16.33
F.solani+ silicate dissolving bacterium+ VAM	42.69	32.65	28.17	24.17
spearmint without any infection (normal)	33.73	25.49	25.49	20.33
LSD at 5%	2.38	NS	5.33	5.70

VAM =mycorrhizal fungi

Table 3. Effect of mycorrhizal fungi and silicate dissolving bacterium on herb fresh and dry weights/plant (g) ofspearmint plants during 2012 and 2013 seasons

Treatments	herb fresh weight /plant(g)			
	1st season		2ed season	
	1 st cut	2 ed cut	1 st cut	2 ed cut
Control (*Fusarium solani*)	0.0	0.0	0.0	0.0
F.solani+VAM	65.00	59.00	47.32	43.73
F.solani+ silicate dissolving bacterium	81.00	62.52	55.92	52.62
F.solani+ silicate dissolving bacterium+VAM	98.00	93.53	71.21	65.27
Spearmint without any infection	87.15	76.39	63.98	59.29
LSD at 5%	NS	NS	NS	NS
herb dry weight /plant(g)				
Control (*Fusarium solani*)	0.0	0.0	0.0	0.0
F.solani+VAM	23.03	24.48	18.35	43.73
F.solani+ silicate dissolving bacterium	28.11	28.69	21.31	52.62
F.solani+ silicate dissolving bacterium+VAM	52.94	50.45	28.12	65.27
Spearmint without any infection (normal)	39.09	37.86	25.18	59.29
LSD at 5%	NS	18.47	NS	NS

VAM=mycorrhizal fungi

3.Volatile oil percentage

Essential oil percentage of spearmint dry herb were significantly responded to the inoculation with silicate dissolving bacterium and or VAM as recorded in Table(4). Regarding the effect of resistance agents, data revealed that, treatment applied with *Fusarium solani* alone all plants were died at the same time the combination between silicate dissolving bacterium and mycorrhizal fungi achieved the highest essential oil percentage of spearmint dry herb, in both season. These values represented 3.94% and 3.76% at two cuts in the first season, while in the second season the values were (2.99 and 2.84) at the first and second cuts respectively. The enhancement of essential oil percentage of spearmint dry herb by the inoculation with silicate dissolving bacterium + mycorrhizal fungi (VAM) may be due to the role of mycorrhizal fungi (VAM) in making phosphorus, manganese, zinc, in available form transfer of metabolite compounds and the efficiency of its root system leading to more absorption of water and nutrients, which led to increasing the rate of physiological processes and finally gave better yield (Liu *et al*., 1995). Also, silicon (Si) is essential for normal growth and development of plants, as well as in improving host plant resistance to pathogens attack (Nxumalo *et al.,* 2008).

4. GLC analysis of essential oil

The GLC analysis were carried out on the essential oil of spearmint plants of two treatments in the first cut of the first season, normal plants (without any infection) and mycorrhizal fungi (VAM) plus silicate dissolving bacterium. Data were recorded in Table (5) and Figures (1-2) revealed that, carvone and D-Limonene were the main components. It was observed that carvone content tended to increase up to 61.84 % in case of mycorrhizal fungi (VAM) plus silicate dissolving bacterium. Also data emphasized that D-Limonene content tended to increase up to 26.38% with the same treatment.

Table 4. Effect of mycorrhizal fungi and silicate dissolving bacterium on volatile oil percentage of spearmint plants during 2012 and 2013 seasons

Volatile oil percentage (in dry herb)				
	1st season		2ed season	
Treatments	1 st cut	2 ed cut	1 st cut	2 ed cut
Control (*Fusarium solani*)	0.0	0.0	0.0	0.0
F.solani+VAM	2.22	2.20	2.04	2.03
F.solani+ silicate dissolving bacterium	2.77	2.55	2.14	2.09
F.solani+silicate dissolving bacterium+VAM	3.94	3.76	2.99	2.84
Spearmint without any infection (normal)	3.77	3.67	2.88	2.80
LSD at 5%	0.44	0.52	0.40	0.53

VAM=mycorrhizal fungi

Table 5. Effect of mycorrhizal fungi (VAM) and silicate dissolving bacterium on volatile oil components % of spearmint plants in the 1St Season (1St cut)

Treatments / Volatile oil components	normal plants (without any infection)%	silicate dissolving bacterium + mycorrhizal fungi (VAM)%
α-Pinene	0.98	0.87
β-Pinene	3.25	1.26
D-Limonene	24.52	26.38
ρ-Cymene	1.16	0.58
1,8- Cineole	0.89	0.53
γ –Terpinone	3.62	3.07
Carvone	61.60	61.84
α-Terpinone	0.38	0.34
β-Caryophyllene	0.71	0.94
Eugenol	1.04	0.55

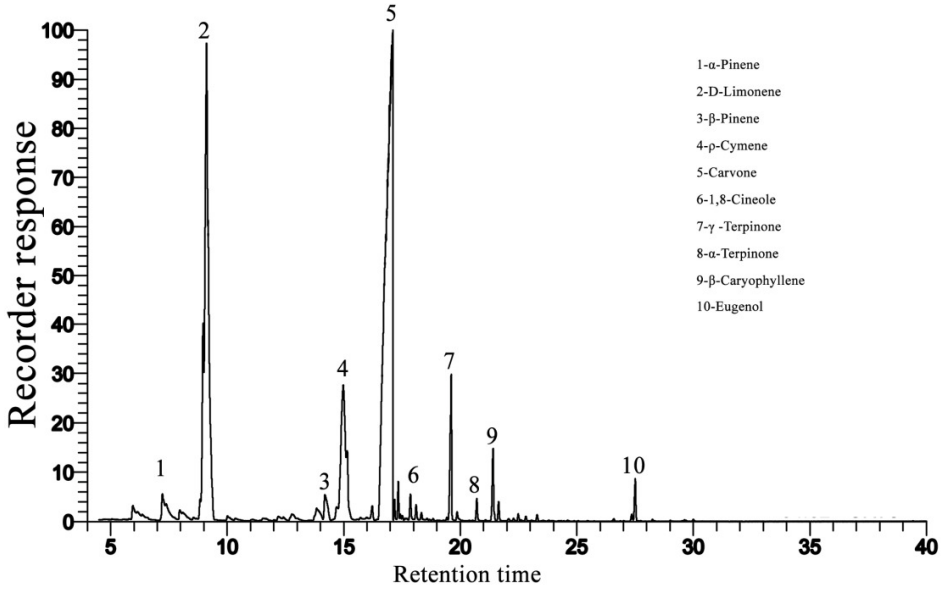

Figure 1. Chromatogram of spearmint volatile oil distilled from normal plants (without any infection).

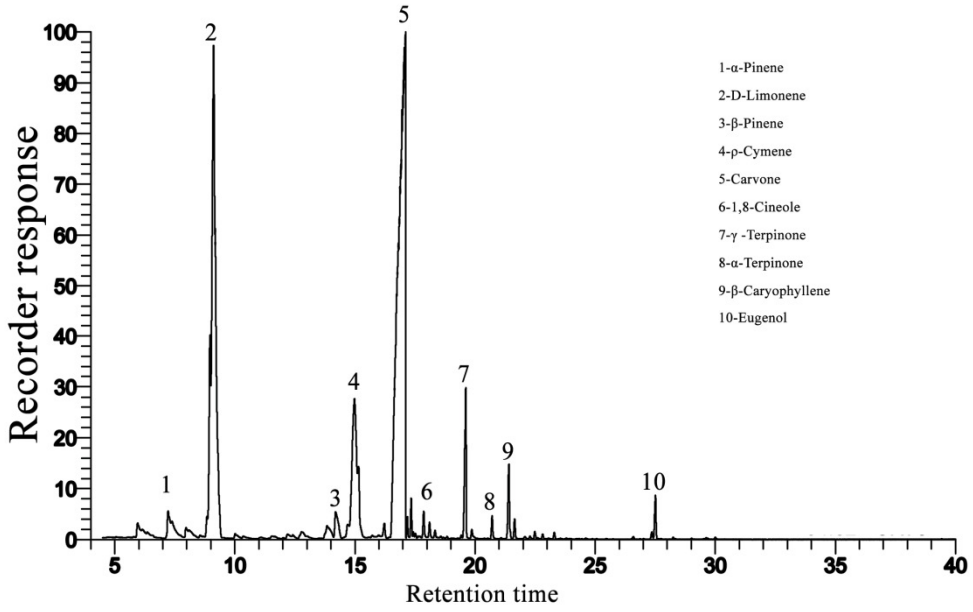

Figure 2. Chromatogram of spearmint volatile oil distilled from plants inoculated with mycorrhizal fungi (VAM) plus silicate dissolving bacterium.

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الملخص العربي

المكافحة الحيوية لعفن جذور النعناع البلدى المتسبب عن فطر فيوزاريم سولانى باستخدام فطريات الميكوريزا والبكتريا المذيبة للسليكات

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اجريت هذه التجربة فى مزرعة معهد بحوث امراض النبات خلال موسمى ٢٠١٢- ٢٠١٣لدراسة تأثير التلقيح الميكروبى لنباتات النعناع البلدى بالبكتريا المذيبة للسليكات وفطريات الميكوريزا مجتمعين او كلامنهما على حدة على مرض عفن الجذور فى نباتات النعناع البلدي وكذلك النمو والنسبة المئوية للزيت الطيار ومكوناتة وكانت اهم النتائج كما يلى :ادى التفاعل بين التلقيح الميكروبى لنباتات النعناع البلدى بالبكتريا المذيبة للسليكات وكذلك فطريات الميكوريزا الى ايقاف نموونشاط الفطر الممرض وكذلك الحصول على اعلى النباتات ارتفاعا فى كلا الموسمين وكذلك زيادة عدد الافرع على النباتات ماعدا فى الحشة الثانية للموسم الاول حيث لم يكن هناك فروق معنوية بين المعاملات .كما ادى التفاعل بين البكتريا المذيبة للسليكات وفطريات الميكوريزا الى زيادة الوزن الجاف للعشب زيادة معنوية فى الحشة الثانية للموسم الاول . اما بالنسبة لنسبة الزيت فقد تم الحصول على اعلى نسبة للزيت من التفاعل بين التلقيح الميكروبى بالبكتريا المذيبة للسليكات وفطريات الميكوريزا ذلك فى كلا الموسمين. وفيما يتعلق بتحليل مكونات الزيت فقد ادى التلقيح الميكروبى لنباتات النعناع البلدى بفطريات الميكوريزا بالاضافة الى البكتريا المذيبة للسليكات الى الحصول على اعلى نسبة للكارفون (Carvone) المكون الرئيسى فى الزيت.

Biotic and Abiotic Factors Affecting Productive Performance of Rotifers (*Brachionus Plicatilis*) Population Produced Under 3 Days Batch Culture System

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ABSTRACT: Rotifers *Brachionus plicatilis* are being used worldwide to feed early developmental stages of marine finfish and crustaceans. Further, rotifer transmits adequate supplies of micro and macro-nutrients, vitamins, probiotic, and even antibodies to fish larvae**.** Food type is regarded as the most important criterion that could affect growth and quality of rotifers. There fore, the present work was performed to study the effect of food type, salinity, water temperature, and initial stocking density on the population growth of rotifers. The first experiment was conducted to during the first phase of the present study investigate the effect of four different algal diets: (1) *Nannochloropsis oculata* life (N), (2) *Spirulina platensis* powder (S), (3) 50% *N. oculata* + 50% beaker yeast (NY), and (4) 50% *S. platensis* + 50% beaker yeast, on rotifer population (as final number/ml) and fatty acid profile of rotifer batch cultured (72 h) was employed. Rotifer culture treatments were conducted in jars (30 liters) with three replicates for each treatment.The results of the firts phase of the study clearly illustrated that NY diet possessed the highest population growth, Eicosapentaenoic acid (EPA), and Docosahexaenoic acid DHA percentage. Depending on the results of the first phase, the diet **NY** was candidate to investigate the effect of different salinities (25, 27, and 29 ppt), temperatures (26, 28, 30, 32 ºC), and initial rotifer stocking densities (50, 100, 150, and 200 Ind./ml) on rotifer population. The results showed that salinity 25 ppt, temperature 28ºC, and initial rotifer density 150 pcs/ml possessed the highest rotifer population growth during a 72-hrs batch culture system of rotifer when fed on 50% *N. oculata* + 50% beaker yeast (NY) food type.

Keywords: Rotifers, *Brachionus plicatilis*, food type, salinity, temperature, stocking density

INTRODUCTION

Rotifer *(Brachionus plicatilis)* is a cyclically parthenogenetic organism that appears regularly and typically in saltwater lakes and coastal lagoons. Several studies revealed that *B. plicatilis* was a complex species and at least three sympatric species (*Brachionus plicatilis*, *Brachionus rotundiformis* and *Brachionus ibericus*) have been observed**.** The two species *B. plicatilis* and *B. rotundiformis* are used worldwide, alone or in conjunction with other types of food to feed early developmental stages of marine finfish and crustaceans under hatchery conditions. Further, rotifer transmits adequate supplies of micro and macro-nutrients, vitamins and even antibodies to fish larvae **(Lubzens *et al.,* 2001).** However, among them *B. plicatilis* was widely used as live feed in aquaculture. Moreover, *B. plicatilis* are currently essential for intensive culture of marine larval fish in many hatcheries throughout the world **(Fielder, *et al.,* 2000).** Rotifer size varies in response to different environmental conditions. The fish larvae select the rotifers according to their size, and this resulted in increasing growth rate, and reduces mortality (**Qie *et al.,* 2011).**

Diet is regarded as the most important criterion that could affect growth and quality of rotifers. Moreover, *B. plicatilis* cultures are often influenced by variety of food types as diets. Rotifers density, production, fecundity, and growth

rate were dependent on food availability and quality (**Ferreira *et al.,* 2011).** Microalgae are the first found to be an excellent food that could provide best rotifer quality and quantity for marine fish larvae **(Yin and Zhao, 2008).** The microalga *Chlorella, Nannochloropsis*, and *Tetraselmis* have often been used as exclusive food in culturing *B. plicatilis* **(Lubzens *et al.,* 1997).** However, **Ashour (2011)** reported that *Nannochloropsis* may be the best microalgal species used as rotifer feed. Rotifer quality is often enhanced by different enrichment techniques. For example, it has been suggested that the replacement of baker's yeast supplemented with oils rich in n-3 HUFA can be used as an alternative food for rotifer culture. However, using yeast could deteriorate water quality (**Nhu, 2004)**.

A large number of researches have been reported that temperature, salinity and food types have variable effects on productivity of different strains of rotifers (**Miracle and Serra, 1989**, **Fulks and Main, 1991).** On the other hand, the density of rotifers in the water column has a significant effect on the feeding success of marine fish larvae by influencing the probability of encounter **(Fielder *et al.,* 2000).**

The aims of the present study were to:

1- Investigate the effect of different algal diets (*Nannochloropsis oculata* or *Spirulina platensis*) as a single diet or a supplemented diet with baker's yeast (*Saccaromysis cervicates***)** on rotifer population, as increase in number.
2- Investigate the effect of different water salinities, temperatures, and initial rotifer culture densities on rotifer population growth during a batch culture of rotifer (72 hrs.).

MATERIAL AND METHODS

MATERIALS

The experiments were conducted in Fish Rearing Laboratory, El-Max Research Station, Aquaculture Division, National Institute of oceanography and Fisheries (NIOF) Alexandria, Egypt. The culture water used in these experiments were obtained from a saline ground water (30±2 ppt).The rotifers *B. plicatilis* (L - type with average length ~ 200 µm) were obtained from a routine culture at the marine Finfish hatchery of NIOF. The present study was divided into two phases using patch culture system, each one was continued for 72 hrs. The necessary dilution to the desired initial density of rotifer was accomplished using sterilized and filtered seawater. The algal cell density was determined with a haemocytometer and the rotifer density with a 1- ml glass pipette using Sedgwick-Rotifer chamber. Rotifer culture treatments were conducted in special jars (30 liters) with three replicates for each treatment .

Phase1: study the effect of different food type on rotifer productive performance and its fatty acids content:

Four treatments were conducted, from different algal species and yeast, as food for rotifer; (1) *Nannochloropsis oculata* **(N)** at 15 $X10^4$ cell/ind/day **(Wendy and Kevan 1991),** (2) *Nannochloropsis oculata* **+** dried yeast **(NY)** at 0.5 g/10^6 ind.**,** (3) dried *Spirulina (Spirulina platensis*) **(S)** at 0.5 g/10^6 ind. and (4) dried *Spirulina* (0.5 g/10^6 ind)+dried yeast (SY) (0.5 g/10^6 ind). The culture conditions during the experiment were: salinity 25 ppt, temperature 30^{o}C, pH

7.8 and desolved oxegen(DO) was 4 mg/l. The initial rotifer density was conducted at 100 ind. /ml **(fulks and main, 1991).**

Phase 2: Effect of salinity, temperature and initial density on rotifer productive performance:

Depending on the results of the phase 1, the treatment **NY which** possessed the highest rotifer final number (population), as well as achieved the highest polyunsaturated fatty acid, Eicosapentaenoic acid (EPA) and Docosahexaenoic acid (DHA) percent. Accordingly, this treatment was selected and candidate to investigate the effects of different salinity, temperature and initial density on rotifer productive performance.

Salinity experiment was conducted at three levels; 25, 27, and 29 ppt. Each level was tested under controlled conditions of temperature 26±1℃, DO 4 mg/l, and pH 7.8. The initial rotifer density was conducted at 100 ind. /ml.

Temperature experiment was conducted at four levels; 26, 28, 30, 32 ^{o}C. Each level was tested under controlled conditions of salinity 25 ppt, DO 4 mg/l, and PH 7.8. The initial rotifer density was conducted at 100 ind./ml.

The previously recorded optimum water quality parameters of Salinity 25‰, temperature 28 ^{o}C and the best food type of **NY** were subsequently provided to test the best initial rotifer cultured densities from between 50, 100, 150 and 200 ind. /ml.

Experimental methodology:

Productive performance of rotifer: At the end of the experiments, as well as at the end of every day during experiments, 1 ml of rotifer culture from each treatment was collected five times and counted to determine the average final number of rotifer, as a population of rotifers *B. plicatilis* **(Ashour, 2011).**

Fatty acids analysis: Preparation of fatty acids methyl ester from total lipids was performed according to the procedure of **Radwan (1978**). All analysis for identification of fatty acids fractions were performed on gas chromatography instrument, model HP (Hewlett Packard) 7890 GC equipped with a flame ionization detector. The conditions for fatty acid analysis were:

Column	HP-5, 30 m, 0.32 mm ID, 0.25 µm film thickness
Detector	FID
Detector temperature	250 ºC
Injected temperature	220 ºC, injection volume 2 µl, splitless mode
Carrier Gas	Nitrogen
Gas Flow	1 ml/min.

Water quality: During this experiment, temperature was kept at 30±0.5℃, salinity 25 ppt, and pH 7.45 – 7.8. Dissolved oxygen concentrations was 4 mg/l at the starting time and decreased after three days of culturing to 2.3, 2.4, 2.6, and 2.4 mg/l for treatments, **S, SY, N, and NY**, respectively. Total ammonia concentrations at the starting time varied between 0.54–0.55 mg/l and

increased after three days of culturing to 0.78, 0.76, 0.78, and 0.77 mg/l for treatments, **S, SY, N, and NY**, respectively.

Statistical Analyses:

At the termination of the experiments, Total Number of Rotifer (millions) in days 1, 2, and 3 , Final Density (ind/ml), Total Increment of rotifer (Millions in 3 days/30 litres), Average Daily Increment (Millions/30 litres/ day), and Average Increment per day (%) were subjected to One-way analysis of variance (ANOVA) using the software Package (SPSS Version 16) to test the significance between treatments (water temperature, water salinity, feeding types, and rotifer density). The differences between Rotifer culture system treatments were performed using LSD test with 0.05 significance level according to Steel and Torrie (1980).

Growth performance, and feed utilization parameters

Means of weight gain, percentage weight gain, average daily gain (ADG) and specific growth rate (SGR % / day) were calculated according to the following equations:

Weight gain = W1- W0.

Percentage weight gain (WG %) = {(W1 - W0) / W0} x 100.

Average daily gain (ADG) = weight gain/experimental period (d).

Specific growth rate (SGR %) = {(ln W1 - ln W0)/T)}x 100.

Where:

W0: Mean initial weight (g).

W1: Mean final weight (g).

T: Time in days between weightings.

Means of feed conversion ratio (FCR), protein efficiency ratio (PER) and Protein Productive Value (PPV %) were calculated according to the following equations:

Feed conversion ratio (FCR) = Feed intake (g) / Weight gain (g).

Protein efficiency ratio (PER) = Weight gain (g). / Protein intake (g).

Protein Productive Value (PPV %) = {(BP1– BP0)/CP} x 100.

Where:

BP0: Initial body protein content (g)

BP1: Final body protein content (g)

CP: Protein intake (g)

Condition Factor:

k= FW / L3 X 100

Fulton's condition factor K with W whole body wet weight In grams and L length in cm; the factor 100 is used to bring K close to unity.

RESULTS:

Food type:

The results of the effect of different food types (N, NY, S, and SY) on rotifers *(B. Plicatilis)* population showed that there were significant differences between all treatments (P≤0.05), as showed in Table 1.

In the first day, data showed that NY diet achieved the highest significant total number of rotifer ($2.25\pm0.042X10^6$/30L), followed by SY ($2.18\pm0.157X10^6$/30L), and N ($1.86\pm0.170X10^6$/30L), while the lowest ($1.80\pm0.085X10^6$/30L) was achieved by S diet. In the second day, our results showed that NY achieved the highest significant total number of rotifer

(3.06±0.085X10^6/30L), followed by SY (2.88±0.212X10^6/30L), and S (2.52±0.099X10^6/30L), while the lowest value was recorded by N diet (2.52±0.099X10^6/30L).while, the results obtained at the third day observed that the highest significant total number of rotifer was achieved by NY (4.74±0.169X10^6/30L) followed by SY(4.50±0.127X10^6/30L), and N(3.60±0.255X10^6/30L), but the lowest was achieved by S diet (3.12±0.084X10^6/30L), as shown in table (1).On the other hand, the highest significant final density (Ind./ml) of *B. plicatilis* was achieved by NY diet (158±5.656, Ind./ml), followed by SY (150±4.243 Ind./ml), and N (120±8.485Ind./ml),while the lowest was achieved by S (104+2.828 Ind./ml).Similar trend was observed in the daily increment percentage,, the highest significant daily increment percentage (%) was achieved by NY (72%), SY (66.7 %), and N (46.7 %), while the lowest was achieved by S diet (36 %).

Table 1: Effect of different food types on the productive performances of rotifers *B. plicatilis*

Food Types (Treatments)*	Total Number of Rotifer (x10^6/30L)				Final Density (Ind./ml)***	Total Increment (x10^6/3 days/30L)	Average Daily Increment (x10^6 /3 days /30L)	Average daily Increment (%)
	Day 0**	Day 1	Day 2	Day 3				
S	1.5	1.80 ± 0.09^b	2.52 ± 0.10^b	3.12 ±0.09^c	104± 2.83^c	1.62 ± 0.09^c	0.54 ± 0.03^c	36.0 ± 1.88^c
SY	1.5	2.18 ± 0.16^a	2.88 ± 0.21^a	4.50 ± 0.13^a	150 ± 4.24^a	3.00 ± 0.13^a	1.00 ± 0.04^a	66.7 ± 2.83^a
N	1.5	1.86 ± 0.17^b	2.43 ± .08^b	3.60 ± 0.26^b	120 ± 8.49^b	2.10 ± 0.26^b	0.70 ± 0.09^b	46.7 ± 5.66^b
NY	1.5	2.25 ± 0.04^a	3.06 ± .08^a	4.74 ± 0.17^a	158 ± 5.66^a	3.24 ± 0.17^a	1.08 ± 0.06^a	72.0 ± 3.78^a
Average	1.5	2.02 ± 0.23*	2.72 ± 0.29*	3.99± 0.72**	133 ± 23.84**	2.49 ± 0.72**	0.82 ± 0.24**	55.34 ± 15.89**

* **N:** *N. oculata*; **NY:***N. oculata* + Yeast; **S:** S. platensis; and **SY:***S. platensis*+Yeast

** Initial Density was 50 Ind./ml.; *** The volume of the rotifer tank is 30 liter of water culture.

The results of fatty acids profile of *B. plicatilis* feed on N, NY, S, and SY were shown in Table 2. Rotifer fed on S diet achieved the highest total saturated fatty acids (TSFA) percentage (52.30%), followed by SY (38.66%) and N (37.93%), while the lowest TSFA was achieved by NY (24.18%). Palmitic acid C16:0 was the main fatty acid (FA) presented in all treatments; it was achieved (28.13, 21.85, 26.80, and 10.91%) at S, SY, N, and NY diet, respectively. The second main FA obtained in SFA was C18:0, it was 5.02, 10.05, 6.04, and 10.91% at S, SY, N, and NYdiet, respectively. Furthermore, rotifer fed on S achieved the highest total monounsaturated fatty acids (TMUFA) percentage (20.78%), followed by NY (6.18%) and N (5.12%), while the lowest TMUFA was achieved by SY diet (4.57%). Moreover, rotifer fed on S diet achieved the lowest total polyunsaturated fatty acids (TPUSFA) percentage (6.23%), followed by SY (7.93%) and N (11.79%), while the highest TPUSFA was achieved by NY (13.65%). As well as, rotifer fed on NY achieved the highest DHA percentage (10.99%) and EPA (2.66%), comparing to rotifer fed on N (8.60 and 2.08%) and S (0.64 and 1.85%), respectively. Further, rotifer fed on SY did not possessed any DHA percent, while possessed EPA about 1.83% of total fatty acids.On the other hand, rotifer fed on NY recorded the highest omega3(*ΣU-3*) (13.66%), comparing to N (10.99%), S (2.49%) and SY (1.83%), while did not achieved any omega6 *(ΣU-6)* percentage, comparing to SY (6.10%), S (3.74%), and N (0.80%).

EPA/DHA ratio was high (2.89) in rotifer fed on S diet, comparing to rotifer fed on N (0.24) and NY (2.24), while DHA/EPA was low (0.35)in rotifer fed on S diet, comparing to rotifer fed on N (4.14) and NY (4.12), as shown in Table 2.

Table 2: Fatty acid profiles (% of total FA) of different food types used as rotifer feed.

Fatty acid profiles	Feeding Types			
	S	**SY**	**ND**	NY
Saturated				
C8:0	6.77	1.03	0.21	ND**
C10:0	2.56	0.90	0.30	ND
C11:0	2.21	0.90	0.38	ND
C12:0	0.40	0.17	0.49	ND
C13:0	1.25	ND	0.12	ND
C14:0	0.34	1.18	1.90	1.57
C15:0	0.20	1.34	1.13	0.78
C16:0	28.13	21.85	26.80	10.91
C17:0	0.21	1.184	ND	ND
C18:0	5.02	10.05	6.04	10.91
C20:0	0.28	ND	ND	ND
C21:0	4.90	ND	0.51	ND
SUM	**52.30**	**38.66**	**37.93**	**24.18**
Monounsaturated				
C14:1	0.34	0.38	0.12	0.456
C15:1	0.33	ND	0.32	ND
C16:1	0.58	1.74	0.42	0.90
C17:1	0.10	ND	0.62	0.88
C18:1c	17.44	ND	ND	ND
C20:1	1.68	ND	0.24	ND
C22:1	0.29	2.44	3.38	3.94
SUM	**20.78**	**4.57**	**5.12**	**6.18**
Polyunsaturated				
C18:2n-6	ND	0.74	0.60	ND
C18:3n-3	ND	ND	0.30	ND
20:2n-6	1.86	2.68	ND	ND
C20:4n-6	ND	ND	ND	ND
C20:5n-3	1.85	1.83	2.08	2.66
C22:2n-6	1.86	2.68	0.2	ND
C22:6n-3	0.64	ND	8.60	10.99
SUM	**6.23**	**7.93**	**11.79**	**13.65**
Total conc. of FA in mg/g of dw	**79.32**	**51.17**	**54.85**	**44.03**
Sat. /Unsat.	**1.94**	**3.09**	**2.24**	**1.22**
ΣU-3	**2.49**	**1.83**	**10.99**	**13.66**
ΣU-6	**3.74**	**6.10**	**0.80**	**0.00**
EPA/DHA	**2.89**	**-**	**0.24**	**0.24**
DHA/EPA	**0.35**	**-**	**4.14**	**4.12**

ND: non detected

Management parameters during the second experimental phase :

Effect of Salinity ;

The results of the effect of different water salinities (25, 27, and 29 ppt) on rotifers *(B. Plicatilis*) population showed that there were significant differences between all treatments (P≤0.05), as showed in Table 3. In the first day, data showed that salinity 25 ppt recorded the highest significant total number of rotifer (2.365±0.495X10^6/30 L), followed by 27 ppt (2.1٠0±0.042 X 10^6/30 L), while the lowest significant total number of rotifer (2.ooo±0.014X10^6/30 L L) was recorded by 29 ppt. In the second day, our results showed that salinity 25 and 27 ppt achieved the highest significant total number of rotifer (3.285±0.021X10^6/30 L) and (3.240±0.042X10^6/30 L respectively). The lowest significant total number of rotifer, 2.130±0.042X106/30 L was achieved by 29 ppt. As well as, the results obtained from the third day showed similar trends, salinity 25 and 27 ppt possessed the highest significant total number of rotifer (3.285±0.021X 10^6/30 L) and (3.240±0.042X10^6/30 L respectively), while the lowest significant total number of rotifer (2.130±0.042X10^6/30 L) was achieved by 29 ppt, as shown in Figure 2. On the other hand, the highest significant final density of *B. plicatilis* was achieved by salinity 25 ppt (1.865±0.007Ind./ml) and 27 ppt (1.795±0.007Ind./ml), respectively, while the lowest was achieved by 29 ppt (1.320±0.042Ind./ml). Furthermore, the highest daily Increment percentage (%) was achieved by salinity 25 ppt (41.33%) and 27 ppt (40.00%), respectively, whereas the salinity 29 ppt achieved the lowest daily Increment (29.34%).

Table3: Effect of different salinities on the productive performance of rotifers *B. plicatilis*

Salinity Treatments	Total Number of Rotifer (10^6/30L)				Final Density (Ind./ml)**	Total Increment (X10^6 /3 days/30L)	Average Daily Increment (X10^6 /3 days /30L)	Average daily Increment (%)
	Day0*	Day 1	Day 2	Day 3				
25	1.50	2.365±0.495^{a}	3.285±0.021^{a}	3.365±0.007^{a}	112.2±0.212^{a}	1.865±0.007^{a}	0.621±0.002^{a}	41.33±0.00^{a}
27	1.50	2.100±0.042^{bd}	3.240±0.042^{a}	3.295±0.007^{a}	109.9±0.211^{a}	1.795±0.007^{a}	0.599±0.002^{a}	40.00±0.00^{a}
29	1.50	2.000±0.014^{cd}	2.130±0.042^{b}	2.820±0.042^{b}	94.0±1.411^{b}	1.320±0.042^{b}	0.440±0.014^{b}	29.34±0.94^{b}
Average	1.50	2.155±0.171**	2.885±0.586**	3.160±0.266**	105.33±.860**	1.66±0.266*8	0.553±0.088**	36.88±5.59**

* Initial density was 50 Ind./ml. **The volume of the rotifer tank is 30 liter of water culture. ***means in within same column sharing same superscript are not significantly different ($p \leq 0.05$)

Table 4: Effect of different water temperatures on the productive performance of rotifers *B. plicatilis*

Temperature Treatments ^{o}C	Total Number of Rotifer (10^6 /30L)				Final Density (Ind./ml)**	Total Increment (x10^6 /3 days/30L)	Average Daily Increment (x10^6 /3 days /30L)	Average daily Increment (%)
	Day0*	Day 1	Day 2	Day 3				
26	1.50	2.140±0.112^{bc}	3.265±0.062^{a}	3.600±0.085^{a}	120±2.828^{a}	2.10±0.085^{a}	0.70±0.028^{a}	46.7±1.888^{a}
28	1.50	2.350±0.056^{a}	3.450±0.042^{cd}	3.900±0.276^{a}	130±9.192^{a}	2.40±0.276^{a}	0.80±0.092^{a}	53.3±6.131^{a}
30	1.50	2.420±0.057^{a}	3.380±0.055^{ad}	3.750±0.212^{a}	125±7.071^{a}	2.25±0.212^{a}	0.75±0.071^{a}	50.0±4.709^{a}
32	1.50	2.280±0.042^{ac}	2.640±0.085^{b}	3.000±0.178^{b}	100±5.656^{b}	1.50±0.184^{b}	0.50±0.057^{b}	33.3±3.769^{b}
Average	1.50	2.298±0.12	3.18±0.34**	3.562±0.40*	119±13.53*	2.062±0.40*	0.687±0.13*	45.825±9.02*

* Initial Density was 50 Ind./ml. ** The volume of the rotifer tank is 30 liter of water culture. ***means in within same column sharing same superscript are not significantly different ($p \leq 0.05$)

Effect of water Temperature:

The results of the effect of different water temperatures (26, 28, 30 and 32 ºC) on rotifers *(B. Plicatilis)* population showed that there were significant differences between all treatments (P≤0.05), as showed in Table 4.

In the first day, the results showed that the highest significant total number of rotifer was achieved at temperature 32 ºC (2.280±0.042X10^6/30 L) followed by 30 ºC (2.420±0.057X10^6/30 L), and 28 ºC (2.350±0.056X10^6/30 L), while the lowest was achieved by 26 ºC (2.140±0 .112X10^6/30 L). In the second day, our results showed that the highest significant total number of rotifer was achieved by temperature 30 ºC (3.380±0.055X10^6/30 L) followed by 28 ºC (3.450±0.042X10^6/30 L), and 26 ºC (3.265±0.062X10^6/30 L), while the lowest was achieved by 32 ºC (2.640±0.085X10^6/30 L), as well as, the results obtained from the third day observed that the temperature 28 ºC achieved the highest significant total number of rotifer (3.900±0.276X 10^6/30 L), followed by 30 ºC (3.750±0.212X 10^6/30 L), and 26 ºC (3.600±0.085X10^6/30 L), while the lowest was achieved by 32 ºC (3.000±0.178X 10^6/30 L), as shown in Figure 3. On the other hand, the highest significant final density (Ind./ml) of *B. plicatilis* was achieved by temperature 28 ºC (130±9.192 Ind./ml), followed by 30 ºC (125±7.071 Ind./ml), 26 ºC (120±2.828 Ind./ml), while the lowest was achieved by 32 ºC (100±5.656 Ind./ml) According the results , the highest significant daily increment percentage (%) was achieved by 28 ºC (53.3 %), 30 ºC (50 %), and 26 ºC (46.7 %), while the lowest was achieved by 32ºC (33.3 %).

Effect of Initial rotifer density:

The results of the effect of different initial density of rotifer (50, 100, 150 and 200 Ind./ml) on rotifers *(B. Plicatilis)* population showed that there were significant differences between all treatments (P≤0.05), as showed in Table 5.

In the first day, the present result showed that the highest significant total number of rotifer was achieved by density 150 (3.48±0.08X10^6/30 L) followed by 200(2.64±0.04 X10^6/30 L), and then 100(2.25±0.04), while the lowest was achieved by density 50 10^6/30 L (1.11±0.17X10^6/30 L).In the second day, our results showed that the highest significant total number of rotifer was achieved by 200 (4.58±0.01X10^6/30 L) followed by 150(4.50±0.13X 10^6/30 L), and then 100(4.05±0.04X 10^6/30 L), while the lowest population was achieved by density 50 10^6/30 L(2.23±0.18X10^6/30 L). As well as, the results obtained from the third day showed that the highest significant total number of rotifer was achieved by density 150 (6.48±0.01X 10^6/30 L) followed by 200 (5.91±0.04X10^6/30 L), and then 100 (4.80±0.00X10^6/30 L), while the lowest was achieved by density 50 Ind./ml . (3.12±0.00X10^6/30 L), as shown in Figure 4.

On the other hand, the highest significant final density (Ind./ml) of *B. plicatilis* was achieved by 150 (216.0±0.42 Ind./ml), followed by 200 (197.0±1.41 Ind./ml), and 100 (160.0±0.14Ind./ml), while the lowest was achieved by 50 Ind./ml (104±0.14 Ind./ml). Moreover, the highest significant daily increment percentage (%) was achieved by 50 (105.20 %), 100 (73.20 %), and 150 (62.80 %), while the lowest was achieved by 200 (32.3 %).

Table 5: Effect of different initial rotifer density on the productive performance of Rotifers *(B. Plicatilis*) during the second phase study

Initial density Treatments	Total Number of Rotifer (10^6 /30L)				Final Density (Ind./ml)**	Total Increment (x10^6 /3 days/30L)	Average Daily Increment (x10^6 /3 days /30L)	Average daily Increment (%)
	Day 0	Day 1	Day 2	Day 3				
50	0.75	1.11±0.17^a	2.23±0.18^a	3.12±0.00^a	104.0±0.14^a	2.37±0.00^a	0.79 ± 0.00^a	105.20 ± 0.21^a
100	1.50	2.25±0.04^b	4.05±0.04^b	4.80±0.00^b	160.0±0.14^b	3.30±0.01^b	1.10 ± 0.00^b	73.20 ± 0.21^b
150	2.25	3.48±0.08^c	4.50±0.13^c	6.48±0.01^c	216.0±0.42^c	4.23±0.01^c	1.42 ± 0.01^c	62.80 ± 0.07^c
200	3.00	2.64±0.04^d	4.58±0.01^c	5.91±0.04^d	197.0±1.41^d	2.91±0.04^d	0.97 ± 0.01^d	32.34 ± 0.47^d
Average	1.87	2.37±0.91**	3.84±1.02**	5.08±1.37**	169.3±45.67**	3.20±0.73**	1.07 ± 0.24**	68.35 ± 27.80**

The volume of the rotifer tank is 30 liter of water culture. . ***means in within same column sharing same superscript are not significantly different (p ≤ 0.05)

DISCUSSION:

The microalga (*Nannochloropsis*) is widely used in the laboratory and in commercial hatcheries for culturing *B. plicatilis* because it supports higher rotifer survival and reproduction rates and contains adequate highley unsaturated fatty acid (HUFA) especially, EPA (Kobayashi *et al.,* 2008). Our results found that rotifer fed on live *N. oculata* achieved final population, as well as EPA and DHA, higher than rotifer fed on dried *S. platensis*.These results indicated that *N. oculata* may be the best microalgal species used as rotifer feed (Ashour, 2011). On the other hand, Nhu (2004) studied the effects of different four feeding types: (1) bakers' yeast (*Saccharomyces cerevisiae*) in wet form plus 10% squid liver oil (by dry weight), (2) *S. cerevisiae* in dry form plus 10% squid liver oil, (3) microalgae (*Nannochloropsis oculata)* and (4) microalgae *(Chaetoceros muelleri*) on growth and quality of rotifer of the L-strain. The results showed that there were significant differences in rotifer growth rate, viability, size and ciliate contamination between the four dietary treatments (P <0.05). Moreover, rotifers fed on microalgae showed better viability, larger size and low ciliate contamination compared to those fed on yeast. These findings were supported the results of the present study. the highest final rotifer population and the highest content of EPA and DHA were achieved by rotifer fed on *N. oculata* supplemented by beaker yeast (NY). However, the combination between *N. oculata* and beaker yeast have some advantages; (1) reduced the rotifer production cost, (2) enhanced rotifer quantity (population) and quality (EPA and DHA percentage), and (3) reduced the contamination occurred while using beaker yeast only.

Evaluating rotifer growth parameters to maximize productivity is important under different management condition (Fotoon *et al.,* 2007). Both temperature and salinity will directly influence the reproductive rate of the rotifer, and the response in general depends on strain and environmental conditions (Miracle and Serra, 1989). Salinity had also a greater effect on rotifer than temperature (Fielder *et al.,* 2000).

The rotifer *B. plicatilis* tolerates salinities ranging from 1 to 97 ppt (Walker, 1981). Viayeh, *et al.,* (2010) found that the maximum final population density of rotifer (*B. urceolaris)* strain fed on *Nannochloropsis* was at 20 ppt(brackish

water), while final population density of rotifer *(B. plicatilis)* strain fed on *Chlorella* was at 10 and 30 ppt.During the present study(brackish water) the salinity 25 ppt possessed the highest final number of rotifer, comparing to salinity 27 and 29 ppt (with using NY as rotifer feed). The differences in these results may be due to the difference of rotifer food and/or rotifer and algal strains. However, the present study illustrated that the decrease of salinity degree (from 29 to 25 ppt) caused increasing of the final number of rotifer *(B. Plicatilis*).

Fielder *et al.* (2000) investigate the effect of rapid changes in temperature and salinity on availability of the rotifers (*Brachionus rotundiformis)* and (*Brachionus plicatilis)* and they concluded that rotifers should be cultured at lower temperatures and similar salinities to the fish larval rearing tanks or acclimated for at least 6 h to larval rearing conditions. The results of the present study reported that the temperature 28 ºC recorded the highest significant final number of rotifer in addition 28 ºC recorded also the highest final density (130± 9.192 Ind. /ml) and average daily Increment percentage (53.3 %), comparing to 26, 30, and 32 ºC (under NY and 25 ppt treatments conditions).

In conclusion, the present study illustrated salinity 25 ppt, temperature 28 ºC and initial rotifer density of 150 Ind/ml recorded the highest rotifer quality, growth and production under 50% *N.oculata* + 50% beaker yeast (NY) feeding conditions.

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الملخص العربى

العوامل الحيويه وغير الحيويه وتأثيرها على إنتاج وكثافه نمو الروتيفير بنظام الاستزراع بالدفعات (٣ ايام)

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تعتبر الحوامات الدوارة (الروتيفرا) لها دور هام فى تغذية يرقات الاسماك البحرية والقشريات. كما انها مهمه لامداد يرقات الاسماك البحرية بالمغذيات والفيتامينات والاحماض الدهنية والاجسام المضادة، حيث ان نوع التغذية هام وله تاثير على نمو ونوعية الحوامات الدوارة (الروتيفرا). ويهدف هذا البحث الى دراسة تاثير نوع التغذية والملوحة ودرجة الحرارة وكثافة التلقيح على نمو وكثافة الروتيفير.

المرحله الاولى : تم فيها ملاحظة تاثير اربع معاملات مختلفة من الطحالب

١- نانو كلوربسس اكيولاتا (حية) .

٢ - سبيرولينا بلاتنس (مسحوق) .

٣- خليط من النانو والخميرة .

٤- خليط من الاسبيرولينا والخميرة على انتاج الروتيفرا .

وتم تعين نسبة الاحماض الدهنية فى الروتيفرا وكان نظام الاستزراع بنظام الدفعات لمدة ٧٢ ساعة فى احواض فيبر جلاس سعة الحوض ٣٠ لتر بثلاث مكررات لكل معاملة . واظهرت النتائج ان المعاملة رقم ٣ وهى خليط من النانوكلوروبسيس والخميرة الجافة هى الافضل فى التغذية فى هذه التجربة .

المرحله الثانيه : وتم دراسة العوامل البيئية وهى الملوحة بمعاملات ٢٥ - ٢٧ - ٢٩ جزء فى الالف ودرجة حرارة المياه بمعاملات ٢٦ - ٢٨ - ٣٠ -٣٢ درجة مئوية، وكثافات تلقيح ٥٠ - ١٠٠ - ١٥٠ - ٢٠٠ كائن /ملى. وقد اظهرت النتائج أن افضل المعاملات البيئية ٢٥ جزء فى الالف للملوحه و ٢٨ درجة مئوية للحراره وكثافة تلقيح ١٥٠ كائن /ملى.

الكفاءة الإنتاجيه لمحصول بنجر السكر فى منطقة النوبارية

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الملخص:

تستهدف هذه الدراسة التعرف على مستوى كفاءة إستخدام الموارد الإقتصادية المستخدمة في إنتاج محصول بنجر السكر بمنطقة النوبارية من خلال تناول الأهداف الفرعية التالية :(١) دراسة وتحديد أهم المتغيرات المرتبطة بكفاءة إستخدام الموارد الاقتصادية في إنتاج محصول بنجر السكر في منطقة النوبارية، (٢) التعرف على مستويات الكفاءة الاقتصادية في إستخدمات الموارد لإنتاج بنجر السكر في منطقة النوبارية وكيفية رفع مستوياتها. وتستند الدراسة إلى أساليب التحليل الإحصائى الوصفى والكمى، كما تم الإستناد إلى أسلوب المنحنى المغلف للبيانات[١] Data Envelopment Analysis (DEA) لقياس الكفاءة الإنتاجية لمحصول بنجر السكر، بالإضافة إلى تقدير بعض المؤشرات والعلاقات الإقتصادية المختلفة لتحقيق أهداف الدراسة.

وقد تبين من نتائج تقدير الكفاءة الفنية بإستخدام إسلوب تحليل مغلف البيانات (DEA) لإنتاج محصول بنجر السكر في منطقة النوبارية خلال الموسم الزراعى (٢٠١٠-٢٠١١) أن مزارعى هذا المحصول بإمكانهم تقليل الموارد الاقتصادية الكلية المستخدمة والحصول على نفس القدر من الإنتاج .

مقدمة :

يعتبر النهوض بإنتاج محاصيل السكر هدفاً رئيسياً للسياسات الزراعية المصرية لمواجهة الزيادة في الطلب المحلى على السكر، ويمكن تحقيق هذا الهدف من خلال التوسع الرأسي بإستخدام أصناف ذات إنتاجية فدانية مرتفعة ولها نسبة إستخلاص جيدة من السكر وتعديل توليفات عناصر الإنتاج المستخدمة في الإنتاج لكل من قصب وبنجر السكر ،أو التوسع الأفقي من خلال زيادة المساحة المخصصة لزراعة بنجر السكر بالأراضى الجديدة نظراً لقلة احتياجاته المائية بالمقارنة بمحصول قصب السكر، ولتحقيق هدف النهوض بإنتاج محاصيل السكر يقتضى توفير بعض البيانات التفصيلية الضرورية عن الوحدات الإنتاجية المزرعية للوقوف على المشاكل والمحددات التي تواجه النهوض بالإنتاج وتحول دون الوصول إلى تحقيق الكفاءة الإنتاجية والإقتصادية للموارد المستخدمة في الإنتاج. وقد أصبح انتاج محصول بنجر السكر مستقراً في بعض المحافظات التي تم إدخال

(١) محمود حنفى ، ممدوح البدرى (دكاترة)، (٢٠١١)، قياس كفاءة الاقتصاد الكلى لدول حوض النيل بإستخدام تحليل مغلف البيانات Data Envelopment Analysis (DEA) ، المؤتمر الدولى السادس والثلاثون للإحصاء وعلوم الحاسب وتطبيقاتها، الجمعية الإحصائية المصرية والجهاز المركزى للتعبئة العامة و الإحصاء، الفترة من ١١ – ٢٢ أبريل.

المحصول بها وأصبح يعتبر من المحاصيل الهامة في التركيب المحصولي لهذه المحافظات ، وقد تزايد الناتج من بنجر السكر تزايداً مستمراً منذ إدخال زراعته في مصر وحتى الآن مما يدل على أن إنتاجه أصبح يتمتع بقدر من الكفاءة [١].

المشكلة البحثية: يعتبر محصول بنجر السكر من المحاصيل الهامة في الزراعة المصرية كما أنه من المحاصيل الجديدة نسبياً والتى ليس للمزارعيين المصريين الخبرة الكاملة للوصول للإنتاجية المثلى منه؛ ويلاحظ في السنوات الأخيرة أن صناعة السكر في مصر واجهت بعض نواحي القصور يعود بعضها للمزارع من حيث عدم الاهتمام بعمليات الخدمة الجيدة بما فيها الحرث تحت التربة والتسوية بالليزر أو إضافة مقادير من الأسمدة بخلاف المقررات المصرح بها أو في غير المواعيد المناسبة للتسميد مما يضر بعملية بلورة السكر أو الحصاد المبكر[٢]. كما توجد بعض نواحي القصور التي تتعلق بمصانع السكر من حيث التأخر في نقل المحصول بعد التقليع وتركه فترة من الوقت على الطرق مما يؤدي إلى إنخفاض نسبة السكر في المحصول الناتج.

مصادر البيانات: تعتمد هذه الدراسة على البيانات الأولية والثانوية المنشورة وغير المنشورة التي تم الحصول عليها من البيانات الميدانية التى تم تجميعها من خلال استمارة استبيان فى منطقة النوبارية لعينة الدراسة، وكذلك الإستعانة ببعض المعلومات المتعلقة بإنتاج بنجر السكر في بعض الدراسات والبحوث ذات الصلة بموضوع هذه الورقة البحثية، ونشرات وزارة الزراعة، والجهاز المركزى للتعبئة العامة والإحصاء، ومجلس المحاصيل السكرية، بالإضافة إلى البيانات غير المنشورة التى تم الحصول عليها من مديرية الزراعة بالنوبارية والجهات التابعة لها من مراقبات وجمعيات زراعية بالإضافة إلى بعض البحوث والدراسات الإقتصادية التي لها صلة بموضوع الدراسة.

الأسلوب البحثى: تستند هذه الدراسة إلى أساليب التحليل الإحصائى الوصفى والكمى للتعرف على الظواهر الخاصة بالدراسة إستناداً إلى أسلوب المنحنى المغلف للبيانات[٣] Data Envelope Analysis (DEA) لقياس الكفاءة الإنتاجية لمحصول بنجر السكر، بالإضافة إلى تقدير بعض المؤشرات والعلاقات الإقتصادية المختلفة لتحقيق أهداف الدراسة.

(١)عبدالجيد حمدي فضل الله عبدالقوي، (٢٠١٢)، دراسة إقتصادية لإنتاج محصول بنجر السكر مع إهتمام خاص بمركز حوش عيسى بمحافظة البحيرة، رسالة ماجستير، قسم الاقتصاد الزراعي ، كلية الزراعة ، جامعة الاسكندرية.

(٢) أحمد محمد أبو روح (دكتور)، (٢٠٠٥)، بنجر السكر، نشرة، وزارة الزراعة واستصلاح الأراضي، مركز البحوث الزراعية، الإدارة المركزية للإرشاد الزراعي.

(٣)علاء أحمد قطب (دكتور) (٢٠١١). تقدير الكفاءة التقنية والإقتصادية لإنتاج محصول عباد الشمس الزيتي بمحافظة الفيوم بإستخدام تحليل مغلف البيانات. المجلة المصرية للإقتصاد الزراعي المجلد (٢١) العدد (٢) يونيه.

أهداف البحث: يستهدف هذا البحث التعرف على مستوى كفاءة إستخدام الموارد الإقتصادية المستخدمة في إنتاج محصول بنجر السكر بمنطقة النوبارية من خلال تناول الأهداف الفرعية التالية :

١- دراسة وتحديد أهم المتغيرات المرتبطة بكفاءة إستخدام الموارد الاقتصادية في إنتاج محصول بنجر السكر في منطقة النوبارية.

٢- التعرف على مستويات الكفاءة الاقتصادية في إستخدمات الموارد[١] لإنتاج بنجر السكر في منطقة النوبارية وكيفية رفع مستوياتها.

أسس إختيار العينة البحثية : تعتمد هذه الدراسة على بيانات قطاعية تم تجميعها من مفردات عينة عشوائية طبقية يكون لكل فرد فيها فرصة في الإختيار لتمثيل العينة[٢]، وقد تم سحب العينة من واقع كشوف المساحات المنزرعة للموسم الزراعى (٢٠١٠-٢٠١١) من مديرية الزراعة بالنوبارية. وتحقيقا لإسلوب المعاينة الطبقية متعددة المراحل تم إتخاذ مجموعة من الأسس والمراحل الاساسية لتكوين مجتمع العينة وبالتالي إختيار عينة الدراسة الميدانية،

وقد كان اختيار عينة الدراسة إستناداً إلى أن منطقة النوبارية في محافظة البحيرة إحدي أهم مناطق الأراضي الجديدة الواعدة في إنتاج بنجر السكر في الجمهورية، وذلك فضلاً عن أن العديد من شركات إنتاج السكر قد أقاموا مصانع لإنتاج السكر من بنجر السكر في هذه المنطقة الحيوية كمصانع شركة النيل للسكر وشركة الإسكندرية للسكر وشركة النوبارية للسكر. حيث تضم منطقة النوبارية خمسة قطاعات أو مراقبات وهي البستان – بنجر السكر – جنوب التحرير – النهضة ومريوط – غرب النوبارية – جدول (١).

جدول (١): توزيع أعداد مزارعين محصول بنجر السكر وفقاً للمساحات المنزرعة من المحصول في مناطق قطاع النوبارية للموسم الزراعى (٢٠١٠-٢٠١١)

الفئات	النهضة ومريوط	غرب النوبارية	بنجر السكر	البستان	جنوب التحرير	الإجمالي
أقل من فدان	٣	٢	٠	٠	٢	٧
من فدان إلى أقل من خمسة أفدنه	٣٩٦	٢٥٥	١٢٥	٨٧	١٢	٨٧٥
خمسة أفدنه فأكثر	٤٧	٦٢	٣٨	١٣	٢	١٦٢
الإجمالي	٤٤٦	٣١٩	١٦٣	١٠٠	١٦	١٠٤٤
العينة ١٠%	٤٤	٣٢	١٦	١٠	٠	١٠٢

المصدر: جمعت وحسبت من استمارة الاستبيان

(1) Coelli, T.J.A 1995 Guide to Frontier Version 4.1: A Computer Program for Stochastic Frontier production and Cost Function Estimation, Mimeo Department of Econometrics, University of New England, Armidale.

(٢) محمود عبد الهادي شافعي (دكتور)، (٢٠٠٥)، الاقتصاد القياسي، محاضرات لطلبة الدراسات العليا، قسم الاقتصاد الزراعي، كلية الزراعة، جامعة الإسكندرية.

وتعتمد الدراسة في توزيع استمارات الاستبيان على المراقبات التابعة لقطاع النوبارية حسب الاهمية النسبية لمساحة بنجر السكر المزروعة بكل مراقبة بعد استبعاد مراقبة جنوب التحرير نظراً للإنخفاض الشديد في مساحة وعدد مزارعي بنجر السكر بهذه المنطقة، وكذلك استبعاد المزارعين ذوي الحيازات الأقل من فدان لنفس السبب السابق، ويبلغ عدد إستمارات الاستبيان ١٠٢ إستماره تمثل ١٠% من عدد منتجي محصول بنجر السكر بمنطقة النوبارية البالغ عددهم ١٠٤٤ مزارع حيث تأتى مراقبة النهضة ومريوط في المرتبة الأولى من حيث عدد مزارعي بنجر السكر ،حيث يبلغ ٤٤٦ مزارعاً بأهمية نسبية تبلغ حوالي ٤٢,٧٢ % وبالتالي حصلت على أكبر عدد من إستمارات الاستبيان تبلغ ٤٤ إستمارة، ثم مراقبة غرب النوبارية بعدد مزارعين يبلغ ٣١٩ مزارعاً وبأهمية نسبيية تبلغ ٣٠,٥٦ % وبعدد إستمارات بلغت حوالي ٣٢ إستمارة ، ثم مراقبة بنجر السكر بعدد مزارعين يبلغ ١٦٣ مزارعاً وبأهمية نسبية تبلغ ١٥,٦١ % وبعدد إستمارات تبلغ حوالي ١٦ إستمارة ،ثم مراقبة البستان بعدد مزارعين بلغ ١٠٠مزارعاً وبأهمية نسبيه بلغت ٩,٥٨% وبعدد إستمارات بلغت حوالي ١٠ إستمارة كما هو موضح بجدول(١).

<u>توصيف العينة البحثية:</u> يتبين من تقسيم مزارع محصول بنجر السكر في العينة البحثية إلى أربعة قطاعات **وفقاً لمناطق الزراعة،** أن عدد مزارع المنطقة الأولى (النهضة ومريوط) يبلغ ٤٤ مزرعة تمثل حوالي٤٣% من مفردات العينة البحثية في حين يبلغ عدد مزارع المنطقة الثانية (غرب النوبارية) ٣٢ مزرعة تمثل ٣١,٤% من مفردات العينة البحثية، بينما يبلغ عدد مزارع المنطقة الثالثة (بنجر السكر) ١٦ مزرعة تمثل ١٥,٧%من مفردات العينة البحثية، ويبلغ عدد مزارع المنطقة الرابعة(البستان)١٠ مزارع تمثل ٩,٨% من مفردات العينة البحثية–جدول رقم(٢).

ويتم في هذه الدراسة تقسيم مزارع العينة البحثية **وفقاً للمساحة المنزرعة من بنجر السكر** إلى فئتان حيث تضم الفئة الأولي المساحة المزروعة من بنجر السكر من فدان واحد إلي أقل من خمسة أفدنة ويبلغ عدد مزارع الفئة الأولى ٨٨ مزرعة تمثل حوالى ٨٦,٣ % من مفردات العينة البحثية الأمر الذي يوضح أن معظم منتجي محصول بنجر السكر في عينة الدراسة تقع تحت هذه الفئة.

جدول (٢): توزيع عدد أفراد العينة حسب مناطق الزراعة

الترتيب	المنطقة	عدد أفراد العينة	%
الأولي	النهضة ومريوط	٤٤	٤٣,١
الثانية	غرب النوبارية	٣٢	٣١,٤
الثالثة	بنجر السكر	١٦	١٥,٧
الرابعة	البستان	١٠	٩,٨
المجموع		**١٠٢**	**١٠٠**

المصدر: جمعت وحسبت من إستمارة الإستبيان

تضم الفئة الثانية المزارع ذات المساحات المزروعة من بنجر السكر من خمسة أفدنة فأكثر ، حيث يبلغ عدد مزارع هذه الفئة ١٤ مزرعة تمثل حوالي ١٣,٧ % من مفردات العينة البحثية – جدول رقم (٣) .

جدول (٣): عدد فئات العينة حسب المساحة المنزرعة من بنجر السكر

الترتيب	الفئة	عدد أفراد العينة	%
الأولي	من فدان إلى أقل من ٥ أفدنة	٨٨	٨٦,٣
الثانية	خمسة أفدنة فأكثر	١٤	١٣,٧
المجموع		١٠٢	١٠٠

المصدر: جمعت وحسبت من إستمارة الإستبيان.

التحليل الإحصائي والنتائج البحثية

تحليل التباين لبيانات العينة البحثية وفقاً لمراقبات منطقة النوبارية: يتبين من إجراء إختبار تحليل التباين لبيانات العينة البحثية فيما يتعلق بمتوسطات الإنتاجية المزرعية في مختلف السعات المزرعية موضع الدراسة الموضحة في جدول (٤) عدم وجود فروق معنوية بين المتوسطات الانتاجية المزرعية في مزارع إنتاج بنجر السكر وفقاً لمناطق زراعة بنجر السكر بالنوبارية في العينة البحثية.

جدول (٤): تحليل التباين لإختبار معنوية الفروق بين متوسطات الانتاجية المزرعية بإختلاف مناطق زراعة محصول بنجر السكر بمنطقة النوبارية بمحافظة البحيرة للموسم الإنتاجى (٢٠١٠-٢٠١١)

مصدر التباين	مجموع مربع الإنحرافات T.S.S	درجات الحرية D.F.	متوسط مربع الإنحرافات M.S	إختبار ف	
				ف المحسوبة	مستوى المعنوية
بين المناطق	٣٤,٨٩٩	٣	١١,٦٣٣	١,٩٨٣	٠,١٢١
داخل المناطق	٥٧٤,٧٥٧	٩٨	٥,٨٦٥		
الكلي	٦٠٩,٥٦٥	١٠١			

المصدر: حسبت من بيانات مزارع العينة البحثية في منطقة النوبارية بمحافظة البحيرة في الموسم ٢٠١٠-٢٠١١

تم الإستدلال على عدم وجود فروق معنوية بين المتوسطات الانتاجية من واقع المقارنات المباشرة بين قيمة(ف)المحسوبة على أساس بيانات العينة البحثية وبين قيمتها الجدولية عند مستويات المعنوية٠,٠١،٠,٠٥[١].

الكفاءة الفنية للموارد المستخدمة في إنتاج محصول بنجر السكر لمزارع العينة البحثية: ويتم هذا التحليل للكفاءة الإنتاجية الفنية للموارد المستخدمة في إنتاج محصول بنجر السكر لمزارع العينة البحثية في ظل ثبات العائد للسعة وفي ظل تغير العائد للسعة[١].

(١) وائل أحمد عزت العبد (دكتور)، وآخرون. (٢٠١٢). تقدير الكفاءة التقنية والإقتصادية لإنتاج محصول الأرز في مصر. مجلة الجمعية السعودية للعلوم الزراعية المجلد (١١) العدد (١) يناير.

ويتبين باستعراض بيانات الجدول رقم (٥) أن مقدار الكفاءة الفنية لإنتاج بنجر السكر في ظل ثبات العائد للسعة تبلغ حوالى ٠,٩٠٢ وهذا يعنى أن منتجي بنجر السكر في مزارع هذه الفئة يمكنهم زيادة الإنتاج من محصول بنجر السكر بنسبة تقدر بحوالى ٩,٨% دون أى زيادة في كمية أو مقدار الموارد المستخدمة لإنتاج بنجر السكر بما يعني أن منتجي بنجر السكر في مزارع هذه الفئة يفقدون قدراً من مواردهم الإقتصادية المستخدمة في إنتاج بنجر السكر أي زيادة تكلفة إنتاجهم بنسبة تقدر بحوالي ٩,٨% .

ويتبين باستعراض بيانات نفس الجدول السابق الإشارة إليه أن مقدار الكفاءة الفنية لإنتاج بنجر السكر في ظل تغير العائد للسعة في مزارع العينة البحثية بمنطقة النوبارية تبلغ حوالى ٠,٩٦٥ وهذا يعنى أن منتجي بنجر السكر في مزارع هذه الفئة يمكنهم زيادة الإنتاج من بنجر السكر بنسبة تقدر بحوالى ٣,٥% دون أى زيادة في كمية أو مقدار الموارد المستخدمة لإنتاج بنجر السكر. وبذلك فإن منتجي بنجر السكر في هذه المزارع يفقدون قدراً من مواردهم الإقتصادية المستخدمة في إنتاج بنجر السكر؛ الأمر الذي يترتب عليه زيادة تكلفة إنتاجهم بنسبة تقدر بحوالي ٣,٥% . ويمكن زيادة إنتاج بنجر السكر في هذه المزارع من خلال : (١) مراعاة مواعيد الزراعة المناسبة واستخدام أصناف انتاجية ذات جودة عالية،(٢) وضع الكميات المثلي من الأسمدة والمقنن المائي المناسب لمحصول بنجر السكر، (٣) زيادة كفاءة الجهاز الإرشادى في توعية المزارعين وتدريبهم على كيفية الإنتاج المتطور الذى يحقق لهم أقصى إنتاجية ممكنة.

جدول (٥): تقديرات الكفاءة الفنية للموارد الإقتصادية المستخدمة في إنتاج محصول بنجر السكر لمزارع العينة البحثية

الكفاءة الفنية في ظل ثبات العائد للسعة	الكفاءة الفنية في ظل تغير العائد للسعة	الكفاءة السعوية
٠,٩٠٢	٠,٩٦٥	٠,٩٣٥

المصدر: جمعت وحسبت من استمارة الإستبيان وبإستخدام برنامج تحليل المنحني المغلف للبيانات الإلكتروني (DEA).

<u>الكفاءة السعوية لإنتاج محصول بنجر السكر علي مستوي مزارع العينة البحثية:</u> يتبين من التحليل أن مقدار كفاءة السعة لإنتاج بنجر السكر علي مستوي مزارع العينة البحثية بمنطقة النوبارية تبلغ حوالى ٠,٩٣٥ وهذا يعنى أنها لم تصل إلى الكفاءة السعوية المثلى التي يمكن الوصول إليها من خلال زيادة إنتاجها بنسبة تقدر بحوالى ٦,٥ % ليبلغ الإنتاج حجمه الأمثل عند أدنى نقطة على منحنى متوسط التكاليف الإنتاجية المتوسطة–جدول (٥).

ويتبين من إجراء التحليل الإقتصادى المقارن للكفاءة الإنتاجية بأنواعها المختلفة في إنتاج محصول بنجر السكر علي مستوي مزارع العينة البحثية بمنطقة النوبارية أن الكفاءة الفنية إزدادت من حوالى ٠,٩٠٢ في ظل ثبات

(2) **Farrel, 1957,** Measuring the Technical Efficiency of Company, Ed., Activity of Production and Allocation, Cowles Commission for Research in Economics, Monograph No 13, Wiley, New York.

العائد للسعة إلى حوالى ٠,٩٦٥ في ظل تغيرالعائد للسعة وهذا يؤكد حقيقة وجود وفورات السعة في إنتاج بنجر السكر علي مستوي مزارع العينة البحثية.

تقديرات فوائض الموارد الإقتصادية المستخدمة في إنتاج محصول بنجر السكر علي مستوي مزارع العينة البحثية بمنطقة النوبارية: يتبين من استعراض بيانات الجدول رقم (٦) أن مقدار الفوائض في الموارد الاقتصادية المستخدمة في إنتاج محصول بنجر السكر لمزارع العينة البحثية خلال الموسم الإنتاجي (٢٠١٠-٢٠١١) هي: (١) عدد سنوات الخبرة في زراعة محصول بنجر السكر حيث يبلغ متوسط الفائض في سنوات الخبرة حوالي ٠,٢٦٥ سنة وهذا يعني أن بعض منتجي بنجر السكر في مزارع هذه الفئة لم يستفيد من التطور التكنولوجي والبرامج الإرشادية الحديثة في زراعة محصول بنجر السكر علي الرغم من توافر سنوات الخبرة في زراعة هذا المحصول، (٢) متوسط إيجار الفدان في منطقة النوبارية حيث يبلغ متوسط الفائض في متوسط إيجار الفدان حوالي ٣١,٨٦ جنيه في مزارع العينة البحثية، (٣) المساحة المزروعة ببنجر السكر حيث يبلغ مقدار الفائض منها حوالي٠,١١٠ فدان وهذا يعني وجود عدد من منتجي بنجر السكر لم يستغلوا المساحة المزروعة ببنجر السكر الإستغلال الأمثل وإهدار هذه المساحة التي كان يمكن استغلالها في زيادة إنتاج بنجر السكر أو استخدامها في أغراض انتاجية أخري بالنسبة لمزارع العينة البحثية، (٤) قيمة العمل البشري المستأجر اللازم لأداء العمليات الإنتاجية في محصول بنجر السكرحيث يبلغ الفائض حوالي ٣٠٩,٨٤٧ جنيه، الأمر الذي يعني تحمل بعض المنتجين من مزارع العينة البحثية تكاليف إضافية في استئجار العمل البشري كان يمكن الاستغناء عنها أو الاستفادة بها في انتاج ناتج مزرعي آخر، (٥) قيمة العمل الآلي المستخدم في زراعة محصول بنجر السكر حيث يبلغ متوسط الفائض في قيمة العمل الآلي المستخدم في مزارع العينة البحثية حوالي ٥١,٨٩١ جنيه، (٦) قيمة التقاوي المستخدمة في زراعة محصول بنجر السكر حيث يبلغ متوسط الفائض في مزارع العينة البحثية حوالي ١٩,٧٣٦جنيه، (٧) ويبلغ متوسط الفائض من السماد الأزوتي حوالي ٣٠,٥٥ كجم/فدان، (٨) ويبلغ متوسط كمية الفائض من السماد البوتاسي حوالي ١١,٣٥كجم/فدان، (٩) ويبلغ متوسط الفائض من السماد الفوسفاتي حوالي ٣٤,٠٥ كجم/فدان، (١٠) ويبلغ متوسط الفائض من سماد المغنسيوم حوالي ٥,١ كجم/فدان، (١١) ويبلغ متوسط الفائض من سماد الكالسيوم حوالي ٤,٣٥ كجم/فدان ، (١٢) ويبلغ متوسط الفائض من إجمالي قيمة الأسمدة العضوية المستخدمة في الزراعة في مزارع العينة البحثية حوالي ١٦٩,٦٨٧ جنيه/فدان، (١٣) ويبلغ متوسط الفائض من كمية الكبريت الزراعي المستخدمة في مزارع العينة البحثية حوالي ٤,٤ كجم/ فدان، (١٤) ويبلغ متوسط الفائض من كمية المبيدات الحشرية المستخدمة في مزارع العينة البحثية حوالي ٠,٠٩٢ لتر/ فدان، (١٥) ويبلغ متوسط الفائض من كمية المبيدات الفطرية المستخدمة حوالي ٠,٣١٠ كجم/ فدان في مزارع العينة البحثية، (١٦) ويبلغ متوسط الفائض من المغذيات الورقية المستخدمة في مزارع العينة البحثية حوالي ١,٠٠ كجم/ فدان.

جدول رقم (٦): تقديرات متوسط فوائض الموارد الإقتصادية المستخدمة في إنتاج محصول بنجر السكر في مزارع العينة البحثية

الموارد الإقتصادية	المتوسط
عدد سنوات الخبرة (سنه)	٠,٢٦٥
متوسط إيجار الفدان (جنيه)	٣١,٨٦٠
مساحة بنجر السكر بالمزرعة (فدان)	٠,١١٠
قيمة العمل البشري المستأجر (جنيه)	٣٠٩,٨٤٧
قيمة العمل الآلي (جنيه)	٥١,٨٩١
قيمة التقاوي (جنيه)	١٩,٧٣٦
كمية سماد اليوريا (كجم)	٣٠,٥٥٠
كمية سماد البوتاسيوم (كجم)	١١,٣٥٠
كمية سماد الفوسفات (كجم)	٣٤,٠٥٠
كمية سماد المغنسيوم (كجم)	٥,١٠٠
كمية سماد الكالسيوم (كجم)	٤,٠٥٠
قيمة الأسمدة العضوية (جنيه)	١٦٩,٦٨٧
كمية الكبريت الزراعي (كجم)	٤,٤٠٠
كمية المبيدات الحشرية (كجم)	٠,٠٩٢
كمية المبيدات الفطرية (كجم)	٠,٣١٠
كمية المغذيات الورقية (كجم)	١,٠٠٠

المصدر: جمعت وحسبت من استمارة الإستبيان وبإستخدام برنامج تحليل المنحني المغلف للبيانات الإلكتروني (DEA).

ويتضح مما سبق تبيانه إسرافاً في إستعمال بعض عناصر الإنتاج المستخدمة في زراعة محصول بنجر السكر في مزارع العينة البحثية بمنطقة النوبارية كالأسمدة الكيماوية والمبيدات الحشرية والفطرية، الأمر الذي يضر بجودة المحصول الناتج من ناحية والإضرار بالتربة الزراعية من ناحية أخري.

تحليل بيانات العينة البحثية وفقاً للمساحة المزروعة بمحصول بنجر السكر بمنطقة النوبارية: يتبين من إجراء إختبار تحليل التباين لبيانات العينة البحثية فيما يتعلق بمتوسطات الإنتاجية المزرعية في مختلف السعات المزرعية موضع الدراسة الموضحه في جدول رقم (٧) أنه يوجد فروق معنوية بين المتوسطات الانتاجية المزرعية في السعات موضع البحث بالنسبة لمزارع إنتاج بنجر السكر وفقاً للمساحة المزروعة بمحصول بنجر السكر بمنطقة النوبارية في العينة البحثية حيث تم الإستدلال على ذلك من واقع المقارنات المباشرة بين قيمة (ف) المحسوبة على أساس بيانات العينة البحثية وبين قيمتها الجدولية عند مستويات المعنوية ٠,٠١، ٠,٠٥ .

جدول (٧): تحليل التباين لإختبار معنوية الفروق بين متوسطات الانتاجية المزرعية بإختلاف للمساحة المزروعة بمحصول بنجر السكر بمنطقة النوبارية بمحافظة البحيرة للموسم الإنتاجى(٢٠١٠-٢٠١١)

مصدر التباين	مجموع مربع الإنحرافات T.S.S	درجات الحرية D.F.	متوسط مربع الإنحرافات M.S	إختبار ف	
				ف المحسوبة	مستوى المعنوية
بين المناطق	٢٢,٨٠٦	١	٢٢,٨٠٦	٣,٩٦٤	٠,٠٤٩
داخل المناطق	٥٧٥,٣٨٢	١٠٠	٥,٧٥٤		
الكلي	٥٩٨,١٨٩	١٠١			

المصدر: جمعت وحسبت من: بيانات العينة البحثية في مزارع العينة في منطقة النوبارية بمحافظة البحيرة في الموسم (٢٠١٠-٢٠١١)

ويتبين من بيانات نفس الجدول أن الإختبار معنوي عند مستوى المعنوية ٠,٠٥ مما يعنى وجود تأثير معنوي للسعة المزرعية على المتوسطات الإنتاجية لإنتاج بنجر السكر وفقاً للمساحة المزروعة بمحصول بنجر السكر بمنطقة النوبارية ، وبالتالى فإن التحليل الإقتصادى القياسى سوف يتم على تقسيم العينة وفقاً للمساحة المزروعة بمحصول بنجر السكر بمنطقة النوبارية إلي فئتين؛ وتضم الفئة الأولى المزارعين ذوي المساحات من بنجر السكر التي تتراوح من فدان إلى أقل من خمسة أفدنة، بينما تضم الفئة الثانية المزارعين ذوي المساحات من بنجر السكر الأكبر من خمسة أفدنة.

الكفاءة الفنية للموارد المستخدمة في إنتاج محصول بنجر السكر للفئات المزرعية في العينة البحثية: يتبين من استعراض بيانات الجدول رقم (٨) أن مقدار الكفاءة الفنية لإنتاج بنجر السكر في ظل ثبات العائد للسعة لمزارع الفئة الأولى (١ – أقل من ٥ أفدنة) تبلغ حوالى ٠,٩٠١ وهذا يعنى أن منتجي بنجر السكر في مزارع هذه الفئة يمكنهم زيادة الإنتاج من محصول بنجر السكر بنسبة تقدر بحوالى ٩,٩% دون أى زيادة في مقدار الموارد المستخدمة لإنتاج بنجر السكر، ويعني هذا أن منتجي بنجر السكر في مزارع هذه الفئة يفقدون قدراً من مواردهم الإقتصادية المستخدمة في إنتاجه، مما يترتب عليه زيادة تكلفة إنتاجهم بنسبة تقدر بحوالي ٩,٩%، ويتبين كذلك أن قيمة الكفاءة الفنية لإنتاج بنجر السكر في ظل ثبات العائد للسعة في مزارع الفئة الثانية (أكثر من خمسة أفدنة) حوالي ٠,٩٦٥ وهذا يعنى أن منتجي بنجر السكر في مزارع هذه الفئة يمكنهم زيادة الإنتاج من محصول بنجر السكر بنسبة تقدر بحوالى ٣,٥% دون أى زيادة في كمية أو مقدار الموارد المستخدمة لإنتاج بنجر السكر. وبذلك فإن منتجي بنجر السكر في مزارع هذه الفئة يفقدون قدراً من مواردهم الإقتصادية المستخدمة في إنتاج بنجر السكر ، مما يترتب عليه زيادة تكلفة إنتاجهم بنسبة تقدر بحوالي ٣,٥%.

ويتبين من إستعراض بيانات نفس الجدول السابق الإشارة إليه – جدول (٨) أن مقدار الكفاءة الفنية لإنتاج بنجر السكر في ظل تغير العائد للسعة في مزارع الفئة الأولى من العينة البحثية بمنطقة النوبارية (١ – أقل من ٥ أفدنة) تبلغ حوالى ٠,٩٦٨ وهذا يعنى أن منتجي بنجر السكر في مزارع هذه الفئة يمكنهم زيادة الإنتاج من بنجر السكر بنسبة تقدر بحوالى ٣,٢% دون أى زيادة في مقدار الموارد المستخدمة لإنتاج بنجر السكر، وبذلك فإن

منتجي بنجر السكر في مزارع هذه الفئة يفقدون قدراً من مواردهم الإقتصادية المستخدمة في إنتاج بنجر السكر ، مما يترتب عليه زيادة تكلفة إنتاجها بنسبة تقدر بحوالي ٣,٢% ، ويتبين كذلك من التحليل أن مقدار الكفاءة الفنية لإنتاج بنجر السكر في ظل تغير العائد للسعة في مزارع الفئة الثانية من العينة البحثية بمنطقة النوبارية تبلغ حوالي واحد صحيح، وهذا يعني أن مزارعي هذه الفئة قد تمكنوا من الوصول للكفاءة الفنية المثلى لإنتاج بنجر السكر بمزارعهم.

جدول (٨): تقديرات الكفاءة الفنية للموارد الإقتصادية المستخدمة في إنتاج محصول بنجر السكر لمزارع العينة البحثية بمنطقة النوبارية.

الفئة	الكفاءة الفنية في ظل ثبات العائد للسعة	الكفاءة الفنية في ظل تغير العائد للسعة	الكفاءة السعوية
الأولي	٠,٩٠١	٠,٩٦٨	٠,٩٣٢
الثانية	٠,٩٦٥	١,٠٠	٠,٩٦٥

المصدر: جمعت وحسبت من استمارة الإستبيان وباستخدام تحليل المنحني المغلف للبيانات .

<u>الكفاءة السعوية لإنتاج محصول بنجر السكر للفئات المزرعية للعينة البحثية:</u> يتبين من استعراض بيانات الجدول رقم (٨) أن مقدار كفاءة السعة لإنتاج محصول بنجر السكر علي مستوي مزارع الفئة الأولي من العينة البحثية تبلغ حوالى ٠,٩٣٢ وهذا يعنى أن مزارع هذه الفئة لم تصل إلى الكفاءة السعوية المثلى التي يمكنها الوصول إليها من خلال زيادة إنتاجها بنسبة تقدر بحوالى ٦,٨ % ليبلغ الإنتاج حجمه الأمثل عند أدنى نقطة على منحنى متوسط التكاليف الإنتاجية المتوسطة. ويتيبين كذلك أن قيمة الكفاءة السعوية لمزارع الفئة الثانية تبلغ ٠,٩٦٥ وهذا يعني أن بعض مزارع الفئة الثانية لم تصل إلى الكفاءة السعوية المثلى ويمكنها الوصول إليها من خلال زيادة إنتاجها بنسبة تقدر بحوالى ٣,٥ % وذلك من خلال العمل على الإنتاج عند حجمه الأمثل عند أدنى نقطة على منحنى متوسط التكاليف الإنتاجية المتوسطة.

ويتبين من إجراء التحليل الإقتصادى المقارن للكفاءة الإنتاجية بأنواعها المختلفة في إنتاج محصول بنجر السكر علي مستوي مزارع الفئة الأولي من العينة البحثية أن الكفاءة الفنية إزدادت من حوالى ٠,٩٠١ في ظل ثبات العائد للسعة إلى حوالى ٠,٩٦٨ في ظل تغيرالعائد للسعة وهذا يؤكد حقيقة وجود وفورات السعة في إنتاج محصول بنجر السكر علي مستوي مزارع الفئة الأولي من العينة البحثية بمنطقة النوبارية، كما إزدادت الكفاءة الفنية لمزارع الفئة الثانية من حوالي ٠,٩٦٥ في ظل ثبات العائد للسعة إلى حوالي الواحد الصحيح في ظل تغير العائد للسعة وهذا يؤكد حقيقة وجود وفورات السعة في إنتاج محصول بنجر السكر علي مستوي مزارع الفئة الثانية من العينة البحثية بمنطقة النوبارية.

<u>تقدير فوائض الموارد الإقتصادية المستخدمة في إنتاج محصول بنجر السكر علي مستوي مزارع الفئة الأولي:</u>

يتبين بإستعراض بيانات الجدول رقم (٩) أن مقدار الفوائض في الموارد الاقتصادية المستخدمة في إنتاج محصول بنجر السكر لمزارع الفئة الأولي للعينة البحثية بمنطقة النوبارية خلال الموسم الزراعي (٢٠١٠/٢٠١١) (١) عدد

سنوات الخبرة في زراعة محصول بنجر السكر يبلغ متوسط الفائض فيها حوالي ٠,٢٨٠ سنة وهذا يعني أن بعض منتجي بنجر السكر في مزارع هذه الفئة لم يستفيد من التطور التكنولوجي والبرامج الإرشادية الحديثة في زراعة المحصول علي الرغم من توافر سنوات الخبرة لديهم، (٢) متوسط إيجار الفدان يبلغ متوسط الفائض فيه حوالي ٢٥,٦٧٨ جنيه/الفدان في مزارع هذه الفئة، (٣) مساحة بنجر السكر تبلغ متوسط الفائض فيها حوالي ٠,١٠٤ فدان وهذا يعني وجود عدد من منتجي بنجر السكر لم يستغلوا المساحة المزروعة ببنجر السكر الإستغلال الأمثل وإهدارهم هذه المساحة التي كان يمكن استغلالها في زيادة الإنتاج أو استخدامها في أغراض انتاجية أخري بالنسبة لمزارع هذه الفئة.

جدول (٩): تقديرات متوسط فوائض الموارد الإقتصادية المستخدمة في إنتاج محصول بنجر السكر في مزارع العينة البحثية

الموارد الإقتصادية	الفئة الأولى	الفئة الثانية
عدد سنوات الخبرة (سنه)	٠,٢٦٥	٠,٠٠٠
متوسط إيجار الفدان (جنيه)	٣١,٨٦٠	٠,٠٠٠
مساحة بنجر السكر بالمزرعة (فدان)	٠,١١٠	٠,٠٢٠
قيمة العمل البشري المستأجر (جنيه)	٣٠٩,٨٤٧	٤٤١,٧٠٠
قيمة العمل الآلي (جنيه)	٥١,٨٩١	١٨٨,٤١٠
قيمة التقاوي (جنيه)	١٩,٧٣٦	٣,٦٢٦
كمية سماد اليوريا (كجم)	٣٠,٥٥٠	١٤,٦٥٠
كمية سماد البوتاسيوم (كجم)	١١,٣٥٠	٢,٠٠٠
كمية سماد الفوسفات (كجم)	٣٤,٠٥٠	١٤,٦٥٠
كمية سماد المغنسيوم (كجم)	٥,١٠٠	١,٠٠٠
كمية سماد الكالسيوم (كجم)	٤,٠٥٠	١,٠٠٠
قيمة الأسمدة العضوية (جنيه)	١٦٩,٦٨٧	٣٤,٢٤٩
كمية الكبريت الزراعي (كجم)	٤,٤٠٠	٠,٨٠٠
كمية المبيدات الحشرية (كجم)	٠,٠٩٢	٠,٠٢٠
كمية المبيدات الفطرية (كجم)	٠,٣١٠	٠,٠٦٠
كمية المغذيات الورقية (كجم)	١,٠٠٠	١,٥٠٢

المصدر: جمعت وحسبت من استمارة الإستبيان وبإستخدام برنامج تحليل المنحني المغلف للبيانات الإلكتروني (DEA).

هذا بالإضافة إلى بعض الموارد الأخرى التي يوجد بها فوائض مثل (٤) قيمة العمل البشري المستأجر اللازم لأداء العمليات الإنتاجية في محصول بنجر السكر يبلغ الفائض فيه حوالي ٢٣٨,٠٣٨ جنيه/الفدان الأمر الذي يعني تحمل بعض المنتجين من مزارع هذه الفئة تكاليف إضافية في استئجار العمل البشري كان يمكن الاستغناء عنها أو الاستفادة بها في انتاج ناتج مزرعي آخر، (٥) قيمة العمل الآلي المستخدم في زراعة محصول بنجر السكر حيث يبلغ متوسط الفائض فيه حوالي ١٦,٠٨١ جنيه/الفدان، ويبلغ متوسط الفائض في قيمة التقاوي المستخدمة في زراعة محصول بنجر السكر حوالي ١٨,٦٩٦ جنيه/الفدان، ويبلغ متوسط الفائض من السماد

الأزوتي حوالي ٥١ كجم/فدان، ويبلغ متوسط الفائض من السماد البوتاسي حوالي ١١,٠٥ كجم/فدان، يبلغ متوسط الفائض من السماد الفوسفاتي حوالي ٣٤,٠٥ كجم/فدان ، ويبلغ متوسط الفائض من سماد المغنسيوم حوالي ٤,٨٥ كجم/فدان، ويبلغ متوسط الفائض من سماد الكالسيوم حوالي ٤,٢ كجم/فدان، ويبلغ الفائض من إجمالي قيمة الأسمدة العضوية في مزارع هذه الفئة حوالي ١٥٥,٨٧٥ جنيه/ فدان، بينما يبلغ الفائض من كمية الكبريت الزراعي حوالي ٥,٢ كجم/ فدان، في حين يبلغ متوسط الفائض من كمية المبيدات الحشرية حوالي ٠,٠٨٥ لتر/ فدان، أما الفائض من كمية المبيدات الفطرية المستخدمة في مزارع هذه الفئة يبلغ حوالي ٠,٢٩٤ كجم/ فدان، كما يبلغ متوسط الفائض من كمية المغذيات الورقية حوالي ٠,٢٧٦ كجم/ فدان.

ويتضح مما سبق وجود إسراف في بعض عناصر الإنتاج المستخدمة في زراعة محصول بنجر السكر في مزارع هذه الفئة لاسيما مقادير الأسمدة الكيماوية التي يجب استخدام المقررات السمادية المناسبة منها، فضلاً عن الإسراف في استخدام المبيدات الحشرية والفطرية الأمر الذي قد يضر بجودة المحصول الناتج أو الإضرار بالتربة الزراعية.

<u>تقديرات فوائض الموارد الإقتصادية المستخدمة في إنتاج محصول بنجر السكر علي مستوي مزارع الفئة الثانية:</u>

يتبين بإستعراض بيانات الجدول السابق أن مقدار الفوائض في الموارد الاقتصادية المستخدمة في إنتاج محصول بنجر السكر لمزارع الفئة الثانية خلال الموسم الإنتاجي(٢٠١٠/٢٠١١): (١) عدد سنوات الخبرة في زراعة محصول بنجر السكر حيث يتضح عدم وجود فائض في سنوات الخبرة لدي منتجي محصول بنجر السكر في مزارع هذه الفئة الأمر الذي يعني أن منتجي هذه الفئة قاموا بالإستفادة من التطور التكنولوجي والبرامج الإرشادية الحديثة في زراعة محصول بنجر السكر، (٢) متوسط إيجار الفدان حيث يتبين عدم وجود فائض في متوسط إيجار الفدان في مزارع هذه الفئة، (٣) مساحة بنجر السكر حيث يبلغ الفائض فيها حوالي ٠,٠٢٠ فدان وهذا يعني وجود عدد من منتجي بنجر السكر لم يستغلوا المساحة المزروعة ببنجر السكر الإستغلال الأمثل وإهدار هذه المساحة التي كان يمكن استغلالها في زيادة الإنتاج أو استخدامها في أغراض إنتاجية أخري بالنسبة لمزارع هذه الفئة، (٤) قيمة العمل البشري المستأجر اللازم لأداء العمليات الإنتاجية في محصول بنجر السكر حيث يبلغ الفائض فيه حوالي ٤٤١,٧٠٠ جنيه/الفدان الأمر الذي يعني تحمل بعض المنتجين من مزارع هذه الفئة تكاليف إضافية في استئجار العمل البشري كان يمكن الاستغناء عنها أو الاستفادة بها في انتاج ناتج مزرعي آخر، (٥) قيمة العمل الآلي حيث يبلغ الفائض منه حوالي ١٨٨,٤١٠جنيه/الفدان، بينما يبلغ الفائض في قيمة التقاوي حوالي ٣,٦٢٦ جنيه/الفدان، ويبلغ الفائض من السماد الأزوتي حوالي ١٤,٦٥ كجم/فدان ، ويبلغ كمية الفائض من السماد البوتاسي حوالي ٢ كجم/فدان، ويبلغ الفائض من سماد الفوسفات حوالي ١٤,٦٥ كجم/فدان، ويبلغ الفائض من سماد المغنسيوم حوالي ٠,٠٢٠ كجم/فدان، ويبلغ الفائض من سماد الكالسيوم حوالي ١ كجم/فدان ، ويبلغ الفائض من إجمالي قيمة الأسمدة العضوية حوالي ٣٤,٢٤٩ جنيه/ فدان، بينما يبلغ الفائض من كمية الكبريت الزراعي حوالي ٠,٠٢٠ كجم/فدان،في حين يبلغ الفائض من كمية المبيدات الحشرية حوالي ٠,٠٢٠ لتر/ فدان، كما يبلغ

الفائض من كمية المبيدات الفطرية حوالي ٠,٠٦٠ كجم/ فدان، أما الفائض من كمية المغذيات الورقية المستخدمة في مزارع هذه الفئة يبلغ حوالي ١,٥٠٢ كجم/ فدان.

ويتضح مما سبق أن مزارعي الفئة الثانية ذوي المساحات الأكبر من محصول بنجر السكر يتمكنون من إستغلال مواردهم الإنتاجية في إنتاج محصول بنجر السكر بمعدل أعلى من مزارعي الفئة الأولى ذوي المساحات الأصغر مما يؤكد أن هناك علاقة طردية بين المساحة المزروعة بمحصول بنجر السكر والكفاءة الإنتاجية لهذا المحصول.

التوصيات

يمكن بإستعراض نتائج التحليل الإحصائي والإقتصادي التي سبق عرضها في هذا البحث التوصل إلى عدة توصيات أهمها:

١- إعادة النظر في السياسات الزراعية المتبعة بهدف العمل علي محاولة تحقيق الاستقرار الاقتصادي في إنتاج محصول بنجر السكر في مصر وذلك بإستقرار العلاقة بين أسعار توريد المحصول الناتج إلى المصانع وأسعار مستلزمات الانتاج وتنظيم نقل المحصول من الحقل الي المصنع، مما يحقق قدر من الاستقرار في الكمية المنتجة من السكر.

٢- دعم ميكنة العمليات الزراعية والخدمات الآلية بالتوسع في إحلال الآلات الزراعية محل العمل البشري وبالأسعار التي تناسب الزراع لخفض تكاليف الإنتاج خاصة أنه تبين أن تكاليف العمل البشري تمثل الجزء الأكبر من التكاليف وهذه من أكثر المشاكل التي قابلت زراع العينة البحثية.

٣- دعم برامج البحوث والارشاد المزرعية فضلاً عن الاهتمام بالدراسات والأبحاث الخاصه بمجالات تحسين الأصناف المنتجة ونقل التكنولوجيا للوصول بالإنتاجية الفدانية الي مستويات الإنتاج العالمية من الوحدة الأرضية لإعادة توليف الموارد المزرعية الإقتصادية المستخدمة في إنتاج محصول بنجر السكر لإستخدام الكميات التى تحقق أدنى مستوى للتكاليف الانتاجية لأعلى إنتاجية فيزيقية ممكنة.

٤- التوصية بزراعة محصول بنجر السكر بمساحات كبيرة نظراً لأن كفاءة إستخدام الموارد تكون أعلى مقارنة بالمساحات الصغيرة خاصة في مشاريع وأنشطة الإستثمار المزرعية في الأراضي الجديدة.

٥- ترشيد الإستهلاك الفردي السنوي في مصر من السكر عن طريق تغيير النمط الغذائي للسكان والتوسع في إنتاج المحليات الطبيعية من شراب الجلكوز والهاي فركتوز البديلة للسكر لتغطية إحتياجات مصانع الحلوى والمياه الغازية وشركات الأدوية من السكر مما يساهم في زيادة نسبة الإكتفاء الذاتي من السكر.

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Production Efficiency of Sugar Beet Crop in Nubaria Region

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ABSTRACT: The main objective of the research is studying access to use of economic resources available to produce sugar beet crop in Nobaria rgion to raise the proportion of efficiency of this crop by measuring the efficiency of technical and economic efficiency and estimate the size of the surplus or deficit in the resources used in the cultivation of been crop in Nobaria region.

Descriptive and statistical analysis has been used to achieve the objectives of the research. The study depends on the secondary data, which collected from local sources during the study period. Aquestionannaire through personal interviews was used to collect data from (102) respondents randomly selected from branches of Nubaria region.

It was found from the results of the assessment of the technical efficiency using the method of Data Envelope Analysis (DEA) adapter for the production of sugar beets in Nubaria region during the (٢٠١٠-٢٠١١) agricultural season this crop that farmers can reduce the economic resources of the college and used to obtain the same amount of production.

In light of the results of the research outlined, the research recommends the following :

1- Reconsider agricultural policies followed in order to work on trying to achieve economic stability in the production of sugar beet crop in Egypt and that the stabilization of the relationship between the prices of the supply crop output to factories and the prices of production inputs and organize the transfer of the crop from the field to the factory, which achieves a measure of stability in quantity produced from sugar.

2- Support mechanization of agricultural operations and automated services and the need to bring agricultural machinery replaces human labor and prices that fit farmers to reduce production costs, particularly as it shows that

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the cost of human labor absorbs the bulk of the costs of these and more problems that growers interviewed sample research .

3- Support research and extension programs farm as well as the interest in studies and research in the areas of improving varieties produced and the transfer of technology to reach productivity Alfdanah to levels of global production of ground unit to re-tune the resource-farm economic used in the production of sugar beet crop to use quantities that achieve the lowest level of the cost of production for higher productivity possible.

4- interest in the cultivation of sugar beet crop on the large scale because the efficient use of resources will be higher compared to small scale, and it is also clear from the data analysis for this search.

5- Rationalize capita consumption of sugar annually by changing the kind of food for the population and the expansion in the production of natural sweeteners of glucose syrup and fructose Hague alternative to sugar factories to meet the needs of candy and soda water and pharmaceutical companies of sugar which contributes to raise the proportion of self-sufficiency.

دراسة بعض المتغيرات المرتبطة بالمستوى المعرفي لمربي الاسماك في حوض نهر الغرّاف في جمهورية العراق

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الملخص : يستهدف هذا البحث بصفة رئيسية التعرف على بعض المتغييرات المرتبطة بالمستوى المعرفي لمربي الأسماك في حوض نهر الغرّاف في جمهورية العراق، ولقد إعتمد الباحث على الإستبيان بالمقابلة الشخصية لإستيفاء البيانات البحثية من جميع مربي الأسماك في أقفاص عائمة بالمديريات والشعب الزراعية الموجودة في حوض نهر الغرّاف بالعراق والبالغ عددهم (١٢٣) مربي ، وقد تمثلت الأساليب الإحصائية التحليلية المستخدمة في: النسبة المئوية Percentage Distribution، والجداول التكرارية Frequency Tables، والمتوسط الحسابي Arithmetic Mean ، وذلك لإظهار التباين بين المبحوثين، كما إستخدم للتحقق من صدق الفروض البحثية معامل الإرتباط البسيط Correlation Coefficient لبيرسون لدراسة العلاقات الإرتباطية بين المتغيرات المستقلة والمتغير التابع وذلك بإستخدام الحاسب الآلي بإستخدام برنامج(SPSS)(الحزمة الإحصائية للعلوم الإجتماعية) وقد أوضحت النتائج البحثية ما يلي:

أولاً: الخصائص الشخصية والإجتماعية – الإقتصادية والإتصالية والنفسية لمربي الأسماك المبحوثين : فيما يرتبط بأعمار المبحوثين بلغت نسبة من تتراوح أعمارهم بين (٢٥ – ٣٩) عاماً حوالي (٤٨,٨%)، ومن (٣٩ – ٥٣) عاماً حوالي (٢٢%) ومن (٥٣ عاماً فأكثر) حوالي (٢٩,٢%) من المجموع الكلي لمربي الأسماك المبحوثين، أما بالنسبة للمستوى التعليمي للمبحوثين فقد إتضح من النتائج أن (٣٠,٩ %) من المبحوثين ذوي مستوى تعليمي منخفض، وأن (٥٢%) ذوي مستوى تعليمي متوسط في حين كان (١٧,١%) من المبحوثين ذوي مستوى تعليمي مرتفع من المجموع الكلي لمربي الأسماك المبحوثين ، وفيما يتعلق بعدد أفراد الأسرة إتضح من النتائج أن (٣٥%) من ذوي الأسر الصغيرة، وأن (٥٧,٧%) من ذوي الأسر المتوسطة في حين كان (٧,٣%) من ذوي الأسر الكبيرة من المجموع الكلي لمربي الأسماك المبحوثين ، وفيما يختص بعدد أفراد الأسرة العاملين في مجال الإستزراع السمكي أوضحت الدراسة أن عدد أفراد الاسرة العاملين في الإستزراع السمكي من الفئة الأولى نسبتهم (١٤,٦%)، وأن عدد أفراد الأسرة العاملين في الإستزراع السمكي من الفئة الثانية بلغت نسبتهم (٤٣,١%)، وأن عدد أفراد الأسرة العاملين في الإستزراع السمكي من الفئة الثالثة بلغت نسبتهم (٤٢,٣%)، من المجموع الكلي لمربي الأسماك المبحوثين ، وفيما يرتبط بالخبرة السمكية للمبحوثين فبلغت نسبة من تتراوح عدد سنوات خبرتهم بين (١–١٠) سنوات (٣٠,١ %)، وممن تتراوح عدد سنوات خبرتهم بين(١٠– ٢٠) (٤٣,٩ %) بينما من تراوحت عدد سنوات خبرتهم من (٢٠ سنة فأكثر) (٢٦%) من المجموع الكلي للمربي الأسماك المبحوثين ، أما بالنسبة للدخل السنوي من الإنتاج السمكي أوضحت الدراسة أن الذين يتسمون بدخل منخفض بلغت نسبتهم (١,٦%)، بينما ذوي الدخل المتوسط بلغت نسبتهم (٧٦,٤ %)، وذوي الدخل المرتفع بلغت نسبتهم (٢٢%) من المجموع الكلي لمربي الأسماك للمبحوثين ، وفيما يختص بالسعة الحيازية من الأقفاص السمكية العائمة أوضحت الدراسة أن نسبة مربي الأسماك المبحوثين الذين يتسمون بحيازة مزرعية صغيرة (٥٦,١%)، والمتوسطة(٢٥,٢%)، والمرتفعة (١٨,٧%) من المجموع الكلي

لمربي الأسماك المبحوثين ، وفيما يرتبط بمتوسط إنتاج القفص من الأسماك فقد أوضحت الدراسة أن نسبة المربين من ذوي الإنتاج المنخفض بلغت (١٦,٣%)، بينما بلغت نسبة ذوي الإنتاج المتوسط (٤١,٥%)، بينما بلغت نسبة ذوي الإنتاج المرتفع (٤٢,٣%) من المجموع الكلي لمربي الأسماك المبحوثين ، أما بالنسبة لمصادر المعلومات الزراعية السمكية للمبحوثين أوضحت الدراسة أن نسبة ذوي مستوى المصادر المنخفضة بلغت (١٣%)، وأن نسبة ذوي المصادر المتوسطة بلغت (٧٣,٢%)، في حين بلغت نسبة ذوي المستوى المرتفع (١٣,٨%) من المجموع الكلي لمربي الأسماك المبحوثين ، وبالنسبة لإتجاه المبحوثين نحو الإستزراع السمكي بلغت نسبة مربي الأسماك ذوي الإتجاه السلبي (٣,٣ %)، والمحايد (٧١,٥%)، والإيجابي (٢٥,٢%) من المجموع الكلي لمربي الأسماك المبحوثين.

ثانياً: المستوى المعرفي العام لمربي الأسماك المبحوثين: أوضحت الدراسة أن نسبة ذوي المستوى المعرفي المنخفض بلغت (٥٩,٣%) بينما بلغت نسبة ذوي المستوى المعرفي المتوسط (٣٠,١%)، ونسبة ذوي المستوى المرتفع بلغت (١٠,٦%) من المجموع الكلي لمربي الأسماك المبحوثين.

ثالثاً: العوامل المرتبطة بالمستوى المعرفي لمربي الأسماك المبحوثين: أوضحت النتائج وجود علاقة إرتباطية معنوية طردية بين متغير المستوى المعرفي لمربي الأسماك كمتغير تابع وبين كل من : أعمار المبحوثين، المستوى التعليمي، عدد أفراد الأسرة، عدد أفراد الأسرة العاملين في الإستزراع السمكي، الخبرة السمكية للمبحوثين، الدخل السنوي من الإنتاج السمكي، السعة الحيازية من الأقفاص العائمة، متوسط إنتاج القفص، مصادر المعلومات الزراعية السمكية للمبحوثين، إتجاه المبحوثين نحو الإستزراع السمكي.

رابعاً: المشكلات التي تواجه مربي الأسماك المبحوثين من وجهة نظرهم: أوضحت الدراسة وجود ستة مشاكل والتي يمكن مقابلتها كما يلي : عقد الدورات الخاصة بالإنتاج السمكي وذكرها (٨٨,٦١%) من المبحوثين، تقديم القروض الميسرة لمربي الأسماك وذكرها (٨٨,٦١%) من المبحوثين ، توفير الأعلاف ورخص أسعارها وذكرها (٨٢,٩٢%) من المبحوثين، توفير الإصبعيات ورخص أسعارها وذكرها (٧٤,٧٩%) من المبحوثين، المواد الأولية وتوفيرها وقد ذكرها (٦٩,١٠%) من المبحوثين، الروتين الحكومي وقد ذكرها (٤٣%) من المبحوثين.
الكلمات الدلالية : الإرشاد الزراعي ، المستوي المعرفي ، مربي الأسماك في أقفاص عائمة .

المقدمة والمشكلة البحثية:

تعتبر الأسماك أحد مصادر البروتين الحيواني الهامة التي تحتوي على قيمة غذائية عالية، كما أنها تعتبر مصدراً للدهون الضرورية والفيتامينات والمعادن، كما أن كيلو واحد من الأسماك يغطي إحتياجات الفرد من اليود لمدة خمسين يوماً، وقد أشارت الدراسات العلمية الى أن نحو (٢٠٠ غم) من لحوم الأسماك تكفي إحتياجات الفرد اليومية من البروتين الحيواني، حيث أن البروتين السمكي يتوافر به كميات وفيرة من الأحماض الأمينية الرئيسية التي يحتاجها الإنسان في غذائه مباشرة ولا يستطيع الجسم البشري تكوينها **(إبراهيم ،١٩٩٠: ص ٩)**.

كما تعتبر الأسماك من الحيوانات الأكثر كفاءة في تحويل غذائها الى أنسجة، فقد وجد أن أحد أنواع الأسماك (التراوت) عندما يغذى على غذاء عالي الجودة فإن كل (١,٥ كيلو غرام) من الغذاء يتحول الى(كيلوغرام)

من اللحم السمكي، كما إن الطاقة اللازمة لإنتاج وحدة من الوزن في الأسماك تكون أقل مما في حالة الحيوانات الارضية الأخرى (**Hepher، 1988**) .

وعلى ذلك يمكن القول أن التوسع الأفقي والرأسي في الإستزراع السمكي يمكن أن يلعب دوراً حيوياً في توفير إحتياجات السكان من البروتين الحيواني وتقليل حجم الفجوة الغذائية وخفض الواردات بصفة عامة من اللحوم والأسماك (**EL- Ghmrini, 1998:p258**)

هذا ويبلغ إنتاج العراق من الثروة السمكية (المزارع السمكية ومن الأنهار والصيد البحري) عام ٢٠٠٥ (٢٥,٦ ألف طن فقط) أي بقدر ما تنتجه الصومال وأقل ٤٠ مرة مما تنتجه مصر، وقد إختفت من الأسواق أنواع رئيسية من الأسماك العراقية كالبني والكطان والشبوط وإنخفض إنتاج الثروة السمكية من (٣٦٩٣٥ طن) عام ١٩٩٧ الى (٢٥٩٩٨ طن) عام ٢٠٠١ بسبب تجفيف الأهوار وإنخفاض مناسيب المياه والتي أعيد غمر (٤٠%) منها بالمياه منذ عام (٢٠٠٣)، إضافة الى الممارسات الخاطئة التي يستخدمها بعض الصيادين كالسموم التي تقتل أعداد كبيرة من الأسماك، وعدم إلتزام الصيادين بمنع الصيد خلال موسم التكاثر مع عدم توفر الأعلاف والأدوية وضعف المتابعة، حيث تشير تقارير منظمة الأغذية والزراعة الى أن الطاقة الإجمالية لإنتاج الأسماك في المياه العذبة أخذت بالهبوط المستمر حيث تراوحت ما بين (١٣,٦) و(١٢,٣) ألف طن بين عامي ٢٠٠٠ و ٢٠٠٤. وتشكل أسماك الكارب الإعتيادي الجزء الأكبر من المحتوى السمكي لمسطحات المياه الداخلية للعراق، يأتي بعدها الكطان، والشبوط، والبني، والأحمر، والشلك، والبز، والجري، وهناك أسماك أخرى غير إقتصادية كأسماك الخشني واللصاف والتي تتوفر بكثرة في المسطحات وسواحل الأنهار الداخلية، أما الأنواع البحرية فهي الهامور، والشانك، والبياح، والزبيدي، وبعض القشريات والروبيان(**وزارة التخطيط والتعاون الإنمائي العراقية – دائرة التخطيط الزراعي ، ٢٠٠٩، ص:١٠).**

وفي السنوات الأخيرة إزداد الإنتاج السمكي في العراق ففي عام ٢٠٠٩ بلغ الإنتاج السمكي العراقي حوالي(٣٢١,٥ طن)، وإرتفع عام ٢٠١٠ إلى (٣٢٤٣٨ طن) وفي عام ٢٠١١ بلغ (٥٤,٩٩ ألف طن) حيث تقدر مقسمة إلى (٣٩,٧٦ الف طن) من المصائد و (١٥,٢٣ الف طن) من المزارع وهذه الكميات لاتكفي لسد حاجات القطر لذا يستورد القطر بحدود (٢١,٧٤ ألف طن) حيث تبلغ نسبة الإكتفاء الذاتي حوالي (٧١,٦٧ %) **المنظمة العربية للتنمية الزراعية** ، (٢٠١١) ، **الكتاب السنوي للإحصاءات الزراعية،الخرطوم، السودان** .

إن التدهور المرحلي واضح حيث تدني إنتاجية الدونم الواحد من الأسماك في المسطحات المائية (٤ كغم / دونم) مقارنة ببعض البلدان (٥٠ كغم / دونم) ومعدل متوسط عالمي(٣٥ كغم/ دونم) أما في أحواض التربية فتبلغ الإنتاجية (٥٠٠ كغم / دونم) أما الإرتفاع النسبي في إنتاج لحوم الأسماك فيرجع الى كثرة التجاوزات الحاصلة بإنشاء بحيرات وأحواض وأقفاص تربية غير مجازة لتربية الأسماك في مختلف أنحاء البلاد (**وزارة التخطيط والتعاون الإنمائي العراقية – دائرة التخطيط الزراعي ،٢٠٠٩ ص ١٢).**

وبالرغم من إهتمام الدولة بتنمية وتطوير المزارع السمكية وبذل المزيد من الجهود لزيادة الإنتاج السمكي منها، إلا إن معدل الزيادة في إنتاج هذه المزارع لا يتماشى مع الزيادة السكانية الكبيرة مما أدى إلى إتساع الفجوة بين الإنتاج والإستهلاك، لذا يجب العمل على الحد من إتساع هذه الفجوة وذلك عن طريق نشاط إرشادي مكثف يعظم الإستفادة من هذه المزارع ويعمل على مد حائزيها بالمعارف والمعلومات الكفيلة بزيادة إنتاجها.

ويستطيع الإرشاد الزراعي بإعتباره عملية تعليمية تستهدف إحداث تغييرات مرغوبة في معارف ومهارات وإتجاهات مربي الأسماك أن يقوم بدور فعال وحيوي وذلك بتوعية مربي الأسماك بأهمية التعرف على الممارسات والتوصيات الإرشادية المرتبطة بتربية وتغذية ورعاية الأسماك ، وما يترتب على ذلك من تحسين مستوياتهم الإنتاجية السمكية وبالتالي تحسين مستوياتهم الدخلية والمعيشية ، ولذلك فقد إهتمت هذه الدراسة بالتعرف على المستوى المعرفي لمربي الأسماك فيما يرتبط بتربية وتغذية ورعاية الأسماك وتحديد المتغييرات المرتبطة بها وذلك في حوض نهر الغرَاف في جمهورية العراق .

الأهداف البحثية:

يستهدف هذا البحث التعرف على بعض المتغييرات المرتبطة بالمستوى المعرفي لمربي الأسماك في حوض نهر الغرّاف في جمهورية العراق، ويمكن تحقيق هذا الهدف من خلال تحقيق الأهداف الآتية :

١- التعرف على بعض الخصائص الإجتماعية- الإقتصادية والإتصالية والنفسية المميزة لمربي الأسماك المبحوثين.
٢- تحديد بعض المتغيرات المرتبطة بالمستوى المعرفي لمربي الأسماك المبحوثين.
٣- التعرف على العلاقات الإرتباطية بين بعض الخصائص الإجتماعية الإقتصادية والإتصالية المميزة لمربي الأسماك المبحوثين وبين المستوى المعرفي للمبحوثين فيما يرتبط بتربية وتغذية ورعاية الأسماك.
٤- تحديد المشكلات التي تواجه مربي الأسماك المبحوثين ومقترحاتهم لحلها من وجهه نظرهم.

الإستعراض المرجعي:

مفهوم المعرفة:

يرى **عمر وآخرون (١٩٧٣ ، ص : ٥٣)** أن المعرفة هي " القدر من المعلومات التي يحوزها الفرد والتي تمكنه من ربط علاقات ما بين الظواهر المختلفة بما يتسنى معه سهولة إدراكها وسرعة إستيعابها ".

في حين يرى **حسن (١٩٩٠، ص :٦٠)** أن المعرفة " لا تقتصر على ظواهر من لون معين بل تتناول جميع ما يحيط بالإنسان وكل ما يتصل به، ويضيف أن مفهوم المعرفة ليس مرادفاً للعلم، فالمعرفة أكثر شمولاً وأوسع حدوداً من العلم حيث تتضمن معارف علمية وغير علمية ".

ويذكر أبو السعود **(١٩٨٧، ص:٣٥١)** أن المعرفة هي " جميع المعلومات والخبرات التي أدركها الإنسان وإستوعبها عن طريق حواسه ويستطيع أن يسترجعها في أي وقت من الأوقات ".

بينما يرى **سيد (١٩٨٩، ص:٣٥)** أن المعرفة هي " إحاطة العلم بالشيء وهي تتناول جميع ما يحيط بالإنسان وما يتصل به، ويضيف أن المعرفة تختلف عن العلم في حد ذاته ذلك لأن العلم هو عملية منهجية لربط المعارف الجزئية وتوسيع نطاقها ".

ويذكر **حسن (١٩٩٠، ص :٢٠)** أن المعرفة هي " مجموعة من المعاني والتصورات والآراء والمعتقدات والحقائق التي تتكون لدى الإنسان نتيجة لمحاولاته المتكررة لفهم الظواهر والأشياء المحيطة به ".

ويعرف **السيد (١٩٩٠: ص: ١٤)** المعرفة على أنها " كل ما إستقر في ذهن الإنسان من معانٍ وخبرات أمكن إكتسابها عن طريق حواسه المختلفة ".

أنواع المعرفة:

تعددت المراجع والدراسات العلمية التي قامت بتصنيف المعرفة وتناولت أنواعها، فقد صنف **عمر وآخرون (١٩٧٣، ص :٥٤)** المعرفة الى نوعين : معارف علمية، ومعارف غير علمية، وإن التفرقة بينهما تكون على أساس قواعد المنهج المستخدم وأساليب التفكير التي تتبع في تحصيل المعارف.

بينما يرى **جامع (١٩٧٥، ص :١١٤)** أن هناك نوعين من المعرفة هما :

١- المعرفة الواقعية : التي تتواجد في الواقع العملي للحياة.
٢- المعرفة الوجوبية : التي يجب أن تكون فعلاً وليس كائناً في الواقع.

ويرى **عمر(١٩٧٨، ص : ١٤،١٣)** أن المعرفة يمكن تصنيفها الى ثلاثة أنواع هي :

١- المعارف العامة : وتشمل مجموعة من المعلومات الأساسية التي يشترك في معرفتها جمهور كبير من الناس، وهي تساهم في تكوين إطار معرفي تبني عليه كثير من المعارف التخصصية الاخرى، وهي تشمل مجموعة مقررات أساسية في مجالات العلوم الطبيعية والإجتماعية والإنسانية.
٢- المعارف المتخصصة: وتشمل مجموعة من المعلومات التخصصية في مجال معين، والتي تكون الركيزة الأساسية للإطار النظري الذي يبنى عليه كثير من التطبيقات المهنية الأخرى.
٣- المعارف المهنية: وتشمل مجموعة من المعلومات ذات الطبيعة التطبيقية المباشرة حيث تشمل معارف عن طبيعة المهنة وخصائصها وكيفية ممارستها، كما تتضمن مقررات أو معلومات تساعد المهني على تطبيق المعارف المتخصصة .

ويرى **سيد (١٩٨٩، ص : ٣٦،٣٥)** أن هناك ثلاثة أنواع من المعرفة هي :

١- المعرفة الحسية: وهي التي تقتصر على الملاحظة البسيطة للظواهر المختلفة ولا تتعدى مستوى الإدراك الحسي العادي.
٢- المعرفة الفلسفية: وهي التي تقوم على الإسلوب القياسي وتتناول الظواهر بالبحث والدراسة وتتجه بالبحث إلى ما وراء الطبيعة.
٣- المعرفة العلمية: وهي التي تقوم على الإسلوب الإستقرائي الذي يعتمد على المنهج العلمي والملاحظة المنظمة للظواهر وفرض الفروض، وإجراء التجارب وجمع البيانات وتحليلها للتأكد من صحة الفرض أو عدم صحته.

طرق قياس المعرفة:

يذكر كل من **جلال (١٩٨٥، ص : ١٠٩)، وأبو حطب وآخرون (١٩٨٧، ص : ٣٩٧)، والنجار(١٩٩١، ص : ٨٩)**، أنه يمكن قياس المعرفة عن طريق إختبارات التحصيل والتي يمكن إيجازها فيما يلي :

١- إختبار الإستدعاء البسيط : ويهدف الى إستدعاء الفرد لما تم حفظه.
٢- إختبار الصواب والخطأ : وهو عبارة عن أسئلة يبين الفرد فيها الصواب والخطأ.

٣- إختبار أسئلة البديلين : ويتطلب إجابة واحدة من بين إجابتين.
٤- إختبار الإختيار المتعدد : حيث يختار الفرد الإجابة الصحيحة من عدة إجابات محتملة.
٥- إختبار إتمام الجمل : وفيه يكمل الفرد الجملة الناقصة بكلمة أو مجموعة من الكلمات.
٦- إختبار المقابلة : وفيها يطابق الفرد بين قائمتين الأولى بها عدد من المشاكل والثانية بها إجابات لهذه المشاكل ولكن بترتيب مخالف ويطلب من الفرد أن يربط كل مشكلة من القائمة الأولى مع حلها في القائمة الثانية .
٧- إختبار الحصر : وفيه يقوم الفرد بحصر بعض النقاط التي يجب أن تتوافر في موضوع معين.
٨- إختبار أسئلة الترتيب : وفيه يقوم الفرد بترتيب خطوات أو إجراءات أو أحداث في تسلسل منطقي.

التصنيفات المعرفية:

لقد صنف **بلوم وآخرون (Bloom et al.,1956)** المجال المعرفي ضمن ست فئات رئيسية كما يذكرها **توق وآخرون (٢٠٠٧ ، ص : ٤٣)** هي :

١- المعرفة (التذكر) : ويقصد بها تذكر المادة التي تم تعلمها سابقاً، وقد يتضمن هذا إستدعاء عدد كبير من المواد إبتداءاً من الحقائق البسيطة وإنتهاءاً بالنظريات، إلا أن كل ما هو مطلوب هو إستعادة المعلومات المناسبة، وتمثل هذه الفئة أدنى مستويات النواتج التعليمية في البعد المعرفي.
٢- الإستيعاب (الفهم) : ويقصد به القدرة على إمتلاك معنى المادة ويمكن إظهار هذا عن طريق ترجمة المادة من شكل الى شكل آخر (الكلمات إلى أرقام) أو عن طريق إتجاهات المستقبل (التنبؤ عن النتائج أو الآثار). إن هذه النتاجات التعليمية أصعب بقليل من مجرد التذكر، وتمثل أدنى مستوى من مستويات الفهم.
٣- التطبيق : ويقصد به القدرة على إستعمال المادة المتعلمة في مواقف محسوسة وجديدة وقد يشتمل هذا على تطبيق قواعد أو طرق أو مفاهيم أو مبادئ أو قوانين، أو نظريات، والنتاج التعليمي في هذا الميدان يتطلب مستوى أعلى من الفهم من ذلك الذي يتطلبه الإستيعاب أو الفهم.
٤- التحليل : ويقصد به القدرة على تجزئة مادة ما إلى عناصرها المكونة لها، لكي يتنسى فهم البناء التنظيمي لتلك المادة وقد يشتمل هذا على تعيين الأجزاء، وتحليل العلاقة بينهما، والتعرف على المبادئ التنظيمية المنتظمة وإن هذا المستوى أعلى من الإستيعاب والتطبيق من حيث أنه يتطلب فهم المحتوى والشكل البنائي للمادة.
٥- التركيب : ويقصد به القدرة على وضع الأجزاء مع بعضها البعض لتشكيل كل جديد، وقد يتضمن هذا إنتاج قطعة فريدة (خطاب موضوع) أو خطة عمليات (مشروع دراسة) أو منظومة علاقات مجردة (خطة لتصنيف معلومات). إن الناتج التعليمي في هذا الميدان يركز على السلوك الإبداعي لتكوين أنماط بنائية جديدة.
٦- التقويم : ويقصد به القدرة للحكم على قيمة المادة لغرض معين، وهذه الأحكام يجب أن تبنى على معايير محددة، وقد تكون هذه المعايير معايير داخلية (التنظيم) أو معايير خارجية (مناسبة المادة للهدف)، إن النتاجات في هذا الميدان هي أعلى درجات الهرم المعرفي لأنها تحتوي على عناصر من كل الفئات الأخرى بالإضافة الى حكم القيمة المبني على معايير معرفة تعريفاً دقيقاً.

تنظم الست فئات أعلاه فيما بينها وفق ترتيب هرمي من الأسهل الى الأصعب ومن البسيط الى المركب، كما يفترض أن الفئة المتقدمة تشتمل على الفئات التي تسبقها وتحتويها وكما هو موضح في الشكل رقم (١).

التقويم					
التركيب	**التركيب**				
التحليل	**التحليل**	**التحليل**			
التطبيق	**التطبيق**	**التطبيق**	**التطبيق**		
الإستيعاب	**الإستيعاب**	**الإستيعاب**	**الإستيعاب**	**الإستيعاب**	
المعرفة	**المعرفة**	**المعرفة**	**المعرفة**	**المعرفة**	**المعرفة**

شكل (١): الترتيب الهرمي لفئات المجال المعرفي وفقاً لتصنيف بلوم

دور الإرشاد الزراعي في مجال الإستزراع السمكي :

يقوم الإرشاد الزراعي بدور هام في تعليم الأفراد كيفية إشباع إحتياجاتهم ومساعدة أنفسهم على حل مشكلاتهم من خلال تنمية معارفهم وفهمهم وتطبيقهم لهذه المعارف، كما يهدف الإرشاد الزراعي إلى مساعدة الناس بمدهم بالمعارف لرفع مستواهم الفكري وتعليمهم مهارات جديدة وتغيير إتجاهاتهم ونظرتهم لتقبل الجديد وحفزهم للسعي المتواصل للتعرف على مشاكلهم المتجددة والتوصل الى طرق علاجها (**الخولي ، ١٩٧١، ص : ١٥٨**).

كما يقوم الإرشاد الزراعي أيضاً بدور هام في نشر وتحسين وإتباع الأساليب العلمية عند تطبيق العديد من المشروعات التنموية والتي من بينها تربية الأسماك (**الرافعي ،١٩٩١، ص : ١٦٤**)، ولذلك فإن دور الإرشاد الزراعي في هذا المجال يتبلور في إعداد برامج تنموية تتناول مجال الإستزراع السمكي، وحث مربي الأسماك على تطبيق التقنيات الفنية المستحدثة في هذا المجال، وكذا تدريب الكوادر الفنية لتأهيلهم للقيام بالدور الإرشادي وكذا إعداد برامج تدريبية لهم تتضمن كافة الممارسات والمهارات الفنية المستحدثة في هذا المجال، بالإضافة الى توفير النشرات الإرشادية التي تساعد على تنمية معارف حائزي المزارع والأقفاص السمكية للتقنيات الفنية المستحدثة في مجال الإستزراع السمكي، وذلك من أجل النهوض بتنمية الثروة السمكية، لذا فإن الأمر يتطلب وجود جهاز إرشادي ذو كفاءة عالية لكي يستطيع تعليم وإقناع مربي الأسماك بإستخدام التقنيات المستحدثة في مجال الإستزراع السمكي لتطوير إنتاجهم وتحسين أحوالهم المعيشية.

وحيث أن غالبية حائزي المزارع السمكية والصيادين يتسمون بأنهم متمسكون بالأساليب التقليدية في حياتهم وذوي مستوى معيشي منخفض، وقد يكون منهم غير ملمين بالقراءة والكتابة، لذلك فإنه لايمكن تغيير خبراتهم في الإستزراع السمكي دون إقناعهم بأنهم سيحققون مكاسب عظيمة بأقل مجهود وأقل مخاطرة، (**Royce,1995:p414**).

والإرشاد الزراعي يمكن أن يقوم بدور مهم في مجال تبني ونقل الأساليب والمبتكرات التكنولوجية السمكية الحديثة وتنمية وتطوير القوى البشرية العاملة بقطاع الثروة السمكية بإعتباره عملية تعليمية تستهدف إحداث تغييرات سلوكية مرغوبة تتناول المعارف والمهارات الذهنية والنفسية الحركية وإتجاهات الأفراد كوسيلة لزيادة كفاءتهم وجدارتهم الإنتاجية، وبالتالي زيادة دخولهم وإرتفاع مستوى معيشتهم (**رضوان ، ١٩٩٨، ص :٣١**).

ويعتمد الإرشاد السمكي في أدائه على معظم الطرق الإرشادية المتعارف عليها إلا أنه يركز على طرق الإيضاح العملي والمطبوعات الإرشادية والزيارات الميدانية حقلية أو منزلية لأنها أكثر مناسبة للإرشاد السمكي من باقي الطرق الإرشادية الأخرى (**الرافعي ،١٩٩١ ، ص :٥١**).

الأسلوب البحثي:

التعريفات الإجرائية للمصطلحات البحثية:

١- **القفص السمكي العائم:** يقصد به إطار (خشبي / بلاستيك) محاط بشبكة من الغزل وتحمله براميل بلاستيك للتعويم وأحجامه تختلف بإختلاف المجرى المائي المستخدم، وهي طريقة من طرق تربية الأسماك داخل حيز محدد موضوع في مجرى مائي داخلي يمكن السيطرة عليه بأقل التكاليف الممكنة.

٢- **مربو الأسماك:** يقصد بهم في هذا البحث كل من يحوز قفصاً سمكياً أو أكثر ويقع ضمن منطقة البحث.

٣- **أعمار المبحوثين:** يقصد في هذا البحث سن المبحوث حائز الاقفاص السمكية وقت إجراء البحث وذلك لأقرب سنة .

٤- **المستوى التعليمي للمبحوث:** يقصد في هذا البحث الحالة التعليمية وقت إجراء البحث من حيث أنه أمي أو عدد سنوات التعليم في مراحل (إبتدائي، إعدادي، ثانوي، جامعة) ويتم التعبير عنه بقيم رقمية.

٥- **عدد سنوات الخبرة في مجال الإستزراع السمكي** : يقصد به في هذا البحث عدد السنوات التي قضاها المبحوث في تربية الأسماك.

٦- **عدد أفراد الأسرة** : يقصد به في هذا البحث عدد أفراد أسرة المبحوث .

٧- **عدد أفراد الأسرة العاملين في مجال الإستزراع السمكي** : ويقصد به في هذا البحث عدد أفراد أسرة المبحوث الذين يعاونونه في مجال الإستزراع السمكي.

٨- **حجم القفص بالمتر المكعب** : يقصد به في هذا البحث حاصل ضرب أبعاد القفص الطول * العرض * العمق في المياه.

٩- **الدخل السنوي من الإنتاج السمكي** : ويقصد به في هذا البحث قيمة إنتاج الأسماك من الإنتاج السمكي سنوياً مقدرة بالدينار العراقى.

١٠- **السعة الحيازية للمبحوث من الأقفاص السمكية** : يقصد به في هذا البحث كمية الأقفاص التي يمتلكها المبحوث مقدرة بقيمة عددية.

١١- **متوسط إنتاج القفص من الأسماك** : يقصد به في هذا البحث كمية الأسماك الموجودة في القفص مقدرة بالكيلو غرام .

١٢- **التعرض لمصادر المعلومات** : يقصد به في هذا البحث مدى تعرض المبحوث للمصادر التي يرجع إليها عندما تواجهه مشكلة ما في مجال الإستزراع السمكي.

١٣- الإتجاه نحو تربية الاسماك في الاقفاص السمكية : يقصد به في هذا البحث ميل وإستعداد المبحوث نحو فكرة تربية الأسماك في الأقفاص السمكية العائمة.

١٤- المستوى المعرفي للمبحوثين فيما يرتبط بتربية وتغذية ورعاية الأسماك: يقصد به في هذا البحث حصيلة معارف المبحوثين حائزي الأقفاص السمكية العائمة محل الدراسة فيما يرتبط بتربية وتغذية ورعاية الأسماك.

الفروض البحثية:

لتحقيق أهداف هذا البحث تم صياغة الفرض البحثي التالي: توجد علاقة إرتباطية بين المستوى المعرفي للمبحوثين فيما يرتبط بتربية وتغذية ورعاية الأسماك كمتغير تابع وبين كل المتغيرات المستقلة الآتية : أعمار المبحوثين، والمستوى التعليمي للمبحوثين، وعدد أفراد الأسرة، وعدد أفراد الأسرة العاملين في الإستزراع السمكي، والخبرة السمكية للمبحوثين، والدخل السنوي من الإنتاج السمكي، والسعة الحيازية من الأقفاص السمكية، ومتوسط إنتاج القفص، ومصادر المعلومات الزراعية السمكية للمبحوثين، وإتجاه المبحوثين نحو الإستزراع السمكي، ويتم إختبار هذا الفرض في صورته الصفرية (فرض العدم) التالية :"لا توجد علاقة إرتباطية بين المستوى المعرفي للمبحوثين فيما يرتبط بتربية وتغذية ورعاية الأسماك كمتغير تابع وبين كل من المتغيرات المستقلة المدروسة كلاً على حده.

منطقة البحث:

وقع الإختيار على منطقة حوض نهر الغرَاف تحديداً كمنطقة لإجراء هذه الدراسة، وذلك لعدة إعتبارات منطقية كان من أهمها: أن هذه المنطقة تعتبر من المناطق الأكثر إنتاجاً من حيث الإستزراع السمكي بها كما أنها تقع في منطقة واسعة نسبياً حيث تشمل محافظتين من وسط وجنوب القطر، بالإضافة الى خبرة المزراعين في مجال الإستزراع السمكي، كما أن الجزء الأكبر منها يقع ضمن المنطقة التي ينتمي إليها الباحث مما يسهل عملية تجميع البيانات الميدانية بمزيد من الدقة، وإمكانية حصوله على الدعم الفني من السادة الباحثين المتخصصين في مجال الدراسة بسهولة مما يدعم صحة ودقة النتائج المتحصل عليها.

الشاملة والعينة:

تمثلت شاملة هذه الدراسة في جميع مربي الأسماك في أقفاص عائمة بالمديريات والشعب الزراعية الموجودة في حوض نهر الغرَاف بالعراق وذلك من واقع سجلات المديريات والشعب الزراعية في تلك المناطق وقد بلغ عدد مربي الأسماك (١٢٣) مربي موزعين على المناطق التالية : منهم (٢٠) مزارعاً في الكوت و(١٠) مزارعين في قضاء الحي وكذلك الى (١١) مزارعاً في ناحية الموفقية، بالإضافة الى (١٥) مزارعاً في ناحية الفجر، وكذلك (١٢) مزارعاً في ناحية قلعة سكَر، كذلك وجود (١٧) مزارعاً في قضاء الرفاعي، ووجود (١٤) مزارعاً في ناحية النصر، ووجود (١٤) مزارعاً في قضاء الشطرة بالإضافة الى (١٠) مزارعين في ناحية الغرَاف، وقد تم أخذهم جميعاً عينة للدراسة وبذلك إنطوت الشاملة على العينة.

النتائج البحثية والمناقشة:

أولاً : بعض الخصائص الشخصية والإجتماعية الإقتصادية والإتصالية والنفسية المميزة لمربي الأسماك المبحوثين:

يتضح من جدول (١) ما يلي : أن غالبية المبحوثين من ذوي الأعمار الصغيرة (٤٨,٨%) وتلك الفئة تتسم بالحيوية والنشاط وتقبل الممارسات الجديدة في مجال تربية وتغذية ورعاية الأسماك الأمر الذي من شأنه أن ينعكس على النهوض بمستوى الإنتاجية وإرتفاع مستوى دخولهم وتحسن أحوالهم المعيشية ، كما تبين إرتفاع نسبة التعليم بين المبحوثين (٥٢%)، الأمر الذي يساعد كثيراً في تعلمهم وتقبلهم للتوصيات الإرشادية المرتبطة بتربية وتغذية ورعاية الأسماك الأمر الذي ينعكس على النهوض بمستوياتهم المعرفية وبالتالي تطور إنتاجيتهم من الأسماك ، وقد إتضح كبر السعة الأسرية للمبحوثين (٥٧,٧%) وقد يعزى ذلك الى رغبة المبحوثين إنجاب أعداد كبيرة بأسرهم لمساعدتهم في الأعمال المزرعية السمكية الأمر الذي قد يشجع على التوسع في مساحات الإستزراع السمكي ، في حين تبين إرتفاع نسبة العمالة الأسرية في الإستزراع السمكي(٤٣,١%) الأمر الذي قد يساعد كثيراً في تطور إنتاجية الأسرة من الأسماك لتحسين دخولهم وتطور أحوالهم المعيشية ، وقد اتضح أن غالبية المبحوثين ذوي خبرة متوسطة (٤٣,٩%) ، في مجال الإستزراع السمكي، وهذا من شأنه أن يؤدي الى تقبلهم الكثير من الممارسات المرتبطة بتربية وتغذية ورعاية الأسماك وتطبيقهم لها في الواقع الميداني، وبالتالي إمكانية تحقيق معدلات إنتاجية عالية ، كما اتضح أن غالبية المبحوثين من ذوي الدخول المتوسطة (٧٦,٤%) الأمر الذي يساعد المبحوثين كثير من الإنفاق وتلبية الإحتياجات النقدية اللازمة للإنتاج ، وهذا من شأنه أن يشجع المبحوثين على تقبل المبتكرات الإنتاجية السمكية الجديدة وبالتالي تطبيقهم لها في الواقع الميداني ، وتبين إنخفاض السعة الحيازية من الأقفاص السمكية لدى المبحوثين(٥٦,١%) الأمر الذي من شأنه أن ينعكس على إنخفاض إنتاجيتهم من الأسماك وبالتالي إنخفاض دخولهم، ويتطلب الأمر من الجهات المعنية تدعيم مربي الأسماك بتوفير مستلزمات المزارع السمكية، وأيضاً إمدادهم بالمعارف والتوصيات الإرشادية السمكية والتي تمكنهم من التوسع في مزارعهم ، كما تبين أن متوسط إنتاجية قفص الأسماك لدى غالبية المبحوثين ذوي مستوى إنتاج متوسط ومرتفع (٤١,٥٥)، (٤٢,٣%) الأمر الذي يشجع كثيراً على إمكانية مزاولة المبحوثين لهذا النشاط الإنتاجي الحيوي، وأيضاً إمكانية التوسع في حجم المزارع السمكية وماتحتويه من أقفاص ، وقد لوحظ أن غالبية المبحوثين من ذوي مستوى متوسط (٧٣,٢%) بالنسبة لمصادر المعلومات السمكية التي يرجعون اليها فيمل يرتبط بتربية وتغذية ورعاية الأسماك وهذا من شأنه أن يساعد كثيراً في التغلب على المشاكل التي تعترض تربية الأسماك ، كما وتبين أن غالبية المبحوثين ذوي إتجاه محايد نحو الإستزراع السمكي (٧١,٥%) الأمر الذي يتطلب من الجهاز الإرشادي السمكي إمداد الزراع بالتوصيات الإرشادية السمكية التي تدعم إتجاهاتهم الإيجابية نحو الإستزراع السمكي ، وبالتالي تقبلهم للتوصيات الإرشادية السمكية وتبنيهم لها مما ينعكس على النهوض بمستوياتهم الإنتاجية السمكية .

جدول (١): توزيع المبحوثين وفقاً لخصائصهم الشخصية والإجتماعية الإقتصادية والإتصالية والنفسية

الخصائص	العدد*	%	الخصائص	العدد	%
١- أعمار المبحوثين:			**٦- الدخل السنوي من الإنتاج السمكي :**		
صغار السن ٢٥ – ٣٩	٦٠	٤٨,٨	مستوى دخل منخفض (١ – ٥) مليون	٢	١,٦
متوسطو السن ٣٩ – ٥٣	٢٧	٢٢,٠	مستوى دخل متوسط (٥ - ٩) مليون	٩٤	٧٦,٤
كبار السن (٥٣ سنة فأكثر)	٣٦	٢٩,٢	مستوى دخل مرتفع (٩ مليون فأكثر)	٢٧	٢٢,٠
٢- المستوى التعليمي للمبحوثين:			**٧- السعة الحيازية للمبحوثين من الأقفاص السمكية :**		
مستوى تعليمي منخفض (١ - ٤)	٣٨	٣٠,٩	سعة حيازية صغيرة (٤ - ٨)	٦٩	٥٦,١
مستوى تعليمي متوسط (٤ - ٧)	٦٤	٥٢,٠	سعة حيازية متوسطة (٨ - ١٢)	٣١	٢٥,٢
مستوى تعليمي مرتفع (٧ درجات فأكثر)	٢١	١٧,١	سعة حيازية كبيرة (١٢ قفص فأكثر)	٢٣	١٨,٧
٣ - عدد أفراد الأسرة :			**٨- متوسط إنتاج القفص من الأسماك:**		
أسرة صغيرة (٣ - ٨)	٤٣	٣٥,٠	ذوي إنتاج منخفض (٦٠٠ - ٨٠٠) سمكة	٢٠	١٦,٣
أسرة متوسطة (٩ - ١٤)	٧١	٥٧,٧	ذوي إنتاج متوسط (٨٠٠ - ١٠٠٠) سمكة	٥١	٤١,٥
أسرة كبيرة (١٤ فرداً أو أكثر)	٩	٧,٣	ذوي إنتاج مرتفع من (١٠٠٠ سمكة فأكثر)	٥٢	٤٣,٩
٤- عدد أفراد الأسرة العاملين في مجال الإستزراع السمكي :			**٩- مصادر المعلومات الزراعية السمكية للمبحوثين :**		
الفئة الاولى (فرد)	١٨	١٤,٦	ذوي مصادر منخفضة (١٢ - ١٦)	١٦	١٣,٠
الفئة الثانية (فردان)	٥٣	٤٣,١	ذوي مصادر متوسطة (١٦ - ٢٠)	٩٠	٧٣,٢
الفئة الثالثة (ثلاثة أفراد فأكثر)	٥٢	٤٢,٣	ذوي مصادر مرتفعة (٢٠ مصدر فأكثر)	١٧	١٣,٨
٥– عدد سنوات الخبرة في مجال الإستزراع السمكي :			**١٠- إتجاه المبحوثين نحو الإستزراع السمكي:**		
خبرة منخفضة (١ - ١٠)	٣٧	٣٠,١	ذوي إتجاه سلبي (٢٦ - ٣٥)	٤	٣,٣
خبرة متوسطة (١٠ - ١٩)	٥٤	٤٣,٩	ذوي إتجاه محايد (٣٥ - ٤٤)	٨٨	٧١,٥
خبرة مرتفعة (١٩ فأكثر)	٣٢	٢٦,٠	ذوي إتجاه إيجابي (٤٤ فأكثر)	٣١	٢٥,٢

المصدر : جمعت وحسبت من بيانات عينة الدراسة *العدد = ١٢٣

ثانياً: المستوى المعرفي لمربي الأسماك المبحوثين:

يتضح من جدول رقم (٢) أن ما يقرب من نصف المبحوثين من صغار السن ، الأمر الذي يساعدهم كثيراً في أداء الأعمال المزرعية السمكية ، وأن غالبية المبحوثين ذوي مستوى تعليمي متوسط ومرتفع مما يساعد المبحوثين على الإستفادة من التوصيات الإرشادية السمكية ، هذا بالإضافة الى غالبية المبحوثين تزيد خبرتهم السمكية عن عشرون عاماً وبالتالي لديهم الخبرة الكافية بزراعة الأسماك ، وأن غالبية المبحوثين ذوي مستويات دخلية متوسطة مما يساعد كثيراً في تلبية مستلزمات الإنتاج السمكي ، وأن أكثر من نصف المبحوثين ذوي إتجاهات محايدة نحو الإستزراع السمكي الأمر الذي يتطلب الإهتمام بمربي الأسماك وإمدادهم بالمعارف والمهارات المرتبطة بتربية وتغذية ورعاية الأسماك وما يترتب على ذلك من تغيير إتجاهاتهم المحايدة الى الإتجاهات الإيجابية ، وبالتالي إمكانية تحقيق معدلات إستفادة عالية من التوصيات السمكية التي يقدمها الإرشاد الزراعي ، وما يترتب على ذلك من زيادة إنتاجهم ودخولهم .

جدول رقم (٢) : توزيع مربي الأسماك وفقاً لفئات مستواهم المعرفي

الخصائص	العدد*	%	الخصائص	العدد	%
١- المستوى المعرفي العام للمبحوثين فيما يرتبط بالإستزراع السمكي			**٣ - المستوى المعرفي للمبحوثين فيما يرتبط بتغذية الأسماك**		
ذوي مستوى معرفي منخفض (٥٥ - ٦٩)	٧٣	٥٩,٣	ذوي مستوى معرفي منخفض (١٤ - ١٩)	٧٣	٥٩,٣
ذوي مستوى معرفي متوسط (٦٩ - ٨٣)	٣٧	٣٠,١	ذوي مستوى معرفي المتوسط (١٩ - ٢٤)	٣٩	٣١,٨
ذوي مستوى معرفي مرتفع (٨٣ درجة فاكثر)	١٣	١٠,٦	ذوي مستوى معرفي مرتفع (٢٤ درجة فأكثر)	١١	٨,٩
٢- المستوى المعرفي للمبحوثين فيما يرتبط بتربية الأسماك			**٤- المستوى المعرفي للمبحوثين فيما يرتبط برعاية الأسماك**		
ذوي مستوى معرفي منخفض (٢١ – ٢٦)	٦٣	٦١,٢	ذوي مستوى معرفي منخفض (١١- ١٥)	٩١	٧٤,٠
ذوي مستوى معرفي متوسط (٢٦ – ٣١)	٥٦	٤٥,٥	ذوي مستوى معرفي متوسط (١٦ – ٢٠)	٢٧	٢٢,٠
ذوي مستوى معرفي مرتفع (٣١ - ٣٦)	٤	٣,٢	ذوي مستوى معرفي مرتفع (٢١ درجة فاكثر)	٥	٤,٠

المصدر : جمعت وحسبت من بيانات عينة الدراسة *العدد = ١٢٣

ثالثاً: العلاقات الإرتباطية بين كل من المتغيرات المستقلة المدروسة وبين المستوى المعرفي للمبحوثين كمتغير تابع:

جدول رقم (٣) : يوضح توزيع المتغيرات المستقلة وفقاً لعلاقاتها الإرتباطية البسيطة مع المستوى المعرفي للمبحوثين كمتغير تابع

المتغيرات المستقلة	معامل الإرتباط البسيط	المستوى المعنوي
أعمار المبحوثين	٠,٢٢٧	*
المستوى التعليمي للمبحوثين	٠,٠٧١	*
عدد أفراد الأسرة	٠,١٤٢	*
عدد أفراد الأسرة العاملين في الإستزراع السمكي	٠,١٣٨	*
عدد سنوات الخبرة في مجال الإستزراع السمكي	٠,١٦٩	*
الدخل السنوي من الإنتاج السمكي	٠,٣٨٣	**
السعة الحيازية المبحوثين	٠,٣٨٠	**
متوسط إنتاج القفص	٠,٤١١	**
مصادر المعرفة لدى مزارعي الأسماك	٠,١٥١	*
الإتجاه نحو مهنة الإستزراع السمكي	٠,٠٨٨	*

*معنوي عند المستوى الإحتمالي (٠,٠٥) **معنوى عند المستوى الإحتمالي (٠,٠١)

يتضح من جدول رقم (٣) وجود علاقة إرتباطية معنوية طردية بين متغير المستوى المعرفي لمربي الأسماك كمتغير تابع وبين كل من : أعمار المبحوثين، المستوى التعليمي، عدد أفراد الأسرة، عدد أفراد الأسرة العاملين في الإستزراع السمكي، الخبرة السمكية للمبحوثين، الدخل السنوي من الإنتاج السمكي، السعة الحيازية من الأقفاص العائمة، متوسط إنتاج القفص، مصادر المعلومات الزراعية السمكية للمبحوثين، إتجاه المبحوثين نحو الإستزراع السمكي ، وبهذا يمكن رفض الفرض الصفري أو الإحصائي وقبول الفرض الأصلي أو البحثي.

رابعاً: المشكلات التي تواجه مربي الأسماك المبحوثين من وجهه نظرهم:

ترجع أهمية دراسة المشكلات التي تواجه مربي الأسماك المبحوثين بهذه الدراسة إلى أن تضع أمام متخذي القرار صورة مكتملة عن أهم المعوقات التي تحول دون إكتمال الخدمات التي توجه إليهم، وتنعكس آثارها سلباً على

العملية الإنتاجية بالنسبة للأسماك، وبالتالي تؤثر على العوائد التي يمكن أن تعود على المربي نتيجة حل هذه المشكلات .

وقد أسفرت النتائج عن وجود ست مشكلات وهي المشكلات التي تكرر ذكرها من غالبية المبحوثين وكانت حسب ترتيبها كما يلي : عدم إنعقاد الدورات الخاصة بالإنتاج السمكي وقد ذكرها (٨٨,٦١ %) من المبحوثين، ثم جاء بعدها عدم تقديم القروض الميسرة لمربي الأسماك وقد ذكرها ايضاً (٨٨,٦١ %) من المبحوثين، يليها عدم توفير الأعلاف وخفض أسعارها وقد ذكرها (٨٢,٩٢%) من المبحوثين، يليها عدم توفير الإصبعيات وخفض أسعارهاوقد ذكرها (٧٤,٧٩ %) من المبحوثين، ثم جاء بعدها عدم توفير المواد الأولية في الأسواق المحلية وقد ذكرها (٦٩,١٠%) من المبحوثين، وجاء بالترتيب الأخير لتلك المشكلات التمسك بتطبيق الروتين الحكومي وقد ذكرها (٤٣%) من المبحوثين جدول رقم (١٦).

جدول رقم (٤) : ترتيب المشكلات التي تواجه مربي الأسماك المبحوثين وفقاً لأهميتها النسبية بالنسبة لهم

التسلسل	المشكلات	التكرار	النسبة المئوية
١	عدم إنعقاد الدروات الخاصة بالإنتاج السمكي	١٠٩	٨٨,٦١
٢	عدم تقديم القروض الميسرة لمربي الأسماك	١٠٩	٨٨,٦١
٣	عدم توفير الأعلاف ورخص أسعارها	١٠٢	٨٢,٩٢
٤	عدم توفير الإصبعيات ورخص أسعارها	٩٢	٧٤,٧٩
٥	عدم توفر المواد الأولية	٨٥	٦٩,١٠
٦	التمسك بتطبيق الروتين الحكومي	٥٣	٤٣,٠

المراجع:

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A Study of Some Variables Related to Knowledge Level of Fish Breeders of Gharraf River in Republic of Iraq

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ABSTRACT : This research is aims mainly to identify some of the variables associated with the level of knowledge of fish breeders in Gharraf River Basin in the Republic of Iraq.

We used personal interview to collect the research data of all fish farmers in floating cages in River Basin Garraf Iraq totaling 123 breeders, has represented the results using the following statistical analyies: Percentage, Percentage Distribution, Frequency tables, SMA, arithmetic mean and so as to

show the contrast between the respondents. It also used to check the veracity of the hypotheses research all of the simple correlation coefficient for Pearson to study the relations questionnaire, between independent variables and the dependent variable, using the computer a program spss (statistical Package for the Social Sciences), The research results showed the following:

First: personal characteristics and socio-economic and psychological connectivity fish breeders to respondents

Ages associated with the percentage of respondents between the ages of (25-39) years (48.8%) and (39-53) years (22%) and (53 years and over) about (29.2%) of the total fish farmers surveyed. As for the educational level of the respondents, it was clear from the results of the respondents that (30.9%) of the respondents with a low level of education, and (52%) with average educational level , while (17%) of the respondents; with high educationd level of the total fish farmers respondents; with regard to the number of family members it was clear from the results that (35%) of those with small families, and (57.7%) oflarge size those middel sized families while (7.3%) of those with families big Alndjemua of total respondents; with respect to the number of family members working in the field of aquaculture study it showed that the number of family members working in the aquaculture of the first category percentage (14.6%) and the number of family members working in the aquaculture of the second category amounted percentage (43.1%), and the number of family members working in the aquaculture of the third category amounted to (42.3%) of the total respondents, fish farmers, In connection with the expertise of the fish reaching the proportion of respondents, ranging from the number of years of experience between (1-11 years) (30.1%), and number of years of experience ranging between (11-21) years (43.9%), while the range of the number of years of experience (21 years and older) (26%) of the total respondents, fish farmers As far as annual income from fish production it showed that those who have a low income accounted to (1.6%), while middle income amounted to (76.4%) and high income earners accounted to (22%) of the total respondents, with respect to capacitive possessory floating fish cages the study showed that the percentage of fish farmers possession of respondents who have a small farm (56.1%), and medium (25.2%) and high (18.7%) of the total respondents; The cage is associated with an average production of fish, the study showed that the percentage of educators with low production amounted to (16.3%), while the percentage of those with average production (41.5%), while the percentage of people with high production (42.3%) of the total fish farmers surveyed; As for the sources of information farming and fishing to respondents, the study showed that the proportion of people with the level of the sources of low reached (13%), and the percentage of people with sources medium was (72.3%) while the percentage of people with sources of high (13.8%) of the total respondents, and for the direction of the respondents about the percentage of aquaculture fish farmers with a negative trend (3.35%) and neutral (71.5%) and positive (25.2%) of the respondents.

Second: the knowledge level of the fish farmers of respondents

The study showed that the proportion of people with low knowledge level was (59.3%) while the percentage of people with cognitive level average

(30.1%), and the proportion of people with a high level of (10.6%) of the total respondents to the fish farmers.

Third: Breeders respondents

The results showed a correlation significant positive correlation between the variable cognitive level for fish farmers as the dependent variable and between each of: Age of the respondents, educational level, number of family members, number of family members working in the aquaculture, experienced fish to respondents, the annual income from fish production, capacity of possessory of the cages, the average production of the cage, the sources of information for the fish farm respondents, the direction of the respondents towards aquaculture.

Fourth: the most important problems facing fish breeders' respondents from their point of view

The study showed the presence of six problems arranged as follows: sessions on production of fish (88.61%) of the respondents, to providers soft loans to fish farmers mentioned (88.61%) of the respondents providers feed and licenses (82.92%) of the respondents, provision of fingerlings licenses and their price mentioned (74.79%) of the respondents, provision of raw material (69.10%) of the respondents, and red tape mentioned by (43%) of the respondents.

معارف واتجاهات الزراع المبحوثين المتعلقة باستخدام الكمبوست كسماد عضوى ببعض قرى مركزى كفر الدوار وابو حمص ـ محافظة البحيرة

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معهد بحوث الارشاد الزراعى والتنمية الريفية – مركز البحوث الزراعية

الملخص : استهدف هذا البحث بصفة اساسية دراسة معارف واتجاهات الزراع المبحوثين المتعلقة باستخدام الكمبوست كسماد عضوى ببعض قرى مركزى كفر الدوار وابو حمص، وقد استلزم ذلك تحقيق الاهداف الفرعية التالية : (١) التعرف على بعض الخصائص المميزة للزراع المبحوثين ، (٢) التعرف على المستوى المعرفى للزراع المبحوثين فيما يتعلق باستخدام الكمبوست كسماد عضوى، (٣) التعرف على اتجاهات الزراع المبحوثين نحو التسميد بالكمبوست كسماد عضوى ، (٤) دراسة العلاقة الإرتباطية بين كل من المتغيرات المستقلة موضع الدراسة والمستوى المعرفى للزراع المبحوثين واتجاهاتهم المتعلقة باستخدام الكمبوست كسماد عضوى كمتغيرين تابعين، (٥) التعرف على بعض الفوائد الزراعية والبيئية لتدوير المخلفات الزراعية إلى كمبوست يستخدم فى التسميد من وجهة نظر الزراع المبحوثين .

وقد استخدم الأستبيان بالمقابلة الشخصية فى استيفاء البيانات الميدانية من عينة عمدية من الزراع الذين سبق لهم استخدام الكمبوست فى التسميد، بواقع ١٠٠ مبحوث من القرى موضع الدراسة، واستخدم فى عرض ومناقشة وتحليل النتائج كل من النسب المئوية، والمدى، والمتوسط الحسابى، والجداول التكرارية، ومعامل الإرتباط البسيط لبيرسون .

وقد خلصت الدراسة إلى العديد من النتائج البحثية أبرزها ما يلى :

١- بالنسبة للمستوى المعرفى للزراع المبحوثين فيما يتعلق باستخدام الكمبوست كسماد عضوى تبين ما يلى : ان القيم المعبرة عن المستوى المعرفى للمبحوثين تراوحت بين ٢٢ ــ ٣٠ درجة بمتوسط حسابى قدرة ٢٦.٧٨ درجة، وقد بلغت نسبة المبحوثين ذوى المستوى المعرفى الضعيف ١٠ %، والمتوسط ٤٤ %، والجيد ٤٦ % من جملة المبحوثين . كما اوضحت النتائج قيام علاقة إرتباطية مغزوية عند المستوى الأحتمالى ٠.٠٥ بين المستوى المعرفى للمبحوثين فيما يتعلق باستخدام الكمبوست كسماد عضوى كمتغير تابع وبين كل من المتغيرات المستقلة التالية: مدة استخدام المبحوث للكمبوست فى التسميد، الحالة التعليمية للمبحوث .

٢- بلغت نسبة المبحوثين فى فئة الاتجاهات الأيجابية نحو التسميد بالكمبوست كسماد عضوى ٥١ % والمحايدة ٣٣%، والسلبية ١٦% من جملة الزراع المبحوثين، كما أوضحت النتائج قيام علاقة إرتباطية عكسية ومغزوية عند المستوى الأحتمالى ٠.٠١ بين اتجاهات المبحوثين نحو استخدام الكمبوست كسماد عضوى وكل من المتغيرات التالية : عمر المبحوث ، مدة العمل المزرعى، كما أوضحت النتائج قيام علاقة إرتباطية طردية مغزوية عند المستوى الاحتمالى ٠.٠٥ بين اتجاهات المبحوثين نحو استخدام الكمبوست كسماد عضوى ومتغير مدة استخدام الكمبوست فى التسميد.

٣- أوضحت النتائج البحثية وجود بعض الفوائد الزراعية كمردود لتدوير المخلفات الزراعية إلى كمبوست يستخدم فى التسميد والمتمثلة فى الأتى وفقا لتكرارها تنازليا : تحسين خواص التربة ١٠٠ %، ارتفاع جودة

المنتج الزراعى وزيادة الأنتاجية (٧٦ %)، سرعة الأنبات (٥٦ %)، تقليل الأصابة بامراض الجذور (٢٥ %) .

كما أشارت النتائج إلى وجود فوائد بيئية لتدوير المخلفات الزراعية إلى كمبوست يستخدم فى التسميد والمتمثلة فى الأتى وفقا لتكرارها تنازليا : التخلص من المخلفات الزراعية بطريقة صحية وآمنه (٩٨ %)، الأستفادة من المخلفات الزراعية (٩٦ %)، تقليل التلوث البيئى وانتشار الحشرات (٨٧ %) .

المشكلة البحثية :

يعانى العالم اليوم العديد من المشكلات المتفاقمة والتى تتصدرها مشكلة التلوث البيئى، والتى خلفها عبث وتجنى الانسان على الحياة الطبيعية، وتعانى مصر من هذه الظاهرة خاصة بالمناطق الريفية وهو ما يؤثر بطرق مباشرة وغير مباشرة على المناطق الحضرية، ويزداد خطر هذا التلوث مع الزيادة المستمرة للسكان وما ينتج عنها من زيادة الاستهلاك وتنوع المخلفات والنفايات الزراعية والصناعية والمنزلية، وخاصة فى ظل غياب الوعى البيئى، وقصور الامكانيات والاعتمادات اللازمة للاستفادة من هذه المخلفات، او السيطرة على هذا التلوث (صالح وأخرون ، ٢٠١٢) .

وتقدر كمية المخلفات الحقلية النباتية فى مصر من أحطاب وقش حوالى (٢٤) مليون طن، (عبد المقصود ،٢٠٠٤) ، ومما لاشك فية ان وجود المخلفات الزراعية وتراكمها بمعدلات عالية وانخفاض الوعى البيئى لدى غالبية الريفيين، وعدم التخلص الآمن من هذه المخلفات، حيث يتم التخلص منها عن طريق الحرق المباشر، أو اللإلقاء فى المجارى المائية أو فى الشوارع (بندارى ، ٢٠٠٦)، سوف يؤدى إلى العديد من المشاكل الصحية والأقتصادية.

وتمثل البقايا النباتية ثروة عظيمة لو استغلها الانسان الاستغلال الامثل، ففى الموسم الزراعى الشتوى تكون معظم هذه المخلفات الزراعية مستغلة فى الانشطة الزراعية مثل تبن القمح والشعير حيث يستغلها المزارعين فى تغذية الحيوانات كأعلاف جافة، أما المخلفات النباتية الناتجة عن الموسم الزراعى الصيفى كحطب القطن أو قش الارز أو حطب الذرة فيتخلص المزارعين من معظمها عن طريق الحرق المباشر وربما يرجع ذلك لانخفاض الوعى البيئى لدى غالبيتهم .

وقد ورد فى تقرير البنك الدولى للشئون البيئية (موقع ستار تايمز، ٢٠١٢) ان حرق المخلفات الزراعية وخاصة قش الأرز ـ حيث يتم حرق ما يقرب من ٤ مليون طن من قش الارز خلال سبتمبر وأكتوبر من كل عام ــ مسئول عن حدوث ازمة تلوث الهواء الحادة بنسبة (٤٢ %)، وزيادة نسبة مرضى حساسية الصدر من ٨% إلى ١٠ %، ويؤدى الدخان وما يحتوى عليه من عوالق إلى التهاب الأغشية المخاطية المبطنة للعين، والتهاب الجيوب الأنفية والحنجرة، وتمتد الخسائر لتشمل قطاعات حيوية تشكل روافد تضخ فى الدخل القومى كالقطاع السياحى والصناعى فمع تكرار ظاهرة السحابة السوداء الناتجة عن حرق قش الارز والأحطاب سوف ترتفع الخسائر المتوقعة فى هذه الصناعات لتصل إلى أكثر من ١٧ مليار جنية .

وقد لوحظ من خلال الزيارات الميدانية للمناطق الريفية ان بعض المزارعين يتجهوا للأستفادة من قش الأرز وتحويلة لسماد عضوى بعد اضافة بعض المخصبات أو فضلات الحمام إلية وهو ما يعرف بالكمبوست، وذلك لتجنب المساءلة القانونية من جانب، والتخلص من المخلفات الزراعية (قش الأرز) بطريقة آمنه من جانب أخر، ولهذا برزت عدة تساؤلات تمثلت فى ماهى الخصائص المميزة للزراع المبحوثين بالقرى موضع الدراسة، وماهو مستواهم المعرفى فيما يتعلق باستخدام الكمبوست كسماد عضوى، وما اتجاهاتهم نحو استخدام الكمبوست كسماد عضوى، وما هى مزايا استخدام الكمبوست البيئية والزراعية من وجهة نظر الزراع المبحوثين.

الاهداف البحثية :

يستهدف هذا البحث بصفة رئيسية دراسة معارف واتجاهات الزراع المتعلقة باستخدام الكمبوست كسماد عضوى ببعض قرى مركزى أبو حمص وكفر الدوار ـ محافظة البحيرة . وذلك من خلال تحقيق الاهداف الفرعية التالية:

١- التعرف على بعض الخصائص المميزة للزراع المبحوثين .

٢- التعرف على المستوى المعرفى للزراع المبحوثين فيما يتعلق باستخدام الكمبوست كسماد عضوى .

٣- التعرف على اتجاهات الزراع المبحوثين نحو التسميد بالكمبوست كسماد عضوى .

٤- دراسة العلاقة الإرتباطية بين كل من المتغيرات المستقلة موضع الدراسة والمستوى المعرفى للزراع المبحوثين واتجاهاتهم المتعلقة باستخدام الكمبوست كسماد عضوى كمتغيرين تابعين .

٥- التعرف على بعض الفوائد الزراعية والبيئية لتدوير المخلفات الزراعية إلى كمبوست يستخدم فى التسميد الزراعى من وجهة نظر الزراع المبحوثين .

الأطار النظرى:

اولا : مفهوم المعرفة :

يقصد بالمعرفة أنها ما استقر فى ذهن الانسان من معانى وخبرات يمكن اكتسابها عن طريق حواسة المختلفة (السيد ، ١٩٩٠)، ويقول جون لوك، أساس المعرفة هو الخبرة والتأمل وبدونها لا يمكن وجود فكر لدى الانسان (خير الدين، ١٩٧٩)

وقد ذكر أبو حطب واخرون (١٩٨٧) أن استجابة الفرد للأشياء والاشخاص من حولة تتأثر إلى حد كبير بالطريقة التى ينظر بها الفرد إلى هذه الأشياء والأشخاص بعالمة المعرفى . ولزيادة معارف الزراع يجب أن تتوافر عدة شروط منها : (١) ان تكون المعلومة نتيجة أبحاث علمية وخبرة سبق أختبار صلاحيتها ومناسبتها للمنطقة وينتج عن تنفيذها تغيرا ملموسا ، (٢) ان تكون المعلومة سهلة الفهم بالنسبة للمزارع وسهلة التطبيق بحيث لا تكون مكلفة . (٣) ان يشعر المزارع بحاجتة إلى مثل هذه المعلومات وأن تقدم له فى الوقت المناسب. ولقد أتفق كلا من عمر واخرون (١٩٧١)، (العادلى ، ١٩٧٣)، (الخولى وأخرون ، ١٩٨٤)، (عمر ، ١٩٩٢) على أن المعرفة هامة جدا للفرد (المزارع) خلال مراحل عملية التبنى فلكى يتبنى الفرد أى فكرة جديدة لابد وأن يمر خلال خطوات تتضمن زيادة الوعى أو التنبية مع القدرة على التقييم والتجريب ثم مرحلة التبنى .

ويذكر حسن (١٩٧١) أن المعرفة فى شمولها تتضمن معارف علمية ومعارف غير علمية، وتقوم التفرقة بين النوعيين على اساس قواعد المنهج وأساليب التفكير التى تتيح تحصيل المعارف ويمكن تقسيم المعرفة إلى ثلاثة أنواع هى : (١) المعرفة الحسية : وهى المعرفة التى تعتمد على مجرد ملاحظة بسيطة تقف عند مستوى الادراك الحسى العادى دون أن تتجة إلى أيجاد الصلات أو تسعى إلى ادراك العلاقات القائمة بين الظواهر . (٢) المعرفة الفلسفية : وهى المرحلة التالية من مراحل التفكير، فوراء الامور الواقعية المكتسبة بالملاحظة مسائل أعم ومطالب أبعد تعالج بالعقل وحدة، وتتناول الفلسفة هذه المسائل بالدراسة والبحث ولا تقتصر على العالم الطبيعى وحدة بل وترقى إلى العالم الفيزيقى فتبحث عن الوجود وعن علتة وعن صفات الوجود وكثير من الوسائل التى تتصل بمعرفة وحدة واثبات وجودة . (٣) المعرفة العلمية : وهى تقوم على الاسلوب الاستقرائى الذى يعتمد على الملاحظة المنظمة للظواهر وفرض الفروض وأجراء التجارب وجمع البيانات وتحليلها للتأكد من صحتها .

وتأخذ المعرفة أشكالا متعددة حددها (Rogers and Shoemaker,1972) ، فى ثلاثة اشكال هى : (١) الوعى أى وعى الفرد بوجود شىء ما . (٢) معرفة الكيفية أى معرفة المعلومات الضرورية لاستخدام الشىء . (٣) معرفة المبادىء التى يقوم عليها هذا الشىء .

ثانيا : الأتجاة كمحدد للسلوك :

يعرف صالح واخرون (٢٠٠٤) الأتجاة على أنه " حالة من الأستعداد العقلى والعصبى تنحو بالفرد ليتفاعل ايجابيا أو سلبيا مع أى مثير فى بيئتة النفسية، سواء كان هذا المثير ماديا أو معنويا بناءا على خبرات شخصية سابقة مباشرة أو غير مباشرة ومتكررة بين الفرد وبين المثير موضوع الأتجاة . وتتخذ عملية تغير الأتجاة مظهرين أساسيين هما تغير الأتجاة حيال موضوع من مؤيد إلى معارض أو موافق إلى غير موافق أو العكس، أى أن التغيير هنا يكون فى درجة أيجابية أو سلبية الاتجاة أو اذا جاز استخدام التعبير (وجهة الاتجاة)، والمظهر الثانى لتغير الأتجاة هو تأكيد ايجابيتة أو سلبيتة حيال موضوع معين، وبنفس المنطق قد يحدث التغير فى اتجاة وتأكيد مدى موافقة الشخص أو قبوله لموضوع معين، (السلمى ، ١٩٧٦)، ويذكر سلامة وعبد الغفار (١٩٧٢) ان أهم طرق تعديل وتغير الأتجاة هى : (أ) تغيير الفرد للجماعة التى ينتمى اليها : حيث أن عضوية الفرد فى جماعة ما تؤثر فى تحديد أتجاهة ،(ب) تغيير الموقف : حيث أن اتجاهات الفرد تتغير بتغير المواقف التى يمر بها ،(ج) كما أن هناك التغير القسرى فى السلوك : فقد تضطر الظروف الافراد لاتخاذ أتجاها معاديا، (د) وأخر طرق تعديل الأتجاة هو الاتصال المباشر بموضوع الأتجاة : والذى يؤدى إلى تغير أتجاة الفرد.

ثالثا : الكمبوست :

(١) مفهومة :

الكمبوست كلمة تعنى بالعربية السباخ أو السماد البلدى الصناعى ، وسمى كمبوست لأنه ناتج عن عملية تخمير هوائـــى (composting) للمخلفات النباتية مثل (قش الأرز ـ والأحطاب ـ والتبن ـ وعروش الخضر ونواتج تقليم الاشجار)، أو المخلفات العضوية الحيوانية مثل(السبلة ـ الروث ـ سبلة الدواجن ـ زرق الطيور)، أو خليط من المخلفات النباتية والحيوانية لذلك فإن الكمبوست يشبة فى تصنيعة السماد البلدى، (موقع وزارة الزراعة واستصلاح الاراضى ، الكمبوست) .

(٢) فوائد الكمبوست الزراعية والبيئية :

تشتد الحاجة إلى اضافة الاسمدة العضوية للأراضى الزراعية القديمة وكذلك الأراضى المستصلحة حديثا لرفع خصوبتها، حيث تتحلل المواد العضوية بسرعة خاصة فى الأراضى الصحراوية، ويمكن اجمال فوائد الكمبوست الزراعية والبيئية فى التالى : يعتبر الكمبوست مصدر هام للنتروجين خاصة بالنسبة للزراعة العضوية وامداد التربة والنباتات بالمغذيات الضرورية وتحسين قوام التربة الزراعية ويزيد من قدرة التربة على الأحتفاظ بالماء ويقلل الأصابة بامراض الجذور (النيماتودا) ويحسن من درجة حرارة التربة ويساعد على معادلة (pH) درجة الحموضة والقلوية ويساعد على تهوية التربة ويساعد التربة فى مقاومة الانجراف والتعرية ويحسن من جودة المنتج الزراعى ويفضل للمحاصيل التصديرية عالية الجودة وكذلك يساعد على ترشيد استخدام الأسمدة الكيماوية ويساعد فى تدوير المخلفات الزراعية وتقليل الأضرار الناتجة من تراكم وحرق المخلفات النباتية وخاصة قش الأرز وتقليل أنتشار الأمراض الناتجة من التسميد الكيماوى والحد من انتشار الأفات الزراعية وأكساب البيئة المحلية مظهر جماليا، (موقع وزارة الزراعة واستصلاح الاراضى، الكمبوست)

الاسلوب البحثى

أولا: التعريفات ألأجرائية للمصطلحات البحثية :

١- المستوى المعرفى للزراع المبحوثين فيما يتعلق باستخدام الكمبوست كسماد عضوى : يقصد به فى هذه الدراسة مدى المام المبحوثين ببعض المعارف المتعلقة باستخدام الكمبوست كسماد عضوى، ويتم التعبير عنة بقيمة رقمية يتم التوصل اليها من اجابات المبحوثين على عشر أسئلة متعلقة بهذا الشأن، حيث يعطى المبحوث ثلاث درجات فى حال (يعرف)، ودرجتين فى حالة (لحد ما)، ودرجة واحدة فى حالة (لا يعرف)، وبذلك يتراوح المدى النظرى المعبر عن المستوى المعرفى للزراع المبحوثين المرتبطة باستخدام الكمبوست كسماد عضوى بين (١٠ – ٣٠) درجة .

٢- اتجاهات الزراع المبحوثين نحو التسميد بالكمبوست كسماد عضوى : ويقصد به فى هذا البحث مدى استجابة المبحوث المؤيدة أو المحايدة أو الرافضة حيال (٢٠ عبارة) تعكس اتجاهاتهم نحو التسميد بالكمبوست كسماد عضوى، معبرا عن ذلك بقيمة رقمية، وقد أعطيت ثلاث درجات للموافقة، ودرجتان للمحايدة، ودرجة واحدة فى حالة الرفض، هذا بالنسبة للعبارات الايجابية، أما فى حالة العبارات السلبية، أعطيت ثلاث درجات للرفض، ودرجتان فى حالة سيان، ودرجة واحدة فى حالة الموافقة، ولقد تراوحت القيمة النظرية بين (٢٠ – ٦٠) درجة .

ثانيا : المتغيرات والفروض البحثية :

أ – المتغيرات البحثية : تم تحديد المتغيرات البحثية فى ضوء طبيعة واهداف الدراسة، وما امكن الأطلاع علية من المراجع والكتابات العلمية فى مجال الأرشاد الزراعى، والملاحظة الميدانية وذلك على النحو التالى :

المتغيرات المستقلة : وتتمثل فى عمر المبحوث، والحالة التعليمية للمبحوث، وحجم الحيازة المزرعية للمبحوث، ومدة العمل المزرعى، ومدة استخدام الكمبوست فى التسميد .

المتغيرات التابعة : وتتمثل فى المستوى المعرفى للمبحوثين فيما يتعلق باستخدام الكمبوست كسماد عضوى، واتجاهاتهم نحو التسميد بالكمبوست كسماد عضوى .

ب ــ الفروض البحثية : الفرض البحثى عبارة عن قضية احتمالية تقرر العلاقة بين متغيرين أو أكثر والفرض يعد تفسيرا مؤقتا لظاهرة ما، ومن ثم فإن صياغة الفروض تعد مطلبا ضروريا لتوجية البحث العلمى (محمد ، ١٩٨٣) ، وبناءا على ذلك وفى ضوء اهداف هذه الدراسة فقد تمثلت الفروض النظرية فيما يلى :

١- توجد علاقة إرتباطية مغزوية بين المستوى المعرفى للمبحوث فيما يتعلق باستخدام الكمبوست كسماد عضوى كمتغير تابع وبين كل من: عمر المبحوث، والحالة التعليمية للمبحوث، وحجم الحيازة الارضية المزرعية، ومدة العمل الزراعى، ومدة استخدام الكمبوست فى التسميد كمتغيرات مستقلة، ويتم اختبار هذا الفرض فى صورته الصفرية.

٢- توجد علاقة إرتباطية مغزوية بين اتجاهات الزراع المبحوثين نحو التسميد بالكمبوست كسماد عضوى كمتغير تابع وبين كل من: عمر المبحوث، الحالة التعليمية للمبحوث، وحجم الحيازة الارضية المزرعية، ومدة العمل الزراعى، ومدة استخدام الكمبوست فى التسميد كمتغيرات مستقلة، ويتم اختبار هذا الفرض فى صورته الصفرية.

ثالثا: منطقة البحث والشاملة والعينه :

١- منطقة البحث : تم اجراء هذا البحث فى اربعة قرى وهى قرية كوم البركة، وقرية منشية عامر بمركز كفر الدوار بمحافظة البحيرة، وقرية ديرآمس وقرية الجرادات بمركز ابو حمص بمحافظة البحيرة، ويبلغ أجمالى مساحة الزمام المنزرع بهذه القرى على التوالى (٣٣٣٠، ١٨٠٠،١٥٣٩،١٦١٧ فدان)، ويبلغ أجمالى عدد الحائزين بالقرى

الأربع موضع الدراسة على الترتيب كالتالى : (١٤٩٠، ١١٥٠، ٩٨٤، ١٢٩٠ حائز)، ووقع الأختيار على تلك القرى كمنطقة لأجراء هذا البحث لعدة أسباب لعل أبرزها : (١) أن هذه القرى تقع فى نطاق البحث والأهتمام لفرع معهد بحوث الأرشاد الزراعى والتنمية الريفية بمحافظة الأسكندرية، (٢) وجود كميات كبيرة من المخلفات الزراعية بتلك القرى وبصفة خاصة قش الأرز، (٣) اتجاة بعض المزارعين إلى تدوير المخلفات المزرعية وتحويلها إلى كمبوست واستخدامها فى التسميد الزراعى.

٢- الشاملة والعينة : ونظرا لعدم وجود حصر دقيق (رسمى) للزراع الذين قاموا بتحويل المخلفات الزراعية الى كمبوست يستخدم فى التسميد، فأضطرت الباحثة الى اختيار عينه عمديه معايير اختيارها تنحصر فى: (١) ان يكون المبحوث ممن خاضوا تجربة تحويل المخلفات الزراعية الى كمبوست. (٢) ان يكون المبحوث ممن استخدموا الكمبوست فى عملية التسميد. وفى ضوء هذين المعيارين بلغ قوام العينه التى امكن تجميع البيانات منها فى منطقة البحث ١٠٠ مبحوث بالقرى الاربع موضع الدراسة بواقع ٢٥ مبحوث من كل قرية، واسغرقت عملية جمع البيانات البحثية من هؤلاء المبحوثين قرابة ثلاثة اشهر.

رابعا : جمع وتحليل البيانات :

وفقا لطبيعة وأبعاد مشكلة هذا البحث وأهدافه، فقد اعتمد على كلا من المصادر الأولية والثانوية للحصول على البيانات والمعلومات الخاصة بهذا البحث، وقد تم إستيفاء البيانات الميدانية باستخدام استمارة الأستبيان وتم إعدادها لهذا الغرض بعد إجراء اختبار مبدئى على ٢٠ مزارع من خارج عينة البحث.

وتم تحليل البيانات البحثية من خلال المرور بعدة مراحل بدءا بالمراجعة اليومية للاستمارات الأستبيانية، تم تفريغ البيانات وتبويبها وجدولتها وتصنيفها وفقا للأهداف البحثية، وقد تم الأستعانه بكل من النسب المئوية، والمدى، والمتوسط الحسابى، والجداول التكرارية فى وصف وتصنيف الزراع المبحوثين، كما تم الاستعانه بمعامل الإرتباط البسيط لبيرسون للتحقق من وجود علاقات إرتباطية بين المتغيرات التابعة والمستقلة والمتضمنة فى الفروض البحثية.

النتائج البحثية :

أولا : بعض الخصائص المميزة للزراع المبحوثين :

١- العمر : اوضحت النتائج البحثية أن أعمار المبحوثين تتراوح بين ٢٥ – ٧٠ سنة، بمتوسط حسابى قدرة ٤٤.٥٢ سنة، ونسبة من تجاوز أعمارهم المتوسط الحسابى ٤٩ %، وبتصنيف المبحوثين فقد بلغت نسبة من تقل أعمارهم عن ٤١ سنة ٣٩ %، ومن تتراوح أعمارهم بين ٤١ – ٥٦ سنة ٤٨ %، ومن يبلغ أعمارهم أكبر من ٥٦ سنة ١٣ % من جملة المبحوثين، (جدول رقم ١).

(جدول رقم ١) : توزيع المبحوثين وفقا لفئات أعمارهم

فئات العمر	العدد	%
صغير (٢٥-٤٠)	٣٩	٣٩
متوسط (٤١-٥٦)	٤٨	٤٨
كبير (٥٧-٧٠)	١٣	١٣
المجموع	**١٠٠**	**١٠٠**

٢- الحالة التعليمية للمبحوثين : أوضحت النتائج البحثية أن ٤ % من أجمالى المبحوثين أتسم بالأمية، وبلغت نسبة الملمين بالقراءة والكتابة ١٨ %، ونسبة الحاصلين على الشهادة الأبتدائية والأعدادية ٢٧ %، ونسبة الحاصلين على الشهادة المتوسطة والجامعية ٥١ %، (جدول رقم ٢).

ومما سبق يتضح ارتفاع المستوى التعليمى للمبحوثين ومؤدى ذلك أمكانية قبول أو تبنى فكرة تحويل المخلفات المزرعية إلى كمبوست كاتجاه مستحدث نحو تدوير المخلفات المزرعية والتخلص منها بطريقة آمنه تفيد البيئة والأرض الزراعية .

(جدول رقم ٢) : توزيع المبحوثين وفقا لفئات حالتهم التعليمية

فئات الحالة التعليمية	العدد	%
امي	٤	٤
يقرأ ويكتب	١٨	١٨
ابتدائي	٢٢	٢٢
أعدادي	٥	٥
شهادة متوسطة	٤٢	٤٢
شهادة جامعية	٩	٩
المجموع	**١٠٠**	**١٠٠**

٣-الحيازة الأرضية المزرعية : أوضحت النتائج البحثية أن الحيازة الأرضية المزرعية للمبحوثين تتراوح بين ٦ – ١٢٧ قيراط ، بمتوسط حسابى قدرة ٥١.٤٥ قيراط، وقد تجاوز المتوسط ٣٤ % من مجموع المبحوثين، وقد بلغت نسبة ذوى الحيازات الصغيرة ٤٠ %، والمتوسطة ٥١ %، والكبيرة ٩ %، (جدول رقم ٣)، ومؤدى ذلك أن أكثر من نصف المبحوثين (٦٠ %) يحوزوا من ٢ – ٥ فدان، الأمر الذى يشير إلى كبر حجم المخلفات المزرعية المتخلفة عن النشاط الزراعى الحقلى الذى يقوم به هؤلاء المبحوثين، مما يستدعى ضرورة الأهتمام بالمبحوثين وتحفيزهم وتدريبهم على كيفية الأستفادة السليمة من المخلفات المزرعية والتخلص منها بطريقة آمنه وصحية ومفيدة للبيئة وللأرض الزراعية.

(جدول رقم ٣) : توزيع المبحوثين وفقا لفئات الحيازة الارضية المزرعية

فئات الحيازة (القيراط)	العدد	%
صغير (٦-٤٦)	٤٠	٤٠
متوسط (٤٧-٨٧)	٥١	٥١
كبير (٨٨-١٢٧)	٩	٩
المجموع	**١٠٠**	**١٠٠**

٤- مدة العمل المزرعى : أتضح من النتائج البحثية أن المدة التى عمل بها المبحوثون بالنشاط المزرعى تتراوح بين ٥ – ٦٠ سنة، بمتوسط حسابى قدرة ٣٣.٥٧ سنة، وقد تجاوز المتوسط ٥١ % من أجمالى المبحوثين، وقد بلغت نسبة ذوى مدة العمل المزرعى القليلة ١٤ %، والمتوسطة ٦٩ %، والكبيرة ١٧ % (جدول رقم ٤)،

ويوضح ذلك أن أكثر من ثلاثة أرباع المبحوثين (٨٦ %) يقعون فى فئتى متوسطى و كبيرى مدة العمل المزرعى، ومؤدى ذلك توافر الخبرة المزرعية لدى هؤلاء المبحوثين لكيفية التعامل مع المخلفات المزرعية وتدويرها بطرق صحيحة وآمنه حفاظا على البيئة وصحة الأنسان والحيوان.

(جدول رقم ٤) : توزيع المبحوثين وفقا لفئات مدة العمل المزرعى

فئات مدة العمل المزرعي	العدد	%
قليلة (٥-٢٣)	١٤	١٤
متوسطة (٢٤-٤٢)	٦٩	٦٩
كبيرة (٤٣-٦٠)	١٧	١٧
المجموع	**١٠٠**	**١٠٠**

٥- مدة استخدام الكمبوست فى التسميد الزراعى : أظهرت النتائج البحثية أن مدة استخدام المبحوثين للكمبوست فى التسميد الزراعى تتراوح بين ١ – ١٠ سنة، بمتوسط حسابى قدرة ٣.٦٣ سنة، وبلغت نسبة المبحوثين الذين تجاوزوا المتوسط الحسابى ٤٣ %، ونسبة ذوى المدة القليلة فى استخدام الكمبوست فى التسميد الزراعى ٥٧ %، والمتوسطة ٣٧ %، والكبيرة ٦ %، (جدول ٥)، وهذا يوضح أن ٤٣ % من اجمالى المبحوثين يستخدمون الكمبوست فى التسميد الزراعى لمدة تتراوح بين ٤ – ١٠ سنة، ومؤدى ذلك أن ما يقرب من نصف المبحوثين لديهم من القناعات ما يدفعهم إلى الأستمرار فى تدوير المخلفات الزراعية إلى كمبوست واستخدامة فى التسميد الزراعى.

(جدول رقم ٥) : توزيع المبحوثين وفقا لفئات مدة استخدامهم للكمبوست فى التسميد الزراعى

فئات مدة الاستخدام	العدد	%
قليلة (١-٣)	٥٧	٥٧
متوسطة (٤-٦)	٣٧	٣٧
كبيرة (٧-١٠)	٦	٦
المجموع	**١٠٠**	**١٠٠**

ثانيا : المستوى المعرفى للزراع المبحوثين فيما يتعلق باستخدام الكمبوست كسماد عضوى :

تراوحت القيم المعبرة عن المستوى المعرفى للمبحوثين بين ٢٢ – ٣٠ درجة بمتوسط حسابى قدرة ٢٦.٧٨ درجة، وقد بلغت نسبة المبحوثين ذوى المستوى المعرفى الضعيف ١٠ %، والمتوسط ٤٤ %، والجيد ٤٦ % من جملة المبحوثين، ويظهر ذلك أن غالبية المبحوثين ٩٠ % يقعوا فى فئتى المستوى المعرفى المتوسط والجيد الامر الذى يؤكد المامهم بفوائد الكمبوست الزراعية فى رفع خصوبة الأرض وامكانية استخدامة كسماد عضوى،(جدول رقم ٦).

(جدول رقم ٦) : توزيع المبحوثين وفقا لفئات مستواهم المعرفى المرتبطة باستخدام الكمبوست كسماد عضوى

فئات المستوي المعرفي (درجة)	العدد	%
ضعيف (٢٢-٢٤)	١٠	١٠
متوسط (٢٥-٢٧)	٤٤	٤٤
جيد (٢٨-٣٠)	٤٦	٤٦
المجموع	**١٠٠**	**١٠٠**

ثالثا : المتغيرات المرتبطة بالمستوى المعرفى للمبحوثين فيما يتعلق باستخدام الكمبوست كسماد عضوى :

أوضحت النتائج البحثية أنه من بين خمسة متغيرات مستقلة تضمنها الفرض البحثى الأول أن متغير المستوى المعرفى للمبحوثين فيما يتعلق باستخدام الكمبوست كسماد عضوى، كمتغير تابع يرتبط طرديا ومغزويا عند المستوى الاحتمالى ٠.٠٥ مع متغيرى، الحالة التعليمية للمبحوث، ومدة استخدام الكمبوست فى التسميد الزراعى، حيث بلغت قيم معامل الإرتباط (.١٨٢)،(.١٧٠) على التوالى.

فى حين لم يثبت وجود علاقة إرتباطية مغزوية عند المستوى الاحتمالى ٠.٠٥ مع باقى المتغيرات المستقلة المتمثلة فى: عمر المبحوث، الحيازة الارضية المزرعية للمبحوث، مدة العمل المزرعى، حيث بلغت قيم معامل الإرتباط على التوالى (.٠٩٤، .٠١٦، .٠٥٣)،(جدول رقم ٧) .

(جدول رقم ٧) :العلاقات الإرتباطية بين المتغيرات البحثية المدروسة

المتغيرات البحثية	متغير المستوي المعرفي المرتبطة باستخدام الكمبوست كسماد عضوي		متغير اتجاهات نحو التسميد بالكمبوست كسماد عضوي	
	معامل الارتباط	مستوي المعنوية	معامل الارتباط	مستوي المعنوية
العمر	.٠٩٤	غير مغزوى	-.٤٥١	.٠١
الحيازة الارضية المزرعية	.٠١٦	غير مغزوى	.٠٨٢	غير مغزوى
مدة العمل المزرعي	.٠٥٣	غير مغزوى	-.٢٢٦	.٠١
مدة استخدام الكمبوست في التسميد	.١٨٢	.٠٥	.١٨٤	.٠٥
الحالة التعليمية	.١٧٠	.٠٥	.١٧٨	.٠٥

تحقيق الفرض الأول : فى ضوء التحليل الإرتباطى فأنه يمكن قبول الفرض البحثى الأول جزئيا وبالتالى يمكن تعديل صياغتة على النحو التالى " توجد علاقة إرتباطية مغزوية بين المستوى المعرفى للمبحوثين المرتبطة باستخدام الكمبوست كسماد عضوى ومتغيري ، الحالة التعليمية للمبحوث، ومدة استخدام الكمبوست فى التسميد الزراعى ".

رابعا : اتجاهات المبحوثين نحو االتسميد بالكمبوست كسماد عضوى :

تراوحت القيم الرقمية المعبرة عن اتجاهات المبحوثين نحو التسميد بالكمبوست كسماد عضوى بين ٤٢ – ٥٨ درجة بمتوسط حسابى قدرة ٥١.٥٢ درجة، وقد بلغت نسبة ذوى الاتجاهات السلبية ١٦ %، والمحايدة ٣٣ %، والإيجابية ٥١ %، (جدول رقم ٨) .

الأمر الذى يوضح إنخفاض نسبة ذوى الاتجاهات السلبية بين المبحوثين وارتفاع نسبة ذوى الاتجاهات المحايدة والإيجابية، ومؤدى ذلك قبول فكرة استخدام الكمبوست فى التسميد كسماد عضوى وبديل للسماد البلدى لدى غالبية المبحوثين (٨٤ %)، (جدول رقم ٨).

(جدول رقم ٨) : توزيع المبحوثين وفقا لفئات اتجاهاتهم نحو التسميد بالكمبوست كسماد عضوى

فئات الاتجاه (درجة)	العدد	%
سلبي (٤٢-٤٦)	١٦	١٦
محايد (٤٧-٥٢)	٣٣	٣٣
ايجابي (٥٣-٥٨)	٥١	٥١
المجموع	**١٠٠**	**١٠٠**

خامسا : المتغيرات المرتبطة باتجاهات المبحوثين نحو التسميد بالكمبوست كسماد عضوى :

أوضحت النتائج البحثية أنه من بين خمسة متغيرات تضمنها الفرض البحثى الثانى أن متغير اتجاهات المبحوثين نحو التسميد بالكمبوست كسماد عضوى كمتغير تابع يرتبط طرديا ومغزويا عند المستوى الاحتمالى ٠.٠٥ مع متغيرين مستقلين هما الحالة التعليمية للمبحوث، ومدة استخدام المبحوثين للكمبوست فى التسميد الزراعى، حيث بلغت قيمة معامل الإرتباط على التوالى (.١٨٤)،(.١٧٨).

بينما اوضحت النتائج قيام علاقة إرتباطية عكسية ومغزوية عند المستوى الاحتمالى ٠.٠١ مع متغيرى: عمر المبحوث، ومدة العمل المزرعى للمبحوث، حيث بلغت قيم معامل الإرتباط (-.٤٥١)،(-.٢٢٦) على التوالى، فى حين لم تثبت وجود علاقة إرتباطية مغزوية عند المستوى الاحتمالى ٠.٠٥ مع متغير واحد وهو حجم الحيازة الارضية المزرعية، (جدول رقم ٧) .

تحقيق الفرض الثانى: فى ضوء نتائج التحليل الإرتباطى فأنه يمكن قبول الفرض الثانى جزئيا حيث يمكن صياغة الفرض البحثى على النحو التالى: " توجد علاقة إرتباطية مغزوية بين اتجاهات المبحوثين نحو التسميد بالكمبوست كسماد عضوى وكل من المتغيرات التالية: عمر المبحوث، الحالة التعليمية للمبحوث، مدة العمل المزراعى، مدة استخدام المبحوث الكمبوست فى التسميد الزراعى" .

سادسا : مزايا وفوائد تدوير المخلفات الزراعية إلى كمبوست من وجهة نظر المبحوثين:

أوضحت النتائج البحثية أن غالبية المبحوثين (٩٨ %) وافق على أن هناك فوائد ومزايا بيئية وزراعية لتدوير المخلفات الزراعية إلى كمبوست، بينما أشار٢% فقط من أجمالى المبحوثين لوجود فوائد بيئية وزراعية لحد ما، (جدول رقم ٩) .

(جدول رقم ٩) : توزيع المبحوثين وفقا لمدى الموافقة على وجود فوائد بيئية وزراعية لتدوير المخلفات الزراعية إلي كمبوست

مدي الموافقة	العدد	%
غير موافق	–	–
موافق لحد ما	٢	٢
موافق	٩٨	٩٨
المجموع	**١٠٠**	**١٠٠**

كما أظهرت النتائج البحثية أن الفوائد الزراعية كمردود لتدوير المخلفات الزراعية إلى كمبوست واستخدامة فى التسميد يمكن ترتيبها وفقا لتكرارت ذكرها تنازليا كالأتـى: تحسين خواص التربـة (١٠٠ %)، ارتفـاع جودة المنتـج الزراعـى ورفع الأنـتـاجية (٧٦ %)، وسرعة الأنبات (٥٦ %)، تقليل الأصابة بأمراض الجذور(النيماتودا) (٢٥ %) ، (جدول رقم ١٠) .

كما أشارت النتائج البحثية إلى أن الفوائد البيئية التى ذكرها المبحثون كعائد تدوير المخلفات الزراعية إلى كمبوست يمكن ترتيبها وفقا لتكرارت ذكرها تنازليا كالأتى: التخلص من المخلفات الزراعية بطريقة صحية وأمنه (٩٨ %)، الأستفادة من المخلفات الزراعية (٩٦ %)، تقليل التلوث البيئى وانتشار الحشرات (٨٧ %)، (جدول رقم ١٠)، الأمر الذى يظهر إلى أن هناك العديد من المزايا والفوائد الزراعية والبيئية لتدوير المخلفات الزراعية وتحويلها إلى كمبوست يستخدم فى التسميد الزراعى من وجهة نظر المبحوثين.

(جدول رقم ١٠) : توزيع المبحوثين وفقا لتكرارات الفوائد الزراعية والبيئية لتدوير المخلفات الزراعية إلى كمبوست

الفوائد	العدد	%
الفوائد الزراعية :		
تحسين خواص التربة الزراعية	١٠٠	١٠٠
ارتفاع جودة المنتج الزراعى	٧٦	٧٦
رفع الانتاجية	٧٦	٧٦
سرعة الانبات	٥٦	٥٦
تقليل الاصابة بامراض الجذور	٢٥	٢٥
الفوائد البيئية :		
التخلص من المخلفات الزراعية بطريقة صحية وآمنة	٩٨	٩٨
الاستفادة من المخلفات الزراعية	٩٦	٩٦
تقليل التلوث وانتشار الحشرات	٨٧	٨٧
المجموع	١٠٠	١٠٠

التـوصيــات :

إزاء ما أسفرت عنة النتائج البحثية من وجود العديد من الفوائد الزراعية والبيئية لتدوير المخلفات الزراعية إلى كمبوست يستخدم فى التسميد، والمتمثلة فى : تحسين خواص التربة، ارتفاع جودة المنتج الزراعى، ورفع الأنتاجية، سرعة الأنبات، تقليل الأصابة بأمراض الجذور، التخلص الآمن والصحى من المخلفات الزراعية، والأستفادة من المخلفات الزراعية، وتقليل التلوث البيئى وانتشار الحشرات، توصى الدراسة بضرورة عمل حقول ارشادية لتوليد اتجاهات أكثر أيجابية لدى الزراع نحو التخلص من المخلفات الزراعية عن طريق تدويرها إلى كمبوست يستخدم فى التسميد نظرا لما له من فوائد زراعية خلصت بها الدراسة، أضافة إلى التخلص من بعض الظواهر البيئية الغير مرغوبة كالسحابة السوداء وما تسببة من أمراض للأنسان.

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Knowledge and Attitudes of Farmers Respondents Related the Use of Compost As Organic Fertilizer in Some Villages Kafr El Dawar and Abu Homs Regions – Behira Governorate

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ABSTRACT : This study aims mainly to identify the knowledge and attitudes of farmers respondents related with the use of compost as organic fertilizer in some villages in Kafr El-dawwar and Abu Homs، from sub-objectives following : (1) identifying some characteristics of farmers respondents، (2) identify the knowledge of respondents farmers related with the use of compost as organic fertilizer، (3) identify the of farmers respondents towards the use of compost as organic fertilizer، (4) identify some of agricultural and environmental useful for recycling agricultural waste into compost is used in fertilization of The view point of respondents farmers.
A personal interview schedule was used for collecting data from intentional of 100 farmers from the villages which studied، the statistical analysis method used included. Percentages، range، frequency، tables، arithmetic mean and person's simple correction coefficient.

The main findings of this study were : (1) level of knowledge of the respondents farmers related with the use of compost as organic fertilizers low levels 10% moderate level 44% ،good level 46% . (2) Attitude of respondents farmers towards the use of compost as an alternative farmyard manure: positive attitudes percentages was 51%، neutral 33% and negative attitudes 16%.(3) There is a positive significant relationship، at 0.05 level between general knowledge level towards the use of compost as organic fertilizer and following variables: compost use duration in fertilizer، respondents farmers education. (4) There is a negative significant relationship، at 0.01 level between attitude of respondents farmers towards the use of compost as organic fertilizer and following variables: age and farm work duration. (5) There is positive significant relationship at 0.05 level between attitude of respondents farmers towards the use of compost as organic fertilizer and following variables: compost use duration in fertilizer and respondents farmers education.

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