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EFFECT OF DIFFERENT ZINC LEVELS AND AV MYCORRHIZAL FUNGI AND THEIR COMBINATIONS ON FLAX.

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ABSTRACT

Two filed experiments were carried out at Giza Agric Res. Station, Agric Res. Center, Giza, Egypt, during 2000/2001 and 2001/2002 seasons to investigate the effect of four levels of Zinc (0, 5. 10 and 20 kg / fed) and mycorrhizal fungi on yield and quality traits of three flax varieties (Sakha 1,Belinka and Bombay).

Data revealed significant differences among flax varieties of straw, seed yields and their components as well as quality characters. Sakha 1 flax variety significantly produced the highest values of straw yield and its components as well as the highest fiber length, capsules number /plant, seed index, seed yield / plant, seed yield /fed oil percentage and oil yield /fed. The application of 20 kg Zn /fed significantly increased straw yield / plant and per fed, capsules number /plant, oil percentage, fiber percentage, fiber fineness and fiber yield /fed. Whereas, seed yield / plant, seed yield /fed, seeds number/ capsule, seed index, oil yield / fed and fiber length were significantly increased by increasing Zinc level up to 10 kg / fed Varieties x Zinc levels interaction had a significant effect on straw yield, seed yield, fiber yield and their components. Also, varieties x inoculation interaction had significant effect on straw yield, seed yield and their components and fiber yield. Varieties x Zn levels x inoculation interaction had a significant effect on all studied characters. In general, it must be concluded that cultivation of flax after maize or inoculation with VA mycorrhizal fungi with the application of 10 kg Zn / fed gave the highest straw yield, seed yield and oil yield.

Keywords: Zinc, fertilizer, inoculation, VA mycorrhizal fungi, Flax.

INTRODUCTION

Flax (*Linum usitatissimum* L.) is an important crop in Egypt for its oil and fiber yields. Improved yield and quality of flax could be achieved by using high yielding cultivars as well as suitable cultural practices. Varietal differences among flax varieties has been studied by many authors. EL Sweify and Mostafa (1996) found that S.2419/1 (oil type) surpassed Giza 8 (dual purpose type) and Belinka (fiber type) in straw and seed yields/ fed, while Belinka cultivar gave higher mean values of technical length than Giza 8 and S.2419/1. Also, Abo-Zaied (1997) evaluated four genotypes *i.e.,* Giza 7 and Giza 8 (dual purpose types) and Viking and Ariane (fiber types). He found that Viking was significantly superior to the other cultivars in plant height, technical length, fiber length, fiber percentage, fiber fineness and straw yield/fed, while Giza 8 was significantly superior in capsules number/plant, seeds number/capsule, seed index, seed yield/plant and seed yield/fed. Whereas, Salama (1996) found that Giza 7 was the best genotype in plant height and technical length, while Giza 8 (dual purpose type) gave higher mean values of straw yield, capsules number, 1000 - seed weight and seed yield/fed than Giza 7 (dual purpose type) and Ariane (fiber type). The effect of zinc ($ZnSO_4$) fertilizer on yield and its components of

different flax varieties has received little attention in the literature. Abo-El Soad *et al.,* (1975) revealed that $ZnSO_4$ significantly increased seed and straw yields/fed., capsule number per plant, 1000-seed weight and fiber fineness when compared with the control treatment. Mourad *et al.,* (1988) reported that foliar spray with 900 ppm of $ZnSO_4$ increased plant height, length of fruit zone, straw and seed yields/plant and per fed, seed number per capsule, and seed index. Plants sprayed with 900 ppm $ZnSO_4$ produced the highest fiber quality characters *i.e.,* fiber length, fiber percentage and fiber fineness. Concerning the effect of bio-fertilization with VA mycorrhizal fungi, Smith and Daft (1977) noticed that when P and N were limiting, plant growth depended on uptake assisted by mycorrhizal fungi. Pacovesky *et al.,* (1986) showed that plant infected with mycorrhizal fungi may lead to decrease fertilizer use. Kawai and Yamamato (1986) and Koreish *et al.,* (1998) observed that plants treated with VA mycorrhizal had higher uptake of P in their stems and leaves compared with untreated ones. Massoud (1999) reported that P uptake by wheat and sorghum plants increased with inoculation by Azo + VA mycorrhizal. Reda (2001) found a positive effect of VA mycorrhizal on shoot dry weight, plant height, grain yield and 100 grains weight of maize compared with un-inoculated treatments. Therefore , the present research was carried out to study the effect of inoculation with VA mycorrhizal fungi and $ZnSO_4$ on yield, yield components and fiber quality characters of some flax cultivars.

MATERIALS AND METHODS

Two experiments were carried out at Giza Agric Research Station, Agric Research Center, Giza, Egypt, during 2000/2001 and 2001/2002 seasons. Flax was sown on Nov. 19 th in both seasons. A split - split plot design with four replications was used in both seasons. Each experiment included 24 treatments which were the combinations of three flax cultivars viz, Belinka (fiber type), Sakha 1 (dual purpose type) and Bombay (American introduction) as main plots, four zinc rates (0,5,10, and 20 kg Zn/fed.) in the from of $ZnSO_4$ as subplot and two inoculation treatments with VA mycorrhizal fungi (+M) and un-inoculated (-M) as sub-sub plots. Each sub –sub plot area was 6 m^2 (10 rows, 3m long and 20 cm apart). The inoculum used in this experiment was propagated on maize plant grown in glasshouse for 12 weeks. The seed inoculation was done before sowing. Zinc sulphate ($ZnSO_4$) was applied before the first irrigation (21 days after sowing). The soil type was clay loam with organic matter of 0.38 and 0.35 %, available nitrogen 28.1 and 25.5, CaCO3 of 7.5 and 7.11% and pH value of 8.11 and 8.01, Zn of 0.75 and 0.85 ppm in the first and second seasons, respectively. Other agronomic practices were carried out as usual. At harvest, ten random guarded plants were taken from each sub plot for determining the following characters:

I) Straw yield and its components:

(1) Straw yield (ton / fed (ton), (2) straw yield/ plant (g), (3) plant height (cm), (4) technical length (cm) and (5) fruiting zone length (cm).

II) Seed yield and its components:

(1) Seed yield /fed (Kg) (2) Seed yield/plant (g), (3) capsules number /plant, (4) seeds number / capsule, (5) seed index (g), (6) oil yield /fed. (Kg) and (7) oil percentage was determined using the procedure described by A.O.A.C. (1957).

III) Fiber yield and its quality characters:

Fiber yield /fed (Kg), (2) fiber length (cm), (3) fiber percentage and (4) fiber fineness (Nm) were determined according to the technique described by Radwan and Momtaze (1966).

Analysis of variance was carried out according to Sendecor and Cochran (1967) and means were compared by Least Significant Difference (L.S.D.) at 0.05 level was used. The combined analysis of variance over the tow seasons was performed for all characters (Le Clerg *et al.*, 1966).

RESULTS AND DISCUSSION

I): Straw yield and its components:

a): Varietal effects:

Data in Table (1) revealed significant differences among flax cultivars in plant height, technical length and fruiting zone length straw yield per plant and per fed Sakha 1 significantly surpassed the other varieties in plant height (88.45cm), technical length (72.54 cm) and fruiting zone length (15.92 cm), and straw yield per plant (2.06 g) and per fed (2.369 ton), followed by Belinka and Bombay in a descending order. These results are in agreement with Salama (1996). On the other hand, Abo- Zaied (1997) found that the fiber type of flax was significantly superior over the other cultivars regarding plant height, technical length and straw yield/fed.

b): Zinc effects:

Data in Table 1 showed that increasing Zinc level up to 10 kg Zn/fed significantly produced the highest values of plant height (81.85 cm), technical length (66.63 cm) and fruiting zone length (15.23 cm). Increasing Zinc level from 10 to 20 kg Zn /fed did not cause significant increase in the aforementioned traits. Mean while the application of 20 kg Zn /fed significantly increased straw yield / plant and per fed, reflecting the increase in plant height; accompanying Zn application as a result of acceleration of both cell division and cell elongation in flax plant. As reported by Porokhnevich and Bykov (1972), Abo-EL Soad *et al.*, (1975) who found that $ZnSO_4$ increased plant height and straw yield/fed. Similarly, Zedan *et al.*, (1986) noticed that the application of 10 kg Zn /fed gave the highest straw yield /plant as well as per fed. Mourad *et al.*, (1988) found that foliar spray with 900-ppm $ZnSO_4$ increased total length, fruiting zone length, and straw yield per plant as well as per fed.

c): Effect of seed inoculation with VA mycorrhizai fungi:

Data in Table (1) indicate that the seed inoculation with VA mycorrhizal fungi significantly increased plant height (82.34 cm), technical length (67.02 cm) and fruiting zone length (15.31cm) and this was reflected in higher yield of straw yield per plant and per fed. In this connection Reda (2001) found that inoculation

by mycorrhizal fungi had a positive effect on plant height and mycorrhizal shoot dry weight of maize.

d): Effect of the interactions:

Data presented in Table (1) reveled that all interactions between the studied factors were significant except for V x M and Zn x M for plant height and technical length as well as V x Zn for fruiting zone length. It is clear that the tallest plants (92.40 cm), the highest of technical length (74.57 cm) and fruiting zone length (17.83 cm) as well as the highest straw yield per plant (2.7g) and per fed (2.578 ton) resulted from cultivar Sakha 1 fertilized with 20 kg Zn and treated with mycorrhizal fungi, while the lowest values for the aforementioned traits resulted from cultivar Bombay with control treatment.

2): Seed yield and its components:

a): Varietal effects:

Data presented in Table (2) revealed significant differences among flax varieties in seed yield and its components. Sakha 1 cultivar significantly produced the highest values of capsules number/ plant (10.34), seed index (9.70 g), seed yield / plant (0.62 g), seed yield /fed (600 kg) and produced the highest oil percentage (39.03%) and the highest oil yield /fed (242 kg). The superiority of Sakha1 in oil production may be due to its higher seed yield /fed as well as higher oil seed content. It is worthy to mention that Belinka cultivar produced the lowest capsules number / plant. These results are in harmony with those reported by EL - Sweify and Mostafa (1996) and Abo - Zaied (1997).

b): Zinc effects:

The results in Table (2) showed significant increase in capsules number /plant (7.08) and oil percentage (37.066%) by increasing Zinc level up to 20 kg Zn /fed. The data indicated that seed yield / plant (0.49 g), seed yield /fed. (511 kg), seeds number / capsule (9.40), seed index (7.00), and oil yield/ fed (190 kg) significantly increased by increasing Zinc level up to 10 kg Zn / fed. The significant increase in seed yield /fed exhibited by Zinc application may be attributed to the increase of seed yield components. These results are in agreement with Abo-El Soad *et al.*, (1975), Zedan *et al.*, (1986) and Mourad *et al.*, (1988).

c): Effect of seed inoculation with VA mycorrhizal fungi:

Data in Table (2) showed that flax plants treated with mycorrhizal fungi produced higher seed and oil yield /fed and were superior in seed yield components and seed oil percentage compared to untreated ones. These findings are in harmony with those obtained by Elwan and Sharawy (1994).

d): Effect of the interactions:

The first and the second order interactions between the studied factors exhibited significant effects on seed yield and its components, except the interaction between V x M for seeds number /capsule and oil yield / fed as well as Zn x M and V x Zn x M for oil percentage. The highest Values of capsules number / plant (12.50), seed index (9.97 g), seed yield / plant (0.84 g), seed

yield /fed (703 kg), oil percentage (39.53%) and oil yield /fed (278 kg), were obtained from flax plants of Sakha 1 cultivar fertilized with 20 kg of Zn and treated with mycorrhizal fungi, while the highest seeds number / capsule resulted from Belinka with 20 kg Zn and mycorrhizal fungi.

3): Fiber yield and its quality characters:

a): Varietal effects:

Data in Table (3) showed that cultivars were significantly different in fiber length, fiber percentage, fiber fineness and fiber yield /fed. Belinka significantly surpassed Sakha 1 and Bombay in fiber percentage (19.89%), fiber fineness (217.70) and fiber yield /fed (436 kg). Sakha 1 gave the highest fiber length (70.9 cm) but, Bombay was the lowest one. It is worth to mention that the lower straw yield of Belinka was compensated by the higher percentage of fiber and finally it produced the highest fiber yield /fed. These results are in harmony with those reported by EL - Sweify and Mostafa (1996) and Abo - Zaied (1997).

b): Zinc effects:

Data in Table (3) indicated that increasing Zinc level of up to 20 kg /fed significantly increased fiber percentage (19.55%), fiber fineness (193.71) and fiber yield /fed (463 kg), while fiber length (64.99 cm) was significantly increased as Zn level was increased up to 10 kg Zn /fed. These results are in harmony with those reported by Abo-El Soad *et al.*, (1975) and Mourad *et al.*, (1988).

c): Effect of seed inoculation with VA mycorrhizal fungi: Data in Table (3) showed that inoculated seed with mycorrhizal fungi significantly increased fiber length, fiber percentage, fiber fineness and fiber yield /fed compared to those without inoculation. These results are in harmony with those reported by Elwan and Sharawy (1994).

d): Effect of the interactions:

Data in Table (3) revealed that all interactions between the studied factors were significant with respect to fiber yield and fiber quality characters, except for V x M for fiber percentage which was not significant. The highest fiber yield / fed (503 kg), fiber percentage (20.36) and fiber fineness (224.57) were obtained from Belinka received 20 kg Zn/fed and with mycorrhizal fungi treatment, while the tallest fibers resulted from Sakha 1 with the same mentioned treatments.

General conclusions:

In general, it can be concluded that cultivation of flax after maize or inoculation with VA mycorrhizal fungi with Zinc level of 10 kg Zn /fed gave the highest straw yield, seed yield and oil yield with Sakha 1 as dual purpose type in Egypt while, application of 20 kg Zn/fed gave the highest fiber yield, fiber percentage and fiber fineness with Belinka (fiber type).

Table 1.Effect of Zinc levels and AV mycorrhizal on plant height, technical length, fruit zone length, straw yield /plant and straw yield/fed. (combined analysis of the two seasons).

Varieties	Zn levels	Plant height (cm)			Technical Length (cm)			Fruit zone length(cm)			Straw yield/plant(g)			Straw yield/fed.(ton)		
		(+M)	(-M)	Means	(+M)	(-M)	Means	(+M)	(-M)	Means	(+M)	(-M)	Means	(+M)	(-M)	Means
Belinka	0 kg zn	78.20	74.47	76.34	64.98	62.70	63.84	13.22	11.77	12.50	1.39	1.03	1.21	2.050	1.762	1.906
	5 kg zn	80.65	76.48	78.57	66.12	63.80	64.96	14.53	12.68	13.61	1.84	1.27	1.56	2.267	2.040	2.154
	10 kg zn	82.75	78.70	80.73	67.23	64.95	66.09	15.52	13.75	14.64	2.33	1.69	2.01	2.440	2.230	2.335
	20 kg zn	83.13	78.92	81.03	67.30	64.95	66.13	15.83	13.97	14.90	2.38	1.74	2.06	2.467	2.240	2.354
	Means	**81.18**	**77.14**	**79.16**	**66.41**	**64.10**	**65.25**	**14.78**	**13.04**	**13.91**	**1.99**	**1.43**	**1.71**	**2.306**	**2.068**	**2.187**
Sakha 1	0 kg zn	87.73	83.48	85.61	72.35	69.97	71.16	15.38	13.52	14.45	1.81	1.40	1.61	2.252	2.052	2.157
	5 kg zn	90.20	85.62	87.91	73.50	70.97	72.24	16.70	14.65	15.68	2.26	1.73	2.00	2.402	2.253	2.328
	10 kg zn	92.18	87.90	90.04	74.53	72.18	73.36	17.65	15.72	16.69	2.59	1.93	2.26	2.560	2.412	2.486
	20 kg zn	92.40	88.12	90.26	74.57	72.22	73.40	17.83	15.90	16.87	2.70	2.02	2.36	2.578	2.432	2.505
	Means	**90.63**	**86.28**	**88.45**	**73.74**	**71.34**	**72.54**	**16.89**	**14.95**	**15.92**	**2.34**	**1.77**	**2.06**	**2.451**	**2.287**	**2.369**
Bombay	0 kg zn	72.47	68.58	70.53	59.63	57.77	58.70	12.83	11.82	12.33	1.25	0.92	1.09	1.927	1.623	1.775
	5 kg zn	74.63	70.55	72.59	60.60	57.88	59.24	14.08	12.67	13.38	1.49	1.12	1.31	2.162	1.840	2.001
	10 kg zn	76.72	72.87	74.80	61.68	59.20	60.44	15.03	13.67	14.35	2.01	1.46	1.74	2.328	2.095	2.212
	20 kg zn	76.97	72.98	74.98	61.77	59.32	60.55	15.20	13.67	14.44	2.12	1.53	1.83	2.353	2.122	2.238
	Means	**75.20**	**71.25**	**73.22**	**60.92**	**58.54**	**59.73**	**14.29**	**12.96**	**13.62**	**1.72**	**1.26**	**1.49**	**2.193**	**1.920**	**2.056**
Mean for mycorrhizal		82.34	78.22	80.28	67.02	64.66	65.84	15.32	13.65	14.48	2.02	1.49	1.75	2.316	2.092	2.204
Mean for Zinc levels																
	0 kg zn	79.47	75.51	77.49	65.65	63.48	64.57	13.81	12.37	13.09	1.49	1.12	1.30	2.080	1.812	1.946
	5 kg zn	81.83	77.55	79.69	66.74	64.22	65.48	15.10	13.33	14.22	1.86	1.37	1.62	2.277	2.044	2.161
	10 kg zn	83.88	79.82	81.86	67.81	65.44	66.63	16.07	14.38	15.23	2.31	1.69	2.00	2.443	2.246	2.344
	20 kg zn	84.17	80.01	82.09	67.88	65.50	66.69	16.29	14.51	15.40	2.40	1.76	2.08	2.466	2.265	2.366

L.S.D. 5% level of significance for:						
Varieties (V)	0.21	0.13	0.13	0.20	0.014	
Zinc (Zn)	0.26	0.19	0.16	0.03	0.017	
Mycorrhizal (M)	0.23	0.18	0.15	0.24	0.017	
V x Zn	0.53	0.32	0.3	0.06	0.033	
V x M	NS	NS	NS	0.15	0.012	
Zn x M	NS	NS	0.17	0.16	0.032	
V x ZN x M	0.56	0.77	0.73	0.12	0.038	

(+M),(-M) =with and without mycorrhizal fungi ,respectively.
NS = Non- Significant

Table 2.Effect of Zinc levels and AV mycorrhizal on No.of capsules/plant, No.of seeds/capsule,seed index, seed yield/plant, seed yield/fed., oil percentage and Oil yield/fed.(combinedanalysis of the two seasons).

Varieties	Zn levels	No.of capsules/plant			No.of seeds/capsule			Seed index			Seed yield/plant(g)			Seed yield/fed.(kg)			Oil percentage(%)			Oil yield/fed.(kg)		
		(+M)	(-M)	Means	(+M)	(-M)	Means	(+M)	(-M)	Means	(+M)	(-M)	Means	(+M)	(-M)	Means	(+M)	(-M)	Means	(+M)	(-M)	Means
Belinka	0 kg zn	7.23	6.27	6.75	7.18	6.59	6.89	5.00	4.77	4.89	0.27	0.20	0.24	369	300	335	34.60	34.12	34.36	128	111	120
	5 kg zn	8.40	6.85	7.63	7.61	6.94	7.28	5.29	5.08	5.19	0.38	0.25	0.32	431	381	406	34.98	34.51	34.75	151	132	142
	10 kg zn	9.32	7.48	8.40	8.02	7.29	7.66	5.50	5.30	5.40	0.48	0.33	0.41	461	411	436	35.46	35.01	35.24	164	147	156
	20 kg zn	9.58	7.78	8.68	8.06	7.32	7.69	5.50	5.36	5.43	0.49	0.35	0.42	466	422	444	35.54	35.14	35.34	166	149	158
	Means	**8.63**	**7.10**	**7.86**	**7.72**	**7.04**	**7.38**	**5.32**	**5.13**	**5.23**	**0.41**	**0.28**	**0.34**	**432**	**379**	**405**	**35.15**	**34.70**	**34.92**	**152**	**135**	**144**
Sakha 1	0 kg zn	10.20	8.00	9.10	5.60	5.22	5.41	9.59	9.38	9.49	0.57	0.41	0.49	481	425	453	38.70	38.38	38.54	223	202	213
	5 kg zn	11.42	8.82	10.12	5.97	5.49	5.73	9.79	9.53	9.66	0.70	0.50	0.60	647	584	616	39.18	38.67	38.93	253	226	240
	10 kg zn	12.25	9.63	10.94	6.32	5.84	6.08	9.97	9.67	9.82	0.77	0.58	0.68	694	639	667	39.52	39.11	39.32	274	244	259
	20 kg zn	12.50	9.93	11.22	6.43	5.95	6.19	9.97	9.73	9.85	0.84	0.60	0.72	703	624	664	39.53	39.16	39.35	278	245	259
	Means	**11.59**	**9.10**	**10.34**	**6.08**	**5.63**	**5.85**	**9.83**	**9.58**	**9.70**	**0.72**	**0.52**	**0.62**	**631**	**568**	**600**	**39.23**	**38.83**	**39.03**	**256**	**229**	**242**
Bombay	0 kg zn	6.67	5.52	6.10	7.17	6.39	6.78	5.62	5.44	5.53	0.28	0.19	0.24	356	323	340	35.76	35.20	35.48	127	114	121
	5 kg zn	7.77	6.58	7.18	7.56	6.76	7.16	5.73	5.57	5.65	0.36	0.24	0.30	409	365	387	36.03	35.58	35.81	147	130	139
	10 kg zn	8.75	7.23	7.99	7.92	7.08	7.50	5.89	5.66	5.78	0.46	0.31	0.39	447	405	426	36.51	36.11	36.31	163	146	155
	20 kg zn	8.92	7.47	8.20	7.97	7.21	7.59	5.93	5.71	5.82	0.47	0.33	0.40	451	415	433	36.64	36.18	36.41	165	150	158
	Means	**8.03**	**6.70**	**7.36**	**7.66**	**6.86**	**7.26**	**5.79**	**5.60**	**5.69**	**0.39**	**0.27**	**0.33**	**416**	**377**	**396**	**36.24**	**35.77**	**36.00**	**151**	**135**	**143**
Mean for mycorrhizal		9.42	7.63	8.52	7.15	6.51	6.83	6.98	6.77	6.87	0.51	0.36	0.43	493	441	467	36.87	36.43	36.65	186	166	176
Mean for Zinc levels																						
	0 kg zn	8.03	6.60	7.32	6.65	6.07	6.36	6.74	6.55	6.64	0.37	0.27	0.32	402	349	376	36.35	35.90	36.13	159	142	151
	5 kg zn	9.20	7.42	8.31	7.05	6.40	6.72	6.94	6.72	6.83	0.48	0.33	0.41	496	443	470	36.73	36.25	36.50	184	163	174
	10 kg zn	10.11	8.11	9.11	7.42	6.74	7.08	7.12	6.88	7.00	0.57	0.41	0.49	534	485	510	37.15	36.74	36.96	200	179	190
	20 kg zn	10.33	8.39	9.37	7.49	6.83	7.16	7.13	6.93	7.03	0.60	0.43	0.51	540	487	514	37.24	36.83	37.03	203	181	192

L.S.D 5% level of significance for:

Varieties (V)	0.14	0.40	0.10	0.11	31.1	0.30	11.1
Zinc (Zn)	0.17	0.12	0.19	0.14	38.2	0.11	12.2
Mycorrhizal (M)	0.11	0.40	0.10	0.08	22.1	0.23	9.3
V x Zn	0.34	0.10	0.04	0.03	80.2	0.09	14.2
V x M	0.31	NS	0.23	0.18	85.2	0.31	NS
Zn x M	0.22	0.16	0.21	NS	53.4	NS	6.0
V x ZN x M	0.54	0.18	0.07	0.04	91.3	NS	5.0

(+M),(-M) =with and without mycorrhizal fungi ,respectively.
NS = Non- Significant

Table 3.Effect of Zinc levels and AV mycorrhizal on fiber yield/fed., fiber length, fiber percentage and fiber fineness(combined analysis of the two seasons).

Varieties		Fiber yield/fed.(kg)			Fiber length (cm)			Fiber percentage (%)			Fiber fineness		
	Zn levels	(+M)	(-M)	Means	(+M)	(-M)	Means	(+M)	(-M)	Means	(+M)	(-M)	Means
Belinka	0 kg zn	402	430	416	63.52	61.13	62.33	19.59	19.30	19.45	211.07	208:98	210.03
	5 kg zn	451	401	426	64.67	62.23	63.45	19.91	19.64	19.78	216.63	218.38	217.51
	10 kg zn	495	445	470	65.75	63.33	64.54	20.29	19.95	20.12	221.15	218.63	219.89
	20 kg zn	503	449	476	65.88	63.40	64.64	20.36	20.06	20.21	224.57	222.42	223.50
	Means	**463**	**431**	**447**	**64.96**	**62.52**	**63.74**	**20.04**	**19.74**	**19.89**	**218.36**	**217.10**	**217.73**
Sakha 1	0 kg zn	401	358	380	70.77	68.13	69.45	17.71	17.45	17.58	145.05	143.02	144.04
	5 kg zn	433	396	415	71.98	69.25	70.62	18.01	17.70	17.86	152.09	150.58	151.34
	10 kg zn	471	434	453	73.03	70.40	71.72	18.39	17.98	18.19	159.07	156.55	157.81
	20 kg zn	478	441	460	73.15	70.50	71.83	18.47	18.14	18.31	163.43	160.83	162.13
	Means	**446**	**407**	**427**	**72.23**	**69.57**	**70.90**	**18.15**	**17.82**	**17.98**	**154.91**	**152.75**	**153.83**
Bombay	0 kg zn	374	312	343	58.05	55.12	56.59	19.41	19.21	19.31	182.68	180.47	181.58
	5 kg zn	430	361	396	59.05	56.28	57.67	19.88	19.62	19.75	188.37	186.32	187.35
	10 kg zn	471	419	445	60.08	57.38	58.73	20.22	19.99	20.11	192.87	190.80	191.84
	20 kg zn	476	428	452	60.27	57.48	58.88	20.24	20.03	20.14	196.40	194.60	195.50
	Means	**438**	**380**	**409**	**59.36**	**56.57**	**57.96**	**19.94**	**19.71**	**19.83**	**190.08**	**188.05**	**189.06**
Mean for mycorrhizal		449	406	427	65.52	62.89	64.20	19.37	19.09	19.23	187.78	185.97	186.87
Mean for Zinc levels													
	0 kg zn	392	367	380	64.11	61.46	62.79	18.90	18.65	18.78	179.60	177.49	178.55
	5 kg zn	438	386	412	65.23	62.59	63.91	19.27	18.99	19.13	185.70	185.09	185.40
	10 kg zn	479	433	456	66.29	63.70	64.99	19.63	19.31	19.47	191.03	188.66	189.85
	20 kg zn	486	439	463	66.43	63.79	65.12	19.69	19.41	19.55	194.80	192.62	193.71
L.S.D. 5% level of significance for:													
	Varieties (V)			9.4			0.10			0.02			0.95
	Zinc (Zn)			6.2			0.14			0.02			1.18
	Mycorrhizal (M)			7.1			0.15			0.03			NS
	V x Zn			7.2			0.26			0.04			2.41
	V x M			9.3			0.32			NS			2.12
	Zn x M			5.4			0.47			0.06			2.19
	V x ZN x M			4.4			0.76			0.06			3.25

(+M),(-M) =with and without mycorrhizal fungi ,respectively.
NS = Non- Significant

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تأثير استخدام مستويات مختلفة من الزنك والميكروهيزا علي الكتـــــــــــان

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أقيمت تجربتين حقليتين بمركز البحوث الزراعية بالجيزة – مصر، اثناء موسمي ٢٠٠٠/٢٠٠١ ، ٢٠٠١/٢٠٠٢ لدراسة تأثير استخدام أربعة مستويات تسميد من الزنك (٠، ٥ ، ١٠ ، ٢٠ كجم/فدان) مع التلقيح بفطر الميكروهيزا علي المحصول وصفات الجودة في الكتان علي ثلاث أصناف من الكتان (سخا ١ ، بلنكا ، اريانا).

تشير النتائج إلى وجود اختلافات معنوية بين الاصناف تحت الدراسة في محصـــول القـش والبذرة ومكوناتهما وصفات الجودة ، كما أن الصنف سخا ١ أعطي أعلي قيم من محصـــول القـش ومكوناته وطول الألياف وعدد الكبسولات/ نبات ومعامل البذرة ومحصول البذرة / نبـــات و/ فـدان والنسبة المئوية للزيت ومحصول الزيت/ فدان ، كما تشير النتائج الي أن استخدام معدل الزنـــك ٢٠ كجم أدي الي زيادة معنوية في محصول القش/ نبات و/ فدان وعدد الكبسولات/ نبات والنسبة المئويـة للزيت والنسبة المئوية للألياف ونعومة الألياف ومحصول الألياف/ فدان ، بينما استخدام المعـــدل ١٠ كجم/ فدان من الزنك أدي الي زيادة معنوية في محصول البذرة / نبات و/ فدان وعدد البذور/ كبسولة ومعامل البذرة ومحصول الزيت / فدان وطول الألياف ، كما تشير النتـــائج الـــي أن التفـــاعل بيـــن الاصناف X الزنك كان معنوي لصفات محصول القش والبذور والألياف ومكوناتها ، كذلك التفـاعل بين الأصناف X الميكروهيزا كان معنوي لصفات محصول القش والبـــذرة والألـيـــاف ومكوناتـــها وصفات الجودة ، كذلك تشير النتائج الي معنوية التفاعل بين الاصناف X الزنك X الميكروهيزا لكـل الصفات تحت الدراسة.

وبصفة عامة تشير النتائج الي أن زراعة الكتان بعد الذرة الشامية أو تلقيح التربة بفطر الميكروهيزا مع استعمال معدل ١٠ كجم زنك/فدان أعطي أعلي محصول من القش والبذرة والزيت .