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EFFECT OF PLANT POPULATION DENSITY ON YIELD AND YIELD COMPONENTS OF EIGHT EGYPTIAN MAIZE HYBRIDS

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ABSTRACT

Two field experiments were carried out at an extension field at Shiba village, Sharkia Governorate, Egypt during the two successive summer seasons of 1996 and 1997 to study the effect of plant populations *viz.*, 20, 24 and 30 thousand plants/fed on eight Egyptian maize hybrids, *i.e.* S.C.10, S.C. 122, S.C. 124, S.C. 129, T.W.C. 310, T.W.C. 320, T.W.C. 321 and T.W.C. 322.

Plant height and ear height were increased as plant population density increased, while both number of leaves/plant, number of leaves above main ear and number of rows/ear were not affected significantly by increasing planting density. The results also indicated that main ear leaf area, ear length, ear diameter, number of grains/row and 100-grain weight were decreased by increasing plant population density from 20 to 30 thousand plants/fed. Grain yield was increased significantly from 24.46 ardab /fed to 29.99 ardab/fed by increasing plant density from 20 to 30 thousand plants/fed. Hybrids significantly differed from each other in most of the studied characters. Single cross 10 gave the highest grain yield (30.40 ardab/fed. and did not differ significantly from either S.C. 122 or S.C. 124, while T.W.C. 321 gave the lowest yield.

Finally, it was found that ear length, number of grains/row and 100-grain weight contributed together 84.96%, 95.07% and 82.16% of

the total grain yield variation under 20, 24 and 30 thousand plants/fed. respectively.

Key words: *maize hybrids, path analysis , plant population density.*

1. INTRODUCTION

Increasing maize production depends on many factors. One important factor affecting, to a great extent, the productivity of a cultivar is determining its optimum population.

Salem *et al.*, (1983) reported that plant population density had no significant effect on plant and ear heights of maize. On the other hand, increasing plant density resulted in decreasing grain yield/ear and 100-grain weight, but ear length and diameter and number of grains/row were not affected by plant population. They added that plant population density had highly significant effect on grain yield/plant and grain yield/fed. which both increased as plant population density increased. Khalifa *et al.*, (1984); El-Habbak (1985); Salwua (1985), and Aly (1988) reported similar findings. Esechie (1992) found that grain yield of maize was higher at 48000 plants/ha. Roy and Biswas (1992) reported that the weight of 100-grain was increased with decreasing plant density from 66600 to 33300 plants/ha.

Ragheb *et al.*, (1993); Ali *et al.*, (1994) and Soliman *et al.*, (1995) found that maize single crosses significantly surpassed other types of hybrids concerning response to higher population density and in most of plant growth traits.

Atta Allah (1996) and Faisal *et al.*, (1996) concluded that increasing plant density from 15 to 30 thousand plants/fed. led to significant increase in plant and ear height. Maximum grain yield/fed (26.8) and (24.2) ardab/fed. in 1994 and 1995 seasons, respectively, was achieved by planting 30000 plant/fed. However, all other studied traits were found to be significantly decreased by increasing plant population density.

Maize hybrids differed in their productivity. The increase of grain yield of maize could be achieved by the development of high yielding varieties. Maize hybrids proved to be one of the most efficient tools for raising maize yield. El-Bially *et al.*, (1991) revealed that there were varietal differences in growth and yield characters. Plants of both S.C. 10 and D.C. 215 were taller but had lower number of rows/ear than the composite cultivar Giza 2. The single cross hybrid 10 produced the highest yield followed by D.C. 215 while Giza 2 gave the lowest yield. Gouda *et al.*, (1992) pointed out that maize cultivars S.C. 10, T.W.C. 310, D.C. 204, Giza 2. Pioneer Taba and population 45 differed significantly in the number of green leaves/plant, leaf area/plant, plant height and ear height. The single cross hybrid 10 showed the highest grain yield. Luchsinger (1993), found that yield of maize hybrids increased with increasing plant population density and added that the yield of maize hybrids increased with increasing plant population density. Hassan (1995) revealed that maize varieties differed significantly in all agronomic characteristics except ear height, leaf area below the first ear and number of ears/plant. Aly *et al.*, (1996) reported that T.W.C. 310 exceeded Giza 2 in all studied characters and produced high grain yield/fed. Atta Allah (1996) found that single cross 10 and T.W.C. 310 had the highest values for all studied traits, while, Giza 2 gave the lowest values for most of the studied traits.

Therefore,this research work was done to determine the optimum planting population for eight hybrids of maize.

2. MATERIALS AND METHODS

Two field experiments were conducted at Shiba village, Sharkia Governorate, during 1996 and 1997 growing seasons to study the response of eight Egyptian maize hybrids to three plant populations. Mechanical and chemical analysis of the soil in the experimental sites (mean of the two seasons for the upper 30 cm of soil depth) are given in Table (1).

2.1. Plant population density

Three plant densities were tested *i.e.*, 20.000, 24.000 and 30.000 plants per fed. These densities were obtained by planting maize in hills 30, 25 and 20 cm aparts, respectively.

2.2. Maize hybrids

1 - Single cross 10
2 - Single cross 122.
3 - Single cross 124.
4 - Single cross 129.
5 - Three way cross 310.
6 - Three way cross 320.
7 - Three-way cross 321.
8 - Three-way cross 322.

Table (1):Some physical and chemical properties of the experimental soil.

Characters	Value
Mechanical analysis	
Coarse sand %	2.00
Fine sand %	13.13
Silt %	23.00
Clay %	58.50
Texture	Clay
Chemical analysis	
Organic matter %	1.59
Total Ca Co3%	1.72
pH	7.60
N %	0.27
P %	0.02
K %	0.03

Each experiment included 24 treatments which were the combinations of eight maize hybrids and three plant population densities.The split plot design in randomized complete blocks arrangement with four replications was used in both seasons. The main plots were occupied by the three hill spacing, whereas, the maize hybrids were arranged at random in the sub-plots. Each sub-plot included 6 ridges 3m long and 70 cm wide. Planting date was 28^{th} May and 4^{th} June in 1996 and 1997 seasons, respectively. Nitrogen fertilizer was applied in a split up dose at the first and second irrigations at a total rate of 105 kgs/fed. and all cultural practices were carried out as usual. At silking stage number of leaves/plant, number of leaves above main ear and main ear leaf area (length x maximum width x 0.75) were recorded. At harvest plant height, ear height, ear length, ear diameter, number of rows/ear, number of grains/row, 100-grain weight and grain yield (ardab/fed.) were recorded.

Data obtained were subjected to standard analysis of variance of split-plot design (Snedecor and Cochran, 1981) and L.S.D. was used to compare the treatment means. The data of yield attributes and yield were subjected to simple correlation and path coefficient analyses according to Svab (1973).

3. RESULTS AND DISCUSSION

3.1. Effect of plant population density

Data in Tables (2 and 3) show that plant height and ear height were increased, while leaf area of the main ear leaf was decreased significantly by increasing plant population from 20 to 30 thousand plants/fed., without significant differences between 20 and 24 thousand plants/fed. for main ear leaf area. Dense sown plants are always forced to elongate due to stimulative effect caused by invisible short and long radiation under such conditions and due to inter-as well as intra-plant competition for light and nutrients, the photosynthesis rate decreased and could account for the decrease in main ear leaf area. These results are in harmony with those of Ragheb *et al.*, (1993), Atta Allah (1996) and Mosalem and Shady (1996).

Data in Table (2) also show that the number of leaves/plant and number of leaves above main ear were not affected significantly by increasing plant population from 20 to 30 thousand/fed. except number of leaves/plant in 1997 season which was decreased significantly by increasing plant population only from 20 to 30 thousand plants/fed.

Data presented in Tables (3 and 4) show that both ear length and diameter, number of grains/row and 100-grain weight were increased by decreasing plant population from 30 to 20 thousand plants/fed. On the other hand number of rows/ear was not affected by changing plant population. This could be attributed to good utilization of light, nutrients and water in case of lower densities. Similar results were obtained by Khalifa *et al.*,(1984), Roy and Biswas (1992), Badr *et al.* (1993) and Atta Allah (1996).

Maize grain yield was significantly affected by plant densities (Table 4).Grain yield recorded as ardab/fed. was increased by 22.6% due to increasing plant population density from 20 to 30 thousand

Table (2): Effect of plant density on some plant characteristics of maize hybrids.

Main effects	Plant height (cm)			No. of leaves/plant			No. of leaves above main ear			Main ear leaf area (dm^2)		
and interaction	1996	1997	comb.	1996	1997	comb.	1996	1997	comb.	1996	1997	comb.
Plant densities (D):												
20.000 plant/fed.	348.59	316.06	332.32	15.93	16.09	16.01	6.56	7.18	6.87	8.52	7.97	8.24
24.000 plant/fed.	356.25	322.75	339.50	16.31	15.84	16.07	6.50	6.96	6.73	8.69	7.24	7.96
30.000 plant/fed.	365.15	333.34	349.25	16.40	15.68	16.04	6.58	6.96	6.76	8.21	6.78	7.48
L.S.D. 0.05	8.23	5.50	4.88	N.S.	0.28	N.S.	N.S.	N.S.	N.S.	0.37	0.43	0.28
Cultivars (C) :												
Single cross 10	412.50	326.66	369.58	16.83	16.16	16.50	6.58	6.75	6.66	9.07	7.06	8.07
Single cross 122	317.50	322.50	320.00	15.08	15.16	15.12	6.50	6.75	6.62	8.44	7.53	7.98
Single cross 124	317.50	330.41	323.95	15.00	16.16	15.58	6.58	7.00	6.79	8.43	6.98	7.71
Single cross 129	361.25	319.83	340.54	15.00	15.66	15.33	6.08	7.50	6.79	8.34	7.29	7.81
Three way cross 310	356.25	324.91	340.58	17.33	15.75	16.54	6.58	7.08	6.83	8.59	7.61	8.10
Three way cross 320	370.83	320.66	345.75	16.58	16.16	16.37	6.66	7.25	6.95	8.27	7.23	7.75
Three way cross 321	347.91	326.66	337.29	16.91	15.83	16.37	6.58	6.75	6.66	8.16	7.29	7.72
Three way cross 322	369.58	320.75	345.16	17.00	16.08	16.54	6.75	7.25	7.00	8.47	7.59	8.03
L.S.D. 0.05	12.90	N.S.	8.01	0.94	0.57	0.53	N.S.	0.53	N.S.	N.S.	N.S.	N.S.
Interaction (D x C):												
L.S.D. 0.05	N.S	N.S	N.S	N.S	N.S	N.S.	N.S.	N.S.	N.S	N.S	N.S	N.S

Table (3): Effect of plant density on ear characteristics of maize hybrids.

Main effects and interaction	Ear height (cm)			Ear length (cm)			Ear diameter (cm)		
	1996	1997	comb.	1996	1997	comb.	1996	1997	comb.
Plant densities (D):									
20.000 plant/fad.	172.81	161.59	167.20	21.46	20.00	20.73	4.88	4.60	4.72
24.000 plant/fad.	180.15	163.18	171.67	20.81	19.46	20.14	4.75	4.45	4.60
30.000 plant/fad.	186.25	169.43	177.84	19.87	18.46	19.17	4.64	4.34	4.49
L.S.D. 0.05	7.07	4.86	4.23	0.55	0.74	0.45	0.08	0.05	0.05
Cultivars (C) :									
Single cross 10	197.50	168.16	182.83	22.08	18.75	20.41	4.80	4.50	4.65
Single cross 122	165.41	164.91	165.16	21.75	19.75	20.75	4.80	4.38	4.59
Single cross 124	171.25	168.25	169.75	21.00	19.16	20.08	4.79	4.65	4.72
Single cross 129	182.08	161.80	171.58	21.50	19.08	20.29	4.82	4.46	4.64
Three way cross 310	177.91	164.08	171.00	19.83	19.66	19.75	4.85	4.50	4.67
Three way cross 320	181.25	167.25	174.25	20.25	19.66	19.95	4.63	4.43	4.53
Three way cross 321	177.08	161.16	169.12	19.33	19.25	19.29	4.77	4.35	4.56
Three way cross 322	185.41	163.00	174.20	20.00	19.16	19.58	4.63	4.46	4.55
L.S.D. 0.05	13.38	N.S.	7.15	1.09	N.S.	0.83	N.S.	0.09	0.09
Interaction (D x C):									
L.S.D. 0.05	N.S	N.S	N.S	N.S	N.S	N.S.	N.S.	N.S.	N.S

Table (4): Effect of plant density on grain yield and its components of maize hybrids.

Main effects and interaction	No. of rows/ear			No. of grains/row			100-grain weight (gm)			Grain yield (ardab/fed.)		
	1996	1997	comb.	1996	1997	comb.	1996	1997	comb.	1996	1997	comb
Plant densities (D):												
20.000 plant/fed.	13.75	13.50	13.62	46.09	41.34	43.71	30.06	29.16	29.61	24.76	24.17	24.46
24.000 plant/fed.	13.31	13.25	13.28	46.12	40.37	43.25	29.07	28.02	28.55	26.89	27.97	27.43
30.000 plant/fed.	13.56	13.09	13.32	43.87	37.03	40.45	27.99	27.95	27.97	29.24	30.74	29.99
L.S.D. 0.05	N.S.	N.S.	N.S.	N.S.	1.95	1.43	0.29	1.01	0.52	0.96	1.80	1.01
Cultivars (C) :												
Single cross 10	13.16	13.53	13.25	47.75	42.41	45.08	30.07	28.69	29.38	30.93	29.86	30.40
Single cross 122	13.33	13.50	13.41	45.50	40.58	43.04	30.10	27.84	28.97	31.04	28.28	29.66
Single cross 124	14.33	13.00	13.66	46.66	38.75	42.70	29.56	28.46	29.01	30.70	28.44	29.57
Single cross 129	14.33	13.83	14.08	43.91	36.83	40.37	28.81	28.96	28.89	28.15	24.18	26.17
Three way cross 310	13.83	13.91	13.87	44.41	38.75	41.58	28.85	28.07	28.46	26.39	28.40	27.39
Three way cross 320	12.16	12.16	12.16	44.83	41.08	42.95	28.13	28.99	28.56	25.16	27.51	26.34
Three way cross 321	14.50	13.33	13.91	45.08	38.16	41.62	28.14	27.75	27.94	21.71	26.76	24.23
Three way cross 322	12.66	13.16	12.91	44.75	40.08	42.41	28.66	28.23	28.45	21.60	27.59	24.54
L.S.D. 0.05	1.16	0.95	0.73	N.S.	N.S.	2.28	0.65	N.S.	0.73	2.11	2.87	1.73
Interaction (D x C): L.S.D. 0.05	N.S	N.S	N.S	N.S	N.S	N.S.	N.S.	N.S.	N.S	N.S	N.S	N.S

plants/fed. Generally, it could be stated that the increase in the number of plants/fed. led to an increase in grain yield/fed., but yield components could be decreased. Esechie (1992), Badr *et al.* (1993) and Atta Allah (1996) agreed with these findings.

3.2 . Effect of maize hybrids

Data presented in Tables (2, 3 and 4) show also the differences between the eight maize hybrids. There were highly significant differences among maize hybrids in plant height, number of leaves/plant, ear height, ear length and ear diameter. While, the other studied growth characters were not influenced significantly.

The tallest hybrid was S.C. 10 and the shortest was S.C 122. Single crosses numbers 122, 124 and 129 had less number of leaves/plant than the other five hybrids. Single cross 10 had the highest ear position, S.C.122 had the lowest and the rest were varying between them. Ear length of S.C. 122 was the tallest and T.W.C. 321 was the shortest. Ear diameter of S.C. 124 was the biggest and that of T.W.C. 320 was the smallest. Single cross 129 had more number of rows/ear and T.W.C. 320 had less. Single cross 10 produced the heaviest grains and T.W.C. 321 produced the lightest ones.

The single crosses numbers 10, 122 and 124 out-yielded the other five hybrids. These five could be categorised into two classes, the first includes S.C. 129, T.W.C. 310 and T.W.C. 320 and the second contains both T.W.C. 321 and T.W.C. 322. These data coincide to a great extent with those of 100-grain weight which could explain the varietal variation.

The differences in growth, yield and yield components of maize hybrids under study may be due to the differences in response of their genetic makeup to stress conditions and environmental factors affecting developmental processes and ability to thrive and benefit from the available nutrients. The results are in harmony with those obtained by Salem *et al.*, (1983), Khalifa *et al.*, (1984), El-Habbak (1985), Salwau (1984), Aly (1988), Gouda *et al.*, (1992), Badr *et al.*, (1993), Hassan (1995) and Atta Allah (1996).

3.3. Effect of the interactions

The reaction of maize crop to varying plant population was independent of the cultivars. Therefore, data of the interaction of the two factors were not presented.

3.4 . Correlation relationships

Grain yield was positively and significantly correlated with 100-grain weight under the first plant density (20.000 plant/fed.), with ear length and number of grains/row under the second plant density (24.000 plant/fed.) and with 100-grain weight under the third plant density (30.000 plant/fed.). Also positive correlation was found between grain yield and number of grains/row under the first density (20,000 plant/fed.).

Concerning 100-grain weight, it is clear that this trait correlated positively and significantly with ear length under 20.000 and 24.000 plant/fed.,and not under 30.000 plants/fed. (Table 5 a, b and c).

3.5 Partitioning of correlation

It is clear from Table (6) that the most positively correlated components to grain yield were ear length followed by 100-grain weight. Also positive association was found between grain yield and number of grains/row. These three components under the three studied plant densities in turn showed in most cases positive direct relationships with grain yield except number of grains/row under 30 thousand plant/fed. and 100-grain weight under 24.000 plant/fed.

Also, ear length under 20 thousand plant/fed. had the highest direct relationship with grain yield followed by 100-grain weight under 30 thousand plant/fed. then ear length under 24 thousand plant/fed. On the other hand, the results indicate that number of grains/row under 30 thousand plant/fed. and 100-grain weight under 20 and 24 thousand plant/fed. had the lowest direct relationships with grain yield. These results indicate the importance of partitioning the correlation which showed that the greatest indirect association to grain yield was due to 100-grain weight through ear length under 20 and 24 thousand plant/fed. and also these traits showed negative and negligible direct relations with grain yield under the above mentioned plant densities.

Table (5):Simple correlation coefficients between grain yield and its attributes of maize (combined over 1996 and 1997 seasons).

A - At 20.000 plant/fed.

	Characteristics	1	2	3	4	5
1	Plant height	-				
2	Ear length	0.248	-			
3	No. of rows/ear	-0.311	0.335	-		
4	No. of grains/row	0.502	0.288	-0.634	-	
5	100-grain weight	0.258	0.812*	0.207	0.342	-
6	Grain yield (ardab/fed.)	0.028	0.732*	0.118	0.611	0.561

B - At 24.000 plant/fed.

	Characteristics	1	2	3	4	5
1	Plant height	-				
2	Ear length	-0.120	-			
3	No. of rows/ear	-0.348	-0.304	-		
4	No. of grains/row	0.722*	0.331	-0.517	-	
5	100-grain weight	0.175	0.821*	-0.130	0.461	-
6	Grainyield (ardab/fed.)	0.247	0.774*	-0.387	0.775*	0.686

C - At 30.000 plant/fed.

	Characteristics	1	2	3	4	5
1	Plant height	-				
2	Ear length	-0.123	-			
3	No. of rows/ear	-0.040	-0.281	-		
4	No. of grains/row	-0.297	0.331	-0.507	-	
5	100-grain weight	0.059	0.659	-0.347	0.427	-
6	Grainyield (ardab/fed.)	-0.174	0.659	-0.001	0.200	0.841**

3.6 . Path analysis

Data in Table (7) indicate that the forementioned three components *i.e.*, ear length, number of grains/row and 100-grain weight contributed together 84.96%, 95.07% and 82.16% of the total grain yield variation under 20, 24, and 30 thousand plant/fed., respectively. Under the dense planting of 30.000 fed., 100-grain weight contributed to most of the yield variation either directly (47.32%) or indirectly (28.54%) through the other components. The ear length replaced 100-grain weight under 20.000 plants /fed. and24.000 plants/fed. as well

Table (6): Partitioning of simple correlation between grain yield (ardab/fed.) and its components of maize (pooled data of the combined analysis).

Sources	Plant densities (plant/fed.)		
	20000	24000	30000
Ear length:			
Direct effect.	0.7975	0.7380	0.2034
Indirect effect *via* No. of grains/row	0.1340	0.2076	-0.0685
Indirect effect *via* 100-grain weight	-0.1995	-0.1716	0.5241
Total (ry 1)	0.7320*	0.7740*	0.6590
Number of grains/row:			
Direct effect	0.4654	0.6271	-0.2069
Indirect effect *via* 100-grain weight	-0.0840	-0.0963	0.3396
Indirect effect *via* ear length	0.2297	0.2443	0.0673
Total (ry 2)	0.6110	0.7750*	0.2000
100-grain weight:			
Direct effect	-0.2457	-0.2090	0.7953
Indirect effect *via* ear length	0.6476	0.6059	0.1340
Indirect effect *via* No of grains/row	0.1592	0.2891	-0.0884
Total (ry 3)	0.5610	0.6860	0.8410**

Table (7): Direct and joint effects of grain yield attributes presented as a percentage of variation of maize (combined data across seasons).

	Plant densities (plant/fed.)					
Sources of variation	20000		24000		30000	
	C.D.	%	C.D.	%	C.D.	%
Ear length.	0.3547	35.47	0.3116	31.16	0.0310	03.10
Number of grains/row	0.1208	12.08	0.2249	22.49	0.0320	03.20
100-grain weight	0.0337	03.37	0.0250	02.50	0.4732	47.32
Ear length x No. of grains/row	0.1193	11.93	0.1752	17.52	0.0209	02.09
Ear length x 100-grain weight	0.1775	17.75	0.1449	14.49	0.1594	15.94
No.of grains/row x100-grain w.	0.0436	04.36	0.0691	06.91	0.1051	10.51
R^2	0.8496	84.96	0.9507	95.07	0.2816	82.16
Residual	0.1504	15.04	0.0493	04.93	0.1784	17.84
Total	1.0000	100	1.0000	100	1.0000	100

C.D = Coefficient of determination. % = Percentage contributed.

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تأثير الكثافة النباتية على المحصول ومكوناته لثمانية هجن ذرة شامية مصرية

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ملخص

أقيمت تجربتان حقليتان في حقل إرشادي بقرية شبيبة مركز الزقازيق محافظة الشرقية في موسمي 1996، 1997 لدراسة تأثير الكثافة النباتية 20، 24، 30 ألف نبات/فدان على ثمانية هجن مصرية من الذرة الشامية هي هجين فردى 10، هجين فردى 122، هجين فردى 124، هجين فردى 129، هجين ثلاثي 310، هجين ثلاثي 320، هجين ثلاثي 321، هجين ثلاثي 322.

وتتلخص أهم النتائج فيما يلي:

1- أدت بوجه عام زيادة الكثافة النباتية الي زيادة في ارتفاع النبات وارتفاع الكوز على النبات في حين لم يتأثر عدد الأوراق على النبات وعدد الأوراق أعلى الكوز الرئيسي بزيادة الكثافة النباتية من 20 إلي 30 ألف نبات للفدان.
2- أدت زيادة الكثافة النباتية إلي نقص في مساحة ورقة الكوز الرئيسي وطول الكوز وقطر الكوز وعدد حبوب الصف ووزن المائة حبة بينما لم يتأثر عدد الصفوف بالكوز بزيادتها.
3- ارتفع محصول الفدان من الحبوب من 24.46 أردب للفدان الى 27.43 أردب للفدان الى 29.99 أردب للفدان بزيادة الكثافة النباتية من 20 الي 24 الى 30 ألف نبات للفدان.
4- اختلفت الأصناف تحت الدراسة معنويا فى جميع الصفات المدروسة عدا عدد الأوراق أعلى الكوز الرئيسي ومساحة ورقة الكوز الرئيسي وكان ترتيب الأصناف حسب تقدمها في كمية محصول الفدان من الحبوب تنازليا كالآتي: هجين فردى 10 الذي وصلت إنتاجيته إلى 30.40 أردب/للفدان - هجين فردى 122 - هجين فردى 124 - هجين ثلاثي 310، هجين ثلاثي 320 - هجين فردى 129 - هجين ثلاثي 322 ثم هجين ثلاثي 321.
5- كان التفاعل بين الكثافة النباتية والأصناف غير معنوي لكل الصفات المدروسة.

6- ساهمت مكونات محصول الحبوب الرئيسية وهى طول الكوز وعدد الحبوب بالسطر ووزن الـ100 حبة مجتمعه بـ 84.96%، 95.07%، 82.16 % من التباين الكلى في محصول الحبوب تحت الكثافات النباتية 20، 24، 30 التباين الكلي في محصول الحبوب تحت الكثافات النباتية 20، 24، 30 ألف نبات/فدان على التوالي إلا أن المساهمة الموجبة سواء المباشرة أو غير المباشرة (من خلال تداخل الفعل) لوزن المائة حبة عند الزراعة بكثافة 30 ألف نبات للفدان شكلت القدر الأعظم من مساهمات هذه المكونات ثلاه في هذا الصدد طول الكوز عند الزراعة بعشرون أو أربعة وعشرون ألف نبات للفدان.

7- توصى الدراسة بإمكانية زيادة معدل الكثافة النباتية حتى 30 ألف نبات للفدان مع استخدام الهجن الفردية عالية المحصول مثل هجين فردى 10 وهجين فردى 122 وهجين فردى 124 حيث ثبت تفوقها معنويا على باقي الهجن تحت الدراسة.

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