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ORIGINAL ARTICLE

Effects of Plant Density and the Ratio of Maternal Lines on Producing Seed Corn Hybrid S.C.704 in the Khuzestan state of Iran

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ABSTRACT

This research was carried out in the summer of 2009 in farm research station of safi-abad (Institute of seed control and certification). The experiment was performed as a split plot as follows: planting density of maternal lines include 60, 70, 80, 90 thousand plants per hectare (respectively D_1 to D_4), as the main plot lines and the ratio of maternal to paternal lines include two levels of maternal lines, 4 lines, and 2 paternal line (4:2) and 6 maternal lines to 2 paternal lines (6:2) in the sub plots (respectively L_1 and L_2) in a complete randomized block design with four replications. To reduce the border effects due to pollination in addition to the two sides tested maternal line, 6 maternal lines were cultured as border. Not to interfere with pollen grains from farms around the thousand meter distance with them was considered. Distance to plot 1.5 m was considered for treatment 4:2, each plot includes 26 sub-line that included 80 sire lines and maternal lines will be and at 2 to 6 times higher than the 30 line 8 line. including sire and 24 maternal line (total 26 lines in the plot), respectively. The results were analyzed with using SAS statistical software. Results showed the effect of density on ear number per square meter and weight of grain has been significant and had no effect on other traits. The number of maternal lines had a significant effect on the number of seed per row and total number of grains per ear. And had not significant effect or row number per ear, number of ear per m^2 and grain yield. Interaction between density and planting pattern on all traits except ear number per m^2 and grain yield had significant effect. Considering that none of the factors discussed and the effects of their interaction on yield per hectare had no significant effects, has chosen the best combination based on the maximum seed weight logical way, in this regard, combination of 6 line native density with 80 thousand plants per hectare will be optimum.

Key words: planting pattern, plant density, seed production, hybrid, Corn

Introduction

Internal consumption of grainy Corn in Iran country, was about 4 million ton and internal production was also 2.6 million ton in year. So developing and progress of this strategic crop have an important value. Gozobenly, *et al* [14] reported that with considering of different Corn plant density (60, 75, 90, 105, 120 & 135 thousand plant in hectare) in two planting pattern, one and two rows, the grain yield is significant. From theoretical point the plants that have square formation use sources efficiently than of plant which have rectangular formation [25] kim and chang [19] by operating an experiment with equal planting distance in two rows planting rather than one row planting in 1980, 1981 and 1982 years, observed that the yield increase 631, 520 and 700 kg per hectare respectively. But, between ear number, ear weight and seeds weight, a significant difference was not observed. In square

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planting method rather than normal method, because of better profitability of plants from environment and decrease of competition between them, the grain yield is more [12]. Stewart [31] reported that when cultivation is in two rows, The grain yield of that is more than pattern state of one rows. Bavace and Bavace (2002) reported that in narrower rows (38 & 48 cm) 12 percent obtained more yield rather than 76 cm rows distance and obtained 6.25 percent of ear numbers more than 76 cm. In more densities, total absorbed sunshine by canopy is increase and at least cause increasing of grain yield [15]. With increasing of Corn plant density (51 thousand plant in hectare) the number of seed in square meter increase and by increase of plant density, Ear weight and the number of seed in Ear have increased and at the end, yield per square meter decreased. Planting density addition of grain yield can have effect on quality and feed value of seed. by decrease of light rate, the amount of protein and oil in maize decrease significantly. so planting pattern must be a kind that could use the maximum of sunshine; because efficiency of absorbing radiation energy which shine on surface of a farm, depending on enough leaf area. This purpose is with possible with optimum plant density in field [10]. Biological yield of maize plant, response to density has a asymptotic Form. it means that by increasing of density in lower boundary, yield in square meter Increase linearly, but gradually speed of increase, decreases and yield is receiving to maximum level. High density didn't leads to crop increase [35].

Increasing of agricultural crops production is possible by increasing of planting surface and yield increasing in square unit. With due attention to natural sources limitation (soil, water,....) they plan to increase yield in square unit that is the main purpose of agriculture. By using of modified cultivar, preparing desire bed, date choice and appropriate planting pattern, agricultural fallow unit and leads to efficiency agriculture increase of crop yield in square meter [18]. Bean and Gerik [9] in an experiment, described that planting rows effect including 50, 75 &100cm and 45000, 64220, 79040 and 98800 thousand plant density in square meter and recommended 50cm row distance with 11.1 percent suitable yield increase rather than 75 row distance and also offer optimum density, 79040 thousand plant per hectare.

One of the main factors in agriculture plants produce is the amount of solar radiation, That penetrate into the canopy [13]. Photosynthesis efficiency, and crop maturity, extensively depending on vertical light distribution into canopy [34] and also photosynthesis yield extensively depending on leaf area index [27]. also grain yield in Corn have a close relationship with leaf area index and canopy [34]. Hanter [16] reported that more leaf surface in plant, leads to more assimilate in plant and increase yield. leaf area index increase in two way: reform for leaf surface increase in plant and increasing plant density. Increase in plant density is a management method for absorption increase of sun radiation in canopy. plant density is one of the important agricultural factors that have a considerable effect of maturity parameters. usually by increasing of density, the leaf area index increase too, and this is simplest method for leaf area index increase, but economical yield is also increase parallel to leaf surface index [20]. Nowatzaki *et al* [26] observed that, by decrease of crop rows distance, the grain yield will increase. In this study ,dry weight of root, about 16 and 32 percent in time density increase, become low. amount of absorbed light for Corn plant and grain yield is different in various weather conditions and is depend on factors like the sunshine amount, radiation angle, diuration of radiation & etc. In each area by using of optimum plant density and suitable maternal line ratio to paternal get more seed produce. so the general purpose of performing this research is determining of the optimum density and planting pattern and their effects on seed produce amount in khouzestan province in Iran country.

Materials and methods

In order to study and describe of plant density and maternal line ratio to paternal, crop lines in Maize seed (single cross 704) produce, an experiment was performed in farm research station of safi-abad in summer, 2009. This center is located in 120km north of Ahvaz with 82 height from sea level and 32 geology wide and 24 north minutes and 48 length and 24 east minutes. Generally all of south country coast lands that their height is less than 100 meter, including desert climate. So whole of khouzestan plain to lorestan's mountain slope have this climate figures. Heat in all of this area is severe (stable maximum temperature in this area is 53 and related to Ahvaz) rain mean annually in this area is of low amount and doesn't in order now.

Almost all of raining is in winter and 7 months of year doesn't have raining (Kochakee et al, 1374). To determine physical and chemical soil characteristics ,after choosing the place of test operation from testing soil before any land preparing operations by oger sampling from 0-30 cm land depth from 10point randomly, the sampling was performed. obtained result of soil deposition in soil laboratory are expressed in table 1.

Used Line Characteristics:

Until now, according to different experiments, Maize hybrid of S.C.704 is the best medium unripe from yield rate point of view in summer cultivate in khouzestan province [21]. Maternal parent of this hybrid is B73 inbred line and mo17 is paternal. This hybrid is two purpose that is more used grainy, the grain yield of that is about 6-9 ton ha^{-1}. whole plant

Table 1: Physicochemical traits of soil of field that used in the experiment.

Soil Tissue	OC(%)	K(mg/kg)	P(mg/kg)	Total N(mg/kg)	pH	EC (m mho/cm)
Clay Loam	0.82	120	10.6	3.32	7.6	1.2

of that is about 285cm height and the last role of ear from soil surface is about 110 cm and cylinder ear with 20-23 cm length. Seeds of this hybrid is horse dent and their color is light yellow and every one thousand seed weigh of that is 370g. This hybrid for seed produce need to 123 days and for forage production needs to 95-100 days [20]. This hybrid relatively was consisted to dryness and is recommended to all Iran area except cold mountains areas.

Characteristics of the Used Experimental Design:

The experiment performed in split design plots in completely blocks design with 4 replication. Densities are situated in main plots and cultivate pattern in sub plot repetitions distance from each other is said 10meter and between two main plot, two border was conducted. In each sub plot for 2 to 4 ratios from 6 paternal line and 12 maternal line (in all, 18 line) and for 2 to 6 ratios from 6 paternal line and 18 maternal line (in all, 24 line) was used, so that the distance of paternal line between near plot included 10 maternal line and the wide of every main plot received to 30 m. The length of cultivate lines was 10 m. So dimensions of experiment for decreasing of marginal effects is cause of pollination in both side of experiment addition to 6 existing maternal line also cultivated as a margin was 130×50.

Characteristics of Treatments:

The fiest factor (density of planting maternal line) were located in main plot, include D_1 (60 thousand plant density per hectare), D_2 (70 thousand plant density per hectare), D_3 (80 thousand plant density per hectare), D_4 (90 thousand plant density per hectare) and second factor of maternal line ratio to paternal was in sub plots and include ($P_{1=}$ 4:2 including 4maternal line and 2 paternal line and P_2 = 6:2 including 6 maternal line and 2 paternal line).

Preparation operations of land in usual way in the land that was fallow in last year accompanied by 300 kg of Ammonium Phosphate per hectare, 50 percent as base and 250 kg potassium sulfate separately per hectare, monotonous and in form of hand-sprinkle was distributed in farm surface and then by disk was located in 15-20 cm depth of mixed soil surface and by using of transfer plough in 10-30 cm depth of soil. Creating mound and stream with 75 cm stable distance for all treatments perform by furrower and then irrigation streams was created in distances of experiment replications. All of mounds and streams was amendment with worker help and located in a suitable frame planting operations after seeds and on mounds that was created based on planting pattern was performed. In each pile 2-3 number of seed was cultivate in 2009/7/25. In this case, seeds distance on every planting row was density of 60thousand plant in 22 cm, density of 70 thousand plant in 19 cm, density of 80thousand plant in 16.5 cm and density of 90 thousand plant in 14.7 cm and in 10 cm paternal lines (with density of 133 thousand plant). Immediately after planting, has been doing for irrigation, then first irrigation was take into account as planting date. To achieve to optimum density in 4 leaf stage sure about germination and complete settlement of plants and subjected note taking and with adjusting 14.7, 16.5, 19 & 22 cm distance of omitting of extra plants and piles were brings out in form of one plant.

Regarding to farms calamity was not in economic loss. There was not any need to spraying Insecticides. For controlling of weeds addition to spraying with Eradican herbicide in form of pre-planting, one time, after germinating used Laso and Aterazin and also was performed a hand harvest for first time. Fertilizer in two stage was used in 100 kg /ha based on urea at first in 6-7 leaf stage and in second period was used before taselling stage. For producing seed farms with due attention to paternal pollen line must pollinate so if it was not used from maternal line bases in maternal line time (in all flowering period) male flowers should drown out that in terminology this operation is called omitting of tassel. This operation, can be performed by hand or machine. This operation, operate before flowering period, with identifying and omitting of tassel, measured traits in this experiment include: ear number per plant, row number per ear, seed number in row seed per ear, seed thousand weight, and grain yield. For determining the weight of one thousand seed between dry seeds, ten sample of 100 seeds were randomly separate and weighted, then mean of one thousand seed was achieved according to measuring of grain yield, after physiological maturity. In order to determining the 4 and 6 maternal line grain yield because of potential difference among maternal line from all lines was used for determining of farm yield and by omitting of 4m plants, the first and the last each row of remained plants was harvesting by hand and harvested ears for grain yield determining were converted to laboratory. Seeds located around 8, clock in oven in 75^0C temperature until water content received to 14 percent. For variance analyze, SAS statistical software was used. Means were showed according to Dunkan test and for drawing graph, Excel was used.

Results and Discussion

Yield Components:

Number of Ear per Plant:

Variance analyze (table 2) showed that, number of maternal lines and interaction effects on ear number have a highly significant and significant effect respectively. But density doesn't had significant effect on said trait. Studies showed that, primary growth of ear is affected by light in plant population extensively. In other word, if there was enough light, usually two bud in same time stimulation and produce two ear together. In khouzestan area, due to clear and sunny sky along maturity period, density increase to an absolute board, has not a lot of effect in received light density decrease by plant population [23]. Usually with density increase, number of ears in each plant and number of seed in ear due to seeds barren increase and decrease of assimilate, decreased due to shading. But the more number of plant, cause compensation, this decrease and in result, seed produce increase in hectare. In principle the relation of density and yield components is linear. But this relation with grain yield is quadratic [6,32]. Mean comparison of maternal line numbers showed that, highest number of ear per plant belong to 0.56 to 6 maternal line and lowest 0.5 to 4 maternal line (Figure1). By comparison it's observed that highest number of ear per plant 0.57 from density of 60 thousand plant per hectare. The reason is that in low density, plant have a high tendency to produce more than one ear, but in 70 to 90 thousand densities, number of ear per plant received to a meaningful increase of 0.56 to 0.49 ear per plant (figure 2) with mean interaction effects comparison of plant density and maternal lines number was observed that most of 0.64 ear numbers in plant with 6 maternal line is obtained (figure 3). Number of ear per plant is a qualitative trait and is not affected by environment, but so the number of ear per each plant according to planted number and plant density can change somehow produces many of ear numbers in low density and suitable conditions of some eares in plant [33].

Number of Row per Ear:

Results (table 2) showed that, number of row per ear significantly affected just by maternal lines number and density and interaction effect of plant density and maternal lines on selected trait was not significant. However, increase of density leads to decrease of row number per ear, but from this point of view was not shown and has a significant difference between different density level (table 2). This case is related to genetics, and that high resistance in front of environmental changes. although decrease of seed row number per ear is reported in increasing of plant density by some of the recearchers and also some of researchers believed that plant density doesn't have effect on seed row number. last number of seed row per ear is determined before particle remains of yield components, probably in determination stage of seed row per ear, there is not a few competence between physiological sink for preserved Materials and high density of plant in square meter Just cause a significant decrease of seed weight of each ear and number of seed in each row [33,5]. In mean comparison, number of maternal lines on said trait of highest number of row in ear with 14.67 to 4 maternal line and lowest of that with 12.23 to 6 maternal line belongs (figure 4). The reason is that ,by increasing number of maternal line, maternal line distance from paternal decreased due to pollination percent and this factor leads to decrease number of row per ear in 6 maternal line rather than 4 line.

Seed Number per Row:

Results (table 2) showed that number of seed per row affected high significantly by number of maternal lines. But density effect and density interaction and maternal lines on obvious trait is not meaningful. By comparison of mean ,the number of maternal lines showed that highest number of seed in row (18.63) with 4 maternal line and lowest (14.31) with 6 maternal line is obtained (figure5). Despite of obtained results by majority of researchers, number of row doesn't affect by density. They believed that considerable decrease of seed number in each row and weight of ear with density increase, show that this yield component in comparison with seed row number in ear rather than density increase of plant have more sensitivity and are effectual particles in yield adjustment [33,30]. But with due attention to said results from related surveys is obtained to Hybrids, the use of B73 line in this investigation is not correct.

Interactions of density and maternal lines number showed that, highest number of seed in row (19.72) from 90 thousand plant with 4 maternal line and lowest (12.42) from 70 thousand plant with 6 maternal line is obtained. In pattern of 4 maternal line with increasing of plant density, number of seed in each row increased, but in 6 maternal line formation is not observed particular procedure, so that weak maturity of lines like B73 which low number of seed in row (16.47 seed in per row) is created, because of the competition due to density about this case can be usefulness. In fact, survey of means showed that with density increase, also number of seed in row increased a little, so it seemed that used densities in this experiment could been more than 90 thousand.

Table 2: Analysis of variance (mean squares) yield and yield component.

S. O. V	Ear per plant	Row per ear	Grain per row	Grain per ear	Thousand-grain weight (g)	Grain yield (ton/ha)
block	0.000012^{ns}	19.644^{ns}	46.652^{ns}	5171.382^{ns}	32932.86146^{**}	17915.22^{ns}
density	0.01418^{ns}	2.407^{ns}	7.271^{ns}	2701.535^{ns}	120162.1979^{**}	278036.10^{**}
Error a	0.002984	11.987	16.348	3171.715	1143.08924	69107.90
Maternal line	0.036450^{*}	47.775^{*}	148.781^{**}	28698.092^{**}	8435.77813^{ns}	530151.34^{*}
density× Maternal line	0.016735^{**}	2.952^{ns}	29.250^{ns}	6926.849^{*}	13248.41146^{*}	196759.15^{**}
Error b	0.1171	6.518	15.767	2310.626	3295.4615	1500167
CV (%)	7.2	15.86	24.10	6.21	16.1	5.26

ns: non significant, * , **: respectively significant ($p \leq 0.05$) and highly significant ($p \leq 0.01$)

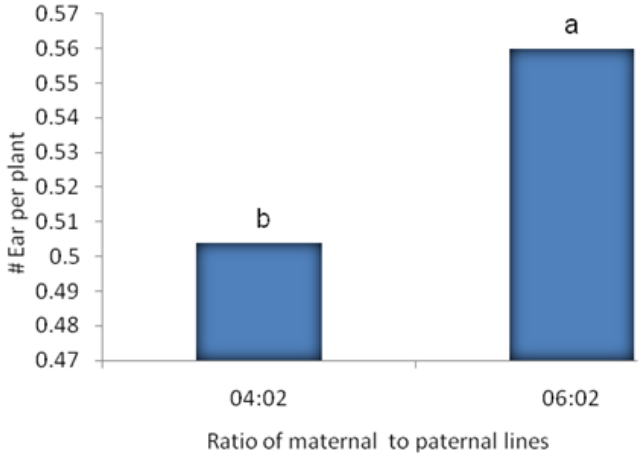

Fig. 1: Effect of maternal lines number on number of ear per plant.

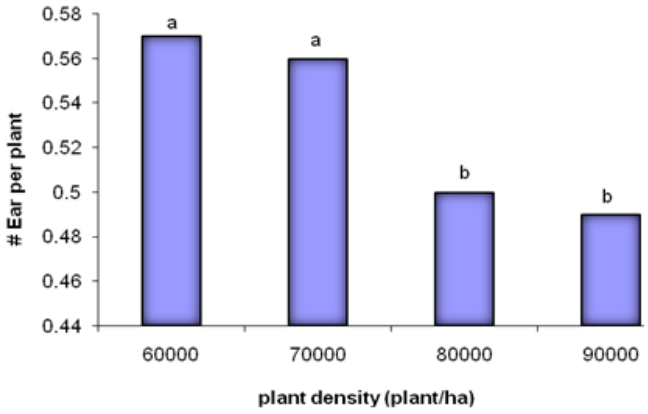

Fig. 2: Effect of plant density on number of ear per plant.

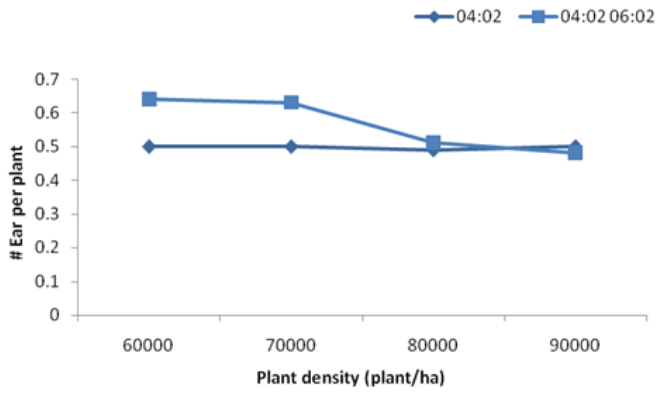

Fig. 3: Interaction effects of plant density and maternal lines on ear per plant.

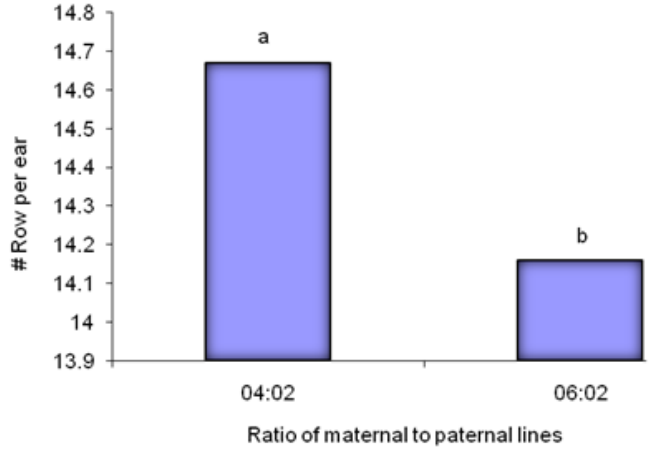

Fig. 4: Effect of maternal lines number on number of row per ear.

Number of Seed per Ear:

Results (table2) showed that, number of maternal lines high significantly and interaction of density and maternal lines significantly has an effect on number of seed in ear. Density effect on mentioned trait doesn't have any significance. A lot of researchers that their used seed was Hybrid, Reported that decreasing of seed number in ear increasing during plant density [2,1]. In most of these cases, with increasing density, seed number in ear decreased. This decrease is not for decreasing of number of seed row in ear, but it is because of decreasing of number of fertial ear in unite square and seed number in ear row [22]. Because with increasing of plant density, Assimilate saved capacity in competition effect increased and ratios of abnormal floret increased, and seed number per ear decreased [29,3,11]. But as was mentioned before, with due attention to lack of lines maturity, competition about B73 line is not correct. It seemed that this line have the capability to bear the competition that is cause of very high densities.

Total number of seed affected by number of maternal lines, showed that highest number of seed with 330 belong to 4 maternal line and lowest with 270 to 6 Maternal line (figure 6). Mainly, the seed number per ear is affected by seed number per row and row number per ear, so treatment of maternal lines number as affected in both seed number and seed number per row. also affect seed number per ear but the row number per seed and number per row is not affected by density interaction, and by number of maternal lines but the result is capable to be effective on seed number per ear and in this case the interaction has been effective (figure7). The effect of maternal lines number on seed number and seed number is due to pollination because of change in number of maternal line is means of change in pollen seeds density, that pollinate little seed and in fact by decreasing and increasing of pollens number, the number of created seeds number also change in ear.

One Thousand Seed Weight:

Variance analyze (table 2) showed that plant density and density interaction and number of maternal lines has a significant effect on one thousand seed weight. But number of maternal line on mentioned trait was not significant. Comparisons of means according to Dunkan method about density effect on one thousand seed weight showed that one thousand weight of 60 until 80 thousand plant density hadn't an obvious difference. But by increasing of 90 thousand plant density, one thousand weight decreased significantly. Also results of most surveys in other operated investigations in country means that one thousand weight by increasing of density decreased [23]. So, lack of one thousand seed decrease in 60-80 thousand densities showed that about B73 line, this subject is somewhat different. This difference is result of that, in this densities seed number per ear increased a little and this means that Assimilates between sink are more and apparently the weight of one thousand must also decreased, but as was mentioned before, inbred lines like B 73 in compare with hybrids because of weakness of maturity, can bear high densities, so it seemed that high densities of 90 thousand are densities that will change the balance between one thousand weigh of seed and seed number needs better operation.

Significant intensity interactions between number of maternal lines and plant density on single weight showed that by increasing of density procedure of seed weight changes in different ratios have different maternal lines (figure 8). Changes of procedure was like that in maternal 6:2 line ratios by increasing of plant density from 60 to 90 thousands plant, at first weigh of one thousand seed increased and then it was decreased (but in maternal 4:2 lines the ratios by increasing of density, weigh of one thousand was decrease nonlinear and this method is results of this ratios, high density of pollen grains caused seed number increase per ear and by making competition between them cause decrease of one thousand and seed weigh, while in 6 to 2 ratios pollen grains was

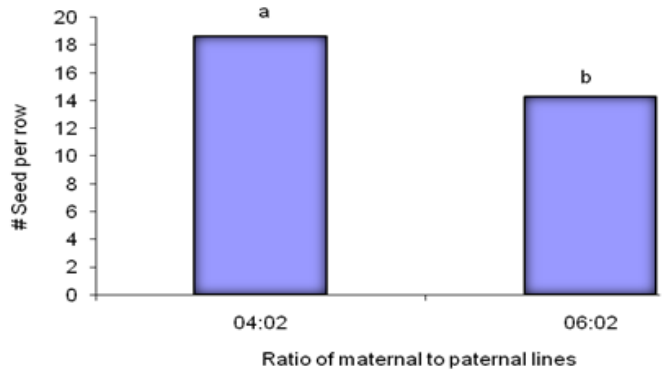

Fig. 5: Effect of maternal lines number on number of seed per row.

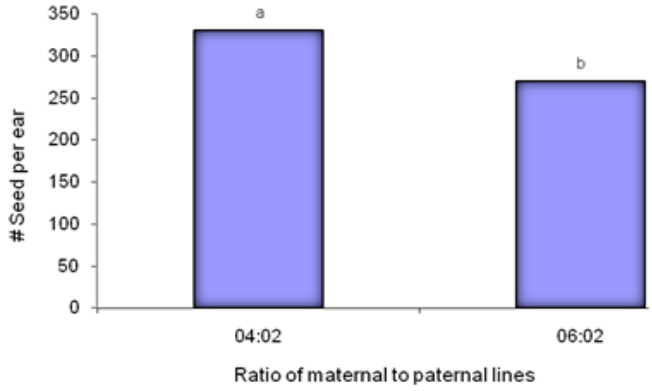

Fig. 6: Effect of maternal lines on seed number per ear.

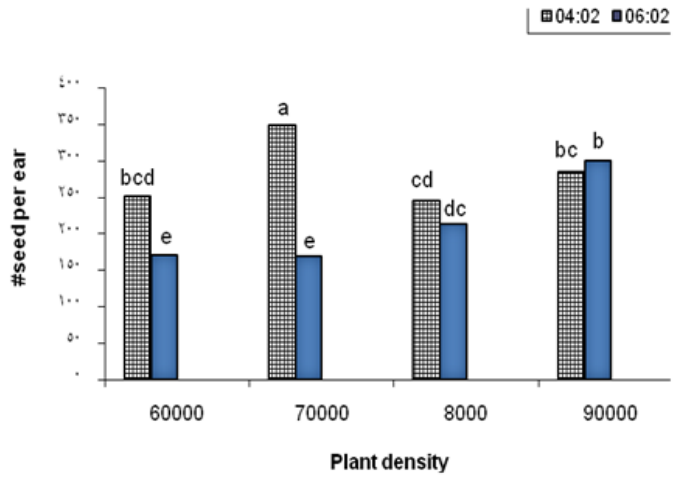

Fig. 7: Interaction effect of plant density and maternal lines on seed number per ear.

low and by creating seed number decreasing until 80 thousand density, there is not obvious competition between seeds and so majority of one thousand weight with 315.78g in thousand densities is obtained, but with density increase to 90 thousand, also one thousand weigh is received to lowest (271g) level.

Grain Yield:

Variance analyze (table2) showed that density and number of maternal lines and density interaction have a significant effect on number of maternal lines. Comparison of means based on Dunkan method showed that, by increasing of plant number, the grain yield increased. So that More grain yield with 2725.12 kg from 90 thousand density and lowest 2278.68 kg from 60 thousand plant density was obtained (figure 9). With effect of number of maternal lines on mentioned trait wasn't observed meaningful. highest production with 2648.74kg from 6 maternal line and lowest production with 2391.31 kg from 6 maternal line was obtained (figure 10). Because, yield in low density in result of lowness of

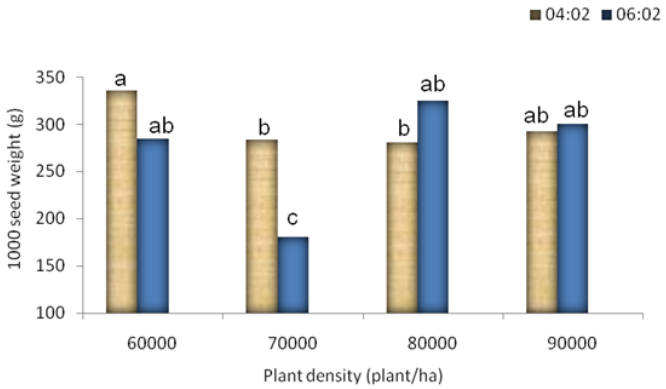

Fig. 8: Interaction effect of plant density and maternal lines on one thousands seed weight.

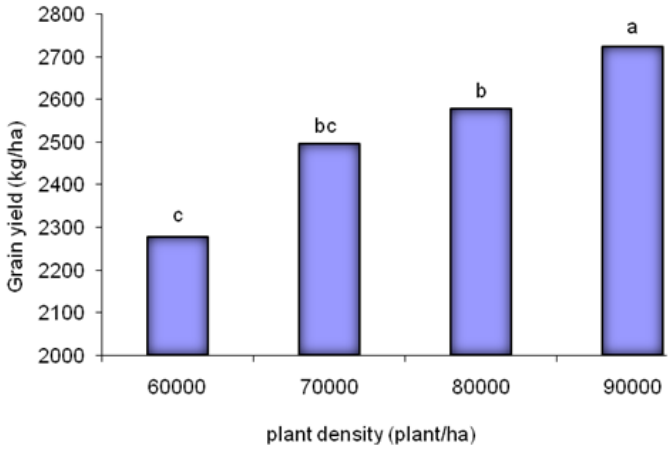

Fig. 9: Effect of plant density on grain yield.

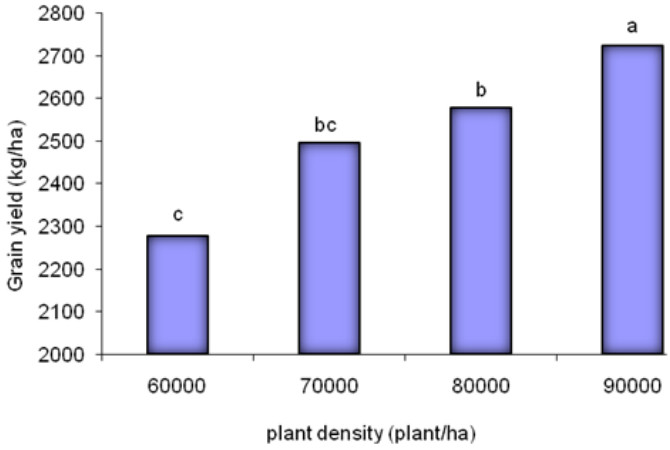

Fig. 10: Effect of maternal lines on grain yield.

plant density and in high density is result of competition for effective absorbed in maturity and also made uncoordinated in male and female flowers is limited. [17].

In evaluation of interaction, 90 thousand plant density in unite square with 6 maternal line and 2884.48 kg in square meter have highest yield and 60 thousand plant density with 4 maternal line and 2161.99 kg in have lowest yield. Increase of grain yield in 9000 plant/ha can be understandable that can say in this density with increasing of plant number, grain yield increased because of plant number in square meter is more and following that high seed number despite of one thousand seed weigh decreasing is increased. Because in high densities, plants can appropriately cover farm surface and used environmental factors [4]. It seem that while used densities are more than 9000 can received to higher grain yield, because as was mentioned before, despite of hybrids Maze that cause decreasing in

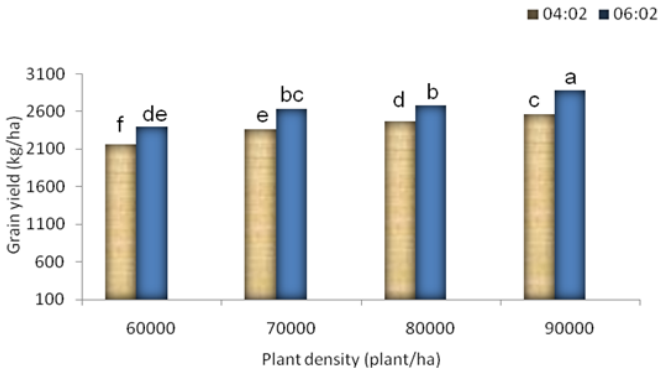

Fig. 11: Interaction effect of plant density and maternal lines on grain yield.

photosynthesis and yield board 70 to 90 thousand density because of shading of plants on together: about B73 seed produced lines until achieving to this point must consider more and high densities.

Conclusion:

As was pointed in survey purpose, this experiment was operated for correct management operation in paternal and maternal line ratios pattern and also finding appropriate densities in north Khozestan province. at all from debates analyze of this test showed that by increasing of ear length, density and one seed weigh received to significant decrease by increasing of number of maternal lines, row number, seed per row, grain number, ear diameter, percent of ordered ears from maternal lines and whole plant biomass is decreased significantly. Highest weigh of one thousand seed belong to 89 thousand density. Highest ear diameter from density of 70000 plant with 4 maternal line is obtained. Highest ear length from density of 60000 with 4 maternal line is obtained. Results showed that 6:2 planting pattern from point of grain yield seed uniformity and also production costs was better than 4:2 plant formation and also by increasing of density grain yield was increase and highest yield for interaction highest densities (90000 plant) and highest number of maternal lines (6 maternal line) is obtained. In farms, produce of potential seed is not same in all lines, highest seed production, highest general number of seeds in ear, row number and seed number in row was obtained for first maternal line.

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