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Original Research Article

~~Investigation of~~ Standard ear yield and some Agronomic Characteristics of Baby Corn Var. ksc 403 su under influence of Planting Date and Plant Density

.

ABSTRACT

In order to investigate of standard ear yield and some agronomic characteristics of baby corn under influence of planting date and plant density. An experiment was conducted at Khorasan Razavi Agricultural and Natural Resources Research center, Mashhad, Iran in 2010. In this research planting date (14th June, 3th July and 24th July) and plant densities (65000, 85000 and 105000 plant.ha^{-1}) were arranged in main and sub plots, respectively. This experiment was laid out using split plot based on a Randomized Complete Block Design with four replications. The results ~~of this study~~ indicated that different planting dates had significant effects on agronomic traits such as plant height, ear height, number of leaves above ear, stem diameter, ear length, and ear diameter, dehusked and husked baby corn yield, standard and sub-standard dehusked ear yield, standard and sub-standard ear percentage. The highest husked ear yield with 13240 kg ha^{-1} was belonged to 24th July planting date. Although, delay in planting date, led to increase of growth period and suitable weather (decreased temperatures) at anthesis, therefore ear yield increased but caused to the reduction ear length and increased ear diameter. Also, ear marketing obviously decreased, not only for fresh consumption but also for industry. Different levels of plant density had significant effects on all traits. The highest dehusked standard ear yield was obtained from the highest plant density (722 kg ha^{-1}). Interaction effect of planting date × plant density had significant on standard ear percentage at a 5% level of probability. Finally, planting date 14th June and the highest plant density (105000 plant~~-~~ha^{-1}), is recommended in order to ~~maximum~~ and produce high quality standard ear that can be presentable in market.

Keywords: Baby corn, Planting date, Plant Density, Standard ear yield

1. INTRODUCTION

Baby corn has had a special place among fresh and conserved vegetables as a product with high nutritional value in recent years. This product is the very green ear, which is harvested and consumed in pollination stage. From decades ago, this production has been consumed freshly in the east west of Asian countries. In fact, it is a long-term that Chinese, Thai, and Taiwanese farmers have used dehusked ears. It is also used as a new nutritional substance in some foods such as salads, soups and pickles [1]. Baby corn contains vitamin B and C, fiber, carotenoids with high nutritional value [2]. Using baby corn technology has led to the suitable land yield in many other countries such as Taiwan, Sri Lanka, Indonesia, India, Zambia, Zimbabwe, South Africa, Guatemala, Nicaragua etc., also baby corn adopted and acclimatized itself to the new environment as the export vegetable [3]. Suitable variety is the most effective factor in producing baby corn, also the most important criteria in variety selection are early maturity, prolificacy (more number of cobs/plant), synchronized ear emergence and yellow kernel of ears [1]. Investigations indicate that there are no researches

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related to the baby corn in Iran and the most of them have focused on sweet corn. In addition, most of researches, which have been done in other countries, are diffuse. Fundamentally, planting date is one of the important components of cropping systems. Selecting appropriate planting date leads to produce high yielding corns. In a research being done in Arlington Mexico, the effect of planting date in improving the products and ear yield has been studied and indicates that late planting date is the cause of yield reduction [4].The results of experiment on a variety of sweet corn (Zea mays L. Saccharata sturt) in eight sowing dates (26April ,11May ,26 May , 11June , 26 June, 11July, 26 July, 11 August) conducted at Agricultural Research Center, Haran University of Turkey determined that plantings dated 5 July to 4 August were significant in terms of grain yield, grain size, single grain weight [5]. Noldin and Mundstock reported that different planting dates (11 October, 2 November) had significant effect on three varieties of sweet corn and it was determined that late planting date was the cause of yield reduction which was about 9% and the number of ear per plant were not affected by planting date [6]. The investigation associated with effect of planting date and plant density on corn yield SC.403 variety indicated that maximum yield being about 20250 per/ha was obtained on 29th April [7]. In this research, corn production rate, ear height and the harvest index were affected by plant density. As plant density increased, ear height decreased and the proper density for spring cultivation of sweet corn and its present ability in markets was 55000-65000 plant/ha. Also, result of the other researcher on four different planting dates (25April, 10 May , 25 May, 9 June) of sweet corn (SC404 variety) revealed that different planting dates had significant differences with each other in terms of ear height and ear diameter. It also revealed that planting date had significant effect on yield in a way that maximum yield (11/2 ton/ha) was obtained with 65000 density plant/ha on 10 May [8]. Selecting the appropriate plant density has effective effect on yield component in a way that appropriate selection of plant density leads to the appropriate yield [9,10]. Genter et al have found that with increase in cultivation density, the number of plants having no ear increases [11]. In the investigation associated with yield and yield components of 35 corn genotypes with two plant density of 55000 and 110000 plant/ha have reported that levels of plant density have significant effect on all investigated traits except ear height and weight of husked ear [12]. Hybrids (27A× 29B) with plant density of 110000 plant/ha had priority over the other studied genotypes in terms of plant height, ear height, number of ear per plot, height and diameter of husked ear and dehusked ear. In an experiment associated with 35 genotypes of single gross yield of baby corn with two levels of density (55000, 110000 plant/ha) it was revealed that hybrid (27A× 31B) had the highest yield of husked and dehusked ear with plant density of 55000 plant/ha. Hybrid (27A × 29B) had the better yield with plant density of 110000 plant/ha [12]. Considering the baby corn as the new plant and because of having nutritional value, it should be added to the individuals' daily consumption. So far, there has not been any arable investigation associated with baby corn at Khorasan Razavi province. Determining planting date and plant density is a necessary requirement for planting baby corn. The objectives of this study were to investigate the effect of plant density and planting date and their interaction effects on baby corn in order to produce high yielding standard baby corn.

2. MATERIAL AND METHODS

The present study was conducted at field experiment of the Khorasan Razavi Agricultural and Natural Resources Research Center (Latitude: 36˚ 13´ N., Longitude: 59˚ 40´E., and 985 meters above sea level), Mashhad, Iran in 2010. Soil texture at the experimental area was silt loam (PH=8, EC=1/67mmho/cm). The experiment was carried out in split plot based on randomized complete block design with four replication. Considering the shortness of growth season of baby corn with the purpose of summer cultivation, planting dates (14th June, 3th July, 24th July) and plant densities (65000 ,85000 and 105000 plant- ha^{-1}) were arranged in main and sub plots with three rows spacing between 20,12 and 16cm, respectively. Each

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experimental plot consisted of 4 rows and spacing between 75cm. In this research each experimental plots consisted of 4 lines with 4/5 meters length, 75 cm spacing between rows. Three seeds were planted per hill, which were thinned to one plant per hill at 4-6 leaf stage. In order to ensure that kernels would sprout irrigation was done in 4-days interval, and then the plantlet was irrigated according to its need after it was sprouted and placed. Fertilizer was used based on soil test. At sowing 200 kg/ha Ammonium phosphate ($NH_4H_2PO_4$), 200 kg/ha K_2SO_4, 300 kg/ha urea (CH_4N_2O) was used for each experiment and this was followed by 200 kg/ha N as urea at the six leaf stage. During the growth period, researchers considered some of the morphological traits such as plant height, ear height, number of ear per plant, stem diameter, number of leaves per plant and number of leaves above ear. Recorded data of 10 competitive plants were obtained from each plot of yield component and all were calculated for the entire plot. At the time of harvesting baby corn, which was the beginning of taslling stage, two lateral rows and half a meter were removed in each plot. Then, the rest of plants were counted and weighed; then ears were harvested by hand. After that, traits including ear height, ear diameter, husked and dehusked ear yield and harvest index of 10 ears in each plot were observed and recorded, on random basis. It is noticeable sweet corn(KSC 403 su) variety has been selected because of having special characteristics of prolificacy, early maturity, synchronized emerging of ears while the others do not enjoy of these characteristics. In this research, data related to traits measurements, were entered to Excel software and the result information was analyzed by SAS (ver.9.2) software. Means were compared using Duncan's multiple range tests at a 5% level of probability and F values were significant

3. RESULTS AND DISCUSSION

3.1 Plant and ear height

Results of variance analysis indicated that planting date had significant effect on plant height and ear height at a 1% level of probability. However, plant density was only significant in plant height ($p<.01$) (table 1). Evaluating the effect of planting date indicated that highest plant height and ear height were obtained on 24th July with mean of 162.6 and 67.46 cm, respectively. Also, the minimum plant height and ear height were obtained on 14th June with mean of 106, 45/82cm (table 3). In addition, the highest plant height was obtained 85000 plants/ha with mean of 140.9cm (table 5).These traits increase on 24th July, because the weather is better (drop in temperature and coldness of the weather) in July and plant growth is in sync with desired temperature and finally reduction in radiance intensity entered to canopy cause increase in the space between nodes and plant height. Increase plant height with increase in plant density is due to plants competition for receiving the light and nutrition. If the plant density increases excessively, the plant height will decreases because of its competition for receiving the light and other environmental factors and resources [13,14].

3.2 Number of leaf per plant and Number of leaf above ear

Planting date and plant density did not have any effect on number of leaves per plant. However, planting date had significant effect on number of leaves above ear at a 1% level of probability (Table1). Also, the highest number of leaves above ear was obtained with average of 6.3 leaves on planting date 24th July (Table 3). Number of leaves per plant is a genetic trait and environmental factors such the plant density do not have significant effect on it. With regard to this, Charles and Arnold have indicated that although the number of leaves per plant is a genetic trait, it can be affected by environmental factors such as temperature, planting date, soil conditions and agronomical cultivation [15].The results of this research are in accordance with result of mentioned research.

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3.3 Stem diameter

Stem diameter was affected by plant density and planting date (table 1). Accordingly, the highest and the lowest stem diameter were observed on planting date~~d~~ 3th July and 14th June with amount of 23/9 and 19.8 mm, respectively (table 3). Also, the highest and lowest stem diameter belonged to 65000 and 110000 plant.ha^{-1} amount of 22.2 and 21.3 mm, respectively (Table 5). These results were in agreement with those obtained by Tamadon Rastagari [8].

3.4 Ear ~~height~~ and ear diameter

Results of variance analysis of ear length and ear diameter revealed that planting date had significant effect on these traits, plant density did not have significant effect on ~~them~~(Table 1). The highest and lowest ear length were obtained on 14th June and 24th July planting date which were about 9.3 and 7.5 cm. Regarding the ear diameter the highest and the lowest ~~amount~~ was obtained on 24th July and on 3th July planting date being about 15.75 and 14.05 mm, respectively (Table 3). Ear diameter and ear length are important traits being considered in selecting the high quality products in convert industry factories. Despite the fact that the ear ~~height~~ decreased on 24th July planting date, its popularity in markets decreased because of the increase in ear diameter and poor quality. Therefore, the best ~~amount~~ of ear diameter and ear length concerning to marketability were obtained on 3th July planting date being about 7.9 (cm) and 14.05 (mm). Along with late planting of sweet corn, the ear length and the corn production decreased [16].

3.5 Number of ear per plant

Planting date did not have significant effect on number of ear per plant. However, plant density had significant effect on number of ear per plant at a 1% level of probability (Table 1). Mean comparison of plant density indicated the highest number of ear per plant was observed with plant density of 65000 plants.ha^{-1} amount of 2.5 ears and increasing of plant density lead to increase in the number of ear per plant, along with plant density change from 65000 to 110000 plants.ha^{-1}, the number of ear decreased up to 1.6 (Table 5).

3.6 Husked ear yield

Planting date had significant effect on husked ear yield at a 1% level of probability. However, plant density did not have significant effect on husked ear yield (Table 2). The highest yield was obtained on 24th July planting date with amount of 13240 ~~(~~kg/ha~~)~~ and it had a significant difference with other planting dates (Table 4). In comparison with other planting dates, desirable temperature at the time of pollination and the appropriate weather conditions on 24th July planting date led to the increase in yield. In an investigation related to the different planting dates of sweet corn reported the highest yield production was obtained on 25th July ~~being about (17751kg)~~ and the lowest amount was obtained on 25th April ~~being (1824kg/ha)~~. ~~The results of this research concur~~ with those obtained by Oktem et al [5].

3.7 Dehusked ear yield, dehusked standard ear yield and dehusked sub-standard ear yield

Variance analysis of dehusked ear yield, dehusked standard and sub standard ear yield indicated that planting date and plant density had significant effect on amount of these traits (Table 2). Investigation of different planting date on yield revealed the highest dehusked ear

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yield and dehusked standard ear yield were obtained on 14th June and 24th July planting date, respectively and it had significant difference with other planting dates (Table 4). The highest yield of dehusked ear and dehusked sub-standard ear were obtained on 24th July planting date which was about 3082 and 2459 (kg/ha), respectively. The highest yield of dehusked standard ear was obtained being about 833 kg/ha on 14th June planting date (Table 4). Also, Mean comparison of plant density indicated that the highest dehusked standard ear yield and sub-standard were obtained with plant density of 105000 plants.ha^{-1} being about 2683, 722 and 1961 kg/ha (Table 5).

3.8 Standard and sub-standard ear percentage

Standard ear percentage is one of the important traits in producing ear in such a way that standard ear percentage is the proportion of the number of ear to the total number of harvested ear. Planting date had significant effect on standard and sub-standard ear percentage. However; this trait did not affected by plant density (Table 2). Investigations demonstrated that interaction effect of planting date × plant density had significant effect on standard ear percentage at a 5% level of probability (Fig1). Mean comparison of planting dates effect on standard ear percentage indicated that the highest percentage of standard and sub-standard ear were obtained on 14th June and 24th July planting dates which were estimated about 53.68 and 66.98 percentage (Table 4). Accordingly, the highest percentage standard ear was obtained on 14th June planting date with plant density of 65000 plants.ha^{-1} being about 49.31 percentage (Fig1).

3.9 Ear harvest index

Ear harvest index was affected by plant density (Table2). Statistical mean comparison indicated the highest ear harvest index was observed on mean of 22.62% with 105000 plants.ha^{-1} (Table 5). Harvest index is the proportion of economic yield to the plant biological yield and it is affected by plant density, the available amount of nutrient and water and environmental temperature during the growth season [17]. This parameter is the index of grain production or transfer coefficient and distribution of photosynthetic nutrient between economic and herbal sections [18].

4. CONCLUSION

Based on the present results, while the production rate of husked ear has been increased on 24th July, the cultivation of this production is not recommended because of the early arrival of autumn coldness on 2nd November and the reduction in demand. In the present investigation, considering the Codex standard for producing and supplying the competitive and high quality corn production in international markets comparing to the production quality of baby corn factories, the high quality and maximum standard ear which can be marketable should be produced on 14th June with plant density of 105000 plants.ha^{-1}. Because the conserved form of baby corn is used in convertor industries, producers consider the active production line of it for a long period of time and high quality corn production, results have revealed that relinquishment of a few percent of reduction in production can produce the maximum standard ear percentage (49.31%) on 14th June with plant density of (105000 plants.ha^{-1}). Considering the weather conditions in Mashhad, this plant can be produced as the second cultivation, which can be considered as its merits.

Tabel1. Analysis of variance for standard ear yield and agronomic characteristics of baby corn on different planting date and Plant density

S.O.V	df	Mean of squares							
		1	2	3	4	5	6	7	8
Replication (R)	3	0.841n.s	15.906 n.s	0.656 n.s	0.182 n.s	2.532 n.s	0.127*	0.051n.s	0.246 n.s
S d	2	11137.88**	1591.18**	2.093 n.s	10.304**	53.438**	11.114**	9.147**	1.903 n.s
Error (a)	6	113.63	87.19	0.685	0.140	2.054	0.029	0.150	2.230
P d	2	0.551**	29.92 n.s	0.242 n.s	0.134 n.s	4.001*	0.132n.s	0.440 n.s	0.826**
S d×P d	4	37.920 n.s	35.55 n.s	0.345 n.s	0.090n.s	1.356n.s	0.111 n.s	0.455 n.s	0.110n.s
Error (b)	18	49.794	22.127	0.294	0.085	1.171	0.057	0.266	0.110
CV %		5.01	7.98	4.99	5.11	5.03	2.89	3.49	15.46

(1): Plant Height (Cm), (2): Ear Height (Cm), (3): Number of Leaves/Plant, (4): Number of Leaves above Ear, (5): Stem Diameter (Cm), (6): Ear Length, (7): Ear Diameter (Cm), (8): Number of Ear/Plant. S d: Planting date, P d: Plant density also Sd × Pd: Interaction between Planting date and Plant density.

CV: Coefficient of variance. Ns,* and **: Non – significant and significant at a 5% and 1% levels of probability, respectively.

Table2. Analysis of variance for standard ear yield and agronomic characteristics of baby corn on different planting date and Plant density

S.O.V	df	Mean of squares						
		1	2	3	4	5	6	7
Replication (R)	3	5.512n.s	25.194n.s	4709791.72 n.s	233256.30 n.s	0.005 n.s	344394.77 n.s	7.141 n.s
S d	2	531.29*	677.73**	117354024.18 **	12340853.8**	0.536**	14733650.53**	88.11 n.s
Error (a)	6	104.78	79.80	2443858.32	323312.24	0.027	288057.87	21.61
P d	2	66.006n.s	36.228n.s	11578263.62 n.s	1813610.75**	0.094**	1303281.83**	23.68*
S d×P d	4	86.429*	69.215 n.s	1133890.85 n.s	173060.93 n.s	0.013 n.s	487190.58 n.s	4.149 n.s
Error (b)	18	29.566	32.870	3865299.40	241659.74	0.012	214909.28	5.919
CV %		13.68	9.57	17.94	21.29	17.49	29.10	11.58

(1):Standard Ear %, (2): Sub-Standard Ear %, (3): Husked Ear Yield, (4): Dehusked Ear Yield, (5): Dehusked Standard Ear Yield, (6): Dehusked Sub- Standard Ear Yield, (7): Ear Harvest Index. S d: Planting date, P d: Plant density also Sd × Pd: Interaction between Sowing date and Plant density.

Also CV: Coefficient of variance. Ns,* and **: Non – significant and significant at 5% and 1% levels of probability, respectively

Tabel 3. Means Comparison for standard ear yield and some agronomic characteristics of baby corn on different planting date

Planting Date	Treatment						
	1	2	3	4	5	6	7
14th June	106 b	45.82 b	10.57 a	4.642 b	19.81 b	9.335 a	14.57 b
3th July	153.7 a	63.46 a	10.69a	6.217 a	23.89 a	7.904 b	14.05 c
24th July	162.6 a	67.46 a	11.35 a	6.275 a	20.90 b	7.505 c	15.75 a

(1): Plant Height (Cm), (2): Ear Height (Cm), (3): Number of Leaves/Plant, (4): Number of Leaves above Ear, (5): Stem Diameter (Cm), (6): Ear Length, (7): Ear Diameter (Cm).

Mean followed by similar letters are not significantly different at a 5% probability level.

Tabel 4. Means Comparison for standard ear yield and some agronomic characteristics of baby corn on different planting date

Planting Date	Treatment					
	1	2	3	4	5	6
14th June	53.68 a	53.68 b	12250 a	2810b	833 a	1977 b
3th July	39.13 ab	60.13 ab	7396 c	755c	411 c	344 c
24th July	33.98 b	66.98 a	13240 a	3082 a	623 b	2459 a

(1):Standard Ear %, (2): Sub-Standard Ear %, (3): Husked Ear Yield, (4): Dehusked Ear Yield, (5): Dehusked Standard Ear Yield, (6): Dehusked Sub-Standard Ear Yield.

Mean followed by similar letters are not significantly different at a 5% probability level.

Table 5. Means Comparison for standard ear yield and some agronomic characteristics of baby corn on different plant density.

Plant density (plant .ha^{-1})	Treatment						
	1	2	3	4	5	6	7
65000	140.5 a	22.19 a	2.50 a	20.42 b	1879c	554 b	1325 b
85000	140.9 a	21.13 b	2. 11 b	20.01 b	2084 b	591 b	1493 b
105000	140.8 a	21.27 c	1.65 c	22.62 a	2683 a	722 a	1961 a

(1): Plant Height (Cm), (2): Stem Diameter (Cm), (3): Number of Ear/Plant, (4): Ear Harvest Index, (5): Dehusked Ear Yield, (6): Dehusked Standard Ear Yield, (7): Dehusked Sub-Standard Ear Yield.

Mean followed by similar letters are not significantly different at a 5% probability level.

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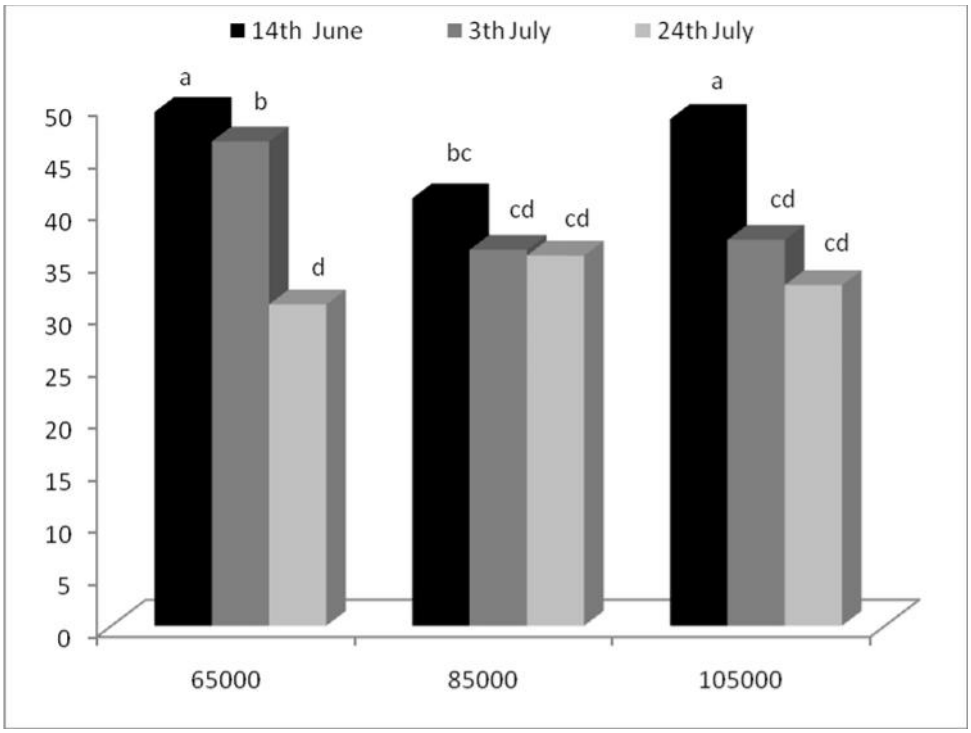

Fig1.The interaction effects of planting date and plant density on standard ear percentage
Mean followed by similar letters are not significantly different at a 5% probability level

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