Influence of Plant Spacing and Fertilizer Dose on Yield Parameters and Yield of Sweet Corn (*Zea mays* L.)

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Abstract

An investigation was carried out to study the influence of plant spacing at four levels, viz. 45x15 cm^2, 45x20 cm^2, 60x15 cm^2 and 60x20 cm^2 and fertilizer doses at three levels, i.e. 90: 45: 45 NPK kg ha^{-1}, 120: 60: 45 NPK kg ha^{-1} and 150: 75: 45 NPK kg ha^{-1} on sweet corn during *kharif* 2008. Significance of fertilizer dose was observed for number of seed rows cob^{-1} and number of seeds cob^{-1}, while plant spacing was significant for shelling percentage. Interaction between plant spacing and fertilizer dose was found to be significant for various parameters, viz. cob girth and length, number of seeds cob^{-1}, shelling percentage, 100 seed weight and seed yield $plant^{-1}$. Combinations, viz. 45x20 cm^2 and 120: 60: 45 NPK kg ha^{-1}, 60x15 cm^2 and 150: 75: 45 NPK kg ha^{-1}, 60x20 cm^2 and 120: 60: 45 NPK kg ha^{-1}, 60x20 cm^2 and 150: 75: 45 NPK kg ha^{-1}, performed better for yield components like cob girth and length, number of seeds cob^{-1} and 100 seed weight thus, higher seed yield $plant^{-1}$. Similar performance of 45x20 cm^2 /120:60:45 NPK kg ha^{-1} with other superior combinations indicated the field value of lower plant spacing and moderate fertilizer dose in realizing higher seed yield.

1. Introduction

In India, maize is one of the top four cereals occupying an area of 7.89 mha with a production of 15.09 mt and productivity of 1904 kg ha^{-1}. Andhra Pradesh is one of the major maize producing states with a production of 4.15 mt from 0.85 million ha averaging 4073 kg ha^{-1} (CMIE, 2010). Approximately 25% of the total corn produced is being used for human consumption either in fresh or processed form. Of late, sweet corn is emerging as one of the important enterprises projecting diversified and value added uses of maize. Fire baked or steam boiled green cobs of sweet corn has gained immense popularity among the urbanites as a favourite dish, resulting in premium price for growers. Diversification and value addition of sweet corn are currently contemplated in view of rapid growth in the food processing industry. Continuous and growing demand for fresh sweet corn cobs has led to cultivation of sweet corn round the year varied soil conditions and management practices. In Andhra Pradesh, lower yield levels of maize in general and sweet corn in particular could be attributed to sub optimal population stand, inappropriate fertilizer dose, and lack of suitable cultivars with good seed and processing qualities. Presently greater emphasis is being given on enhancing the productivity and quality of sweet corn through suitable agro techniques with an intention to augment the net profits to farming community dwelling in the vicinity of big cities and metropolis.

Exploring possible combinations of plant spacing and fertilizer doses that would enable the urban farmer to efficiently utilize scarce resources and reduce the cost of cultivation is worth attempting. Such a backdrop necessarily calls for certain reoriented research efforts commensurate with modern needs with reference to sweet corn. Therefore, the present investigation was planned to understand the ultimate influence of plant spacing and fertilizer doses of NPK on yield and yield components.

2. Materials and Methods

The present experiment was conducted during *Kharif* 2008 at the Seed Research and Technology Center, Acharya N. G. Ranga Agricultural University, Rajendranagar, Hyderabad, India with maize sweet corn cv. Madhuri. The crop was raised in randomized block design with factorial arrangement and

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replicated thrice with 12 treatments obtained from combining plant spacing at 45x15 cm^2, 45x20 cm^2, 60x15 cm^2 and 60x20 cm^2 levels, each combined with three fertilizer doses of 90:45:45, 120:60:45 and 150:75:45 NPK kg ha^{-1}. Each treatment was imposed in 4.8x4.5 m^2 plot. The field was once disc ploughed followed by harrowing and cultivator operation and finally the land was leveled using tractor drawn leveler. Entire phosphorus and potassium along with half of nitrogen as per the treatment was applied as basal in band placement in small grooves of 5 cm from the seed. The remaining half of the nitrogen was top dressed in two split doses at knee high stage and early flowering stage of the crop. Seed of sweet corn cv. Madhuri was dibbled by hand as per the treatment to get desired population on ridges and was irrigated for uniform germination. Gap filling was done one week after sowing and thinning was carried out to get single plant per hill. All other recommended cultural and plant protection measures were carried out as per schedule. Observations were recorded on days to 50% tasseling, cob length (cm), cob girth (cm), number of seed rows cob^{-1}, number of seeds cob^{-1}, shelling percentage, 100 seed weight (g) and seed yield $plant^{-1}$ (g) from five plants randomly selected $treatment^{-1}$ in each replication from the net plot area. The data collected were analyzed statistically by the method of analysis of variance outlined by Gomez and Gomez (1984) for the factorial experiment employing a randomized block design. The calculated *t* value was compared with table *t* value at error degrees of freedom to test the significance of treatments.

3. Results and Discussion

Analysis of variance for yield and yield components revealed the existence of significant differences among the treatments for all the characters studied (Table 1).

Dimensions of sweet corn cob, viz. cob length and girth would ultimately decide the number of seeds accommodated in individual cob. Among these two parameters, cob girth plays vital role as an increment in girth leads to inclusion of an extra row of seeds which exponentially increases the total number of seeds cob^{-1}. Interaction effect between plant spacing and fertilizer doses apart from significance of main factors was observed for both these parameters (Table 2, 3 and 4). Earlier researchers, viz. Ramachandrappa et al. (2004), Kar et al. (2006) and Azam et al. (2007) reported that higher cob dimensions were realized at wider plant spacing in combination with higher fertilizer dose of NPK.

A critical appraisal of the data recorded in Table 3 revealed that higher cob girth and length of 12.43 cm and 15.83 cm were recorded, respectively, with fertilizer dose of 150:75:45 NPK kg ha^{-1}. Further perusal of results on interaction effects for these two parameters also indicated that highest cob length of 16.30 cm was observed at (60x15 cm^2/150:75:45 NPK kg ha^{-1}) followed by (60x20 cm^2/150:75:45 NPK kg ha^{-1}) with 15.90 cm cob length (Table 4).

This may be attributed to early initiation of flowering after 36 days of sowing at above levels of spacing (Table 2), resulting in availability of more time for translocation of assimilates

Table 1: Mean squares for yield parameters and yield at four levels of plant spacing in combination with three fertilizer doses

Source of variation	df	Days to 50% tasseling	Cob length	Cob girth	Rows cob^{-1}	Seeds cob^{-1}	Shelling percentage	100 seed weight	Seed yield $plant^{-1}$
Replication	2	0.111	0.242	0.317*	0.083	4.527	1.270	0.043	0.344
Plant spacing(PS)	3	19.186**	2.437**	2.211*	0.704	137.138	2.044*	3.817**	74.851**
Fertilizerdose (FD)	2	2.528**	13.247**	4.117*	2.25**	12120.86**	0.591	2.351**	335.560**
Interaction (PS*FD)	6	0.936*	0.967**	0.261*	0.28	2098.083**	1.874**	0.361**	22.053**
Error	22	0.263	0.102	0.068	0.386	145.285	0.439	0.036	0.348

*Significant at $p<0.05$; **Significant at $p<0.01$

Table 2: Mean influence of plant spacing on yield parameters and yield at all fertilizer doses

Plant spacing (cm^2)	Days to 50% tasseling	Cob length (cm)	Cob girth (cm)	Shelling percentage	100 seed weight (g)	Seed yield $plant^{-1}$ (g)	Seed yield (q ha^{-1})
45x15 (1,48,148)	38.3	14.34	11.39	78.6	10.18	37.16	55.05
45x20 (1,11,111)	38.6	15.61	12.41	79.5	11.26	43.17	47.96
60x15 (1,11,111)	36.4	14.96	11.98	79.4	11.26	41.86	46.51
60x20 (83,333)	35.5	14.86	12.46	78.6	11.71	43.30	36.08
SEm±	0.17	0.11	0.09	0.22	0.06	0.19	0.19
CD (p=0.05)	0.50	0.31	0.26	0.65	0.19	0.58	0.58

Table 3: Mean influence of fertilizer dose on yield parameters and yield at all levels of plant spacing

Fertilization doses (NPK kg ha^{-1})	Days to 50% tasseling	Cob length (cm)	Cob girth (cm)	Seed rows cob^{-1}	Seeds cob^{-1}	100 seed weight (g)	Seed yield plant^{-1} (g)
90:45:45	36.8	13.78	11.38	13	353	10.61	35.40
120:60:45	37.2	15.21	12.36	14	408	11.23	43.24
150:75:45	37.6	15.83	12.43	14	409	11.47	45.47
SEm±	0.15	0.92	0.75	0.18	3.48	0.06	0.17
CD (*p*=0.05)	0.43	0.27	0.22	0.53	10.21	0.16	0.49

Table 4: Influence of interaction between plant spacing and fertilizer dose on yield parameters and yield

Plant spacing (cm^2)	Days to 50% tasseling				Cob length (cm)			
	Fertilizer dose (NPK kg ha^{-1})				Fertilizer dose (NPK kg ha^{-1})			
	90:45:45	120:60:45	150:75:45	Mean	90:45:45	120:60:45	150:75:45	Mean
45x15	38.3	38.0	38.7	38.3	13.30	14.37	15.37	14.34
45x20	38.0	39.0	38.7	38.6	15.17	15.90	15.77	15.61
60x15	36.3	36.3	36.7	36.4	13.10	15.47	16.30	14.95
60x20	34.3	35.7	36.7	35.5	13.57	15.10	15.90	14.85
Mean	36.8	37.2	37.6	37.2	13.76	15.21	15.84	14.93
SEm±	0.29				0.27			
CD (*p*=0.05)	0.87				0.54			

up to physiological maturity. Similarly, maximum cob girth of 13.07 cm was recorded at a wider spacing, fertilized with highest dose (60x20 cm^2/150:75:45 NPK kg ha^{-1}). However, Pandey et al. (2002) and Rangarajan et al. (2002) while working with sweet corn varieties reported that row spacing does not affect the cob dimensions, particularly in cultivars with small sized cobs. In the present investigation, the interaction effect (45x20 cm^2/120:60:45 NPK kg ha^{-1}) recorded highly desirable cob girth and length of 12.90 and 15.90 cm, respectively. This interaction effect would not only enhance land use efficiency but also reduce the cost of cultivation in terms of the lesser quantities of fertilizer used. This result is in conformity with that of Mahesh et al. (2010) who reported a seed number of 459 cob^{-1} at a higher fertilizer dose of 150:75:45 NPK kg ha^{-1}. Similarly, in the present investigation, maximum number of 409 seeds cob^{-1} were recorded at 150:75:45 NPK kg ha^{-1} (Table 2). Higher number of seeds at higher fertilizer dose could be directly related to enhancement in number of seed rows cob^{-1} with a concomitant increase in NPK dose. Highest mean number of rows was registered at 150:75:45 NPK kg ha^{-1} which corresponded to maximum number of seeds at this fertilizer level. However, results also indicated no significant change in both number of seed rows cob^{-1} and number of seeds cob^{-1} as the NPK dose was raised from 120:60:45 to 150:75:45 kg ha^{-1}. This clearly suggested the field value of adopting a moderate dose of 120:60:45 NPK kg ha^{-1}, highlighting the cost effectiveness. This was supported by realization of higher seed number of 420 at 45x20 cm^2/120:60:45 NPK kg ha^{-1}. The interaction between levels of spacing and fertilizer doses was found to be significant with respect to number of seed cob^{-1}. The fertilizer dose 150:75:45 NPK kg ha^{-1} (Table 3) recorded higher seeds cob^{-1} of 426 at wider plant spacing of 60x20 cm^2 and also at narrow spacing of 45x20 cm^2 (423). These results have clearly indicated the importance of NPK dose for attaining desirable number of seeds cob^{-1}. These findings are in agreement with earlier reports of Kumar et al. (2007), Srikanth et al. (2009) and Bors et al. (2009).

Further, shelling percentage is another parameter which gives an indication about seed yield. Shelling percentage is more of a post harvest handling attribute and is less influenced directly by management practices like plant spacing and fertilizer dose. However, superior performance of treatment combination for other yield components like number of seeds cob^{-1}, cob length, cob girth, extent of tip filling, 100 seed weight, etc. would result in better shelling percentage due to greater seed weight in comparison to weight of the shank. Plant spacing of 45x20 cm^2 in combination with 90:45:45 and 120:60:45 NPK kg ha^{-1} resulted in 80% shelling (Table 1). It could be concluded that among superior treatments for shelling, combinations with 45x20 cm^2 spacing expressed superior values of cob dimensions, seed number and 100 seed weight.

Review of earlier studies in corn revealed that test weight or 1000 seed weight is the most important yield attribute that truly reflects the yield potential. Researchers like Yadav and Singh (2000), Ramachandrappa et al. (2004), Sahoo and Mahapatra (2004) reported that wider plant spacing and higher NPK have resulted in significantly superior test weight. Accordingly, highest 100 seed weight (11.71 g) was noticed at 60x20 cm^2 (Table 2). Similarly, fertilizer dose of 150:75:45 NPK kg ha^{-1} also realized 11.46 g (Table 3). The interaction effects were also highly significant in influencing the 100 seed weight. Maximum seed weight of 12.00 g was recorded at 60x20 cm^2/150:75:45 NPK kg ha^{-1}. This interaction effect was significantly superior to all other treatments except 45x20 cm^2/120:60:45 NPK kg ha^{-1}, 60x15 cm^2/150:75:45 NPK kg ha^{-1} and 60x20 cm^2/120:60:45 NPK kg ha^{-1} which were at par (Table 4). These superior treatments were outstanding for their ability to efficiently utilize the resources both in space and time.

Seed yield is a rather complex result of a number of its attributing traits. Two plant spacing 60x20 cm^2 and 45x20 cm^2 which had equal intra row spacing were at par in influencing the seed yield $plant^{-1}$ (Table 2). However, plant spacing of 45x15 cm^2 which accommodated 1,48,148 plant ha^{-1} recorded 55.05 q compared to 47.96 q at 45x20 cm^2 in view of higher plant population $unit^{-1}$ area. Earlier research studies indicated that yield components, viz. cob length, breadth, number of seeds cob^{-1}, cobs $plant^{-1}$ were identified as most important factors towards enhancement of seed yield *per se* (Yadav and Singh, 2000). The present study had also confirmed that influence of various levels of plant spacing, fertilizer doses and their interaction effects were highly significant in governing the seed yield $plant^{-1}$. Further, certain parameters like cob length, cob girth, number of seed rows cob^{-1}, number of seeds cob^{-1} and 100 seed weight were identified as the most important yield contributing traits for sweet corn.

4. Conclusion

Considering the superior performance of interaction effects, in terms of judicious and efficient use of natural and applied inputs four combinations, viz. 60x20 cm^2 /150:75:45 NPK kg ha^{-1} (48.77 g), 45x20 cm^2/120:60:45 NPK kg ha^{-1} (47.97 g), 60x15 cm^2/150:75:45 NPK $kgha^{-1}$ (47.83 g) and 60x20 cm^2/120:60:45 NPK kg ha^{-1} (45.20 g) were found to be outstanding for seed yield $plant^{-1}$. These combinations excelled for all the yield components indicating their superiority in providing congenial field conditions for expression of sweet corn cv. Madhuri to its full potential. From commercial view point 45x20 cm^2/ 120:60:45 NPK kg ha^{-1} performed exceedingly well for all the parameters and found to be promising due to its capacity to exploit inherent yield potential using moderate resources.

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