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Yield and Yield Attributes of Sweet Corn as Influenced by Planting Geometry and Fertilizer Levels

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Aim: Field experiment was conducted to study the productivity of sweet corn as influenced by planting geometry and fertilizer levels.
Study Design: Split-plot design with three replications and nine treatment combinations.
Place and Duration of Study: Plot number '125' 'E' block, Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, Karnataka (India) during 2015-16 and 2016-17.
Methodology: Treatments includes three planting geometry and three fertilizer levels were applied as per protocol.
Results: Individual yield parameters such as fresh cob weight with husk, without husk, cob girth and number of grains per row were significantly higher in wider planting geometry with higher fertilizer levels. But with respect to respect to fresh cob yield with husk and fresh fodder yield was recorded higher significantly in planting geometry of 60 cm x 15 cm along with higher fertilizer level (125:60:25 N:P_2O_5:K_2O kg ha^{-1}) which was on par with planting geometry of 45 cm x 20 cm along with higher fertilizer level (125:60:25 N:P_2O_5:K_2O kg ha^{-1}).
Conclusion: Planting geometry of 60 cm x 15 cm along with higher fertilizer level (125:60:25

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$N:P_2O_5:K_2O$ kg ha^{-1}) was found superior with respect to fresh cob yield with husk and fresh fodder yield, which was on par with planting geometry of 45 cm x 20 cm along with higher fertilizer level (125:60:25 $N:P_2O_5:K_2O$ kg ha^{-1}).

Keywords: Yield; yield parameters; planting geometry; fertilizer levels.

1. INTRODUCTION

Specialty corns (*viz.*, sweet corn, pop corn, baby corn and high oil corn) assume tremendous market potential not only in India but also in the international market. Among them, sweet corn is gaining importance in the star/big hotels, shopping malls and departmental stores *etc.* It is used for the preparation of special soups, sweets, jams, cream pastes and other delicious eatables in urban areas. So now a day's sweet corn industry is expanding because of increasing domestic consumption, export development and import replacement. Since 3 to 4 crops can be harvested in a year and fresh fodder is highly succulent, palatable and digestible for dairy animals. Hence it is becoming increasingly popular in India and other Asian countries. Increasing demand, premium price and global spread of sweet corn make it attractive options for the farmers.

Plant densities or geometries are very important parameters in crop production. The optimum plant density paves the way for better use of time, light, temperature, precipitation and other resources. Plant density is of particular importance in sweet corn because it does not have the tillering capacity to adjust to variation in plant stand. In order to achieve higher cob yields, maintenance of optimum plant density is the most important factor. Few of the studies were confirmed positive response for the optimum plant population along with nutrients in order to achieve the higher productivity of sweet corn [1]. Maize has high production potential especially under the irrigated condition when compared to any other cereal crop. The productivity of sweet corn largely depends on its nutrient requirement and management practices particularly that of nitrogen, phosphorus and potassium.

2. MATERIALS AND METHODS

The field experiment was conducted at University of Agricultural Sciences, Dharwad of Northern Transition Zone of Karnataka, during *Kharif* 2015-16 and 2016-17 to study the productivity of sweet corn as influenced by planting geometries and fertilizers levels. Soil have pH (7.24), electrical conductivity (0.25 dS m^{-1}), organic carbon (0.63%), available N (237.9 kg ha^{-1}): P_2O_5 (32.14 kg ha^{-1}): K_2O (410.5 kg ha^{-1}) and micronutrients *viz.,* Zn and Fe (0.58 and 4.47 ppm, respectively). The field experiment was laid out in split plot design with three replications. There were 9 treatment combinations involving three main plots**.,** Planting geometry: P_1 - 60 cm x 15 cm (1,11,111, plants ha^{-1})**,** P_2 - 45 cm x 20 cm (1,11,111, plants ha^{-1}) and P_3 - 60 cm x 20 cm (83,333, plants ha^{-1}) and sub plots: Fertilizer levels: F_1 - 75:40:25 $N:P_2O_5:K_2O$ kg ha^{-1}, F_2 - 100:50:25 $N:P_2O_5:K_2O$ kg ha^{-1} and F_3 - 125:60:25 $N:P_2O_5:K_2O$ kg ha^{-1}. The recommended dose of diffèrent fertilizer was applied, 50% of N appliéd at basal, 25% at 30 DAS and remaining 25 % appliéd at 45 DAS. A full dose of P_2O_5 and K_2O appliéd at the time of sowing. The test crop was sweet corn (Hybrid sugar 75) yield and yield attributes were recorded as per treatments accordingly.

2.1 Observation on Sweet Corn

2.1.1 Fresh cob weight with husk

The total weight of sweet corn cobs from five tagged plants was taken along with the husk and the average weight of cob was recorded in grams per cob (g cob^{-1}).

2.2.2 Fresh cob weight without husk

The weight of dehusked sweet corn form each plant was recorded in grams per cob (g cob^{-1}).

2.1.3 Number of cobs per hectare

The total number of sweet corn cobs per hectare was calculated with a help of number of cobs per plant and plant population at the time of cob harvesting.

2.1.4 Cob length

The length of the cob was measured from base to the tip of the cob and expressed in centimetres (cm).

2.1.5 Cob girth

The circumference measured at the centre of cob was taken as the girth of the cob and expressed in centimetres (cm).

2.1.6 Number of grains per row

The number of grains per row of five cobs was measured manually and the average was worked out to get the number of grains per row.

2.1.7 Fresh cob yield with husk

The weight of fresh sweet corn cobs with husk from each net plot was weighed and expressed in kg and it was converted into quintal per hectare (q ha^{-1}).

2.1.8 Fresh fodder yield

After harvesting the fresh cobs, the plants were cut immediately from each net plot and the weight was recorded in kg and it was converted into quintal per hectare (q ha^{-1}).

2.1.9 Harvest index

The ratio of economic yield (fresh cob yield) to the biological yield (fresh cob yield and fodder yield) was worked out as harvest index [2] and expressed in percentage:

$$\text{Harvest Index (\%)} = \frac{\text{Economic yield (q ha}^{-1}\text{)}}{\text{Biological yield (q ha}^{-1}\text{)}} \times 100$$

2.2 Statistical Analysis

Statistical analysis was carried out based on mean values obtained. Analysis of variance is carried out and the level of significance used in 'F' and 'T' test was P= 0.05. The treatment means were compared by Duncan's Multiple Range Test (DMRT) at 0.05 level of probability [3].

3. RESULTS AND DISCUSSION

3.1 Effect of Planting Geometry and Fertilizer Levels on Yield Parameters

The pooled results indicated that, significantly higher fresh cob weight with husk (364.99 g cob^{-1}), without husk (310.46 g cob^{-1}), cob girth (15.56 cm), number of grains per row (40.67) was noticed in wider planting geometry of 60 cm x 20 cm and it was on par with 60 cm x 15 cm and both were significantly superior over planting geometry of 45 cm x 20 cm. A similar trend was also observed during individual years of 2015 and 2016. Among the fertilizer levels, significantly higher fresh cob weight with husk (371.11 g cob^{-1}), without husk (318.63), cob length (19.35), cob girth (16.22 cm), number of grains per row (43.06) was observed with higher fertilizer level (125:60:25 $N:P_2O_5:K_2O$ kg ha^{-1}) which was at par with recommended fertilizer level (100:50:25 $N:P_2O_5:K_2O$ kg ha^{-1}) and both were significantly superior to lower fertilizer level. The similar trend was observed during individual years. With respect to interaction effects, the combination of P_3F_3 (60 cm x 20 cm along with 125:60:25 $N:P_2O_5:K_2O$ kg ha^{-1}) was registered significantly higher yield attributes and which was on par with treatment combinations of P_1F_3, P_2F_3, P_1F_2 and P_2F_2.Whereas, significantly lower yield attributes was observed with treatment combination of P_2F_1. However, wider planting geometry of 60 cm x 20 cm produced higher yield parameters of individual plants which were mainly due to better resource availability and reduced inter and intra plant competition in the community [4].

3.2 Effect of Planting Geometry and Fertilizer Levels on Yield

In the present study, the pooled data of two years revealed that, planting geometries of 60 cm x 15 cm and 45 cm x 20 cm were found superior and were recorded significantly higher fresh cob yield with husk (315.9 and 313.2 q ha^{-1}, respectively) and fresh fodder yield (595.5 and 586.3 q ha^{-1}, respectively). The increase in the fresh cob yield with husk was to the tune of 6.6 and 5.7 percent higher, respectively and 8.6 and 6.8 percent higher of fresh fodder yield, respectively as compared to planting geometry of 60 cm x 20 cm (296.1 and 548. 1 q ha^{-1}, respectively). Higher yield was due to significantly higher plant density. These results are in close conformity with the findings of [5,6 and 7] who also found that increase in plant population increased fresh cob yield. Higher fresh cob yield with husk was produced at planting geometry of 60 cm x 15 cm and 45 cm x 20 cm, though values of yield attributing characters were better in planting geometry of 60 cm x 20 cm, these improvement were not sufficient to compensate the increased plant number per unit area obtained from 60 cm x 15 cm and 45 cm x 20 cm. The similar results were reported by [8]. With respect to fertilizer levels;

Table 1. Fresh cob weight with husk, fresh cob weight without husk and cob length of sweet corn as influenced by planting geometries and fertilizer levels

Treatments	Fresh cob weight with husk (g cob^{-1})			Fresh cob weight without husk (g cob^{-1})			Cob length (cm)		
	2015-16	**2016-17**	**Pooled**	**2015-16**	**2016-17**	**Pooled**	**2015-16**	**2016-17**	**Pooled**
Main plot - Planting geometry									
P_1: 60 cm x 15 cm (1,11,111)	354.69 ab	366.48 ab	360.58 ab	299.98 ab	309.23 ab	304.61 ab	18.27 a	18.72 a	18.50 a
P_2: 45 cm x 20 cm (1,11,111)	350.37 b	362.90 b	356.63 b	293.63 b	305.97 b	299.80 b	17.83 a	18.30 a	18.06 a
P_3: 60 cm x 20 cm (83,333)	359.61 a	370.37 a	364.99 a	302.97 a	317.94 a	310.46 a	18.46 a	18.59 a	18.52 a
S.Em. ±	1.33	1.41	1.33	1.70	2.35	1.95	0.23	0.42	0.24
Sub-plot - Fertilizer levels									
F_1: 75:40:25 $N:P_2O_5:K_2O$ kg ha^{-1}	341.97 b	353.12 b	347.54 b	283.94 b	296.51 b	290.23 c	17.00 b	17.32 b	17.16 b
F_2: 100:50:25 $N:P_2O_5:K_2O$ kg ha^{-1}	357.63 a	369.48 a	363.56 a	300.03 a	311.98 a	306.01 b	18.39 a	18.76 a	18.57 a
F_3: 125:60:25 $N:P_2O_5:K_2O$ kg ha^{-1}	365.07 a	377.14 a	371.11 a	312.60 a	324.66 a	318.63 a	19.16 a	19.53 a	19.35 a
S.Em. ±	4.08	4.59	2.86	3.88	4.61	3.77	0.37	0.42	0.33
Interaction									
P_1F_1	341.23 bc	352.47 ab	346.85 cd	285.97 de	292.83 c	289.40 cd	17.27 ab	17.77 ab	17.52 bc
P_1F_2	358.23a-c	370.20 ab	364.22 ab	303.17 a-d	312.37 a-c	307.77 a-c	18.27 ab	18.73 ab	18.50 ab
P_1F_3	364.60 ab	376.77 a	370.68 ab	310.80 ab	322.50 ab	316.65 ab	19.27 a	19.47 a	19.30 ab
P_2F_1	335.27 c	347.03 b	341.15 d	279.00 e	291.83 c	285.42 d	16.37 b	16.77 b	16.57 c
P_2F_2	353.53 a-c	365.57 ab	359.55 a-c	292.57 b-e	308.20 a-c	300.38 b-d	18.03 ab	18.67 ab	18.35 a-c
P_2F_3	362.30 ab	376.10 a	369.20 ab	309.33 a-c	317.87 a-c	313.60 ab	19.09 a	19.47 a	19.28 ab
P_3F_1	349.40 a-c	359.87 ab	354.63 b-d	286.87 c-e	304.87 bc	295.87 b-d	17.37 ab	17.43 ab	17.40 bc
P_3F_2	361.13 ab	372.67 ab	366.90 ab	304.37a-d	315.37 a-c	309.87 a-c	18.87 a	18.87 ab	18.87 ab
P_3F_3	368.30 a	378.57 a	373.43 a	317.67 a	333.60 a	325.63 a	19.13 a	19.67 a	19.47 a
S.Em. ±	7.07	7.95	4.95	6.73	7.98	6.52	0.64	0.72	0.56

Means followed by the same letter (s) within a column are not significantly differed by DMRT (P = 0.05)

Table 2. Cob girth, number of grains per row and number of rows per cob of sweet corn as influenced by planting geometries and fertilizer levels

Treatments	Cob girth (cm)			Number of grains per row			Number of rows per cob		
	2015-16	**2016-17**	**Pooled**	**2015-16**	**2016-17**	**Pooled**	**2015-16**	**2016-17**	**Pooled**
Main plot - Planting geometry									
P_1: 60 cm x 15 cm (1,11,111)	14.98 a	15.59 a	15.29 a	39.00 a	41.33 a	40.17 ab	16.22 a	16.44 a	16.33 a
P_2: 45 cm x 20 cm (1,11,111)	14.39 b	15.20 b	14.80 b	37.78 a	38.89 a	38.33 b	15.78 a	16.43 a	16.11 a
P_3: 60 cm x 20 cm (83,333)	15.19 a	15.92 a	15.56 a	39.78 a	41.56 a	40.67 a	16.67 a	16.44 a	16.56 a
S.Em. ±	0.28	0.32	0.24	0.80	0.83	0.50	0.63	0.29	0.31
Sub-plot - Fertilizer levels									
F_1: 75:40:25 $N:P_2O_5:K_2O$ kg ha^{-1}	13.47 b	14.36 b	13.91 b	35.00 b	36.33 b	35.67 b	15.33 b	15.44 b	15.39 b
F_2: 100:50:25 $N:P_2O_5:K_2O$ kg ha^{-1}	15.26 a	15.76 ab	15.51 a	39.33 ab	41.56 a	40.44 a	16.44 ab	16.56 ab	16.50 a
F_3: 125:60:25 $N:P_2O_5:K_2O$ kg ha^{-1}	15.84 a	16.60 a	16.22 a	42.22 a	43.89 a	43.06 a	16.89 a	17.33 a	17.11 a
S.Em. ±	0.25	0.51	0.28	1.41	1.19	1.10	0.40	0.52	0.36
Interaction									
P_1F_1	13.31 d	14.31 a	13.81 cd	35.00 ab	37.67 b-d	36.33 bc	15.33 ab	15.67 a	15.50 ab
P_1F_2	15.21 ab	15.88 a	15.55 ab	39.67 ab	42.33 a-c	41.00 ab	16.67 ab	16.33 a	16.50 ab
P_1F_3	16.41a	16.58 a	16.50 a	42.33 ab	44.00 ab	43.17 a	16.67 ab	17.33 a	17.00 ab
P_2F_1	13.31 d	13.91a	13.61 d	34.00 b	34.67 d	34.33 c	14.67 b	15.33 a	15.00 b
P_2F_2	15.08 a-c	15.35 a	15.21 a-c	37.67 ab	39.33 a-d	38.50 a-c	16.00 ab	16.67 a	16.33 ab
P_2F_3	14.78 bc	16.35 a	15.56 ab	41.67 ab	42.67 a-c	42.17 ab	16.67 ab	17.33 a	17.00 ab
P_3F_1	13.78 cd	14.85 a	14.31 b-d	36.00 ab	36.67 cd	36.33 bc	16.00 ab	15.33 a	15.67 ab
P_3F_2	15.48 ab	16.05 a	15.76 ab	40.67 ab	43.05 a-c	41.83 ab	16.67 ab	16.67 a	16.67 ab
P_3F_3	16.31 a	16.88 a	16.60 a	42.67 a	45.00 a	43.83 a	17.33 a	17.33 a	17.33 a
S.Em. ±	0.42	0.88	0.48	2.44	2.06	1.90	0.68	0.89	0.61

Means followed by the same letter (s) within a column are not significantly differed by DMRT (P = 0.05)

Table 3. Fresh cob yield with husk, fresh fodder yield and harvest index of sweet corn as influenced by planting geometries and fertilizer levels

Treatments	Fresh cob yield with husk (q ha^{-1})			Fresh fodder yield (q ha^{-1})			Harvest index (%)		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015	2016	Pooled
Main plot - Planting geometry									
P_1: 60 cm x 15 cm (1,11,111)	311.6 a	320.1 a	315.9 a	586.0 a	605.0 a	595.5 a	34.72 a	34.60 a	34.66 a
P_2: 45 cm x 20 cm (1,11,111)	309.0 a	317.4 a	313.2 a	577.8 a	594.9 a	586.3 a	34.84 a	34.79 a	34.82 a
P_3: 60 cm x 20 cm (83,333)	292.9 b	298.7 b	296.1 b	538.9 b	557.3 b	548.1 b	35.26 a	34.90 a	35.08 a
S.Em. ±	2.80	4.14	1.95	3.88	5.09	3.58	0.20	0.18	0.15
Sub-plot - Fertilizer levels									
F_1: 75:40:25 $N:P_2O_5:K_2O$ kg ha^{-1}	298.5 b	304.61 b	301.5 b	555.0 b	572.9 b	563.9 b	34.98 a	34.71 a	34.85 a
F_2: 100:50:25 $N:P_2O_5:K_2O$ kg ha^{-1}	305.0 ab	313.11 ab	309.0 ab	568.2 a	587.8 ab	578.0 a	34.94 a	34.75 a	34.85 a
F_3: 125:60:25 $N:P_2O_5:K_2O$ kg ha^{-1}	310.5 a	318.68 a	314.6 a	579.5 a	596.5 a	588.0 a	34.90 a	34.83 a	34.86 a
S.Em. ±	2.88	3.54	3.95	4.05	5.34	3.54	0.19	0.20	0.16
Interaction									
P_1F_1	304.1 a-d	314.6 ab	309.3 a-c	572.1 bc	594.7 ab	583.4 bc	34.71 a	34.58 a	34.64 a
P_1F_2	312.1 ab	321.6 a	316.9 ab	586.8 ab	605.9 a	596.4 ab	34.72 a	34.67 a	34.70 a
P_1F_3	318.6 a	324.3 a	321.4 a	599.0 a	614.4 a	606.7 a	34.72 a	34.54 a	34.63 a
P_2F_1	302.8 a-d	310.1 ab	306.4 a-c	566.3 bc	582.9 a-c	574.6 cd	34.84 a	34.72 a	34.78 a
P_2F_2	309.7 a-c	317.5 ab	313.6 ab	579.2 ab	596.9 ab	588.0 a-c	34.84 a	34.72 a	34.78 a
P_2F_3	314.3 a	324.7 a	319.5 ab	587.8 ab	604.7 a	596.3 ab	34.84 a	34.94 a	34.89 a
P_3F_1	288.5 d	289.1 c	288.8 c	526.5 e	541.0 d	533.8 f	35.40 a	34.83 a	35.11 a
P_3F_2	293.2 cd	300.1 bc	296.7 bc	538.6 de	560.7 cd	549.6 ef	35.24 a	34.87 a	35.06 a
P_3F_3	298.6 b-d	306.9 a-c	302.8 a-c	551.6 cd	570.4 b-d	561.0 de	35.13 a	35.00 a	35.06 a
S.Em. ±	4.98	6.13	6.84	7.02	9.24	6.13	0.23	0.24	0.20

Means followed by the same letter (s) within a column are not significantly differed by DMRT (P = 0.05)

Significantly higher fresh cob yield with husk and fodder yield was recorded with higher fertilizer level (125:60:25 $N:P_2O_5:K_2O$ kg ha^{-1}) and which was on par with the recommended fertilizer level (100:50:25 $N:P_2O_5:K_2O$ kg ha^{-1}) and both fertilizer levels found superior over lower fertilizer level (75:40:25 $N:P_2O_5:K_2O$ kg ha^{-1}). Similar results were observed by Singh et al. [9]. The natively available soil nitrogen was low (237.9 kg ha^{-1}) and hence the application of higher nitrogenous fertilizer resulted in higher nutrient availability The optimum availability of nutrients has favored the growth and development of better root system, which helped in better uptake of nutrients. Further, it improves the rate of photosynthesis, dry matter production and translocation to reproductive parts as indicated by higher values of yield components that resulted in higher fresh cob yield with the husk of sweet corn. Higher yield was observed during 2016-17 as compared to 2015-16. It might be due to a good amount of rainfall received during the cropping period which resulted in higher yield and yield attributes of sweet corn. Among the different treatment interactions, significantly higher fresh cob yield with husk (321.4 q ha^{-1}) and fresh fodder yield (606.7 q ha^{-1}) was recorded with planting geometry of 60 cm x 15 cm along with higher fertilizer level (125:60:25 $N:P_2O_5:K_2O$ kg ha^{-1}) over wider planting geometry of 60 cm x 20 cm along with lower fertilizer level (75:40:25 $N:P_2O_5:K_2O$ kg ha^{-1}). The increase in yield was due to synergetic effect between planting geometry and fertilizer levels were more effective than their individual effects. The improvement in nutrient availability with the application of higher fertilizer levels resulted in higher yield parameters and which contributed to increased fresh cob yield with husk of sweet corn [4].

4. CONCLUSION

Planting geometry of 60 cm x 15 cm along with higher fertilizer level (125:60:25 $N:P_2O_5:K_2O$ kg ha^{-1}) was found superior with respect to fresh cob yield with husk and fresh fodder yield, which was on par with planting geometry of 45 cm x 20 cm along with higher fertilizer level (125:60:25 $N:P_2O_5:K_2O$ kg ha^{-1}).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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