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Research Paper

Plant density and fertilizer management in spring baby corn (*Zea mays*) under central plain region of Punjab

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ABSTRACT

The field study evaluates the relative effects of plant density and fertilizer management on the growth, yield, and nutrient uptake of spring baby corn (*Zea mays* L.) in the central plain region of Punjab. The experiment was conducted during 2019–20 and 2020–21 at the Agricultural Research Farm of Lovely Professional University, Phagwara, Punjab at 31°14'30.5" N' and 75°41'52.1" E', in a split-plot design comprising four plant spacings (45 cm × 20 cm, 50 cm × 20 cm, 60 cm × 25 cm, and 60 cm × 20 cm) and three fertility levels (200-100-100, 150-75-75, and 100-50-50 kg N-P-K/ha). The results revealed that plant height was maximum at a spacing of 50 cm × 20 cm (181.8 cm), whereas chlorophyll content was maximized at 60 cm × 25 cm (44.5). Nutrient uptake was also highest at 60 cm × 25 cm spacing with respect to fertility levels, an increase in N-P-K application (200-100-100 kg/ha) led to higher green cob yield (8.29 t/ha) and baby corn yield (1.83 t/ha), whereas reduced fertility levels (100-50-50 kg/ha) resulted in lower productivity. Under the highest fertility regime results highlighting the positive influence of a balanced nutrient supply and optimal plant spacing. The present study emphasizes how relevant agronomic management techniques may improve crop yield and sustainability in cropping systems based on maize.

Key words: Baby corn, Nutrient management, Nutrient uptake, Plant density

Maize is a versatile crop belonging to family Poaceae adapts well in different ecologies and does not need intensive cultivation. Among all the cereal crops growing worldwide, maize occupies third position as cereal crop after rice and wheat and is termed as "Queen of Cereals" due to highest production potential (Das *et al*., 2008). Globally maize is cultivated over 140 m ha in about 170 countries. It contributes about 36% of global grain production. In India, maize cultivation occurs in different agroclimatic and agroecological zones. USA is the largest producer of the maize and contributes 35% of total maize production worldwide. The productivity of maize is 9.6 t/ha whereas India contributes only 2.43 t/ha (Zaidi *et al*., 2015).

Beyond traditional uses for food, seed and fodder, maize is now grown for sweet corn, baby corn, popcorn etc (Muthukumar *et al*., 2005). Amongst the cultivated maize crops, the most promising one is the baby corn which is usually taken as a promising vegetable crop. It is the most exquisite one as it provides the increased range of production, value addition as well as increased income of farmers (Singh *et al*., 2015). It is a dual-purpose crop which provides food and nutrition for human along with fodder for livestock within 60-70 days after sowing (Hargilas, 2015).

Crop geometry is regarded as one of the most crucial elements among the several agronomic techniques for maximizing solar radiation, efficiently using soil resources, and ultimately improving photosynthetic formation (Neelam, 2018). Although the spacing requirements for grain and fodder maize have been defined, it is still ambiguous how spacing affects the production of the baby corn composite. Proper nutrition management is another crucial factor that should not be overlooked in order to improve baby corn output. Being a high nutrient feeder, nutrient management plays a major role in its production. The main source of plant nutrition is chemical fertilizers (Kumar *et al.,* 2016). Although their application may help achieve the highest possible yield of baby corn, overuse of chemical fertilizers has been linked to a decrease in crop yield and soil physical and chemical characteristics (Araújo *et al.,* 2017). Thus, it is crucial to maximize its production through optimal nutrient management under various plant densities. Since there is currently not much data on various crop densities in combination with fertilizer management, standardization is basically necessary for increased crop

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yield (Bahuguna and Pal, 2021). The present field experiment was carried out to study the effect of different plant spacing and fertilizer application on various growth and yield attributes of spring baby corn under central plain region of Punjab.

MATERIALS AND METHODS

A field experiment was conducted during spring season of 2019–20 and 2020–21 on sub-tropical monsoon climate of Punjab at agriculture research farm, Lovely Professional University, Phagwara, Punjab, located at 31.2690º N′, 75.7021º E′ and 240 m altitude above mean sea level. Soil was slightly alkaline *p*H (7.4) with low OC content (0.22%), available nitrogen (124.2 kg/ha), available phosphorus (7.15 kg/ha) and available potassium (69.5 kg/ha). The total precipitation received during the growing period was 9.1 mm. Maximum and minimum temperature during the whole growing period in 2020 and 2021 varied between 35 to 17.8º C and 21.2 to 9º C respectively. The experiment was laid out in split plot design with three replications. The treatments comprised combination of four plant spacing (45 cm × 20 cm, 50 cm × 20 cm, 60 cm × 25 cm and 60 cm × 20 cm) allocated in main plots and three fertility levels (200-100-100 kg N-P-K/ha, 150-75-75 kg N-P-K/ha, 100-50-50 kg N-P-K/ha) in sub-plots. Half nitrogen dose and full phosphorus and potassium dose was applied as basal. Remaining half nitrogen was top dressed at knee high stage as per treatments. Baby corn variety G-5417 was sown manually at varying row spacing.

The height of the plant was measured from the randomly tagged plants from each plot at 30, 45 and 60 DAS and an average height was calculated at mentioned growth stages. The same plants were used to record the number of leaves per plant. The number of leaves on the plant was recorded at 30, 45 and 60 DAS. The SPAD chlorophyll meter was used for rapid estimation of extractable chlorophyll in leaves at 30, 45 and 60 DAS. Length, diameter and fresh weight of both cob and corn were measured from which mean values were recorded. Ray *et al.* (2018)'s methodologies were used for the initial and post-harvest soil and plant nutrient (N, P, and K) content (%). Total nutrient absorption (NPK) was computed by dividing the concentration (%) by the plant dry matter (kg/ha) at harvest, then dividing the result by 100. The analysis of variance (ANOVA) was used to examine all of the data using standard variance methodologies, as recommended by Gomez and Gomez (1984). In order to increase the homogeneity of variance, weed data were transformed using the square root method [$\sqrt{(x + 1)}$] before statistical calculations. At the 5% level of significance ($P \leq 0.05$), treatment means were separated using the critical difference (CD).

RESULTS AND DISCUSSION

Effect of plant density on growth attributes

Plant density significantly influenced the growth attributes, viz. plant height (cm), number of leaves per plant and chlorophyll content at all stages of growth (Table 1). Among all the plant spacing, 50 cm × 20 cm recorded the tallest plant (181.78 cm) followed by (*fb*) 45 cm × 20 cm and 60 cm × 20 cm i.e., 177.67 cm and 171.65 cm respectively. The lowest plant height (167.35 cm) recorded in the plant spacing 60 cm × 25 cm. This can be attributed to reduced competition for nutrients and light under wider spacing, which favour better crop growth in terms of height. Highest number of leaves (11.48) was recorded in plant spacing 60 cm × 20 cm, *fb* 50 cm × 20 cm (11.46)

Table 1. Effect of different plant spacing and fertility levels on growth and yield attributes of baby corn (pooled data of 2 years)

Treatment	Plant height (cm)	Number of leaves	Chlorophyll content	Cob length (cm)	Corn length (cm)	Cob diameter (cm)	Corn diameter (cm)	Fresh Cob weight (g)	Fresh Corn weight (g)
Spacing									
45 cm × 20 cm	177. 7	11.3	43.65	29.86	11.22	4.04	1.06	56.37	7.96
50 cm × 20 cm	181. 8	11.5	44.21	29.92	11.28	4.05	1.07	59.19	9.1
60 cm × 25 cm	167.5	11.4	44.53	30.86	11.42	4.22	1.14	58.13	7.82
60 cm × 20 cm	171.65	11.5	44.41	30.02	11.41	4.15	1.07	59.38	8.88
SEm±	0.25	0.01	0.05	0.06	0.03	0.03	0.04	0.13	0.03
CD (P=0.05)	0.9	0.04	0.19	0.23	0.1	0.01	0.01	0.13	0.13
Fertility level									
200N-100P-100K	184.68	11.73	47.44	30.76	11.62	4.16	1.12	60.21	8.79
150N-75P-75K	176.06	11.46	44.83	30.12	11.49	4.15	1.11	60.9	9.22
100N-50P-50K	163.09	11.06	40.33	29.13	10.89	4.01	1.03	53.6	7.31
SEm±	0.15	0.03	0.04	0.01	0.01	0.02	0.05	0.08	0.02
CD (P=0.05)	0.47	0.09	0.14	0.05	0.04	0.07	0.01	0.24	0.08

and 60 cm × 25 cm (11.39). This can be achieved through better resource availability and canopy development in intermediate plant densities compared to extreme densities. At 30 and 60 DAS plant spacing, 60 cm × 25 cm registered maximum SPAD value i.e., 36.60 and 44.53 respectively, indicating better chlorophyll synthesis and enhanced photosynthesis at wider spacing. Saha *et al.* (2023) determined that planting maize at a spacing of 67.5 cm × 20 cm improved plant height and dry matter/m^2. Application of RDN-SSB resulted in considerably higher growth metrics among nitrogen management techniques. Similar results were reported by Sobhana *et al.,* 2012; Neelam, 2018.

Effect of fertilizer management on growth attributes

Different level of fertility significantly influenced all the growth attributes *viz.,* plant height (cm), number of leaves per plant and chlorophyll content recorded highest reading in high fertility level (200N-100P-100K kg/ha) i.e., 184.68 cm, 11.73 and 47.44 respectively, fb medium fertility level (150N-75P-75K kg/ha). Lowest readings of all the growth attributes recorded in low fertility level (100N-50P-50K kg/ha) (Table 1). This result indicates the critical role of balanced nutrient supply in enhancing vegetative growth and photosynthetic efficiency in baby corn. Application of RDN-SSB resulted in considerably higher growth metrics among nitrogen management techniques (Saha *et al.,* 2023). Similar results were observed by Marahatta, 2021; Bahuguna and Pal, 2020; Neelam, 2018.

Effect of plant density on yield attributes

Yield attributes*, viz.* cob length (cm), corn length (cm), corn diameter (cm), cob diameter (cm), corn fresh weight (g), cob fresh weight (g), baby corn yield (q/ha), cob yield (q/ha) and fodder yield (q/ha) showed significant difference due to different plant spacing. Plant spacing, 60 cm × 25 cm recorded maximum reading of cob length (30.86 cm), corn diameter (1.14 cm) and cob diameter (4.22 cm) (Table 1). However, plant spacing 50 cm × 20 cm recorded highest reading in corn fresh weight (9.1 g) and cob yield (79.01 q/ha) (Fig. 1). Maximum cob fresh weight (59.38 g) and corn length (11.42 cm) recorded in plant spacing 60 cm × 20 cm, indicating that wider spacing provided more resources per plant and improving the diameter of individual corns and cobs, while narrow spacing optimized overall yield. Golada *et al.* (2013) revealed that the highest yields of green cob, baby corn, and green fodder were found at 60 × 15 cm^2 spacing, which was more than 90 × 10 cm^2 (14.0, 24.3, and 8.8%, respectively). Similar results were found by Neelam (2018).

Effect of fertilizer management on yield attributes

The significant differences in all the yield attributes observed due to different fertility level during the experimentation. The maximum corn fresh weight (9.22 g) and cob fresh weight (60.9 g) was recorded in the treatment of medium fertility level i.e., 150 N-75P-75K kg/ha. The maximum corn length (11.62 cm), cob length (30.8 cm), corn diameter (1.12 cm), cob diameter (4.16 cm), baby corn yield (1.83 t/ha), cob yield (8.29 t/ha) and fodder yield (23.5 t/ha) was recorded with the highest fertility level of 200 N-100 P-100 K kg/ha (Table 2). The higher fertility levels resulted in the maximum crop yields because there was an adequate supply of the vital nutrients, which boosted both vegetative and reproductive growth of the crops, whereas the lower fertility levels caused nutritional limits, which decreased growth and yield. In comparison to 60 kg/N ha, application of nitrogen up to 90 kg/ha level considerably boosted the yield of baby corn and green cob

Table 2. Effect of different plant spacing and fertility levels on yield of baby corn (pooled data of 2 years)

Treatment	Cob yield (t/ha)	Baby corn yield (t/ha)	Fodder yield (t/ha)
Spacing			
45 cm × 20 cm	7.83	1.68	23.63
50 cm × 20 cm	7.9	1.66	22.69
60 cm × 25 cm	7.27	1.51	19.15
60 cm × 20 cm	7.38	1.57	20.55
SEm±	0.029	0.004	0.007
CD (P=0.05)	0.101	0.014	0.025
Fertility level			
200N-100P-100K	8.29	1.82	23.35
150N-75P-75K	7.98	1.7	22.06
100N-50P-50K	6.51	1.29	19.1
SEm±	0.018	0.003	0.007
CD (P=0.05)	0.053	0.009	0.023.

by 20.5 and 23.6%, respectively. Similar results were reported by the several workers (Bahuguna and Pal, 2020; Marahatta, 2021).

Different plant density and fertility management on nutrient uptake

The results indicate that the highest nutrient uptake was achieved under plant spacing of 60 cm × 25 cm, with total N, P, and K uptakes of 163, 24.3, and 84.5 kg/ha, respectively (Fig. 1). Among the fertility level of, application of 200 N-100 P-100 K kg/ha, with total N, P, and K uptakes of 195, 27.5, and 100.4 kg/ha, respectively (Fig. 2). This highlights the significant influence of optimal fertility and spacing on nutrient uptake in baby corn cultivation. Ray *et al.* (2020) also was recorded that total N, P and K uptake increase with the application of higher fertility of 150% RDF application.

Plant density and fertilizer management significantly enhance the baby corn growth and yield. The plant spacing of 50 cm × 20 cm had maximized baby corn yield (7.90 t/ha), while plant spacing 60 cm × 20 cm had enhanced the growth attributes of plant such as plant height and leaf number. The fertility level of 200 N-100 P-100 K outyielded the superior results by enhancing the cob yield (8.29 t/ha) and baby corn yield (1.83 q/ha). Thus, this combination is recommended for sustainable baby corn production in the central plain region of Punjab, ensuring the efficient resource utilization and enhanced profitability.

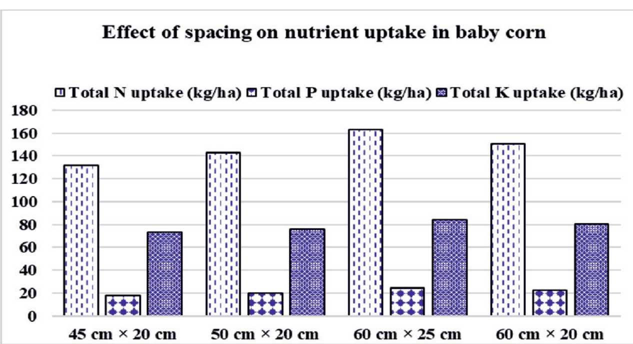

Fig. 1. Effect of spacing on nutrient uptake in baby corn (pooled data of 2 years)

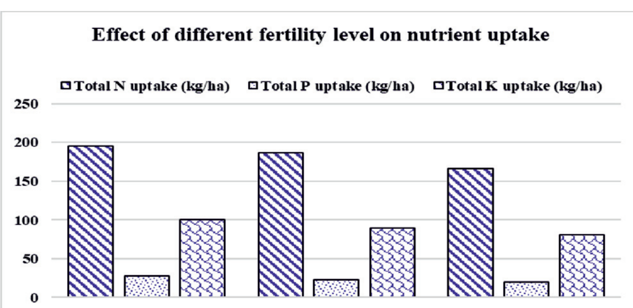

Fig. 2. Effect of different fertility level on nutrient uptake (pooled data of 2 years)

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