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Effect of crop geometry and nutrient levels on growth, yield and economics of maize

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Abstract

A field experiment was conducted during *kharif* 2025–26 at the Agronomy Farm, College of Agriculture, Nagpur, to study the effect of crop geometry and nutrient levels on growth, yield and economics of maize (*Zea mays* L.) cv. PDKV Aarambh. The experiment was laid out in a Factorial Randomized Block Design with three crop geometries and three nutrient levels, replicated thrice. Among the crop geometries, 45 cm × 20 cm recorded the highest grain yield (75.47 q ha⁻¹), straw yield (78.91 q ha⁻¹), gross monetary returns (Rs. 1,75,805 ha⁻¹), net monetary returns (Rs. 1,32,573 ha⁻¹) and benefit: cost ratio (4.07). Among nutrient levels, 180:90:90 kg N: P₂O₅:K₂O ha⁻¹ resulted in the highest grain yield (69.65 q ha⁻¹), straw yield (71.51 q ha⁻¹), gross monetary returns (Rs. 1,62,123 ha⁻¹), net monetary returns (Rs. 1,17,423 ha⁻¹) and benefit: cost ratio (3.63). The interaction between crop geometry and nutrient levels was non-significant for growth, yield and economic parameters. Thus, 45 cm × 20 cm crop geometry and 180:90:90 kg N: P₂O₅:K₂O ha⁻¹ nutrient level may be considered a suitable one for improving productivity and profitability of maize under the agro-ecological conditions of Nagpur.

Keywords: Maize, crop geometry, nutrient levels, plant population, grain yield, straw yield, economics, benefit:cost ratio

1. Introduction

Maize (*Zea mays* L.) often referred to as the “Queen of Cereals” is an important cereal crop of India and has wide applications as food, feed and industrial raw material. Its adaptability to diverse environments and capacity to produce substantial biomass within a comparatively short period make it an important crop for improving farm productivity. The productivity of maize is closely associated with appropriate agronomic management, particularly crop geometry and nutrient supply. Crop geometry determines plant distribution and consequently influences the capture and utilization of solar radiation, water and nutrients. Suitable spatial arrangement can improve plant performance, photosynthetic activity and source–sink relationships (Aliveni *et al.*, 2025) ^[1]. Nutrient management is another major determinant of maize growth and yield. Nitrogen, phosphorus and potassium have complementary roles in vegetative development, energy transfer, photosynthesis, assimilate production and grain formation. Increasing nutrient availability can enhance biomass accumulation and yield components when the additional supply is effectively utilized by the crop (Maeda *et al.*, 2018; Hu *et al.*, 2019; Medici *et al.*, 2019) ^[8, 6, 10]. Previous studies cited in the present investigation have reported beneficial effects of appropriate planting geometry and increased fertility levels on maize growth, yield and economics (Mahapatra *et al.*, 2006 and Kar *et al.*, 2006) ^[9, 7].

Despite the recognized importance of these practices, their combined response can vary with genotype and growing conditions. Therefore, the present investigation was undertaken at Nagpur to study the effects of different crop geometries and nutrient levels on growth, yield and economics of maize variety PDKV Aarambh. The objectives were to study the effect of crop geometry on maize growth, to assess the impact of nutrient levels on maize yield and to work out the economics of the treatments.

2. Materials and Methods

The field experiment entitled was conducted during *kharif* 2025–26 at Field No. 10 of the

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Agronomy Farm, College of Agriculture, Nagpur. The experiment was conducted in Factorial Randomized Block Design (FRBD) with three crop geometries and three nutrient levels, having nine treatment combinations replicated thrice.

Table 1: Experimental treatments and layout

Treatment	Description
G ₁	60 cm × 15 cm
G ₂	45 cm × 20 cm
G ₃	45/90 cm × 20 cm (paired row)
N ₁	120:60:60 kg N:P ₂ O ₅ :K ₂ O ha ⁻¹ (100% RDF)
N ₂	150:75:75 kg N:P ₂ O ₅ :K ₂ O ha ⁻¹ (125% RDF)
N ₃	180:90:90 kg N:P ₂ O ₅ :K ₂ O ha ⁻¹ (150% RDF)
Variety	PDKV Aarambh (BMH-18-2)

Maize was sown on 28 June 2025 by dibbling two seeds per hill according to the assigned geometry. Gap filling and thinning were carried out to maintain the required plant population. Nitrogen was applied through urea in two splits, with half as basal and half at 30 days after sowing, while the full doses of phosphorus and potassium were applied at sowing through single super phosphate and muriate of potash, respectively. The crop was maintained weed-free through intercultural operations and herbicide application. Harvesting was carried out manually at physiological maturity. During the crop growth period (June-November) total rainfall received was 1217 mm, data pertaining to yield attributes were recorded from randomly selected five plants from each net

plot and the mean value was calculated. Cost of cultivation was worked out with help of prevailing market prices of finger millet. The data was statistically analyzed with standard method outlined for randomized block design (Gomez and Gomez, 1984) ^[5]. Statistically significance was tested by F- value at 0.05% level of probability and critical difference was worked out wherever the effect was significant.

3. Results and Discussion

3.1 Yield attributes

Number of cobs plant⁻¹ was not significantly affected by either crop geometry or nutrient level. Numerically, the paired-row geometry recorded 2.19 cobs plant⁻¹. Cob length, cob weight, number of grains cob⁻¹, grain yield plant⁻¹ and straw yield plant⁻¹ were significantly improved under the tested crop geometries, with the paired-row geometry recording 22.74 cm cob length, 120.31 g cob weight, 400.28 grains cob⁻¹ 66.16 g grain yield plant⁻¹ and 77.14 g straw yield plant⁻¹. The improved individual-plant performance under paired rows was associated with greater space and resource availability. Similar responses were reported by Sultani and Bakhtyar (2025) ^[11] and Tanisha *et al.* (2026) ^[12]. Nutrient level 180:90:90 recorded the highest values for these yield attributes, except that number of cobs plant⁻¹ and seed index were non-significant. The improved yield components with higher nutrient supply were associated with better nutrient availability and assimilate production.

Table 2: Yield attributes of maize at harvest

Treatment	No. of cobs plant ⁻¹	Length of cob (cm)	Weight of cob (g)	No. of grains cob ⁻¹	Grain yield plant ⁻¹ (g)	Straw yield plant ⁻¹ (g)	Seed Index (g)
A. Crop geometry							
G ₁ - 60 cm x 15 cm	1.88	21.13	117.85	364.23	60.20	74.23	23.98
G ₂ - 45 cm x 20 cm	1.94	21.94	118.85	386.44	63.87	75.62	23.99
G ₃ - 45/90 cm x 20 cm	2.19	22.74	120.31	400.28	66.16	77.14	24.50
S.E. (m) ±	0.19	0.14	0.20	2.89	0.48	0.26	0.57
C.D. at 5%	NS	0.43	0.61	1.16	1.43	0.78	NS
B. Nutrient levels (kg N: P: K ha⁻¹)							
N ₁ -120:60:60 (100% RDF)	1.77	21.25	118.35	369.89	61.14	74.85	23.61
N ₂ -150:75:75 (125% RDF)	2.00	22.00	118.95	382.48	63.22	75.86	23.80
N ₃ -180:90:90 (150% RDF)	2.24	22.56	119.71	398.58	65.88	76.28	25.05
S.E. (m) ±	0.19	0.14	0.20	2.89	0.48	0.26	0.57
C.D. at 5%	NS	0.43	0.61	1.16	1.43	0.78	NS
Interaction (G x N)							
S.E. (m) ±	0.33	0.25	0.35	5.00	0.83	0.45	0.99
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS
GM	2.00	21.94	119.00	383.65	63.41	75.66	24.15

3.2 Grain and straw yield

Grain yield was significantly influenced by crop geometry. The highest grain yield (75.47 q ha⁻¹) was obtained with 45 cm × 20 cm followed by 60 cm × 15 cm (72.13 q ha⁻¹) while 45/90 cm × 20 cm produced 52.76 q ha⁻¹. Although the paired-row arrangement improved individual-plant yield attributes, its lower plant population reduced yield ha⁻¹. The 45 cm × 20 cm geometry combined adequate plant population with favourable resource distribution and consequently recorded the highest grain and straw yields. Similar results were reported by Sultani and Bakhtyar (2025) ^[11], Bhusal *et al.* (2025) ^[4] and Tanisha *et al.* (2026) ^[12].

Nutrient levels produced a progressive increase in grain yield, from 64.11 q ha⁻¹ with 120:60:60 to 69.65 q ha⁻¹ with 180:90:90 kg N: P₂O₅:K₂O ha⁻¹. The increased nutrient supply likely enhanced vegetative growth, photosynthetic activity, assimilates production and grain development. These findings are supported

by Alka *et al.* (2019) ^[3] and Abhigna *et al.* (2024) ^[2]. Straw yield followed a similar pattern, with the highest value under 45 cm × 20 cm among crop geometries and under 180:90:90 among nutrient levels. The interaction effect was non-significant.

3.3 Economics

Economics clearly reflected the yield response of the treatments. Crop geometry significantly influenced gross monetary returns, net monetary returns and benefit:cost ratio. The 45 cm × 20 cm geometry recorded the highest gross monetary returns (Rs. 1,75,805 ha⁻¹), net monetary returns (Rs. 1,32,573 ha⁻¹) and benefit: cost ratio (4.07), followed by 60 cm × 15 cm. The paired-row geometry had lower returns because of its lower grain and straw productivity. Similar economic advantages of suitable planting geometry have been reported by Kar *et al.* (2006) ^[7]. Nutrient levels increased gross and net monetary returns progressively. The highest gross monetary returns (Rs. 1,62,123

ha⁻¹), net monetary returns (Rs. 1,17,423 ha⁻¹) and benefit: cost ratio (3.63) were obtained with 180:90:90 kg N:P₂O₅:K₂O ha⁻¹. The additional returns associated with higher productivity compensated for the additional fertilizer expenditure. Comparable improvements in maize economics with increasing fertility levels were reported by Kar *et al.* (2006)^[7] and Alka *et al.* (2019)^[3].

Table 3: Grain and straw yield of maize

Treatment	Yield (q ha ⁻¹)	
	Grain	Straw
A. Crop geometry		
G ₁ - 60 cm x 15 cm	72.13	78.56
G ₂ - 45 cm x 20 cm	75.47	78.91
G ₃ - 45/90 cm x 20 cm	52.76	54.34
S.E. (m) ±	0.61	0.33
C.D. at 5%	1.84	0.99
B. Nutrient levels (kg N: P: K ha⁻¹)		
N ₁ -120:60:60 (100% RDF)	64.11	69.47
N ₂ -150:75:75 (125% RDF)	66.60	70.82
N ₃ -180:90:90 (150% RDF)	69.65	71.51
S.E. (m) ±	0.61	0.33
C.D. at 5%	1.84	0.99
Interaction (G x N)		
S.E. (m) ±	1.06	0.57
C.D. at 5%	NS	NS
GM	66.79	70.60

Table 4: Cost of cultivation, gross monetary returns, net monetary returns and benefit:cost ratio

Treatment	Cost of cultivation (Rs. ha ⁻¹)	GMR (Rs. ha ⁻¹)	NMR (Rs. ha ⁻¹)	B:C ratio
A. Crop geometry				
60 cm × 15 cm	43232	168355	125124	3.89
45 cm × 20 cm	43232	175805	132573	4.07
45/90 cm × 20 cm	43012	122831	79819	2.85
SEm ±	-	1378	1378	-
CD at 5%	-	Sig.	Sig.	-
B. Nutrient levels (kg N: P: K ha⁻¹)				
120:60:60	41617	149599	107982	3.59
150:75:75	43158	155269	112111	3.60
180:90:90	44699	162123	117423	3.63
SEm ±	-	1378	1378	-
CD at 5%	-	Sig.	Sig.	-
Interaction (G x N)				
SEm ±	-	2386	2386	-
CD at 5%	-	NS	NS	-
GM	43158	155664	112505	3.61

4. Conclusion

Under the agro-ecological conditions of Nagpur during *kharif* 2025–26, crop geometry had a pronounced influence on plant population, growth, yield attributes, grain & straw yield and economic returns. The 45 cm × 20 cm geometry improved the plant population, grain yield (75.47 q ha⁻¹), straw yield (78.91 q ha⁻¹), gross monetary returns (Rs. 1,75,805 ha⁻¹), net monetary returns (Rs. 1,32,573 ha⁻¹) and benefit: cost ratio (4.07). The 45/90 cm × 20 cm paired-row geometry enhanced several individual-plant yield attributes but its lower population reduced productivity on a hectare basis.

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