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EFFECT ON GROWTH PERFORMANCE OF MAIZE (*Zea mays* L.) BASED CROPPING SYSTEMS UNDER DIFFERENT FARMING PRACTICES

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ABSTRACT

A field experiment was conducted at the Instructional Farm, Department of Agronomy, Rajasthan College of Agriculture, MPUAT, Udaipur, during two consecutive *kharif* seasons 2024 and 2025 and then after the succeeding crops in *rabi*, 2024-25 and 2025-26. The experiment was laid out in a split-plot design with four farming practices, *viz*., biodynamic, organic and natural farming and four maize-based cropping systems, *viz*., maize-wheat, maize-barley, maize-mustard and maize-chickpea, replicated thrice. The results revealed that farming practices significantly influenced maize plant height, while cropping systems had no significant effect. Among farming practices, organic farming recorded the highest pooled plant height followed by biodynamic and natural farming, whereas the control recorded the lowest plant height. Different cropping systems recorded statistically no significant effect on plant height. However, mean of two years data pertaining to *rabi* crops (wheat, barley, mustard and chickpea) on growth parameters, the highest mean value was recorded under organic farming, followed by natural farming and biodynamic farming. The control recorded the lowest mean plant height of *rabi* crops.

Key words : Maize, Natural farming, Biodynamic farming, Organic farming, Control, *Rabi* crops, Cropping System, Plant height.

Introduction

Maize (*Zea mays* L.) is the world's leading crop and is widely cultivated as a cereal grain. It is one of the most versatile emerging crops with wide adaptability. Globally, maize is known as "Queen of Cereals" because of its highest genetic yield potential. Maize is the only food cereal crop that can be grown in diverse seasons and ecologies (IIMR, 2024). Maize contains about 72% starch, 10% protein and 4% fat, supplying an energy density of 365 kcal 100 g^{-1} compared with rice and wheat, but has lower protein content (Nuss *et al.*, 2010). In India, maize plays a vital role in ensuring food security and supporting the livelihoods of millions of farmers due to its high productivity, wide adaptability and diverse end uses. Maize (*Zea mays* L.) is a major cereal crop cultivated in Southern Rajasthan and an important component of the *kharif* cropping system, because it required small amount of water and supports crop variety. It is a staple food for households of tribal dominated southern Rajasthan besides fodder for animals. Maize-based cropping systems in India are increasingly for diversifying from water-intensive rice-wheat systems, offering higher profitability and lower water footprint. Common, profitable sequences include maize-pea, maize-rajmash and maize-mustard, often yielding higher net returns and sustaining soil health. The integration of diverse crops such as maize (*Zea mays* L.), wheat (*Triticum aestivum* L.), barley (*Hordeum vulgare* L.) and chickpea (*Cicer arietinum* L.) within these sustainable models is essential for resource conservation and nutritional security (Yang *et al*., 2024). Key, high-performing rotations include maize-mustard-mung and maize-chickpea, which are particularly

effective in optimizing resource use in states like Punjab, Haryana, Rajasthan and Bihar. In Southern Rajasthan maize-wheat is a common cropping system in irrigated areas. Whereas, in water scares and dryland areas of South Rajasthan, maize-barley, maize-mustard and maize-gram are popular cropping system adopted by farmers. Organic farming has emerged as a powerful solution-bringing back traditional ecological wisdom while integrating modern sustainable techniques. Over the last decade, India has witnessed a sharp rise in organic farms, organic food demand and export opportunities. Natural farming, particularly through India's National Mission on Natural Farming and the Bhartiya Prakritik Krishi Paddhati, emphasises a chemical-free, low-cost approach that utilises locally sourced inputs (Varaprasad and Rao, 2024 and Mane *et al*., 2026). Despite the burgeoning interest in sustainable intensification, a critical knowledge gap persists regarding the comparative systemic performance of organic, natural and biodynamic paradigms when evaluated concurrently across diversified crop rotations (Mane *et al*., 2026). Current academic literature often focuses on singular comparisons between a specific alternative system and conventional methods, frequently neglecting the complex interaction between holistic soil management and the productivity of intensive sequences involving maize, wheat, barley, chickpea and mustard (Pooniya *et al*., 2021 and Yang *et al*., 2024). This research addresses this void by providing a multidimensional assessment of yield stability, microbial functional diversity and economic resilience across these three distinct ecological frameworks (Salakinkop, 2024).

Materials and Methods

A field experiment was carried out at field No. $C_{5,}$ Organic Farm unit of the Instructional Farm, Department of Agronomy, Rajasthan College of Agriculture, MPUAT, Udaipur (Rajasthan) during two consecutive *kharif* seasons 2024 and 2025 and then after the succeeding crops in *rabi*, 2024-25 and 2025-26. The experiment was laid out in a Split Plot Design with three replications. The main plot treatments consisted of four farming practices: control, organic farming (vermicompost (4.5 t ha^{-1}) + seed treatment (PSB-Biofertilizer) + 10% vermiwash spray (20 days interval) natural farming (ghanjeevamrit (5 q ha^{-1}) + seed treatment (Beejamrit) + 10% jeevamrut spray (20 days interval) + mulching and biodynamic farming (BD 500 (62.5 g ha^{-1}) + BD 501 (2.5 g ha^{-1}). The sub-plot treatments included four cropping system *viz*. Maize-Wheat, Maize- Barley, Maize-Mustard and Maize-Chickpea. Recommended agronomic practices were followed throughout the crop season. The plant height was taken regularly at 30, 60 DAS and at harvest (cm). Five plants were tagged from the net plot area and the plant height was recorded with the help of a metre scale from the base of the ground surface to the tip of the uppermost leaf. The mean height of the plants was worked out by averaging the observations recorded from each treatment. The experimental data were analyzed statistically using analysis of variance (ANOVA) for Split Plot Design and treatment means were compared using the Critical Difference (CD) test at the 5% level of significance.

Results and Discussion

Growth attributes

Kharif

Farming Practices : Farming practices had no significant effect on maize plant height at 30 DAS. However, a significant influence was observed at 60 DAS and at harvest in both years and in the pooled data (Table 1). At 60 DAS, biodynamic farming recorded the highest pooled plant height (155.35 cm), followed by organic (152.39 cm) and natural farming (149.46 cm) while the control recorded the lowest (135.21 cm). At harvest, organic farming recorded the maximum plant height (211.40 cm) whereas the control recorded the minimum (178.45 cm) indicating higher plant height under biodynamic and organic farming may be attributed to better nutrient availability, enhanced microbial activity and improved root growth. These conditions promote efficient nutrient and water uptake, resulting in greater cell division, cell elongation and internodal growth. The lower plant height under control may be due to comparatively poor nutrient availability and restricted vegetative growth. (Amujoyegbe *et al*., 2007 and Kumar *et al*., 2019).

Cropping Systems : Different cropping systems did not significantly influence maize plant height at 30 DAS, 60 DAS or harvest in either year or pooled analysis. At 30 DAS, the maize-chickpea system recorded the highest pooled plant height (32.57 cm), while maize-wheat recorded the lowest (32.09 cm). Similarly, at 60 DAS, maize-chickpea recorded the maximum plant height (148.60 cm) and maize-barley the minimum (147.67 cm). The non-significant differences indicate that the choice of cropping system had little influence on maize plant height.

***Rabi* :** Regarding plant height, the data presented in Tables 2 to 5 revealed that plant height increased progressively with the advancement of crop growth from 30 DAS to harvest in all the succeeding crops. In succeeding wheat, at 30 DAS, the highest mean plant height (23.17 cm) was recorded under organic farming,

Table 1 : Effect of farming practices and cropping systems on plant height of maize.

Treatments	Plant height (cm)								
	30 DAS			60 DAS			At harvest		
	2024	2025	Pooled	2024	2025	Pooled	2024	2025	Pooled
Farming Practices									
Control	30.88	32.51	31.70	132.78	137.63	135.21	176.49	180.41	178.45
Organic Farming	32.09	33.33	32.71	153.53	151.24	152.39	209.44	213.36	211.40
Natural Farming	32.15	32.88	32.52	145.88	153.03	149.46	197.38	201.31	199.34
Biodynamic Farming	31.90	32.81	32.36	146.14	164.56	155.35	199.63	203.55	201.59
S.Em.±	0.50	0.60	0.28	3.86	2.82	2.02	4.94	4.94	2.67
C.D. (P= 0.05)	NS	NS	NS	13.37	9.77	5.99	17.08	17.08	7.92
Cropping Systems									
Maize-wheat	31.74	32.43	32.09	144.83	151.66	148.25	195.82	199.75	197.78
Maize-barley	31.76	33.13	32.44	145.44	151.77	148.60	196.29	200.22	198.26
Maize-mustard	31.79	32.58	32.19	144.31	151.43	147.87	195.66	199.58	197.62
Maize-chickpea	31.74	33.39	32.57	143.75	151.59	147.67	195.16	199.08	197.12
S.Em.±	0.43	0.59	0.22	3.78	1.93	1.90	2.38	2.38	1.22
C.D. (P= 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2 : Effect of farming practices on plant height of succeeding wheat.

Treatments	Plant height (cm)								
	30 DAS			60 DAS			At harvest		
	2024-25	2025-26	Mean	2024-25	2025-26	Mean	2024-25	2025-26	Mean
Farming practices									
Control	19.20	19.30	19.25	64.68	64.95	64.81	93.82	94.57	94.19
Organic Farming	23.12	23.23	23.17	73.08	73.37	73.22	103.48	104.65	104.07
Natural Farming	20.29	20.40	20.34	66.67	66.94	66.80	98.37	99.12	98.74
Biodynamic Farming	20.14	20.40	20.27	64.96	65.24	65.10	97.35	98.10	97.73

followed by natural farming (20.34 cm) and biodynamic farming (20.27 cm) whereas the control recorded the lowest mean plant height (19.25 cm). At 60 DAS, organic farming recorded the maximum mean plant height (73.22 cm) followed by natural farming (66.80 cm) and biodynamic farming (65.10 cm) while the minimum value was observed under control (64.81 cm). At harvest, the highest mean plant height was recorded under organic farming (104.07 cm) followed by natural farming (98.74 cm) and biodynamic farming (97.73 cm) whereas the control recorded the lowest value (94.19 cm). In succeeding barley, the highest mean plant height at 30 DAS was recorded under organic farming (16.49 cm) followed by natural farming (15.69 cm) and biodynamic farming (15.62 cm), while the control recorded the lowest value (14.64 cm). At 60 DAS, organic farming recorded the maximum mean plant height (67.80 cm) followed by natural farming (65.43 cm) and biodynamic farming (64.18 cm) with the minimum value under control (62.40 cm). At harvest, the maximum mean plant height was recorded under organic farming (101.85 cm) followed by natural farming (97.41 cm) and biodynamic farming (95.07 cm) whereas the control recorded the minimum value (94.62 cm). In succeeding mustard, at 30 DAS, the maximum mean plant height was recorded under organic farming (25.98 cm) followed by control (24.36 cm) natural farming (23.48 cm) and biodynamic farming (23.42 cm). At 60 DAS, organic farming recorded the highest mean plant height (109.10 cm) followed by natural farming (96.76 cm) biodynamic farming (92.95 cm) and control (86.94 cm. (Veeranna *et al*., 2023). At harvest, the highest mean plant height was recorded under organic farming (200.90 cm) followed by natural farming (188.16 cm) biodynamic farming (186.16 cm) and control (176.10 cm). In succeeding chickpea, at 30 DAS, the highest mean plant height was recorded under organic farming (11.03 cm) followed by natural farming (10.70 cm) and biodynamic farming (10.42 cm) whereas the control recorded the lowest value (10.26 cm). At 60 DAS, organic farming recorded the maximum mean plant height (51.72

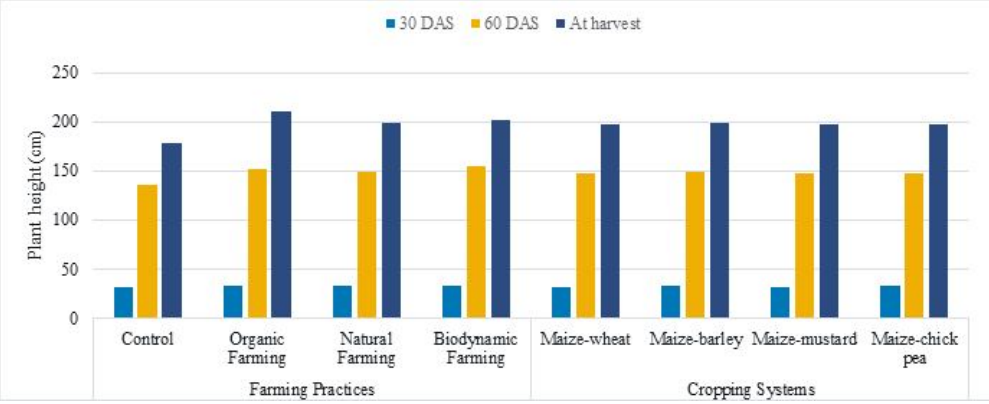


Fig. 1 : Effect of farming practices and cropping systems on plant height of maize.

Table 3 : Effect of farming practices on plant height of succeeding barley.

Treatments	Plant height (cm)								
	30 DAS			60 DAS			At harvest		
	2024-25	2025-26	Mean	2024-25	2025-26	Mean	2024-25	2025-26	Mean
Farming practices									
Control	14.59	14.68	14.64	62.34	62.46	62.40	94.55	94.70	94.62
Organic Farming	16.46	16.53	16.49	67.74	67.86	67.80	101.67	102.04	101.85
Natural Farming	15.66	15.72	15.69	65.37	65.49	65.43	97.33	97.48	97.41
Biodynamic Farming	15.59	15.66	15.62	64.13	64.24	64.18	95.00	95.15	95.07

Table 4 : Effect of farming practices on plant height of succeeding mustard.

Treatments	Plant height (cm)								
	30 DAS			60 DAS			At harvest		
	2024-25	2025-26	Mean	2024-25	2025-26	Mean	2024-25	2025-26	Mean
Farming practices									
Control	24.27	24.46	24.36	86.84	87.03	86.94	176.00	176.20	176.10
Organic Farming	25.89	26.07	25.98	109.00	109.19	109.10	200.80	201.00	200.90
Natural Farming	23.39	23.57	23.48	96.67	96.86	96.76	188.06	188.26	188.16
Biodynamic Farming	23.32	23.51	23.42	92.85	93.04	92.95	186.06	186.26	186.16

Table 5 : Effect of farming practices on plant height of succeeding chickpea.

Treatments	Plant height (cm)								
	30 DAS			60 DAS			At harvest		
	2024-25	2025-26	Mean	2024-25	2025-26	Mean	2024-25	2025-26	Mean
Farming practices									
Control	10.18	10.34	10.26	47.45	47.65	47.55	55.33	55.74	55.53
Organic Farming	10.95	11.11	11.03	51.62	51.82	51.72	62.22	62.81	62.51
Natural Farming	10.62	10.78	10.70	49.10	49.30	49.20	59.26	59.47	59.36
Biodynamic Farming	10.34	10.50	10.42	48.18	48.38	48.28	58.64	58.85	58.75

cm) followed by natural farming (49.20 cm) and biodynamic farming (48.28 cm) while the minimum value was observed under control (47.55 cm). At harvest, the highest mean plant height was recorded under organic farming (62.51 cm) followed by natural farming (59.36 cm) and biodynamic farming (58.75 cm) whereas the control recorded the lowest mean plant height (55.53 cm). Overall, organic farming consistently recorded superior plant height across the growth stages and succeeding crops, followed by natural and biodynamic farming, while the control generally recorded the lowest plant height (Nasim, 2012 and Borase *et al*., 2020).

Conclusion

Based on findings, it is application of organic farming, natural, biodynamic and control treatments in both *kharif* maize and succeeding *rabi* crops resulted as the superior plant growth under organic farming may be attributed to the better availability and gradual release of nutrients, improved soil physical conditions and enhanced microbial activity, which collectively promoted root development and nutrient uptake. Natural and biodynamic farming showed intermediate performance while the control generally recorded the lowest plant height due to comparatively limited nutrient availability. Overall, organic farming proved more effective in improving plant growth and plant height across the cropping sequence.

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