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Effect of fertility levels and anti-transpirants on growth and yield of pearl millet {*Pennisetum glaucum* (L.) R. Br. emend Stuntz}

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Abstract

A field experiment was conducted during the *Kharif* season of 2024–25 at the Agronomy Farm, School of Agricultural Sciences, Suresh Gyan Vihar University, Jaipur, to study the effect of different fertility levels and anti-transpirants on growth and yield of pearl millet. The experiment was laid out in a factorial randomized block design (FRBD) with 16 treatment combinations consisting of four fertility levels (0, 50, 75 and 100% of RDF) and four anti-transpirant treatments (control, Cycocel @ 200 ppm, PMA @ 250 ppm and Kaolin @ 3.0%), replicated thrice. revealed that increasing fertility levels significantly improved plant height, dry matter accumulation, tillers, leaf area index, yield attributes and yield of pearl millet. Application of 100% RDF recorded the highest grain yield (3032 kg ha⁻¹), stover yield (6975 kg ha⁻¹) and biological yield (10007 kg ha⁻¹). Among anti-transpirants, Kaolin @ 3% proved superior by improving growth and yield parameters. Interaction effects between fertility levels and anti-transpirants were mostly non-significant. The study concluded that application of 100% RDF along with Kaolin @ 3% is beneficial for enhancing productivity of pearl millet under semi-arid conditions.

Keywords: Pearl millet, fertility levels, anti-transpirants, kaolin, yield, semi-arid region

Introduction

Pearl millet (*Pennisetum glaucum* L.) ranks as the fourth most vital cereal in the rainfed regions of Africa and Asia, following rice, wheat, and maize (Yadav *et al.*, 2021) ^[15]. As an annual tillering diploid (2n = 14) grass, it belongs to the Gramineae family and the Panicoideae subfamily (Kumar *et al.*, 2018) ^[6]. It is a fast-growing, erect, and short-duration crop. Commonly referred to as candle millet, horse millet, or bulrush millet, and known as bajra in many Indian states-this crop is predominantly cultivated during the kharif season under rainfed conditions in arid and semi-arid areas (Rai *et al.*, 2019) ^[9]. It plays a significant role in the livelihoods of rural populations and is expected to maintain this role into the future (Ravindran, 2020) ^[11]. Despite its adaptability, productivity of pearl millet remains low due to poor soil fertility, erratic rainfall and moisture stress during critical growth stages. Balanced fertilization plays a crucial role in enhancing crop growth, dry matter production and yield. However, nutrient use efficiency is often limited under moisture-stress conditions (Ansari *et al.*, 2012) ^[2]. Anti-transpirants are substances that reduce transpiration losses by forming a thin film on leaf surfaces or by regulating stomatal activity, thereby helping plants conserve moisture. Chemicals such as Cycocel, PMA and Kaolin have shown promise in improving water-use efficiency and yield under drought-prone environments. Among the different anti-transpirants, Cycocel (chlormequat chloride) at 200 ppm acts as a growth retardant that reduces shoot elongation, increases leaf thickness, and improves water use efficiency under stress conditions. PMA (phenylmercuric acetate) at 250 ppm reduces transpiration by inducing partial stomatal closure, thereby conserving plant moisture without significantly affecting photosynthesis. Kaolin at 3% is a reflective type anti-transpirant that forms a white film on leaves, lowering leaf temperature and reducing evapotranspiration losses (Singh *et al.*, 2014) ^[12].

Materials and Methods

The field experiment was conducted during the *Kharif* season of 2024–25 at the Agronomy Farm, School of Agricultural Sciences, Suresh Gyan Vihar University, Jaipur (75°48'84" E longitude and 26°82'47" N latitude), located in a semi-arid region with sandy loam soil and limited water availability. The study was laid out in a factorial randomized block design (FRBD) with 16 treatment combinations and three replications, involving four fertility levels (0, 50, 75, and 100% of Recommended Dose Fertilizers (RDF)) and four Anti-transpirants treatments (control, Cycocel @ 200ppm, PMA @ 250 ppm and Kaolin @ 3.0%). The Pearl millet (*Pennisetum glaucum* (L.) R. Br. emend Stuntz} variety 'RHB-233' was sown on 14th June 2024 using the drilled method at a spacing of 45 × 15 cm with a seed rate of 4 kg ha⁻¹. The recommended dose of fertilizer *i.e.* 60 kg N ha⁻¹, 40 kg P₂O₅ ha⁻¹ and 40 kg K₂O ha⁻¹ were drilled in crop rows through urea and di-ammonium phosphate (DAP) at the time of sowing as basal application. Standard agronomic practices were uniformly followed across all plots. Observations on growth parameters (Plant stand m⁻¹ row length, Plant height (cm), Dry matter accumulation (g plant⁻¹), Number of tillers per plant, Leaf area index and yield components (Number of effective tillers per plant, Ear length (cm), Test weight, seed, stover, biological yield and Harvest index (%)) were recorded from five randomly selected plants per plot. Data were analyzed statistically using ANOVA, and treatment means were compared using LSD at a 5% significance level.

Results and Discussion

The data presented in Table 1 and 2 clearly demonstrate the significant positive effects of fertility levels and anti-transpirants of agro-chemicals on the growth and yield parameters of pearl millet.

Effect of fertility levels

The growth parameters of pearl millet were significantly influenced by different fertility levels (Table 1). Plant stands per meter row length at 29 DAS and at harvest was not significantly affected by fertility levels, indicating uniform germination and establishment across treatments. However, plant height increased significantly with increasing fertility levels at all growth stages. Application of 100% RDF recorded the maximum plant height at 30 DAS (62.13 cm), 60 DAS (182.97 cm) and at harvest (227.05 cm), which was significantly superior over control and lower fertility levels. This increase in plant height may be attributed to improved availability of essential nutrients, particularly nitrogen, which promotes cell division, elongation and overall vegetative growth. Similar findings were reported by Yadav *et al.*, (2017) [14] and Meena *et al.*, (2020) [8] in pearl millet. Dry matter accumulation also showed a significant increasing trend with higher fertility levels. The maximum dry matter accumulation at harvest (178.98 g m⁻¹ row length) was observed under 100% RDF. Adequate nutrient supply enhances photosynthetic efficiency and assimilates production, resulting in higher biomass accumulation. These results are in close conformity with the findings of Kumar *et al.*,

(2016) [7] and Rathore *et al.*, (2018) [10]. The number of tillers per plant and leaf area index (LAI) increased significantly with increasing fertility levels. Higher LAI under higher fertility levels might be due to increased leaf expansion and better canopy development. Similar observations were reported by Choudhary *et al.*, (2019) [3] in pearl millet under semi-arid conditions.

Yield attributes such as number of effective tillers per plant, ear length and test weight were significantly influenced by fertility levels (Table 2). Application of 100% RDF resulted in the maximum number of effective tillers (3.43), ear length (26.28 cm) and test weight (11.60 g).

Grain yield increased significantly with increasing fertility levels, with the highest grain yield (3032 kg ha⁻¹), stover yield (6975 kg ha⁻¹) and biological yield (10007 kg ha⁻¹) recorded under 100% RDF. This increase in yield can be attributed to improved yield components and better partitioning of assimilates towards grain formation. Similar results have been reported by Yadav *et al.*, (2016), Meena and Singh (2019) [8]. Harvest index was not significantly affected by fertility levels, indicating proportionate increase in both grain and stover yield.

Effect of anti-transpirants

Different anti-transpirant treatments did not significantly influence plant stand and plant height at early stages, but significant differences were observed in dry matter accumulation, number of tillers and leaf area index (Table 1). Among anti-transpirants, Kaolin @ 3% recorded the highest dry matter accumulation (156.68 g m⁻¹ row length at harvest), number of tillers per plant (15.17) and LAI (2.39 at 60 DAS). Kaolin forms a reflective white film on leaf surfaces, which reduces leaf temperature and transpiration rate, thereby improving photosynthetic efficiency under moisture stress. Similar results were also reported by Abd El-Rahman *et al.*, (2017) [1] and Dutta *et al.*, (2021) [4]. Cycocel and PMA treatments also showed improvement over control, which may be due to their role in regulating stomatal activity and reducing water loss. These findings are in agreement with Taiz *et al.*, (2015) [13]. Among anti-transpirants, Kaolin @ 3% recorded the highest values of yield attributes and yields, including grain yield (2377 kg ha⁻¹), stover yield (5792 kg ha⁻¹) and biological yield (8170 kg ha⁻¹). The increase in yield under Kaolin treatment may be attributed to reduced transpiration losses, improved plant water status and enhanced photosynthetic activity under semi-arid conditions. Similar beneficial effects of Kaolin spray on yield have been reported by Glenn *et al.*, (2010) [5].

Interaction Effect on Growth Parameters

The interaction effect between fertility levels and anti-transpirants was found to be non-significant for most growth parameters. This indicates that fertility levels and anti-transpirants acted independently in influencing crop growth. The interaction effect between fertility levels and anti-transpirants was found to be non-significant for most yield parameters, indicating that the response of pearl millet to fertility levels was consistent across anti-transpirant treatments.

Table 1: Effect of fertility levels and anti-transpirants on growth parameters of pearl millet

Treatment	Plant stand /m row length		Plant height (cm)			Dry matter accumulation (g /m row length)			Total number of tillers per plant at harvest	Leaf area index at 60 DAS
	At 29 DAS	At harvest	At 30 DAS	At 60 DAS	At harvest	At 30 DAS	At 60 DAS	At harvest		
Fertility Levels										
Control	32.23	29.33	43.83	145.78	187.18	12.30	65.48	125.15	2.98	1.99
2.5 kg/ha	34.18	32.40	50.10	157.91	201.15	13.97	75.18	141.90	3.35	2.22
5.0 kg/ha	35.40	34.10	56.10	170.32	214.28	15.58	85.58	160.25	3.75	2.44
7.5 kg/ha	36.68	35.13	62.13	182.97	227.05	17.19	96.65	178.98	4.15	2.66
S.Em+	0.89	0.84	1.34	0.74	1.61	0.14	1.25	2.15	0.06	0.01
CD at 5%	NS	NS	3.88	2.14	4.66	0.40	3.61	6.21	0.18	0.03
Anti-transpirants (Foliar spray)										
Absolute control	33.80	31.93	51.45	160.40	203.58	14.23	77.43	145.95	3.40	2.26
Cycocel @200 ppm	34.70	32.88	53.53	165.60	208.78	14.96	81.73	153.05	3.60	2.34
PMA @250 ppm	34.35	32.73	52.55	163.78	206.65	14.68	80.28	150.60	3.53	2.32
Kaolin @ 3%	34.95	33.43	54.63	167.21	210.65	15.17	83.45	156.68	3.70	2.39
S.Em+	0.89	0.84	1.34	0.74	1.61	0.14	1.25	2.15	0.06	0.01
CD at 5%	NS	NS	NS	NS	NS	0.40	3.61	6.21	0.18	0.03
Interaction (Fertility Levels x Anti-transpirants)										
S.Em+	1.76	1.67	2.68	1.48	3.22	0.14	2.50	2.15	0.08	0.08
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	0.24	NS

Table 2: Effect of fertility levels and anti-transpirants on yield parameters and yield of pearl millet

Treatment	Number of effective tillers per plant	Ear length (cm)	Test weight (g)	Yield (kg ha ⁻¹)				Biological yield
				Grain yield (kg/ha)	Stover yield (kg/ha)	Biological yield (kg/ha)	Harvest index (%)	
Fertility Levels								
Control	1.55	19.00	8.38	1500	4317	5817	25.77	4257
2.5 kg/ha	2.15	21.18	9.30	1950	5162	7112	27.41	5215
5.0 kg/ha	2.83	23.75	10.48	2417	6037	8455	28.58	5660
7.5 kg/ha	3.43	26.28	11.60	3032	6975	10007	30.28	5783
S.Em+	0.04	0.10	0.09	10.95	18.79	29.44	3.77	100
CD at 5%	0.11	0.30	0.27	31.63	54.28	85.03	NS	290
Anti-transpirants (Foliar spray)								
Water spray	2.30	21.75	9.55	2070	5425	7495	27.32	4323
Thiourea @500 ppm	2.55	22.80	10.05	2252	5675	7927	28.10	5717
Salicylic acid @100 ppm	2.45	22.40	9.85	2200	5600	7800	27.87	5564
NPK (19:19:19) @0.5%	2.65	23.25	10.30	2377	5792	8170	28.74	5311
S.Em+	0.04	0.10	0.09	10.95	18.79	29.44	3.77	101
CD at 5%	0.11	0.30	0.27	31.63	54.28	85.03	NS	293
Interaction (Fertility Levels x Anti-transpirants)								
S.Em+	0.09	0.21	0.19	21.91	37.59	58.88	7.54	150
CD at 5%	0.27	0.60	NS	63.27	108.56	170.05	NS	450

Conclusion

The study clearly demonstrates that fertility levels and anti-transpirants significantly influenced the growth and yield of pearl millet under semi-arid conditions. Increasing fertility levels improved plant height, dry matter accumulation, tillers, yield attributes and yield, with application of 100% recommended dose of fertilizers (RDF) recording the highest grain, stover and biological yields. Among anti-transpirant treatments, Kaolin @ 3% proved most effective in enhancing crop growth and productivity by reducing transpiration losses and improving plant water status. The interaction between fertility levels and anti-transpirants was mostly non-significant, indicating their independent effects. Overall, the study concluded that application of 100% RDF along with foliar spray of Kaolin @ 3% is the most suitable practice for obtaining higher yield of pearl millet under sandy loam soils and semi-arid

conditions.

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