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Studies on the effect of moisture conservation techniques and integrated nutrients management in *kharif* maize (*Zea mays* L.)

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Abstract

A field experiment was carried out during *kharif* season of 2024 and 2025 at Student Instructional Farm (SIF) of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.), India. The soil of experimental field was silt loam in texture, slightly saline in reaction, low in available nitrogen and organic carbon, medium in available phosphorus, potassium and zinc. The experiment was comprised of three moisture conservation practices viz., no mulch (M1), dust mulching (M2) and crop stubble mulching @ 15 ton ha⁻¹ (M3) in main plots and five treatments of nutrient management of soil and foliar applied RDF (150 kg N, 60 kg P₂O₅, 40 kg K₂O) + 25 kg ZnSO₄ (N1), 75% RDF + 2.5 t FYM + 25 kg ZnSO₄ (N2), 75% RDF + 2.5 t FYM + Zn spray 2% (N3), 75% RDF + 1.5 t vermicompost (N4) and 75% RDF + 1.5 t vermicompost + Zn spray 2% (N5) in sub plots. The experiment was laid out in split plot design with tree replication. The result revealed that the application of crop stubble mulch @ 15 t/ha along with 75% RDF + 2.5 t FYM + 25 kg ZnSO₄ (N2) recorded significantly higher growth as compared to control during both the years.

Keywords: Moisture conservation practices, Nutrient management, FYM, Vermicompost, RDF, plant height, dry weight, fresh weight, leaf area index

Introduction

Maize (*Zea mays* L.) is one of the most important cereal crops belonging to the grass family Poaceae with its origin in Central America. Maize is a versatile crop grown over a range of agro climatic conditions. In fact, the suitability of maize to diverse environments is unmatched by any other crop. At present, nearly 1147.7 million MT of maize is being produced together by over 170 countries from an area of about 193.7 million ha with average productivity of 5.75 t/ha. Over 70% of *kharif* maize area is grown under the rainfed condition with a prevalence of many biotic and abiotic stresses. Moisture conservation practices have been widely used as an important management tool in which, application of organic residues helps in improving the proper growth and development of crops due to conserving the soil moisture and also the enhanced productivity of the crop. Moisture conservation could be greatly increased by imposition of mulches on soil surface (Singh *et al.*, 2018) [3]. For increasing moisture conservation and yield, mulching is the appropriate agronomic management practice. There is need to adopt agronomic management practices that limit evaporation losses, reduce runoff and weed growth, increase infiltration, soil moisture content, organic matter content, facilitate nutrients availability in soil, higher crop productivity and water use efficiency.

Materials and Methods

A field experiment was carried out during *kharif* season of 2024 and 2025 at Student Instructional Farm (SIF) of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.), India. The soil of experimental field was silt loam in texture, slightly saline in reaction, low in available nitrogen (215 and 220 kg/ha) and organic carbon (0.60 and 0.62%), medium in available phosphorus (20.5 and 21.6 kg/ha), potassium (201 and 202 kg/ha) and zinc (0.711 and 0.714 mg/ha). The main-plot treatment consisted of 3 moisture conservation practices viz., no mulch, dust mulching and crop stubble mulching @

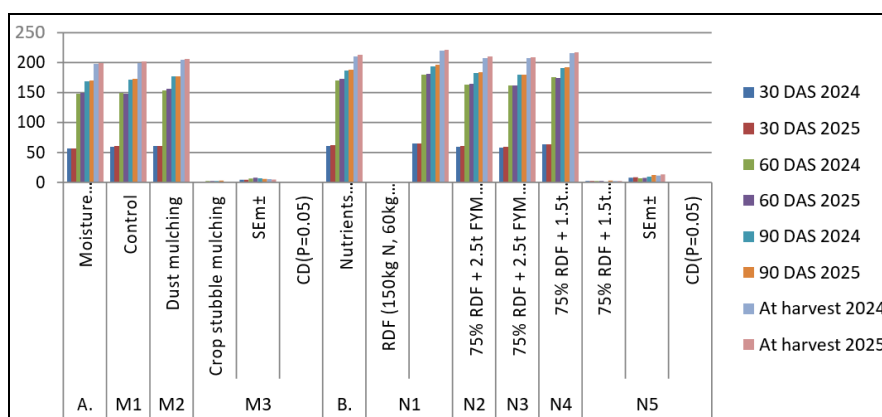
15 ton ha⁻¹. The sub plots treatment also consisted of 5 doses of nutrient management of soil and foliar applied RDF (150 kg N, 60 kg P₂O₅, 40 kg K₂O) + 25 kg ZnSO₄, 75% RDF + 2.5 t FYM + 25 kg ZnSO₄, 75% RDF + 2.5 t FYM + Zn spray 2%, 75% RDF + 1.5 t vermicompost and 75% RDF + 1.5 t vermicompost + Zn spray 2%. The maize variety Dharti was used as a test crop which with a dose of 25 kg/ha sown in line mark at 60 cm row to row and 20 cm of plant to plant distance. A common dose of 150 kg N, 60 kg P₂O₅, and 60 kg K₂O/ha was applied in the form of urea, DAP and murate of potash, respectively. All other agronomic practices were applied equally to each experimental plot

except mulching practices and nutrient management and foliar application during both the years. Three irrigations were applied to each treatment.

Plant height (cm)

Five plants were randomly selected and tagged in the central row of each plot. The plant height of the crop was recorded in cm with help of a meter scale from the base of the plant to the top of leaves before tasseling and up to the base of tassel thereafter at 30, 60, 90 DAS and at harvesting stages. The average values were computed and recorded in centimetres.

S. No.	Treatments	Plant height (cm)							
		30 DAS		60 DAS		90 DAS		At harvest	
A.	Moisture conservation practices (Main plot)	2024	2025	2024	2025	2024	2025	2024	2025
M1	Control	56.6	55.8	147.3	149.5	168.3	169.2	197.4	198.3
M2	Dust mulching	59.2	60.3	148.8	148.2	171.6	172.7	199.2	201.8
M3	Crop stubble mulching	60.8	61.4	153.3	155.6	176.1	176.3	204.9	205.5
	SEm±	0.9	0.7	2.5	2.2	2.6	2.7	1.6	1.6
	CD(P = 0.05)	4.6	4.3	6.3	7.6	6.7	5.8	5.2	4.9
B.	Nutrients Management (Sub plot)								
N1	RDF (150 kg N, 60 kg P ₂ O ₅ , 40 kg K ₂ O) + 25 kg ZnSO ₄	61.3	62.6	170.3	172.5	186.4	187.5	210.1	212.6
N2	75% RDF + 2.5 t FYM + 25 kg ZnSO ₄	65.3	64.8	179.6	180.5	194.2	196.4	219.3	221.7
N3	75% RDF + 2.5 t FYM + Zn spray 2%	59.8	60.4	162.6	163.9	182.7	184.1	207.4	209.3
N4	75% RDF + 1.5 t vermicompost	58.4	58.8	160.8	161.6	178.8	180.2	206.7	208.9
N5	75% RDF + 1.5 t vermicompost + Zn spray 2%	62.8	63.2	175.1	174.1	190.7	191.4	214.8	216.4
	SEm±	2.3	2.3	2.0	2.1	1.6	2.7	1.9	2.3
	CD(P = 0.05)	7.5	8.5	6.7	7.3	9.7	11.8	11.2	13.3



Fresh weight (g/plant) at harvesting

Select representative plants from the net plot area of each treatment, avoiding border rows to eliminate the edge effect. Carefully uproot the designated plants, wash the root system gently with running water to remove adhering soil particles,

and blot them dry with filter paper. Separate the plants into components if required, or keep them intact, and immediately weigh them on a calibrated digital electronic balance to prevent moisture loss through transpiration.

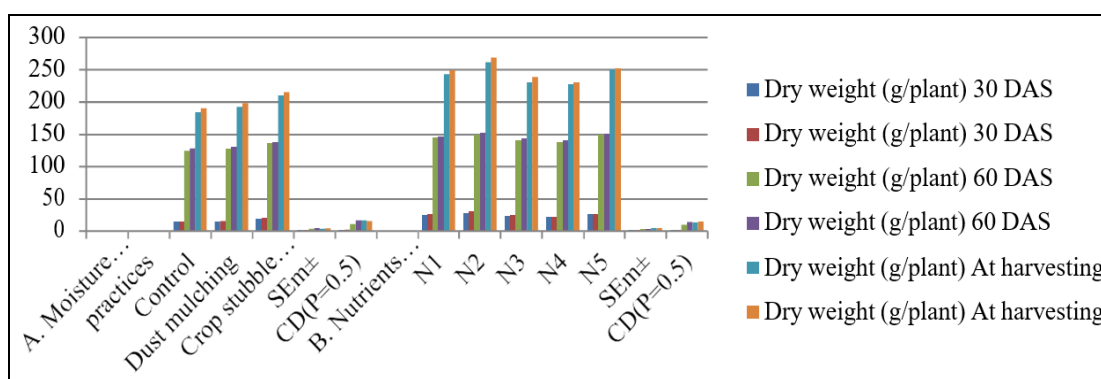
S. No.	Treatments	Fresh weight (g/plant)					
		30 DAS		60 DAS		At harvesting	
A.	Moisture conservation practices (Main plot)	2024	2025	2024	2025	2024	2025
M1	Control	26.21	26.90	448.43	457.46	635.02	643.23
M2	Dust mulching	26.78	27.38	460.37	470.18	642.93	649.31
M3	Crop stubble mulching	28.12	28.69	518.41	525.73	670.93	672.59
	SEm±	0.06	.08	6.46	6.35	0.35	0.43
	CD(P = 0.05)	NS	NS	14.4	15.18	0.89	0.94
B.	Nutrients Management (Sub plot)						
N1	RDF (150 kg N, 60 kg P ₂ O ₅ , 40 kg K ₂ O) + 25 kg ZnSO ₄	29.85	30.04	552.43	558.38	717.72	717.72
N2	75% RDF + 2.5 t FYM + 25 kg ZnSO ₄	31.61	31.82	598.32	608.05	817.46	826.57
N3	75% RDF + 2.5 t FYM + Zn spray 2%	29.23	29.67	548.29	543.40	722.54	728.68
N4	75% RDF + 1.5 t vermicompost	28.78	29.07	530.27	538.32	693.80	694.80
N5	75% RDF + 1.5 t vermicompost + Zn spray 2%	30.32	30.10	584.83	588.78	739.34	748.87
	SEm±	0.82	0.83	7.40	7.52	0.60	0.62
	CD(P = 0.05)	0.69	3.65	18.23	21.19	1.20	1.19

Dry Weight (g plant⁻¹) at maturity

To determine the Dry Weight (g plant⁻¹) at harvest, take the exact plants used for fresh weight measurement and place them into labelled perforated paper bags. Dry the samples in a forced-air hot-air oven at 60-65 °C until they reach a constant weight, which typically requires 48 to 72 hours.

Immediately transfer the dried samples to a desiccator to cool to room temperature without absorbing atmospheric moisture, and then weigh them on a precision digital electronic balance to record the final dry matter accumulation per plant.

S. No.	Treatments	Dry weight (g/plant)					
		30 DAS		60 DAS		At harvesting	
A.	Moisture conservation practices (Main plot)	2024	2025	2024	2025	2024	2025
M1	Control	14.68	15.01	124.4	128.3	184.4	190.3
M2	Dust mulching	14.89	15.28	128.3	131.4	192.8	198.6
M3	Crop stubble mulching	19.78	20.34	135.7	137.6	210.3	215.4
	SEm±	0.67	0.64	3.59	4.7	3.6	4.3
	CD(P = 0.05)	0.54	2.21	11.07	16.4	16.2	15.4
B.	Nutrients Management (Sub plot)						
N1	RDF (150 kg N, 60 kg P ₂ O ₅ , 40 kg K ₂ O) + 25 kg ZnSO ₄	25.46	25.9	145.3	146.4	243.2	249.7
N2	75% RDF + 2.5 t FYM + 25 kg ZnSO ₄	28.60	30.23	149.7	151.6	262.0	269.2
N3	75% RDF + 2.5 t FYM + Zn spray 2%	23.32	24.40	141.2	143.2	230.6	238.9
N4	75% RDF + 1.5 t vermicompost	21.67	22.64	138.3	140.6	227.6	230.02
N5	75% RDF + 1.5 t vermicompost + Zn spray 2%	26.37	27.04	148.7	150.7	250.5	252.7
	SEm±	0.64	0.56	3.2	3.2	4.8	4.7
	CD(P = 0.05)	1.86	1.64	9.5	13.9	13.4	14.6

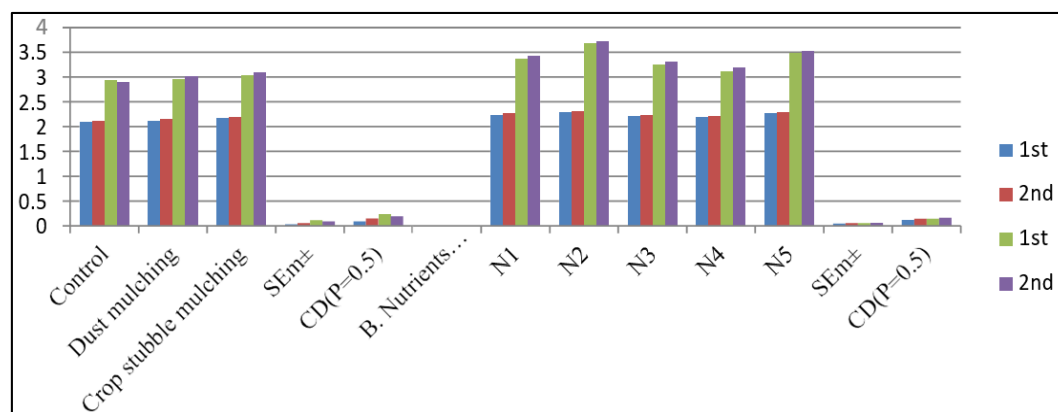
**Leaf Area Index (LAI)**

From the samples collected for dry matter estimation, leaves of plant were plucked at knee high stage and tasseling stage and leaf area was measured with the help of Leaf Area Meter (LI-3100C). The

leaf area for each sample recorded was averaged to give leaf area/plants. The following relationship was used to compute LAI (Watson, 1952) at 30 and 60 DAS.

$$\text{LAI} = \text{Leaf area (cm}^2\text{)}/\text{Land area (cm}^2\text{)}$$

S. No.	Treatments	Leaf area index			
		30 DAS		60 DAS	
A.	Moisture conservation practices (Main plot)	2024	2025	2024	2025
M1	Control	2.09	2.11	2.94	2.90
M2	Dust mulching	2.12	2.16	2.96	3.01
M3	Crop stubble mulching	2.18	2.19	3.04	3.09
	SEm±	0.03	0.05	0.11	0.09
	CD(P = 0.05)	0.09	0.15	0.23	0.19
B.	Nutrients Management (Sub plot)				
N1	RDF (150 kg N, 60 kg P ₂ O ₅ , 40 kg K ₂ O) + 25 kg ZnSO ₄	2.23	2.27	3.37	3.42
N2	75% RDF + 2.5 t FYM + 25 kg ZnSO ₄	2.30	2.31	3.68	3.72
N3	75% RDF + 2.5 t FYM + Zn spray 2%	2.21	2.24	3.24	3.30
N4	75% RDF + 1.5 t vermicompost	2.19	2.21	3.11	3.19
N5	75% RDF + 1.5 t vermicompost + Zn spray 2%	2.26	2.29	3.48	3.52
	SEm±	0.04	0.05	0.05	0.06
	CD(P = 0.05)	0.12	0.14	0.14	0.16



Results and Discussion

Growth parameters

Growth parameters viz., Plant height (cm) at 30, 60, 90 DAS and at harvesting stage, Fresh Weight (g plant⁻¹) & Dry Weight (g plant⁻¹) at 30, 60 DAS and at harvesting stage, Leaf Area Index (LAI) at 30, 60 DAS significantly influenced by moisture conservation practices and soil applied nutrient along with foliar application both years. Among moisture conservation practices, application of crop stubble mulch (M3) @ 15 t/ha was recorded significantly maximum plant height (60.8, 153.3, 176.1, 204.9 cm and 61.4, 155.6, 176.3, 205.5 cm both year), fresh weight (28.12, 518.41, 670.93 g plant⁻¹ and 28.69, 525.73, 672.59 g plant⁻¹ at 30, 60 DAS and harvesting stage both year), dry weight (19.78, 135.7, 210.3 g plant⁻¹ and 20.34, 137.6, 215.4 g plant⁻¹ at 30, 60 DAS and harvesting stage both year) and leaf area index (2.18, 3.04% and 2.19, 3.09% at 30, 60 DAS both year) followed by dust mulch (M2) during first and second year, respectively. Although these treatments remained on par to each other produced significantly more growth parameters as compared to no mulch (M1). However, the significantly lowest plant height (56.6, 147.3, 168.3, 197.4 cm and 55.8, 149.5, 169.2, 198.3 cm at 30, 60, 90 DAS and at harvesting both year, respectively), fresh weight (26.21, 448.43, 635.02 g/plant and 26.90, 457.46, 643.23 g/plant at 30, 60 DAS and harvesting stage both year, respectively) and dry weight (14.68, 124.4, 184.4 g/plant and 15.01, 128.3, 190.3 g/plant at 30, 60 DAS and at harvesting stage respectively) and leaf area index (2.09, 2.94% and 2.11, 2.90% at 30, 60 DAS both year) was recorded with no mulch (M1). The average plant height varied from 55.8 cm to 64.8 cm, 147.3 cm to 180.5 cm, 168.3 cm to 196.4 cm and 197.4 cm to 221.7 cm at 30, 60, 90 DAS and at harvesting, respectively, fresh weight varied from 26.21 to 31.82 g/plant, 552.43 to 608.05 g/plant, 635.02 to 826.57 g/plant at 30, 60 DAS and harvesting stage respectively and leaf area index varied from 2.09 to 2.31% and 2.90 to 3.72% at 30, 60 DAS respectively both of the years. Although, these treatments remained at par to each other promote significantly plant height, fresh weight, dry weight and leaf area index as compared to control (N1) during both the years.

Conclusion

On the basis of two-year experimentation it may be concluded that the application of crop stubble mulch @ 15.0 t/ha along with nutrient management practice 75% RDF + 2.5 t FYM + 25 kg ZnSO₄ (N2) is the most effective strategy for maize cultivation, as it consistently recorded the highest plant height, fresh weight, dry weight and leaf area

index across both years. While 75% RDF + 2.5 t FYM + 25 kg ZnSO₄ (N2) significantly outclassed all other options in biomass production, it was statistically on par with 75% RDF + 1.5 t vermicompost + Zn spray 2% regarding total plant height, fresh weight, dry weight and leaf area index making both treatments excellent choices for quality improvement. Conversely, treatment 75% RDF + 1.5 t vermicompost proved to be the least effective growth and development parameters. Therefore, to maximize maize crop growth and development parameters, the adoption of nutrient management protocol 75% RDF + 2.5 t FYM + 25 kg ZnSO₄ (N2) is highly recommended for hot semi-arid climate of central U.P. region.

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