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Response of integrated nutrient management (INM) and different varieties on growth and yield of pearl millet (*Pennisetum glaucum* L.)

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Abstract
A field experiment was carried out at the Agricultural Research Farm of United University, Rawatpur, Jhalwa, Prayagraj (U.P.) in the *Kharif* season (2023) to investigate the Response of Integrated Nutrient Management (INM) and different varieties on growth and yield of Pearl Millet (*Pennisetum glaucum* L.) the study was performed in Randomized block design with three replications in ten treatments. The heterogeneous permissible combination with inorganic fertilizer 100%, 75%, and 50% (RDF) + the organic substance of Farm yard manure + vermicompost and different varieties of pearl millet (V_1 Raj 171, V_2 Raj Bajra Chari-2, V_3 Dhanshakti ICTP-8203). Significantly increased plant height (168.84 cm) at harvest, dry weight plant^{-1} (68.35 g), number of effective ear head plant^{-1} (7.17), Ear head length (30.06 cm), Number of grains/ear head (2154.33), Test weight (9.44 g), seed yield (2.17 t/ha.), straw yield (4.57 t/ha.), and Harvest Index (32.66 % was recorded by the application of T_9 (50 % RDF + FYM + Vermicompost + V_3-Dhanshakti ICTP-8203) the maximum economical value was recorded of Total cost of cultivation (31919.24 ₹/ha), Gross return (99299.67 ₹/ha), Net return (67260.43 ₹/ha) and benefit-cost ratio (B: C ratio) (2.11). these results indicate that inorganic fertilizer, bio-fertilizer, and adding organic matter proved useful in achieving the yield with integrated use of nutrients and effects of different varieties.

Keywords: Pearl millet, integrated nutrient management (INM), varieties, growth, yield, and economics

Introduction
Pearl millet (*Pennisetum glaucum*) It is commonly known as Bajra, Bajri, Sajje, Kambu, Kamban, Sajjalu, etc. in various Indian local languages. It is commonly used for food, feed, and forage. It is the most widely grown type of millet and is one of the important millet crops in hot and dry areas of arid and semi-arid climatic conditions, particularly in Rajasthan. Pearl millet belongs to the family *Gramineae* or *Poaceae*. Inflorescence present are spikes. It is a highly cross-pollinated crop due to protogynous habit Being a C4 plant, it has a very high photosynthetic efficiency and dry matter production capacity. Pearl millet originated in tropical Western Africa some 4000 years ago (Amarghade, *et al.*, 2021) [1].

Bajra is a coarse grain crop and is regarded to be the poor man's staple nourishment and is suitable to cultivate in dry lands. It is a warm-weather annual plant root system like sorghum seminal, adventitious, and prop roots. Rainfall requires (250-350) mm of water. The loamy sands to loams, well-drained, non-saline, and non-alkaline are more suitable and sensitive to waterlogged areas. This crop can grow at very high temperatures with low water requirements whereas other crops like rice, wheat, and maize fail to grow. It has also advantageous physiological characteristics when compared to other cereals as it is resistant to drought, low soil fertility and high salinity Pearl millet grain content is 75% endosperm, 17% germ, and 8% bran The pearl millet germ proportion is thus about twice that of sorghum, it is a factor that contributes to the higher nutritive value of pearl millet grain (Ghuraiya *et al.*, 2021) [6].

The crop adapts well to the driest and marginal soils than most other cereals. It is cultivated in marginal environments where it encounters frequent drought, high temperatures, low and erratic rainfall, and infertile soils with poor water-holding capacity.

Pearl millet is grown as a rainy season crop in the north, while in south and northwest India, it may be grown in two or even three seasons a year. Pearl millet owing to its high drought tolerance potential occupies a unique position in rainy-season (*kharif*) crops. It also provides good quality fodder to cattle in arid and semi-arid tropical regions and is recognized as a valuable forage crop because of its robust and fast growth habit. Its stalk is used for fuel and thatching.

In India, pearl millet is a primary source of dietary energy (360 kcal/kg) for rural populations and the fourth most important cereal after rice, wheat, and sorghum. It is a rich source of protein, calcium, phosphorous, and iron. Pearl millet grain contains fairly high amounts of thiamine, riboflavin, and niacin. Pearl millet grain is also used for non-food purposes such as poultry feed, cattle feed, and alcohol extraction (Mohan *et al.*, 2022) [7].

Pearl millet is a rich source of energy (361 Kcal/100g) which is comparable with commonly consumed cereals such as wheat (346 Kcal/100g), rice (345 Kcal/100g) maize (125 Kcal/100g), and sorghum (349 Kcal/100g) as per the nutritive value of Indian foods. It is a good source of protein having higher digestibility (12.1%), carbohydrates (67.5%), Protein (11.5%) fats (5%), and minerals (2.3%). It contains about (92.5%) dry matter, (2.1%) ash, (2.8%) crude fiber, (7.8%) crude fat, (13.6%) crude protein, and (63.2%) starch green fodder is used as preserved hay or silage which has proved extremely useful in dry regions (Amarghade, *et al.*, 2021) [1].

According to (Agricultural Statistics at a Glance) as of 2021-22, the top five countries in terms of pearl millet production were: India, Nigeria, Niger, Mali, and Burkina Faso. pearl millet was grown on approximately 11.6 million hectares of land in India. All India total production of pearl millet (1436 kg/ha.) highest yield was obtained in Andhra Pradesh (1782 kg/ha.). The lowest yield in West Bengal (428 kg/ha) in Uttar Pradesh is obtained (2156 kg/ha.) (Department of Agriculture and Farmer Welfare).

Materials and Methods

The experiments was conducted during the *Kharif* season of year (2023). Was carried out at the Agricultural Research farm of the Department of Agriculture Sciences & Technology, United University, Jhalwa, which is situated in district Prayagraj (U.P) – 211012. The field was well leveled having good soil condition. Geographically Rawatpur, Jhalwa, Prayagraj engage in a subtropical climate and are situated at 25.390 north latitude, and 81.750 east longitude with an altitude of 113 meters above mean sea level. It is positioned about 6 km away from IIIT, Jhalwa. The soil of the research field constitutes a part of central Gangetic alluvium and is neutral and deep. The PH of soil was 7.2 and Available Nitrogen (75.3 kg ha^{-1}), Available Phosphorus (31.78 kg ha^{-1}), and Available Potassium (253.14 kg ha^{-1}). Nutrient sources were inorganic sources urea, DAP, MOP (with recommended dose of fertilizer is 60:40:40), and organic sources vermicompost, farm yard manure. Seed treatment with biofertilizer (*Azotobacter culture*). The experiment involved Response of Integrated Nutrient Management (INM) and different varieties (V_1 Raj 171, V_2 Raj Bajra Chari-2, V_3 Dhanshakti ICTP-8203). Was laid out in a Randomized Block design with ten treatments and three replications. With a gross cultivated area of (793.88 m2) and a Net cultivated area (600 m2). The treatment consisted of T_1: 100% RDF + V1 Nutra pearl, T2: 100% RDF + V2 ICTP-8203, T_3: 100% RDF + V3 Badshah-6668, T_4: 75% RDF + Vermicompost+ V1, T_5: 75% RDF + Vermicompost + V2, T_6: 75% RDF + Vermicompost + V3, T_7: 50% RDF + FYM + Vermicompost +V1, T_8: 50% RDF + FYM +Vermicompost + V2, T_9: 50% RDF + FYM + Vermicompost + V3, and T_{10}: Control. The sowing was done on 17 July (2023) with the spacing of 50 x 10 cm. and the crop was harvested on 30. 10. 2023 (105 DAS). The statistical data analysis was done using analysis of variance (ANOVA) techniques at 0.05% probability level.

Results and Discussion

The present study indicated that all the treatments of Integrated Nutrient Management (INM) and different varieties significantly increased the growth parameters *viz.* Plant height (cm) was significantly influenced among all treatments 30 DAS, 60 DAS, 90 DAS. At harvest days after sowing, and the higher plant height was observed as superior plant height with the application of (50% RDF + FYM + Vermicompost + V3-Badshah-6668) that is (168.84) cm. in at harvest. The Number of tillers/ plants observed in the treatment combination of (50% RDF + FYM + Vermicompost + V_3-Dhanshakti ICTP-8203) is Data captured significantly at harvest DAS, number of tillers (8.00). The Plant dry matter (g/plant) Data recorded significantly that the greatest Plant dry matter (g/plant) was treatment combination T_9 (50% RDF + FYM + Vermicompost + V_3- Dhanshakti ICTP-8203) that is (68.35g) significantly at harvest.

Seed yield (t/ha)

The seed yield of Pearl millet Differences due to the application of different treatment combinations are Data captured significantly (2.17t/ha) in the highest T_9 (50 % RDF + FYM + Vermicompost + V_3- Dhanshakti ICTP-8203) and smallest T_{10} control (1.24t/ha) Although T_8 (50 % RDF + FYM + Vermicompost + V_2- Raj Bajra Chari-2), (1.90t/ha) and T_7 (50 % RDF + FYM + Vermicompost + V_1- Raj 171), (1.60t/ha) was found to be statistically at par with T_9 (Bora *et al.*, 2020) [2].

Straw yield (t/ha)

The Straw yield of Pearl millet was significantly affected by applying different treatments at different levels are was significantly the highest with the application of treatment combination T_9 (50% RDF + FYM + Vermicompost + V_3-Dhanshakti ICTP-8203) (4.57 t/ha) while T_8 (50% RDF + FYM +Vermicompost + V2- ICTP-8203) (4.57 t/ha) and T_7 (50% RDF + FYM + Vermicompost +V1-Nutra pearl) (4.35 t/ha) was found to be statistically at par with T_9. As T_{10} control (2.83 t/ha) was found lowest (Choudhary *et al.*, 2014) [4].

Harvest Index (%)

A critical examination of data showed that a Harvest Index (%) was non-significant due to different treatment combinations was recorded maximum Harvest Index of T_9 (50% RDF +FYM + Vermicompost + V_3- Dhanshakti ICTP-8203) (34.99%). and minimum harvest index was recorded with a treatment combination of T_{10} Control (30.95%).

Economics

Data in table 3 tabulated Experimental results revealed that application of Maximum Gross return (99299.67 ₹/ha), Net return (67380.43 ₹/ha), and B: C ratio (2.11) were recorded in (50% RDF +FYM + Vermicompost + V_3- Dhanshakti ICTP-8203) and minimum net returns (24514.33 ₹/ha), Gross return (45124.33 ₹/ha) and benefit: cost ratio (1.19) were recorded with the treatment T_{10} Control (Prathyusha *et al.*, 2022) [9].

Table 1: Effect of Integrated Nutrient Management (INM) and different varieties on growth of pearl millet at harvest.

Tr. No.	Treatment combination	Plant height (cm)	Number of tillers	Plant dry weight (g)
T_1	100% RDF + v1	148.75	5.73	52.65
T2	100% RDF + V2	148.86	5.87	52.65
T_3	100% RDF + V3	150.02	5.90	53.87
T_4	75% RDF + Vermicompost+ V1	150.43	5.93	55.39
T_5	75% RDF + Vermicompost + V2	151.00	6.00	56.25
T_6	75% RDF + Vermicompost + V3	152.06	6.07	56.69
T_7	50% RDF + FYM + Vermicompost +V1	157.56	7.23	64.25
T_8	50% RDF + FYM +Vermicompost + V2	158.85	7.33	64.75
T_9	50% RDF + FYM + Vermicompost + V3	168.84	8.00	68.35
T_{10}	Control	135.55	4.07	49.86
	F-test	S	S	S
	S.Em±	5.23	0.54	3.83
	CD (P=0.05)	15.54	1.62	11.38

Table 2: Effect of Integrated Nutrient Management (INM) and different varieties on yield of pearl millet

Tr. No.	Treatment combination	Seed yield (t/ha)	Straw yield (t/ha)	Harvest Index (%)
T_1	100% RDF + v1	1.36	2.99	34.99
T2	100% RDF + V2	1.36	3.02	30.97
T_3	100% RDF + V3	1.38	3.03	30.95
T_4	75% RDF + Vermicompost+ V1	1.49	3.16	32.69
T_5	75% RDF + Vermicompost + V2	1.53	3.33	32.40
T_6	75% RDF + Vermicompost + V3	1.57	3.41	33.56
T_7	50% RDF + FYM + Vermicompost +V1	1.90	4.35	31.17
T_8	50% RDF + FYM +Vermicompost + V2	1.90	4.57	31.16
T_9	50% RDF + FYM + Vermicompost + V3	2.17	4.57	32.66
T_{10}	Control	1.24	2.83	31.44
	F-test	S	S	NS
	S.Em±	0.13	0.38	2.40
	CD (P=0.05)	0.39	1.14	7.14

Table 3: Effect of Integrated Nutrient Management (INM) and different varieties on economics of pearl millet.

Tr. No.	Treatment combination	Gross return (₹/ha)	Net return (₹/ha)	B: C ratio
T_1	100% RDF + v1	53116.00	30327.40	1.33
T2	100% RDF + V2	61194.00	38465.40	1.51
T_3	100% RDF + V3	61995.50	39086.90	1.71
T_4	75% RDF + Vermicompost+ V1	71852.67	45643.85	1.74
T_5	75% RDF + Vermicompost + V2	72370.67	46221.85	1.77
T_6	75% RDF + Vermicompost + V3	74240.83	47912.01	1.82
T_7	50% RDF + FYM + Vermicompost +V1	91018.67	59219.43	1.86
T_8	50% RDF + FYM +Vermicompost + V2	93416.17	61676.93	1.94
T_9	50% RDF + FYM + Vermicompost + V3	99299.67	67380.43	2.11
T_{10}	Control	45124.33	24514.33	1.19

Summary and conclusion

The result reveled that the application of T_9 (50 % RDF + FYM + Vermicompost + V_3-Badshah-6668) recorded maximum plant height (168.84 cm.), number of tillers/ m^2 (8.00), dry matter accumulation (68.35 g), Ear head length (30.06 cm), Number of productive Ear head (7.17), Number of grains/ear head (2154.33), Test weight (9.44 g), Seed yield (2.17 t/ha), Straw yield (4.57 t/ha), Biological yield (7197.33 t/ha), Harvest Index (32.66 %), highest gross return (99299.67 ₹/ha), Net return (67260.43 ₹/ha), Total Cost of cultivation (32039.24 ₹/ha), and B: C ratio (2.11) was recorded with the treatment of T_9 (50 % RDF + FYM + Vermicompost + V_3- Dhanshakti ICTP-8203). The result summarized above, it may be concluded that the combined application of nutrients such as organic, inorganic, and biofertilizers had a significant and positive effect on pearl millet. The result indicates that the productivity of pearl millet. The crop can be sustained by supplying integrated use of nutrient management recorded higher value at T_9 (50 % RDF + FYM + Vermicompost + V_3-Dhanshakti ICTP-8203) total Net return (67260.43 ₹/ha) since the data based on *Kharif* season further trail may be conducted to confirm the above findings.

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