E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; SP-7(9): 780-783
Received: 17-06-2024
Accepted: 21-07-2024

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To assess the impact of agronomical biofortification on growth, yield and quality of pearl millet

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DOI: https://doi.org/10.33545/2618060X.2024.v7.i9Sk.1595

Abstract
A field experiment was conducted at Research Farm of Vivekananda Global University, Jaipur (Rajasthan) during *Kharif*, 2023 on loamy sand soil, which consisted seven treatment combinations of agronomic biofortification with RDF and zinc. For experimentation, pearl millet variety "Krishna-99" were used.
The results of one year study clearly showed that application of agronomic biofortification with RDF and zinc brought an additive effect in increasing growth, yield and quality attributes of pearl millet as compared to control. Maximum plant height, dry matter accumulation, number of leaves plant^{-1}, number of effective tillers plant^{-1}, grain yield, stover yield and biological yield of pearl millet and quality parameters like nitrogen uptake, protein content and zinc content was obtained with 125% RDF + 0.5% $ZnSO_4$ at 25-30 DAS and 40-45 DAS (T6) significantly higher over all other remaining treatments.

Keywords: Pearl millet, biofortification, zinc, RDF

Introduction
Worldwide, there is a growing interest in the role of micronutrients in optimizing health and in prevention or treatment of diseases. Micronutrients play a crucial role in human nutrition, including the prevention and treatment of various diseases and conditions, as well as the optimization of physical and mental functioning, globally in Asia, Africa and Latin American countries deficiency of micronutrients such as iron, zinc, folic acid and beta-carotene is the most prevalent. (Anteneh *et al*. 2016) [8]. People from a poorer background, who are basically vegetarian and deprived to fresh fruits and vegetables, have a poorer intake of nutrients caused by a complex interaction between social and economic circumstances. In developing countries women and children are prone to risks associated with deficiency of micronutrients (Bilski *et al*. 2012) [9]. The concern of nutritional security has gained momentum in the world at the same pace as food security. Among agronomic management, the grain biofortification has proved to improve the concentration of micronutrients in cereal crops.
Pearl millet [*Pennisetum glaucum* (L.) R. Br. Emend Stuntz] is one of the important millet crop of India as well as Rajasthan. Pearl millet is a short day, C4 plant with high photosynthetic efficiency and dry matter production capacity adapted to hot climate. It is a warm weather coarse cereal crop grown in arid and semi-arid climate of tropical and subtropical regions of the country. It is staple food of poor and small land holders provides source of fodder and feed for livestock in the rainfed area in Rajasthan. In India, pearl millet is the third most widely cultivated food crop after rice and wheat on area basis. Pearl millet is nutritionally better than many other cereals as 100 grams of pearl millet has the nutritional values *viz*., energy (361 kcal), moisture (12 g), fiber (1.2 g), fat (5 g), carbohydrate (67.5 g), protein content (12.1 g), calcium (42 mg), phosphorus content (296 mg), iron (8 mg), zinc (3.1 mg), vitamin- E and B-complex and many amino acids.

Materials and Methods
The field experiments were carried out during *Kharif* season (2023) to study the "To Assess the Impact of Agronomical Biofortification on Growth, Yield and Quality of Pearl millet" in randomized block design (RBD) with consisted seven treatment combinations of agronomic

biofortification with RDF and zinc *viz.* control (T0), 100% RDF (T_1), 125% RDF (T_2), 100% RDF + 0.5% $ZnSO_4$ at 25-30 DAS (T_3), 100% RDF + 0.5% $ZnSO_4$ at 25-30 DAS (T_4), and 40-45 DAS, 125% RDF + 0.5% ZnSO4 at 25-30 DAS (T_5) and 125% RDF + 0.5% $ZnSO_4$ at 25-30 DAS and 40-45 DAS (T_6) at Research Farm, Vivekananda Global University- Jaipur, Rajasthan. The experimental farm is geographically located at 75° 51'44" E longitude, 26°48'35" N latitude and an altitude of 432 m above mean sea level (AMSL). The experimental fields were clay loam and the soil fertility status contained available nitrogen (137.8 kg ha^{-1}) by Subia and Asija 1996, available phosphorus (16.3 kg ha^{-1}) by Olsen *et al*. 1954 and available potassium (250.12 kg ha^{-1}) by Jackson, 1973. The organic carbon content was from 0.34-0.38 per cent. The weekly mean maximum and minimum temperatures were of temperature during both summers (40.6 °C) and winters (2.7 °C). The mean relative humidity fluctuated from 63.50 to 91 per cent during the crop season. The average rainfall is 557 mm per annum, which is mostly received during July to September. The sporadic showers during winters are also common, which are probably observed during this period. The experiments were laid out in randomized block design (RBD) with three replications and 7 treatments. The observation were recorded at harvest was analysed by statistical methods (Fisher, R.A. 1950) [3].

Result and Discussion

It is clear from the result of present study that, agronomic biofortification with RDF and zinc applications had significantly affected the growth yield and quality parameters of pearl millet at harvest. Application of 125% RDF + 0.5% $ZnSO_4$ at 25-30 DAS and 40-45 DAS (T6) recorded the highest growth attributes *viz*. plant height (192.13 cm), dry matter accumulation (548.15g m^{-1} row length), number of leaves $plant^{-1}$ (19.27) at harvest, however; treatment *i.e.* T_4 remained statistically at par with each other (Table 1).

The increase in plant height due to adequate availability of fertilizers and zinc attributed to better nutritional environment for plant growth at active vegetative stages as result of enhancement in root growth, energy providing, multiplication, cell elongation and cell expansion in the plant body which ultimately increased the height of plant. The results of present investigation are in agreement with the finding of Hashim *et al*., (2015) and Bijarnia *et al*. (2020). Dry matter production successively increased till maturity due to favorable effect of fertilizer and zinc on the growth and development of plants. Increase in number of leaves and plant height is directly responsible for increasing the dry matter accumulation in plants. Husain *et al.* (2006) [4], Lakshmi *et al*. (2022) [5] and Dharaviya *et al.* (2023) [2] also reported the similar results. Further yield attributes and yields like number of effective tillers $plant^{-1}$ (2.83), grain yield (2661.22 kg ha^{-1}), stover yield (6548.15 kg ha^{-1}) and biological yield (9209.37 kg ha^{-1}) presented in table 2, which significantly higher recorded with the application of 125% RDF + 0.5% $ZnSO_4$ at 25-30 DAS and 40-45 DAS (T6), further, treatment *i.e.* T_4 remained statistically at par with each other's. However, test weight and harvest index (Singh and Stoskopt, 1971) was found non-significant under the agronomical biofortification in pearl millet. Yield components by enhancing cell division, cell elongation process and photosynthetic activity leading to production and accumulation of more carbohydrates and auxins which favours retention of more flowers ultimately leading to more number of reproductive parts $plant^{-1}$. Quality parameters like nitrogen uptake (82.27 kg ha^{-1}), Protein content in grain (11.75 %) and zinc content in grain (18.61 ppm) significantly higher recorded due to application of 125% RDF + 0.5% $ZnSO_4$ at 25-30 DAS and 40-45 DAS (T6) which being statistically at par with T_4 presented in table 3. The higher content of nutrients in plants under application of RDF is due to adequate supply of nutrients. Thus, crop manured with higher dose of RDF and $ZnSO_4$ had utilized more nutrients as compared to lower doses resulting in increased in nitrogen uptake, protein content and zinc content in grain. Maharana and Singh, (2021) [7], Lakshmi *et al.* (2023) and Verma *et al*. (2023).

Table 1: Effect of agronomic biofortification on growth attributes of pearl millet

Treatments	Plant height (cm)	Dry matter accumulation (g m^{-1} row length)	Number of leaves $plant^{-1}$
T_0: Absolute Control	155.66	331.29	12.36
T_1: 100% RDF (60:40:30)	156.70	432.59	14.00
T_2: 125% RDF	160.26	463.02	15.12
T_3: 100% RDF + 0.5% $ZnSO_4$ at 25-30 DAS	169.47	495.31	16.28
T_4: 100% RDF + 0.5% $ZnSO_4$ at 25-30 DAS and 40-45 DAS	181.47	535.45	18.20
T_5: 125% RDF + 0.5% $ZnSO_4$ at 25-30 DAS	172.52	505.45	16.31
T_6: 125% RDF + 0.5% $ZnSO_4$ at 25-30 DAS and 40-45 DAS	192.13	548.15	19.27
Sem $\pm$	3.30	3.30	0.37
CD at (p= 0.05)	10.39	10.39	1.02
CV (%)	7.87	7.87	8.70

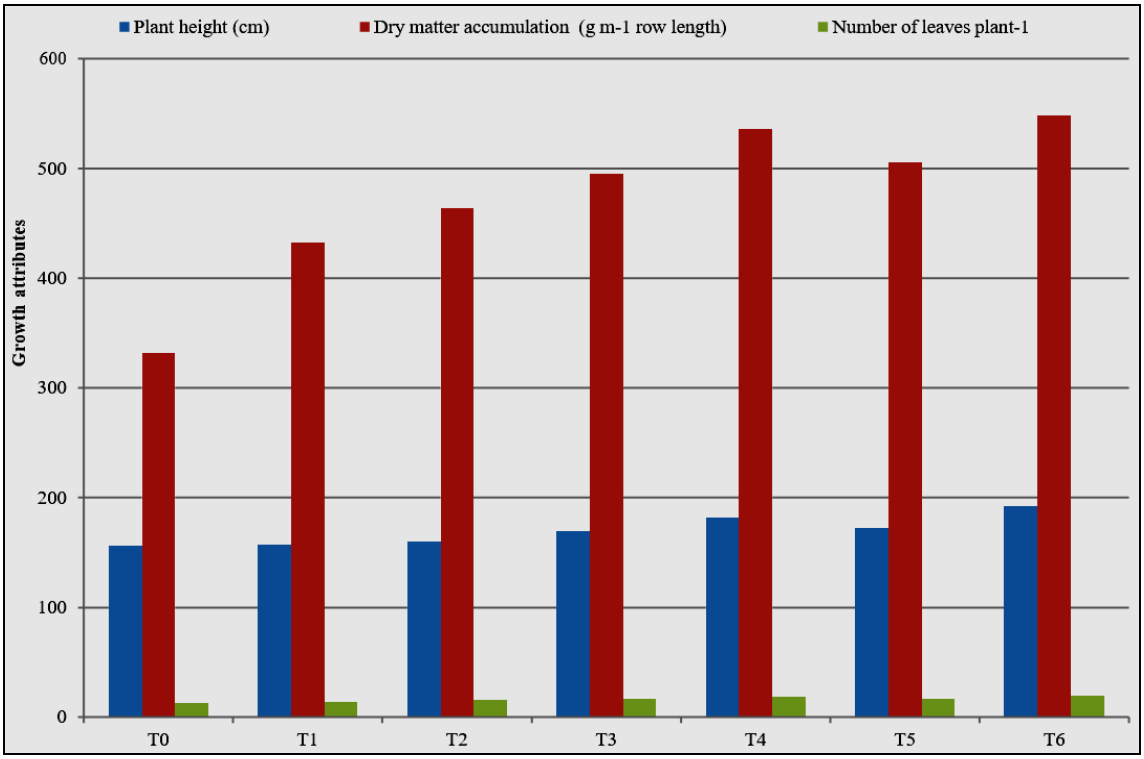

Fig 1: Effect of agronomic biofortification on growth attributes of pearl millet

Table 2: Effect of agronomic biofortification on yield parameter of pearl millet

Treatments	Number of effective tillers plant^{-1}	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
T_0: Absolute Control	1.63	1429.49	4523.71	5953.20	24.012
T_1: 100% RDF (60:40:30)	2.13	1941.57	5236.43	7178.00	22.274
T_2: 125% RDF	2.17	1922.14	5412.33	7334.47	26.207
T_3: 100% RDF + 0.5% $ZnSO_4$ at 25-30 DAS	2.51	2233.33	5932.39	8165.72	21.442
T_4: 100% RDF + 0.5% $ZnSO_4$ at 25-30 DAS and 40-45 DAS	2.76	2573.48	6493.42	9066.90	21.414
T_5: 125% RDF + 0.5% $ZnSO_4$ at 25-30 DAS	2.57	2273.33	5982.39	8255.72	23.101
T_6: 125% RDF + 0.5% $ZnSO_4$ at 25-30 DAS and 40-45 DAS	2.83	2661.22	6548.15	9209.37	22.581
SEm±	0.05	51	116	109	0.71
CD at (p= 0.05)	0.12	148	248	304	NS
CV (%)	7.14	8.77	8.09	8.34	9.45

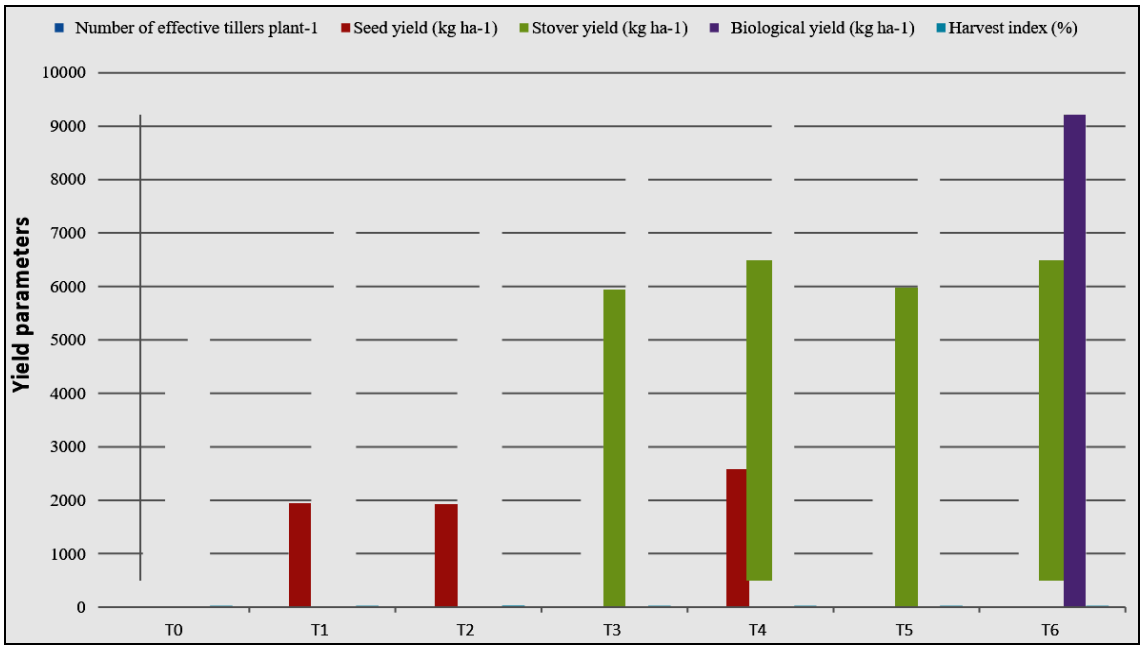

Fig 2: Effect of sulphur and phosphorus fertilizers on yield attributes and yields of India mustard

Table 3: Effect of agronomic biofortification on quality parameter of pearl millet

Treatments	Nitrogen uptake (kg ha^{-1})	Protein content (%)	Zinc content (ppm)
T_0: Absolute Control	57.69	8.63	12.14
T_1: 100% RDF (60:40:30)	65.42	9.38	14.90
T_2: 125% RDF	66.61	9.94	14.99
T_3: 100% RDF + 0.5% $ZnSO_4$ at 25-30 DAS	73.20	10.63	16.77
T_4: 100% RDF + 0.5% $ZnSO_4$ at 25-30 DAS and 40-45 DAS	79.73	11.56	18.40
T_5: 125% RDF + 0.5% $ZnSO_4$ at 25-30 DAS	74.78	10.69	16.94
T_6: 125% RDF + 0.5% $ZnSO_4$ at 25-30 DAS and 40-45 DAS	82.27	11.75	18.61
SEm ±	1.60	0.12	0.23
CD at (p= 0.05)	3.62	0.56	1.07
CV (%)	8.15	6.42	3.27

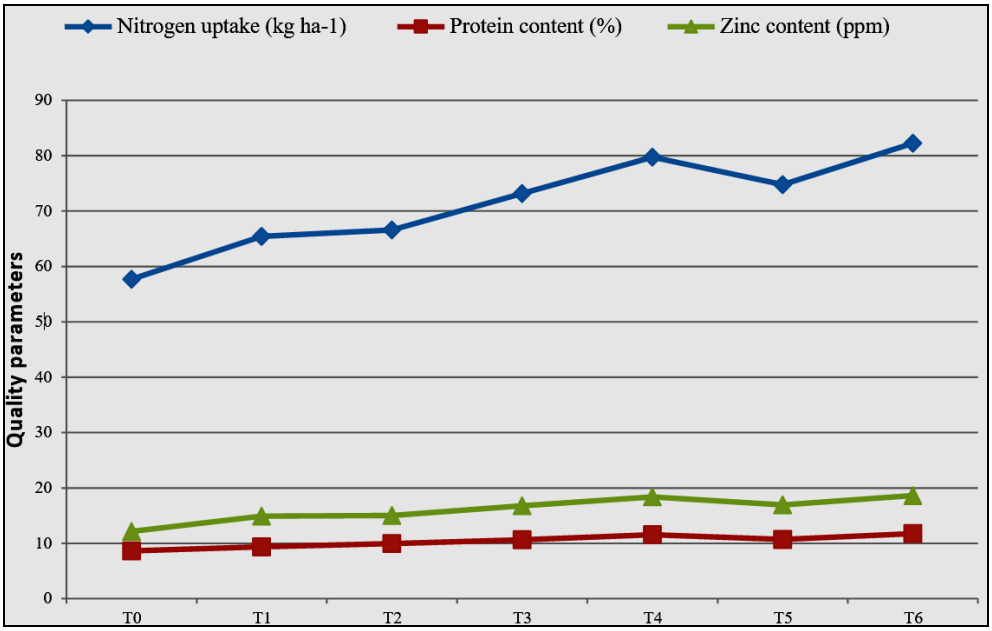

Fig 3: Effect of agronomic biofortification on quality parameter of pearl millet

Conclusion

Based on the results of one year experimentation, it is concluded that the application of 125% RDF + 0.5% $ZnSO_4$ at 25-30 DAS and 40-45 DAS (T_6) provided significantly higher growth, yield and quality parameters over rest of the treatments. These most effective treatments for pearl millet biofortification under loamy sand in semi-arid region of Rajasthan, However, these results are only indicative and require further experimentation to arrive at more consistent and final conclusion.

Acknowledgments

A feeling of sincere and heartfelt gratitude envelops me as I draft this acknowledgement. I acknowledge my esteemed Major Advisor, advisory committee, Head, Department of Agronomy, faculty members and non-teaching staff of Department of Agriculture, Vivekananda Global University, Jaipur for providing me the necessary help and suggestions during the course of the study.

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