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Effect of FYM, Zn and Fe on Growth, Yield Attribute, Yield and Quality of *Kharif* Pearl Millet

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

A field experiment on a pearl millet–chickpea cropping sequence was conducted during *kharif* and *rabi* seasons of 2023–24 and 2024–25 at the Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Gujarat, on loamy sand ("Goradu") soil. The study evaluated two FYM levels (0 and 10 t/ha), three zinc levels (0, 12.5 and 25 kg Zn/ha), and three iron levels (0, 25 and 50 kg Fe/ha) in a factorial randomized block design with three replications. Treatments were applied to pearl millet, and residual effects were studied on chickpea. Application of FYM (10 t/ha), $ZnSO_4$ (25 kg/ha), and $FeSO_4$ (50 kg/ha) with 100% RDF significantly increased pearl millet plant height, effective tillers, and yields, with grain yields of 3949, 3839 and 3819 kg/ha in 2023; 3980, 3880 and 3871 kg/ha in 2024 and pooled: 3965, 3859 and 3845 kg/ha.
The aim of this study is to find out how the FYM, Zn and Fe affect growth, yield attributes, yield and quality of *kharif* pearl millet.

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Keywords: FYM; zinc; iron; pearl millet.

1. INTRODUCTION

Pearl millet (*Pennisetum glaucum* L.) is a vital cereal crop grown extensively in arid and semi-arid regions due to its drought tolerance, short growth cycle, and adaptability to marginal soils (Bidarlord & Ghahremaninejad, 2022). In *kharif* cultivation, achieving higher productivity depends not only on genetic potential but also on improved nutrient management strategies that sustain soil fertility under intensive cropping systems. The integration of organic and inorganic nutrient sources has been recognized as an effective approach to enhance crop performance while maintaining soil health. FYM contributes to the improvement of soil physical, chemical, and biological properties, while micronutrients like Zn and Fe play critical roles in plant metabolic processes, enzyme activation and photosynthesis. Their adequate supply is essential for achieving optimum growth, yield attributes, and grain quality in pearl millet (Jhansi et al., 2023). The productivity of pearlmillet, which is much lesser than its production potential, vary greatly with rainfall quantity, intensity and its distribution. Hence, the research effort should be diverted to overcome the constraints that are responsible for its productivity. To bring millets into mainstream for exploiting the nutritional rich properties and promoting their cultivation, the Government of India has declared Year 2018 as the “Year of Millets” and the Year 2021 was declared as “International Year of Millets” by FAO Committee on Agriculture (COAG) forum (Chaudhary et al., 2024a; Chaudhary et al., 2024).

2. MATERIALS AND METHODS

A field experiment entitled *“*Effect of FYM, Zn and Fe on Pearl Millet Yield and its Residual Effect on Chickpea*”* was conducted during the *kharif* and rabi seasons of 2023–24 and 2024–25 at the Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand. The study was laid out in a Factorial Randomized Block Design (F-RBD) with 3 replications, comprising 18 treatment combinations and a total of 54 plots. Each gross plot measured 3.6 × 6.0 m, while the net plot size was maintained at 2.7 × 5.0 m. Pearl millet (variety GHB 1129) was sown using a seed rate of 3.75 kg/ha, and after its harvest, chickpea (variety GG 5) was grown at a seed rate of 60 kg/ha. Fertilizer applications were made as per the treatment schedule and irrigations were provided as required. To assess the influence of treatments on crop growth and development, periodic observations were recorded and biometric parameters were measured at different growth stages as well as at harvest.

3. RESULT AND DISCUSSION

3.1 Effect of FYM

Table 1 illustrated that application of FYM at different levels did not exert any significant effect on the plant population of pearl millet in either year or in the pooled results. Similar results were reported by Singh *et al*. (2020) and Singh & Chauhan (2021) in pearl millet, which support the current study.

Plant height at 30 DAS remained unaffected by FYM application; however, at harvest, a significant influence was observed. The treatment F_1 (10 t/ha FYM) produced the tallest plants, recording 169.95 cm, 172.03 cm and 170.10 cm during the first year, second year and pooled analysis, respectively (Table 1).

From the table 1, it can be inferred that number of effective tillers per plant was significantly enhanced by FYM application. Treatment F_1 (10 t/ha FYM) consistently recorded the maximum number of effective tillers, with values of 2.39 and 2.43 in the first and second year, respectively and 2.41 on a pooled basis. Similar result was observed by and Raja *et al.* (2012) and Sanwal *et al.* (2023).

According to the table 2, it is observed that Grain and straw yields of pearl millet were also significantly influenced by FYM levels. The application of 10 t/ha FYM (F_1) resulted in the highest grain yield of 3949 kg/ha in 2023, 3980 kg/ha in 2024 and 3965 kg/ha on a pooled basis. Similarly, straw yield was significantly higher under F_1, recording 6356 kg/ha, 6668 kg/ha and 6512 kg/ha in the respective years and pooled analysis. These findings are consistent with the research of Bhagchand & Gautam (2000), Kumar & Gautam (2004), Choudhary & Gautam (2007) and Rana & Prasad (2020). In contrast, FYM application had no significant effect on harvest index and test weight across both years and in the pooled data (Table 2).

Table 1. Effect of FYM, Zn and Fe on growth of pearl millet

Treatment	Plant Population at (per meter row length)			Plant height						Effective tillers per plant		
				At 30 DAS (cm)			At harvest (cm)					
	2023	2024	Pooled	2023	2024	Pooled	2023	2024	Pooled	2023	2024	Pooled
Level of FYM (t ha^{-1})												
F_0	8.57	8.83	8.70	46.30	46.64	46.47	136.08	135.53	135.81	2.10	2.14	2.12
F_1	8.77	8.90	8.84	46.55	46.39	46.46	169.95	172.03	170.10	2.39	2.43	2.41
S. Em. ±	0.12	0.13	0.09	0.76	0.77	0.54	2.49	2.39	1.73	0.04	0.04	0.03
C. D. at 5%	NS	NS	NS	NS	NS	NS	7.16	6.87	4.87	0.11	0.11	0.08
Level of Zn (kg ha^{-1})												
Zn_0	8.61	8.79	8.70	46.69	46.15	46.42	144.67	147.50	146.08	2.08	2.18	2.13
Zn_1	8.66	8.88	8.77	46.18	46.56	46.37	153.66	151.23	152.45	2.28	2.31	2.29
Zn_2	8.75	8.92	8.84	46.41	46.81	46.61	158.86	162.62	161.66	2.37	2.38	2.38
S. Em. ±	0.14	0.18	0.10	0.93	0.94	0.66	3.05	2.93	2.44	0.05	0.05	0.03
C. D. at 5%	NS	NS	NS	NS	NS	NS	8.77	8.41	6.89	0.13	0.13	0.09
Level of Fe (kg ha^{-1})												
Fe_0	8.61	8.78	8.69	46.64	45.86	46.25	146.14	148.25	147.20	2.13	2.18	2.15
Fe_1	8.69	8.85	8.77	47.25	46.63	46.94	154.04	153.78	153.91	2.24	2.32	2.28
Fe_2	8.73	8.96	8.84	45.39	47.03	46.21	158.86	159.31	159.09	2.36	2.37	2.36
S. Em. ±	0.14	0.18	0.10	0.93	0.94	0.66	3.05	2.93	2.44	0.05	0.05	0.03
C. D. at 5%	NS	NS	NS	NS	NS	NS	8.77	8.41	6.89	0.13	0.13	0.09
Year	-	-	NS	-	-	NS	-	-	NS	-	-	NS
S. Em. ±	-	-	0.09	-	-	0.54	-	-	1.73	-	-	0.03
C. D. at 5%	-	-	NS	-	-	NS	-	-	4.87	-	-	0.08
Significant Interaction(s)	-	-	-	-	-	-	-	-	-	-	-	-
CV%	7.02	7.29	7.16	8.53	8.59	8.56	8.46	8.07	8.27	8.69	8.61	8.65

Table 2. Effect of FYM, Zn and Fe on yield, yield attributes and crude protein content (grain) of pearl millet

Treatment	Grain yield (kg/ha)			Straw yield (kg/ha)			Harvest index (%)			Test weight (g)			Crude protein content (grain) (%)		
	2023	2024	Pooled	2023	2024	Pooled	2023	2024	Pooled	2023	2024	Pooled	2023	2024	Pooled
Level of FYM (t ha^{-1})															
F_0	3384	3430	3407	6047	6159	6103	36.83	36.75	36.79	8.81	8.86	8.84	10.98	10.85	10.91
F_1	3949	3980	3965	6356	6668	6512	38.31	37.36	37.83	9.09	8.95	9.00	11.36	11.30	11.33
S. Em. ±	70	61	46	95	110	73	0.57	0.53	0.39	0.11	0.10	0.07	0.09	0.13	0.08
C. D. at 5%	201	175	131	274	315	205	NS	NS	NS	NS	NS	NS	0.26	0.37	0.22
Level of Zn (kg ha^{-1})															
Zn_0	3529	3494	3512	6041	6103	6072	38.20	37.76	37.98	8.89	8.86	8.89	10.90	10.67	10.79
Zn_1	3633	3741	3687	6046	6433	6239	37.49	36.73	37.11	8.94	9.00	8.97	11.15	11.25	11.20
Zn_2	3839	3880	3859	6518	6705	6611	37.02	36.67	36.84	8.96	8.82	8.89	11.45	11.30	11.37
S. Em. ±	86	75	57	117	134	89	0.69	0.65	0.48	0.13	0.12	0.09	0.11	0.16	0.10
C. D. at 5%	246	215	160	335	386	251	NS	NS	NS	NS	NS	NS	0.32	0.46	0.27
Level of Fe (kg ha^{-1})															
Fe_0	3509	3524	3516	5950	6105	6027	37.53	36.99	37.26	8.92	8.69	8.81	10.96	10.80	10.88
Fe_1	3672	3720	3696	6204	6472	6338	37.69	36.86	37.27	8.93	9.06	8.99	11.17	11.14	11.16
Fe_2	3819	3871	3845	6450	6664	6557	37.49	37.32	37.41	8.93	8.97	8.95	11.37	11.29	11.33
S. Em. ±	86	75	57	117	134	89	0.69	0.65	0.48	0.13	0.12	0.09	0.11	0.16	0.10
C. D. at 5%	246	215	160	335	386	251	NS	NS	NS	NS	NS	NS	0.32	0.46	0.27
Year	-	-	NS	-	-	Sig.	-	-	NS	-	-	NS	-	-	NS
S. Em. ±	-	-	46	-	-	73	-	-	0.39	-	-	0.07	-	-	0.08
C. D. at 5%	-	-	NS	-	-	205	-	-	NS	-	-	NS	-	-	NS
Significant Interaction(s)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CV%	9.90	8.56	9.25	7.98	8.89	8.47	7.85	7.45	7.65	8.46	8.07	8.27	4.18	6.08	5.21

The Table 2 illustrates that crude protein content in pearl millet grain was significantly improved with FYM application, with the highest values observed under F_1 (10 t/ha FYM), recording 11.36% in 2023, 11.30% in 2024 and 11.33% on a pooled basis.

3.2 Effect of Zn

The Table 1 presents evidence that application of $ZnSO_4$ at different levels did not significantly affect the plant population of pearl millet in either year or in the pooled results (Maharana & Singh, 2021).

The data summarized in the Table 1 confirm that plant height at 30 DAS remained unaffected; however, at harvest, a significant effect was observed. The treatment Zn_2 (25 kg/ha $ZnSO_4$) recorded the tallest plants, with heights of 158.86 cm in 2023, 162.62 cm in 2024 and 161.66 cm on a pooled basis. Treatment Zn_2 found statistically at par with treatment Zn_1 (12.5 kg/ha $ZnSO_4$) in year 2023.

The number of effective tillers per plant was also significantly influenced by $ZnSO_4$ application (Pathak et al., 2017). The Zn_2 treatment (25 kg/ha $ZnSO_4$) produced the maximum number of effective tillers, recording 2.37 in 2023, 2.38 in 2024 and 2.38 on a pooled basis. Zn_2 was statistically at par with Zn_1 (12.5 kg/ha $ZnSO_4$) across both years and pooled basis (Table 1).

The data in the Table 2 indicate that grain yields of pearl millet were markedly enhanced by $ZnSO_4$ application. The Zn_2 treatment resulted in the highest grain yield of 3859 kg/ha in 2023, 3880 kg/ha in 2024 and 3859 kg/ha on a pooled basis. Zn_2 significantly enhanced pearl millet grain yield but was statistically at par with Zn_1 (12.5 kg/ha $ZnSO_4$) in both years(Vaja et al., 2020). Similarly, straw yield was significantly higher under Zn_2, with values of 6518 kg/ha, 6705 kg/ha and 6611 kg/ha in the respective years and pooled data. In 2024, the Zn_2 treatment was statistically at par with Zn_1.

On the other hand, harvest index and test weight of pearl millet were not significantly influenced by $ZnSO_4$ application across individual years or in the pooled analysis (Table 2).

The findings in the Table 2 suggest that crude protein content in grain was significantly improved, with the Zn_2 (25 kg/ha $ZnSO_4$) treatment recording the maximum values of 11.45% in 2023, 11.30% in 20242 and 11.37% on a pooled basis. Zn_2 was statistically at par with Zn_1 (25 kg/ha $FeSO_4$) across all years.

3.3 Effect of Fe

The application of $FeSO_4$ at different levels did not produce any significant effect on the plant population of pearl millet in either of the individual years or in the pooled analysis (Table 1).

The data summarized in the Table 1 confirm that plant height at 30 days after sowing (DAS) was not significantly influenced; however, at harvest, $FeSO_4$ application had a significant impact. The treatment Fe_2 (50 kg/ha $FeSO_4$) recorded the tallest plants, with heights of 158.86 cm in 2023, 159.31 cm in 2024 and 159.09 cm in the pooled data. Fe_2 was statistically at par with Fe_1 (25 kg/ha $FeSO_4$) in both years and on a pooled basis.

The number of effective tillers per plant was also significantly enhanced by $FeSO_4$ application. The Fe_2 treatment (50 kg/ha $FeSO_4$) consistently produced the highest values, recording 2.36 in 2023, 2.37 in 2024 and 2.36 on a pooled basis. The Fe_2 treatment was statistically equivalent to Fe_1 (25 kg/ha $FeSO_4$) across both years and in the pooled data analysis (Table 1).

According to the table, it is observed that grain yields of pearl millet were significantly influenced by $FeSO_4$ application (Reddy et al., 2022). The Fe_2 treatment resulted in the maximum grain yield of 3819 kg/ha in 2023, 3871 kg/ha in 2024 and 3845 kg/ha on a pooled basis. The Fe_2 treatment was statistically at par with Fe_1 (25 kg/ha $FeSO_4$) across both years and on pooled basis, respectively. Similarly, straw yield was significantly higher under Fe_2, with 6450 kg/ha, 6664 kg/ha and 6557 kg/ha during the respective years and pooled analysis. Fe_2 was statistically at par with Fe_1 (25 kg/ha $FeSO_4$) in 2023, 2024 and the pooled analysis for the evaluated parameters.

In contrast, harvest index and test weight of pearl millet were not significantly affected by $FeSO_4$ levels across both years or in the pooled data (Table 2).

The data in the Table 2 indicate that crude protein application, with the Fe_2 treatment (50 kg/ha $FeSO_4$) registering 11.37% in 2023,

11.29% in 2024 and 11.33% in the pooled results. Fe_2 treatment remained statistically at par with Fe_1 (25 kg/ha $FeSO_4$) across both years and in the pooled data.

3.4 Interaction Effect

No significant impact of various levels of FYM, zinc and iron on growth, yield, yield and quality of *kharif* pearl millet in 2024, 2025 and pooled basis, respectively (Tables 1 & 2).

4. CONCLUSION

The integrated application of FYM 10 t/ha, $ZnSO_4$ 25 kg/ha and $FeSO_4$ 50 kg/ha along with 100% RDF (80:40:00 NPK) significantly enhanced the growth, yield attributes, yield, quality, nutrient content and its uptake in pearl millet (*kharif*) during 2023 and 2024.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that they have no known competing financial interests or non-financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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