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Response of Pearlmillet to Soil and Foliar Nutrition of Zinc and Iron

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ABSTRACT

A field experiment was carried out during *kharif*, 2019 at Agricultural College Farm, Bapatla, Acharya N.G. Ranga Agricultural University. The experiment was laid out in simple Randomised Block Design with nine treatments and replicated thrice. Plant growth characters like drymatter production and yield attributing characters like number of effective tillers m^{-2} recorded highest with soil application of 50 kg ha^{-1} $ZnSO_4$ as basal + soil application of 25 kg ha^{-1} $FeSO_4$ as basal along with soil test based NPK fertilizer application (T_9) compared to rest of the treatments. Highest grain and straw yield of pearlmillet was recorded with T_9 treatment *i.e.* STBF + soil application of 50 kg ha^{-1} $ZnSO_4$ as basal + soil application of 25 kg ha^{-1} $FeSO_4$ as basal over the rest of the treatments.

Keywords: *pearlmillet and Soil and foliar application of Zn and Fe.*

Pearlmillet (*Pennisetum glaucum* (L.) R. Br.) is popularly known as bajra and also referred as cattail millet, bulrush millet. It belongs to poaceae family. In India, area under pearlmillet is about 7.12 million hectares and its production is 8.07 million tonnes with an average productivity of 1132 kg ha^{-1}. In Andhra Pradesh area under pearlmillet is about 0.042 million hectares and its production is 0.072 million tonnes with an average productivity of 1718 kg ha^{-1} (Indiastat.com, 2018-19). Globally, the main staple food for humans is cereals. Unfortunately, the availability of zinc and iron in cereal grains is low. Zinc enhances the protein content in grains. Zn involves in biosynthesis of indole acetic acid (IAA) which helps in better development of growth attributes (Ganapathy and Savalgi, 2006). Zn improves yield attributes by improving source and sink relationship as it affects translocation of photosynthates towards reproductive system (Sammauria and Yadav, 2010). Fe is an essential constituent of many enzymes. Fe also participates in the oxidation process that releases energy from sugars and starches. It plays an essential role in nucleic acid metabolism and improves photosystems performance (Havlin *et al.,* 2013).

Agronomic fortification is a strategy where the short of essential nutrients (macro and micro) can be restored through foliage or by soil application of fertilizers. Based on previous studies, soil and foliar application of Zn enhance the yield of crops, whereas increased Zn uptake and accumulation in crop grain have been found with both the soil and foliar application. Foliar spraying is a method where the liquid fertilizers are applied directly on the leaf surface. It requires lesser rates of nutrients since, they are readily soluble and enter into leaf apoplast which can be easily taken up by plant cells. As people are more concerned about the environment, uptake of nutrients through plant leaves is better than soil application therefore, foliar spraying was advised (Bozorgi *et al*., 2011).

Looking to widespread deficiency of zinc and iron and its response to pearlmillet in terms of soil as well as foliar application, the current field research was undertaken to study the response of hybrid pearlmillet to soil and foliar application of zinc and iron.

MATERIALS AND METHODS

The present research was carried out at College Farm, Agricultural College, Bapatla during *kharif*, 2019. The experiment was laid out in Randomized Block Design with nine treatments each replicated thrice. STBF was common to all treatments (75: 38: 18 NPK kg ha^{-1}). The treatments comprises of T_1 (STBF -Soil Test Based Fertilizer application) *i.e.* 75: 38: 18 NPK kg ha^{-1}, T_2 (STBF + soil application of 50 kg ha^{-1} $ZnSO_4$ as basal), T_3 (STBF + soil application of 25 kg ha^{-1} $FeSO_4$ as basal), T_4 (STBF + 25 kg ha^{-1} $ZnSO_4$ as basal + foliar application of 0.5% $ZnSO_4$ at panicle initiation stage), T_5 (STBF + 15 kg ha^{-1} $FeSO_4$ as basal + foliar application of 0.5 % $FeSO_4$ at panicle initiation stage), T_6 (STBF + foliar application of 0.2% $ZnSO_4$ at 25 DAS), T_7 (STBF + foliar application of 0.2% $FeSO_4$ at 25 DAS), T_8 (STBF + foliar application of 0.2% $ZnSO_4$ at 25 DAS + foliar application of 0.2% $FeSO_4$ at 25 DAS) and T_9 (STBF + soil application of 50 kg ha^{-1} $ZnSO_4$ as basal + soil application of 25 kg ha^{-1} $FeSO_4$ as basal. The soil of the experimental site was neutral in reaction, clay in texture with 0.42 % organic carbon, 163 kg ha^{-1} of N, 9.8 kg ha^{-1} of P_2O_5, 388 kg ha^{-1} of K_2O, 0.42 mg kg^{-1} of available Zn and 2.4 mg kg^{-1} of available Fe.

Observations on plant height, drymatter accumulation (kg ha^{-1}), number of productive tillers per m^{-2}, number of earheads m^{-2}, length and weight of earhead were recorded from five randomly selected plants from each plot. Subsequently the grain yield (kg ha^{-1}) and straw yield (kg ha^{-1}) were estimated after harvest.

All the data recorded in the study were subjected to statistical analysis using Fisher's method of analysis of variance as outlined by Panse and Sukhatme (1985) for the design adopted in this study. Statistical significance was tested by applying F-test at 0.05 level of probability.

RESULTS AND DISCUSSION

At 30, 60 DAS and maturity, the plant height and drymatter production were obtained with soil test based NPK fertilizer application along with soil application of 50 kg ha^{-1} $ZnSO_4$ + soil application of 25 kg ha^{-1} $FeSO_4$ (T_9) followed by STBF + 25 kg ha^{-1} $ZnSO_4$ as basal + foliar application of 0.5% $ZnSO_4$ at panicle initiation stage (T_4) (Table 2). Supplementation of Zn and Fe during different stages of plant growth through soil and foliar application might have helped the plant in natural assimilation of nutrients to shoot and leaf portions. Also, increase in plant growth might be due to the favourable synergistic effect of combined application of Zn and Fe in the soils which enhanced the better translocation of nutrients by developing good root growth (Shekawat and Kumawat, 2017) and Mehdi *et al.* (2012). Zn acts as a catalyst in various plant physiological processes and also involves in synthesis of auxin which results in increase of plant growth parameters like height which in turn helps in higher drymatter accumulation (Arshewar *et al.*, 2018).

Significantly highest number of effective tillers m^{-2} and earheads m^{-2} were recorded with treatment T_9 *i.e.* soil application of 50 kg ha^{-1} $ZnSO_4$ + soil application of 25 kg ha^{-1} $FeSO_4$ followed by STBF + 25 kg ha^{-1} $ZnSO_4$ as basal + foliar application of 0.5% $ZnSO_4$ at panicle initiation (T_4). Length and weight of the earhead recorded significantly higher with treatment T_9 *i.e.* soil application of 50 kg ha^{-1} $ZnSO_4$ + soil application of 25 kg ha^{-1} $FeSO_4$ (Table 3). Balanced supply of all the macro and micro nutrients

Table 1. Plant height (cm) of pearl millet as influenced by soil and foliar application of Zn and Fe

Treatment	30 DAS	60 DAS	Maturity
T_1 - STBF (Soil Test Based Fertilizer application) (75: 38: 18 NPK kg ha^{-1})	99	188	192
T_2 - STBF + soil application of 50 kg ha^{-1} $ZnSO_4$ as basal	118	210	224
T_3 - STBF + soil application of 25 kg ha^{-1} $FeSO_4$ as basal	111	202	203
T_4 - STBF + 25 kg ha^{-1} $ZnSO_4$ as basal + foliar application of 0.5% $ZnSO_4$ at panicle initiation	122	213	240
T_5 - STBF + 15 kg ha^{-1} $FeSO_4$ as basal + foliar application of 0.5% $FeSO_4$ at panicle initiation	108	201	214
T_6 - STBF + foliar application of 0.2% $ZnSO_4$ at 25 DAS	106	198	216
T_7 - STBF + foliar application of 0.2% $FeSO_4$ at 25 DAS	103	193	204
T_8 - STBF + foliar application of 0.2% $ZnSO_4$ at 25 DAS + foliar application of 0.2% $FeSO_4$ at 25 DAS	116	207	225
T_9 - STBF + soil application of 50 kg ha^{-1} $ZnSO_4$ as basal + soil application of 25 kg ha^{-1} $FeSO_4$ as basal	124	218	255
S. Em±	5.32	6.01	8
CD (P=0.05)	NS	18	23
CV (%)	8.23	5.12	6

Table 2. Drymatter production (kg ha^{-1}) of pearlmillet as influenced by soil and foliar application of Zn and Fe

Treatment	30 DAS	60 DAS	Maturity
T_1 - STBF (Soil Test Based Fertilizer application) (75: 38: 18 NPK kg ha^{-1})	1904	4318	7555
T_2 - STBF + soil application of 50 kg ha^{-1} $ZnSO_4$ as basal	2503	5377	9481
T_3 - STBF + soil application of 25 kg ha^{-1} $FeSO_4$ as basal	2452	4903	8666
T_4 - STBF + 25 kg ha^{-1} $ZnSO_4$ as basal + foliar application of 0.5% $ZnSO_4$ at panicle initiation	2629	5925	9851
T_5 - STBF + 15 kg ha^{-1} $FeSO_4$ as basal + foliar application of 0.5% $FeSO_4$ at panicle initiation	2311	4962	8814
T_6 - STBF + foliar application of 0.2% $ZnSO_4$ at 25 DAS	2118	4792	8370
T_7 - STBF + foliar application of 0.2% $FeSO_4$ at 25 DAS	2074	4592	8221
T_8 - STBF + foliar application of 0.2% $ZnSO_4$ at 25 DAS + foliar application of 0.2% $FeSO_4$ at 25 DAS	2444	5111	9332
T_9 - STBF + soil application of 50 kg ha^{-1} $ZnSO_4$ as basal + soil application of 25 kg ha^{-1} $FeSO_4$ as basal	2807	6185	10443
S. Em±	92	222	359
CD (P=0.05)	278	672	1088
CV (%)	6.7	7.5	7

Table 3. Number of effective tillers m^{-2}, number of earheads m^{-2}, length (cm) and weight (g) of earhead of pearl millet as influenced by soil and foliar application Zn and Fe

Treatment	Number of effective tillers m^{-2}	Ear heads m^{-2}	Length of ear head (cm)	Weight of ear head (g)
T_1 - STBF (Soil Test Based Fertilizer application) (75: 38: 18 NPK kg ha^{-1})	19	19	24	43
T_2 - STBF + soil application of 50 kg ha^{-1} $ZnSO_4$ as basal	24	24	30	51
T_3 - STBF + soil application of 25 kg ha^{-1} $FeSO_4$ as basal	22	22	28	49
T_4 - STBF + 25 kg ha^{-1} $ZnSO_4$ as basal + foliar application of 0.5% $ZnSO_4$ at	24	24	31	53
T_5 - STBF + 15 kg ha^{-1} $FeSO_4$ as basal + foliar application of 0.5% $FeSO_4$ at panicle initiation	21	21	27	48
T_6 - STBF + foliar application of 0.2% $ZnSO_4$ at 25 DAS	20	20	26	46
T_7 - STBF + foliar application of 0.2% $FeSO_4$ at 25 DAS	20	20	26	45
T_8 - STBF + foliar application of 0.2% $ZnSO_4$ at 25 DAS + foliar application of 0.2% $FeSO_4$ at 25 DAS	22	22	29	50
T_9 - STBF + soil application of 50 kg ha^{-1} $ZnSO_4$ as basal + soil application of 25 kg ha^{-1} $FeSO_4$ as basal	25	25	33	55
S. Em±	0.8	0.8	1.38	1.7
CD (P=0.05)	2.3	2.3	4.19	5.17
CV (%)	6.1	6.1	8.5	6.06

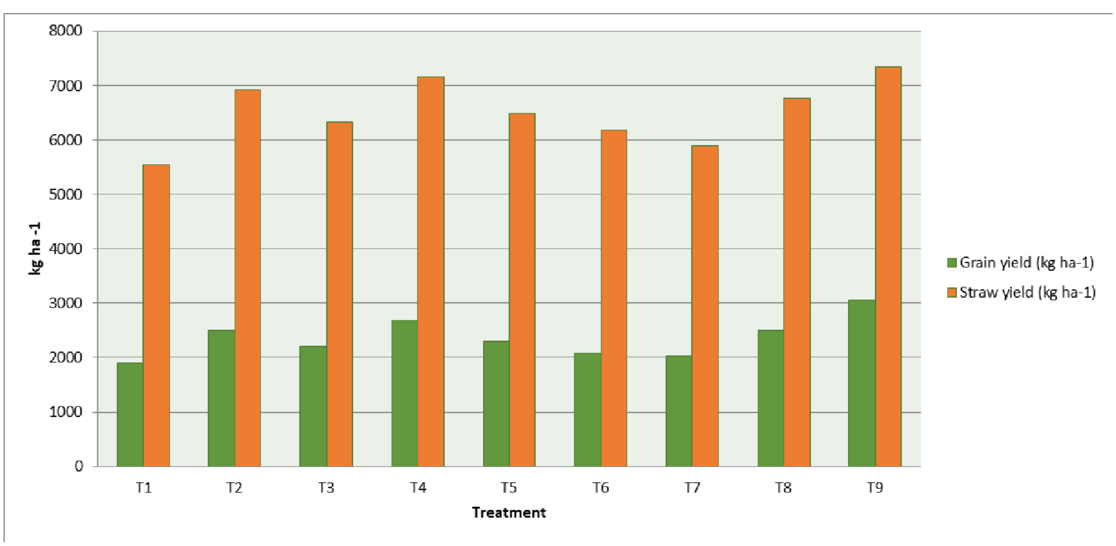

Fig. 1. Grain and Straw yield (kg ha^{-1}) of pearlmillet as influenced by soil and foliar application of Zn and Fe

Table 4. Grain yield, straw yield (kg ha^{-1}) and harvest index of pearl millet as influenced by soil and foliar application of Zn and Fe

Treatment	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)
T_1 - STBF (Soil Test Based Fertilizer application) (75: 38: 18 NPK kg ha^{-1})	1903	5547	25.2
T_2 - STBF + soil application of 50 kg ha^{-1} $ZnSO_4$ as basal	2503	6922	26.6
T_3 - STBF + soil application of 25 kg ha^{-1} $FeSO_4$ as basal	2202	6327	25.9
T_4 - STBF + 25 kg ha^{-1} $ZnSO_4$ as basal + foliar application of 0.5% $ZnSO_4$ at panicle initiation	2686	7164	27.3
T_5 - STBF + 15 kg ha^{-1} $FeSO_4$ as basal + foliar application of 0.5% $FeSO_4$ at panicle initiation	2303	6487	26.2
T_6 - STBF + foliar application of 0.2% $ZnSO_4$ at 25 DAS	2083	6180	25.8
$_7$ - STBF + foliar application of 0.2% $FeSO_4$ at 25 DAS	2032	5901	25.7
T_8 - STBF + foliar application of 0.2% $ZnSO_4$ at 25 DAS + foliar application of 0.2% $FeSO_4$ at 25 DAS	2492	6767	27
T_9 - STBF + soil application of 50 kg ha^{-1} $ZnSO_4$ as basal + soil application of 25 kg ha^{-1} $FeSO_4$ as basal	3060	7346	29.4
S. Em±	95	275	1.1
CD (P=0.05)	289	833	NS
CV (%)	7	7.3	7.2

like N, P, K, Zn and Fe resulted in better growth of the pearlmillet crop which enable better assimilate accumulation from source to sink might have helped in attaining more number of effective tillers m^{-2} (Prasad *et al.*, 2014). Increase in earhead length in case of soil and foliar application of Zn and Fe over the control might be due to availability of micronutrients to the plant helps in direct absorption of nutrients and facilitated better length of the earhead.

Significantly higher grain yield and straw yield was recorded with soil test based NPK fertilizer application along with soil application of 50 kg ha^{-1} $ZnSO_4$ + soil application of 25 kg ha^{-1} $FeSO_4$ (T_9) compared to rest of the treatments (Table 4). Harvest index was not significantly influenced by soil and foliar application of Zn and Fe.

Soil application of 50 kg ha^{-1} $ZnSO_4$ + soil application of 25 kg ha^{-1} $FeSO_4$ along with soil test based fertilizer application registered highest grain yield among the different treatments was due to availability of balanced nutrients to the crop which included both macro (N, P, K) and micro (Zn, Fe) nutrients through soil application helped in attaining vigorous root growth which in turn promoted growth and development leading to better photosynthetic activity which prolonged the flowering period, which helped in having higher yield attributing characters like number of effective tillers which finally contributes to higher grain yield (Satyajeet and Nanwal, 2007). The increase in grain yield through foliar application of zinc was due to its role in various physiological processes like photosynthesis and auxin metabolism resulted in gaining more plant height and accumulation of more drymatter in turn helped in partitioning of photosynthates evenly towards newly formed sink. Translocation of assimilates from source to sink helped in gaining higher yield attributing characteristics which was a direct function of yield and finally resulted in higher grain and straw yields (Kumar *et al.*, 2012).

CONCLUSION

It can be concluded that basal application of zinc and iron @ 50 kg ha^{-1} and 25 kg ha^{-1}, respectively along with STBF (75: 38: 18 NPK kg ha^{-1}) resulted in higher yield of pearlmillet.

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