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Studies on nutrients integration of organic and inorganic amendments for higher production of rainfed pearl millet

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ABSTRACT : A field study was carried out during three years from 2009-10 to 2011-12 at Regional Research Station, Kali, Aligarh, C.S. Azad University of Agriculture and Technology, Kanpur. The main objective was to findout the effect of trace elements on grain yield of pearl millet in the integration of FYM and recommended dose of fertilizers. The soil of experimental field was sandy loam, having pH 8.0, organic carbon 0.23%, total nitrogen 0.02%, available phosphorus 13.9 kg/ha and available potash 115 kg/ha, therefore, the fertility status was poor. The twelve treatment combinations *i.e.*, FYM 0 t/ha, RDF + FYM 0 t/ha, RDF + FYM 0 t + $ZnSO_4$ 20 kg/ha, RDF + FYM 0 t + $FeSO_4$ 20 kg/ha, RDF + FYM 0 t + boron 10 kg/ha, RDF + FYM 0 t + gypsum 250 kg/ha, FYM 5 t/ha, RDF + FYM 5 t /ha, RDF + FYM 5 t + $ZnSO_4$ 20 kg/ha, RDF + FYM 5 t + $FeSO_4$ 20 kg/ha, RDF + FYM 5 t + boron 10 kg/ha and RDF + FYM 5 t +gypsum 250 kg/ha were tested. The pooled results of three years displayed that application of RDF + FYM 5 t + $FeSO_4$ 20 kg/ha gave significantly higher grain yield of pearl millet (3111 kg/ha), closely followed by RDF + FYM 5 t + $ZnSo_4$ 20 kg/ha (3000 kg/ha). The lowest grain yield of pearl millet recorded at FYM 0 t /ha (1331kg/ha). The growth and yield traits were concordant to the grain yield obtained from rainfed pearl millet.

KEY WORDS : Boron, $FeSO_4$, Rainfed, Trace elements, $ZnSO_4$

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Pearl millet [*Pennisetum glacum* (L.) R. Br.] is the stable food of poor farm house hold reeling below the poverty line and small land holder as well as feed and fodder for livestock in the dry farmed area of country. Pearl millet excels all other cereals because it is a C_4 plant with high photosynthetic efficiency and dry matter production capacity, requires less inputs, mature in short duration and is considered as nutrient food, feed and fodder. It is usually grown under the most adverse agro-climatic conditions, where other crops like sorghum and maize fail to produce economic yields. It is a rich source of fibres and minerals especially iron, calcium, zinc and high in fats among cereals. Despite all these advantages, it is perceived inferior due to lack of awareness about its nutritional richness, lack of right processing technologies and lack of economic incentives to farmers. Its per capita consumption is declining and productions increasing to high volatility in prices and farmers income.

In India, pearl millet is the third most widely cultivated food crop after rice and wheat. It is grown on 7.128 million ha with an average productivity of 1132 kg/ha during

2015-16 (Anonymous, 2017). The major pearl millet growing states are Rajasthan, Maharastra, Gujarat, Uttar Pradesh and Haryana, which account for more than 90% of pearl millet acreage in the country.

Under rainfed condition pearl millet proved a drought saving crops, it checks the growth during dry spell period and moisture stress condition and recovers the growth on availability of proper soil moisture.

In U.P. its area, production and productivity are 9.52 lakh hectare, 18.08 lakh mt and 19.00 q/ha, respectively (Anonymous, 2016).

Pearl millet yield is very low in U.P., principally due to imbalance use of fertilizers and non use of trace elements. Farmers apply only nitrogen through urea but seldom apply phosphorus to pearl millet through DAP. Imbalance nutrition to pearl millet is the major cause of yield reduction. The reduced availability and utilization of nutrients under dry conditions *vis-à-vis* fertilizer induced drought tolerance make the problem even more complex (Joshi, 1997).

It is well known fact that less or nil use of trace elements through FYM or agro-chemicals, produce nutrient deficit grain and fodder. This fodder is used for feeding to milching cattle responsible for production of inferior quality milk. Such type production of both grain and milk become responsible for poor human health.

Therefore, for quality production of grain and milk and to enhance the productivity both grain and stover, the present study was conducted to find out the suitable integration of different nutrients through organic and inorganic amendment with RDF under rainfed situation.

Research Procedure

The present study was carried out during *Kharif* season of 2012 to 2014 at Regional Research Station, Kalai, Aligarh, C.S. Azad University of Agriculture and Technology, Kanpur. The soil of experimental field was sandy loam, having pH 8.0, organic carbon 0.23%, total nitrogen 0.02%, available phosphorus 13.9 kg/ha and available potash 115 kg/ha, therefore, the fertility status was poor. The pH was determined by Electrometric glass electrode method (Piper, 1950), while organic carbon was determined by Colorimetric method (Datta *et al.,* 1962). Total nitrogen was analysed by Kjeldahl's method as discussed by Piper (1950). The available phosphorus and potassium were determined by Olsen's method (Olsen *et al.*, 1954) and Flame photometric method (Singh, 1971), respectively. Twelve treatment combinations *i.e.*, FYM 0 t/ha (T_1), RDF + FYM 0 t/ha (T_2), RDF + FYM 0 t + $ZnSO_4$ 20 kg/ha (T_3), RDF + FYM 0 t + $FeSO_4$ 20 kg/ha (T_4), RDF + FYM 0 t + boron 10 kg/ha (T_5), RDF + FYM 0 t + gypsum 250 kg/ha (T_6), FYM 5 t/ha (T_7), RDF + FYM 5 t /ha (T_8), RDF + FYM 5 t + $ZnSO_4$ 20 kg/ha (T_9), RDF + FYM 5 t + $FeSO_4$ 20 kg/ha (T_{10}), RDF + FYM 5 t + boron 10 kg/ha (T_{11}) and RDF + FYM 5 t + gypsum 250 kg/ha (T_{12}) were tested. The experiment was laidout in Factorial Randomized Block Design with three replications. The pearl millet variety HHB-223 was planted in the first fortnight of July 2012, 2013 and 2014 and harvested after complete maturity. The recommended dose of 80 kg N + 40 kg P_2O_5 + 40 kg K_2O was given to pearl millet. The other recommended agronomical practices were followed in pearl millet. The irrigations were given in the absence of rains as a protective irrigations.

The pooled data of the three years were statistically analysed with standard method as described by Gomez and Gomez (1984). The results of the study are discussed on mean value of three years.

Research Analysis and Reasoning

The results obtained from the experiment are reported in Table 1 and discussed below on the basis of pooled results.

Effect on growth parameters:

The different treatments did not affect the significant to the plant stand but slight improvement was noted under RDF + FYM 5 t + $FeSO_4$ 20 kg/ha over the other treatments (Table 1). The plant height under different treatment was found insignificant, however, there was numerically increae in the plant height at RDF + FYM 5 t + $FeSO_4$ 20 kg/ha. The number of total tillers/plant and effective tillers was numerically maximized by application of RDF + FYM 5 t + $FeSO_4$ 20 kg/ha. The higher head length (24.25 cm) was measured at RDF + FYM 5 t + $FeSO_4$ 20 kg/ha but the difference among the treatments was not found significant.

The conjunction of $FeSO_4$ with RDF and FYM has the composition of iron and sulphur. Both iron and sulphur helped in formation of chlorophyll. Iron also helped to the absormation of the plant nutrients and increased the photosynthesis. Similarly encouraged to vegetative growth of pearl millet and stimulated to the seed formation. Therefore, application of $FeSo_4$ in iron deficit soil increased the growth parameters considerable in comparison to other trace elements. These findings confirm the results of Bhardwaj and Prasad (1979); Gupta and Mishra (1982) and Patel *et al.* (1990).

Effect on yield traits:

Among the yield traits test weight of grain is most important yield contributing character, therefore, data on this character has been recorded. Significant highest test weight was recorded under RDF + FYM 5 t + $FeSO_4$ 20 kg/ha in comparision to other tested treatments. Conjunction of $ZnSO_4$ with RDF and FYM was stimulated to the healthy seed formation, which produced the highest test weight. Similar observations have also been reported by Bhardwaj and Prasad (1979), Gupta and Mishra (1982) and Patel *et al.* (1990).

Effect on grain yield:

The integrated dose of RDF + FYM 5 t + $FeSO_4$ 20 kg/ha yielded significantly higher grain yield (3111 kg/ha) except RDF + FYM 5 t + $ZnSO_4$ 20 kg/ha (3000 kg/ha), which was significantly at par to the RDF + FYM 5 t + $FeSO_4$ 20 kg/ha. The lowest grain yield by 1331 kg/ha was recorded at FYM 0 t/ha. The other treatment combinations gave the grain yield between these two limits. The considerable increase in effective tillers/plant, ear head length and test weight at RDF + FYM 5 t + $FeSO_4$ 20 kg/ha and RDF + FYM 5 t + $ZnSO_4$ 20 kg/ha supported to higher grain yield (kg/ha) of pearl millet. Bhardwaj and Prasad (1979), Gupta and Mishra (1982) and Patel *et al.* (1990) also reported good response of pearl millet with $FeSO_4$ application under the soil deficient in Fe, Zn and S.

The better combination of nutrients maintained better source-sink relationship. Under this situation the dry matter or photosyntahtes produced by source organs translocated towards sink organ (economic part) and produced higher seed of pearl millet. The sowing of pearl millet under T_9 and T_{10} had higher growth parameters means it possessed higher sink capacity to utilize the photoassimilates translocated from source, rsulted in, higer test weight and more seed yield (kg/ha). These results confirm the findings of Panwar *et al.* (1986); Shrivastava and Bharadwaj (1986); Pachpor and Shete (2010); Singh *et al.* (2015) and Singh *et al.* (2015).

Stover yield (q/ha):

The different treatment combinations of major and trace elements with FYM affected significantly to the stover yield. The treatment combination of RDF + FYM 5 t + $FeSO_4$ 20 kg/ha gave highest stover yield by 109.03 q/ha, closely followed by RDF + FYM 5 t + $ZnSO_4$ 20 kg/ha (104.61 q/ha). The significantly lowest stover yield was weighed at FYM 0 t/ha in comparision to all other treatment combinations.

Table 1 : Growth parameters, yield traits and grain and stover yield of pearl millet as influenced as different treatments (pooled data of three years)

	Treatment combinations	Plant stand (,000/ha)	Plant height (cm)	Total tillers/ plant	Effective tillers/ plant	Ear head length (cm)	Test weight (g)	Grain yield (kg/ha)	Stover yield (q/ha)	Harvest index (%)
T_1	FYM 0 t/ha	139	212	1.8	1.1	21.35	7.80	1331	69.34	16.10
T_2	RDF + FYM 0 t/ha	139	227	2.1	1.2	22.75	8.00	2411	79.26	23.32
T_3	RDF + FYM 0 t + $ZnSo_4$ 20 kg/ha	139	240	2.2	1.3	22.60	9.20	2527	88.07	22.29
T_4	RDF + FYM 0 t + $FeSo_4$ 20 kg/ha	141	248	2.4	1.5	23.45	9.60	2711	92.59	22.64
T_5	RDF + FYM 0 t + Boron 10 kg/ha	140	232	2.3	1.3	22.20	8.00	2609	86.34	23.20
T_6	RDF + FYM 0 t + Gypsum 250 kg/ha	141	233	2.3	1.3	22.70	8.30	2485	85.18	22.58
T_7	FYM 5 t/ha	141	221	2.0	1.2	21.25	7.90	1714	72.01	19.22
T_8	RDF + FYM 5 t /ha	141	236	2.4	1.5	21.95	8.30	2609	94.49	21.61
T_9	RDF + FYM 5 t + $ZnSo_4$ 20 kg/ha	141	238	2.8	1.7	23.65	14.40	3000	104.61	22.28
T_{10}	RDF + FYM 5 t + $FeSo_4$ 20 kg/ha	142	241	3.0	1.8	24.25	10.80	3111	10.9.03	22.19
T_{11}	RDF + FYM 5 t + Boron 10 kg/ha	140	236	2.6	1.5	22.85	9.00	2700	99.67	21.83
T_{12}	RDF + FYM 5 t +Gypsum 250 kg/ha	141	239	2.7	1.6	22.75	9.00	2728	102.14	21.07
	C.D. (P=0.05)	NS	NS	NS	NS	NS	0.10	233	5.82	-

NS=Non-significant

Effect on harvest index (%):

Not much variation was noted in harvest index under different treatments of nutrients combinations but all the nutrient combination treatments displayed the higher value of harvest index over the FYM 0 t/ha (16.10%).

Conclusion:

Pearl millet responded very well from the application of RDF + FYM 5 t + $FeSO_4$ 20 kg/ha and RDF + FYM 5 t + $ZnSO_4$ 20 kg/ha, therefore, these both plant nutrient combinations may be recommended to the farm families for obtaining better yield of pearl millet under rainfed eco system.

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