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Impact of zinc enriched pressmud compost, azophos, ZnSO_4 and vermiwash for enhancing yield attributes and yield of pearl millet cv. CO7 in black soil

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Abstract

Pearl millet (*Pennisetum glaucum* L.) is an erect annual short duration crop. It is grown globally in 29 million ha in more than 40 countries. Zn deficiency reduces not only the grain yield, but also nutritional quality of grain and ultimately nutritional quality of human diet. Pressmud contains cellulose, hemicellulose, fiber, organic carbon in addition to nitrogen, phosphorus, potassium, magnesium, calcium, micronutrients viz., zinc (Zn), iron (Fe), copper (Cu) and manganese (Mn) and also contains beneficial microorganisms. Azophos is a composite culture consisting of azospirillum and phosphate solubilizing bacteria. It contains essential macro and micro plant nutrients, plant growth-promoting hormones (auxin and gibberellins), enzymes and symbiotic microbes. To find the effect of these above sources on yield attributes and yield of pearl millet, field experiment was carried out at the Farmer's Field at Isukkali Katteri Village, Kilpenathur Taluk in Tiruvannamalai District. There were eight treatments and three replications in Randomized Block Design (RBD). The effect of different treatments on yield attributes viz., earhead length, earhead girth, earhead weight, 1000 grain weight, grain and stover yield were studied and recorded. The results of the field experiment revealed that application of Zn- EPMC @ 10 t ha⁻¹ + Azophos @5 kg ha⁻¹ + ZnSO_4 @0.5%+VW@5% (T₈) recorded significantly highest yield attributes viz., earhead length, earhead girth, earhead weight and 1000 grain weight were 32.45 cm, 8.56 cm, 51.98 g and 9.04 g, grain and stover yield of pearl millet were 3670 and 7287 kg ha⁻¹, respectively compared to control (T₁).

Keywords: Pearl millet, yield attributes, yield, zinc enriched pressmud compost, Azophos, Vermiwash and ZnSO_4

Introduction

Pearl millet is also called as bajra, a major coarse grain crop and poor man's staple food in dry tracts of the country. India is the largest producer of pearl millet, it occupies an area of 9.16 million hectares and production of 13.51 million tonnes with a productivity of 1.5 tonnes per hectare (USDA, 2023) [12]. Zinc is a structural constituent and regulatory co-factor in enzymes and proteins involved in many biochemical pathways (Behera and Chitdeshwari, 2021) [3]. Besides improving photosynthesis and regulation of auxin concentration, it also plays an important role in nitrogen metabolism and protein synthesis. Pressmud compost is a plentiful source of carbon for the soil besides being rich in N, P and K. The use of pressmud compost balances organic carbon content in the soil and thereby preserves optimum productivity and soil fertility (Avishek *et al.*, 2017) [1]. The use of azophos in soil adds nutrients through natural processes viz., nitrogen fixation, phosphorus solubilization and stimulating plant growth through synthesis of growth promoting substances. Vermiwash acts as a plant tonic and thus helps in reducing several plant pathogenic fungi. It increases the rate of photosynthesis in crops plants. Considering the above facts, present investigation was undertaken with the objective of to evaluate the effect of soil application of zinc enriched pressmud compost, azophos and foliar spray of ZnSO_4 and vermiwash on yield attributes and yield of pearl millet.

Materials and Methods

The field experiment was conducted in Farmer's Field at Isukkali Katteri Village, Kilpenathur Taluk in Tiruvannamalai District, Tamil Nadu, India. The pH, EC, organic carbon content of an

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initial soil were 8.10, 0.39 dSm⁻¹, 2.51 g kg⁻¹ and taxonomically as *Typic Ustropept*. The study included eight treatments were T₁- Absolute control, T₂- 100% RDF (N:P₂O₅:K₂O) (80:40:40 kg ha⁻¹), T₃-Zn – EPMC @ 10 t ha⁻¹, T₄- T₃+ Azophos @ 5 kg ha⁻¹, T₅-T₃+ ZnSO₄ @0.5% (F.S), T₆-T₃ + Azophos @ 5 kg ha⁻¹ + ZnSO₄ @0.5% (F.S), T₇- T₃+ ZnSO₄ @0.5% (F.S) + V.W @5% (F.S), T₈- T₃+ Azophos @ 5 kg ha⁻¹ + ZnSO₄ @ 0.5%(F.S) +V.W @5% (F.S). The RDF for pearl millet was 80:40:40 kg N: P₂O₅: K₂O ha⁻¹ applied to through Urea, SSP and MOP, respectively. Based on treatments, Zn – EPMC @ 10 t ha⁻¹, azophos@ 5 kg ha⁻¹ were applied one week before transplanting. As per the treatment schedule, ZnSO₄ @ 0.5% and vermiwash @5% were sprayed at 30 and 60 DAT during vegetative and reproductive stages, respectively. The effect of different treatments on various yield attributes viz., earhead length, earhead girth, earhead weight, 1000 grain weight and grain and stover yield were studied and recorded.

Results and Discussion

Yield attributes

Earhead length

The earhead length ranged from 14.35 to 32.45 cm due to different treatments (Table 1). The earhead length was significantly high in T₈ (32.45 cm) and was followed by T₇ (29.31 cm) and T₆ (28.82 cm). T₇ was on par with T₆. Application of 100% RDF (T₂) was registered the earhead length of 25.96 cm. The control (T₁) recorded lowest earhead length of 14.35 cm. The enhanced earhead length is attributed to the microbial stimulation effect of enriched pressmud compost, gradually providing essential nutrients throughout the growth period and sustained nutrient supply improved photosynthetic assimilation, fostering a better source-sink relationship (Gangadhar Nanda, 2015)^[4]. It might be also due to the effective utilization of vermiwash which improved availability and translocation of plant nutrients along with combined beneficial effects of earthworms and micro-organisms which led to enhanced earhead length (Manoj *et al.*, 2018)^[6].

Earhead girth

Application of Zn – EPMC @ 10 t ha⁻¹ + Azophos @ 5 kg ha⁻¹ + ZnSO₄ @ 0.5% +VW @ 5% (T₈) recorded significantly highest ear head girth of 8.56 cm followed by T₇- Zn – EPMC @ 10 t ha⁻¹ + ZnSO₄ @ 0.5% +VW @ 5% (7.67 cm) against control T₁(3.37 cm). It might be also due to foliar spray of zinc improved the yield attributes by improving the source and sink relation due to increased translocation of photosynthates towards reproductive system and ultimately, enhanced earhead girth. Similar results were reported by Singh *et al.* (2017)^[11].

Earhead weight

Among the treatments tried, application of Zn – EPMC @ 10 t ha⁻¹ + Azophos @ 5 kg ha⁻¹ + ZnSO₄ @ 0.5% +VW @ 5% (T₈) registered highest earhead weight of 51.98 g over control (20.35 g). The next highest earhead weight (47.88 g) noted in the treatment T₇. However, the lowest earhead weight of 20.35 g was noticed in T₁. The beneficial effect of yield attributes might also be owing to the supply of all the essential nutrients by Zn enriched pressmud compost that might have resulted in higher manufacture of food and its subsequent partitioning of photosynthates towards sink. These finding was similar to Seema *et al.* (2017)^[9].

1000 grain weight (g)

The maximum 1000 grain weight (9.04 g) was registered with T₈ - Zn – EPMC @ 10 t ha⁻¹ + Azophos @ 5 kg ha⁻¹ + ZnSO₄ @ 0.5% +VW @ 5% compared to control (T₁) (7.89 g). It might be due to enriched pressmud compost was good in increasing 1000-grain weight and cause higher moisture content. The presence of water softening agents in enriched pressmud compost facilitates rapid root expansion in moist soil conditions (Gangadhar Nanda, 2015)^[4]. Azophos provides non-limiting supplies of nutrients viz., N, P and K from the soil owing to their high content increased the test weight (Hasan *et al.*, 2013)^[5].

Yield

Grain yield (kg ha⁻¹)

Among the different treatments tried, highest grain yield of 3670 kg ha⁻¹ was found to be with T₈. The second-best grain yield (3279 kg ha⁻¹) found to be with T₇ followed by T₆ recorded 3112 kg ha⁻¹. The treatment T₇ was statistically on par with T₆. Application of 100% RDF (T₂) registered the grain yield of 2728 kg ha⁻¹. However, lowest grain yield (1379 kg ha⁻¹) was observed in control (T₁). An increase in grain yield could be assigned to the cumulative ameliorating effect of yield parameters. The addition of enriched pressmud compost increased the organic matter and nutrient availability and reduced the uptake of toxic ions results in improved growth and yield of crops (Azhar *et al.*, 2019)^[2]. Application of azophos increased photosynthetic activity which resulted in higher accumulation of photosynthates and translocation to sink due to better source which resulted in higher grain yield.

Stover yield (kg ha⁻¹)

Application of Zn – EPMC @ 10 t ha⁻¹ + Azophos @ 5 kg ha⁻¹ + ZnSO₄ @ 0.5% +VW @ 5% (T₈) recorded highest stover yield (7287 kg ha⁻¹) was followed by T₇ registered the stover yield of 6561 kg ha⁻¹, respectively. The treatments T₂, T₅ and T₄ recorded stover yield of 5590, 4874 and 4752 kg ha⁻¹, respectively. However, control recorded lowest stover yield (2925 kg ha⁻¹). The positive effect on yield might be due to the use of enriched pressmud compost and bio-fertilizers increased the availability of plant nutrients and balanced supply of nutrients through compost results in better growth and development of crop, increased fertile ear heads, number of grains ear head⁻¹ and test weight which led to increased stover yield. (Selvamurugan *et al.*, 2013)^[10]. It might be also due to the fact that phytohormones produced by the azophos (*Azospirillum* + PSB) stimulated root growth and induced changes in root morphology, which in turn affected the assimilation of nutrients. Vermiwash was rich source of macro and micronutrients, enzymes and growth regulator, which improved the stover yield because of increasing the dry matter production. (Naroila and Poonia, 2011)^[7].

Harvest Index

The harvest index was significantly higher in T₈ - Zn – EPMC @ 10 t ha⁻¹ + Azophos @ 5 kg ha⁻¹ + ZnSO₄ @ 0.5% +VW @ 5% (33.49). This was followed by T₇ and T₆ recorded harvest index of 33.32 and 32.99, respectively. However, lowest harvest index (32.03) was recorded in T₁. It might be also due to profound influence of foliar spray of zinc on growth attributes as increased metabolic process in plants which promoted meristematic activities and photosynthetic process, ultimately better growth resulted in higher yield and improving harvest index (Saraswathi *et al.*, 2019)^[8].

Table 1: Effect of zinc enriched pressmud compost, azophos, ZnSO₄ and vermiwash on yield attributes (Earhead length, girth, weight and 1000 grain weight) of pearl millet cv. CO7

T. No.	Treatment Details	Earhead length (cm)	Earhead girth (cm)	Earhead weight (g)	1000 grain weight (g)
T ₁	Absolute Control	14.35	3.37	20.35	7.89
T ₂	100% RDF (N:P ₂ O ₅ :K ₂ O) (80:40:40 kg ha ⁻¹)	25.96	6.70	41.88	8.63
T ₃	Zn – EPMC @ 10 t ha ⁻¹	17.24	4.57	27.90	8.02
T ₄	T ₃ + Azophos @ 5 kg ha ⁻¹	20.16	5.54	33.27	8.20
T ₅	T ₃ + ZnSO ₄ @0.5% (F.S)	22.75	5.91	36.76	8.42
T ₆	T ₄ + ZnSO ₄ @0.5% (F.S)	28.82	7.61	46.99	8.81
T ₇	T ₃ + ZnSO ₄ @0.5% (F.S) + VW @5%(F.S)	29.31	7.67	47.88	8.93
T ₈	T ₄ + ZnSO ₄ @0.5%(F.S) + VW@5%(F.S)	32.45	8.56	51.98	9.04
	S. Ed	1.20	0.34	2.09	0.08
	CD (P = 0.05)	2.62	0.76	4.56	0.19

Table 2: Effect of zinc enriched pressmud compost, azophos, ZnSO₄ and vermiwash on grain yield (kg ha⁻¹), stover yield (kg ha⁻¹) and harvest index of pearl millet cv. CO7

T. No.	Treatment Details	Yield		Harvest index
		Grain yield (kg ha ⁻¹)	Stover yield (kg ha ⁻¹)	
T ₁	Absolute Control	1379	2925	32.03
T ₂	100% RDF (N:P ₂ O ₅ :K ₂ O) (80:40:40 kg ha ⁻¹)	2728	5590	32.79
T ₃	Zn – EPMC @ 10 t ha ⁻¹	1799	3891	31.61
T ₄	T ₃ + Azophos @ 5 kg ha ⁻¹	2186	4752	31.50
T ₅	T ₃ + ZnSO ₄ @0.5% (F.S)	2343	4874	32.46
T ₆	T ₄ + ZnSO ₄ @0.5% (F.S)	3112	6320	32.99
T ₇	T ₃ + ZnSO ₄ @0.5% (F.S) + VW 5%(F.S)	3279	6561	33.32
T ₈	T ₄ + ZnSO ₄ @0.5%(F.S) + VW@5%(F.S)	3670	7287	33.49
	S.Ed	166	297	
	CD (P = 0.05)	362	649	

Conclusion

Based on the results obtained from the field experiment, it can be concluded that application of Zn – EPMC @ 10 t ha⁻¹ + Azophos @ 5 kg ha⁻¹ + ZnSO₄ @ 0.5% + VW @ 5% (T₈) registered significantly highest yield attributes and yield of pearl millet grown in clay loam soil. Adopting organic nutrients sources with zinc is an excellent approach for fostering more resilient and eco-friendly agricultural practice, in harmony with the objectives of sustainable development and food security.

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