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Effect of Vermicompost and Zinc Application on Growth and Yield Attribute of Maize Crop

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A B S T R A C T

A field experiment was conducted at Instructional Farm, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan during 2018 to Effect of vermicompost and zinc application on growth and yield attribute of maize crop. The experiment was laid out in a randomized block design, comprising vermicompost and zinc and their combination, *viz*., T_1 control, T_2 vermicompost (1.5 t ha^{-1}) + zinc (0 kg ha^{-1}), T_3 vermicompost (1.5 t ha^{-1}) + zinc (2.5 kg ha^{-1}), T_4 vermicompost (1.5 t ha^{-1}) + zinc (5.0 kg ha^{-1}), T_5 vermicompost (3.0 t ha^{-1}) + zinc (0 kg ha^{-1}), T_6 vermicompost (3.0 t ha^{-1}) + zinc (2.5 kg ha^{-1}), T_7 vermicompost (3.0 t ha^{-1}) + zinc (5.0 kg ha^{-1}), T_8 vermicompost (4.5 t ha^{-1}) + zinc (0 kg ha^{-1}), T_9 vermicompost (4.5 t ha^{-1}) + zinc (2.5 kg ha^{-1}), T_{10} vermicompost (4.5 t ha^{-1}) + zinc (5.0 kg ha^{-1}), treatments replicated three times. The increased growth parameter such as chlorophyll content, plant height (30, 60 and at harvest), Leaf area index (30, 45 and 60 DAS) with the application of vermicompost (4.5 t ha^{-1}) + zinc (5.0 kg ha^{-1}). The application of vermicompost (4.5 t ha^{-1}) + zinc (5.0 kg ha^{-1}) increased number of grain per cob (457.09), weight of grain per cob (95.04 g), seed index (33.65 g) seed yield (3896.33 kg ha^{-1}), Stover yield (5415.13 kg ha^{-1}) and biological yield (9311.46 kg ha^{-1}) as compared to control.

Introduction

Maize is an important cereals crop ranking 3rd after wheat and rice in respect of area and production. Maize (*Zea mays* L.) belongs to Gramineae family; it is considered as the native to Central America & Mexico. Maize is one of most important cereal crop in term of world agriculture economy both as food for man and feed for animal. It is a miracle crop as its grain yield potential (GYP) is twice as high as compared to other cereal crops (Tollenaar and Lee, 2002). There is no cereal on earth which has so immense potentiality and that is why it is also called "queen of cereals". Maize is grown in almost all the states of India. Maize grain contains about 10% protein, 4% oil, 70% carbohydrate 2.3% crude fiber, 10.4% aluminizes, 1.4% ash. Maize protein 'Zein' is rich in tryptophan and

lysine, the two essential amino acids. Being highly cross pollinated, maize has become highly polymorphic through the course of natural and domesticated evolution and thus contains enormous genetic variability. Maize may also have the capacity to tolerate salinity stress (Paterniani, 2009). Maize crop furnishes huge quantities of green fodder for cattle.

Vermicompost is a good substitute to commercial fertilizers and has more N, P and K content than the normal heap manure (Srivastava and Beohar, 2004). The application of vermicompost helps to improves and conserves the fertility of soil. Vermicompost imparts a dark colour of the soil and thereby help to maintain the temperature of soil. Vermicompost is one of the manure used by the farmer in growing crops because of early availability and presence of almost all the nutrients required by plants.

Zinc is an essential element for plant growth, crop yield and quality. When the supply of plant-available zinc is insufficient, crop yields are reduced and the quality of crop products is frequently impaired (Alloway *et al.,* 2003). Natural levels of zinc in the soil range from 10 to 300 mg kg^{-1} with an average of 50 mg kg^{-1} (Mulligan *et al.,* 2001). It is estimated that 30 per cent of the world's cultivated soils are deficient in zinc (Suzuki *et al.,* 2006) and Grain-yield reductions of upto 80 per cent along with reduced grain zinc level have been observed under zinc deficiency (Cakmak *et al.,* 1998)

Materials and Methods

A field experiment was conducted during *kharif* season of 2018 at Instructional Farm, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan. The soil was sandy clay loamy. The soil had pH value of 8.10, medium in available nitrogen (338.32 kg N ha^{-1}), medium in available phosphorus (28.32 kg P_2O_5 ha^{-1}) and high in potassium (352.68 kg K_2O ha^{-1}). The experiment was laid out in a randomized block design, comprising vermicompost and zinc and their combination, *viz*., T_1 control, T_2 vermicompost (1.5 t ha^{-1}) + zinc (0 kg ha^{-1}), T_3 vermicompost (1.5 t ha^{-1}) + zinc (2.5 kg ha^{-1}), T_4 vermicompost (1.5 t ha^{-1}) + zinc (5.0 kg ha^{-1}), T_5 vermicompost (3.0 t ha^{-1}) + zinc (0 kg ha^{-1}), T_6 vermicompost (3.0 t ha^{-1}) + zinc (2.5 kg ha^{-1}), T_7 vermicompost (3.0 t ha^{-1}) + zinc (5.0 kg ha^{-1}), T_8 vermicompost (4.5 t ha^{-1}) + zinc (0 kg ha^{-1}), T_9 vermicompost (4.5 t ha^{-1}) + zinc (2.5 kg ha^{-1}), T_{10} vermicompost (4.5 t ha^{-1}) + zinc (5.0 kg ha^{-1}), treatments replicated three times. Seed rate 25 kg ha^{-1} of maize variety 'PHEM-2' was used in this study. Whole amount of vermicompost as per treatment was broadcasted uniformly at the time of sowing and. The recommended dose of nitrogen (120 kg ha^{-1}) through urea, phosphorus (60 kg ha^{-1}) through DAP, potassium (40 kg ha^{-1}) through MOP and zinc through $ZnSO_4.7H_2O$ were applied as basal as per treatments.

Results and Discussion

Growth parameter

Application of vermicompost (4.5 t ha^{-1}) + zinc (5.0 kg ha^{-1}) significantly increased plant height at 30, 60 DAS and at harvest as compared to control. The application of vermicompost (4.5 t ha^{-1}) + zinc (5.0 kg ha^{-1}) significantly increased of leaf area index at 30, 45 and 60 DAS and Chlorophyll content at 45 DAS as compared to control. Vermicompost and farmyard manure are rich source of macro-and micro-nutrients and growth hormones, which not only supply essential nutrients to the soil but also improve the physico-chemical and biological properties of the soil (Sharma *et al.,* 2005; Rawat and Pareek, 2003). The improved physico-chemical properties and slow release of

nutrients over longer period with the uses of organic sources might be responsible for better growth of popcorn plants with FYM and vermicompost application. The improvement in plant height and LAI with the use of organic sources consequently enhanced the dry matter/plant. These results corroborate the findings of Jayaprakash *et al.,* (2004) and Kumar *et al.,* (2007). This may be due to the fact that in addition to the involvement of zinc in many enzymatic functions within plant it also play hole in the chlorophyll formation and acts as structural constituent of chloroplast and increased the chlorophyll content. The magnificent role of zinc in increasing the metabolic and physiological activity of the plants is of preponderant importance as it influenced the nitrogen metabolism, chlorophyll formation. The application of zinc up to 5.0 kg ha^{-1} significantly increased plant height and leaf area index at all the stages of observation compared to control the favorable effect of applied zinc on plant height and leaf area index may be due to its stimulatory effect on most of the physiological and metabolic processes of plants. Zinc is a constituent of carbonic anhydrase (an enzyme promotes carbon dioxide assimilation pathway in C_4 cycle of photosynthesis) and there is direct relationship between carbonic anhydrase and photosynthetic carbon dioxide assimilation on growth of plants. It is well known fact that zinc is involve in the protein synthesis, biosynthesis of Indole 3-acetic acid (a growth hormone, involved in cell division and cell elongation), hence increased plant height and leaf area index. It also performs many catalytic functions in the plant besides transformation of carbohydrates and chlorophyll synthesis. The significant response to zinc in terms of improvement in plant height is further supported by the fact that soil of the experimental field was low in zinc status and its early supply corrected the deficiency and considerably improved the crop growth. The finding of this investigation confirm the observation of earlier worker, Hossaini *et al.,* (2007), Meena *et al.,* (2013), Preetha *et al.,* (2014) Jangir *et al.,* (2015) and Gupta *et al.,* (2018).

Yield attribute

Application of vermicompost (4.5 t ha^{-1}) + zinc (5.0 kg ha^{-1}) significantly increased number of grain per cob (457.09), weight of grain per cob (95.04 g), seed index (33.65) seed yield (3896.33 kg ha^{-1}), stover yield (5415.13 kg ha^{-1}) and biological yield (9311.46 kg ha^{-1}). The application of vermicompost 4.5 t ha^{-1} with zinc up to 5 kg ha^{-1} significantly increased yield and yield attributes. The considerable improvement in grain yield owing to application of organic sources might be attributed to the fact that organic sources of nutrients had the positive effect on yield attributes and cumulative effect of yield attributes mainly responsible for higher productivity with the application of organic sources. The increase in grain and stover yield, weight of cob $plant^{-1}$, number of grains cob^{-1} and test weight of maize due to application of vermicompost might be attributed mainly to higher content of available nutrients in vermicompost, presence of beneficial micro flora such as nitrogen fixers, phosphate solubalizers, VAM fungi and higher activity of dehydrogenase enzyme in soil. The finding of this investigation close conformity with finding of Ramesh *et al., (*2008) and Meena *et al., (*2013).

The application of 5 kg zinc ha-1 significantly increased yield and its attributes *viz.*, number of cob-1, number of grain cob-1, seed index, weight of grain cob-1 compared to control. The increase in yield attributes might also be in biosynthesis of indole acetic acid and especially due to its role in initiation of reproductive parts and partitioning of photosynthates toward them, which resulted in better flowering and fruiting.

Table.1 Effect of vermicompost and zinc application on growth parameters of maize

Treatments	Plant height (cm)			Leaf Area Index			Chlorophyll content (mg g^{-1})
	30 DAS	60 DAS	At harvest	30 DAS	45 DAS	60 DAS	at 45 DAS
T_1 Control	71.14	171.21	203.11	0.98	1.29	2.76	1.56
T_2 VC (1.5 t)+ Zn (0 kg)	74.16	174.02	206.89	1.12	1.42	2.94	1.61
T_3 VC (1.5 t)+ Zn (2.5 kg)	76.19	175.68	210.77	1.18	1.47	3.05	1.66
T_4 VC (1.5 t)+ Zn (5.0 kg)	79.26	177.41	213.52	1.25	1.51	3.17	1.71
T_5 VC (3.0 t)+ Zn (0 kg)	80.58	178.98	216.13	1.31	1.58	3.30	1.76
T_6 VC (3.0 t)+ Zn (2.5 kg)	82.19	180.48	219.58	1.37	1.63	3.41	1.82
T_7 VC (3.0 t)+ Zn (5.0 kg)	85.03	182.37	222.66	1.43	1.69	3.53	1.87
T_8 VC (4.5 t)+ Zn (0 kg)	87.84	183.77	225.16	1.49	1.76	3.65	1.93
T_9 VC (4.5 t)+ Zn (2.5 kg)	91.38	185.94	227.92	1.57	1.79	3.77	2.01
T_{10} VC (4.5 t)+ Zn (5.0 kg)	93.72	188.68	230.36	1.64	1.84	3.91	2.08
SE.m ±	0.44	0.47	0.74	0.02	0.01	0.03	0.01
CD (P=0.05)	1.30	1.39	2.20	0.05	0.02	0.10	0.04

Table.2 Effect of vermicompost and zinc application on yield attributes of maize

Treatment	No. of seeds per cob	Weight of grain cob^{-1}	Seed index (g)	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Biological yield (kg ha^{-1})
T_1 Control	308.12	77.46	19.09	2110.00	3270.00	5380.00
T_2 VC (1.5 t)+ Zn (0 kg)	346.88	81.47	20.73	2628.00	4016.00	6644.00
T_3 VC (1.5 t)+ Zn (2.5 kg)	352.16	82.95	21.86	2764.00	4168.00	6932.00
T_4 VC (1.5 t)+ Zn (5.0 kg)	365.22	84.47	23.55	2882.00	4294.00	7176.00
T_5 VC (3.0 t)+ Zn (0 kg)	389.12	86.68	24.95	3066.00	4511.00	7577.00
T_6 VC (3.0 t)+ Zn (2.5 kg)	395.31	88.11	26.56	3246.33	4716.00	7962.33
T_7 VC (3.0 t)+ Zn (5.0 kg)	405.03	89.97	28.43	3372.00	4839.00	8211.00
T_8 VC (4.5 t)+ Zn (0 kg)	440.13	91.64	29.62	3494.00	4912.00	8406.00
T_9 VC (4.5 t)+ Zn (2.5 kg)	450.44	93.13	31.64	3645.33	5148.00	8793.33
T_{10} VC (4.5 t)+ Zn (5.0 kg)	457.09	95.04	33.65	3896.33	5415.13	9311.46
SE.m ±	1.25	0.44	0.36	31.93	22.28	31.00
CD (P=0.05)	3.72	1.32	1.08	94.87	66.20	92.11

Under such situation an increase in yield attributes and yield is quite natural. The crop efficiency estimated in terms of harvest index significantly increase with the application of zinc. The positive response of yield components of maize because of due to greater availability of zinc and metabolites for growth and development of reproductive structure which ultimately led to recognition of higher productivity of individual plant. The increased availability of zinc and photosynthates might have enhanced yield and yield attributes. The finding of present investigation are supported by Meena *et al.*, (2013), Kumar *et al.*, (2014), Singh *et al.*, (2017) and Gupta *et al.*, (2018).

On the basis of experimental finding, it can be concluded that, higher growth and yield of the *kharif* maize crop (var. PHEM-2) can be obtained with the combined application of vermicompost (4.5 t ha^{-1}) + zinc (5.0 kg ha^{-1}) under sandy clay loam soil of sub humid region of Rajasthan.

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