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Effect of vermicompost based zinc application on growth and yield of fodder maize (Pratap Makka Chari-6)

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Abstract
India supports 17 percent of global human and 11 percent of the livestock population with only 2.3 percent of the worlds land area. Maize means literally "that which sustains life," provides nutrients for human beings and animals and serves as a basic raw material as an ingredient to more than 3000 industrial products A field experiment was conducted at Plantica, IARD, Dehradun to study the effect of vermicompost based zinc application on growth, and yield of fodder maize. The experiment was laid out in Randomized Block Design (RBD) with 3 replications. Total 17 treatments were done. The results show that exogenous application of vermicompost recorded maximum plant height and number of leaf per plant. All over the results shows most effective treatment for increasing quality characters and yield is vermicompost and zinc combination i.e., Vermicompost 30 T/ha + Zinc 30 kg/ha.

Keywords: Vermicompost, growth, yield, maize, RBD

Introduction

Maize in India, contributes nearly 8.0 percent to the national food basket and more than Rs.100 billion to the agricultural GDP at current prices apart from providing employment to over 100 million man days at the farm and downstream agricultural and industrial sectors. Pingali and Pandey (2001) [11] reported that a major shift in global cereal demand is underway and by 2020, demand for maize in developing countries is expected to surpass the demand for both wheat and rice. This shift will be reflected in 50 percent increase in global maize demand from its 1995 level of 558 million tonnes to 837 million tones by 2020.

The major factor leading to this shifting trend is rise in income and the consequent growth in meat and poultry consumption. This has resulted in a rapid increase in the demand for maize as livestock feed In India, maize is grown in an area of 8.12 million hectares with a production and productivity of 19.77 million tonnes and 2.43 t ha^{-1} respectively. By 2020, the requirement of maize for various sectors will be around 100 million tonnes, of which the poultry sector demand alone will be around 31 million tonnes.

It is well known that maize is an exhaustive crop and responds well to applied fertilizers. Though the continuous use of fertilizers had significantly improved the crop productivity, heavy fertilizer application on the same plot every year in continuous maize system will drain the soil fertility rapidly and result in a plethora of problems *viz*., decline in crop productivity, deficiency of several micro nutrients, environmental pollution etc. Nutrients contained in organic manures are released more slowly and stored for a long time in the soil, ensuring a long residual effect (Sharma and Mittra, 1991) [12] and supporting better root development leading to higher crop yields (Mahajan, 2007) [6]. Safety of environment as well as public health are also important reasons for advocating increased use of organic materials (Hazra, 2007) [4].

Thus, it has been realized that application of chemical fertilizers in conjunction with organic manures and bio fertilizers will sustain and maintain the productivity of soil. Therefore, it is necessary to compare various organic as well as biological sources of nutrients with chemical fertilizers in order to find out the most effective combination.

Extensive studies carried out in India showed that there is much to be learnt from the traditional wisdom and Indigenous Technical Knowledge (ITK) of Indian farmers. Though it is believed to be region specific, it can be extrapolated to similar agro climatic conditions, because most of the indigenous agricultural technologies have got scientific rationale (Sabarathnam, 1997) [5].

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. 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) [7]. It is estimated that 30 percent of the world's cultivated soils are deficient in zinc (Suzuki *et al*., 2006) [9] and Grain-yield reductions of upto 80 percent along with reduced grain zinc level have been observed under zinc deficiency.

However, a few research works has done on this aspect in this Region, in general and Uttarakhand, in particular and therefore, the present study was carried out to find out the response on growth and yield of fodder maize to Zn application with integrated use of Vermocompost.

Materials and Methods

Field experiments were carried out at Plantica, Indian Academy of Rural Development (IARD), Dehradun. The experiment was laid out in a randomized block design, comprising vermicompost and zinc and their combination treatments, *viz*., T_0 control, T_1 (NPK); T_2 vermicompost (10 t ha^{-1}), T_3 vermicompost (20 t ha^{-1}), T_4 vermicompost (30 t ha^{-1}), T_5 Zinc (10 kg ha^{-1}), T_6 zinc (20 kg ha^{-1}), T_7 zinc (30 kg ha^{-1}), T_8 vermicompost (10 t ha^{-1}) + zinc (10 kg ha^{-1}), T_9 vermicompost (10 t ha^{-1}) + zinc (20 kg ha^{-1}), T_{10} vermicompost (10 t ha^{-1}) + zinc (30 kg ha^{-1}), T_{11} vermicompost (10 t ha^{-1}) + zinc (30 kg ha^{-1}), T_{12} vermicompost (20 t ha^{-1}) + zinc (10 kg ha^{-1}), T_{13} vermicompost (20 t ha^{-1}) + zinc (20 kg ha^{-1}), T_{14} vermicompost (20 t ha^{-1}) + zinc (30 kg ha^{-1}), T_{15} vermicompost (30 t ha^{-1}) + zinc (10 kg ha^{-1}), T_{16} vermicompost (30 t ha^{-1}) + zinc (20 kg ha^{-1}), T_{17} vermicompost (30 t ha^{-1}) + zinc (30 kg ha^{-1}), with three replication.

Seed rate 40 kg ha^{-1} of maize variety "Pratap Makka Chari-6" was used in this study. Whole amount of vermicompost as per treatment was uniformly distributed at the time of sowing. 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 ZnSO4.7H2O were applied as basal as per treatments. The sowing was taken by dibbling method with seed rate 40 kg per hectare with the spacing of 40 x 25 cm. Seed was placed at depth of 3 to 4 cm covered with soil.

Results

Effect of zinc on growth

Plant height (cm)

The data pertaining to plant height at different stage of crop growth as affected by different treatments are presented in Table 1. It is apparent from the data that different zinc doses affected significantly plant height at different growth stages during both the years. The plant height increased in early at successive growth stages and attained maximum height at harvest, irrespective of zinc application. A perusal of data also revealed that different zinc levels exhibited a significant effect on maize plant height at all the growth stages. The increased zinc levels progressively increased the plant height, the 15 kg zinc sulphate per ha produced significantly taller plant as compared to 30 kg zinc sulphate per ha and foliar application of 5 kg zinc + Vermicompost in both the years in all growth stages.

Table 1: Effect of zinc levels on plant height at various growth stages

	Plant height	
	30 days	**60 days**
T_0	8.53±0.50	23.77±0.70
T_1	12.47±0.55	32.83±0.45
T_2	13.10±0.85	33.07±0.35
T_3	13.77±0.35	33.83±0.47
T_4	12.97±1.40	37.03±0.51
T_5	11.43±0.91	31.67±0.55
T_6	10.70±0.61	32.17±0.76
T_7	11.30±0.60	31.50±0.53
T_8	12.47±1.06	31.17±085
T_9	18.73±0.35	45.50±0.44
T_{10}	16.63±0.23	41.93±0.74
T_{11}	17.43±0.25	43.37±0.31
T_{12}	15.57±0.31	40.80±0.87
T_{13}	16.13±0.65	42.83±0.57
T_{14}	16.67±0.71	40.30±0.46
T_{15}	12.67±0.55	45.07±0.61
T_{16}	15.83±0.76	39.37±0.84
T_{17}	17.73±0.64	46.23±1.52
SE(M)	±0.63	±0.64
CD(P=0.05)	1.92	1.92
CV	4.90	1.86

Number of green leaves per plant

The data pertaining to number of green leaves per plant at different crop growth stages as affected by zinc levels have been summarized in Table 2. Different levels of zinc showed linearly significant variation in the number of green leaves per plant at all the stages of crop growth except at 30 DAS during both the years. Zinc level at 90 kg / ha exerted significant increase in number of green leaves per plant as compared to 60 kg and 30 kg in control plant during the experiment period.

Table 2: Effect of zinc levels on number of green leaves at various growth stages

Number of Green Leaves per Plant (30 & 60 days)		
	30 DAS	**60 DAS**
T_0	4.20±0.10	8.53±0.50
T_1	5.00±0.10	12.47±0.55
T_2	5.20±0.10	13.10±0.85
T_3	5.40±0.30	13.77±0.35
T_4	5.00±0.26	12.97±1.40
T_5	5.07±0.25	11.43±0.91
T_6	4.97±0.21	10.70±0.61
T_7	5.27±0.21	11.30±0.60
T_8	5.30±0.36	12.47±1.60
T_9	5.60±0.36	18.73±0.35
T_{10}	5.63±0.23	16.63±0.23
T_{11}	4.50±0.40	17.43±0.25
T_{12}	5.23±0.15	15.57±0.25
T_{13}	5.57±0.25	13.57±0.65
T_{14}	5.43±0.23	16.67±0.75
T_{15}	5.13±0.45	12.37±0.55
T_{16}	5.53±0.35	15.83±0.76
T_{17}	5.37±0.15	17.73±0.64
SE (M)	±0.25	±0.63
CD (P=0.05)	1.92	1.92
CV	5.19	4.90

A perusal data (Table 2) reveal that the application of zinc levels caused significantly change in number of green leaves per plant at all growth stages except 30 DAS during both the years. 30 kg Zinc sulphate per ha application produced the more number of green leaves. Interaction effect was found to be non-significant in respect of all growth stages.

Dry matter accumulation (g per plant)

The data regarding dry matter accumulation per plant (g) as influenced by different zinc level treatment have been presented in the Table 3. Zinc levels showed significant response on dry matter accumulation at all the growth stages during the study period. The dry matter production under 90 kg Zinc levels per ha was significantly higher as compared to 60 and control at all stages during the study period.

Table 3: Effect of zinc levels on dry matter accumulation at various growth stages

Dry matter production	30 days
T_0	16.57±0.91
T_1	27.63±0.60
T_2	32.07±0.35
T_3	22.03±0.55
T_4	32.17±0.50
T_5	42.33±0.57
T_6	33.37±1.76
T_7	22.00±0.70
T_8	41.13±0.50
T_9	32.33±0.96
T_{10}	33.30±0.44
T_{11}	25.37±0.72
T_{12}	29.07±0.72
T_{13}	34.23±0.64
T_{14}	35.27±0.71
T_{15}	38.77±0.02
T_{16}	41.17±0.95
T_{17}	41.13±0.87
SE(M)	±0.72
CD(P=0.05)	1.92
CV	2.39

The highest dry matter production (176.26) obtained with 30 kg Zn at harvest during the first year from other treatments of all crop growth stage during both the years and lowest dry matter accumulation at 30 DAS during both the years from control. The interaction on dry matter production of P x Zn were found to be non-significant at all crops growth stages.

Grain yield

The data of grain yield (q per ha) as influenced by zinc levels have been presented in table below.

Table 4: Zinc application also increased the yield upto highest level

Yield	
T_0	200.60±0.53
T_1	261.90±0.85
T_2	264.57±0.51
T_3	241.90±0.85
T_4	282.80±0.26
T_5	228.60±0.53
T_6	234.83±0.76
T_7	230.50±0.50
T_8	318.50±0.50
T_9	344.17±1.26
T_{10}	316.37±0.55
T_{11}	310.13±0.32
T_{12}	315.07±0.60
T_{13}	313.73±0.81
T_{14}	277.13±0.15
T_{15}	280.37±0.40
T_{16}	315.37±0.35
T_{17}	354.87±0.81
SE	±0.59
CD(P=0.05)	1.92
CV	3.62

Discussion

Plant height increased significantly with increase in the dose of vermicompost upto 10, 20, 30 T/ha and Zinc kg/ha which was 10, 20 and 30 kg/ha + NPK at all the growth stages but significant over control.. At harvest the maximum plant height were recorded with 30 kg Zn ha^{-1} i.e. 22%, 26% more over control during 2004-05 and 2005-06 respectively This may be due to the fact that Zinc resulted in increase in IAA vis-a-vis cell division and cell elongation. Wang *et al*. (1999) [10] and Arya and Singh (2001) [2] have also reported an increase in plant height with zinc application. Number of green leaves and Leaf area index increased significantly with increase in the dose of zinc sulphate upto 30 kg Zn ha^{-1} at all the growth stages. Application of 30 kg $ZnS0_4$ ha^{-1} recorded LAI of 4.38 and 4.45 which were 32.18 and 29.9% higher over control during 2004-05 and 2005-06, respectively. The results may be attributed to involvement of zinc in cell division and enlargement which resulted in better growth of stem and leaves. Wang *et al*. (1999) and Arya and Singh (2001) [2] have also reported increase in leaf area with increase in zinc application. Dry matter accumulation was increased with increase in the dose of zinc upto 30 kg Zn ha^{-1}. Application of this treatment produced 178.26 and 176.41 g dry matter plant'1 respectively for first and second year. Dry matter which showed an increase of 21% and 19.7% higher than control at harvest stages of 2004-05 and 2005-06, respectively. This was mainly due to an increase in growth and development characters *viz*., plant height, leaf area index which resulted in increase in dry matter accumulation. Arya and Singh (2001) [2] have also reported increase in dry matter accumulation with zinc application. Application of zinc sulphate did not influence the phenological stages *viz*., 50% silking and maturity being a genetical behaviour of the crop. Non-significant differences in final plant population were observed due to $ZnS0_4$ application in both the years.

Conclusion

The Maximum plant height was observed in treatment T_{17} (VC-30 T/ha+ Zinc 30 kg/ha) and then in T_{13} (VC-20 T/ha+Zinc 20kg/ha). Higer stem girth was observed in treatment T_9 (VC-10 T/hac+Zn-20 Kg/ha) and T_{12} (VC-20 T/hac+Zn-20 Kg/ha) and then in T_{15} (VC-30 T/hac+Zn-10 Kg/ha).Number of leaves higher in treatment T_9 (VC-10 T/hac+Zn-20 Kg/ha) And then in T_{17} (VC-30 T/hac+Zn 30 Kg/ha). Highest dry matter accumulation was recorded in treatment T_5 (Zn-10 kg/hac) and then in T_{16} (VC-30 T/hac+Zn-20 Kg/ha). Application of 30 kg ZnSC> 4 ha^{-1} resulted significant increase in plant height, green leaves, dry matter accumulation and LAI at all the growth stage during both the years

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