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Response of Inorganic Fertilizers and Vermicompost on Growth and Yield of Maize (*Zea mays* L.) Inoculated with *Azotobacter*, *var.* DHM-1

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The field experiment was carried out at central research farm of Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during Kharif season year 2022-2023. The experiment was comprised of 9 treatments with 3 level of NPK and Vermicompost in randomized block design. The treatment T_9 has shown the significant results when applied 100% of NPK with Vermicompost among the different levels of treatment

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combination. Growth parameters *viz.,* plant height (171.10 cm), number of leaves plant^{-1} (14.65) at 90 DAS (day after sowing), and yield parameters *viz.,* length of cob (24.73 cm), number of grains cob^{-1} (308), test weight (218.46 g), grain yield (46 q ha^{-1}) has shown best in treatment T_9 (NPK @ 100% + Vermicompost @ 100%) of maize (*Zea Mays* L.) in comparison to other treatment combination.

Keywords: Maize; NPK; vermicompost; azotobacter; growth parameters and yield attributes.

1. INTRODUCTION

Maize (*Zea mays L*.) is one of the most versatile emerging crops having wide adaptability under varied agro-climatic conditions. It is cultivated on nearly 197 m ha with production of 1148 m T and productivity of 5823.8 kg ha^{-1} all over the world having wider diversity of soil, climate, biodiversity and management practices, contributing 37% in the global grain production. In world, some major growing countries USA (13601 m T), China (8841 m T), Brazil (3208 m T), Mexico (925 m T) and India (827 m T) etc. "In are India maize ranks 5th in total area and 6th in production and productivity. In India area under maize crop is 72.7 million hectares with production of 1586 million tones and productivity is 2181 kg ha^{-1}. The predominant maize growing states that contributes more than 80% of the total maize production are Andhra Pradesh (20.9%), Karnataka (16.5%), Rajasthan (9.9%), Maharashtra (9.1%), Bihar (8.9%), Uttar Pradesh (6.1%), Madhya Pradesh (5.7%), and Himachal Pradesh (4.4%)" (Anonymous, 2016).

"Nitrogen is a most important element for the synthesis of protoplasm, which is responsible for rapid cell division, (Plant, shape, and size). It increased the production of grain yield in maize as well as it is important for the quality of produce like increases protein in grains. It increases utilization of P and K to an appreciable extent" (Kumar et al., 2018).

"Phosphorus has a great role in energy storage and transfer and closely related to cell division and development of maize" [1,2]. Phosphorus is a constituent of nucleic acid, phytin and phospho-lipid. Phosphorus compound act as "energy currency" within plants. Phosphorus is essential for transformation of energy, in carbohydrate metabolism, in fat metabolism, in respiration of plant and early maturity of maize" Marngar and Dawson [3,4].

"Vermicompost has large particulate surface area that provides many micro- sites for the microbial activity and strong retention of nutrients. Vermicompost contains significant quantities of nutrients; a large beneficial microbial population and biologically active metabolites; particularly gibberellins, cytokinin, auxins and group B vitamins which can be applied alone or in combination with organic or inorganic fertilizers, to get better yield and quality of diverse crops", [5,6,7].

2. MATERIALS AND METHODS

The experiment was conducted at the research farm of department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute (NAI), SHUATS. It is situated at 25^{0}57'69" N latitude, 81^{0}59'74''E longitude and at the altitude of 98 meter above the sea level. The experiment was conducted in 3x3 randomized block design with three level of NPK and three levels of Vermicompost. The treatments were replicated three times were allocated at random in each replication and details treatment combinations were listed in Table 1.

Table 1. Treatment combination

Treatment	Treatment combination
T_1	[Control]
T_2	[@ 0 % NPK + @ 50 % Vermicompost]
T_3	[@ 0 % NPK + @ 100 % Vermicompost]
T_4	[@ 50 % NPK + @ 0 % Vermicompost]
T_5	[@ 50 % NPK + @ 50 % Vermicompost]
T_6	[@ 50 % NPK + @ 100 % Vermicompost]
T_7	[@ 100 % NPK + @ 0 % Vermicompost]
T_8	[@ 100 % NPK + @ 50 % Vermicompost]
T_9	[@ 100 % NPK + @ 100 % Vermicompost]

(Note: Seed treatment with Azotobacter)

Table 2. Response of Inorganic and Vermicompost on growth parameters

Treatment combination	Plant height (cm)			Number of leaves plant^{-1}		
	30 DAS	**60 DAS**	**90 DAS**	**30 DAS**	**60 DAS**	**90 DAS**
T_1 (Control)	40.62	108.34	110.32	2.82	5.46	6.84
T_2 (@ 0%NPK + (@50% VC)	55.74	122.45	136.96	3.58	6.04	7.65
T_3 (@ 0% NPK + @ 100 % VC)	55.65	123.10	132.81	4.4 7	6.56	7.58
T_4 (@ 50% NPK + @ 0% VC)	50.23	125.36	134.43	4.56	7.91	8.96
T_5 (@ 50 % NPK + @ 50 % VC)	56.76	126.21	136.43	4.44	8.90	9.60
T_6 (@ 50 % NPK + @ 100 % VC)	62.25	146.69	160.48	5.76	9.25	10.76
T_7 (@ 100 % NPK + @ 0 % VC)	49.31	152.43	165.65	6.85	9.67	11.25
T_8 (@ 100 % NPK + @ 50 % VC)	52.63	164.85	168.56	6.95	10.53	11.88
T_9 (@100 % NPK + @ 100 % VC)	66.54	167.63	171.10	7.10	12.93	14.65
F-Test	**S**	**S**	**S**	**S**	**S**	**S**
S. Em (±)	**0.96**	**2.18**	**2.33**	**0.06**	**0.13**	**0.19**
C.D. at 5%	**2.88**	**6.54**	**6.97**	**0.17**	**0.38**	**0.57**

Table 3. Response of Inorganic and Vermicompost on yield attributes

Treatment combination	**Length of cob^{-1} (cm)**	**Number of grains cob^{-1}**	**Test weight (g)**	**Grain yield (q ha^{-1})**
T_1 (Control)	18.26	218	192.42	30.54
T_2 (@ 0%NPK + (@50% VC)	19.74	266	194.67	32.78
T_3 (@ 0% NPK + @ 100 % VC)	19.74	238	195.45	35.27
T_4 (@ 50% NPK + @ 0% VC)	20.48	249	198.45	35.40
T_5 (@ 50 % NPK + @ 50 % VC)	20.69	267	202.56	36.50
T_6 (@ 50 % NPK + @ 100 % VC)	21.41	276	206.42	37.40
T_7 (@ 100 % NPK + @ 0 % VC)	22.18	290	211.34	38.90
T_8 (@ 100 % NPK + @ 50 % VC)	24.48	299	215.78	42.30
T_9 (@100 % NPK + @ 100 % VC)	24.73	308	218.46	46
F-Test	**S**	**S**	**S**	**S**
S. Em (±)	**0.36**	**4.39**	**3.47**	**1.381**
C.D. at 5%	**1.07**	**13.16**	**10.41**	**3.091**

3. RESULTS AND DISCUSSION

3.1 Response on Growth Parameters of Maize

The significant response of inorganic fertilizer and Vermicompost on growth parameters of maize. Inoculated with Azotobacter *viz*. Plant Height (cm), and Number of leaves plant^{-1} days after sowing details data were shown in Table 2 for each treatment combination. The interaction of NPK and Vermicompost found significant. The maximum Plant Height (cm), was (66.54,167.63, and 171.10 cm), Number of leaves plant^{-1} (7.10, 12.93 and 14.65), found in T9 (NPK @ 100% + Vermicompost @ 100%) were similar effect of Vermicompost on growth parameters was found in positive application of Vermicompost on growth parameters have also been reported by [8] and minimum (40.62,108.34 and 110.32 cm) and (2.82, 5.46 and 6.84) was recorded in T1 (NPK @ 100% + Vermicompost @ 100%) respectively. The interaction effect of these factors can lead to improved plant growth in cereal crops. The balanced application of NPK fertilizers can provide the necessary nutrients for plant growth, (Kumar et al., 2018).

3.2 Response on Yield Attributes of Maize

The significant response of inorganic fertilizer and Vermicompost on growth parameters of maize. Inoculated with Azotobacter *viz*. Length of cob (cm), No. of grains cob^{-1}, test weight (g) and grain yield (q ha^{-1}). The interaction of NPK and Vermicompost found significant. The maximum Length of cob (cm), No. of grains cob^{-1}, test weight (g) and grain yield (q ha^{-1}) were (24.73, 308, 218.46 and 46) found in T9 (NPK @ 100% + Vermicompost @ 100%) and minimum 18.26, 218, 192.42 and 30.54 was recorded in T1 (NPK @ 00% + Vermicompost @ 00%) respectively. The increasing the population of Vermicompost in the soil can lead to an increase in the length of cob (cm), number of grains. These results corroborate with the similar findings of Rao et al., [8] and Umesha et al., [9], Jinjala et al., [10].

The interaction Response of Inorganic and Vermicompost on the length of cob (cm), number of grains can be significant, as all these factors can influence the growth and development of the plant's root system. Similar results were reported by Malligawad et al. (2000) in groundnut, Rajkhowa et al. (2002 and 2003) in green gram and Pawar et al. (1995) in maize.

4. CONCLUSION

The results of experiment concluded as Response of Inorganic Fertilizers and Vermicompost was found positively significant on plant height (cm), number of leaves plant^{-1}, length of cob (cm), number of grains cob^{-1}, Test weight (g) and Grain yield (q ha^{-1}) was found significant. The effect application of this combination treatment T9 (NPK @ 100% + Vermicompost @ 100%) shown the significantly highest vegetative growth as well as yield attributes and benefits farmers to increase yield with better management.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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