Original Research Article

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

Comment [NSN1]: Corrected

ABSTRACT

Comment [NSN2]: Corrected

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. 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 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*.

Comment [NSN3]: Corrected

1. INTRODUCTION

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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 **(Singh *et al.*, 2003).**

Phosphorus has a great role in energy storage and transfer and closely related to cell division and development of maize. 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 (2017).**

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 **Gill *et al.*, (2018).**

2. MATERIALS AND METHODS

Comment [NSN5]: Corrected

Theexperimentwasconductedat the research farm of department of Soil Science and Agricultural Chemistry,NainiAgriculturalInstitute (NAI),SHUATS. It is situated at $25^{0}57^{'}69^{''}$ N latitude, $81^{0}59'74''$E longitude and at the altitude of 98meter above the sea level. The experiment was conducted in 3x3 randomized blockdesign with three level of NPK and three levels of Vermicompost. The treatments werereplicatedthreetimeswereallocatedatrandomineachreplicationanddetailstreatmentcombinations werelistedintable.1.

3. RESULTS AND DISCUSSION

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3.1 Response on growth parameters of Maize

Comment [NSN7]: Corrected

The significant response of inorganic fertilizer and Vermicompost on growthparameters of maize. Inoculated with Azotobacter*viz.* Plant Height (cm), and Number of leaves plant^{-1} daysaftersowingdetailsdatawereshownintable.2foreachtreatment combination. The interaction of NPK and Vermicompost foundsignificant.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 wasfoundin positive application of Vermicompost on growth parameters have alsobeen reported by **(Singh*etal.*,2014).**and minimum (40.62,108.34 and 110.32 cm) and (2.82, 5.46 and 6.84) was recordedinT1(NPK@ 100% + Vermicompost @ 100%)respectively.Theinteractioneffectofthesefactorscanleadtoimproved plant growth in cereal crops. The balanced application of NPK fertilizers can providethe necessary nutrients for plant growth,**(Singh*etal.*,2014)**.

3.2 Response on yield attributesof Maize

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The significant response of inorganic fertilizer and Vermicompost on growthparameters 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 foundsignificant.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%) andminimum18.26, 218, 192.42 and 30.54wasrecordedinT1(NPK @ 00% + Vermicompost @ 00%) respectively. The increasing

the population of Vermicompost in the soil can lead to anincrease in the length of cob (cm), number of grains. These results corroborate with thesimilar findingsof **Singh *et al.* (2014) and Umesha *et al.*, (2014). Jinjala *et al.*, (2016), Shah and Wani (2017).**

The interaction Response of Inorganic and Vermicompost on the length of cob (cm), number of grains canbesignificant,asallthesefactorscaninfluencethegrowthanddevelopmentof the plant's rootsystem. 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)**inmaize.

4. CONCLUSION

The results of experiment concluded as Response of Inorganic Fertilizers and Vermicompost was found positively significant onplant 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 effectapplication of this combination treatment T_9 (NPK @ 100% + Vermicompost @ 100%) shown the significantlyhighest vegetative growth as well as yield attributes and benefits farmers to increase yield withbettermanagement.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Kumar, (2014). Reported an experiment at Madurai, Tamil Nadu revealed that the highest grain yield of 4402 kg ha^{-1} was recorded in treatment of vermicompost @ 5 t ha^{-1} with 75 percent recommended dose of fertilizer (RDF) and it was found to be superior to over other treatments.

Umesha *et al.*, (2014)reported a field study at Tumkur, Banglore found that recommended dose of NPK + *Azotobacter chroococcum* + *Bacillus megaterium* + *Pseudomonas fluorescence* + enriched compost has showed the highest plant height at 30, 60, 90 days after sowing and at harvest (31.70, 180.93, 186.07 and 188.13 cm, respectively). The highest total dry matter production at harvest (375.80 g) and yield parameters like weight of cob (207.63 g), grain yield per plant (158.93 g), grain yield per ha (54.53 q) and test weight of seed (33.10 g) was also found highest in this treatment.

Jinjala *et al.*, (2016)reported a field experiment at Navsari Agricultural University, Navsari and

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revealed that the cob length (8.88 cm), cob girth (2.98 cm), cob weight with (38.79 g plant^{-1}) and without husk (7.74 g plant^{-1}) had significantly increased with the application of 100% RDN from chemical fertilizer with bio- fertilizers (*Azotobacter* and PSB) in baby corn.

Mali *et al.*, (2017) reported that application of various sources and levels of phosphorus (DAP, SSP and PRC incubated with and without PSB and Vermiculture) significantly increased grain, stover and biological yield of maize, which was recorded under treatment 25% RDP through PRC + Vermiculture + PSB + 75% RDP through DAP by 107.55, 82.56 and 91.96 per cent, respectively over control.

Marngar and Dawson (2017)reported a field trial at Allahabad revealed the highest number of cobs plant^{-1} (148.23 cm), plant height, dry weight (23.10 g plant^{-1}), grains cob^{-1} (323.33) and grain yield (7.90 t ha^{-1}) and stover yield (11.20 t ha^{-1}) in maize was recorded in the plots treated with 150 kg ha^{-1} N + 15 kg $ZnSO_4$ basal along with seed inoculation with *Azospirillum* 20g per kg seeds.

Shah and Wani (2017)reported a field trial at Kashmir valley, India observed that application of 100% RDF (NPK) + vermicompost @ 3 tonnes per hectare recorded maximum grains per cob, number of cobs per meter square, test weight, cob length and grain yield (3.26 t ha^{-1}) of maize.

Wailare and Kesarwani (2017) reported that effect of integrated nutrient management on growth & yield parameters of maize and soil physico-chemical properties. They observed that the yield parameters (number of grains per cob, cobs weight per plant, test weight and stover yield) were significantly higher under integrated nutrient management system compared to 100% chemical fertilizer. They concluded that the integrated combination of 50% RDF with either FYM or poultry manure or both at 5 t ha^{-1} resulted in maximum maize productivity as compared with sole use of 100% RDF.

Gill *et al.*, (2018)reported a field trial at Ajmer, Rajasthan, during rabi season on maize revealed that plant height (64.8, 128, and 224.3 cm) and dry matter accumulation (36.6, 119.5, 431.4 g plant^{-1}) at 30, 60, and 90 DAS were significantly increased with the application of nitrogen @ 60 kg ha^{-1} along with *Azotobacter* and nitrogen through vermicompost @ 30 kg ha^{-1} over Nitrogen @ 60 kg ha^{-1}.

Prajapati *et al.*, (2018) recorded the highest plant height (158.22 cm), number of leaves per plant (11.00), cob length (17.50 cm), leaf length per plant (48.50 cm), dry weight (163.46 g), grain yield

(42.77 q ha^{-1}) and test weight (209.03 g) of maize with treatment NPK 100% + vermicompost 100%. They also revealed that the application of NPK with vermicompost were excellent source for fertilization than sole application of fertilizers.

Reddy *et al.*, (2018)reported that combined application of 250 kg N and 60 kg P_2O_5 ha^1, produced significantly higher growth and yield parameters of maize *viz*., plant height, leaf area index, dry matter production, grain and stover yield of maize during *kharif* season.

Raman and Suganya (2018) conducted a field experiment found that growth and yield components of hybrid maize *viz*., plant height (241.57 cm), leaf area index (7.18), dry matter production, cob length (22.68 cm), cob diameter (4.76 cm), number of grains cob^{-1}, 100 grain weight, grain yield (6830.19 kg ha^{-1}), stover yield (9361 kg ha^{-1}) and harvest index were favorably influenced with 100% RDF + pressmud compost @ 5 t ha^{-1}. It was followed with 100% RDF + enriched farmyard manure @ 750 kg ha^{-1}. Their results evidently proved that 100% RDF + press mud compost @ 5 t ha^{-1} in hybrid maize is an effective integrated nutrient management practice for better maize yield & productivity and soil health.

Kumar *et al.*, (2020) reported that maximum increase in yield attributes were recorded with 100% RDF + 25% N through vermicompost + S + Zn + bio-fertilizers (*Azotobactor* + PSB) followed by 100% RDF + 25% N through FYM + S + Zn + biofertilizers (*Azotobactor* + PSB). The highest grain and straw yield were recorded with 100% RDF + 25% N through vermicompost + S + Zn + bio-fertilizer (*Azotobactor* + PSB) which was 104% and 108% higher in grain and 96.5% and 98.3% in straw as compared to control.

Rao *et al.*, (2020)reported that application of 75% RDF + 25% RDN (vermicompost) + BFC @15 kg ha^{-1} recorded the highest crop growth (plant height, number of leaves $plant^{-1}$ and leaf area index), yield attributes (number of cobs $plant^{-1}$, cob length, cob girth and cob weight), green cob (12.01 t ha^{-1}) and green fodder (16.52 t ha^{-1}) yield in maize. The combined application of 100% RDF (120-60-60 kg N, P_2O_5 and K_2O ha^{-1}) and biofertilizers (*Azotobactor* + *Azosporillum* + phosphobacter) @15 kg ha^{-1} registered the highest net returns (₹ 164206 ha^{-1}) and benefit cost ratio (1.92).

Sharma *et al.*, (2020)reported that fertility level of 150-180 kg nitrogen, 60- 90 kg P_2O_5, 60-90 kg K_2O, 5-10 kg Zn and 30-40 kg Sulphur ha^{-1} increased baby corn yield, fodder yield, nutrient content and monetary returns to the growers.

Table1.Treatment Combination

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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)

Table2.ResponseofInorganic and Vermicompostongrowthparameters

Comment [NSN15]: Corrected

Treatmentcombination	**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	4.47	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**

Table3.Responseof Inorganic and Vermicompostonyieldattributes

Comment [NSN16]: Corrected

Treatmentcombination	Lengthof 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**