EFFECT OF VERMICOMPOST AND TRIPLE SUPERPHOSPHATE ON YIELD OF CORN (*Zea mays L*) IN BEHBAHAN

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KEYWORDS

Corn

Vermicompost

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Growth parameters

Yield components

ABSTRACT

This study was conducted to investigate the effects of vermicompost and chemical fertilizers on corn yield. Study was carried out at Gomez village in Behbahan, Iran in cropping season of 2013. The experiment was design in factorial completely randomized block design with four replications. Two doses of vermicompost viz 5000 & 10000 kg ha⁻¹ and three level of triple superphosphate i.e. 50, 75 & 100 % were used as study factors. Effect of these factors were accessed on chlorophyll content, plant height, harvest index, rows number per cob, cob per plant, 1000 seed weight, grains number in rows and yield. Result of study revealed a positive correlation between the level of selected factors and various growth parameters; increasing in the applied quantity of vermicompost and phosphorus also increased the chlorophyll content, growth, yield and other yield components of the plant.

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1 Introduction

Wheat, rice and maize are the most important cereal crops throughout the world but maize is the most popular due to its high yielding, easy processing, readily digested and less costs than other cereals (Jaliya et al., 2008). It widely used as a major source of carbohydrate in human and livestock diet. Significatory effect of corn in textile and pharmaceutical industries was also well reported hence it is called 'queen of cereal'. In cereals, maize can grow throughout the year mainly due to photo thermo insensitive characteristics. Maize has immense potential in the tropics and its yield reached up to 7.5 t / ha if the crop is properly managed (Law-Ogbomo & Law-Ogbomo, 2009). But unfortunately still crop yields are below 5 t/ha (FAO, 2007) and it caused inadequacy of maize for its numerous usages. Yield differences between temperate and tropical areas have been attributed to low nutrient status especially these soils are deficient to nitrogen, phosphorus and potassium. Resulting of slash and burn farming system associated with bush fallow and excessive leaching of the soil nutrients (Law-Ogbomo & Law-Ogbomo, 2009) are presently unsustainable due to high population pressure and other human activities which have resulted in reduced fallow period (Steiner, 1991).

Various factors affected the productivity of winter maize; however, the fertilizer management is one of the most important factors that affect the growth and yield of maize (Anonymous, 1979). Low fertility status of tropical soils hindered maize production as maize has a strong exhausting effect on the soil. It was generally observed that maize fail to produce good grain without adequate nutrients (Adediran & Banjoko, 2003). Inorganic fertilizer exerts strong influence on plant growth, development and yield of maize crop (Predieri et al., 2004). Availability of sufficient nutrients leads to improve cell activities, cell multiplication and enlargement and luxuriant growth (Fashina et al, 2002). Luxuriant growth resulting from fertilizer application leads to larger dry matter production (Obi et al., 2005) owing better utilization of solar radiation and more nutrient (Saeed et al., 2001). Furthermore, substantial depletion of nutrients increased with the cultivation where no NPK fertilizer was applied Adediran & Banjoko (2003).

Vermicomposting technology involves the bio-conversion of organic waste into vermicasts and vermiwash utilizing earthworms (Jadia & Fulekar, 2008). These earthworms feed on the waste and their gut act as the bioreactor where the vermicasts are produced (Ansari & Sukhraj, 2010). These vermicasts are also termed vermicompost and are rich in nitrogen, phosphorous, potassium and micronutrients (Ansari & Sukhraj, 2010; Palanichamy et al., 2011). Effect of these vermicompost on plant growth is well reported but mostly it used as a main source of nitrogen.

Phosphorus is an essential nutrient as a part of several key plant structural components and worked as catalysis in the conversion of numerous key biochemical reactions in plants. Availability of phosphorus in tropic soils is very low and average 0.6% P was reported from these soil. Phosphorus (P) deficiency is a major constraint to agricultural production affecting an area of over 2 billion hectares worldwide (Fairhurst et al., 1999). Soil P is classified in two broad group's i.e. organic and inorganic, availability of inorganic P in acid Alfisols in the tropics can be limited by its adsorption onto Fe and Al oxides and by formation of Fe and Al phosphate complexes with humic acids (Gerke, 1992).

Phosphorus transformation in soils involves complex microbiological, chemical and biological process. Unlike C and N, phosphorus does not undergo oxidation-reduction reaction in soil but occupies a central position in organic matter decomposition (Zibilske et al., 2002). Plant roots acquire inorganic phosphorus from the soil solution. Immobilization of inorganic P by microbes and its gradual release via microbial turnover can protect P from physicochemical adsorption reactions if their release is synchronized with the demand of growing plants and or a subsequent generation of microorganisms (Magid et al., 1996). This study therefore focused on evaluating the effect of individual or combined application of vermicompost and phosphorus on the growth of corn over the time.

2 Materials and Methods

This study was conducted under field conditions in 2013 at Behbahan Khozestan, Iran. Behbahan is located in 160 km south east of Ahwz (50° 12' N, 30° 36' E, 320 m above the sea level). Average annual precipitation study site is 354.2 mm and average annual temperature is 24°C. The properties of soil at the test site are listed in Table 1.

The study was conducted in factorial completely randomized block design with four replications. The factors studied were Phosphorus (50,75 and 100 %) and Vermicompost (0, 5 and 10 t / ha) while the plots without phosphorus or vermicompost are treated control. Each treatment was replicated four times. Distance between plant to plant was 75 cm while the distance between rows plans in each row was 15 cm. Seeds were planted in the month of May, 2013 and irrigated regularly. Thinning was conducted after emergence, when plants were at four leaves stage.

3 Results and Discussion

3.1 Effect of fertilization on chlorophyll content

Analysis of variance showed that vermicompost and phosphorus had significant effect on chlorophyll content ($p < 0.05$).

Table 1 Physio-chemical characteristics of the study area soil.

Organic carbon (%)	T.N.V	K (mg kg ⁻¹)	P (mg kg ⁻¹)	N (%)	Sand %	Silt%	Clay %	Texture	Ec (ds m ⁻¹)	Ph
19.14	17.5	350	20.09	2.07	41	29	36	loamy Clay	5.34	8.2

All the data were collected from the department of soil sciences, Behbahan Branch, Islamic Azad University, Behbahan, Iran

Table 2. Mean of squares for chlorophyll content, plant height and yield components in corn.

Source of variance	df	harvest index	T. Chl	Plant height (cm)	Rows number per cob	Cob per plant	1000 seed weight (gr)	Grains number in rows	Seed yield (kg)
Vermicompost (A)	2	803.6 *	.0159*	20043**	699.9*	7.01 *	10001 *	30988.3*	35883301**
Phosphorus (B)	3	792.6 *	.0131 *	2800.3 *	701.6 *	6.92 *	1889.3 ^{ns}	34888.2 *	790042*
A × B	6	5800.3 **	.0141 **	12888**	22881 **	38.82 **	14882.9**	139002.6 **	40843221**
Error	16	125.6	.0022	453.6	102.4	1.45	255.6	4899.2	1245880
Cv (%)		10.12	6.18	15.4	12.21	9.21	8.88	13.82	15.15

^{ns}, non Significant, *and**: Significant difference at 5% and 1% level respectively

Table 3 Effect of individual application of various level of vermicompost on Corn yield.

Treatment	Mean of Parameters							
Vermicompost (t/ ha)	harvest index	T. chl	Plant height (cm)	Rows number per cob	Cob per plant	1000 seed weight (gr)	Grains number in rows	Seed yield(kg)
0	33.9 ^b	1.44 ^c	169.1 ^c	15.5 ^b	1.18 ^b	207.3 ^c	19.6 ^b	4083.5 ^b
5	39.64 ^a	1.58 ^b	189.5 ^b	16.9 ^{ab}	1.46 ^a	241.1 ^b	28.6 ^a	7147.1 ^a
10	40.33 ^a	1.81 ^a	206.7 ^a	18.4 ^a	1.72 ^a	246.2 ^a	32.7 ^a	7924.5 ^a

Means that have at least one common letter didn't show significant difference in 5% level

Table 4 Effect of triple superphosphate on the growth characteristics and grain yield in the Corn plants.

Treatment	Mean of Parameters							
Phosphorus (%)	harvest index	T. chl	Plant height (cm)	Rows number per cob	Cob per plant	1000 seed weight (g)	Grains number in rows	Seed yield (kg)
0	33.72 ^b	1.43 ^b	177.2 ^b	15.5 ^b	1.31 ^b	214.1 ^b	23.03 ^b	4939.9 ^b
50	39.15 ^a	1.68 ^a	190.2 ^a	16.9 ^{ab}	1.51 ^a	243.6 ^a	28.13 ^a	6967.8 ^a
75	39.72 ^a	1.67 ^a	191.9 ^a	17.5 ^a	1.48 ^a	249.3 ^a	27.4 ^a	6721.9 ^a
100	39.19 ^a	1.67 ^a	194.4 ^a	17.9 ^a	1.51 ^a	243 ^a	29.4 ^a	6910.3 ^a

Means represent by different letters show significant difference at level 5%

Table-5 Effect of combined application of vermicompost and triple superphosphate on the various growth and yield parameters for the corn plants

Treatment		Mean of Parameters							
Vermicompost (t/ ha)	Phosphorus (%)	harvest index	T. chl	plant height (cm)	Rows number per cob	Cob per plant	1000 seed weight (g)	Grains number in rows	Seed yield (kg)
0	0	26.3 ^c	1.36 ^c	162.8 ^c	13.6 ^c	1.01 ^d	179.3 ^a	14.7 ^e	2590.8 ^h
	50	36.24 ^b	1.45 ^b	168.3 ^c	14.8 ^c	1.14 ^{cd}	214.6 ^d	18.7 ^d	4382.3 ^g
	75	36.38 ^b	1.48 ^b	171.4 ^{bc}	16.3 ^{bc}	1.26 ^{cd}	219.7 ^d	20.6 ^{cd}	4432.9 ^{eg}
	100	36.53 ^b	1.49 ^b	173.9 ^{bc}	17.4 ^b	1.33 ^c	215.6 ^d	24.3 ^c	4927.9 ^e
5	0	36.43 ^b	1.41 ^b	179.8 ^{bc}	15.9 ^{bc}	1.41 ^{bc}	226.7 ^d	24.7 ^c	5681.7 ^d
	50	40.53 ^a	1.64 ^b	187.6 ^b	16.6 ^{bc}	1.44 ^{bc}	246.9 ^c	28.9 ^b	7573.9 ^c
	75	41.37 ^a	1.62 ^b	193.8 ^b	17.7 ^b	1.48 ^{bc}	248.8 ^c	29.6 ^b	7689.3 ^c
	100	40.24 ^a	1.65 ^b	196.9 ^b	17.6 ^b	1.52 ^b	241.7 ^c	31.4 ^b	7643.5 ^c
10	0	38.42 ^b	1.53 ^{bc}	189.1 ^b	16.9 ^{bc}	1.51 ^b	236.2 ^c	29.7 ^b	6547.3 ^d
	50	40.69 ^a	1.93 ^a	214.7 ^a	19.4 ^a	1.96 ^a	269.4 ^b	36.8 ^a	8947.7 ^a
	75	41.4 ^a	1.91 ^a	210.7 ^a	18.6 ^a	1.71 ^b	279.6 ^a	31.9 ^b	8043.7 ^b
	100	40.82 ^a	1.87 ^a	212.6 ^a	18.8 ^a	1.69 ^b	271.7 ^b	32.6 ^b	8159.6 ^b

Means that have at least one common letter didn't show significant difference in 1% level

Increasing the vermicompost and phosphorus quantity applied increased the chlorophyll content of the corn plant but in case of phosphorus such improvement was not reported and all the selected percentage of the phosphorus are at par to each other and not showing any significant differences (Table 3 and 4). Mean comparison of the effect of these two factors interaction showed that chlorophyll content was the highest (1.93mg/g) in 10t/ ha vermicompost + 50% phosphorus combination while it was the lowest in control without fertilization (Table 5).

3.2 Fertilization and plant height

Height of corn plant was also significantly affected by the application of vermicompost and phosphorus (Table 2). Mean comparison indicated that the plant height increased from 169.1 cm (control plants) to 206.7 cm in 10 t/ ha by the application vermicompost (Table 3). Individual application of phosphorus is not showing significant difference at various selected level but it is significantly differ than the control. Results of the mean comparison of the effect of the two factors interaction (Table 5) showed similarity with the chlorophyll content and highest plant height (214.7 cm) was reported from the treatment containing combination of 10 (t/ ha) vermicompost × 50% phosphorus (Table 5).

3.3 Impact of fertilization on harvest index and rows number per cob

Analysis of variance showed that vermicompost, phosphorus and two factors interaction significantly affected the harvest index and row number per cob (Table 2). Increasing the level of vermicompost and phosphorus either individually or in combination also increased the harvesting index and row number per cob in the maize plant (Table 3, 4 & 5).

3.4 Cob per plant

A significant difference was reported in the number of cob per plant on the application of vermicompost and phosphorus ($p < 0.05$). Mean comparison indicated that the cob per plant increased from 1.18 (control) to 1.72 in 10 t/ ha vermicompost treatment (Table 3). Increasing in the applied phosphorus quantity also increased the rows number per cob (Table 4). Mean comparison of the effect of the two factors interaction showed that cob per plant was the highest in 10 t/ ha vermicompost + 50% phosphorus (1.96 cm) and was the lowest (1.01) in control plants (Table 5).

3.5 Effect of fertilization on seed weight

Analysis of variance showed that vermicompost, phosphorus and two factors interaction significantly affected the weight of 1000 seed (Table 2). Results presented in table. 3 shows that 1000 seed weight in corn increased with the increase in phosphorus levels. Mean comparison of the effect of the two factors interaction showed that 1000 seed weight was the highest in 10 t/ ha vermicompost × 75% phosphorus (279.6 g) combination and the lowest (179.3 g) seed weight (for 1000 seeds) was reported in control plants without fertilization (Table 5).

3.6 Number of seeds in a rows and seed yield

Number of grain per row and final yield was also influenced by the application of fertilizers, results presented in table 3 shows that grains number in rows increased with the increase in phosphorus levels. Mean comparison of the effect of the two factors interaction showed that grains number in rows was highest (36.8 seed/row) in treatment containing combination

of 10 t/ha vermicompost + 50% phosphorus (Table 5). Similar types of results were reported for the final seed yield and analysis of variance showed that vermicompost, phosphorus and two factors interaction significantly affected the seed yield (Table 2). Increasing the quantity of phosphorus application also increased the seed yield in corn (Table 4).

Increasing the vermicompost quantity also promoted plant growth as well as growth of the cob webs by increasing the zinc and phosphorous like nutrients. Zinc enhances plant growth regulation whilst phosphorous promotes plant growth (Abbasi et al., 2009; Manyuchi et al., 2013a; Manyuchi et al., 2013b). Increasing the level of phosphorous content in the soils also promoted plant growth, high resistance and quality of seed. Furthermore, it was well documented that increasing the application time of both the vermicompost and vermishash also increased the soil copper, iron and phosphorous content (Manyuchi et al., 2013c; Nath & Singh 2012). This increase in soil nutrient content promoted plant growth and chlorophyll production; hence boost the overall *Zea mays* growth. In addition, microbial activities was also reported higher in the soil treated by vermicompost and this higher microbial activity also affected the production of plant growth regulators such as cytokinins as well as humic acid which promote plant growth (Gopal et al., 2010; Manyuchi et al., 2013d).

Conflict of interest

Authors would hereby like to declare that there is no conflict of interests that could possibly arise.

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