Research Article

Effects of Vermicompost, Vermi-tea and Chemical Fertilizer on Morpho-physiological Characteristics of Maize (*Zea mays* L.) in Suleymanpasa District, Tekirdag of Turkey

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Abstract | Nutrients deficiency is a major threat against maize growth. The effects of nutrients can be mitigated by vermicompost, vermi-tea and chemical fertilizers. With the objective to combat the nutrients deficiency, an experiment was conducted in Riverm Kompost Vermikompost Tarım Hay. Mak. San. ve Ltd. Şti. Suleymanpasa, Tekirdag, Turkey under field conditions. In field four different states of fertilizers [F_0: Control (No fertilizer application); F_{vc}: Solid vermicompost @ 5 ton/ha; F_{vt}: vermi-tea @ 6 %; F_c: Chemical fertilizers (N and P) @ 120-100 kg/ha were applied in maize hybrid P30B74. The plants were harvested 45 days after sowing and the evaluation was done on the basis of various morphological (root length, shoot length, root fresh weight, shoot fresh weight, root dry weight, shoot dry weight, number of leaf, leaf length, stem girth) and physiological parameters (relative water contents (RWC), chlorophyll contents and membrane stability index (MSI)). The obtained results indicated that vermi-fertilizers and chemical fertilizer significantly increased all of the above said parameters of maize as compared to control but foliar application of 6% vermi-tea treatment showed maximum morphological and physiological performance of maize.

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Keywords | Deficiency, Maize, Morphological, Nutrients, Physiological

1. Introduction

Maize (*Zea mays* L.) is belonged to Poaceae family and is broadly cultivated as an annual cereal crop in the world (Parthasarthi and Ranganathan, 2002). It has been considered a main staple crop and is recognized a third leading crop after wheat and rice (Parthasarthi and Ranganathan, 2002). Among yield producing of other cereal crops, maize has been noticed globally as a queen of cereals and USA is a larger producing state of maize production followed by other countries at contribution of 35% whole maize production in the world (Ali and Hussain, 2012). Maize is usually utilized for animal feeding purpose and is also processed into distinct types of products including grits, four, corn meal, tortillas, starch and snacks whereas maize is processed traditionally for "chapatti" baking purpose (Milind and Isha, 2013). Nutritionally, maize enriches with adequate amount of 72% starch, 10% protein, 4% fat and provides 365 Kcal/100 g of energy density than wheat and rice (Mehta and Dias, 1999).

Vermicompost is well-broken peat-like organic material with better water retaining capacity, high porosity, soil conservation tendency and well microbial activity, is produced by microorganisms and earthworms interactions through degradation,

stabilization and mineralization of distinct organic substances under mesophilic condition at 25°C.

Vermicompost produces completely stabilized soil modification with less C: N ratios. It provides (N, P, K, Ca and Mg) nutrients in already available form to plant rhizosphere after mineralization in the soil and has high particulate surface area that maintains space for microbial activities i.e. (fungi bacteria and actiniomycetes), nutrients regulation in soil and amending the growth related trait and yield parameters (Nuss and Tanumihardjo, 2010; Chen and Aviad, 1990; Canellas et al., 2002; Sinclair and Vadez, 2002). In current research investigation, various studies have conducted that application of vermicompost has significant effect on improvement of growth and yield of various crops for instance, sorghum, maize and rice (Ansari and Sukhraj, 2010; Meghvansi et al., 2012; Zularisam et al., 2010; Sampedro and Domínguez, 2010). Application of vermicompost enhances the ripening stage of crop of 7-14 days with bettering the qualitative parameters of grown plants (Bansal and Kapoor, 2000). Humic acids contained in vermicompost importantly increased root enlargement and development of lateral roots in maize. Vermicompost also increase the uptake of nutrients by the plant through enhancing the cell membrane permeability of root cell, enhancing proliferation of root hairs and stimulation of root growth (Domínguez and Edwards, 2011).

Vermitea is a lateral product of vermicomposting process which contains nitrogen, phosphorous and many micronutrients, hormones; etc. Also it contains earthworm enzyme and promote plant growth and yield and increase resistance of plant to disease and pests. It also contains dissolved nutrient, some organic acids and earthworm mucus (Singh et al., 2011). Vermicompost tea has influential effect on improving plant vigor, nutritive quality and yield of crop (Tara, 2003; Chen, 2006). Moreover, vermicompost application promoted the tap root length and enhanced growth okra crop (Siddiqui et al., 2008; Keeling et al., 2003).

Keeping in view the above literature the trial had following objectives. (i). To compare the effects of natural and synthetic fertilizers on the morphology and physiology of maize crop.

2. Materials and Methods

The present experiment was designed in Riverm Kompost Vermikompost Tarım Hay. Mak. San. ve Ltd. Şti. Suleymanpasa, Tekirdag, Turkey under field conditions. Four different fertilizers; Solid vermicompost @ 5 ton / ha, vermi-tea @ 6%, Chemical fertilizers (NP) @ 120-100 kg / ha were used in hybrid maize hybrid (P30B74) crop. Randomized Complete Block Design (RCBD) were used. Solid vermicompost was prepared from cow dung. Vermi-tea was prepared by extraction of vermicompost by dissolving 500g of solid vermicompost in 2.0 L of distilled water and kept for two days. Later on, vermi-tea was extracted by using sieve cloth and vermi-tea was applied by foliar application. Chemical fertilizer (NP) @ 120-100 kg / ha was used. Data for following parameters were noted.

Germination %age was calculated. Shoot length (cm) and root length (cm) was calculated by meter rod. Root and shoot fresh weights were measured by separating roots from shoot at base and their weights were calculated on digital weight balance. To measure the dry weight of shoot and root, they were placed in oven for 72 hours after sun drying. After removing roots and shoots from oven, placed them on weight balance to measure dry weight. Number of leaves and leaf length was counted. Stem girth was measured Vernier caliper. Membrane stability index (MSI) was measured as the method of (Premachandra et al., 1990; Sairam, 1994) with slide change. Leaf samples (0.1g) were added in double distilled water (10 ml) in two groups. One group was placed for 30 minutes at 40^{0}C and its conductivity (C_1) was recorded by conductivity meter. The other group was placed in water bath for fifteen minutes and its conductivity was calculated (C_2). Following formula was used to calculate MSI.

$$MSI = 1-(C_1/C_2)\ x100$$

Leaf chlorophyll contents was measured by SPAD and Relative water contents (RWC) was determined according to Sairam (1994). RWC was determined by removing maize shoot and measured fresh weight (FW). Leaves were put in distilled water to determine turgid weight (TW) for 24 hours under dim light. Leaves were weighed again after the imbibition for TW. Then these leaves were placed in oven at 70°C for 3 days to calculate dry weight (DW). RWC was determined by RWC (%) = [(fresh weight - dry weight)/ (turgid weight - dry weight)]*100.

2.1 Statistical analysis

The recorded data was statistically analyzed via Fisher's analysis of variance (ANOVA) technique. LSD test was used ($p \leq 0.05$) to compare significant treatments means using Statistic version 8.1(Analytical Software ©, 1985-2005) and according to (Steel et al., 1997).

3. Results and Discussion

3.1 Germination %age

Data presented in table (Table 1) it has been depicted that maximum seed germination (92.33%) was attained by application of solid vermicompost. Solid vermicompost has significant effect on viability and germination of seed as compared to other treatments. Chemical fertilizer provided average seed germination of maize germplasm and vermi-tea showed lowest seed germination out of all treatments. On contrary, the germination of maize crop was significantly reduced under control condition (No fertilizer application). Thus the findings of this research evidence the previous finding of (Canellas et al., 2002) which demonstrate that vermicompost has significant impact on seed germination and yield enhancement of various vegetable crops.

3.2 Shoot length (cm)

Data presented in table (Table 1) depicted that vermi-tea significantly affected shoot length. More shoot length observed by foliar application of vermin-tea (158.33) as compared to the remaining treatment but there was least length was observed even foliar application of solid vermi-compost (145.33) and chemical fertilizer (133.33). This result was similar with findings of (Tomati et al., 1988) that vermi tea exhibited growth promoting effects on length of shoot. In addition, vermi-tea was able to supply balanced nutrients to plant roots and stimulate growth; increase organic matter content of the compost including the 'humic substances' that affect nutrient accumulation and promote shoot growth (Siddiqui et al., 2008).

3.3. Root length (cm)

It was recorded (Table 1) that root of length of maize was significantly enhanced by application vermi-tea and this result closely resembled to the investigation of (Siddiqui et al., 2008), that vermicompost tea treatment provided essential nutrients to roots and stimulate the growth of plant additionally enhance humic substances that mainly impact on nutrient assimilation and encourage the development of root. Gandhi et al. (1997) also reported that effect of vermicompost tea application noticeably enhanced root initiation and root biomass. Respectively, Siddiqui et al. (2008) found similar effect of vermicompost tea on root enhancement on plant followed by research findings of Musa et al. (2018), that evaluated the effect of vermitea on physiological root growth on crop that encourage nutrients (N and P) uptake through rhizosphere of plant.

3.4 Root fresh weight (g)

Observed data (Table 1) showed that root fresh weight increased significantly with the application of solid vermicompost, vermi-tea and chemical fertilizer than control. Highest response to root fresh weight was observed with application of vermi-tea than solid vermicompost and chemical fertilizer and this is in accordance with the results of (Kmeťová and Kováčik, 2014). Application of vermicompost to the soil increased the microbial activities of soil and improving soil health that leads to enhancement of better root growth. Yield parameters of maize increased with the application of vermicompost (Chen and Aviad, 1990).

3.5 Shoot fresh weight (g)

The effect of vermicompost, vermi-tea and chemical fertilizers on shoot fresh weight of maize showed in current studies. More shoot fresh weight was detected with the vermi-tea application (141.00) as compared with control (96.67), solid vermicompost (122.67) and chemical fertilizer (117.67) (Table 1). This is due to presence of growth regulators in vermi-tea that enhance the nutrition and growth of plants (Parthasarthi and Ranganathan, 2002). Vermi-tea contain nitrogen (N), potassium (K), phosphors (P), calcium (Ca) and rhizobacteria that promote plant growth and contribute to initiate roots formation, growth and soil organic matter.

3.6 Root dry weight (g)

Root dry weight of maize improved considerably with the application of vermicompost and vermi-tea than control. Vermi-tea increased root dry weight more than any other treatment (Table 1). When tea applied to soil, it infiltrates to the roots where supply nutrients to roots which is used by plants and microbes of rhizosphere (Parthasarthi and Ranganathan, 2002). and also improved plant growth (Bess, 2000). Most favorable effect of vermicompost on soil is the elevation of organic matter of soil which contribute to improve pore spaces of soil then increases the root density and root mass.

Table 1: effect of solid vermicompost, vermi-tea and chemical fertilizers on germination %age, root length, Shoot length, Root fresh weight, Shoot fresh weight and Root dry weight.

Treatments	Germination %age	Root length (cm)	Shoot length (cm)	Root fresh weight (g)	Shoot fresh weight (g)	Root dry weight (g)
No fertilizer (F_0)	79.667 B	25.667 C	108.67 D	21.000 D	96.67 C	1.0600 C
Solid vermicompost (F_{VC})	92.333 A	40.333 A	145.33 B	34.000 B	122.67 B	3.1000 B
Vermi-Tea (F_{VT})	80.667 B	42.333 A	158.33 A	39.667 A	141.00 A	4.8000 A
Chemical Fertilizer (F_C)	84.667 B	33.667 B	133.33 C	30.000 C	117.67 B	2.6667 B

Table 2: Effect of solid vermicompost, vermi-tea and chemical fertilizers on shoot dry weight, number of leaf, leaf length, stem girth, relative water contents, chlorophyll contents and MSI.

Treatments	Shoot dry weight (g)	Number of leaf	Leaf length (cm)	Stem girth (cm)	Relative water contents (RWC) %	Chlorophyll contents (SPAD Value)	MSI (%)
No fertilizer (F_0)	7.667 D	10.333 B	50.000 D	1.6667 B	76.000 C	77.667 D	75.333 D
Solid vermicompost (F_{VC})	15.833 B	15.333 A	74.333 B	2.6667 AB	91.333 A	84.333 B	84.667 A
Vermi-Tea (F_{VT})	18.167 A	17.000 A	83.333 A	3.3333 A	93.000 A	89.667 A	85.333 A
Chemical Fertilizer (F_C)	11.433 C	12.333 B	60.667 C	2.0000 B	82.333 B	80.333 B	81.000 C

3.7 Shoot dry weight (g)

Shoot dry weight (Table 2) determined the biological yield. Very less (7.667) shoot dry weight was observed in the treatment where no fertilizer was used as compared to treatments where solid vermicompost (15.833), vermitea (18.167) and chemical fertilizer (11.433). Highest shoot dry weight of maize in response of vermicompost and vermitea application was perceived (Table 2) and similar results obtained by Bess (2000).

3.8 Number of leaves and leaf length (cm)

Effect of solid vermicompost, vermi-tea and chemical fertilizer on number of leaves and leaf length of maize are presented in (Table 2). Compared to the no fertilizer treatment (control), addition of solid vermicompost, chemical fertilizer and vermi-tea showed significant difference. But more number of leaves and leaf length was observed where vermi-tea was applied. This liquid vermi-tea holds many enzymes like amylase, protease and phosphatase which are beneficial for plant growth and increase yield. (Edwards et al., 2006) perceived that the application of vermicompost and vermiwash has constructive effect on okra as compared to chemical fertilizer and control. This leads to 64% increase in okra yield as compared to control.

3.9 Stem girth and relative water contents (%)

Stem girth (cm) and relative water contents of maize improved with use of vermi-tea, solid vermicompost and chemical fertilizer. Highest stem girth and relative water contents (RWC) were maximum for the maize plants applied with vermi-tea followed by solid vermicompost and chemical fertilizer (Table 2). (Ansari and Sukhraj, 2010) stated that 7.3% yield of radish increased by weekly application of vermi-tea. Decrease in relative content shows symptoms of drought condition and this reduction in RWC is associated with decline in plant vigour (Halder and Burrage, 2003).

3.10 Chlorophyll contents (SPAD value) and MSI (%)

Table 2 shows that the use of vermi-tea, vermicompost and chemical fertilizer increased chlorophyll contents in maize leaf. Highest chlorophyll contents were observed in vermi-tea treatment compared with control and others treatments. Effect of vermicompost application on membrane stability index (MSI) of maize hybrid is listed in Table 2. Solid vemicompost and foliar application of vermi-tea caused considerable increase in MSI than with chemical fertilizer application (Ansari and Sukhraj, 2010).

Conclusions and Recommendations

Vermi-fertilizers and chemical fertilizer significantly increased all the above said parameters of maize excluding seed germination as compared to control but foliar application of 6% vermi-tea treatment showed maximum morphological and physiological performance of maize. So, it is recommended the use of vermi-tea to the farmers for better crop production.

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Authors Contributions

Conceived and designed the experiment: Ali Ahmad and Zubair Aslam. Performed the experiment: Ali Ahmad and Zubair Aslam. Analyzed the data: Ali Ahmad and Zubair Aslam. Contributed reagents/ materials/ analysis tools: Ali Ahmad and Zubair Aslam. Wrote the paper: Ali Ahmad and Zubair Aslam.

Conflict of interest

The authors have declared no conflict of interest.

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