Biological Forum – An International Journal **7**(1): 856-860(2015)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Effect of Different Levels of Vermicompost on Yield and Quality of Maize Varieties

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(Received 12 February, 2015, Accepted 17 March, 2015)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Maize (*Zea mays* L.) is in the third rank after wheat and rice and is grown all over the world in a wide range of climatic condition. Excessive use of chemical fertilizers, decline in soil and food quality due to loss of soil organic matter is the main characteristics of the conventional farming systems which are more pronounced in arid and semi-arid areas. Vermicompost is a good substitute for commercial fertilizer and has more N, P and K than the normal heap manure. The use of vermicompost appears to affect plant growth in ways that cannot be directly linked to physical or chemical properties. However, the improvements in physical and chemical structure of the growth media are attributed to the increase in plant growth. The field experiment was laid out in split plot design with factorial design with four replications. Treatments included levels of vermicompost (0, 4, 8 and 12 t/ha) as main plot and variety (700 and 704) as sub plot. Analysis of variance showed that the effect of vermicompost and variety on all characteristics was significant.

Key words: Biological yield, Seed yield, Harvest index, Protein (%)

INTRODUCTION

Maize (*Zea mays* L.) is in the third rank after wheat and rice and is grown all over the world in a wide range of climatic condition. Being highly cross pollinated, maize has become highly polymorphic through the course of natural and domesticated evolution and thus contains enormous variability in which salinity tolerance may exist (Paterniani, 2009). Maize, which belongs to the plants with C4 metabolism, is also classified as moderately sensitive to salinity (Mass and Hofffman, 2013; Katerji *et al.*, 2012; Ouda *et al.*, 2008). For maize grown under salinity, reduction in growth characters and yield were observed (Ouda *et al.*, 2008). In organic farming found use of a recovery of waste products with farming technology of earthworm in the genus *Eisenia foetida*, which in the gastrointestinal tract mixed digested organic matter with minerals, i.e. soil, thereby is created an organo-mineral complex secreted in the form of rollers *i.e.* casts, which having a positive impact on the physical, chemical and biological soil parameters. Compared to conventional compost contains vermicompost large amounts of total nutrients with larger percentage of available forms. Valuable is the high number of microorganisms and also considerable level of growth regulators such as auxins, gibberellins, cytokinins. Vermicompost application accelerates the ripening process of the crop of 1–2 weeks with improving the quality parameters of cultivated plants (Kovacik, 2014). Excessive use of chemical fertilizers, decline in soil and food quality due to loss of soil organic matter is the main characteristics of the conventional farming systems which are more pronounced in arid and semi-arid areas (Singh *et al.*, 2007; Melero *et al.*, 2008; Liu *et al.*, 2009). Increasing public awareness of the negative environmental impacts, growing consumer demand for healthier products and criticism of high input production systems lead to more emphasis on organic crop production under integrated management systems (Guarda *et al.*, 2004). Alternate agricultural practices such as organic farming, eco-farming, biodynamic farming and traditional farming practices are considered important alternatives to increase soil fertility and soil health. In organic farming the application of organic manure especially vermicompost is recommended. It is ecofriendly, non-toxic, consumes low energy input for composting and is a recycled biological product (Lourduraj and Yadav, 2005). Vermicomposts are organic materials broken down by interactions between microorganism and earthworms in a mesophilic process (up to 25°C), to produce fully stabilized organic soil amendments with low C:N ratios. They have a high and diverse microbial and enzymatic activity, fine particulate structure, good moisture-holding capacity, and contain nutrients such as N, P, K, Ca and Mg in forms readily taken up by plants (Lavelle and Martin, 1992; Prabha *et al.*, 2005; Arancon and Edwards, 2009).

Vermicompost is a good substitute for commercial fertilizer and has more N, P and K than the normal heap manure (Srivastava and Beohar, 2004). The use of synthetic fertilizers causes a great impact on the environment and the cost of these fertilizers is increasing over the years. The farmers need to raise the crops by organic farming that will reduce the costs and will decrease the impact on the environment. In addition, organic farming will reduce the additional burden of environmental pollution that is caused while manufacturing these synthetic fertilizers at the source (Rathier and Frink, 1989). Now it is a well-established fact that organic fertilizers provide enough requirements for proper growth of the crop plant and may enhance the uptake of nutrients, increase the assimilation capacity and will stimulate the hormonal activity as well (Tomati *et al.,* 1990; Grapelli et al., 1985). Vermicompost is also useful as it increases soil porosity, aeration and water holding capacity. Vermicompost increases the surface area, provides strong absorbability and retention of nutrients as well and retain more nutrients for a longer period of time. It has been found that soil amended with vermicompost had significantly greater soil bulk density and the soil does not become compacted (Lunt and Jacobson, 1994; Martin, 1976). Vermicomposts are organic materials broken down by interactions between micro-oganism and earthworms in a mesophilic process, to produce fully stabilized organic soil amendments with low C: N ratios (Ramasamy, *et al.,* 2011). 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, cytokinins, auxins and group B vitamins which can be applied alone or in combination with organic or inorganic fertilizers, so as to get better yield and quality of diverse crops (Atiyeh *et al.,* 2002; Arancon *et al.,* 2006 and Jack *et al.,* 2011). The use of vermicompost helps in maintaining soil fertility since the mineral elements contained in it were changed to forms more that could be readily taken up by plants such as nitrates, exchangeable phosphorous, soluble potassium, calcium, manganese etc. Various workers have examined the suitability of vermicompost as plant growth media (Zhao and Huang, 1988; Pashanasi *et al.,* 1996) and have addressed their potential commercial value. A number of field experiments have reported positive effects of quite low application rates of vermicompost to field crops. It has been reported that vermicompost increases growth, yield and tomato quality when used as a soil supplement (Gutierrez-Miceli *et al.,* 2007) or as an alternative to mineral fertilizers in rice– legume intercropping (Jeyabal and Kuppuswamy, 2001). The addition of vermicompost to field strawberries was found to produce significantly higher yields than the addition of equivalent amounts of mineral fertilizers, and the presence of plant growth regulators in the vermicompost was suggested (Arancon *et al.,* 2004). Humic acids isolated from vermicompost enhanced root elongation and formation of lateral roots in maize vermicompost enhance the nutrient uptake by the plants by increasing the permeability of root cell membrane, stimulating root growth and increasing proliferation of root hairs (Pramanik *et al.,* 2007). The suppressing, repelling or by inducing biological resistance in plants to fight them or by killing them through pesticide action of Vermicompost aids in protecting crop plants against pests and diseases (Al-Dahmani *et al.,* 2003). The use of vermicompost appears to affect plant growth in ways that cannot be directly linked to physical or chemical properties (Dash and Petra, 1979). However, the improvements in physical and chemical structure of the growth media are attributed to the increase in plant growth. It is argued that growth promotion may be due to micro flora associated with vermicomposting that induce hormone-like activity on the production of metabolites (Parle, 1963; Tomati *et al.,* 1987; Atiyeh *et al.,* 2002). Decomposition of organic matter and recycling of carbon have substantial effect on the activity of enzyme evolved in mineralization of nutrients. soil enzymes significantly contribute to soil health. Vermicomposting is one such viable technique for augmentation of organic source in soil. Application of vermicompost influences the physical, chemical and biological properties of soil. It improves the water holding capacity of the soil. Use of vermicomposting is being advocated for sustaining soil fertility in various field crops (Senthil Kumar and Surendran, 2002). In recent years, vermicompost effects were investigated by researchers, and influences of type and concentration of vermicompost were reported on diverse plant species. Smith et al. (1999) found that the exchangeable calcium and base saturation of the soils were increased in 200 mm of surface soil by the application of vermicompost, and it was more effective than compost in increasing exchangeable Ca values although the compost contained significantly more Ca than the vermicompost. Vermicomposts are finely divided peat-like materials with high porosity, good aeration, drainage, water holding capacity and very high microbial activity, which make them excellent as soil amendments or conditioners and as plant growth media (Arancon *et al.* 2008).

MATERIAL AND METHODS

A. Location of experiment

The experiment was conducted at the Mirjaveh (Iran) which is situated between 30° North latitude and 61° East longitude.

B. Composite soil sampling

Composite soil sampling was made in the experimental area before the imposition of treatments and was analyzed for physical and chemical characteristics.

C. Field experiment

The field experiment was laid out in split plot design with factorial design with four replications.

D. Treatments

Treatments included levels of vermicompost (0, 4, 8 and 12 t/ha) as main plot and variety (700 and 704) as sub plot.

E. Data collect

Data collected were subjected to statistical analysis by using a computer program MSTATC. Least Significant Difference test (LSD) at 5 % probability level was applied to compare the differences among treatments` means.

RESULTS AND DISCUSSION

A. Biological yield

Analysis of variance showed that the effect of vermicompost on biological yield was significant (Table 1). The maximum of biological yield (22407.3) of treatments 12 t/ha was obtained (Table 2). The minimum of biological yield (14598.3) of treatments control was obtained (Table 2). Analysis of variance showed that the effect of variety on biological yield was significant (Table 1). The maximum of biological yield (22220.7) of treatments 704 was obtained (Table 2). The minimum of biological yield (18257.8) of treatments 700 was obtained (Table 2).

B. Seed yield

Analysis of variance showed that the effect of vermicompost on seed yield was significant (Table 1). The maximum of seed yield (6839.3) of treatments 12 t/ha was obtained (Table 2). The minimum of seed yield (4482.5) of treatments control was obtained (Table 2). Analysis of variance showed that the effect of variety on seed yield was significant (Table 1). The maximum of seed yield (5444.44) of treatments 704 was obtained (Table 2). The minimum of seed yield (5251.00) of treatments 700 was obtained (Table 2).

Table 1: Anova analysis of the corn affected by vermicompost and variety.

		Ms			
S.O.V	**df**	**Biological yield**	**Seed yield**	**Harvest index**	**Protein (%)**
R	3	82955.4^{ns}	32194.36^{ns}	0.549^{ns}	0.290^{ns}
Vermicompost	3	87421609.5**	8792278.86**	88.990**	20.469**
Error a	9	4259963.7	137111.70	2.128	0.141
Variety	1	30824989**	299344.53**	104.835**	1.051**
Vermicompost * Variety	3	14339522.2**	54356.20^{ns}	23.576**	0.579**
Error b	12	1004658.2	16626.36	0.955	0.072
CV (%)	-	5.210	2.411	3.476	2.235
*, **, ns: significant at p<0.05 and p<0.01 and non-significant, respectively.					

Table 2: Comparison of different traits affected by vermicompost and variety.

Treatment	**Biological yield**	**Seed yield**	**Harvest index**	**Protein (%)**
Vermicompost (t/ha)				
Control	14598.3c	4482.5d	24.28c	9.91d
4	19727.4b	4781.9c	26.38b	10.62c
8	20224b	5287.3b	30.77a	11.90b
12	22407.3a	6839.3a	31.04a	13.55a
variety				
704	22220.7a	5444.44a	29.93a	11.68a
700	18257.8b	5251.00b	26.31b	11.31b
Any two means not sharing a common letter differ significantly from each other at 5% probability				

C. Harvest index

Analysis of variance showed that the effect of vermicompost on harvest index was significant (Table 1). The maximum of harvest index (31.04) of treatments 12 t/ha was obtained (Table 2). The minimum of harvest index (24.28) of treatments control was obtained (Table 2). Analysis of variance showed that the effect of variety on harvest index was significant (Table 1). The maximum of harvest index (29.93) of treatments 704 was obtained (Table 2). The minimum of harvest index (26.31) of treatments 700 was obtained (Table 2).

D. Protein (%)

Analysis of variance showed that the effect of vermicompost on protein was significant (Table 1). The maximum of protein (13.55) of treatments 12 t/ha was obtained (Table 2). The minimum of protein (9.91) of treatments control was obtained (Table 2). Analysis of variance showed that the effect of variety on protein was significant (Table 1). The maximum of protein (11.68) of treatments 704 was obtained (Table 2). The minimum of protein (11.31) of treatments 700 was obtained (Table 2).

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