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Investigation Role of Vermicompost to Improve Quantitative and Qualitative Characteristics of Corn (*Zea mays* L.) Production

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RESEARCH ARTICLE

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ABSTRACT

Overuse of different chemical fertilizers is one of the causes for the degradation of environment and soil. Biological fertilizers are the newest and most technically advanced way of supplying mineral nutrients to crops. Compared to chemical fertilizers, their supply nutrient for plant needs, minimizes leaching, and therefore improves fertilizer use efficiency. Vermicompost is an organic compound that is microbial active and rich in nutrients that results from the interaction of earthworms and microorganisms with organic matter decomposition. In vermicomposting process, earthworms are used to enhance the process of residue conversion. Vermicomposting is faster than composting and the resulting earthworm castings are rich in microbial activity and plant growth regulators, and fortified with pest repellence attributes as well. Vermicomposting reduces the C:N ratio and retains more N than the traditional methods of preparing composts. It can improve seed germination, growth and yield of crops. Current research was conducted according evaluate results of valid researcher. Evaluation result of many researchers revealed apply vermicompost had positive effect to improve plant height, Number of Row per Ear, Number of Seed per Row, Number of seed per spike, Number of spike per m^2, Seed weight, Biologic yield, Seed yield, Harvest index, Growth indices and Protein content in compare control treatments. Addition of vermicompost to soil contributes to the nutrient requirements of the plant, as well as the improvement of the physical and physical condition of the vital soil and creates a suitable bed for root growth, increases the growth of shoot and dry matter production, and ultimately improves the agrophysiological traits and crop production. It seems consume 10 $t.ha^{-1}$ vermicompost can lead to achieve highest yield and can be advised to farmers.

KEYWORDS: *Growth indices, Nutrition, Organic matter, Protein, Seed yield.*

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1. BACKGROUND

In developing countries, different agricultural organic wastes are created after harvest, which can be converted to vermicompost or compost and applied to the soil as organic fertilizers to increase soil fertility and reduce the application of chemical fertilizer. This not only helps to reduce environmental pollution but also better nutrient cycling and sustainability of agricultural systems. Compost and vermicompost are organic fertilizers containing various plant nutrients that become available to plants after microbial decomposition. The nutritional value of these organic fertilizers depends to a large extent on the type and nature of the raw materials used to produce those (Atiyeh *et al*., 2000a). Overuse of different chemical fertilizers is one of the causes for the degradation of environment and soil. Bio fertilizers are the newest and most technically advanced way of supplying mineral nutrients to crops. Compared to chemical fertilizers, their supply nutrient for plant needs, minimizes leaching, and therefore improves fertilizer use efficiency (Subbarao *et al.,* 2013). Fertilizer management is one of the most important factors in successful cultivation of crops affecting yield quality and quantity (Tahmasbi *et al.,* 2011). Chemical fertilizers are significant to succor nutrients in soil. Heavy doses of chemical fertilizers and pesticides are commonly used in order to enhance corn yields. Excessive nitrogen content in soil causes an inappropriate high uptake of this macronutrient by plants, which may result in inadequate growth and development due to the accumulation of nitrogen compounds in plant tissue (Szulc, 2013). Organic farming has emerged as an important priority area globally in view of the growing demand for safe and healthy food and long term sustainability and concerns on environmental pollution associated with indiscriminate use of agrochemicals. Though the use of chemical inputs in agriculture is inevitable to meet growing demand for food in world, there are opportunities in selected crops and niche areas where organic production can be encouraged to tape domestic export market (Venkatash-Warlu, 2008). Vermicomposting is an ecobiotechnical stabilization process, which involves the breakdown of organic waste and in contrast to microbial composting it involves the joint action of earthworms and mesophilic micro organisms and does not involve a thermophilic stage. Worms require environment that is encouraging for microbial degradation to maintain biochemical processes that enhance microbial decomposition. They add various intestinal microflora in matrix, moreover gut enzymes play dominant role in process (Fig.1. Chandra).

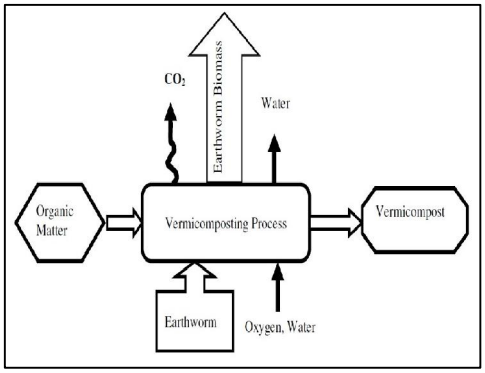

Fig. 1. Process Diagram of Vermicomposting Process

Vermicompost is an organic compound that is microbial active and rich in nutrients that results from the interaction of earthworms and microorganisms with organic matter decomposition. It has been shown that these pitched and homogeneous materials have high porosity, adequate ventilation and drainage, and high water retention capacity, and contain nutrients found in the plant's absorbable form (Koozehgar kaleji and Ardakani, 2017). Vermicompost, along with chemical fertilizers, improves the usefulness of low-energy elements and their absorption in plants compared with the use of chemical fertilizers alone (Jabeen and Ahmad, 2017). Vermicomposting is similar to traditional composting. Both use natural processes to stabilize organic matter (Fig. 2, Hamilton).

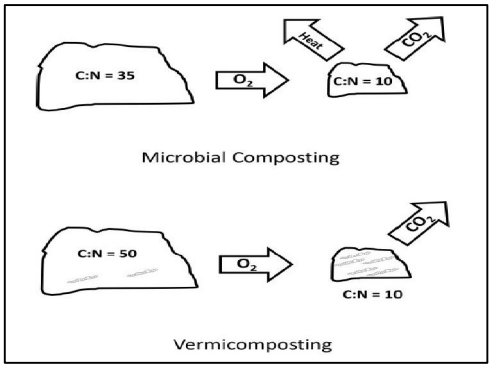

Fig. 2. The difference between microbial composting and vermicomposting

Worms Composting of organic wastes would increase the availability of nutrients within the organic wastes, will increases photosynthesis (chlorophyll and pigments) and plant biomass. In an experiment the application of vermicompost increased the amounts of anthocyanin and flavonoids in plants (Joshi *et al*., 2014). The three products from vermicomposting are worms, vermicompost and vermicompost tea (Fig. 3, Hamilton). In several studies, the importance of organic wastes in the preparation of compost and vermicompost and the role of these organic fertilizers in sustainable agriculture and the growth, yield, macro and micronutrient content of plants have been discussed (Hernandez *et al*., 2015).

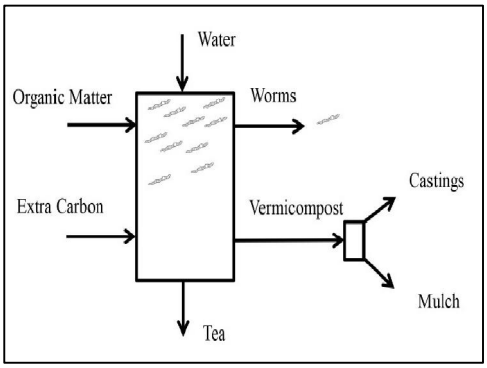

Fig. 3. Inputs and products of vermicomposting

Increasing 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 vermiwash also increased the soil copper, iron and phosphorous content (Manyuchi *et al*., 2013a; Nath and Singh, 2012). In vermicomposting process, earthworms are used to enhance process of residue conversion. Vermicomposting is faster than composting and resulting earthworm castings are rich in microbial activity and plant growth regulators, and fortified with pest repellence attributes as well. Vermicomposting reduces C:N ratio and retains more N than traditional methods of preparing composts.

It can improve seed germination, growth and yield of crops (Zahedifard *et al*., 2014). Joshi *et al*. (2013) reported organic manures are slow leaching and have to be applied in bulk because of their lower N, P and K content. Applying organic manures like vermicomposts in bulk raises economical concerns in the minds of farmers who wish to opt for organic farming. They are believed 5 $t.ha^{-1}$ vermicompost is as effective as higher doses. So, vermicompost application is cost effective. Moreover, it may take more than two years time for an organic farm to improve the soil health enough to make the growth and yield equivalent to chemical fertilizers. Futher studies with a trial period of more than two years are needed in future for this. In India, thousand tons of grains get destroyed every year due to lack of storage if we provide proper storage facilities, the yield loss which occurs during initial years in an organic farm may be recovered. Moreover, Consumer health, harmful effects of agrochemicals and over-populations are bigger issues than yield loss.

2. OBJECTIVES

This study was conducted to evaluate the effects of vermicompost on agro-physiological properties of corn crop.

3. EVIDENCE ACQUISITION

Current research was conducted according evaluate results of valid researcher.

4. RESULT

4.1. Plant height

The highest values of plant height were obtained from the application of 6% of sugar beet vermicompost. This increase in plant height was 98% more than control. Height parameter was improved 25% by vermicompost application when compared to control and conventional fertilization (Hernandez-Rodríguez *et al*., 2015). Agrawal *et al*. (2003) found that the increase in soil organic matter content through the application of farm yard manure in wheat increased plant height.

4.2. Number of row per ear

Sujatha *et al*. (2008) confirmed mentioned result, because they showed that the application of vermicompost by improving the physical properties of the soil to increase absorption elements, improve the production led to increase the number of seeds per row and number of rows per ear.

4.3. Number of seed per row

Sinha *et al*. (2010) reported the application of vermicompost increased the length and diameter of the ear, increased the number of seeds per ear and number of rows per ear in corn. Other researchers also reported that the application of vermicompost on rice led to an increase in seed yield and rice cluster (Eftekhari *et al*., 2006).

4.4. Number of seed per spike

According to the research of Mosanaei *et al*. (2017), the effect of nitrogen fertilizer on the number of wheat spikes was significant, which was consistent with the results of the present study. Nitrogen increases the biomass production and increases the possibility of re-transmission of photosynthetic materi-

als, producing more seeds per spike and better filling them after flowering, which will increase seed yield (Shanggan *et al*., 2000).

4.5. Number of spike per m^2

Researchers reported that the increase in nitrogen consumption increases the number of spikes per unit area, which can increase vegetative growth and, consequently, increase the amount of tillering due to nitrogen consumption. In such a situation, the number of fertilized tillers per unit area increases and the number of spikes per unit area also increases (Mosanaei *et al*., 2017).

4.6. Seed weight

Naseri *et al*. (2017a) showed that mycorrhizal fungus increases the weight of the seeds. The Glomus Musa mushroom provides improved growth of the air organs by increasing the root system and absorbing the nutritious nutrients, increasing the amount of leaf chlorophyll (Naseri *et al*., 2017b), which subsequently increases the plant's green surface and causes more material to be stored. Photosynthesis toward seeds and increasing the weight of one thousand seeds. Biofertilizers seem to have provided more seed filling time with the production of growth hormones and the supply of nutrients while increasing the filling speed of the seed (Naseri *et al*., 2017c). The researchers stated that 1000-seed weight as a result of use vermicompost fertilizer showed the positive effect of vermicompost on seed yield, resulting in an increase in the amount of photosynthesis stored, resulting in an increase in the weight of one thousand seeds, and the application of vermicompost fertilizer led to increased yield and seed weight of sesame (Ghosh and Mohiuddin, 2000). In a research on wheat, it was determined that the application of vermicompost fertilizer would increase the seed weight of wheat (Bar-Tal *et al*., 2004). Some researchers reported that increase 1000-seed weight due to the application of iron Nano fertilizer due to the optimal combination of micronutrient and main nutrient elements in the reproductive stages of the plant. Available main elemental led to improve the accumulation of assimilates in the seeds and produce heavier seeds (Bybordi and Mamedov, 2010).

4.7. Biologic yield

Edwards and Bates (1992) found that earthworms increased significantly the number, growth rate, and yield of plants growing on inoculated sites. Manure application improves the soil structure and soil moisture content, provides plant with essential elements, increases growth, number of umbrella per plant and biological yield and finally led to increase seed yield (Ahmadian *et al.,* 2011). Several studies have investigated the positive effect of vermicompost on increasing the quantitative and qualitative performance of crops and medicinal plants, including the effect of vermicompost on biological yield, basil, chamomile, forage corn, forage forage, forage sorghum, artemisia and Joe pointed out (Haj Seyed Hadi *et al.,* 2010). Application of vermicompost on wheat increased the content of nutrients in the leaf and resulted in improved photosynthesis and biological yield

(Anwar *et al*., 2005). The addition of vermicompost to soil increased availability of the nutrients, and also improves the physical and vital processes of the soil, and provides optimum environment for root growth to increase biological yield. Some researchers reported that the use of vermicompost (due to the presence of fungi, bacteria, yeast, and actinomycetes that have microbial activity) improves the nutritional elements through hormones such as auxin, gibberellin, cytokinin and ethylene, have a positive effect on growth and yield, so the use of 10 $t.ha^{-1}$ vermicompost increased the biological yield (Singh, 2000).

4.8. Seed yield

Using vermicompost, the physical and chemical properties of the soil have improved, resulting in more root development, reducing water losses, and conditions for improved growth and photosynthesis, and thus the plant will be able to produce more biomass and biological yield (Sainz *et al.,* 1998). Singh *et al*. (2012) reported that vermicompost increased chickpea yield. Seghatoleslami (2013) on cumin also reported that manure application increases cumin yield. The effect of vermicompost on plant growth is significant and increases the growth potential, yield and yield components of different plants (Atiyeh *et al.,* 2000b). The effect of vermicompost from 0 to 10 $t.ha^{-1}$ on seed yield of corn showed that seed yield increased significantly showed the positive effect vermicompost on crop production because of stored assimilates (Amyanpoori *et al*., 2015). Andhikari and Mishra (2002) showed in that the combined application of vermicompost organic manure with urea chemical fertilizer can reduce by 50 percent the amount of urea in the field conditions. Also the yield was 12% higher than treatments that only received fertilizer. Behera *et al*. (2007) showed that the use of 2.5 $t.ha^{-1}$ vermicompost manure fertilizer with 50 percent fertilizer recommendations for wheat, grain yield in 4.08 $t.ha^{-1}$. While the in treatments of only the fertilizer was added to yield 4.87 $t.ha^{-1}$, respectively. The use of vermicompost has positive effects on crop yield. The favorable effect of vermicompost is probably due to the relatively higher amounts of nutritional elements and hence the increase in availability of macro and micro nutritional elements (Jat and Ahlawat, 2008). Arsalan *et al*. (2016) investigated effect of different level of vermicompost (control and 2 $t.ha^{-1}$) on growth and nutrient uptake in mung bean and reported maximum seed yield, number of pod per plant and number of seed per pod and plant height was obtained from use 2 $t.ha^{-1}$ vermicompost treatment and the least of these traits were obtained from control.

4.9. Harvest index

Harvest index is also an important factor in increasing yield, in grains, the increase in biomass has reached its final limit, hence the increase in seed yield through the allocation of more photosynthetic materials to the sink (seeds) is possible, in which case the harvest index will significantly increase (Krishnan *et al*., 2003). The experimental re-

sults showed that the use of vermicompost in corn increased the harvest index (Mojab Qasr al-Dashti *et al*., 2011). The application of vermicompost fertilizer led to an increase in harvest index in sorghum because of vermicompost has positive effect on soil micro flora and increased soil Mycorrhiza activity (Cavender *et al*., 2003). Veisi Nasab *et al.* (2015) by evaluate the effect of different level of vermicompost on maize production reported the maximum harvest index (31.04%) was obtain from consume 12 t.ha^{-1} vermicompost.

4.10. Growth indices

In a study, the effects of vermicompost on growth of grape showed that the use of 20% of vermicompost had the best result on some growth parameters (10% increase) (Nadi and Golchin, 2011). In another study the use of 2% vermicompost increase the growth of seedlings by 200% (Sallaku *et al*., 2009). Vermicompost can increase relative growth rate 16% more than control (Yusof *et al*., 2018). In a study on Effects of vermicompost on growth and nutrients uptake by lettuce in a calcareous soil, Biological fertilizers significantly increased shoot dry matter and some nutrients uptake (Durak *et al*., 2017). Nadi and Golchin (2011) in a study showed that, the leaf area due to the use of 10% vermicompost of animal manure increased significantly. Semi compost and vermicompost mixed with peat moss enhance development of lettuce and leaf area (94.5%), (Azarmi *et al*., 2008). Asghari *et al*. (2016) reported that the effect of urban waste compost and vermicompost on dry weight of the Lemon Verbena was significant (Mohsen *et al*., 2016). In a study the use of vermicompost/compost in a ratio of 4:1 respectively caused more growth and development of the roots and biomass of tested lettuce (Porter *et al*., 1999). Vermicompost, in addition to its direct role in the plant nutrition, also helps absorb more nutrients by developing a root system. Probably increased access to nutrients has increased the amount of pigments and photosynthesis, resulting in increased carbon fixation, plant growth and yield (Baca *et al*., 1992). Vermicompost with rate of 15 t ha^{-1} increased fruit dry matter up to (24%), (Adiloglu *et al*., 2018). With using carrot vermicompost, counts of Chlorophyll a increased 33% with respect to control. Chlorophyll content was improved in a ratio of 1:5 and 1:3 vermicompost treatments (Alhajhoj, 2017). Providing nutrients needed for the plant and further developing the root system of the plant to absorb nutrients as well as modifying the soil fertility by using vermicompost fertilizer increases the leaf area index (Maghsudi *et al*., 2012). Sainz *et al*. (2008) reported the application of vermicompost led to increase leaf area index, chlorophyll and yield of strawberry, also another researchers Nazari *et al*. (2006); Sinha *et al*. (2010) and Bybordi and Mamedov (2010) reported same result. Singh (2000) reported the application of iron Nano fertilizer on canola resulted in an increase in plant height. One of the reasons for improving the plant height, iron availability in the growth stages is led to improve leaf area index and photosynthesis, which is consistent with the findings

of current research. Bar-Tal *et al*. (2004) reported application of vermicompost fertilizer led to increase leaf area index and chlorophyll index in wheat, also Mousavi *et al*. (2009) reported same result.

4.11. Protein content

Suhane *et al*. (2008) reported that the use of only 2.5 $t.ha^{-1}$ vermicompost wheat farm has a better result compared to use chemical fertilizers. Vermicompost could also reduce plant's water requirement by about 30 to 40%. The use of vermicompost increases protein yield, probably this increase is due to the relatively higher amounts of nutrients and increased grain yield (Jat and Ahlawat, 2008). The use of vermicompost has positive effects on the amount of protein and nutrient uptake by the plant. The favorable effect of vermicompost is probably due to relatively higher amounts of nutritional elements and hence increase in availability of macro and micro nutrients which leads to increased protein percentage (Jat and Ahlawat, 2008). Shadab Niazi *et al*. (2017) by evaluate the effect of different level of vermicompost (0, 2.5 and 5 $t.ha^{-1}$) on mung bean, reported the highest protein yield and seed yield were obtained from 5 $t.ha^{-1}$ vermicompost and the least of these traits were due to non-use of vermicompost.

4.12. Chlorophyll content

Lee *et al*. (2013) reported effect of biofertilizer on (*Bacillus subtilus*) improved plant growth more than control, and also observed an increase in the leaf number, leaf length, and leaf mass, 128%, 122%, and 153% respectively more than the control. Recommendations on the application rate of compost depend on the type of compost, soil and environmental conditions. This increase in soil nutrient content promoted plant growth and chlorophyll production; hence boost the overall corn 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.,* 2013b). Nadi and Golchin (2011) showed that the leaf chlorophyll content of plants treated with iron-enriched vermicompost was higher than that in control treatment. Cruz *et al*. (2012) in the study showed that the enrichment of 0 to 20% fresh coffee waste showed that less than 10% of the waste in the planting ground could increase the amount of xanthophyll, β-carotene, chlorophyll of lettuce leaf and biomass. In the similar study on coriander, vermicompost treatments were superior in terms of the plant height, leaf length and width, dry weight, biomass yield, and total chlorophyll a and b and total carotenoids to the control treatment, and the treatment of 200 grams of vermicompost in the pot had the highest values of these parameters compared to levels of 0, 100 and 150 grams of vermicompost in the pot (Zaidi *et al*., 1999). Considering the importance of chlorophyll in production and the direct relationship between this trait and seed yield, researchers believe that increasing the amount of organic

fertilizers and vermicompost in the soil leads to an increase in nutrients such as nitrogen, iron and magnesium, so mentioned nutrient have important role for chlorophyll production, more availability of nutrient for sink (seeds) and improve crop production. The effect of vermicompost from 0 to 10 tons per hectare on seed yield of corn showed that seed yield increased significantly showed the positive effect vermicompost on crop production because of stored assimilates (Amyanpoori *et al*., 2015).

5. CONCLUSION

Addition of vermicompost to soil contributes to the nutrient requirements of the plant, as well as the improvement of the physical and physical condition of the vital soil and creates a suitable bed for root growth, increases the growth of shoot and dry matter production, and ultimately improves the crop production.

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FOOTNOTES

CONFLICT OF INTEREST: Author declared no conflict of interest.

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