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Short Review Paper

Effect of Municipal Solid Waste compost on growth and productivity of different crops: A Review

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Abstract

The utilization of municipal solid waste compost reduces the application of chemical fertilizers and increase the growth and yield of crops. Application of upto 25 t ha^{-1} of municipal solid waste compost was found to have a minimum of 15% increase in growth and yield of crops compared to no treatment. The application of 50% of municipal solid waste compost and 50% chemical fertilizer also leads to approximately the same level in increasing the growth and yield of crops compared to 100% treatment of chemical fertilizers.

Keywords: Chemical fertilizers, control, corn, tomato.

Introduction

Compost constitutes stable, well decomposed organic materials formed as result of accelerated degradation of organic waste under aerobic, controlled conditions by the microorganisms[1]. Compost is made from plant and animal remains with the objective of reusing plant and animal waste for crop production. The composting process converts potentially toxic and putrescible organic matter into a stable state which can improve soil and helps in growth of crops. Composted organics has beneficial effects of reducing landfills thereby saving the space for other alternative uses. The presence of organic matter in the soil is fundamental in reducing nutrient loss from soil and maintaining fertility. Thus, compost is an organic fertilizer as it contains high amount of organic matter. Rich organic matter in soil maintains the optimum condition necessary for biological activity, provides nutrients to the soil and improves its water holding capacity[1].

Adding compost in agricultural field increase crop productivity due to increase in organic matter content of the soil, and provide nutrients and plant growth promoting microorganisms. Compost can be considered as a useful material in maintaining soil pH at moderate levels in highly acidic and alkaline soils. Compost use in agriculture is also beneficial for reducing greenhouse gas emission as open dumping and land filling of the organic wastes releases methane. The positive effects of compost on soil acidity, salinity and toxicity can also improve crop productivity[2]. The composts which are intended for use in plant production needs evaluation of their maturity. The plant growth test are normally done by recording the rate of germination, number of fruits, shoot elongation, root elongation and total biomass. Negative effects of composts produced from urban waste such as municipal solid waste (MSW) when added to soil can be cause due to high concentrations of toxic elements. However, when treated in degraded lands, where restoration of soil fertility is the main priority, these drawbacks can be considered as minor. Further, compost when incorporated into polluted soil, it could accelerate the soil porosity, moisture retention, stimulating soil microbial making remediation of the polluted soil possible[3]. If municipal solid waste compost (MSWC) are to be treated in fertile soils environmental issues gain relevance[4]. Municipal organic waste when collected separately and properly composted, produce high-quality MSWC which have low heavy metal content and high organic matter content[5]. Numerous studies have been done on estimation of the impact of treatment of MSWC on different types of crops. The present review was undertaken to evaluate the efficiency of the MSWC.

Compost and growth of crop: Application of compost produced by combining 70% of household urban solid wastes and 30% poultry manure at a dose of 30 and 40 t ha^{-1} produced maximum plant height of 199.6 to 209.5cm of corn compared to control and chemical fertilizer amended plots. The grain yield and straw yields also recorded maximum in 30 and 40 t ha^{-1} application of compost with 4.55 to 4.70 t ha^{-1} and 5.10 to 5.45 t ha^{-1} respectively. The application of 10 t ha^{-1} of compost was at par with the application of chemical fertilizer. The grain yield was 66% and 67% greater than the control in the 30 and 40 t ha^{1} application of MSWC respectively. When compared with application of chemical fertilizers it was 23% and 25% greater in the 30 and 40 t ha^{-1} respectively[6]. The dry weight of lettuce showed maximum record with 21.8g plant^{-1} in the 1% treatment of compost made from chicken manure compared to no treatment showing an increase of 78%. However, application of inorganic fertilizer was superior to all compost's treatments with 34.5g plant^{-1} of dry weight[7].

Bashir *et al.* recorded a gradual increase in plant height, dry shoot biomass and dry root biomass of maize due to application of MSWC at 1.5 and 3% rate of application. A change of 66.3 to 74.7 in plant height, 9.2 to 10.6 in dry shoot biomass and 4.3 to 5.3 in dry root biomass compared to control was recorded. The overall increased in crop characteristics was 10 to 20% due to treatment of MSWC[8]. Diaz-Perez and Camacho-Ferre reported theplant height of tomato to be maximum with 14.0cm in vegetable waste derived compost to an application rate attaining Electrical Conductivity (EC) of 4.5 dSm^{-1}. The maximum total dry weight was recorded at 2.5 dSm^{-1} with 449 mg $plant^{-1}$. The result showed an increase of 9% and 25% in plant height and dry weight respectively[9].

The above ground biomass and root biomass of corn was recorded to be higher in 15.0 t ha^{-1} application of MSWC when compared to application of inorganic fertilizer and 7.5 and 22.5 t ha^{-1} application of MSWC. However, the aboveground biomass and root biomass showed maximum record in 0.5 NPK + 0.5 MSWC. The results indicated that providing three times the required amount of nutrients retards growth as the crops cannot tolerate other elements present in excess, while providing only the required amount of nutrients mainly phosphorus or nitrogen cannot provide all the other required micronutrients in lower application rates[10]. Golabi *et al.*showed that dry weight of corn increased in 5, 10 and 20 t ha^{-1} application of MSWC when compared to control. The rate of increase in dry biomass ranged from 96 to 98% in the MSWC treated plots[11]. Herrera *et al.* recorded that composition of 30% MSWC and 65% peat was the ideal ratio for nursery production of tomato seedlings and yielding quality indices[12].

Compost obtained by mixing garden waste and cow manure was found to have significant impact on tomato and cucumber seedling growth. The plant height, shoot dry weight and root dry weight recorded approximately 15 to 20 % more in the 60% and 100% treatment of the compost compared to control[13].The treatment of MSWC upto 8% leads to an increase of shoot length, root length, plant biomass and weight of seeds of green gram and fenugreek compared to control[14].Lalremruati *et al.*recorded 20.6% increase in the shoot length and 54% in root length of maize due to treatment of 17% of municipal solid waste compost compared with control[15]. The biomass of maize also increased with an average of 3.4% due to treatment of 17 to 20% treatment of MSWC. Corn cultivated at 15 t ha^{-1} MSWC dose leads to a gain of 54% in height, 52.5 % in stem diameter, 71.1 and 81.2 % in root and aerial biomass respectively compared to control[16].

The treatment of composted pineapple residue on the growth of pineapple at the rate of 40 t ha^{-1} leads to increase of 32.9 % in plant height, 53.9 % in root length and 91.2% increase in fresh aboveground biomass when compared with control[17]. Municipal solid waste stacked and aged for 1 year after composting was used as compost for treatment in *Sedum aizoon* cultivation. It was found that 25% treatment of the compost recorded maximum height of the plant with 8 cm compared to control (5.8cm). The root volume also recorded more with 1.73 cm^3 compared to control (0.60cm^3)[18]. Machado *et al.* recorded similar fresh yield of spinach by application of 70 t ha^{-1} of MSWC with 92 $kgNha^{-1}$ of inorganic fertilizer treatment[19]. The treatment of MSWCon the growthof corn recorded maximum aboveground biomass of more than 50% under the application of 25.6% compared to no treatment plots[20].

Utilization of 20 t ha^{-1} of MSWC showed promise as an alternative to 50% of the recommended dose of NPK fertilizers in the growth and yield of common bean[21]. Rashwan *et al.* reported the treatment of 15% tomato waste compost resulted in the optimum yield of cucumber and summer squash compared to a lower and higher dose. The result of the yield of the crops was at par with the treatment of peat moss which is used as a natural fertilizer although a non-renewable resource[22]. Ravindran *et al.* proved that application of 3% of dry vermicompost obtained from tannery wastes was found to have 10% higher plant height, 14% more leaf number and 60% more in fruit yield in tomato compared to control[23]. Ribas-Agustí *et al.* recorded a 45% increase in the total crop yield of tomato due to treatment of 50% MSWC and 50% mineral fertilizer compared to treatment of MSWC alone. There was also 3.4% increase in crop yield in the same composition compared to application of mineral fertilizer only[24]. Roghanian *et al.* observed the treatment of 60% MSWC on corn recorded maximum stem height and dry matter with 37% and 50% respectively compared with control[25]. An application of 5 t ha^{-1} MSWC + 100 $kgNha^{-1}$ + 100 $kgTSPha^{-1}$ + 50 $kgMoPha^{-1}$ produced maximum yield of tomato with 57% increase compared to control[26].

Sultana et al. recorded the treatment of 50% chemical fertilizer and 50% MSWC added with 20% mustard oil cake and 30% sugarcane press mud at the rate of 10 t ha^{-1} produced maximum growth and yield of cabbage, which was equal with 100% treatment of chemical fertilizer. Compared to control there was an increase of 26% in plant height and 87% increase in individual head weight in the treatment[27]. Sultana *et al.* again recorded the treatment of a combination of 50% MSWC with 20% of mustard oil cake and 30% poultry manure at the rate of 10 t ha^{-1} produced the same level of plant height, straw yield and 1000-grain weight of rice with 100% rate of application of chemical fertilizers. When compared to control there was an increase of 29%, 50% and 2% increase in plant height, straw yield and 1000-grain weight respectively in the treatment of the mentioned compost mixture[28]. Weerasinghe *et al.* noted that the performance of a locally available MSWC namely Dikovita in Western province of Sri-Lanka was found to have maximum increase in plant height and biomass of corn at a ratio of 1:0.5 (soil: Dikovita compost; 25% of compost) compared with other types of locally available composts. The study also highlighted at higher ratio certain composts may show negative effect on growth of crops[29].

Topcuoglu and Onalreported that the best application level of MSWC for yield of potato was found at 40 t ha^{-1}. The application level of 160 t ha^{-1} also indicated better yields compared to control, however, concentrations of Zn, Pb and Cd in the potato tubers exceeded the permissible limit in vegetables[30]. The treatment of 20% MSWC provided maximum yield of basil relative to control. The basil oil was also found to be free of heavy metals showing 20% of MSWC can be used as soil conditioner without phytotoxic effects on agricultural crops[31]. A level of 30% of the required N fertilizer was provided by the compost, thereby reducing the application of chemical fertilizers. Therefore, by careful management in N fertilization, less nitrogen may be needed at the same time increasing grain yield and conserving environment[1].

Utilization of compost is a sound technology for decreasing food shortage and combating degradation of soil. In order to increase application of compost in soil socio-ecological constraints need to be removed at a large scale. The constraints can be land tenure security and lack of credit for investment in soil management[32].

Taking into consideration of 0.15 m soil depth with an approximately soil bulk density of 1.2 gcm^{-3}, the soil mass is 1800 t ha^{-1}. Application of upto 25 t ha^{-1} of MSWC was found to have at the minimum of 15% increase in growth and yield of crops such as corn, tomato, potato, common bean, lettuce and cucumber compared to no treatment. The application of 25 t ha^{-1} of MSWC is only 1.38% of the total mass of soil. In most of the studies, the application of upto 40% of MSWC was found to have positive impact on growth of crops. However, these studies were done mostly in pot cultivation. Application of MSWC in agricultural fields is different from application in pot cultivation. Therefore, care should be taken in application of MSWC in agricultural fields so that excess amount of MSWC is not added in the soil.

The application of 50% of MSWC and 50% chemical fertilizers was also found to increase the growth and yield of crops. Before application of the MSWC, analysis of total nitrogen and other macronutrient content is necessary, so that the required dose of the nutrient is applied in the agricultural fields.

Conclusion

Application of MSWC in agricultural fields should be done based upon the content of the macronutrients containing in the MSWC. Studies have shown that upto a minimum dose of 25 t ha^{-1} is applicable in agricultural fields in order to increase the growth and yield of crop, thereby reducing the utilization of chemical fertilizers. Application of 50% of MSWC and 50% of chemical fertilizers based upon the level of macronutrient in MSWC is also profitable in term of increasing growth and yield of crops as well as reducing application of chemical fertilizers in crop fields.

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