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Use of groundnut shell compost as a natural fertilizer for the cultivation of vegetable plants

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ABSTRACT

The use of organic waste in agriculture can reduce the need of chemical fertilizer and restore the organic carbon deficiency in the soil. As chemical fertilizers are causing ecological damage, an alternative method is required to replace the use of chemical fertilizers for the growth of vegetable plants. In this orientation, groundnut shells (230-300g/Kg) produced during processing are used as a natural fertilizer for the cultivation of vegetable plants to increase their yield and to reduce the environmental pollution. So, we conducted a pot experiment to analyze the possibility of using groundnut shell compost as an alternative to chemical fertilizer in the cultivation of vegetable plants. In this experiment, we selected bitter gourd and brinjal plants as test plants. We used 2:1 ratio of soil to chemical fertilizer as a control and in test chemical fertilizer was replaced by 50, 75 & 100 % v/v of groundnut shell compost. Among the different combinations tested, high yield was observed in 50 % groundnut shell compost treatment. Based on these results, groundnut shell compost can be used as an effective alternative to chemical fertilizer to enhance the growth and yield of vegetable plants and is also an appropriate method to manage environmental pollution.

Keywords: flowering, groundnut shell compost, natural fertilizer, vegetable plants, yield

I. INTRODUCTION

Groundnut cultivation is common as a major food crop in many popular countries. According to the World Food and Agriculture Organization, the major groundnut producing countries are India, China, USA, Indonesia and Myanmar. In worldwide, groundnut cultivation covers about 22.2 million hectares of land, constituting 16.3 million hectares in Asia, 7.39 million hectares in Africa and 0.7 million hectares in South and Central America [1], [2]. From the year 1980 to 2003, the average yield of pods increased globally and in many countries, highest yield around 9.6 tons per hectare has been reported. In India, groundnut is the major oilseed crop accounting for 45 percent of oilseed crops in area and 55 percent in case of production and is playing a major role in bridging the vegetable oil gap in the country. As a legume, groundnuts are rich in nitrogen and its shell contains calcium, phosphorus, potassium, magnesium, zinc and more than 10 kinds of other trace elements, small amount of fat and protein.

In India, 6,853 thousand hectares of area is under cultivation and produced 8643 thousand tons with the yield of 1138 kg per hectare during 1996-97 years and 7867 thousand tons of groundnut during the years 2005-2006. From the several million tons of groundnuts produced each year, hulls constitutes about 25 percent of the total mass produced and are not being utilized. At present in the developing countries the majority of groundnut hulls

are either burned, dumped in forest areas or left to degrade naturally. It is also used as cattle feed and as a carrier of insecticide, in the manufacture of logs and production of pulp and can also be used for preparing activated carbon. In India and other developing countries, the groundnut shell is also used as soil amendment, manure and mulch. Using of groundnut shell waste as an organic fertilizer for the growth of ornamental plants was previously reported by Mohammadi Torkashvand et al. 2015 [3]. So, we have conducted an experiment to evaluate the possibility of using this organic waste as an organic fertilizer for the growth of vegetable plants.

Now a days, mostly vegetable plants are cultivated with cocopeat and soil supplemented with chemical fertilizers, which causes ecological damage to the environment. These factors caused various researchers to use beds, which are of high quality and low expensive instead of fertilizers and peat [4]. Million tons of different agricultural wastes are produced annually across the country, but desperately the major fraction of it is burned or left neglected, leading to environmental pollution [5]. As awareness is increasing on environmental problems related to wastes and to decrease the use of non-renewable sources such as peat, use of composted biosolids has been suggested in farming [6], [7]. But now a days, the wastes are being biologically or chemically treated to attain useful products before the are disposed [8], [9]. Studies conducted by previous researchers reported that, fertilizers can be substituted with organic wastes such as sewage sludge, municipal wastes, paper, pruning waste, fungi beds livestock manure, and other organic waste after composting [10]. Investigations of *Ficus benjamina* variety Starlight in a growth media containing 1:1 ratio of peat to olive waste (as volume) showed that plant growth was very high during 10 months [11]. Papafotiou et al. (2005) [7] conducted studies on using olive waste compost and reported that, using olive waste compost can be used instead of peat to cultivate some ornamental plants and proposed that 25, 75 and 75 % v/v of olive waste compost can be used for cultivating *Cordyline*, *Syngonium podophyllum* and *Ficus benjamina* varieties respectively. Compost is defined as an organic matter that has encountered partial thermophilic, aerobic decomposition and this process is called composting and is totally environmental safe. The method of composting and the combination of raw materials used produces various characteristics, like nutrient content, potential for disease control, organic matter (OM) content and other physical, chemical and biological properties. The main objective of this study is to illustrate the characteristics of organic compost, raw materials for composting, procedure for compost preparation and the use of compost in vegetable plants cultivation.

Composts can also be used as a constituent for low-cost peat substitute, which acts as a potential source against various soil borne diseases and helps the plants to get high yields. The aim of this study is to use groundnut shells compost as an alternative to chemical fertilizer for the cultivation of vegetable plants like bitter gourd and brinjal plants.

II. MATERIALS AND METHODS

This experiment was conducted to evaluate the impact of composted groundnut shell waste as an alternative to chemical fertilizer for the growth of vegetable plants. Groundnut shells were placed in wooden boxes that had pores to provide aerobic conditions and to assure the activity of microorganisms. The temperature and aerations were recorded during the experiment and the compost prepared was applied as a growth media to the plants. Some physical and chemical characteristics of groundnut shells such as total nitrogen, phosphorus, potassium,

organic carbon, C/N ratio, EC and pH in 1:5 extract groundnut shells to water were measured before and after composting. Normally the compost keeps the soil at a neutral pH, which is healthier for most of the plants, which makes beneficial nutrients such as nitrogen, phosphorous and potassium available to the plants.

Bitter gourd and brinjal plants were selected as test plants. These are the important crops grown in India, where bitter gourd belongs to the family Cucurbitaceae and brinjal belongs to Solanaceae. Bitter gourd is a tropical and sub-tropical vine of the family Cucurbitaceae, which is widely grown in Asia, Africa, and the Caribbean as an edible fruit and brinjal is an versatile crop adapted to different agro-climatic regions and can be grown throughout the year. Bitter gourd is an excellent source of vitamins B1, B2, and B3, C, magnesium, folate, zinc, phosphorus, manganese, and has high dietary fiber and iron. Where as, brinjal contain flavonoids, such as anthocyanins, which are water-soluble pigments that have many health benefits and the skin of the eggplant is rich in antioxidants, fiber, potassium, and magnesium. The groundnut shell compost was prepared and passed through a 20 mm sieve. Some physical and chemical characteristics like total nitrogen, phosphorus, potassium, organic carbon, C/N ratio, EC and pH in 1:5 extract groundnut shells to water were measured (Table 1). The experiment was carried out in a Randomized Complete Block Design. The four treatments of the growth media were: (i) control media with 2:1 v/v of soil to chemical fertilizer, (ii) 50 % compost: chemical fertilizer was replaced by 50 v/v of groundnut shell compost in the media, (iii) 75 % compost: chemical fertilizer was replaced by 75 v/v of groundnut shell compost in the media, (iv) 100 % compost: 100 v/v of groundnut shell compost was used as the growth media. After the media is prepared the plants were transferred to pots. Before transferring to the pots, the roots were completely washed. Then for each pot, one plant with a new bed of prepared media was cultivated and then transferred to the greenhouse for further growth. During the growth period, the pots were irrigated regularly. Plant height, number of branches, number of flowers, number of fruits and fruit size were measured during the experiment and the collected data was statistically analyzed.

III. RESULTS AND DISCUSSION

3.1 Physical and chemical characters of the ground shell compost media

Increase in the levels of total nitrogen, phosphorus and potassium of the media and decrease in the bulk density was observed with the use of groundnut shell compost. In 100 % treatment, low yield was observed and accordingly, the porosity of the media was increased by more than 2 % compared to the control. Due to high organic carbon and low total nitrogen, the C/N ratios in the groundnut shell compost treatments were much lower than that of control. Decrease in the available phosphorus of cultivation beds was noticed with the use of groundnut shell compost and a notable aspect was the increase in potassium in the cultivation beds in proportion to the groundnut shell compost used.

3.2 Effect of groundnut shell compost on flowering and fruiting

From the data it was observed that flowering and fruiting of bitter gourd and brinjal plants were positively influenced by the source of compost media applied. In case of bitter gourd, maximum number of flowers (Fig. 1), highest number of fruits per plant (26.0) and maximum weight of fruit (128.0 gm) (Fig. 2) was observed in T_2 treatment (TABLE 1). In case of brinjal plant also, highest number of branches/plant (20.1), maximum

number of flowers per plant (94.2) (Fig. 3), maximum number of fruits per plant (15.20) and maximum fruit weight (1970 gm) (Fig. 5) was observed in T_2 treatment (TABLE 1) (Fig. 4). In both the plants, lowest yield was obtained from the T_4 treatment containing 100 % compost. In brinjal plant, maximum length of fruits (14.1 cm) and the maximum fruit diameter (4.3 cm) were recorded in T_2 treatment. All groundnut compost treatments increased the plant height compared to the control.

TABLE. 1 EFFECT OF GROUNDNUT SHELL COMPOST ON GROWTH AND YIELD OF BITTER GOURD AND BRINJAL PLANTS

	Bitter gourd		Brinjal	
Treatments	**No. of fruits /plant**	**Single fruit weight (gm)**	**No. of fruits /plant**	**Single fruit weight (gm)**
T_1	18.00	104.0	12.20	1530.0
T_2	26.00	128.0	15.20	1970.0
T_3	22.00	120.0	14.40	1880.0
T_4	15.00	95.0	11.70	1490.0

T_1= 2:1 v/v of soil to chemical fertilizer, T_2= 50 % Groundnut shell compost, T_3=75 % Groundnut shell compost, T_4=100 % Groundnut shell compost

Fig. 1 Flowering bitter gourd plant

Fig. 2 Ready to harvest bitter gourds

Fig. 3 Flowering stage of brinjal plant

Fig. 4 Fruiting stage of brinjal plant

Fig. 5 Fully developed brinjal fruits

3.3 Impact of organic and inorganic farming on soil properties and fruit yield

The chemical properties of soil were influenced by different sources of soil nutrients (organic and chemical). Soil pH varied significantly with the treatments and it decreased with organic manures application and combined application but increased with the case of chemical fertilizer application (Table. 2). Availability of major plant nutrients like N, P, K and S were also affected by organic cultivation of bitter gourd and brinjal plants. In all cases, the nutrient availability increased and the highest availability of N, P and S was found from groundnut shell compost. The result might be due to the improvement of other physical and chemical properties of organic manure applied compared to the chemical fertilizer application.

TABLE 2. EFFECT OF DIFFERENT TREATMENTS ON NUTRIENT UPTAKE AND CHEMICAL PROPERTIES OF SOIL

Treatments	Soil pH	Organic matter (%)	Total N %	Available P (ppm)
T_1	6.38	1.82	0.16	13.10
T_2	6.19	3.57	1.16	13.55
T_3	6.13	3.06	0.17	14.91
T_4	6.01	2.05	0.12	13.12

T_1= 2:1 v/v of soil to chemical fertilizer, T_2= 50 % Groundnut shell compost, T_3=75 % Groundnut shell compost, T_4=100 % Groundnut shell compost

The nitrogen content increased with the amount of groundnut shell compost applied, which is due to high amount of nitrogen provided by the compost. Related to this, some earlier reports stated that, increase in nitrogen content was observed in pot cultivation beds grown by adding manure compost to the soil compared to peat and the phosphorous content decreased with the amount of compost applied [12]. According to Nappi and Barberis (1993) [13], the nitrogen level present in the soil beds is sufficient for plant growth. Actually the phosphorous content is high in groundnut shell compost, but the available phosphorous was low in compost treatments. It was observed that the microorganisms in the compost had changed mineral phosphorous to organic phosphorous, thus decreasing the level of available phosphorous [14]. Decreased levels of phosphorous was also reported by Grigatti et al. (2007) [12] and Prez- Murcia et al. (2006) [15] in the case of media containing sludge and green waste compost. Reduced C/N ratio (69 %) of vegetable waste along with the utilization of 50 % phosphorus by fungal species was observed in the experiments of Logakanthi et al. (2006) [16]. The pH values of the groundnut compost media were ideal for the cultivation of vegetable plants.

Different types of organic and inorganic fertilizers had great impact on the yield of vegetable plants. The results revealed that in both the plants, the maximum fruit yield was recorded from plants grown with the T_2 treatment and low yield was observed in T_4 treatment (100 % compost). Increase in nitrogen levels were observed with the increase in the level of groundnut compost supplied to the growth media. Oworu et al. (2010) [17] reported the same, where nitrogen uptake was observed in Amaranthus ornamental plant, with the addition of compost to the growth media. These results indicate that the application of organic manures maintained the health of the soil, where as inorganic fertilizers application will affect the soil, which in turn may affect flowering and fruiting of the crop. So, the cultivation of vegetable plants with the growth media containing a mixture of soil and organic source like groundnut shell compost supplies the essential nutrients required for good yield and successively decreases the soil pollution causing by the use of chemical fertilizers.

IV. CONCLUSION

Application of groundnut shell compost as a substitute to inorganic fertilizers in the cultivation media enhanced the growth of vegetable plants and acted as an effective organic fertilizer. According to our study, application of 50 % groundnut shell compost to the vegetable plants is suitable for better yield. Based on our results, we conclude that the use of groundnut shell compost is an effective alternative source to chemical fertilizer, to enhance the yield without affecting the fertility of the soil and environment.

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