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RESEARCH ARTICLE Agricultural Science Digest

Efficiency of Biocomposted Agroindustrial Wastes and Their Response in the Growth and Yield of *Vigna unguiculata* (L.) Walp

M. Silpa, A. Vijayalakshmi

10.18805/ag.D-5321

ABSTRACT

Background: Agroindustrial by-products of cocoa shell and jack fruit peels generally considered as organic waste have almost no economic value and create a big problem in disposal time. A significant amount of biocomposted cocoa shell and jack fruit peel waste is used as organic manure that enhances growth in *Vigna unguiculata* (L.) Walp.

Methods: This research work was conducted in the period of 2019 in the Department of Botany, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, Tamil Nadu (India). A large amount of cocoa shell and jack fruit peel waste was used for the biocompost preparation using *Pleurotus eous, Pleurotus florida* spawns and *Eudrilus eugeniae.* After 90 days, biocompost were taken and sieved used as manure for plant study. Eight different treatments were carried out for the cultivation of Cowpea. Plant samples at various stages (25, 35 and 45 DAS) were analyzed for shoot and root length, number of leaves, flowers, nodules /plant, fresh weight and dry weight of plant. On 65th day yield parameters like number of pods/plant, length of the pod, number of seeds/pod, weight of seeds/pods, pod fresh weight and pod dry weight were analyzed.

Result: The experimental results showed that the application T_8 (Raw jackfruit peel + 10 g *Pleurotus eous* + 10 g *Pleurotus florida* + *Eudrilus eugeniae* 5 t/ha^{-1}) recorded maximum root (20.63 cm, 32.73 cm and 39.23 cm), shoot length (70.73 cm, 167.50 cm and 175.83 cm), number of leaves/plant (26.46 cm, 33.53 cm and 37.50 cm), number of flowers/plant (12), number of nodules (14, 21.20 and 11.34), fresh weight (10.076 g, 12.146 g and 14.047 g) and dry weight (1.744 g, 1.854 g and 2.827 g) are closely followed by T_4 (Raw cocoa shell+ 10 g *Pleurotus eous* + 10 g *Pleurotus florida* + *Eudrilus eugeniae* 5 t/ha^{-1}). A significant increase in the yield parameters such as number of pods/plant (21), length of pod (16.50 cm), number of seeds/pod (20), weight of seed/pod (1.68 g), fresh weight (5.711 g) and dry weight of pod (2.398 g) was observed in treatment T_8 as compared to the other treatments (T_1, T_2, T_3, T_5, T_6 and T_7) and control respectively.

Key words: Biocompost, C- control, Cowpea, DAS-days after sowing, *Eudrilus eugeniae, Pleurotus species*, T- Treatment.

INTRODUCTION

Every year a large amount of agroindustrial wastes and by-products are generated all over the world and disposal of these wastes is a major problem in many countries. Improper dumping of agroindustrial wastes also causes environmental hazards in different ways. Fruit industries by-products such as bagasse, peels, trimmings, stems, shells, bran and seeds account for more than 50% of fresh fruit and have at times a nutritional or functional content higher than the final product (Ayala *et al*., 2011). These residues are released into the environment that may cause environmental pollution and harmful effect on human and animal health. Most of the agroindustrial wastes are untreated and underutilized, therefore in maximum reports it disposed of either by burning, dumping or unplanned landfilling. Fruit and food waste is also generated by damage during transportation, storage and processing. Agroindustrial waste generation is having an impact on environmental, economic and social sectors (Girotto *et al*., 2015). In some cases, by-products are burned to remove fungi and parasites. Many organic residues and related effluents are produced every year through the food processing industries like juice, chips, meat, confectionery and fruit industries. Other fruit industrial wastes constitute the different compositions of cellulose, hemicellulose, lignin, moisture, ash, carbon, nitrogen, etc. These constituents are biochemically digested to produce valuable products like biogas, bio-ethanol and other commercially practical examples. Agricultural solid wastes are used as an alternative source of fertilizers to save the national economy. These wastes help achieve sustainable high yields in food, nutritional security and environmental safety (Munendra Pal *et al.,* 2014). Biocomposting can be

Department of Botany, School of Biosciences, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore-641 043, Tamil Nadu, India.

Corresponding Author: M. Silpa, Department of Botany, School of Biosciences, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore-641 043, Tamil Nadu, India. Email: silpasvp@gmail.com

How to cite this article: Silpa, M. and Vijayalakshmi, A. (2021). Efficiency of Biocomposted Agroindustrial Wastes and Their Response in the Growth and Yield of *Vigna unguiculata* (L.) Walp Agricultural Science Digest. DOI: 10.18805/ag.D-5321.

Submitted: 08-03-2021 **Accepted:** 05-07-2021 **Online:** 04-08-2021

explored as an eco-friendly, cost-effective and sustainable waste management approach. This method is proving an excellent remedy to overcome modern chemical agriculture. Cocoa and jack fruit are important commercial crops in India.

Cocoa is a significant agricultural commodity and a cash product of great economic importance in the world (Afoakwa, *et al.,* 2011). It is obtained from the beans of the *Theobroma* cacao tree belonging to the Malvaceae family. About 80% of cocoa fruit is discarded as residual biomass, including cocoa bean shells, cocoa pod husks and cocoa sweatings. Farmers routinely discard these residues during the initial cocoa bean processing steps, occupying vast areas and raising social and environmental concerns. Alternatively, this residual biomass is used as cocoa tree fertilizer (Zulma *et al.,* 2019). The cocoa and chocolate industries have huge problems with the utilization of waste generated during the production process. Cocoa shells can create material for soil amendment since their addition to the soil as bio-fertilizers increases soil fertility and crop productivity (Sadasivuni *et al*., 2015). Jackfruit is one of the most remunerative and main fruits of India. In India, it is mainly grown in the top ten states in production such as Kerala, Assam, West Bengal, Chattisgarh, Madhya Pradesh, Tamil Nadu, Tripura and Karnataka (Antony and Thottiam, 2018). The unsystematic disposal of cocoa shells and jack fruit peel creates a serious burden on the environment. However proper utilization of the by-products not only increases the economic value but also reduces the cost of disposal. Improper handling of both these wastes makes the proliferation of pests and diseases, air and water pollution.

Vigna unquiculata (L.) Walp. (Cowpea) is one of the most accepted and important leguminous vegetable crops. Cowpea is rich in micronutrients, nutraceuticals and antioxidants. It is an important food legume growing in tropical and subtropical regions of the world, where tender leaves, fresh pods and grains are consumed (Alemu *et al.* 2016). The present investigation determines the impact of biocomposted cocoa shell and jack fruit peel waste on the growth and yield characteristics of *Vigna unguiculata* (L.) Walp.

MATERIALS AND METHODS

Biocomposting study of cocoa shell and jack fruit peel waste

Biocomposting of cocoa shell and jack fruit peel waste studies was done from March to May 2019 and pot culture experiments of cowpea during June to August 2019 at Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, Tamil Nadu, India. A large amount of cocoa shell and jack fruit peel waste was collected from Calicut and Wayanad district of Kerala and these collected wastes were smashed into small pieces. It was sun-dried and stored in gunny bags. The research work was carried out to examine the influence of cocoa shell and jack fruit peel waste biocompost and its response in the growth and yield of cowpea *Vigna unguiculata* (L.) Walp. The preparation of biocompost consists of eight pits of 4 square feet wide and 1-meter depth. *Pleurotus eous* and *Pleurotus florida* spawns are used for the easy decomposition of raw cocoa shell and jack fruit peel waste. After 30 days pre-digested cocoa shell and Jack fruit peel were treated with fifteen exotic earthworms (*Eudrilus eugeniae*). Water is regularly sprayed to maintain the moisture content of each tray. These vermicomposting trays were kept undisturbed for 60 days. After the 90th day biocomposted samples were taken and sieved.

Pot Culture study of *Vigna unguiculata* (L.) Walp

Each experimental pot is filled with 5 kg of red sandy loam soil and control was maintained. Eight biocompost treatments were applied to the respective pots and mixed thoroughly. Seeds of *Vigna unguiculata* (L.) Walp were collected from TNAU Coimbatore. Five cowpea seeds were sown in each pot with three replications. After germination three healthy plants were maintained in each pot. The vegetative growth was analyzed for shoot length, root length, number of leaves, number of flowers, number of nodules, fresh weight and plant dry weight on 25, 35 and 45 DAS. On the 65th-day yield parameters like number of pods /plant, length of pod, number of seeds/pod, weight of seeds/pods, pod fresh weight and pod dry weight were analyzed.

Statistical analysis

The experimental data obtained on 25 DAS, 35 DAS and 45 DAS for vegetative growth and yield parameters of *Vigna*

Table 1: Biocomposting treatments of Cocoa shell and Jack fruit peel waste.

Treatments	Biocomposting combination
C	Control, no manure
T_1	Raw cocoa shell + *Eudrilus eugeniae* 5t/ha^{-1}
T_2	Raw cocoa shell + 20 g *Pleurotus eous* + *Eudrilus eugeniae* 5t/ha^{-1}
T_3	Raw cocoa shell + 20 g *Pleurotus florida* + *Eudrilus eugeniae* 5t/ha^{-1}
T_4	Raw cocoa shell +10 g *Pleurotus eous* +10 g *Pleurotus florida* + *Eudrilus eugeniae* 5t/ha^{-1}
T_5	Raw Jack fruit peel + *Eudrilus eugeniae* 5t/ha^{-1}
T_6	Raw Jack fruit peel + 20 g *Pleurotus eous* + *Eudrilus eugeniae* 5t/ha^{-1}
T_7	Raw Jack fruit peel + 20 g *Pleurotus florida* + *Eudrilus eugeniae* 5t/ha^{-1}
T_8	Raw Jack fruit peel + 10 g *Pleurotus eous* + 10 g *Pleurotus florida*+ *Eudrilus eugeniae* 5t/ha^{-1}

unguiculata (L.) Walp on 65 DAS was subjected to the statistical analysis (one way and two way Anova) and based on the results, inference were drawn.

RESULTS AND DISCUSSION

Influence of biocomposted cocoa shell and jack fruit peel waste response on the vegetative parameters of cowpea

Root length

The treatment combination T_8 (Raw Jack fruit peel +10 g *Pleurotus eous* + 10 g *Pleurotus florida* + *Eudrilus eugeniae* 5t/ha^{-1}) was recorded maximum root length in cowpea plants 20.63cm, 32.73 cm and 39.23 cm followed by T_4 (Raw cocoa shell+10g *Pleurotus eous* +10 g *Pleurotus florida* + *Eudrilus eugeniae* 5t/ha^{-1}) treatment 18.13 cm, 28.86 cm and 30.10 cm on 25,35 and 45 DAS as compared to the control 5.71 cm, 10.76 cm and 14.73 cm (Fig 1a).

Shoot length

A remarkable increase in shoot length was recorded in T_8 treatment 70.73 cm, 167.50 cm and 175.83 cm followed by T_4 treatment 67.93 cm, 112.13 cm and 119.30 cm from 25 to 45 DAS when compared to control 13.93 cm, 35.23 cm and 50.23 cm.

Number of leaves

An appreciable increase in the number of leaves/ plant were recorded in all the treatments as shown in Fig 1(c). A substantial increase in the number of leaves/plant were observed in T8 treatment 26.46 cm, 33.53 cm and 37.50 cm followed by T_4 20.50 cm, 28.83 cm and 34.50 cm as compared to the control 10.50 cm,12.50 cm and 14.46 cm respectively.

Number of flowers

A significant increase in the number of flowers/plant (12) was showed T_8 followed by T_4 (10) on 45 DAS. Minimum numbers of flowers were observed in control (4).

Number of nodules

Number of nodules showed a maximum increase up to 35 DAS after that it was declined. The results were depicted in Fig 1 (d). An remarkable increase in the number of nodules were recorded in T_8 treatment (14, 21.20 and 11.34) followed by T_4 treatment (13.04, 19.23 and 11.23) as compared to the control (3, 10 and 2.19) on 25,35 and 45 DAS.

Fresh weight and dry weight of Plant

A remarkable increase in the fresh weight of test crop was registered in the treatment T_8 (10.076 g, 12.146 g and 14.047 g) closely followed by T_4 (7.195 g, 8.186 g and 12.555 g) on 25 to 45 DAS. The minimum plant fresh weight content was observed in control (1.053 g, 1.077 g and 1.856 g). Similarly the maximum plant dry weight was recorded in T8 (1.744 g, 1.854 g and 2.827 g) followed by T_4 (1.277g, 1.465 g and 2.254 g) on 25, 35 and 45 DAS. The lowest plant dry weight content was noted in control (0.494 g, 0.604 g and 0.819 g) on selected four days as shown in Fig 1 (f and g).

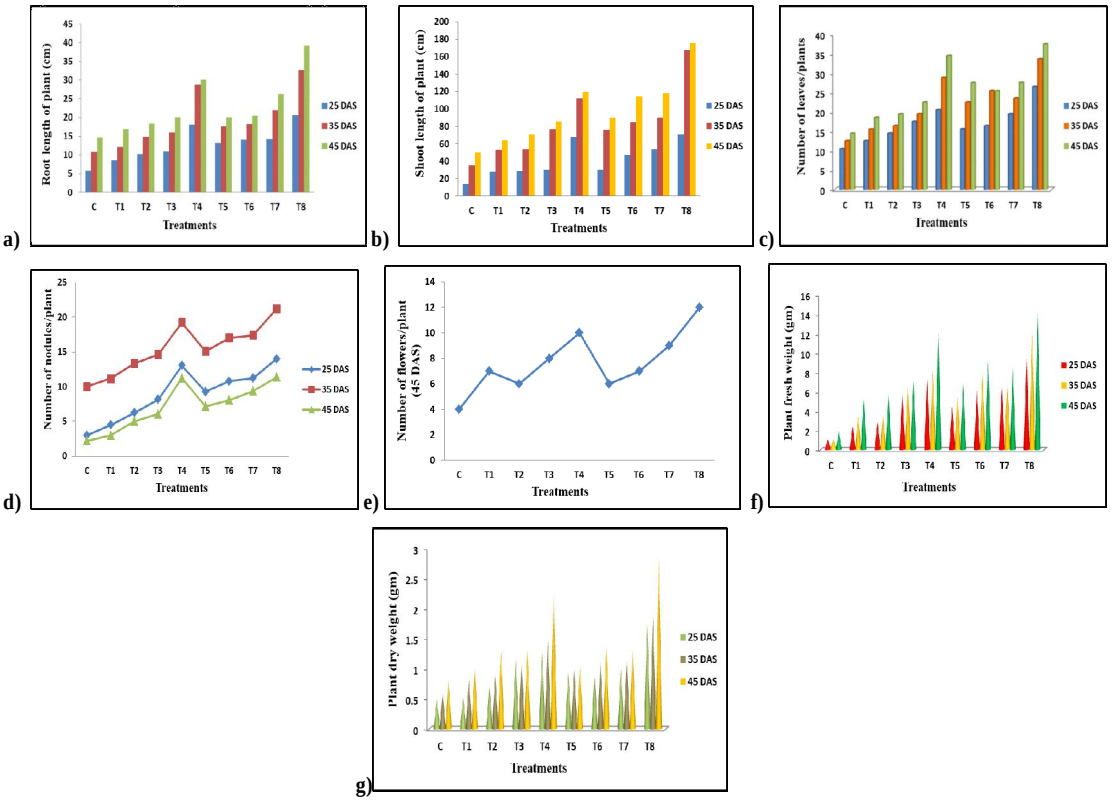

Fig 1: (a-g): Influence of biocomposted cocoa shell and Jack fruit peel waste response on the vegetative parameters of Cowpea on 25, 35 and 45 DAS.

Joshi *et al.* (2016) reported that the recommended dose of RDF (fertilizer 20-40-0 NPK kg ha^{-1}) was significantly higher the number of green pods per plant (79.60) and number of seeds per pod (13.45) in Similar result was obtained by Thomas *et al*. (2013) who observed application of coirpith enhanced the number of nodules in Cowpea. The application of vermicompost combination with bio inoculants influenced the fresh weight (903.7 g) and dry weight (43.5 g) content in *Rumex acetosella* was done by Sanjukta (2014*).* Similar result was determined in *Lycopersicum esculentum* plant by Gopinathan and Prakash, 2014. The use of agro-industrial wastes as raw materials can help to reduce the production cost and reduce the pollution load from the environment. Agro-industrial wastes are used for the manufacturing of biofuels, enzymes, vitamins, antioxidants, animal feed, antibiotics, chemicals and compost (Sadh *et al.* 2018).

Influence of biocomposted cocoa shell and jack fruit peel waste response on the yield parameters of cowpea (65 DAS)

The maximum number of pods/plant, length of pod, number of seeds/pod, weight of seeds/ pod, pod fresh weight and pod dry weight were superior in the treatment T_8 (Raw Jack fruit peel +10 g *Pleurotus eous* + 10 g *Pleurotus florida* + *Eudrilus eugeniae* 5t/ha^{-1}) when compared to other treatments and control on 65 DAS. Among the treatments a significant increase in the number of pods/plant (21), length of pod (16.50 cm), number of seeds/pod (20), weight of seed/pod (1.68 g), pod fresh weight (5.711 g) and pod dry weight (2.398 g) was recorded in treatment combination T_8 as compared to the control respectively as shown in Fig 2 (a-f).

Dash *et al*. (2010) stated that combined application of digested sludge + press mud + carpet waste compost increased the grain and straw yield in *Oryza sativa*. Similar results were found in in *Capsicum annum* by Rahman *et al*. (2012). Sadiq *et al*. (2018) reported that different organic manures in combination with Zn soil and foliar fertilization resulted in significantly increased growth in maize plant. Kitchen waste compost (KWC) has good potential to improve the physical growth parameters of tomato plants (Choudhary and Mishra, 2019). Nasar *et al.* (2019); Adebayo *et al*. 2017; Meena *et al.* 2019 also reported that the addition of different composts significantly effect on the growth of Wheat plant, *M. oleifer* and *Allium cepa*.

Al-Sabbagh *et al*. (2020) reported that maximum number of leaves was recorded in Ecodrum compost treatment (13.66) grown plants followed by coarse compost treatment and control in Chinese kale. King Chilli plant growth and yield parameters increased significantly in the application of vermicompost and compost when compared to control (Mithra *et al.* 2019). Similar results were found in Kumarimanimuthu and Kalaimath,(2020). Raihing and Vijayalakshmi, (2020) reported that the application of composted fruit waste increased number of pods (24) when compared to control (5) and pod length and number of seeds/ pods (4.2 and 8) have significantly increased in T_4 followed by T_3 (3.800 and 6). Similarly Omidi *et al*. (2017); Nirmala and Vasavi, 2018 also reported that groundnut shell compost enhance the growth of Bitter gourd,Brinjal and canopy plant. Similar results were found Priyanga and Vijayalakshmi, 2020. Increasing the amount of chicken manure tea significantly increase the growth parameters and yield in *Cucumis sativus* on 40, 65 and 90 days done by Mehran *et al.*

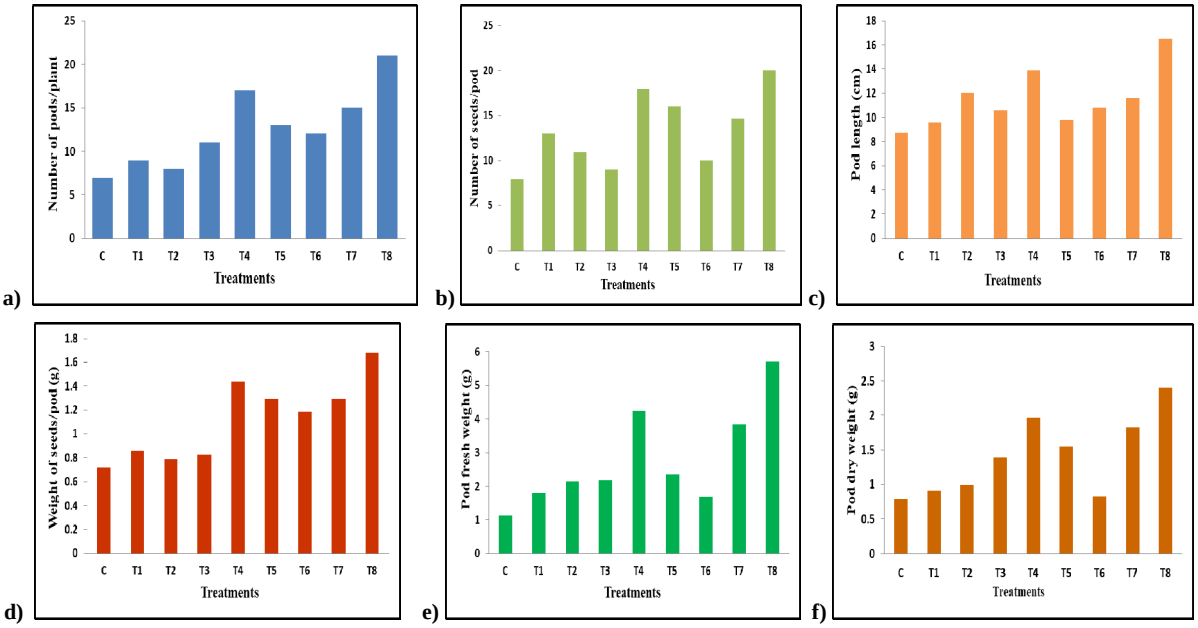

Fig 2: (a-f): Influence of biocomposted cocoa shell and Jack fruit peel waste response on the yield parameters of cowpea on 65 DAS.

2020. Yaiphabi *et al*. (2018) determined that amendment of flower and pineapple wastes has positive impact on the growth and production of the *Solanum melongen*. Similar result was found in the growth amaranthus by Vipitha and Geethakumari, (2016). Chakraborty *et al*. (2017); Majerska *et al*. 2019; Vodnar *et al.* (2019); Malenica and Bhat, (2020) also reported that the there are many implemented strategies currently available to tackle the fruit and vegetable wastes generated in the agro-food supply chain. The utilization of fruit and vegetable wastes used as organic soil amendments, heavy metals adsorbents, ingredients for the production of functional food for humans and livestock feed, energy recovery or bio-refineries and much more. Praveena *et al.* (2018) reported that agricultural waste is converted into compost or farm manure before used in crop production to improve soil fertility. Composting improves healthy food intake, disease resistance, stressful activity and beneficial microbial communities.

CONCLUSION

The present study clearly shows that biocomposted cocoa shell and jack fruit peel waste improves the growth and yield of *Vigna unguiculata* (L.) Walp. Significantly higher values of vegetative parameters was achieved in root (20.63 cm, 32.73 cm and 39.23 cm), shoot length (70.73 cm, 167.50 cm and175.83 cm), number of leaves/plant (26.46 cm, 33.53 cm and 37.50 cm), number of flowers/plant (12), number of nodules (14, 21.20 and 11.34), fresh weight (10.076 g, 12.146 g and 14.047 g) and dry weight of plant (1.744 g, 1.854 g and2.827 g) on 25, 35, 45 DAS respectively. Similarly the maximum yield parameters like number of pods/plant (21), length of pod (16.50 cm), number of seeds/pod (20), weight of seed/pod (1.68 g), pod fresh weight (5.711 g) and pod dry weight (2.398 g) was observed in treatment combination T_8 followed by T_4 as compared to the other treatments (T_1, T_2, T_3, T_5, T_6 and T_7) on 65 DAS. Biocomposted treatment T_8 (Raw Jackfruit peel + 10 g *Pleurotus eous* + 10 g *Pleurotus florida* + *Eudrilus eugeniae* 5 t/ha^{-1}) and T_4 (Raw cocoa shell+ 10 g *Pleurotus eous* + 10 g *Pleurotus florida* + *Eudrilus eugeniae* 5 t/ha^{-1}) used as an effective natural fertilizer as compared to other treatments and control. Biocomposting is an effective tool for agroindurstiral waste management. The present investigation confirms that the utilization of biocomposted agroindustrial waste has tremendous potential for sustainable crop production and reduces harmful environmental effects. However this biocompost recommend as organic manure and support small scale producers for earn more income and food security.

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