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Suitability of Jute Caddies as Partial Growing Media for Sustainable Broccoli Production

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ABSTRACT
A Jute caddie is an important lingo-cellulosic waste generated in the jute mill looms as the unspinnable short fibers during jute processing. Jute caddies as potting material is probably the new concept for cultivation of vegetable crops. A pot experiment was conducted at the University farm of Regional Research Station, New Alluvial zone of Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal to investigate the effect of various combinations of jute caddies and soil mixture on broccoli production. Five treatment combinations viz. T_1: 100% soil (control), T_2: 75% soil + 25% jute caddies, T_3: 50% soil + 50% jute caddies, T_4: 25% soil + 75% jute caddies and T_5: 100% jute caddies were mixed before transplanting of broccoli seedlings along with the levels of N-P-K at 20-40-40 kg/ ha and in RBD design with four réplications. Initials and final soil samples were analysed for relevant physical and chemical properties by following standard methods. Response of broccoli yield over control (T_1) were 2.18 t/ ha (97 %), 1.86 t/ ha (82.67%) and 0.62 t/ ha (27.55 %) in T_2, T_3 and T_4 treatments respectively. They also improved moisture use efficiency, in general, by 96.5% over control. Decreasing bulk density with simultaneous increasing of porosity under each treatment also improved the moisture retention capacity in soil. Better aggregation and their stabilization as well as broccoli yield occurred with applied T_2 (75% Soil + 25% Jute caddies) treatments.
Key words: *Jute caddies, bulk density, porosity, moisture use efficiency, aggregation.*

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INTRODUCTION

Jute is an important fibre cash crop, extensively used for the manufacture of flexible packaging fabrics besides its prospective use as carpet backing, decorative fabrics and in some other fields of technical textiles [2]. This fibre of commerce is extracted from the stem of two cultivated species - tossa jute (*Corchorus olitorius* L.) and white jute (*C. capsularis* L.) [9]. Like other industries, jute industry also generates processing waste as by-products which is about 40,000 tonnes, commonly known as Jute Caddies[5]. This unspinnable short fibre, usually free from foreign particles has found its usage in diverse industries such as: Roof insulation for light and heavy vehicles, Blanket for animal, Seating cushion, Electric wire, Insulation for home. Again biogas can be produced from jute caddies by anaerobic fermentation and after the production of the gas, the left over manure is very rich in nutrient and can be used efficiently for increasing the yield of jute crop[1]. But, adequate information on the direct use of jute caddies as growing media by partial substitution of soil towards improving crop productivity are lacking and probably a new concept.

Broccoli, (*Brassica olaracea*), is an important cash crop whose large flower-head is eaten as a vegetable. It is an excellent source of vitamins and minerals and can be used in table as well as cooking purpose, so the demand of broccoli is gradually increasing day by day. India is the second largest producer of broccoli after China, while the US ranks third. However, the productivity of the crop gradually decreases due to declining soil fertility status and inadequate availabilities of water and other resources.

Keeping in view the above considerations, the present study was undertaken to compare the impact of different proportion of jute caddies and soil on productivity of broccoli and soil quality parameters in sub-tropical condition.

MATERIAL AND METHODS

The experiment was carried out in winter season of 2017-2018 at Regional Research Station, Bidhan Chandra Krishi Viswavidyalaya, New Alluvial zone, Nadia, West Bengal using clay pots for planting broccoli seedlings. The farm is located at $22^0$58' N L, $88^0$26' E L, with an altitude at 10.9 m above MSL having an average rainfall of 1500-1600 mm/year with variation of temperatures between 10^0-38^0 C. The soil i.e. used for filling the pots were belong to the family Typic ustifluvent, sandy loam in texture with almost neutral pH of 6.7, low in organic carbon (0.52%), available N (43.5 kg/ha), available P (11.6 kg/ha) and available k content (155.0 kg/ha).

The experiment was conducted in randomized block design with five treatments each of which was replicated four times using Broccoli (variety Princess) as a test crop. The treatments, composing different combinations of jute caddies with soil were as follows: T_1: 100% Soil (control), T_2: 75% Soil + 25% Jute caddies , T_3: 50% Soil + 50% Jute caddies and T_4: 25% Soil + 75% Jute caddies and T_5: 100% Jute caddies. Standard sized pot was filled with soil and jute caddies in proper ratio according to the treatments and proper numbering of each and every treatment with their replication was done alongwith the basal dose of N-P-K @ 20-40-40 kg/ha. Thirty days old healthy seedlings were transplanted on each pot on first week of December, 2017. The recommended package of practices were adopted for growing the crop. Broccolies were harvested on first week of March,2018.

All the data regarding the yield, yield attributes and water use efficiency of the crop were recorded. The moisture content of surface soil samples collected at 7 days interval of the entire growth period were determined by gravimetric method. Bulk density and porosity of soil were determined by the method proposed by Black [3]. The pH, organic carbon (by wet digestion method of Walkley and Black, [16] and available potassium was measured as described by Jackson [8]. Available soil nitrogen and phosphorus were estimated by the method outlined by Subbaiah and Asija [15] and Bray's no. 1 method [4] respectively. The size distribution of aggregates in soil was evaluated by the methods as proposed by Piper [13]. Necessary statistical analysis was worked out to interpret the effects of treatments as suggested by Gomez and Gomez [6].

RESULTS AND DISCUSSION

YIELD OF BROCCOLI

The results of the effect of different treatments on yield and its attributes of broccoli are presented in Table 1. The significantly highest ($P<0.05$) yield (4.43 ton/ha) of broccoli were observed in treatment T_2 (75% soil + 25% jute caddies) along with highest fruit weight (1.2 kg), length and diameter of fruit (29.16 cm & 16.43 cm respectively). Response of broccoli yield over control (T_1) were 2.18 t/ ha (97 %), 1.86 t/ ha (82.67%) and 0.62 t/ ha (27.55 %) respectively in treatments T_2, T_3 and T_4 respectively. But in treatment T_5 (100% jute caddies) the resultant yield was observed lower than the control (100% soil) by 44.44 %. Though all the obtained values are statistically at par with treatment T_1 (control) except T_5 , the increment of yield from treatment T_4 to T_3 is more (1.24 tons/ha) than T_3 to T_2 (0.32 tons/ha). The benefit cost ratio of the crop was also maximum in T_2 but the rate gradually diminishes from T_2 to T_4. These kind of results were obtained probably due to proper root growth towards uninterrupted availability of nutrients through continuous supply of moisture and air. The above results are supported by Paza [12].

SOIL MOISTURE CONTENT AND WATER USE EFFICIENCY OF BROCCOLI:

Soil moisture changes at 7 days interval for the entire growing period of the test crop under various treatments have been depicted in Figure 1. Results revealed that its content was lowest at T_1 (without jute caddies) compared to other treatments. Moisture content of the surface soil at every stage was higher under each of the treatment over control in the following order : $T_5 > T_4 > T_3 \leq T_2 > T_1$. The changes of soil moisture content due to the treatment might be attributed by increasing porosity for the increment of organic matter content. High surface soil moisture due to increase in organic matter content in soil has been reported in many studies [10].

Again the data showed that, the moisture use efficiencies of the crop, generally, increased by 96.5% due to the treatments of jute caddies over control. Though the highest of 116.67% increment occurred in 75% Soil + 25% Jute caddies treatment, increment of MUE was more from treatment T_4 to T_3 (12.47%) than T_3 to T_2 (9.82%). Increase in water use efficinecy and crop productivity due to addition of organic matter or mulching has been reported in many cases [11,7].

PHYSICAL AND CHEMICAL PROPERTIES OF SOIL:

The results of the effects of different amount of jute caddies on the changes of physical and chemical properties of soil are presented in Table 2. Bulk density of soil were decreased by 20.45%, 43.18%, 60.6% and 74.24% with simultaneous increase of porosity by 10.19 (20.3%), 21.51 (42.85%), 30.19 (60.15%) and 36.98 (73.68%) in treatment T_2 , T_3 and T_4 respectively. The results further indicated that

significantly increased availability of nitrogen, phosphorus and potassium. The sole treatment with applied jute caddies improved the availability of nitrogen, phosphorus and potassium. The results also reveal the increment of organic carbon by 7.37%, 14.24%, 24.03% and 36.18% in treatment by 25% , 50% , 75% and 100% jute caddies respectively. Thus the obtained values showed that as the quantity of applied jute caddies increases, soil physical properties and nutrient availability increases over the plot not treated with jute caddies. The above results are supported by [17].

SOIL AGGREGATION

Impact of jute caddies on various indices of soil structure and their stabilization are presented in Table 3. Results clearly revealed much variation of all the indices of soil structure and their stability due to application of various treatments over the control. The values of mean weight diameter (MWD), Structural coefficient, Geometric mean diameter (GMD) and water stable aggregates (WSA > 0.25%) were found highest in the pot having 75% soil with 25% jute caddies treatment. The pot cultivated without any application of jute caddies showed the lowest values of all the structural indices. The above results are supported by [14].

Table 1: Effect of different jute caddies treatments on yield, yield attributes and B:C ratio

Treaments	Fruit weight (kg)	Length of fruit (cm)	Diameter of fruit (cm)	Yield (ton/ha)	Benefit Cost ratio
T_1	0.65	20.16	11.75	2.25	1.5:1
T_2	1.20	29.60	16.43	4.43	2.54:1
T_3	1.00	28.43	14.95	4.11	2.48:1
T_4	0.66	20.21	11.35	2.87	1.85:1
T_5	0.31	12.05	4.08	1.25	1.25:1
CD at 5%	0.084	1.68	1.64	0.64	
SE (m) ±	0.027	0.54	0.525	0.206	

Table 2: Effect of different treatments on soil physical and chemical properties under Broccoli

Treatments	Bulk Density (g/cc)	Porosity (%)	pH	Organic carbon (%)	Available Nitrogen (kg/ha)	Available phosphorous (kg/ha)	Available Potassium (kg/ha)
T_1	1.32	50.19	6.7	0.52	43.50	11.60	155.0
T_2	1.05	60.38	6.72	7.89	52.70	15.75	186.23
T_3	0.75	71.7	6.74	14.76	61.40	21.89	232.5
T_4	0.52	80.38	7.45	24.55	64.55	28.75	269.27
T_5	0.34	87.17	7.98	36.70	79.15	32.64	302.50
CD at 5%	0.20	2.09	0.55	0.69	1.40	1.14	4.26
SE (m) ±	0.06	0.67	0.176	0.22	0.45	0.45	1.36

Table 3: Effect of different treatments on soil structure and their stabilization

Treatment	MWD(mm)	Structural coefficient	GMD(mm)	WSA >0.25%
T1	1.18	0.92	0.67	56.45
T2	1.46	1.12	0.71	84.82
T3	1.86	1.06	0.70	80.29
T4	1.21	0.98	0.55	63.83
T5	1.04	0.84	0.43	58.67
CD at 5%	0.03	0.075	0.03	0.96
SE (m) ±	0.01	0.024	0.01	0.308

CONCLUSION

The results of the study exhibited that the partial substitution of soil with jute caddies as growing media is beneficial for getting higher productivity of broccoli over the control as it has increased the soil moisture content, organic C, available N, P and K contents. Sharp improvements of bulk density, porosity as well as better aggregation and well stabilization of soil aggregates occurred due to application of each different quantities of jute caddies in general, of which 25% jute caddies with 75% soil showed most prominent effect. Though in all cases T_2 has showed the highest result, treatment T_3 has showed much more beneficial effect when compared in percentage increase with other treatments. The increment from treatment T_4 to T_3 is higher than from T_3 to T_2 but, in treatment T_5 all the values diminishes significantly as plant could not get the proper environment for growth. So, treatment T_3 i.e. soil and jute caddies in

equal proportion is the most economical treatment among the other treatments and can be effectively utilized for higher growth of the crop and subsequent improvement in soil health.

Figure 1: Soil moisture content (%) under Broccoli on weekly basis

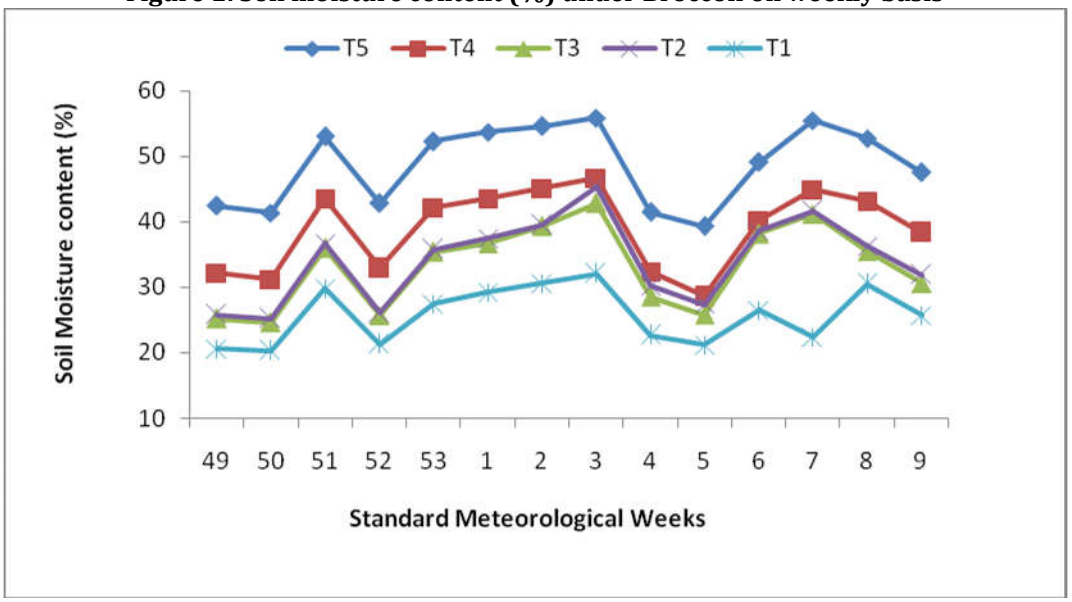
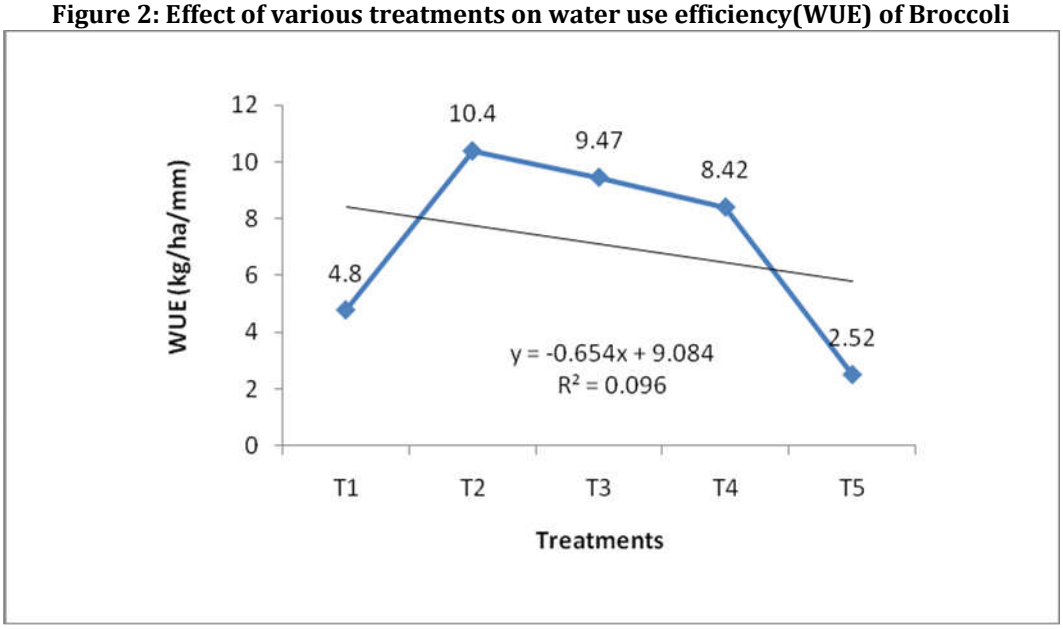


Figure 2: Effect of various treatments on water use efficiency(WUE) of Broccoli



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