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# Capsicum productivity improvement by use of jute caddies as soil conditioner in an inceptisols

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**Abstract**
Use of jute caddies as a mulching material is probably the new concept for cultivation of vegetable crops. A jute caddie is an important lingo-cellulosic waste, produced in the factories as the unspinnable short fibers during jute processing. A field 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 doses of jute caddies on capsicum yield and change of soil properties. Four treatment combinations *viz*. $T_1$: farmer's practice (control), $T_2$: 5 t/ha jute caddies, $T_3$: 10 t/ ha jute caddies and $T_4$: 15 t/ha jute caddies were mixed before transplanting of capsicum seedlings along with the levels of N-P-K at 40-60-30 kg/ ha and in RBD design with four replications. Initials and final soil samples were analysed for relevant physical and chemical properties by following standard methods. The yields of crop were found 14.31, 20.4, 27.14 and 30.96 t/ha, in respectively $T_1$, $T_2$, $T_3$ and$T_4$. The yield of crop was increased 16.65 t/ha (116.35%) under 15 t/ha treatment over farmers practices (control). But the difference in percentage increase in yield between 5 t/ha and 10 t/ha is greater than the percentage difference between 10 t/ha and 15 t/ha. That is, the percentage increase in yield shows a declining trend with the increase in jute caddies. They also improved moisture use efficiency, in general, by 90.5% over control. Decreasing bulk density with simultaneous increasing of porosity under jute caddies treatments also improved the moisture retention capacity in soil. Better aggregation and their stabilization as well as capsicum yield occurred with applied $T_3$ (10 t/ha jute caddies) treatments.

**Keywords:** Jute caddies, organic carbon, porosity and moisture use efficiency

## Introduction
In third world countries, one of the most common natural fibre is Jute and in India, being one of the major traditional earner of foreign exchange, it has a great influence on country's economy [11]. Though the diversification of jute fibre made it a very attractive industrial commodity, the produced jute by-products are not used efficiently [14]. The jute industry generates about 40,000 tonnes of processing waste as by-products, commonly known as jute Caddies [3]. Mitra *et al.,* (1998) [10] found that jute caddies based non-woven fabrics was found suitable as reinforcing material in making Fibre Reinforced Plastic (FRP), there by replacing costlier glass fibre. Nayak *et al.,* (2011) [15] stated that jute caddies in combination with other agro-residues viz., rice husk, sawdust, jute stick can be briquetted at optimum moisture condition of 10-15%. It can be used as a cellulosic raw material for production of biogas with the residual slurry for making manure [16]. But use of jute caddies as mulching material for soil conditioning is probably a new concept for cultivation of vegetable crops.
Capsicum is a genus of flowering plants in the family Solanaceae. Its species are native to the Americas, where they have been cultivated for thousands of years and are now cultivated worldwide. Capsicum is an excellent source of vitamins A, B, C and E and also rich in minerals like molybdenum, potassium, manganese and thiamine. β- carotenoids and vitamin C & A are powerful antioxidants that destroy free radicals [6, 8, 17]. As medicine, it is used as counter irritant in lumbago, neuralgia, rheumatic disorders, non-allergic rhinitis, among others, thus their importance is widely known as a wellbeing food. Due to its high demand in both domestic and foreign market, to minimize the cost of production and maximize profit, use of jute caddies for fetching higher productivity may be a very beneficial approach.
On behalf of these, the present study was done to compare the different amount of applied jute caddies as soil conditioner on capsicum yield and water productivity as well as the soil quality parameters in new alluvial zone of West Bengal.

## Materials and Methods

A field experiment was conducted in winter season of 2017-2018 at Regional Research Station, Bidhan Chandra Krishi Viswavidyalaya, New Alluvial zone, Nadia, West Bengal. 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 of the experimental site is an typical alluvial soil (Typic ustifluvent), sandy loam in texture with almost neutral pH of 6.4, low in organic carbon (0.51%), available N (43.5 kg/ha), available P (9.05 kg/ha) and available k content (157.25 kg/ha).

The experiment was conducted in randomized block design with four treatments each of which was replicated four times using Capsicum (variety Pusa Deepti) as a test crop. The treatments, composing different amounts of jute caddies were as follows: $T_1$: farmer's practice (control), $T_2$: 5 t/ha jute caddies, $T_3$: 10 t/ ha jute caddies and $T_4$: 15 t/ha jute caddies. The unit plot size was maintained by 20 sq.m with spacing of 60 cm between row to row and 30 cm between plant to plant. Before transplanting, the jute caddies were mixed thoroughly with soil alongwith the basal dose of N-P-K @ 40-60-30 kg/ha. Forty days old healthy seedlings were transplanted on each plot on first week of december, 2017. The recommended package of practices were adopted for growing the crop. The green capsicum crops were harvested from 2nd fortnight of February upto 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 (1965) [1]. The pH, organic carbon (by wet digestion method of Walkley and Black, 1934) [20] and available potassium was measured as described by Jackson (1973) [7]. Available soil nitrogen and phosphorus were estimated by the method outlined by Subbaiah and Asija (1956) [19] and Bray's no. 1 method (Bray and Kurtz 1945) [2] respectively. The size distribution of aggregates in soil was evaluated by the methods as proposed by Piper (1966) [16]. Necessary statistical analysis was worked out to interpret the effects of treatments as suggested by Gomez and Gomez (1984) [4].

## Results and Discussion

### Capsicum Yield and Moisture Use Efficiency

Results of the experiment revealed highly significant variation in growth and yield of capsicum under different treatments imposed (Table 1). Highest fruit weight (190 g), length and diameter of fruit ( 8.75 & 7.85 respectively) were recorded in $T_3$ treatment i.e. in plot treated with jute caddies @ 15 t/ha. However, results with the lowest values were recorded in $T_1$ treatment (without jute caddies). Response of yield over control due to treatments were 6.09 ton/ha (42.5%), 12.83 ton/ha (89.65%) and 16.65 ton/ha (116.35%) in treatments $T_2$: 5 t/ha jute caddies, $T_3$: 10 t/ ha jute caddies and $T_4$: 15 t/ha jute caddies respectively. Though all the obtained values are statistically at par with treatment $T_1$ (control), the increment of yield from treatment $T_2$ to $T_3$ is more (6.74 Tons/ha) than $T_3$ to $T_4$ (3.82 Tons/ha).

**Table 1:** Effect of different jute caddies treatments on yield & its component and moisture use efficiency (MUE) of Capsicum

| Treatments | Fruit weight (g) | Length of fruit (cm) | Diameter of fruit (cm) | Yield (ton/ha) | MUE (kg/ha/mm) |
|---|---|---|---|---|---|
| $T_1$ | 130 | 8.15 | 7.20 | 14.31 | 42.7 |
| $T_2$ | 146 | 8.40 | 7.45 | 20.40 | 71.22 |
| $T_3$ | 178 | 8.65 | 7.76 | 27.14 | 83.05 |
| $T_4$ | 190 | 8.75 | 7.85 | 30.94 | 89.75 |
| CD at 5% | 3.08 | 0.33 | 0.45 | 0.79 | 1.37 |
| SE (m) ± | 0.95 | 0.10 | 0.14 | 0.24 | 0.42 |

Again the data showed that, the moisture use efficiencies of the crop, generally, increased by 90.5% due to the treatments of jute caddies over control. Though the highest of 110.2% increment occurred in 15 tons/ha jute caddies treatment, increment of MUE was more from treatment $T_2$ to $T_3$ (27.7%) than $T_3$ to $T_4$ (15.7%). Increase in water use efficinecy and crop productivity due to addition of organic matter or mulching has been reported in many cases [5, 12].

### Effect of Jute Caddies On Soil Moisture Content

Soil moisture content is an important factor which influences the activity of microorganisms in soil as well as growth of the crop. So, the moisture changes data at 7 days interval for the entire growing period of capsicum under various treatments have been depicted in Fig.1. Results revealed that its content was lowest at $T_1$ (without jute caddies) compared to other treatments. Though it was found maximum under the soil treated with 15 tons /ha i.e. $T_3$, the amount of increment under $T_3$ from $T_2$ is more than treatment $T_4$ from treatment $T_3$. Treated plot showed higher soil moisture content compared to control because of their increased water retention capacity due to the increment of porosity. High surface soil moisture due to increase in organic matter content in soil has been reported in many studies [9].

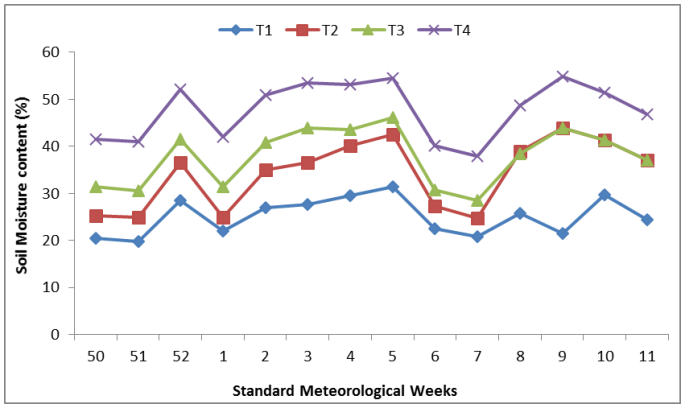


**Fig 1:** Soil moisture content (%) under Capsicum on weekly basis

### 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 0.10 (7.19%), 0.12 (8.63%) and 0.13 (9.35%) with simultaneous increase of porosity by 6.2 (15.27%), 7.9 (19.45%) and 9.1 (22.4%) in treatment $T_2$, $T_3$ and $T_4$ respectively. The results further indicated that significantly increased availability of nitrogen, phosphorus and potassium.

The highest quantity of applied jute caddies improved the availability of N-P-K by 83.56%, 91.49% and 30.09% over control respectively. The results also reveal the increment of organic carbon by 0.24 (47.05%), 0.36 (70.58%) and 0.47 (92.15%) in treatment by 5 tons/ha, 10 tons/ha and 15 tons/ha 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 Walsh *et al*. (2012) [21].

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

| Treatments | Bulk Density (g/cc) | Porosity (%) | pH | Organic carbon (%) | Available Nitrogen (kg/ha) | Available phosphorous (kg/ha) | Available Potassium (kg/ha) |
|---|---|---|---|---|---|---|---|
| $T_1$ | 1.39 | 40.6 | 6.4 | 0.51 | 43.50 | 9.05 | 248.25 |
| $T_2$ | 1.29 | 46.8 | 6.6 | 0.75 | 65.34 | 14.35 | 281.55 |
| $T_3$ | 1.27 | 48.5 | 6.7 | 0.87 | 73.68 | 16.75 | 307.85 |
| $T_4$ | 1.26 | 49.7 | 6.8 | 0.98 | 79.85 | 17.33 | 322.95 |
| CD at 5% | 0.08 | 1.87 | 0.23 | 0.15 | 2.54 | 0.72 | 4.00 |
| SE (m) ± | 0.02 | 0.57 | 0.07 | 0.05 | 0.78 | 0.22 | 1.23 |

**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 non-treated plot. 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 plot treated with 15 tons/ha jute caddies followed by 10 tons/ha, 5 tons/ha jute caddies. The plot cultivated without any application of jute caddies showed the lowest values of all the structural indices. The above results are supported by Six *et al*. 2000 [18].

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

| Treatment | MWD (mm) | Structural coefficient | GMD (mm) | WSA> 0.25% |
|---|---|---|---|---|
| $T_1$ | 1.22 | 0.92 | 0.77 | 59.87 |
| $T_2$ | 2.25 | 1.09 | 1.01 | 72.58 |
| $T_3$ | 2.63 | 1.23 | 1.26 | 82.23 |
| $T_4$ | 2.91 | 1.27 | 1.42 | 84.74 |
| CD at 5% | 0.01 | 0.05 | 0.03 | 0.82 |
| SE (m) ± | 0.003 | 0.01 | 0.009 | 0.25 |

**Conclusion**

The results of the study exhibited that application of jute caddies as soil conditioner is beneficial for getting higher productivity of capsicum over the non-treated plot 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 15 tons/ha jute caddies showed most prominent effect. Though in all cases the highest amount of jute caddies i.e. 15 tons/ha has showed the highest result, treatment $T_3$ has showed much more beneficial effect when compared in percentage increase with other treatments. The percentage increase from treatment $T_2$ to $T_3$ is higher than from $T_3$ to $T_4$ that is after treatment $T_3$ the increment occurred in all cases but in a declining pattern. So, treatment $T_3$ i.e. 10 tons/ha jute caddies 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.

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