Original Research Article

Effect of Organic Manures and Inorganic Fertilizers on Plant Growth and Tuber Yield of Cassava under Allahabad Agro Climatic Conditions (*Manihot esculenta*) cv. Sree Vishakham

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**A B S T R A C T**

The present investigation was undertaken to study the effect of organic manures and inorganic fertilizers on plant growth and tuber yield of cassava (*Manihot esculenta*) under Allahabad agro climatic conditions cv. Sree vishakham. The experiment was laid out in Randomized block design with 12 treatments and each replicated thrice. The treatments consist different combinations of inorganic fertilizers like Urea, DAP, MOP, and organic manures like FYM, Poultry manure, Vermicompost. Among these 12 treatments, the growth attributes like plant height, total number of leaves per plant, total number of branches per plant are maximum, yield attributes like, average tuber weight, tuber yield are maximum and number of tuber is minimum under the treatment T<sub>9</sub> (25% RDF + 75% Poultry manure) followed by the treatment T<sub>6</sub> (50% RDF + 50% poultry manure). Maximum gross returns (Rs.4,33,300 ha<sup>-1</sup>), net returns (Rs.2,79,724 ha<sup>-1</sup>) and B: C ratio (2.82:1) was found in treatment T<sub>9</sub> (25% RDF + 75% poultry manure).

**Keywords**

Cassava, Organic fertilizer, Inorganic fertilizer and Yield

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**Introduction**

Cassava is a perennial shrub of the family Euphorbiaceae, cultivated mainly for its starchy roots. It is one of the most important food staples in the tropics, where it is the fourth most important source of energy. It derives its importance from the fact that it produces more calories/ unit area from its starchy tuberous root which is valuable source of cheap calories especially in developing countries (Som, 2007). On a worldwide basis it is ranked as the sixth most important source of calories in the human diet (FAO, 1999). The introduction of improved varieties of cassava helped boost yield of this main staple by almost 40 percent (FAO, 1999). Apart from its use as food, it is also an important industrial raw material for the production of starch, alcohol, pharmaceuticals, gums, confectioneries and livestock feed (Nnodu et al., 2006).

Cassava possesses a high potential for yielding large amounts of food per unit area and also it is an efficient producer of calorie (135 calorie/100 g fresh tuber) compared with other cereal crops (Sridevi et al., 2013). In India, cassava ranks first in area (2.35 lakh ha) and production (5.4 million tonnes of fresh tubers).
followed by sweet potato. Its average productivity is 23 tonnes/ha, the highest in the world (Department of Economics and Statistics, Season and Crop Report, 2005). Although cassava is a perennial crop, the storage roots can be harvested from 6-24 months after planting, depending on cultivar and the growing conditions (El-Sharkawy, 1993). In the humid lowland tropics the roots can be harvested after 6-7 months.

In regions with prolonged periods of drought or cold, the farmers harvest after 18-24 months (Cock, 1984). Moreover the roots can be left in the ground without harvesting for a long period of time, making it very useful crop as a security against famine (Cardoso and Souza, 1999). It is generally propagated from either stem cuttings or sexual seed. Propagation through true seed occurs under natural conditions and is widely used in breeding programme.

Plants from true seeds take longer to become established, and they are smaller and less vigorous than plants from cuttings. Application of organic manures and inorganic fertilizers will increase the crop yield. Agbaje et al., (2004) reported that the influence of NPK fertilizer on tuber yield of early and late planted cassava which resulted fertilizer influence on tuber yield was not significant in early planted cassava and in late planted significant reduction in yields. Ojeniyi et al., (2012) reported that effects of combined application of reduced levels of NPK fertilizer and poultry manure on soil and plant nutrient composition, growth and yield of cassava was studied, result was Nutrient content in cassava growth, and tuber yield parameters increased in the order of control<NPK<PM<5t/ha PM+300kg/ha NPK<2.5t/ha PM+450kg/ha NPK, it increased tuber yield by 34, 28, 66,133% respectively. Keeping in view all the above factors an experiment has been conducted to access the effect of organic and inorganic fertilizers on plant growth and tuber yield of cassava with the comparative economics of various treatment combinations.

Materials and Methods

The present research work has been carried out to find the effect of organic manures and inorganic fertilizers on plant growth and tuber yield of cassava (Manihot esculenta) under Allahabad agro climatic conditions.

The field experiments were conducted in the vegetable research field, Department of Horticulture, Allahabad School of Agriculture, Sam Higginbottom Institute of Agriculture, Technology and Sciences (SHIATS), Allahabad. During kharif season (2015-16), the stem cuttings of cassava obtained from CTCRI, Thiruvananthapuram. Cassava (Manihot esculenta) variety Sree visakham was utilized for study. Stem cuttings of 15cm were used as planting material. The field was prepared as per the recommended agronomic practices.

Field experimental design and details

Crop: cassava
Cultivar: Sree visakham
Plot size: 5.0 m x 1.0 m
Spacing: 1.0 m x 1.0 m
Design: RBD
Replication: three
Duration: 300 days

Fertilizer application

The recommended fertilizer schedule of 75:50:75 kg N, P₂O₅ and K₂O was followed for the cassava crop. The phosphorus was applied as a single basal dose, whereas nitrogen and potassium were applied in two split doses. The fertilizers urea, diammonium phosphate and muriate of potash were used for the above schedule.
Results and Discussion

Growth Parameters

The data revealed that the combination of different organic manures and inorganic fertilizers affected growth attributes like plant height of cassavas shown in (Table 1). Significant difference in the plant height was recorded due to application of different combination of organic manures and inorganic fertilizers. The treatment $T_9$ (25% RDF+75% Poultry manure) recorded the maximum plant height (185.93 cm), followed by $T_6$ (50% RDF+50% Poultry manure), (181.50 cm) which differed significantly from each other as well from other treatment.

The data revealed that the combination of different organic and inorganic fertilizers affected growth attributes like total number of leaves per plant of cassavas shown in (Table 2). Significant difference in the plant leaves per plant was recorded due to application of different combination of organic manures and inorganic fertilizers. The treatment $T_9$ (25% RDF+75% Poultry manure) recorded the maximum plant leaves per plant, followed by $T_6$ (50% RDF+50% Poultry manure) which differed significantly from each other as well from other treatment.

The data revealed that the combination of different organic and inorganic fertilizers affected growth attributes like total number of branches per plant of cassavas shown in (Table 3). Significant difference in the plant leaves per plant was recorded due to application of different combination of organic and inorganic fertilizers. The treatment $T_9$ (25% RDF+75% Poultry manure) recorded the maximum no of branches per plant, followed by $T_6$ (50% RDF+50% Poultry manure) which differed significantly from each other as well from other treatment.

The plant height, total number of leaves per plant, total number of branches per plant in the treatments $T_9$ and $T_6$ might be due to the application of organic manures and inorganic fertilizers might have improved the soil physical and chemical properties and leading to the adequate supply of nutrients to the plants which might have promoted the maximum vegetative growth while the minimum plant growth was due to non-availability of it. Similar findings were reported by Ojeniyi et al., (2012) in cassava.

Details of Treatment

| TREATMENTS | TREATMENT COMBINATION |
|------------|-----------------------|
| $T_0$      | Control-RDF(75:50:75kg/ha NPK) |
| $T_1$      | Complete organic (33.3% FYM+33.3% vermicompost+33.3% poultry manure) |
| $T_2$      | 75% RDF+25% FYM |
| $T_3$      | 75% RDF+25% poultry manure |
| $T_4$      | 75% RDF+25% vermicompost |
| $T_5$      | 50% RDF+50% FYM |
| $T_6$      | 50% RDF+50% Poultry manure |
| $T_7$      | 50% RDF+50% Vermicompost |
| $T_8$      | 25% RDF+75% FYM |
| $T_9$      | 25% RDF+75% Poultry manure |
| $T_{10}$   | 25% RDF+75% Vermicompost |
| $T_{11}$   | 25% RDF+25% FYM+25% Poultry manure+25% Vermicompost |
Table.1 Effect of organic manures and inorganic fertilizers on plant height of cassava (cm)

| Treatments | 30dap | 60dap | 90dap | 120dap | 150dap | 180dap | 210dap | 240dap | 270dap | 300dap |
|------------|-------|-------|-------|--------|--------|--------|--------|--------|--------|--------|
| T₀         | 20.73 | 52.76 | 70.98 | 90.38  | 106.71 | 118.44 | 130.70 | 159.41 | 172.52 | 174.50 |
| T₁         | 21.65 | 56.74 | 73.03 | 97.19  | 108.33 | 121.61 | 131.67 | 165.44 | 174.71 | 176.49 |
| T₂         | 25.61 | 54.66 | 76.23 | 96.33  | 113.45 | 123.67 | 134.60 | 166.58 | 178.52 | 180.42 |
| T₃         | 22.12 | 55.29 | 77.33 | 95.23  | 110.45 | 119.79 | 135.77 | 161.62 | 177.49 | 179.37 |
| T₄         | 23.89 | 57.11 | 74.32 | 92.39  | 111.43 | 122.77 | 133.60 | 162.54 | 174.69 | 178.63 |
| T₅         | 23.13 | 53.51 | 71.33 | 94.29  | 112.44 | 121.7  | 137.65 | 163.63 | 175.28 | 181.35 |
| T₆         | 25.97 | 57.15 | 77.87 | 97.60  | 114.30 | 124.35 | 138.53 | 166.65 | 178.77 | 181.50 |
| T₇         | 25.07 | 56.42 | 76.11 | 93.41  | 106.71 | 118.44 | 136.59 | 164.60 | 173.64 | 181.48 |
| T₈         | 23.77 | 56.15 | 75.15 | 96.18  | 108.72 | 122.57 | 136.64 | 165.61 | 175.64 | 179.56 |
| T₉         | 29.25 | 60.85 | 80.45 | 100.20 | 115.37 | 125.53 | 141.61 | 169    | 180.45 | 185.93 |
| T₁₀        | 21.95 | 56.51 | 74.25 | 95.37  | 107.47 | 120.33 | 130.86 | 163.87 | 174.79 | 176.55 |
| T₁₁        | 21.07 | 54.38 | 75.29 | 97.16  | 108.47 | 118.69 | 132.67 | 161.52 | 176.56 | 178.41 |

| F test     | S     | S     | S     | S     | S     | S     | S     | S     | S     |
| CD (5%)    | 0.39  | 0.30  | 0.31  | 0.11  | 0.12  | 0.51  | 0.16  | 0.17  | 0.20  | 0.24  |
| CV         | 0.97  | 0.32  | 0.24  | 0.07  | 0.07  | 0.25  | 0.07  | 0.09  | 0.07  | 0.08  |
| SE(+-)     | 0.19  | 0.15  | 0.05  | 0.06  | 0.25  | 0.25  | 0.08  | 0.08  | 0.10  | 0.11  |

Table.2 Effect of organic manures and inorganic fertilizers on total number of leaves of cassava

| Treatments | 30dap | 60dap | 90dap | 120dap | 150dap | 180dap | 210dap | 240dap | 270dap | 300dap |
|------------|-------|-------|-------|--------|--------|--------|--------|--------|--------|--------|
| T₀         | 21.60 | 30.53 | 61.13 | 81.13  | 90.60  | 110.87 | 89.80  | 80.40  | 70.87  | 59.20  |
| T₁         | 22.47 | 34.40 | 62.80 | 85.53  | 95.13  | 112.93 | 91.60  | 84.53  | 73.60  | 62.40  |
| T₂         | 23.13 | 35.53 | 63.60 | 84.60  | 93.87  | 115.87 | 90.53  | 81.40  | 71.80  | 61.13  |
| T₃         | 24.47 | 37.60 | 64.20 | 82.87  | 94.40  | 115.60 | 89.87  | 83.47  | 70.87  | 62.40  |
| T₄         | 26    | 36.40 | 65.62 | 83.13  | 93.60  | 113.13 | 91.87  | 84.60  | 72.87  | 60.13  |
| T₅         | 26.47 | 34.53 | 62.40 | 84.60  | 91.87  | 114.13 | 90.60  | 80.60  | 74.40  | 61.80  |
| T₆         | 26.80 | 37.87 | 65.73 | 86.27  | 95.87  | 117.80 | 92.87  | 84.87  | 75.60  | 62.40  |
| T₇         | 25.60 | 33.60 | 63.60 | 85.60  | 93.87  | 116.13 | 91.40  | 81.60  | 74.87  | 61.53  |
| T₈         | 24.13 | 34.67 | 62.87 | 86.20  | 94.60  | 111.53 | 90.60  | 83.60  | 72.60  | 60.67  |
| T₉         | 28.40 | 39.87 | 68    | 89.87  | 98.20  | 120.13 | 94.87  | 90.13  | 79.13  | 64.20  |
| T₁₀        | 22.87 | 32.53 | 63.93 | 82.53  | 91.13  | 113.87 | 89.87  | 82.53  | 75.33  | 60.20  |
| T₁₁        | 23.53 | 32.60 | 62.60 | 84.40  | 92.60  | 114.40 | 91.13  | 81.40  | 72.40  | 61.40  |

| F test     | S     | S     | S     | S     | S     | S     | S     | S     | S     |
| CD (5%)    | 0.63  | 0.44  | 0.46  | 0.41  | 0.40  | 0.52  | 0.47  | 0.43  | 0.94  | 0.54  |
| CV         | 1.50  | 0.74  | 0.42  | 0.28  | 0.25  | 0.27  | 0.30  | 0.30  | 0.75  | 0.52  |
| SE(+-)     | 0.30  | 0.21  | 0.22  | 0.20  | 0.19  | 0.25  | 0.23  | 0.21  | 0.45  | 0.26  |
Table 3. Effect of organic manures and inorganic fertilizers on total number of branches of cassava

| Treatments | Total number of Plant branches |
|------------|--------------------------------|
|            | 30dap | 60dap | 90dap | 120dap | 150dap | 180dap | 210dap | 240dap | 270dap | 300dap |
| T0         | 2.53  | 2.27  | 2.60  | 2.20   | 2.40   | 2.20   | 2.40   | 2.07   | 2.33   | 2.00   |
| T1         | 3.80  | 3.33  | 3.20  | 2.60   | 2.93   | 2.40   | 3.00   | 3.00   | 2.60   | 2.40   |
| T2         | 3.40  | 3.33  | 2.60  | 2.40   | 2.60   | 2.73   | 2.47   | 2.80   | 2.53   | 2.87   |
| T3         | 3.87  | 3.40  | 3.20  | 2.80   | 2.60   | 2.60   | 2.67   | 3.00   | 2.53   | 3.00   |
| T4         | 3.53  | 2.40  | 3.00  | 3.20   | 3.13   | 2.40   | 2.87   | 3.00   | 2.40   | 2.60   |
| T5         | 2.60  | 2.47  | 3.60  | 2.20   | 3.20   | 2.20   | 2.80   | 2.80   | 2.47   | 2.53   |
| T6         | 4.60  | 3.42  | 4.00  | 3.40   | 3.58   | 3.00   | 3.97   | 3.20   | 3.19   | 3.19   |
| T7         | 3.20  | 2.40  | 4.00  | 2.40   | 2.87   | 2.27   | 2.73   | 2.60   | 3.13   | 2.80   |
| T8         | 4.27  | 3.40  | 2.60  | 2.80   | 2.60   | 2.40   | 2.40   | 2.33   | 3.00   | 3.13   |
| T9         | 5.53  | 3.60  | 4.20  | 3.60   | 3.60   | 3.20   | 4.00   | 3.40   | 3.20   | 3.20   |
| T10        | 3.53  | 3.42  | 3.00  | 2.20   | 3.40   | 2.60   | 2.60   | 3.20   | 2.53   | 2.40   |
| T11        | 3.13  | 2.53  | 2.67  | 2.40   | 3.57   | 2.40   | 3.40   | 3.00   | 3.00   | 2.20   |
| F test     | S     | S     | S     | S      | S      | S      | S      | S      | S      | S      |
| CD (5%)    | 0.47  | 0.43  | 0.36  | 0.33   | 0.37   | 0.36   | 0.42   | 0.34   | 0.40   | 0.35   |
| CV         | 7.54  | 8.62  | 6.52  | 7.19   | 7.47   | 8.39   | 8.48   | 6.95   | 8.50   | 7.72   |
| SE(+-)     | 0.23  | 0.21  | 0.17  | 0.16   | 0.18   | 0.17   | 0.20   | 0.16   | 0.19   | 0.17   |

Table 4. Effect of organic manures and inorganic fertilizers on number of tubers, average tuber weight (kg), and tuber yield (kg) of cassava

| Treatment details | No of tubers per plant | Average tuber weight(kg) | Tuber yield per plant(kg) | Tuber yield per plot(kg) | Tuber yield per hectare(t) |
|-------------------|------------------------|--------------------------|---------------------------|--------------------------|----------------------------|
| T0                | 4.07                   | 0.82                     | 2.25                      | 11.23                    | 22.47                      |
| T1                | 3.20                   | 0.84                     | 2.41                      | 12.03                    | 24.07                      |
| T2                | 2.87                   | 0.89                     | 3.19                      | 15.97                    | 31.93                      |
| T3                | 2.73                   | 0.95                     | 2.36                      | 11.80                    | 23.60                      |
| T4                | 4.00                   | 0.93                     | 3.31                      | 16.57                    | 33.13                      |
| T5                | 2.60                   | 0.88                     | 2.67                      | 13.37                    | 26.73                      |
| T6                | 2.67                   | 1.30                     | 3.36                      | 16.80                    | 33.60                      |
| T7                | 2.80                   | 0.93                     | 2.52                      | 12.60                    | 25.20                      |
| T8                | 3.07                   | 0.86                     | 2.31                      | 11.57                    | 23.13                      |
| T9                | 2.20                   | 2.01                     | 4.33                      | 21.67                    | 43.33                      |
| T10               | 3.13                   | 1.13                     | 2.33                      | 11.63                    | 23.27                      |
| T11               | 2.27                   | 1.10                     | 2.28                      | 11.40                    | 22.80                      |
| F test            | S                      | S                        | S                         | S                        | S                          |
| CD (5%)           | 0.48                   | 0.19                     | 0.31                      | 1.55                     | 3.09                       |
| CV                | 9.59                   | 10.92                    | 6.57                      | 6.57                     | 6.57                       |
| SE(+-)            | 0.23                   | 0.09                     | 0.15                      | 0.75                     | 1.49                       |
Table 5 Economics of different treatment for cultivation of cassava

| Treatments | Total fixed cost Rs | Total variable cost Rs | Total cost of cultivation Rs | Tuber Yield ha$^{-1}$ (kgs) | Sale rate Rs kg$^{-1}$ | Gross return Rs/ha | Net return Rs/ha | Cost Benefit ratio |
|------------|---------------------|------------------------|------------------------------|-----------------------------|------------------------|-------------------|-----------------|------------------|
| T0         | 150800              | 5105                   | 155905                       | 22470                       | 10                     | 224700            | 68795           | 1:1.44           |
| T1         | 150800              | 7600                   | 158400                       | 24070                       | 10                     | 240700            | 82300           | 1:1.52           |
| T2         | 150800              | 4630                   | 155430                       | 31930                       | 10                     | 319300            | 163870          | 1:2.05           |
| T3         | 150800              | 4330                   | 155130                       | 23600                       | 10                     | 236000            | 80870           | 1:1.52           |
| T4         | 150800              | 4153                   | 154953                       | 33130                       | 10                     | 331300            | 176347          | 1:2.13           |
| T5         | 150800              | 3753                   | 154553                       | 26730                       | 10                     | 267300            | 112747          | 1:1.72           |
| T6         | 150800              | 3553                   | 154353                       | 33600                       | 10                     | 336000            | 181647          | 1:2.17           |
| T7         | 150800              | 3676                   | 154476                       | 25200                       | 10                     | 252000            | 97524           | 1:1.63           |
| T8         | 150800              | 2716                   | 153516                       | 23130                       | 10                     | 231300            | 77784           | 1:1.50           |
| T9         | 150800              | 2776                   | 153576                       | 43330                       | 10                     | 433300            | 279724          | 1:2.82           |
| T10        | 150800              | 3176                   | 153976                       | 23270                       | 10                     | 232700            | 78724           | 1:1.51           |
| T11        | 150800              | 2750                   | 153550                       | 22800                       | 10                     | 228000            | 74450           | 1:1.48           |

Yield parameters

The data revealed that the combination of different organic manures and inorganic fertilizers affected yield parameters of cassava as shown in (Table 4). In the present study, among the various treatment combinations T9 (25% RDF+75% poultry manure) recorded maximum yield per plant (4.33kg) minimum number of tubers per plant (2.20), maximum average tuber weight (2.01kg), maximum yield per plot (21.67kg) and maximum yield per hectare (43.33t/ha) followed by T6 (50% RDF+50% poultry manure) and minimum were recorded in Treatment T0 (Control).

The increase yield per plant, per plot and per hectare might be due to the increased growth attributes which in turn lead to the increased photosynthates and dry matter production. Minimum number of height and yield in T0 (Control) might be due to non-availability of organic fertilizer during its development. Similar findings were reported by Ojeniyi et al., (2012), Ayoola et al., (2006) in cassava.

Economics of cassava

The optimum rates of fertilizer to use depend not only on physical yield response of cassava but also the economic conditions such as prices of fertilizers and the cassava product. Table 5 shows the economics of cassava cultivation experiment.

The treatment T9 (25% RDF + 75% Poultry manure) gave highest gross return (4, 33,300), highest net return (2, 79,724) and highest cost benefit ratio (1:2.82).

On the basis of present study, it is concluded that the application of 25% RDF + 75% Poultry manure resulted in maximum plant height (185.93 cm) and tuber yield (4.33kg/plant).

This treatment also gives maximum gross return (Rs.4, 33,300) and maximum net return (Rs.2, 79,724).

The cost benefit ratio (1:2.82) is also high in this treatment combination.
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