

Original Research Article

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Effect of Organic Manures and Biofertilizers on Growth, Yield and Quality of Chilli (*Capsicum annum*) cv. Pusa Jwala

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ABSTRACT

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A field experiment was conducted to evaluate the effect of organic manures and bio-fertilizers on the growth, yield and quality of chilli cv. Pusa Jwala. The experiments were conducted in Randomized Block Design with three replication. Among the various thirteen treatments, the combination of poultry manure + Azotobacter + Phosphotika stimulated better response. The growth, yield, ascorbic acid, TSS and NPK uptake by chilli plants were influenced by the application of organic manures and biofertilizers in combination. The maximum dry yield of 10.93q ha⁻¹, ascorbic acid content of 300.00 mg, TSS (12.0 Brix) and 312.50kg ha⁻¹, 20.15 kg ha⁻¹ and 264.00 kg ha⁻¹ of NPK uptake and the highest profit were recorded in the treatment combination of poultry manure + Azotobacter + Phosphotika. Thus, combine use of organic manures and bio-fertilizers proved better in improving the growth, yield and quality than using organic alone.

Introduction

Chilli is one of the most important spices of India and is used in bulk quantities of both in fresh as well as dried forms. Important cultivated species of chilli are *Capsicum annum*, *Capsicum frutescens* and *Capsicum chinense*. Chilli (*Capsicum annum*) belongs to family solanaceae. India is a leading country in production of chilli in the world, present area under chilli cultivation is about (0.79 million ha) with a production of (1.2 million tonnes) and productivity of about (1.5 t/ha). The production of chilli in North East Region is (3000 t) from an area of (600 ha). Presently,

India is the main source of red chilli for international market. Export of chilli accounts for (2, 41,000 t) in terms of quantity and (2, 14,408 Rs in lakhs) in terms of value from India in 2011-2012. Chilli is one of the richest sources of vitamin 'C' and fruits accumulate maximum ascorbic acid when it turns to maturity and it ranges from 100 – 320 mg per 100 g of fruits. Active principle for pungency is capsaicin (N-vanillyl-8-methyl-6(9H)-xanthen-9-oneamide). The principle colouring pigment is 'capsanthin'.

Chilli is a group of warm humid tropics or sub-tropics and is grown from sea level to 600m above MSL. Medium pungent chilli cultivated for green chilli and dry chilli purpose prefers a temperature of 20-30°C for growth. Low pungent capsicum prefers a low temperature of 17-23°C, highly pungent *Capsicum frutescens* and *Capsicum chinense* come up well in high rainfall region of southern and non-eastern region of India. Ideal soil pH for cultivation is around 6.5.

Among the various factors responsible for low production of chilli, nutrition is of prime importance. The application of chemical fertilizer has led to increase in production but also deteriorated ecosystem. The chemical fertilizers are not ecofriendly but also costly. The use of inorganic fertilizer has come to level of causing a concern to environment and human health. Hence it has become essential to adopt a strategy of organic manures, green manures, biofertilizers, vermicompost etc. Organic manures and biofertilizers are one of the alternative renewable sources of nutrient supply. Organic manure not only regularly supply macro, micro, and secondary nutrient, but also improve physical, chemical and biological properties of soil. Organic manures are slow releasing, hence are less prone to loss than inorganic fertilizers, hence soil, water and air pollution can be reduced. Biofertilizers enhance availability of nutrients to plants. *Azotobacter* (nitrogenous biofertilizer) converts atmospheric nitrogen into ammoniacal form which is made available to plants. Phosphotika (phosphoric biofertilizer) solubilize fixed phosphorus already in the soil and make it available to plants.

Materials and Methods

The field experiment was conducted during September, 2012 to July, 2013 at Experimental Farm, Department of

Horticulture, School of Agriculture Science and Rural Development (SASRD), Nagaland University, Medziphema Campus. The field stands 304.8 meter above mean sea level and geographically located at 25° 45' 43" N latitude and 93° 53' 04" E longitude. The soil of the experimental site was sandy loam, well drained and strongly acidic with pH of 4.65. Soil sampling was done before land preparation by collecting soil sample from different locations of the experimental plots at a soil depth of 15 cm with the help of soil auger.

The experiment was laid out in Randomized Block Design with 13 treatments and 3 replications. Treatments comprised : T1 (Control), T2 (FYM 40 tha^{-1}), T3 (Pig manure 30 tha^{-1}), T4 (Poultry manure 20 tha^{-1}), T5 (Vermicompost 10 tha^{-1}), T6 (FYM + *Azotobacter*), T7 (Pig manure + *Azotobacter*), T8 (Poultry manure + *Azotobacter*), T9 (Vermicompost + *Azotobacter*), T10 (FYM + *Azotobacter* + Phosphatika), T11 (Pig manure + *Azotobacter* + Phosphatika), T12 (Poultry manure + *Azotobacter* + Phosphatika), T13 (Vermicompost + *Azotobacter* + Phosphatika).

The plot was measured with measuring tape, then making three blocks for replication with block to block distance of 1 m within the block, thirty-nine individual plots each measuring (1.8m x 1.8m) were allotted for treatments with distance of 30 cm between individual plots. Twenty five days old healthy seedling with uniform vigour and height were transplanted in the main field. Irrigation was withheld 2 days prior to transplanting in order to hardening the seedlings. Full dose of organic manures FYM @ 40 t/ha, Pig manures @ 30t/ha, Poultry manure @ 20t/ha, Vermicompost @ 10/ha were incorporated in the blocks according to treatments 15 days before planting the crop. Biofertilizers (*Azotobacter* and Phosphotika) were

inoculated to seedlings before transplanting as seedling dip methods @ 2 kg ha⁻¹ (400 g bio fertilizers in 300 ml water).

Harvesting started about 90 days after transplanting when they were fully red. Fruits were hand-picked carefully at different intervals.

Results and Discussion

Plant height (80.20 cm), number of branches (46.67), number of leaves (501.67), plant canopy (1198.33cm²) were recorded maximum with treatment T12 (Poultry manure @ 20t/ha + *Azotobacter* + Phosphotika).

Yield and yield attributing characters were observed and found superior over control. Number of fruits(97.67), fresh weight of fruit (1.95g), fruit length(1.00cm) and fruit diameter (7.07 cm), were recorded maximum with combined application of T12 (Poultry manure @ 20t/ha + *Azotobacter* + Phosphotika). Such effect could be attributed

to the release of nitrogen at higher levels from poultry manure which was readily available to plant, abundant supply of available nutrients from the soil with comparatively lesser retention in roots and more translocation to aerial parts for protoplasmic proteins and synthesis of other compounds. Also bio-fertilizers might have helped in production of growth regulating substances, also supplemented by favourable micro climate which proved for increasing plant growth. This result confirmed with Jaipaul *et al.*, (2011) that among the organic manures, plots supplied with chicken manure (7.5 t/ha) + bio-fertilizer exhibited highest plant height (70.73 cm) in potato.

On the other hand, Yeptho *et al.*, (2012) concluded that poultry manure @ 20 t ha⁻¹ along with *Azotobacter* application resulted in maximum plant growth. Similar results found by Changkijan (2013) on soyabean, Ghoname and Shafeek (2005) on sweet pepper (*Capsicum annum* L.).

Table.1 Initial fertility status of the experimental plot

| Parameters | Value | Status | Method employed |
|--|--------|--------|--|
| pH | 4.65 | Acidic | Digital pH meter scale (single electrode meter). |
| Organic carbon (%) | 1.09 | High | Walkey and Black method, (Piper,1966) |
| Available N(kg ha ⁻¹) | 240.30 | Low | The alkaline potassium permanganate method Subbiah and Asija (1956). |
| Available P ₂ O ₅ (kg ha ⁻¹) | 16.18 | Medium | Bray and Kurtz method |
| Available K ₂ O(kg ha ⁻¹) | 230.47 | Medium | Flame photometer (Hanway and Hiedal, 1952) |

Table.2 Growth characters

| Treatments | Growth characters | | | |
|---|-------------------|---------------------------|-------------------------|---------------------------------|
| | Plant Height (cm) | No. of branches per plant | No. of leaves per plant | Plant Canopy (cm ²) |
| T ₁ - Control | 59.67 | 32.57 | 200.00 | 375.00 |
| T ₂ - FYM @40t ha ⁻¹ | 72.77 | 46.87 | 405.00 | 903.33 |
| T ₃ - Pig manure @30t ha ⁻¹ | 69.80 | 44.53 | 358.00 | 712.67 |
| T ₄ - Poultry manure @20t ha ⁻¹ | 73.33 | 47.18 | 359.00 | 675.33 |
| T ₅ -Vermicompost @10t ha ⁻¹ | 67.97 | 43.53 | 329.00 | 465.60 |
| T ₆ - FYM @40t ha ⁻¹ + <i>Azotobacter</i> | 70.67 | 45.20 | 339.00 | 704.67 |
| T ₇ - Pig manure@30t ha ⁻¹ + <i>Azotobacter</i> | 71.83 | 42.87 | 334.67 | 696.67 |
| T ₈ - Poultry manure @20t ha ⁻¹ + <i>Azotobacter</i> | 73.53 | 46.57 | 378.33 | 866.67 |
| T ₉ - Vermicompost @10t ha ⁻¹ + <i>Azotobacter</i> | 70.73 | 39.30 | 257.33 | 495.97 |
| T ₁₀ - FYM @40t ha ⁻¹ + <i>Azotobacter</i> + Phosphotika | 77.90 | 48.53 | 468.67 | 1006.00 |
| T ₁₁ - Pig manure @30t ha ⁻¹ + <i>Azotobacter</i> + Phosphotika | 75.20 | 44.20 | 324.60 | 839.67 |
| T ₁₂ - Poultry manure @20t ha ⁻¹ + <i>Azotobacter</i> + Phosphotika | 80.20 | 49.67 | 501.67 | 1198.63 |
| T ₁₃ - Vermicompost @10t ha ⁻¹ + <i>Azotobacter</i> + Phosphotika | 71.37 | 40.47 | 221.33 | 546.67 |
| SE(m)± | 0.95 | 5.14 | 5.74 | 7.15 |
| CD (<i>P</i> =0.05) | 2.79 | 16.78 | 16.78 | 20.87 |

Table.3 Yield and yield attributes

| Treatments | Yield and Yield attributes | | | | | |
|--|----------------------------|---------------------------|----------------------|-------------------|---------------------------|--------------------------------|
| | No. of fruits / plants | Fresh fruits wt/plant (g) | Fruits Diameter (cm) | Fruit length (cm) | Fresh Yield per plant (g) | Projected Dry yield per ha (q) |
| T ₁ - Control | 80.60 | 1.47 | 0.63 | 5.00 | 120.33 | 5.18 |
| T ₂ - FYM @40t ha ⁻¹ | 92.67 | 1.80 | 0.74 | 6.03 | 167.67 | 8.79 |
| T ₃ - Pig manure @30t ha ⁻¹ | 90.33 | 1.79 | 0.86 | 6.30 | 162.43 | 8.08 |
| T ₄ - Poultry manure @20t ha ⁻¹ | 94.20 | 1.90 | 0.85 | 6.90 | 173.67 | 9.43 |
| T ₅ -Vermicompost @10t ha ⁻¹ | 90.00 | 1.75 | 0.76 | 6.33 | 139.53 | 7.50 |
| T ₆ - FYM @40t ha ⁻¹ + <i>Azotobacter</i> | 92.67 | 1.79 | 0.72 | 6.27 | 171.53 | 9.68 |
| T ₇ - Pig manure@30t ha ⁻¹ + <i>Azotobacter</i> | 92.00 | 1.77 | 0.77 | 6.40 | 164.03 | 8.10 |
| T ₈ - Poultry manure @20t ha ⁻¹ + <i>Azotobacter</i> | 93.33 | 1.84 | 0.80 | 6.37 | 175.60 | 9.06 |
| T ₉ - Vermicompost @10t ha ⁻¹ + <i>Azotobacter</i> | 89.67 | 1.71 | 0.71 | 6.27 | 158.67 | 8.10 |
| T ₁₀ - FYM @40t ha ⁻¹ + <i>Azotobacter</i> + Phosphotika | 92.00 | 1.85 | 0.79 | 6.90 | 175.76 | 9.70 |
| T ₁₁ - Pig manure @30t ha ⁻¹ + <i>Azotobacter</i> + Phosphotika | 90.67 | 1.82 | 0.90 | 6.53 | 165.23 | 8.40 |
| T ₁₂ - Poultry manure @20t ha ⁻¹ + <i>Azotobacter</i> + Phosphotika | 97.67 | 1.95 | 1.00 | 7.07 | 182.17 | 10.93 |
| T ₁₃ - Vermicompost @10t ha ⁻¹ + <i>Azotobacter</i> + Phosphotika | 88.23 | 1.81 | 0.70 | 6.07 | 153.57 | 8.80 |
| SE(m)± | 1.66 | 0.03 | 0.02 | 0.08 | 2.82 | 0.67 |
| CD (P=0.05) | 4.83 | 0.11 | NS | 0.23 | 8.24 | 1.95 |

Table.4 Quality parameters

| Treatments | Quality parameters | |
|---|--------------------|---------------------|
| | TSS (°Brix) | Vitamin C (mg/100g) |
| T ₁ - Control | 8.31 | 163.07 |
| T ₂ - FYM (40t/ha) | 9.33 | 253.03 |
| T ₃ - Pig manure (30t/ha) | 10.67 | 250.00 |
| T ₄ - Poultry manure (20t/ha) | 11.83 | 292.33 |
| T ₅ - Vermicompost (10t/ha) | 10.87 | 200.00 |
| T ₆ - FYM + <i>Azotobacter</i> | 9.13 | 260.67 |
| T ₇ - Pig manure+ <i>Azotobacter</i> | 11.57 | 240.00 |
| T ₈ - Poultry manure+ <i>Azotobacter</i> | 10.87 | 253.27 |
| T ₉ - Vermicompost + <i>Azotobacter</i> | 10.03 | 210.20 |
| T ₁₀ - FYM + <i>Azotobacter</i> + Phosphotika | 10.18 | 260.00 |
| T ₁₁ - Pig manure+ <i>Azotobacter</i> + Phosphotika | 11.40 | 280.20 |
| T ₁₂ - Poultry manure+ <i>Azotobacter</i> + Phosphotika | 12.00 | 300.00 |
| T ₁₃ -Vermicompost + <i>Azotobacter</i> + Phosphotika | 9.68 | 248.00 |
| SE(m)± | 0.049 | 3.94 |
| CD (<i>P</i> =0.05) | NS | 11.49 |

Table.5 Nutrient status of the soil after harvest

| Treatments | Nutrient status of the soil after harvest | | | | |
|---|---|--|---|--------------------|-------------|
| | Available N (kg ha ⁻¹) | Available P ₂ O ₅ (Kg ha ⁻¹) | Available K ₂ O (Kg ha ⁻¹) | Organic Carbon (%) | Soil pH |
| T ₁ - Control | 231.17 | 7.16 | 170.10 | 1.75 | 4.7 |
| T ₂ - FYM @40t ha ⁻¹ | 271.60 | 15.03 | 184.46 | 2.00 | 4.87 |
| T ₃ - Pig manure@30t ha ⁻¹ | 275.53 | 17.93 | 198.33 | 1.95 | 4.83 |
| T ₄ - Poultry manure @20t ha ⁻¹ | 303.93 | 19.76 | 190.66 | 2.00 | 4.85 |
| T ₅ -Vermicompost @10t ha ⁻¹ | 255.17 | 14.60 | 180.00 | 1.92 | 4.82 |
| T ₆ - FYM @40t ha ⁻¹ + <i>Azotobacter</i> | 262.00 | 16.37 | 202.00 | 2.14 | 4.82 |
| T ₇ - Pig manure@30t ha ⁻¹ + <i>Azotobacter</i> | 266.53 | 13.03 | 206.33 | 1.97 | 4.85 |
| T ₈ - Poultry manure@20t ha ⁻¹ + <i>Azotobacter</i> | 300.60 | 18.20 | 195.50 | 2.10 | 4.85 |
| T ₉ - Vermicompost@10t ha ⁻¹ + <i>Azotobacter</i> | 255.17 | 12.23 | 212.00 | 1.94 | 4.82 |
| T ₁₀ - FYM @40t ha ⁻¹ + <i>Azotobacter</i> + Phosphotika | 299.07 | 17.40 | 226.33 | 2.27 | 4.94 |
| T ₁₁ - Pig manure@30t ha ⁻¹ + <i>Azotobacter</i> + Phosphotika | 285.23 | 13.27 | 234.93 | 2.05 | 4.90 |
| T ₁₂ -Poultry manure@20t ha ⁻¹ + <i>Azotobacter</i> + Phosphotika | 312.50 | 20.15 | 264.00 | 2.19 | 4.88 |
| T ₁₃ - Vermicompost@10t ha ⁻¹ + <i>Azotobacter</i> + Phosphotika | 262.27 | 12.13 | 214.00 | 2.00 | 4.83 |
| SE(m)± | 2.13 | 0.28 | 4.29 | 0.03 | 0.01 |
| CD (<i>P</i> =0.05) | 6.30 | NS | NS | NS | NS |

The highest ascorbic acid content (300 mg/100g) in chilli was recorded with the treatment T12 (Poultry manure @ 20t/ha + *Azotobacter* + Phosphotika). The maximum TSS (12.00 °Brix) was recorded in T12 (Poultry manure @ 20t/ha + *Azotobacter* + Phosphotika). Improvement in ascorbic acid content in chilli fruits with poultry manure may be because of slow but continuous supply of all major and micro-nutrients, which might have helped in the assimilation of carbohydrates and in turn synthesis of ascorbic acid. Also the increased activity of

bio-fertilizers might have resulted in release of more amounts of gibberellins, auxins and cytokinins which accelerate the physiological process like synthesis of carbohydrates and thus improve quality. Fruit quality parameter of tomato such as pericarp thickness, TSS, acidity, ascorbic acid, lycopene were found to be better in the treatment with organic fertilizers in combination biofertilizer (Gosavi *et al.*, 2010). Quality parameters like protein content, ascorbic acid, TSS and shelf life of knolkhol were increased by the application of organic manures with bio-fertilizers, while

crude fibre content decreased significantly (Divya, 2010). Maximum available N ($312.50 \text{ kg ha}^{-1}$), P_2O_5 (20.15 kg ha^{-1}) and K_2O ($264.00 \text{ kg ha}^{-1}$) in soil after crop harvest was obtained from application of Poultry manure @ 20 t/ha + *Azotobacter* + Phosphotika in T12. Whereas, maximum organic carbon (2.27%) and soil pH (4.94) in soil after harvest were also obtained from integrated application of FYM @ 40 t/ha + *Azotobacter* + Phosphotika (T12).

Maximum available N ($312.50 \text{ kg ha}^{-1}$), P_2O_5 (20.15 kg ha^{-1}) and K_2O ($264.00 \text{ kg ha}^{-1}$) in soil after crop harvest was obtained from application of Poultry manure @ 20 t/ha + *Azotobacter* + Phosphotika in T12. Whereas, maximum organic carbon (2.27%) and soil pH (4.94) in soil after harvest were also obtained from integrated application of FYM @ 40 t/ha + *Azotobacter* + Phosphotika (T12). The economics of different treatments were calculated and highest profit (₹ 106350) and highest cost benefit ratio of 1:1.85 was obtained from the combined application of poultry manure @ 20 t/ha + *Azotobacter* + Phosphotika in T12.

Hence, from the present investigation it can be concluded that among the different organic manures and bio-fertilizers, poultry manures @ 20 t/ha + *Azotobacter* + Phosphotika proved best in influencing the growth, yield and quality of chilli crop with better economic returns under the prevailing agro-climatic condition of Nagaland. Simultaneously, the organic manures are locally available, eco-friendly and helpful in sustaining the soil health. However, further investigation is

advisable before recommendation for farming since these results are based upon only one year of investigation.

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