Effect of various organic nutrient schedules on growth and nutrient uptake of chilli (Capsicum annuum)

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ABSTRACT
The experiment was conducted at Instructional Farm, College of Agriculture, Vellayani during July-November of 2012. The treatments consisted of three levels of FYM - F₁ (20 t ha⁻¹), F₂ (15 t ha⁻¹) and F₃ (10 t ha⁻¹) and three levels of substitution of the recommended dose of nitrogen. The levels of substitution are N₁ (100 % recommended dose of N- 75 kg ha⁻¹), N₂ (75 % recommended dose of N - 56.25 kg ha⁻¹) and N₃ (50 % recommended dose of N - 37.5 kg ha⁻¹). Three controls were, C₁ -Kerala Agricultural University (KAU) POP recommendation (FYM @ 25 t ha⁻¹ along with 75:40:25 kg N:P:O₃:K₀ ha⁻¹ as inorganic fertilizer), C₂ –KAU Adhoc organic POP recommendation (FYM @ 25 t ha⁻¹ + Poultry manure at 5 t ha⁻¹ + Pseudomonas + Trichoderma and PGPR mix 1, each @ 2.5 kg ha⁻¹) and C₃-Farmers practice – (Cow dung slurry @ 20 t ha⁻¹). FYM @ 20 t ha⁻¹ recorded significantly higher plant height, number of branches and LAI. The maximum value for all growth parameters were observed at 100% level of N substitution. Combined application of FYM @ 20 t ha⁻¹ along with 100% substitution of recommended dose of N (75 kg ha⁻¹) in organic form registered maximum plant height, branches, LAI, and root spread.

Key words: Growth, Nutrient uptake, Nutrient schedule, Organic.

INTRODUCTION
Organic agriculture is gaining movement in India due to the individual as well as group efforts to conserve environments and to avoid contamination of the farm produce by the continuous use of chemical fertilizers and pesticides. The important principle of organic food movement is promotion of ecological soundness and sustainable use of natural resources, and maintenance of crop diversity. The need for supplementary cheaper sources of nutrients should be recognised due to low yields of most of crops and to match demands for production with forms of soil management that are sensitive to maintaining soil biodiversity. India with its strength in intrinsic quality of spices and low consumption of fertilizers and pesticides can exploit the commercial agriculture sector. Chilli is an important export oriented crop, suitable for both tropical and sub tropical regions. Organic products fetch 20-50 per cent higher price than inorganic products. Organic forms of nutrients through crop residues, dung, compost, green manuring and the use of bacterial fertilizers constitute a potential renewable source of nutrient supply to the crops under all situations (Motsara, 1999). Application of FYM resulted in higher plant height and the use of chemical fertilizers in the absence of FYM retarded the formation of vegetative organs in Capsicum was reported by Valskikova and Ivanic (1982).

MATERIALS AND METHODS
The field investigation on the “effect of various organic nutrient schedule on growth character and nutrient uptake of chilli was taken up at the Instructional Farm, College of Agriculture, Vellayani, Thiruvananthapuram, Kerala, during 2012-13. The chilli variety Vellayani Athulya selected for the experiment had attractive light green colour, long fruit with medium pungency. The investigation was laid out in randomised block design with 3 replications. The experiment consisted of 12 treatments with three levels of FYM - F₁ (20 t ha⁻¹), F₂ (15 t ha⁻¹) and F₃ (10 t ha⁻¹) and three levels of substitution of the recommended dose of nitrogen. The levels of substitution are N₁ (100 % recommended dose of N- 75 kg ha⁻¹), N₂ (75 % recommended dose of N - 56.25 kg ha⁻¹) and N₃ (50 % recommended dose of N - 37.5 kg ha⁻¹). FYM along with neem cake in 1: 1 ratio is used as organic manure for N substitution. Three controls were also tested in this study. Three controls were C₁- Kerala Agricultural University (KAU) POP recommendation FYM @ 25 t ha⁻¹ along with 75:40:25 kg N:P:O₃:K₀ ha⁻¹ as inorganic fertilizer), C₂ (KAU Adhoc organic POP recommendation - FYM @ 25 t ha⁻¹ + Poultry manure at 5 t ha⁻¹ + Pseudomonas + Trichoderma and PGPR mix 1, each @ 2.5 kg ha⁻¹) and C₃ (Farmers practice - Cow dung slurry @ 20 t ha⁻¹). Farm yard manure (0.50 % N, 0.2 % P, 0.5 % K₂O) and neem cake (3.0 % N, 0.60 % P, 0.5 % K₂O) and poultry manure

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RESULTS AND DISCUSSION

Effect on growth parameters: The critical evaluation of the data (Table 1) revealed that application of 20 t ha\(^{-1}\) FYM was significantly superior to all other treatments with respect to plant height, number of branches per plant and leaf area index at all stages of plant growth. The length and spread of root (Table 2) were also significantly superior with the application of 20 t ha\(^{-1}\) FYM. Plant height, number of branches, LAI, root length and spread were observed to differ significantly among the various levels of substitution. \(N_1\) (100 % RFD- applied as combination of FYM + neem cake in 1:1 ratio) recorded higher growth characters followed by \(N_2\) (75% RFD). The lowest plant height, number of branches and LAI were recorded by \(N_3\) (50% RFD) at all growth stages.

Plant height, number of branches, LAI and root spread were observed to vary significantly among the different treatment combinations. The application of 20 t ha\(^{-1}\) FYM (100 % FYM) combined with 100 % RFD (\(f_{n_1}\)) recorded maximum plant height (Fig. 1), number of branches, LAI and root spread. The increase in plant height, number of leaves, number of branches plant\(^{-1}\) and length and spread of root might be due to organic manures with narrow C: N ratio which resulted in the production of more humic acid and humic substances in the form of chelates with phosphorous. The chelated phosphorous has been reported.

Table 1: Height, number of branches and LAI as influenced by different levels of FYM, levels of substitution and their interaction.

| Height | No. of branches | Leaf area index (LAI) |
|--------|----------------|----------------------|
| FYM levels | 30 DA T | At harvest | 30 DA T | At harvest | 30 DA T | At harvest |
| \(F_1\) | 38.78 | 82.54 | 3.33 | 12.00 | 0.36 | 2.21 |
| \(F_2\) | 36.40 | 81.21 | 2.97 | 11.75 | 0.33 | 2.08 |
| \(F_3\) | 33.75 | 76.61 | 3.03 | 11.11 | 0.31 | 1.74 |
| SEm | 0.200 | 0.61 | 0.082 | 0.129 | 0.200 | 0.02 |
| CD (0.05) | 0.498 | 1.823 | 0.248 | 0.388 | 0.014 | 0.067 |

Levels of substitution

- \(N_1\): 37.38 | 81.56 | 3.17 | 11.86 | 0.35 | 2.09
- \(N_2\): 36.08 | 80.32 | 3.14 | 11.56 | 0.33 | 2.01
- \(N_3\): 35.47 | 78.49 | 3.03 | 11.44 | 0.31 | 1.93

SEm: 0.200 | 0.61 | 0.082 | 0.129 | 0.200 | 0.02

CD (0.05): 0.498 | 1.823 | NS | NS | 0.014 | 0.067

Interaction effects

- \(f_{n_1}\): 39.42 | 83.29 | 3.58 | 12.42 | 0.38 | 2.29
- \(f_{n_2}\): 38.58 | 83.21 | 3.25 | 12.17 | 0.36 | 2.21
- \(f_{n_3}\): 38.33 | 81.13 | 3.17 | 11.42 | 0.33 | 2.12
- \(f_{n_4}\): 38.38 | 81.71 | 2.92 | 11.67 | 0.35 | 2.15
- \(f_{n_5}\): 36.29 | 81.21 | 3.08 | 11.58 | 0.33 | 2.08
- \(f_{n_6}\): 34.54 | 80.71 | 2.92 | 12.00 | 0.32 | 2.02
- \(f_{n_7}\): 34.33 | 79.67 | 3.00 | 11.50 | 0.33 | 1.83
- \(f_{n_8}\): 33.38 | 76.54 | 3.08 | 10.92 | 0.31 | 1.74
- \(f_{n_9}\): 33.54 | 73.63 | 3.00 | 10.92 | 0.29 | 1.64

Treatments Vs Controls

| Controls | NS | S | NS | S | NS | S |
|-----------|----|---|----|---|----|---|
| Control 1 | 39.96 | 81.92 | 4.00 | 12.75 | 0.37 | 2.26 |
| Control 2 | 39.53 | 82.67 | 3.42 | 12.83 | 0.36 | 2.25 |
| Control 3 | 30.00 | 62.08 | 2.42 | 9.08 | 0.25 | 1.21 |

Control mean: 36.50 | 75.56 | 3.28 | 11.56 | 0.33 | 1.91
to be more soluble in water which could make it available to crop. This is mainly due to FYM supplies plant nutrients through its own decomposition, forming an additional source of ammoniacal nitrogen (NH$_3$-N) that might have resulted in increased growth parameters. The beneficial effect of organic amendments in increasing the growth parameters was reported by Pushpa (1996) in tomato and Anitha (1997) in chilli. The increased availability of nutrients through higher dose of FYM and neem cake might have increased the nutrient uptake, which might have contributed to rapid meristematic activity and the higher rate of metabolic activity coupled with rapid cell division brought about by phosphorus and the increased growth of meristematic tissue might have led to the increase in plant height, branches plant$^{-1}$ and LAI. So the combined application of FYM and neem cake might have increased the growth attributes in chilli. Similar findings of increased plant height by the application of FYM in tomato have been reported by Sharma and Sharma (2004). Sharu (2000) also reported the increased growth characters viz. plant height, number of branches, LAI and dry matter accumulation as a result of neem cake application in chilli.

### Table 2: Root characters of chilli (cm) as influenced by different levels of FYM, levels of substitution and their interaction

| FYM levels | Length of taproot | Root spread | Root shoot ratio |
|------------|------------------|-------------|-----------------|
| $F_1$      | 12.67            | 25.00       | 0.119           |
| $F_2$      | 11.68            | 23.00       | 0.115           |
| $F_3$      | 10.44            | 21.22       | 0.118           |
| SEm        | 0.200            | 0.200       | 0.02            |
| CD (0.05)  | 0.511            | 0.024       | 0.067           |

Levels of substitution

|            | $N_1$      | $N_2$      | $N_3$      |
|------------|------------|------------|------------|
|             | 12.30      | 11.32      | 11.17      |
| SEm        | 0.200      | 0.200      | 0.02       |
| CD (0.05)  | 0.014      | 0.024      | 0.067      |

Interaction effects

| $f_{n_1}$ | 13.67      | 27.03      | 0.118      |
| $f_{n_2}$ | 12.43      | 25.07      | 0.118      |
| $f_{n_3}$ | 11.91      | 22.90      | 0.121      |
| $f_{n_1}$ | 12.20      | 23.40      | 0.114      |
| $f_{n_2}$ | 11.40      | 22.77      | 0.112      |
| $f_{n_3}$ | 11.43      | 22.83      | 0.119      |
| $f_{n_1}$ | 11.03      | 22.03      | 0.121      |
| $f_{n_2}$ | 10.13      | 20.13      | 0.117      |
| $f_{n_3}$ | 10.17      | 21.50      | 0.116      |

Treatment mean

| SEm          | 0.350      | 0.350      | 0.04       |
| CD (0.05)    | NS         | NS         | NS         |

Control

| Control 1   | 13.00      | 27.10      | 0.093      |
| Control 2   | 14.70      | 27.00      | 0.089      |
| Control 3   | 10.10      | 21.03      | 0.111      |
| Control mean| 12.60      | 25.04      | 0.098      |

Treatments Vs Controls

| S          | S          | NS         |
| Between controls | S         | S         | NS         |
| Between treatments | 0.885     | 1.801     | NS         |

(incuding controls)

**Volume 52 Issue 1, February 2018**

Among the control treatments, the POP recommendation for integrated nutrients as well as the Adhoc organic farming POP recommendations of KAU recorded more or less similar plant height, number of branches plant$^{-1}$

### Table 3: Nutrient uptake of chilli at harvest as influenced by different levels of FYM, levels of substitution and their interaction

| FYM levels | Nitrogen (kg ha$^{-1}$) | Phosphorus (kg ha$^{-1}$) | Potassium (kg ha$^{-1}$) |
|------------|-------------------------|---------------------------|--------------------------|
| $F_1$      | 43.76                   | 10.43                     | 30.96                    |
| $F_2$      | 42.21                   | 10.36                     | 29.64                    |
| $F_3$      | 39.00                   | 9.26                      | 28.41                    |
| SEm        | 1.148                   | 0.200                     | 0.200                    |
| CD (0.05)  | 3.336                   | 0.617                     | 1.071                    |

Levels of substitution

|            | $N_1$      | $N_2$      | $N_3$      |
|------------|------------|------------|------------|
|             | 42.79      | 10.46      | 30.52      |
| $N_2$      | 41.85      | 9.94       | 29.47      |
| $N_3$      | 40.33      | 9.64       | 29.01      |
| SEm        | 1.148      | 0.200      | 0.200      |
| CD (0.05)  | NS         | NS         | 1.701      |

Interaction effects

| $f_{n_1}$ | 44.85      | 10.70      | 31.58      |
| $f_{n_2}$ | 43.91      | 10.37      | 30.98      |
| $f_{n_3}$ | 42.53      | 10.20      | 30.30      |
| $f_{n_1}$ | 43.41      | 11.21      | 30.86      |
| $f_{n_2}$ | 43.21      | 10.16      | 29.19      |
| $f_{n_3}$ | 40.01      | 9.69       | 28.86      |
| $f_{n_1}$ | 40.12      | 9.46       | 29.13      |
| $f_{n_2}$ | 38.44      | 9.29       | 28.24      |
| $f_{n_3}$ | 38.44      | 9.03       | 27.87      |

Treatment mean

| SEm        | 41.66      | 10.01      | 29.67      |
| CD (0.05)  | 1.988      | 0.350      | 0.350      |

Control

| Control 1   | 53.69      | 13.46      | 33.51      |
| Control 2   | 47.27      | 13.20      | 31.38      |
| Control 3   | 36.09      | 8.63       | 24.18      |

Control mean

| Treatments Vs Controls | S         | S         | NS         |
| Between controls      | S         | S         | S          |
| Between treatments    | 5.831     | 1.069     | 1.856      |

(incuding controls)
and LAI and these were significantly superior to the farmers' practice of applying 5 tonnes of cow dung slurry at fortnight intervals. Application of fertilizers as per POP recommendation of KAU resulted in the ready availability of nutrients from chemical fertilizers and FYM and this might have resulted in increased photosynthetic surface area leading to more production and assimilation of photosynthates. This in turn increased the plant height and number of branches. This corroborates with the findings of Sherly (1996) and Jayasree (2005) in chilli.

The Adhoc organic POP recommendation comprising of 25 t of FYM ha\(^{-1}\) along with 5 t ha\(^{-1}\) of poultry manure also recorded higher plant height, number of branches plant\(^{-1}\) and LAI. Nutrient value of poultry manure was higher due to combined presence of urinary faecal excretions in the manure. The higher availability of nutrients might also have contributed to the higher growth parameters. Similar better growth attributes like plant height, number of branches, and dry matter production with poultry manure application in chilli were reported early by Anitha (1997).

**Effect on nutrient uptake:** The uptake of nitrogen, phosphorus, potassium (Table 3) by the crop differed with different levels of FYM. Levels of substitution significantly influenced the potassium uptake only. 20 t FYM ha\(^{-1}\), recorded maximum nitrogen uptake (43.76 kg ha\(^{-1}\)), phosphorus uptake (10.43 kg ha\(^{-1}\)) and potassium uptake (30.96 kg ha\(^{-1}\)) and these were on par with F\(_2\) with nitrogen uptake (42.21 kg ha\(^{-1}\)), phosphorus uptake (10.36 kg ha\(^{-1}\)) and potassium uptake (29.64 kg ha\(^{-1}\)). The higher levels nutrients N\(_1\)(100% RFD) and N\(_2\)(75 % RFD) recorded higher potassium uptake of 30.52 kg ha\(^{-1}\) and 29.47 kg ha\(^{-1}\), respectively. The increase in nutrient uptake due to the application of organic manures might be due to fact that organic manure like FYM when applied to soil results in the breakdown of complex nutrientous compounds by the action of micro organisms (slow mineralization) and its availability to the soil in the form of nitrite nitrogen. Increase in available phosphorus content of soil (10.43 kg ha\(^{-1}\)) due to organic manures application may be due to the solubilization of native phosphorus through release of various organic acids which might be the reason for increased uptake. Similar results of increased nutrient uptake were reported by Raju et al. (1991) (N uptake) in chickpea and Minhas and Sood (1994) (phosphorus uptake) in rotational cropping system. Similar results of increased nutrient uptake in bhindi due to the application of organic manures were reported by Barani and Anburani (2004).

POP recommendation of KAU (C) recorded maximum nitrogen, phosphorus and potassium uptake of 53.69 kg ha\(^{-1}\), 13.47 kg ha\(^{-1}\) and 33.51 kg ha\(^{-1}\) respectively. The additional nutrient supply by the application of organic manures might have resulted in increased nitrogen uptake. Shashidhara (2000) and Kattimani (2004) also reported the increased uptake of nitrogen due to combined application of organics and inorganics in chilli followed by only organics. The synergistic effect of sulphur in phosphorus uptake might have contributed the increase of uptake of phosphorus by potato as reported by Sud et al. (1996). Similarly, the increased uptake of potassium observed in above said treatments might be the result of increased availability of potassium in soils due to the application of organics and inorganics.

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