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To study the effect of fertilizer doses and soil test levels on crop response of Brinjal

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Abstract

A field experiment was carried out to formulate the fertilizer recommendation for Brinjal crop in Inceptisol of Chhattisgarh during Rabi season 2005-06. The objectives were to find out the nutritional requirement of the crop. The experimental field was divided into three fertilizer gradient strips (L_0 , L_1 and L_2), which was already created during previous Kharif season, 2005 by adding different graded dose of fertilizer N, P and K with maize as exhaust crop. Thirty-six treatments considered of 3^3 factorial combinations of fertilizer N, P and FYM were superimposed over each fertility strip (L_0 , L_1 and L_2). Mukta Kesi variety of Brinjal was taken as the test crop. The crop response to added nutrients and various regression analysis were performed after the crop harvest. Linear Response Plateau (LRP) and Quadratic Response Plateau (QRP) models were used to relate yield with soil test and fertilizer dose and resulted significantly high R^2 values suggesting their suitability. Brinjal crop required 0.31 Kg N, 0.037 Kg P and 0.57 Kg K to produce one quintal of Brinjal fruit yield. The LRP model considered constant nutrient use efficiencies for each level of soil test and fertilizer doses, However QRP model estimated variable soil and fertilizer efficiencies. The special feature of these models was the consideration of yield plateau, which makes them suitable under resource constraints situations.

Keywords: Effect, fertilizer, soil, crop response

Introduction

Brinjal is one of the most popular vegetable crop grown in India and Chhattisgarh in particular. India ranks second for vegetable in the world. Total production of vegetable in India is 71.6 million tones from an area of 5.3 million ha {ICAR, 1998}. Brinjal belong to Solanaceae family grown in all part of the country throughout the year mainly due to its better adaptability to varied agro climatic condition and assured market. Annual world production of brinjal is amounted to 29.84 million tones from an area of 1.70 m. ha. with productivity of 17.54 tones per hectare. India's contribution to this pool is 8.2 million tones from an area of 0.51 m ha with a productivity of 16.07 tones per hectare (Anonymous, 2004). Brinjal covers 14% of total vegetable area and produces 9% of total vegetable production in India. In Chhattisgarh brinjal occupies an area of 13.57 thousand ha. With productivity of 1.50 tones per ha with a production of 2.03 lake tones (Anonymous, 2004). The average productivity of this crop is low as compared to the other state. Being vegetable crop, the nutrient consumption is higher as compared to other agricultural crops. Therefore, it is essential to monitor the nutrient requirement is this crop. Once the nutrient requirement is known and efficiency of the available nutrient is evaluated than requirement based on soil test for a definite yield goal can be estimated. The contribution of applied organic fertilizer {FYM} can also be estimated in terms of chemical fertilizer and accordingly can be adjusted to save chemical fertilizer. In this way, balance use of the nutrients, through soil testing ensure the improvement of the soil physical and chemical quality and productivity. Requirement can be determined taking into consideration the contribution of soil available nutrient and applied fertilizer nutrient to the total uptake of nutrient by the crop. Promotion of the use of chemical fertilizer has become our necessity to Meet the increasing demand of food grains as well as vegetables crops. It is apparent that fertilizer use per hectare will increase in future. Further, efficient and economic use of fertilizers would help in increasing the input cast for obtaining maximum returns. It has been proved that unbalanced use of fertilizer causes deterioration in the soil quality. Such adverse effect of fertilizer occurs in situation where unbalanced fertilizers are used. Therefore, it is recommendation to use those nutrients through fertilizers which are deficient in soil. Unnecessary use of nutrients which are already present in excess amount should be avoided.

The Information about the nutrients which are present in soil can be obtained by soil testing this will also provide the information in regard to the nutrient which is present in excess in soil. In such situation application of chemical fertilizers would not be required for such nutrients. Soil testing is a specific procedure which provides information regarding the deficiency of particularly nutrients due to which plants may suffers in a particular soil type. The essential nutrients are considered as one of the most important factor limiting plant growth and yield of crop.

Materials and Methods

This chapter deals with the description of the materials used and the methods or techniques adopted during the course of investigation.

Experimental site

A field experiment was conducted at the Instructional Farm of Indira Gandhi Agricultural University, Raipur (C.G.) during 2005-06, Rabi season for investigation on soil test crop response correlation for N, P and FYM in order to evolve soil test-based fertilizer recommendation for Brinjal crop (variety- Mukta kesi) in Inceptisol.

Geographical situation

Raipur is situated in mid-eastern part of Chhattisgarh state and lies at 21° 16', N latitude and 81° 36' E longitude with an attitude of 298.56 meter above the mean sea level.

Climatic and weather condition

The region comes under sub-humid climatic condition. The average annual rainfall of the area is 1250 mm. Major amount of precipitation occurs between June and September (about 3-4 Months) which is the main rice growing season. The hottest and coolest months are May and December respectively.

Soil

The soil is well drained and belongs to the order of an Inceptisol. The Color of soil is yellowish with low clay content and slightly acidic in reaction.

Table 1: Physico-chemical properties of experimental soil

| Rating/value | |
|------------------------|--------------------------------------|
| pH (1:2.5) | 6.3 |
| EC (dSm-1) | 0.23 |
| CEC (Cmol (p+) kg-1) | 22.61 |
| Organic C % | 0.45 |
| Available N (kg/h) | 260 |
| Available P (kg/h) | 20.4 |
| Available K (kg/h) | 336 |
| Mechanical analysis | |
| Send (%) | 47.5 |
| Silt (%) | 22.2 |
| Clay (%) | 30.3 |
| Textural class | Sandy loam |
| Treatment details | |
| N levels | 4 (0, 60, 120, 180 kg/ha) |
| P levels | 3 (0, 40, 80 kg/ha) |
| FYM levels | 3 (0, 5, 10 t/ha) |
| Experimental design | Factorial RBD |
| Treatments | 36 |
| Replications | Three |
| Plot Size | 5.5 x 6m |
| Test crop | Brinjal (<i>Solanum melongena</i>) |
| Variety | Mukta Kesi |
| Date of nursery sowing | 22nd and 24th October |
| Date of planting | 29-11-2005 |
| Picking | Total 12 pickings |

Field experiment

A special field technique developed by Ramamoothy *et al.* (1961) [4] was used for this experiment. The field was divided into three equal long strips and denoted as L₀, L₁ and L₂. Prior to the current experiment, attempt was made to create the fertility variation with respect to N, P and K among the strips. The soil samples (0-15cm) were drawn from each plot of the experimental field before taking crop. Mukta kasi variety of Brinjal was taken as test crop. Each strip was divided into 36 plots. Factorial combination of 4 levels of N, 3 levels of P and 3 levels of FYM were applied to each strip in the fields. There were 35 treatments with one control (i.e. one control plot in each strip). Factorial combination four level of N three level of P and three level of FYM were applied to each strip. The potassium level was not included due to non-response of the crop to its application.

Phosphorus as a single super phosphate and potassium as muraite of potash were applied as a basal dose and N was applied as urea in 3 equal splits, half dose of nitrogen were applied at the time of transplanting of seedling and the remaining half of the N was applied in two equal split dose at 30 and 50 days after transplanting. Before application of fertilizer, FYM @ the rate of 0.5 and 10 t/ha were applied and thoroughly mixed in soil. Mukta Kesi variety of brinjal was transplanted on October 24, 2005 with spacing of 60 x 60 cm (row x plant) Field was regularly monitored and 12 picking of fruits were done. Fruit and straw samples were collected from each plot for N, P and K uptake. Fruit and straw yields were recorded plot wise and calculated on ha basis.

Field preparation

The Experiment field was prepared by two cross ploughing followed by one harrowing and leveling by tractor drawn.

Fruit picking

A Total of 12 picking of fruit were done at 5-10 days interval.

Observation recorded

The following plant parameter observations were recorded at harvesting of crop.

1. Fruit yield.
2. Total wt. of fruit per plots.

Soil parameter

The experimental soil was analyzed for the following Physicochemical Properties.

PH

Soil pH was determined in 1:2.5 soil water suspension after stirring for 30 minutes, by glass electrode pH meter as suggested by piper (1967) [3].

Electrical conductivity

The sample soil used for pH determination was allowed to settle down for four hours then conductivity of supernatant liquid was determined by Solubridge as described by Black (1965) [1] using Systronics (1644).

Cation exchange capacity

The cation exchange capacity was determined by leaching the soil with neutral normal ammonium acetate as described by black (1965) [1].

Organic carbon

Organic Carbon was determined by Walkley and Blacks rapid titration method (1934) as described by piper (1967) [3].

Available nitrogen

Available "N" was determined by alkaline KMnO_4 method as suggested by Subbiah and Asija (1956) [6].

Available phosphorus

Available soil P was extracted by 0.5 N NaHCO_3 as described by Olsen *et al.* (1954) and phosphorus in the extract was determined by ascorbic acid method (Watanabe and Olsen, 1965) [7] by using Spectrophotometer.

Available potassium

Soil potassium was extracted by neutral normal ammonium acetate and determined with the help of flame photometer as described by Muhr *et al.* (1965) [2].

Mechanical analysis

The mechanical analysis of soil was carried out by International Pipette Method as described by piper (1950).

Statistical analysis

Standard regression procedure was used to relate the soil test and fertilizer with crop yield response. The nutrient

requirement, soil and fertilizer efficiencies were estimated from regression coefficients using computer IRRISTAT package ver.1.1 for statistical analysis and sigma plot ver.8 for graphics were used.

Results and Discussion

Soil available nutrients

The range and mean values of available nutrients (N, P and K) (Table No.3) indicate that soil test N did not vary with different fertility strips whereas P increased across the fertility strips and average values ranged from 16.7-31.8 Kg ha^{-1} . The mean values of available K did not reflect with respect to fertility strips (329-351 Kg ha^{-1}). This shows that the experimental field is well supplied with K.

Table 2: Fertilizer doses added to various strips and maize yields during previous kharif season, 2005).

| Fertility strips | Soil test values (kg/ha) | | |
|------------------|--------------------------|-------|-----|
| | SN | SP | SK |
| L0 | 227 | 14.16 | 309 |
| L1 | 222 | 25.95 | 317 |
| L2 | 232 | 46.70 | 336 |

Table 3: Range and average of available N, P and K in soil Kg ha^{-1}

| Available nutrients | Fertility strips | | |
|-------------------------------------|------------------|--------------------|--------------------|
| | L0 | L1 | L2 |
| Alkaline KMnO_4 -N (kg/ha) | 238 – 272 (258) | 247 – 275 (259) | 247 – 278 (264) |
| Olsen P (kg/ha) | 11.3-23.9 (16.7) | 18.4 - 38.5 (27.0) | 19.1 - 43.5 (31.8) |
| Amm acetate extractable K (kg/ha) | 298-358 (329) | 282-399 (328) | 315 – 410 (351) |

Response of added nutrients to fruit yield

Yield response of Brinjal fruit due to N and P applications were studied by taking variable nutrient levels in question at fixed level of other two nutrients (Table 4 to 6). The treatment comparisons for N showed that fruit yields of Brinjal were markedly responded to the application of this nutrient in all

fertility strips (Table No. 4). This indicates that overall control of N on yield in this soil. The average crop responses to added fertilizer P were less consistent as compared to that of N application (Table No. 5). Crop responses to FYM were less marked than that of N in all fertility strips. (Table 6).

Table 4: Fruit yield of Brinjal in relation to N application at selected P and FYM level in three fertility strips.

| Fertilizer doses Kg /ha | | | Fertility strips | | | Fruit yield (q /ha) |
|-------------------------|------------------------|-----|------------------|--------|--------|---------------------|
| N | P_2O_5 | FYM | L0 | L1 | L2 | Mean |
| 0 | 0 | 10 | 113.86 | 128.81 | 130.91 | 124.53 |
| 60 | 0 | 10 | 183.56 | 180.37 | 206.23 | 190.05 |
| 120 | 0 | 10 | 225.32 | 240.17 | 255.61 | 240.37 |
| 180 | 0 | 10 | 217.08 | 248.52 | 254.44 | 240.01 |
| 0 | 40 | 10 | 120.71 | 139.78 | 142.36 | 134.28 |
| 60 | 40 | 10 | 194.56 | 205.65 | 210.15 | 203.45 |
| 120 | 40 | 10 | 240.12 | 250.68 | 266.48 | 252.43 |
| 180 | 40 | 10 | 245.83 | 270.79 | 268.51 | 261.71 |
| 0 | 80 | 10 | 140.82 | 146.91 | 155.86 | 147.86 |
| 60 | 80 | 10 | 195.64 | 200.71 | 215.55 | 203.97 |
| 120 | 80 | 10 | 241.39 | 260.89 | 270.56 | 257.61 |
| 180 | 80 | 10 | 249.45 | 269.8 | 271.56 | 263.6 |

Table 5: Fruit yield of Brinjal in relation to P application at selected N and FYM level in three fertility strips.

| Fruit Yield (q ha-1) | | | | | | |
|-------------------------|------------------------|-----|------------------|--------|--------|--------|
| Fertilizer Doses Kg /ha | | | Fertility Strips | | | |
| N | P_2O_5 | FYM | L0 | L1 | L2 | Mean |
| 0 | 0 | 10 | 113.86 | 128.81 | 130.91 | 124.53 |
| 0 | 40 | 10 | 120.71 | 139.78 | 142.36 | 134.28 |
| 0 | 80 | 10 | 140.82 | 146.91 | 155.86 | 147.86 |
| 60 | 0 | 10 | 183.56 | 180.37 | 206.23 | 190.05 |
| 60 | 40 | 10 | 194.56 | 205.65 | 210.15 | 203.45 |
| 60 | 80 | 10 | 195.64 | 200.71 | 215.55 | 203.97 |
| 120 | 0 | 10 | 225.32 | 240.17 | 255.61 | 240.37 |
| 120 | 40 | 10 | 240.12 | 250.68 | 266.48 | 252.43 |
| 120 | 80 | 10 | 241.39 | 260.89 | 270.56 | 257.61 |
| 180 | 0 | 10 | 217.08 | 248.52 | 254.44 | 240.01 |
| 180 | 40 | 10 | 245.83 | 270.79 | 268.51 | 261.71 |
| 180 | 80 | 10 | 249.45 | 269.8 | 271.56 | 263.6 |

Table 6: Fruit yield of Brinjal in relation to FYM application at selected N and P level in three fertility strips.

| Fertilizer Doses Kg /ha | | | Fruit yield (q ha ⁻¹) | | | |
|-------------------------|-------------------------------|-----|-----------------------------------|--------|--------|--------|
| N | P ₂ O ₅ | FYM | Fertility strips | | | |
| | | | L0 | L1 | L2 | Mean |
| 60 | 0 | 0 | 130.23 | 145.77 | 170.31 | 148.77 |
| 60 | 0 | 5 | 160.12 | 175.09 | 182.62 | 172.61 |
| 60 | 0 | 10 | 183.56 | 180.37 | 206.23 | 190.05 |
| 60 | 40 | 0 | 139.69 | 159.95 | 185.53 | 161.72 |
| 60 | 40 | 5 | 170.85 | 181.76 | 192.45 | 181.69 |
| 60 | 40 | 10 | 194.56 | 205.65 | 210.15 | 203.45 |
| 60 | 80 | 0 | 160.72 | 185.12 | 188.44 | 178.09 |
| 60 | 80 | 5 | 182.2 | 196.19 | 200.87 | 193.09 |
| 60 | 80 | 10 | 195.64 | 200.71 | 215.55 | 203.97 |

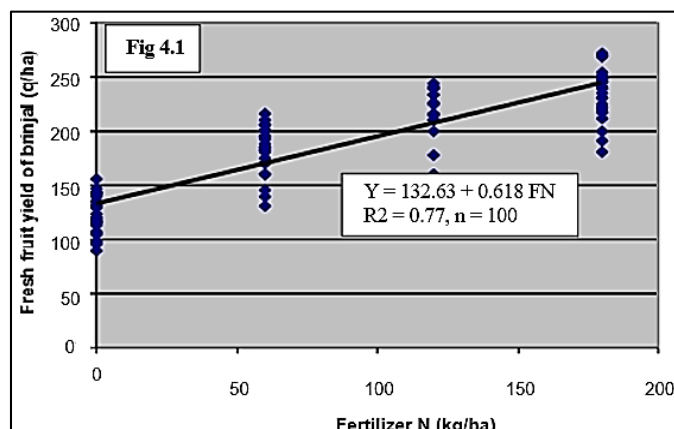
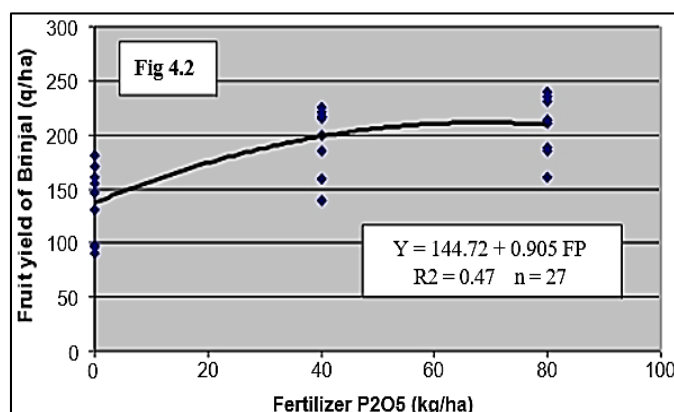
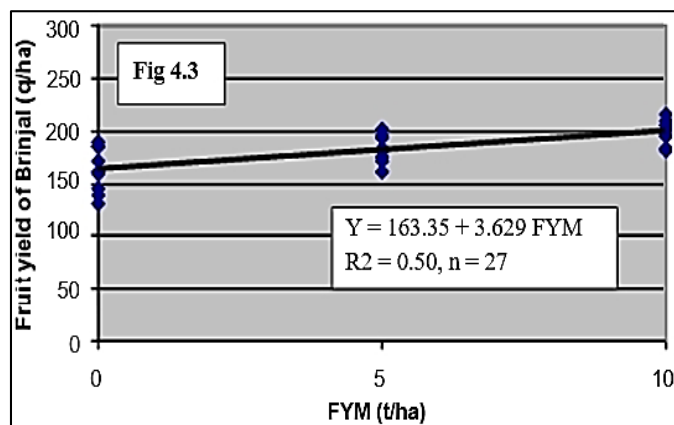
**Fig 1:** Response of brinjal to application of fertilizer N**Fig 2:** Response of brinjal to fertilizer P**Fig 3:** Response of brinjal of FYM application

Fig 1 indicate that the fruit yield response to N application was linear. The maximum average fruit yield of 263.60 q ha⁻¹

was recorded when N was applied at the rate of 120 Kg along with 80 kg P₂O₅ and 10 tons of FYM. Fruit yield response to P application was found curvilinear (Fig 2). Maximum fruit yield was 263.60 q ha⁻¹ and minimum 124.53 q ha⁻¹. Similarly, Brinjal response to FYM application was also found to be linear relation at 60 kg N ha⁻¹ (Fig 3). The analysis of variance table 4.6 indicates that the fruit yield was significantly influenced by N and P application. Interaction of nitrogen and phosphorus application influenced the yield of Brinjal significantly (Table 8). Fig 3 shows the fruit yield of Brinjal in relation to fertilizer N and P₂O₅ application. The interaction of nitrogen with FYM (NF) phosphorus and FYM (PXF) showed a significant result (Table No.7, 10 and Fig 1-3).

Table 7: Analysis of variance table.

| Effects | Test of significance |
|----------------|----------------------|
| Nitrogen (N) | ** |
| Phosphorus (P) | ** |
| FYM (F) | ** |
| NxP | * |
| NxF | ** |
| PxF | ** |
| NxPxP | * |

** - significant at 1% level, * significant at 5% level.

Table 8: Fruit yield of Brinjal in relation to fertilizer N and P application

| N (Kg/ha) | P (Kg/ha) | | | |
|-----------|-----------|--------|--------|----------|
| | 0 | 40 | 80 | N - Mean |
| 0 | 111.47 | 122.96 | 134.13 | 122.85 |
| 60 | 170.48 | 182.29 | 191.6 | 181.46 |
| 120 | 209.54 | 234.4 | 238.35 | 227.43 |
| 180 | 219.39 | 239.59 | 249.29 | 236.09 |
| P - Mean | 177.72 | 194.81 | 203.34 | 191.96 |

CD at 5% level NxP = 6.22, N, =3.59, P=3.11

Table 9: Fruit yield of brinjal in relation to fertilizer N and FYM application

| N (Kg/ha) | FYM (t/ha) | | | N - Mean |
|------------|------------|--------|--------|----------|
| | 0 | 5 | 10 | |
| 0 | 104.94 | 128.06 | 135.56 | 122.85 |
| 60 | 162.86 | 182.46 | 199.05 | 181.46 |
| 120 | 195.83 | 236.33 | 250.14 | 227.43 |
| 180 | 215.72 | 237.44 | 255.11 | 236.09 |
| FYM - Mean | 169.84 | 196.07 | 209.96 | 191.96 |

CD at 5% level NxF = 6.22, N, =3.59, P=3.11

Table 10: Fruit yield of brinjal in relation to fertilizer P and FYM application

| P (kg/ha) | FYM (t/ha) | | | P - Mean |
|------------|------------|--------|--------|----------|
| | 0 | 5 | 10 | |
| 0 | 149.59 | 174.99 | 184.93 | 169.84 |
| 40 | 184.82 | 196.47 | 206.93 | 196.07 |
| 80 | 198.74 | 212.97 | 218.18 | 209.96 |
| FYM - Mean | 177.72 | 194.81 | 203.34 | 191.96 |

CD at 5% PxF = 5.38, P=3.11, F=3.11

Linear response of fruit yield (Fig 1) to fertilizer N application was attributed to the high N requirement and being a mobile nature of this element, it is accessible to the plant in the root system sorption zone (Ramamoorthy *et al.*, 1967) [5]. Application of fertilizer P₂O₅ increased the fruit yield of Brinjal but the response was curvilinear (Fig 2). The Pions react very quickly with soil constituents to form

insoluble compounds and are thus rendered immobile in the soil. Furthermore, the requirement of P nutrient in Brinjal is lower than N. The curvilinear nature of fruit yield response to P application can therefore be attributed to the above facts. Linear response to FYM application as depicted in Fig 3 also exhibited but had less marked as compared to Fertilizer N.

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