

EFFECT OF SOIL FERTILITY AND INTEGRATED PLANT NUTRITION SYSTEM ON YIELD, RESPONSE AND NUTRIENT UPTAKE BY AGGREGATUM ONION

R. Santhi, R. Natesan and G. Selvakumari

Department of Soil Science and Agricultural Chemistry,
Tamil Nadu Agricultural University, Coimbatore - 641 003, India

ABSTRACT

Field experiments were conducted following the Inductive cum targeted yield concept, to study the effect of soil fertility and Integrated Plant Nutrition System (IPNS) on the yield of onion (var CO 4) in Typic Ustropept soils of Tamil Nadu. The treatments consisted of five levels of N, four levels of P_2O_5 , three levels of K_2O , two levels of FYM and two levels of Azospirillum (Azo). Marked fertility built up due to fertiliser addition at graded levels was recorded. The bulb yields as well as uptake by onion increased with increase in dose of fertiliser N, P_2O_5 and K_2O and also with application of FYM and Azospirillum. Response to fertiliser nutrients was also recorded.

INTRODUCTION

Soil testing is a scientific tool to evaluate soil fertility by predicting the probability of getting profitable crop response to recommended fertiliser applications under specific soil crop conditions which may further be improved by the application of soil amendments (Biswas, 2002). The pre-requisite to develop a quantitative and significant relationship between crop yield and soil test values is to have a wide range in the soil test values and the resultant yields. In any crop, the response to applied nutrients mainly depends on fertility status of the soil. Soil test based fertiliser recommendation plays a vital role in ensuring balanced nutrition to crops and also in preventing wasteful expenditure on the use of costly inorganic fertilisers. Fertiliser schedules should therefore be based on magnitude of crop response to applied nutrients at different soil fertility levels. Based on this concept, soil test crop response studies were undertaken in different parts of India for different crops (Subba Rao and Sanjay Srivastava, 2000). Onion being one of the major vegetable crops of Tamil Nadu, this study was undertaken on Inceptisols.

MATERIAL AND METHODS

Soil test crop response studies on aggregatum onion (var CO 4) were carried out

during 1998-99. The soil was red, sandy clay loam (Typic Ustropept), pH 7.5, E.C.0.15 dSm^{-1} and non-calcareous. The soil had 194, 13.4 and 211 $kg\ ha^{-1}$ of $KMnO_4-N$, Olsen-P and NH_4OAc-K respectively before the start of the gradient experiment.

A gradient experiment was conducted following the fertility gradient concept (Ramamoorthy *et al.*, 1967). The experimental field was divided into four equal strips *viz.*, $N_0P_0K_0$ (Strip I), $N_{1/2}P_{1/2}K_{1/2}$ (Strip II), $N_1P_1K_1$ (Strip III) and $N_2P_2K_2$ (Strip IV) and fertiliser N, P_2O_5 and K_2O were applied at graded levels to each one of the strips ($N_1P_1K_1$ - 150:90:76 $kg\ ha^{-1}$ respectively). The gradient crop of fodder maize var. African Tall was grown and harvested as fodder.

After the creation of fertility gradients, each strip was divided into 24 plots to accommodate 24 treatments and thus making a total of 96 plots in all the four strips. Complex field experiment with onion (var. CO 4) was conducted during *kharif* adopting fractional factorial design. The treatments consisted of N (0, 30, 60, 90 and 120 $kg\ ha^{-1}$), P_2O_5 (0, 30, 60 and 90 $kg\ ha^{-1}$ and K_2O (0, 30 and 60 $kg\ ha^{-1}$), FYM (0 and 25 $t\ ha^{-1}$) and Azospirillum (0 and 2 $kg\ ha^{-1}$). The sources of N, P_2O_5 and K_2O were urea, single super phosphate and

muriate of potash.

The initial surface samples from all the plots were analysed for alkaline $\text{KMnO}_4\text{-N}$ (Subbiah and Asija, 1956), Olsen-P (Olsen *et al.*, 1954) and $\text{NH}_4\text{OAc-K}$ (Hanway and Heidal, 1952). Fresh bulb yields were recorded treatment wise. Bulb and straw samples were analysed for N, P and K contents (Piper, 1966) and total N, P and K uptake were computed. The response of onion to fertiliser nutrients was also computed.

RESULTS AND DISCUSSION

The data on range in soil test values, bulb yield and total N, P and K uptake and also the mean values in the experimental field from control and treated plots showed that the operational range has been obtained in the case of soil available N, P and K in the field experiments (Table 1). Crop yield is a function of soil fertility under optimal levels of other production factors which has been substantiated by the results recorded in the present study. Thus, marked fertility built up due to fertiliser addition at graded levels to create fertility gradient was evident from the crop response data also. Almost in all type of soils, the fertility variations were developed by application of graded doses of NPK fertilisers (Subba Rao and Sanjay Srivastava, 2001).

Pre-sowing soil analysis

The range and mean values of pre-sowing soil available nutrients in treated plots are furnished in Table 1. For alkaline $\text{KMnO}_4\text{-N}$, the range was from 170-188, 192-219, 227-241 and 238-252 kg ha^{-1} with mean values of 180, 203, 235 and 245 kg ha^{-1} respectively in S I - S IV with regard to Olsen-P, the range recorded was from 11.2-14.6, 22.4-33.6, 37.0-44.8 and 40.3-58.2 kg ha^{-1} with mean values of 12.5, 26.1, 42.0 and 50.6 kg ha^{-1} respectively in S I - S IV. With reference to $\text{NH}_4\text{OAc-K}$, the range was 210-235, 235-260, 260-300 and 305-340 kg ha^{-1} with mean values of 222, 248, 286 and 321 kg ha^{-1}

respectively in S I - S IV. Likewise the range and mean values of control plots are also reported in Table 1.

Bulb yield and nutrient uptake

Fresh and dry bulb yield of onion was recorded in all the four strips. Using the total N, P and K contents and the dry matter yield of bulbs and straw, the total N, P and K uptake values were computed (Table 1). The fresh yield of bulbs in treated plots ranged from 10.61-18.31, 11.14-18.84, 12.47-18.57 and 10.61-18.57 t ha^{-1} with mean yield of 14.40, 16.05, 16.18 and 16.42 t ha^{-1} in S I, S II, S III and S IV respectively. The increase in yield was 11.49 % in S II, 12.41% in S III and 14.07 % in S IV respectively over the yield in S I. The bulb yields of onion increased with the increase in dose of fertiliser N, P_2O_5 and K_2O in all the strips and with the application of FYM and Azospirillum.

The maximum yield in treated plots was recorded in fertility strip II (18.84 t ha^{-1}) with the application of N, P_2O_5 and K_2O @ 90, 60 and 60 kg ha^{-1} respectively along with FYM @ 25 t ha^{-1} and Azospirillum @ 2 kg ha^{-1} (Table 2). The favourable influence of organics, inorganics and biofertilisers on chemical, physical and biological properties of soil under IPNS would have resulted in such maximum bulb yields of onion. Findings of Dixit (1997) and Gupta *et al.* (1999) corroborate with the findings recorded in the present study. The minimum yields were obtained with the absence of P_2O_5 , K_2O and FYM and with 30 kg N and 2 kg ha^{-1} of Azospirillum in the treated plots of strip I (10.61 t ha^{-1}). This emphasizes the importance of balanced use of all the three macro nutrients for getting higher yields of onion. In the control plots, the maximum yields were recorded with the application of FYM and Azospirillum alone in strip IV (12.20 t ha^{-1}) and the minimum yield was obtained with absolute control plot of strip I (7.43 t ha^{-1}).

The uptake of N in treated plots

Table 1. Range and mean values of available nutrients in the pre-sowing surface soil, yield and uptake of onion

| Parameters (kg ha ⁻¹) | Control plots (kg ha ⁻¹) | | Treated plots (kg ha ⁻¹) | |
|--|--------------------------------------|-------|--------------------------------------|-------|
| | Range | Mean | Range | Mean |
| N₀P₀K₀ | | | | |
| Alk.KMnO ₄ -N | 182-188 | 187 | 170-188 | 180 |
| Olsen-P | 12.3,14.6 | 14.0 | 11.2-14.6 | 12.5 |
| NH ₄ OAc-K | 210-230 | 223 | 210-235 | 222 |
| Fresh bulb yield (t ha ⁻¹) | 7.43-10.61 | 9.05 | 10.61-18.31 | 14.40 |
| N uptake | 28.74-47.64 | 37.32 | 41.17-69.63 | 53.74 |
| P uptake | 5.34-9.74 | 7.98 | 12.06-32.52 | 24.12 |
| K uptake | 34.22-50.12 | 42.65 | 35.65-70.48 | 51.87 |
| N_{1/2}P_{1/2}K_{1/2} | | | | |
| Alk.KMnO ₄ -N | 202-219 | 207 | 192-219 | 203 |
| Olsen-P | 22.4-25.8 | 24.4 | 22.4-33.6 | 26.1 |
| NH ₄ OAc-K | 245-260 | 256 | 235-260 | 248 |
| Fresh bulb yield (t ha ⁻¹) | 7.96-11.14 | 9.62 | 11.14-18.84 | 16.05 |
| N uptake | 30.69-50.97 | 39.57 | 42.92-71.14 | 59.85 |
| P uptake | 8.97-13.38 | 11.45 | 14.76-33.78 | 26.46 |
| K uptake | 38.27-54.09 | 47.29 | 41.34-77.03 | 63.77 |
| N₁P₁K₁ | | | | |
| Alk.KMnO ₄ -N | 227-235 | 231 | 227-241 | 235 |
| Olsen-P | 35.8-38.1 | 37.0 | 37.0-44.8 | 42.0 |
| NH ₄ OAc-K | 290-300 | 298 | 260-300 | 286 |
| Fresh Bulb yield (t ha ⁻¹) | 8.23-11.94 | 10.42 | 12.47-18.57 | 16.18 |
| N uptake | 31.63-51.94 | 41.55 | 44.51-72.50 | 60.19 |
| P uptake | 11.24-16.76 | 14.48 | 14.47-34.19 | 26.25 |
| K uptake | 41.85-59.62 | 51.67 | 44.57-77.77 | 63.87 |
| N₂P₂K₂ | | | | |
| Alk.KMnO ₄ -N | 238-244 | 240 | 238-252 | 245 |
| Olsen-P | 41.4-47.0 | 44.5 | 40.3-58.2 | 50.6 |
| NH ₄ OAc-K | 320-330 | 328 | 305-340 | 321 |
| Fresh Bulb yield (t ha ⁻¹) | 8.75-12.20 | 10.75 | 10.64-18.57 | 16.42 |
| N uptake | 33.11-53.92 | 42.82 | 41.14-72.06 | 62.18 |
| P uptake | 11.38-19.83 | 16.17 | 12.40-33.37 | 27.15 |
| K uptake | 45.44-60.31 | 54.28 | 39.37-78.17 | 65.47 |

Table 2. Effect of pre-sowing soil fertility status and treatments on bulb yield of onion

| Particulars | Strip | STVs (kg ha ⁻¹) | | | Fertiliser doses (kg ha ⁻¹) | | | FYM (t ha ⁻¹) | Azo. (kg ha ⁻¹) | Yield (t ha ⁻¹) |
|----------------------|--|-----------------------------|---------|-----------------------|---|-------------------------------|------------------|---------------------------|-----------------------------|-----------------------------|
| | | KMnO ₄ -N | Olsen-P | NH ₄ OAc-K | N | P ₂ O ₅ | K ₂ O | | | |
| Maximum yield | N ₀ P ₀ K ₀ | 188 | 11.2 | 230 | 120 | 60 | 30 | 25 | 2 | 18.31 |
| Minimum yield | N ₀ P ₀ K ₀ | 182 | 12.3 | 230 | 0 | 0 | 0 | 0 | 0 | 7.43 |
| Maximum yield | N _{1/2} P _{1/2} K _{1/2} | 202 | 24.6 | 260 | 90 | 60 | 60 | 25 | 2 | 18.84 |
| Minimum yield | N _{1/2} P _{1/2} K _{1/2} | 202 | 22.4 | 260 | 0 | 0 | 0 | 0 | 0 | 7.96 |
| Maximum yield | N ₁ P ₁ K ₁ | 235 | 44.8 | 295 | 90 | 90 | 0 | 25 | 0 | 18.57 |
| Minimum yield | N ₁ P ₁ K ₁ | 232 | 37.0 | 300 | 0 | 0 | 0 | 0 | 0 | 8.23 |
| Maximum yield | N ₂ P ₂ K ₂ | 252 | 56.9 | 330 | 90 | 90 | 30 | 25 | 2 | 18.57 |
| Minimum yield | N ₂ P ₂ K ₂ | 244 | 41.4 | 330 | 0 | 0 | 0 | 0 | 0 | 8.75 |
| Overall strips | | | | | | | | | | |
| Treated plots | | | | | | | | | | |
| Maximum yield | N _{1/2} P _{1/2} K _{1/2} | 202 | 24.6 | 260 | 90 | 60 | 60 | 25 | 2 | 18.84 |
| Minimum yield | N ₀ P ₀ K ₀ | 182 | 12.3 | 210 | 30 | 0 | 0 | 0 | 2 | 10.61 |
| Control plots | | | | | | | | | | |
| Maximum yield | N ₂ P ₂ K ₂ | 244 | 41.4 | 330 | 0 | 0 | 0 | 25 | 2 | 12.20 |
| Minimum yield | N ₀ P ₀ K ₀ | 182 | 12.3 | 230 | 0 | 0 | 0 | 0 | 0 | 7.43 |

Table 3. Response of onion to different levels of fertiliser nutrients

| S.No. | Nitrogen (N) | | Phosphorus (P ₂ O ₅) | | Potassium (K ₂ O) | |
|-------|------------------------------|---------------------------|---|---------------------------|------------------------------|---------------------------|
| | Level (kg ha ⁻¹) | RR (kg kg ⁻¹) | Level (kg ha ⁻¹) | RR (kg kg ⁻¹) | Level (kg ha ⁻¹) | RR (kg kg ⁻¹) |
| 1. | 30 | 49.3 | 30 | 27.3 | 30 | 18.8 |
| 2. | 60 | 58.2 | 60 | 27.5 | 60 | 18.2 |
| 3. | 90 | 71.1 | 90 | 25.1 | - | - |

recorded a range of 41.17-69.63, 42.92-71.14, 44.51-72.50 and 41.14-72.06 kg ha⁻¹ with mean values of 53.74, 59.85, 60.19 and 62.18 kg ha⁻¹ in strips S I, S II, S III and S IV respectively. The P uptake ranged from 12.06-32.52, 14.76-33.78, 14.47-34.19 and 12.4-33.37 kg ha⁻¹ with mean values of 24.12, 26.46, 26.25 and 27.15 kg ha⁻¹ in strips S I, S II, S III and S IV respectively.

Regarding the uptake of K, the range was 35.65-70.48, 41.34-77.03, 44.57-77.77 and 39.37-78.17 kg ha⁻¹ with mean values 51.87, 63.77, 63.87 and 65.47 kg ha⁻¹ in S I, S II, S III and S IV respectively.

Response of onion to fertiliser nutrients

The response recorded in terms of response ratio for the test crop of onion is furnished in Table 3. The response ratio recorded for 30 kg N ha⁻¹ was, 49.3 kg of fresh

onion bulbs per kg of N. The response ratio was 58.2 and 71.1 kg kg⁻¹ for 60 and 90 kg N ha⁻¹ levels respectively. For phosphorus, @ 30 kg ha⁻¹ of P₂O₅, the ratio was 27.3 kg kg⁻¹ while it was 27.5 and 25.1 kg kg⁻¹ for P₂O₅ @ 60 and 90 kg ha⁻¹ levels respectively. With regard to K, the response ratio was 18.8 and 18.2 kg kg⁻¹ for 30 and 60 kg ha⁻¹ levels of K₂O respectively. In case of N, the response showed an increasing trend from 30 to 90 kg N ha⁻¹, for P, the response to added P₂O₅ declined from 90 kg P₂O₅ ha⁻¹ and in the case of K, the response declined from 60 kg K₂O ha⁻¹.

The results emanated in the present study have clearly revealed that soil fertility and IPNS had profound influence on the bulb yields, response and nutrient uptake pattern of aggregatum onion.

REFERENCES

- Biswas (2002). *Fertil. News.*, **47**(10): 21-24.
 Dixit, S.P. (1997). *Indian J. Agric. Sci.*, **67**: 222-223.
 Gupta, R.P. et al. (1999). *NHRDF News Letter*, **XIX**(2&3): 7-9.
 Hanway, J.J. and Heidal, H. (1952). *Iowa State College Agric. Bull.*, **57**: 1-13.
 Olsen, S.R. et al. (1954). *USDA Circ.*, 939.
 Piper, C.S. (1966). *Soil and Plant Analysis*. Hans Publications, Bombay.
 Ramamoorthy, B. et al. (1967). *Indian Fmg.*, **17**: 43-45.
 Subba Rao, A. and Sanjay Srivastava (2000). *Fertil. News.*, **45**(2): 25-38.
 Subba Rao, A. and Sanjay Srivastava (2001). Sixteenth Progress Report of All India Co-ordinated Project for Investigations on Soil Test Crop Response Correlation (1998-2001), IISS, Bhopal.
 Subbiah, B.V. and Asija, G.L. (1956). *Curr. Sci.*, **25**: 259-260.