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# Effect of organic and inorganic sources of nutrients on productivity and nutritional quality of pigeonpea (*Cajanus cajan* L.)

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## ABSTRACT

*A field experiment was conducted during rainy-cum-winter seasons of 2013-16 and 2014-15 at the Private Research Farm, Benda-Semaria Road, Rewa (M.P.) to study the effect of organic and inorganic sources of nutrients on productivity and nutritional quality of pigeonpea (Cajanus cajan L.). Amongst the applied organic sources of nutrients, farmyard manure (10 t FYM ha$^{-1}$) resulted in significantly higher grain yield (11.83 q ha$^{-1}$) and straw yield (57.14 q ha$^{-1}$) as well as N-uptake (41.92 kg ha$^{-1}$ in grain and 50.20 kg ha$^{-1}$ in straw). The protein content in all the five organics was found significantly higher (21.0 to 22.12%) than the control, however the maximum grain protein (22.12%) was found in case of FYM closely followed by 5 t vermicompost ha$^{-1}$ (21.92%). The protein yield was found significantly higher (261.6 kg/ha) from FYM over other organics. The second best was vermicompost (244.0 kg ha$^{-1}$), followed by 5 t poultry manure ha$^{-1}$. The lowest protein yield (142.0 kg ha$^{-1}$) was found from control. Sulphur containing amino acids (methionine, cystine and cysteine) were found maximum (1.44, 1.02 and 0.77 g/16gN, respectively) due to FYM. This was followed by vermicompost, poultry manure, compost and then biofertilizers. Application of 100% RDF ($N_{20}P_{60}K_{20}$) resulted in significantly higher protein yield (241.3 kg ha$^{-1}$**)** over the preceding fertility levels. Whereas the grain yield and grain protein were at par under 75 and 100% RDF. The increasing RDF levels upto 100% level did not change the methionine, cystine and cysteine contents in grain up to the significant extent. However, N-uptake was significantly highest in grain and straw.*

**Key words:** Integrated nutrient management, nutritional quality, pigeonpea, N-uptake

## INTRODUCTION

The long term use of chemical fertilizers is known to degrade physico-chemical and biological properties of soil. The integrated nutrient management having organic manures, vermicompost, biofertilizers, etc. improves the soil properties, its health and fertilizer use efficiency, mitigates short supply of micronutrients, stimulates the proliferation of diverse group of soil micro-organisms and plays an important role in the maintenance of soil fertility and improves the ecological balance of rhizosphere (Singh *et al.*, 2014; Singh and Singh, 2017). The organic sources of nutrients are gaining global importance in crop production and are required to be integrated with chemical fertilizers. Recycling of farm by-products has become inevilable for enhancing nutritional quality and productivity of crop as well as sustaining soil health. Therefore, application of these nutrients in balanced amount is important to pigeonpea because of their positive role in root-nodulation process and protein synthesis in plants. Pigeonpea is one of the important pulse crops which is gaining popularity because of its high market value. By adding different types of organics to this crop it was essential to judge any changes in the grain quality particularly sulphur-containing amino acids in the improved pigeonpea variety ICPL-87. Such information was lacking under the agro-climatic conditions of Kymore plateau of M.P., hence the present experiment was taken up.

## MATERIALS AND METHODS

The field experiment was conducted at the Private Agriculture-Research Farm, Benda-Semaria Road, Rewa (M.P.) during 2013-14 and 2014-15. The soil was sandy-loam having pH 7.4, electrical conductivity 0.32 dSm$^{-1}$, organic carbon 6.0 g kg$^{-1}$, available N 220 kg ha$^{-1}$, available $P_2O_5$ 23.8 kg ha$^{-1}$, available $K_2O$ 372 kg ha$^{-1}$and available S 12.6 kg ha$^{-1}$. The total rainfall received from June to January was 759.8 and 794.2 mm in 2013-14 and 2014-15, respectively. The treatments comprised six organic sources (control, FYM, vermicompost, poultry manure, farm compost and *Rhizobium* + PSB + VAM biofertilizers) and four levels of NPK fertilizers (0, 50, 75 and 100% RDF ($N_{20}P_{60}K_{20}$).

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The experiment was laid out in a factorial randomized block design with three replications. Pigeonpea var. ICPL 87 was sown on 16 July using 20 kg seed ha $^{-1}$ in rows 60 cm apart in both the years. As per treatments, N, P and K were applied through urea, single superphosphate and muriate of potash, respectively. Before sowing, seeds were treated with thirum fungicide and biofertilizers as per recommended procedure. Pigeonpea was grown as per package of practices. The crop was harvested in the last week of March in both the years. The protein content in grain was determined by multiplying the per cent N-content in grain with 6.25 (A.O.A.C, 1997). Methionine content in grain was determined by colorimetric procedure (Horn *et al.* (1946) whereas cystine and cysteine content by the method of Leach (1968).

## RESULTS AND DISCUSSION

### Yield

Application of 10 t FYM recorded significantly higher grain and straw yield of pigeonpea (11.83 and 57.14 q ha$^{-1}$, respctively), followed by 5 t vermicompost, 5 t poultry manure and 10 t compost ha$^{-1}$. The higher yield response due to organics ascribed to improvement in the physico-chemical and biological properties of soil which resulted in better supply of plant nutrients and led to good crop growth and yield. Similarly the 100% RDF ($N_{20}P_{60}K_{20}$) produced the maximum grain and straw yield (11.18 and 48.92 q ha$^{-1}$, respctively). The increased supply of NPK might have increased multi-role activities in plant and soil which, in turn, resulted in greater accumulation of carbohydrates, protein and their translocation to the reproductive organs. These results corroborate the findings of Shah and Namdeo (2009), Singh *et al.* (2013), Saket *et al.* (2014) and Saket *et al.* (2017).When 10 FYM was applied with 100% RDF, the grain yield was further augmented significantly (13.26 q ha$^{-1}$) over the remaining interactions. This was followed by 5 t vermicompost with 100% RDF. The yield was discouraged significantly with the decrease in fertilizer levels under each of the organics (Table 2).

Table 1: Productivity, grain quality and N-uptake of pigeonpea as influenced by organic and inorganic sources of nutrients (Mean of 2 years)

| Treatments | Grain yield (q ha$^{-1}$) | Straw yield (q ha$^{-1}$) | Grain protein (%) | Protein yield (kg ha$^{-1}$) | Methionine content (g/16 g N) | Cystine (g/16 g N) | Cysteine (g/16 g N) | N-uptake (kg ha$^{-1}$) | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Grain | Straw |
| Organic sources | | | | | | | | | |
| Control | 6.88 | 37.49 | 20.67 | 142.2 | 1.22 | 0.865 | 0.599 | 22.81 | 26.98 |
| 10 t FYM ha$^{-1}$ | 11.83 | 57.14 | 22.12 | 261.6 | 1.44 | 1.019 | 0.774 | 41.92 | 50.20 |
| 10 t Compost ha$^{-1}$ | 9.68 | 43.62 | 21.20 | 205.1 | 1.33 | 0.941 | 0.677 | 32.8 | 34.39 |
| 5 t Poultry manure ha$^{-1}$ | 10.05 | 48.31 | 21.51 | 216.1 | 1.36 | 0.965 | 0.720 | 34.65 | 40.04 |
| 5 t Vermicompost ha$^{-1}$ | 11.14 | 52.32 | 21.92 | 244.0 | 1.40 | 0.994 | 0.741 | 39.11 | 44.34 |
| Biofertilizers | 8.12 | 39.74 | 21.00 | 170.4 | 1.28 | 0.895 | 0.640 | 27.18 | 30.24 |
| C.D. (P=0.05) | 0.32 | 0.10 | 0.23 | 2.27 | 0.064 | NS | 0.067 | 2.21 | 0.55 |
| Inorganic sources | | | | | | | | | |
| Control | 8.18 | 44.11 | 21.19 | 173.3 | 1.32 | 0.921 | 0.670 | 27.91 | 34.57 |
| 50% ($N_{10}P_{30}K_{10}$) | 9.05 | 43.71 | 21.36 | 193.3 | 1.34 | 0.944 | 0.688 | 31.11 | 36.81 |
| 75% ($N_{15}P_{45}K_{15}$) | 11.02 | 47.00 | 21.47 | 215.0 | 1.34 | 0.953 | 0.697 | 34.57 | 38.52 |
| 100% ($N_{20}P_{60}K_{20}$) | 11.18 | 48.92 | 21.59 | 241.3 | 1.36 | 0.967 | 0.712 | 38.78 | 40.91 |
| C.D. (P=0.05) | 0.26 | 0.08 | 0.19 | 1.85 | NS | NS | NS | 1.81 | 0.45 |

### Quality parameters

The FYM and vermicompost recorded equally higher grain protein (21.92 to 22.12%) but proved significantly superior to the remaining organics. Compost and biofertilizers recorded more or less equally lower grain protein (21.00 to 21.20%), whereas the control treatment indicated significantly lowest grain protein (20.67%). The variable response of all the five organics in improving seed quality may be attributed to their differential quantum of supplying nitrogen which is a constituent of amino acid precursor of protein synthesis. The variable grain protein content due to different organics may be attributed to the differences in the production of amino acids as a result of activated plant enzymes, differences in the metabolism of absorbed plant nutrients and ultimately differences in the photosynthetic efficiency (Chaurasia and Chaurasia, 2008). These results are in close agreement with those of Saket *et al.* (2014) and Saket *et al.* (2017).The 100% fertilizer application ($N_{20}P_{60}K_{20}$) resulted in significantly higher grain protein (21.59%) over the other fertility levels having control and 50% NPK. Application of 75 and 100% NPK fertilizer resulted in more or less equal protein content in grain (21.47 to 21.59%). The results on protein yield eventually followed the same trend, because it is the resultant of the multiplication of grain protein percentage with the grain yield. Application of 10 t FYM $ha^{-1}$ recorded significantly higher protein yield (261.6 kg $ha^{-1}$), followed by vermicompost, poultry manure and compost. The 100% NPK fertilizer recorded significantly higher protein yield (241.3 kg $ha^{-1}$) over the preceding NPK levels. Similarly, 75% NPK recorded significantly higher protein yield (215.0 kg $ha^{-1}$) over control and 50% NPK levels. The trend of protein yield is exactly in accordance with the resultant grain yield. The present results are in agreement with those of Gupta (2005), Saket *et al.* (2014) and Saket *et al.* (2017).

Table 2: Grain yield (q $ha^{-1}$) of pigeonpea as influenced by interaction effects of treatments (Mean of 2 years)

| Organic sources of nutrients | Inorganic sources of nutrients (NPK kg $ha^{-1}$)_ | | | |
|---|---|---|---|---|
| | 0% ($N_0P_0K_0$) | 50% ($N_{10}P_{30}K_{10}$) | 75% ($N_{15}P_{45}K_{15}$) | 100% ($N_{20}P_{60}K_{20}$) |
| Control | 5.80 | 6.12 | 7.38 | 8.23 |
| 10 t FYM $ha^{-1}$ | 10.39 | 11.48 | 12.19 | 13.26 |
| 10 t Compost $ha^{-1}$ | 7.95 | 9.35 | 10.15 | 11.28 |
| 5 t Poultry manure $ha^{-1}$ | 8.47 | 9.57 | 10.19 | 11.98 |
| 5 t Vermicompost $ha^{-1}$ | 9.58 | 10.65 | 11.75 | 12.59 |
| Biofertilizers | 6.91 | 7.16 | 8.46 | 9.78 |

*CD (P=0.05) for interaction 0.64*

## Sulphur containing amino acids

Application of 10 t FYM ha $ha^{-1}$ resulted in maximum methionine (1.44 g/16 g N), cystine (1.019 g/16 g N) and cysteine content (0.774 g/16 g N). This was followed by vermicompost, poultry manure, compost and biofertilizers. The significant variation in S-containing amino acids might be owing to the variation in their nutrient contents particularly supply of sulphur, decomposition in organic residues, carbon-nitrogen ratio and nutrient release pattern. All these variable factors in different organics influenced the synthesis of S-containing amino acids. The increased amount of such amino acids from FYM application may be owing to the increased supply of sulphur to the growing plants. The inorganic sources of nutrients comprising only N, P and K from control to $N_{20}P_{60}K_{20}$ did not alter the amounts of S-containing amino acids upto significant level. The methionine content ranged from 1.32 to 1.36 g/16 g N, cystine content from 0.921 to 0.967 g/16 g N and cysteine content from 0.670 to 0.712 g/16 g N. The small variation in S-containing amino acids was owing to the fact that sulphur was not available to the growing plants because only NPK fertilizers were applied. The findings are in conformity with the results of Tiwari and Pandey (2002), Shahi *et al.* (2003) and Sandeep Kumar (2009).

## Nitrogen uptake

Amongst the organics, 10 t FYM $ha^{-1}$ recorded significantly higher N-uptake by grain (41.92 kg $ha^{-1}$) and straw (50.20 kg $ha^{-1}$), followed by 5 t vermicompost $ha^{-1}$. Similarly, 100% RDF enhanced N-uptake by grain (38.78 kg $ha^{-1}$) and straw (40.91 kg $ha^{-1}$) significantly over the lower RDF levels. This may be due to maximum increase in grain and straw yield. The results corroborate the findings of Shah and Namdeo (009), Saket *et al.* (2014) and Singh *et al.* (2014). It may be concluded that the application of 10 t FYM as well as 100% RDF recorded maximum grain yield, grain protein and S-containing amino acids in pigeonpea var. ICPL-87 in Kymore plateau of Madhya Pradesh.

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