Integrated nutrient management practices for enhancing growth and yield of pigeonpea: A Review

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ABSTRACT

Pigeonpea [Cajanus cajan (L.) Millsp.] is an important pulse crop grown for its dhal, fuel, and fodder belonging to the family fabaceae. It is an important crop amongst pulses and ranked second after chickpea in India in terms of area and production. It provides protein rich food, firewood and income for resource poor small farmers. It is a protein rich legume grown throughout the tropical and subtropical regions of the world between 30° N and 35° S latitudes. However, in India major area under pigeonpea is lying between 14° and 28° N latitudes, which occupies an area of about 3.81 m ha with a production of 3.02 mt and average productivity of 806 kg ha⁻¹. Integrated nutrient management practices are essential in realizing the higher productivity of pigeonpea and reducing cost of production on sustainable basis.

Key words: Growth, Integrated nutrient management, Pigeonpea, Yield.

Pigeonpea is a major source of dhal which is important constituent in the food habit of Indian people. Protein content (20-22 %) in pigeonpea makes it an important source for supplementing the energy rich cereal diet, besides fixing atmospheric nitrogen up to 200 kg ha⁻¹ (Anonymous, 2010). Water stress (drought and water logging), non-availability of suitable varieties, inadequate transfer of technology, problems of weeds, insects pests and diseases are the major constraints for reduction of yield in pigeonpea (Anonymous, 2010). The low yield of pigeonpea is not only due to its cultivation in sub marginal lands, but also due to poor management. It is generally due to soil moisture deficit during critical growth stages, such as flowering and pod development which results in significant reduction in grain yield (Sharma et al., 2012). The use of organic manures is known to promote soil health and better plant nutrition. But organic manures alone cannot meet the nutrient requirement of crops, since their availability is limited. Use of bio-fertilizers such as biological nitrogen fixing and phosphate solubilizing micro-organisms is also gaining importance since bio-fertilizers are cost effective, eco-friendly and renewable source of plant nutrient to supplement chemical fertilizers. Organic manures and bio fertilizers (Rhizobium + phosphate solubilizing bacteria) which have been reported to be beneficial in augmenting the yield of grain legumes cannot meet the total nutrients need of the modern agriculture. One such approach is, use of different integrated nutrient management systems which can save the soil, environment and farmer’s limited resource. Integrating inorganic, organic and bio-fertilizers are essential in realizing the higher pigeonpea yield and reducing cost of production was reported by Reddy et al. (2011). The work of various research workers discussed above indicated that integrated nutrient management practice may play significant role to promote growth and productivity of pigeonpea in a sustainable basis as well as soil health.

Effect of INM practices on growth and yield of pigeonpea:

The integrated nutrient management practices which could increase growth and yield parameter of pigeonpea. The different research workers who studied INM practices in pigeonpea have been discussed here. Gholve et al. (2005) reported that pigeonpea + pearl-millet intercropping system, application of 50 % RDF + 5 t ha⁻¹ vermicompost + bio-fertilizers recorded significantly higher grain yield of pigeonpea and pearl millet (19.16 and 16.61 q ha⁻¹) as compared to 50 % RDF + bio-fertilizers (15.89 and 13.33 q ha⁻¹). Anonymous (2008) reported that pigeonpea + soybean intercropping with application of 100 % RDF, FYM @ 5.0 t ha⁻¹ and bio-fertilizer seed treatment produced higher pigeonpea yield (957 kg ha⁻¹ and PEY of (1558 kg ha⁻¹) over other treatment combinations. Anonymous (2008) opined that pigeonpea yield was significantly influenced by fertilizers levels, organic manures as well as bio-fertilizer. Application

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of recommended dose of fertilizer gave significantly higher seed yield of pigeonpea (1574 kg ha\(^{-1}\)) than 50 % RDF. Similarly application of FYM @ 5.0 t ha\(^{-1}\) gave higher yield (1558 kg ha\(^{-1}\)) than no FYM at Bengaluru. Seeds inoculation with *Rhizobium* + PSB + PGPR produced higher yield (1643 kg ha\(^{-1}\)) than no seed inoculation. Application of 50 per cent RDF + FYM @ 5 t ha\(^{-1}\) + bio- fertilizers was the suitable integrated plant nutrient management system for economizing inorganic fertilizer use, sustaining the soil health and productivity in pigeonpea + pearl millet intercropping system (2:2 reported by Patil and Shete (2008). Similarly, Roddannavar (2008) reported that, pigeonpea + soybean (1:1) and pigeonpea + finger millet (2:1) with the application of recommended dose of fertilizer based on area basis and FYM @ 5.0 t ha\(^{-1}\) along with seed inoculation of PSB recorded significantly higher pigeonpea equivalent yield (1878 and 1869 kg ha\(^{-1}\)), respectively as compared to sole crop of pigeonpea with INM practices (1680 kg ha\(^{-1}\)). Pandey and Kushwaha (2009) reported that interaction effect of *Rhizobium* + PSB with 100 % RDF produced the maximum seed yield (2150 kg ha\(^{-1}\)) of pigeonpea followed by *Rhizobium* + PSB inoculation with 50 % RDF (1909 kg ha\(^{-1}\)). Nagaraju and Mohankumar (2009) revealed that application of recommended nitrogen and potassium along with 100 % P\(_2\)O\(_5\) through activated mussorie rock phosphate (cow dung + urine + silt) recorded higher plant height, pods plant\(^{-1}\) and yield (185 cm, 193 and 1949 kg ha\(^{-1}\), respectively) of pigeonpea. Sharma et al. (2009) revealed that application of FYM @ 5 t ha\(^{-1}\) + seed inoculation with *Rhizobium* + micronutrient (ZnSO\(_4\) @ 15 kg ha\(^{-1}\)) and crop residue @ 5 t ha\(^{-1}\) recorded significantly higher plant height, primary and secondary branches plant\(^{-1}\) and seed yield (184 cm, 12.34, 7.86 and 15.81 q ha\(^{-1}\), respectively) of pigeonpea as compared to all other treatments. Sharma et al. (2010) reported that application of 50 % RDF + vermicompost @ 2.5 t ha\(^{-1}\) recorded significantly higher pigeonpea yield, pigeonpea grain equivalent yield (15.72 q ha\(^{-1}\) and 19.36 q ha\(^{-1}\), respectively) as compared to other INM practices and was found to be on par with application of phosphocompost @ 2.5 t ha\(^{-1}\) + 50 % RDF. Koushal and Singh (2011) reported that application of 50 per cent recommended N applied through urea + 50 % N through FYM + PSB recorded the maximum plant height of 16.8, 65.78 and 73.77 cm at 30, 60, and 90 DAS, higher number of pods plant\(^{-1}\), and higher test weight of soybean as compared to control treatment. Reddy et al. (2011) reported that application of 50 % RDF + seed treatment with *Rhizobium* @ 200 g kg\(^{-1}\) seeds recorded significantly higher number of branches plant\(^{-1}\), pods and higher grain yield of pigeonpea (16.3, 151.3 and 1358 kg ha\(^{-1}\), respectively) as compared to seed treatment with *Rhizobium* @ 200 g kg\(^{-1}\) seeds + 100 % RDF + FYM @ 5 t ha\(^{-1}\) (14, 142 and 1325 kg ha\(^{-1}\), respectively). Tiwari et al. (2011) reported that seed inoculation with PSB recorded higher number of trifoliates leaves plant\(^{-1}\) of pigeonpea as well as intercrops (urdbean and maize) over control. Balanced application of nutrient is essential to increase the yield of pigeonpea. Application of 25:50:25:20 kg N: P\(_2\)O\(_5\): K\(_2\)O: S ha\(^{-1}\) and ZnSO\(_4\):15 kg ha\(^{-1}\) with FYM or compost @ 7.5 tones ha\(^{-1}\) as basal application at the time of sowing is found optimum for pigeonpea (Anonymous, 2012). Further they also reported that application of 100 % recommended fertilizers with FYM @ 5.0 t ha\(^{-1}\) gave significantly higher seed yield than 50 % recommended fertilizer without FYM. Seed treatment with *Rhizobium* + PSB + PGPR recorded significantly higher seed yield over without seed treatment of pigeonpea. Goud et al. (2012) reported that sowing at 90 x 30 cm with application of 30:60:30:20:15 kg N: P\(_2\)O\(_5\): K\(_2\)O: S: ZnSO\(_4\) ha\(^{-1}\) are essential for obtaining higher plant height, number of branches plant\(^{-1}\) and number of pods plant\(^{-1}\) (180 cm, 4.6 and 163, respectively) as compared to sowing at 75 x 25 cm with application of 20:45:20:20:15 kg N: P\(_2\)O\(_5\): K\(_2\)O: S: ZnSO\(_4\) ha\(^{-1}\) recorded lower values (175 cm, 4.5 and 138, respectively) on pigeonpea. Meena et al. (2012) found that application of fertilizer (NPK) at soil-test based recommended rates produced 1.44 t ha\(^{-1}\) of grain yield of pigeonpea which was significantly higher as compared to unfertilized control (0.94 t ha\(^{-1}\)). Sharma et al. (2012) opined that, interaction effect of 100 % RDF, FYM @ 5 t ha\(^{-1}\) and *Rhizobium* + PSB + PGPR application significantly increased seed yield of pigeonpea (23.3 q ha\(^{-1}\)) compared to 100 % RDF with FYM @ 5 t ha\(^{-1}\) and treatment without inoculation recorded lower seed yield (18.70 q ha\(^{-1}\)). Singh and Singh (2012) found that interaction between phosphorus levels and bio inoculants was significant. Higher grain yield was recorded with combined application of 75 kg P\(_2\)O\(_5\) ha\(^{-1}\) + PSB + PGPR, being on par with application of 50 kg P\(_2\)O\(_5\) ha\(^{-1}\) + PSB + PGPR and significantly superior over 25 kg P\(_2\)O\(_5\) ha\(^{-1}\) + PSB + PGPR. Among the integrated nutrient management treatments, application of 100 % RDF + 50 % N through vermicompost + 5 kg Zn ha\(^{-1}\) and 50 % RDF + 100 % N through vermicompost + 5 kg Zn ha\(^{-1}\) were equally effective and significantly superior to the rest of the treatments with respect to growth (plant height and branches plant\(^{-1}\)) and yield attributes (pods plant\(^{-1}\), test weight and grain yield) of pigeonpea (Kumawat et al., 2013). Similarly, Pandey et al. (2013) reported that application of FYM @ 5.0 t ha\(^{-1}\) or vermicompost @ 2.5 t ha\(^{-1}\)with 100 % RDF proved equally effective for enhancing the grain yield of pigeonpea and both produced significantly higher grain yield than RDF alone.
Effect of INM on soil fertility: Application of FYM alone or in combination with chemical fertilizers significantly increased the residual status of available nitrogen and phosphorus in soil (Dudhat et al. 1997). Integrated application of recommended fertilizer with FYM recorded significantly higher available soil nitrogen and improving soil fertility status over rest of the treatment (Babalad, 2000). Similarly, Sharma et al. (2003) reported that FYM or vermicompost enhanced the yield of turmeric by 7-10% over the preceding year.Application of 50% RDF + 10 t vermicompost ha⁻¹ improved porosity, reduced soil bulk density and increased organic carbon content (from 0.44 to 0.72%). Gholve et al. (2005) reported that maximum productivity, net returns in addition to improvement in soil fertility status and chemical properties from pigeonpea + pearl millet intercropping system (2:2) under dry land condition with application of 50% RDF of the respective crops on the basis of area proportion + vermicompost @ 3 t ha⁻¹ or FYM @ 5 t ha⁻¹. Dubey and Vyas (2010) reported that application of 50% RDF + FYM @ 5 t ha⁻¹ + bio-fertilizers proved conducive to sustain the soil health by enhancing the organic carbon, available nutrient status, nutrient uptake by both crop (pigeonpea and soybean) by reducing the bulk density of soil. Reddy et al. (2011) reported that application of 50% RDF through inorganic fertilizer + seed treatment with *Rhizobium* and PSB improves nutrient status of soil and ultimately increased the nutrient uptake which enhanced the yield of pigeonpea. Meena et al. (2012) reported that the soil-test based NPK resulted in significantly higher grain yield of pigeonpea and wheat compared to sole manure treatment. Integration of fertilizer with FYM and induced defoliation appeared superior to sole fertilizer or manures. Conjuct use of fertilizer NPK and FYM improved soil health as revealed by lower bulk density and higher water holding capacity over sole fertilizer treatment. Singh and Singh (2012) reported that application of 75 kg P₂O₅ ha⁻¹ gave higher total nitrogen, phosphorus, potassium and sulphur uptake and was significantly superior over 25 kg P₂O₅ ha⁻¹ and control. Pandey et al. (2013) reported that pigeonpea + urdbean intercropping system with application of FYM @ 5.0 t ha⁻¹ or vermicompost @ 2.5 t ha⁻¹ and RDF improved bulk density, organic carbon and increased available N, P and K content of the soil over initial soil value.

Economics of INM on cultivation of pigeonpea: Pigeonpea + pearl millet intercropping (2:2) under integrated nutrient management system revealed that gross monetary returns were significantly higher due to application of 50% RDF + vermicompost @ 3 t ha⁻¹ + bio fertilizer recorded maximum gross returns (Rs. 36,236 ha⁻¹) and B:C ratio (1.92) than those recorded in remaining treatments except 50% RDF + FYM @ 5 t ha⁻¹ + bio-fertilizer which was on par with it is observed by Gholve et al. (2005). In a study Pandey and Kushwaha (2009) reported that combined inoculation of *Rhizobium* + PSB with 100% RDF recorded significantly higher net returns (Rs. 38,233 ha⁻¹) followed by *Rhizobium* + PSB inoculation with 50% RDF (Rs. 32,437 ha⁻¹) of pigeonpea. Sharma et al. (2010) reported that pigeonpea + green gram intercropping system with RDF + 2% urea spray at 15 and 30 days after harvest of intercrops recorded significantly higher pigeonpea equivalent yield (19.53 and 18.99 q ha⁻¹), gross returns (Rs. 31,439 and 30,576 ha⁻¹), net returns (Rs. 23,984 and 22,928 ha⁻¹) and B: C ratio (3.81 and 3.63, respectively) over other intercropping systems. Sharma et al. (2010a) concluded that use of vermicompost or phosphocompost @ 2.5 t ha⁻¹ or FYM @ 5 t ha⁻¹ along with 50% recommended fertilizer is economically beneficial for realizing the higher productivity of pigeonpea, pearl millet and green gram in pigeonpea + pearl millet (1:2) and pigeonpea + green gram (1:2) intercropping systems. Reddy et al. (2011) concluded that 50% RDF + *Rhizobium* was the best combination for getting higher productivity with maximum net returns of pigeonpea compared to others. Tiwari et al. (2011) reported that pigeonpea + urdbean cropping system with the application of PSB + FYM @ 2.5 t ha⁻¹ recorded higher net returns (Rs. 27,911 ha⁻¹) and B:C ratio (1.58) compared to pigeonpea + maize cropping system (Rs. 14,293 ha⁻¹) with the B:C ratio of 0.70. Meena et al. (2012) revealed that adoption of induced defoliation in pigeonpea along with NPK + FYM gave the highest system productivity whereas significantly higher net returns (Rs. 32,400 ha⁻¹) was found under NPK + induced defoliation over the other treatments. Similarly, Sharma et al. (2012) reported that 100% RDF, FYM @ 5 t ha⁻¹ and *Rhizobium* + PSB + PGPR gave significantly higher net returns, of 27,608, 29,764, and 27,330 Rs. ha⁻¹, respectively. Similar, results were obtained in case of benefit cost ratio also (1.49, 1.59 and 1.52, respectively).

CONCLUSION

These reviews clearly suggest that integrating inorganic (50%), organic and bio-fertilizers are essential in realizing the higher growth, yield and yield attributes of pigeonpea and reducing cost of cultivation by practicing integrated manner. The practices not only improve yield but also improves physical chemical properties of soil.
REFERENCES