EFFECT OF RHIZOBIUM, FYM AND CHEMICAL FERTILIZERS ON LEGUME CROPS AND NUTRIENT STATUS OF SOIL - A REVIEW

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ABSTRACT

Legume, the most important plant group concerned in symbiotic nitrogen fixation or dicotyledonous plants of the family Fabaceae. Legume crop inoculated with Rhizobium were found well nodulated and resulted increase in yield. Biological nitrogen fixation is an important process for agricultural productivity in many cropping system because of direct inputs of atmospheric nitrogen, and rotational effects such as disease control. In many agricultural situations the availability of a suitable source of nitrogen is the major factor limiting crop productivity. Addition of FYM 10 to 15 t/ha stimulated the growth and activity of microorganisms and therefore, increased growth and development of legume crops. Application of FYM and Rhizobium inoculation of legumes increased yield and made soil more fertile. N applications decreased the number of nodules formed during early growth stages of legumes. But inoculation combined with foliar application of N and P gave better seed yield.

Indian soil is mostly impoverished in nitrogen. The pulse crop capable of fixing atmospheric nitrogen symbiotically occupies the second position next to cereals. The seeds of these plants contain more proteins. The high protein content is related to the presence of root nodules containing nitrogen fixing bacteria. Microbes play many important roles in agricultural biotechnology, one of these is biological nitrogen fixation. The symbiotic associations between leguminous plants and root nodule bacteria have been estimated to fix approximately 80% of the biological fixed nitrogen in agricultural areas (Burns and Hardy, 1975). There have been many reports indicating a wide variation in the level of biological nitrogen fixation is soybean crops in field situations. The data from these studies on soybean grown in a diverse range of countries show the total amount of nitrogen fixed ranging from 0 to 450 kg/ha, with the proportion of plant nitrogen being derived from fixation varying from 0 to 95% (Graham and Hara, 1998). Effective symbiotic nitrogen fixation depends upon the proper establishment of interrelationship between a particular legume and specific strain of Rhizobium. Incorporation of FYM increased the nodulation and resulted in higher nitrogen fixation. There was significant increase on green pod yield, harvest index and also raised 100 seed weight in pea (Negm et al., 1998). There is an increasing awareness in many areas that the development of ecologically sustainable agricultural systems is essential for maintaining agricultural productivity at sufficient levels to meet increasing demands from the growing world population. So, this review is written in order to highlight some research findings which will be very much useful to develop an ecologically sustainable agricultural system.

Effect of FYM

Farm Yard Manure (FYM) application @ 15 tonnes/ha increased primarily branches/plant, number of nodules, dry weight of the nodules which gave significantly higher grain yield of soybean (Glycine Max) than the non application one. Harvest index was however, not affected. Available N status of 0-15 cm deep soil after harvest increased significantly due to farmyard manure application (Nimje and Seth, 1987). The FYM application favourably influenced the branches/plant, dry matter in shoot, root and the pod yield of summer ground nut (Arachis hypogaeas) (Chawale et al., 1993).
It had been reported that application of FYM did not affect the plant height and test weight but significantly increased the number of developed pod/plant of groundnut over the control (Mehta et al., 1995). Application of FYM significantly increased the number of pods/plant of soybean. However, the test weight could not show significant increase due to FYM application in soybean (Aruna and Reddy, 1999). There was an increase in nodule number of soybean due to incorporation of FYM 0-8 tonnes/ha (Singh et al., 1999). Farmyard manure 0-10 tonnes/ha increased dry matter/plant, pods plant and seed yield by 8.3, 9.2 and 6.5% respectively over no farmyard manure application in the field of blackgram (Phaseolus mungo) Reddy and Swamy, 2000.

Effect of organic manure along with chemical fertilizers

Broad beans were grown in pots containing sandy soil mixed with ammonium nitrate, ammonium sulphate, urea or sodium nitrate at rates equivalent to 0.23, 46 or 69 kg/feddan [1 feddan = 0.42 ha] and in combination with 4% poultry manure or FYM, plant dry weight was higher in pots given urea and ammonium sulphate than the nitrate sources and shoot dry weight was increased by poultry manure and only slightly increased by FYM (Faiyad et al., 1991). When Vicia faba cv. Wasesoramame was grown with ammonium sulphate with or without farmyard manures total plant weight, fresh pod weight, N content and N yield was higher with both FYM and ammonium sulphate application comparatively with no farmyard manure (Kpakpo et al., 1994). The response of soybean to organic matter (FYM + rice straw in the proportion of 1:1 at 0, 5 and 10 t/ha) increased significantly the grain yield from 20.7 to 23.0 and 26.9 q/ha respectively (Ramamuthy and Shivashankar, 1996). The application of 5 t/ha or FYM singly or in combination with phosphate solubilizing bacteria gave a significant increase in yield and yield attributes comparatively with control in blackgram (Phaseolus mungo L.), (Tomar, 1998). Low rates of N fertilizer stimulated the activity of symbiotic bacteria whereas high rate were inhibitory in Vicia faba. P fertilizers increased total N content, number of weight and crude protein content of root nodules. Farmyard manure markedly stimulated the activity of symbiotic bacteria, the highest content of total N and crude protein in root nodules where obtained with 40 t FYM + 40 kg P₂O₅/ha (Saghin, 1998).

Stony alluvial soil in the mountainous area of Suceava district showed the positive effect of fertilizer application especially with manure, no soil acidity and fertility. Further application of 20 or 40 t FYM/ha increased soil pH by an average of 0.3 and FYM also increased broad bean seed content of total nitrogen, crude protein, phosphorus, potassium starch and fats (Saghin, 1998). Broad bean cv. Giza 2 and Giza 402 were grown on a sandy calcareous soil and treated 0, 15 or 30 m² FYM/feddan [1 feddan = 0.42 ha] along with foliar sprays of micronutrients at the pre flowering and pod filling stages and reported that the highest seed and straw yields and N and Mn contents were obtained with Giza 2 given 30 m² FYM and sprayed twice with micronutrients (Attia, 1999). The residual effect of long term application of FYM and fertilizer on soil properties and yield of soybean was studied and found that due to addition of FYM, organic carbon, total nitrogen, available phosphorus and potassium contents were higher as FYM stimulated the growth and activity of microorganisms in the soil (Babulkar et al., 2000). The application of FYM 10 t/ha significantly improved fodder yield of groundnut as well as organic carbon, available phosphorus, potash and sulphur status of post harvest soil (Akbari et al., 2000).
The seed yield of 19.66 q/ha was obtained from application of 20 kg N + 40 kg P₂O₅/ha + 5 t poultry manure in pea field. The fertility status of the soil was also markedly improved after crop harvest (Bhattarai, 2002).

Effect of organic manure in conjunction with Rhizobium inoculation

The application of FYM and Rhizobium inoculation on chickpea (Cicer arietinum) observed significantly higher nodule number per plant and higher grain yield. Available N of soil after crop harvest also increased considerably as compared to initial level of soil available N (Raju et al., 1991). Application of 5 t/ha of biodigested slurry, pressmud (filter cake), or FYM, with or without seed inoculation with Bradyrhizobium japonicum resulted in high nodule formation in soybean with inoculated treatments which was also increased by organic amendments comparatively with untreated control. Seed yield was found to be highest from inoculation + biodigested slurry treatment (Prabhakaran and Ravi, 1996). The residual organic matter and total nitrogen contents in the soil were positively affected with FYM and inoculation with Rhizobium in legumes. Significant with inoculation as compared to control and organic manure was increasing was reported by Negm et al. (1998). There was significant increase in grain yield of soybean treated with two strains of Bradyrhizobium japonicum (USDA-110 and BAU-118) singly and in combination over control (Sonaria and Rani, 1998). Two strains of Bradyrhizobium sp. (Vigna) MO5 and BMI) when treated to mungbean (Vigna radiata L.) singly as well as in combination with Pseudomonas strain (PSM) and Cattle dung manure (CDM), there was highly significant increase in number of nodules and dry weight of nodules due to Bradyrhizobium strains (MO5 or BMI) in combination with PSM or CMD over the inoculation. The same trend was found in respect of grain yield (Singh and Sanoria, 2001).

Effect of seed inoculation of legume along with chemical fertilizer

In pot experiment in New Zealand, the response of chickpea to added N fertilizer with or without Rhizobium inoculation (strain CC 1192) were studied. It was found that plants inoculated with Rhizobium were well nodulated. N application decreased the number of nodules formed during early growth stages. Inoculation alone and in combination with N fertilizer increased dry matter production. The highest shoot dry matter yield (3.5 g/plant) obtained from inoculated plants given the equivalent of 30 kg N/ha 30 days after sowing (Hernandez and Hill, 1984). In another pot experiment at North Iraq, with Vicia faba cv. 4-52 and 20-72 inoculated with R. leguminosarum strains 202, 1049 or RI and found that inoculation increased V. faba N content and dry matter yield, especially in cv. 20-72. Urea application markedly increased dry weight and total N content of inoculated plants. In absence of urea inoculation increased N fixation efficiency (Gewaily et al., 1985). When broad bean variety 7269 was inoculated with strains of R. leguminosarum and treated with molybdenum and lime it was found that molybdenum increased yield while inoculation alone did not. However, inoculating with the addition of molybdenum and lime increased yield. The indigenous R. leguminosarum was highly competitive as few nodules were produced by the introduced strain (Brhada et al., 1988). The effect of a combination of inoculation with R. leguminosarum and no NPK, 50 kg P₂O₅, 50 kg K₂O or 100 kg N + 50 kg P₂O₅ + 60 kg K₂O/ha on Vicia faba cv. Dhamari were studied and observed that the treatments had no significant effect on plant yield components. However, the weight and number of nodules/plant were significantly higher with than without inoculation and the mean seed yield
reported was 3.36 t/ha (Melli, 1990). Rhizobium inoculation caused marked increase in yield and quality parameters of broad bean such as protein methionine and tryptophan seed contents. Further, integrated application of 90 kg P₂O₅/ha phosphorus and seed inoculation resulted marked improvement in seed yield (Parashar et al., 1999). When broad bean cv. Giza 674 seed inoculated with R. leguminosarum viovar viceae with or without different N and P fertilizer inoculation increased nodule number and dry weight and N content of shoots by 12.2, 24.8, 21.1 and 25.6% respectively compared with uninoculated controls. Inoculation combined with foliar application of N and P also gave the highest increase in seed yield (Saleh et al., 2000).

Some focus areas for future work
- to study the better combination of biofertilizers and organic manures.
- to study on effect of Vennicompost and Rhizobium as well as biofertilizers.
- to select the best Rhizobium for each particular areas.
- to study how to reach to the farmers in the easiest form.
- to study diseases and pest control by the Rhizobium inoculation.
- to study the drought resistance by applying Rhizobium and others.

REFERENCES