Effect of INM on Soil Fertility, Productivity and Economics of Cotton + Greengram Intercropping System in Vertisols

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ABSTRACT

A long term field experiment to study the effect of INM on soil fertility and productivity of cotton + greengram intercropping system in Vertisols was initiated during 1987-88 and the present study was conducted during kharif 2015-16 at Research field of AICRP for Dryland Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra. The soil of the experimental site was moderately alkaline in reaction, low in available nitrogen, medium in available phosphorus and high in available potassium. The eight treatments comprised of control, 100% RDF (50:25:00 NPK kg ha⁻¹) through chemical fertilizer, 50% RDF through chemical fertilizer, 50% N through FYM/gliricidia, 50% N through fertilizers + 50% N through FYM/gliricidia +100% P₂O₅ ha⁻¹ fertilizers and 100% N ha⁻¹ gliricidia + 100% P₂O₅ ha⁻¹ fertilizers in randomised block design with three replications. The results after 29th cycle indicated that the use of FYM followed by gliricidia green leaf manuring in conjunction with chemical fertilizers recorded higher cotton and greengram yields with maximum monetary returns with improvement in soil fertility. Hence, it is concluded that long term application of 50% N through FYM/gliricidia + 50% N through inorganics + 100% P₂O₅ ha⁻¹ to cotton+greengram (1:1) intercropping system resulted in sustaining crop productivity and build up fertility status of Vertisols under rainfed condition.

Keywords
INM, soil fertility, Cotton + greengram intercropping system, Vertisols.

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Introduction

Cotton (Gossypium spp.) is an important cash crop globally known as “king of fiber” and play vital role in the economy of farmers as well as the country and is popularly known as “white gold”. India ranks first in area under cotton in the world however, stands third in production. It is a fiber crop originated in India and belongs to Malvaceae family. Among different species of cotton, Gossypium hirsutum and Gossypium arborium are commonly grown in Maharashtra and used in textile industries for manufacture of cloth. Besides this, it is also used for several other purposes like making threads and for mixing in other fibers.

India ranks first in the world having an area of 10.15 million ha with the production of 31.00 million bales. Maharashtra is one of the leading cotton growing states in India having 41.92 lakh ha area under cotton cultivation which is one third of country’s area of cotton cultivation with the production of 85 lakh bales. The productivity of cotton in
Maharashtra is 345 kg lint per ha (Anonymous, 2015).

Pulses play an important role in Indian agriculture. Unique ability of biological nitrogen fixation, deep root system, mobilization of insoluble soil nutrients and bringing qualitative changes in soil physical properties make them known as “soil fertility restorers”. Pulses are the main source of protein for the bulk of population, which is mostly vegetarian.

Greengram (*Vigna radiata*) is an excellent source of high (25%) quality protein. The whole or split grains are used as ‘dal’ or made into flour. The straw and husk are a fodder for cattle. Grains are also used in many Indian dishes. It belongs to leguminosae family and is believed to be native of central Asia. It can be raised on wide array of soil ranging from red lateritic soils of south India to black cotton soils of Maharashtra. It is one of the thirteen food legumes grown in India and third most important pulse crop of India after chickpea and pigeonpea.

In India, the area under greengram is about 3.55 mha with production of 1.80 m tones and productivity of 512 kg ha\(^{-1}\) whereas, Maharashtra has about 4.08 lakhs ha area and production is 2.38 lakh tones with productivity of 531 kg ha\(^{-1}\). The area under Vidarbha is 1.30 lakh ha, production 0.38lakh tones with productivity of 344 kg ha\(^{-1}\) (Anonymous, 2014).

Integrated plant nutrient management is an intelligent use of optimum combination of organic, inorganic and biological nutrient sources in specific crop, cropping system and climatic situation so as to achieve and sustain optimum yield and to improve or maintain soil physical, chemical and biological properties. Integrated plant nutrient management is beneficial to maintain soil fertility, sustainable agricultural production and increase availability of nutrients from all resources and minimizing loss of nutrients.

**Materials and Methods**

With the aim of maintenance of soil fertility and plant nutrient supply to an optimum level for sustaining the desired crop productivity through optimization of benefit from organic plant nutrient sources available at farm level in the region, a fixed frame plot experiment with the combinations of organic and inorganic nutrient sources is being conducted in cotton + greengram intercropping system on Vertisols since 1987-88. The present study was carried out during 2015-16(29th cycle).

**Treatment details**

T1 - Control

T2 - 100% N + 100% P\(_2\)O\(_5\) ha\(^{-1}\) fertilizers

T3 - 50% N + 50% P\(_2\)O\(_5\) ha\(^{-1}\) fertilizers

T4 - 50% N ha\(^{-1}\) gliricidia

T5 - 50% N ha\(^{-1}\) FYM

T6 - 50% N Fertilizers + 50% N gliricidia+100% P\(_2\)O\(_5\) ha\(^{-1}\) fertilizers

T7 - 50% N Fertilizers + 50% N ha\(^{-1}\) FYM + 100% P\(_2\)O\(_5\) ha\(^{-1}\) fertilizers

The soil samples were collected after harvest of cotton crop and were analyzed for available nutrients (N, P & K) as per standard methods.

**Results and Discussion**

**Soil fertility**

The results pertaining to available N status of soil was significantly influenced by different
treatments. The available N in soil varied from 209.1 to 257.2 kg ha\(^{-1}\). The higher available N (257.2 kg ha\(^{-1}\)) was observed in treatment \(T_7\) receiving 50% N fertilizers + 50% N ha\(^{-1}\) FYM + 100% P\(_2\)O\(_5\) ha\(^{-1}\) fertilizers and it was found to be at par with treatment \(T_6\) i.e. 50% N fertilizers + 50% N gliricidia + 100% P\(_2\)O\(_5\) ha\(^{-1}\) fertilizers. The lower value of N was found in treatment \(T_1\) i.e. control. The higher value of available N over the initial value might be due to nitrogen fixation by greengram crop. The favourable soil conditions under FYM addition might have helped in mineralization of soil N leading to build up of higher available N. Similar results were also given by Goud and Konde (2007), Yadav 

et al., (2010) and Vidyavathi et al., (2012).

The available P content of soil varied significantly and it ranged from 10.3 to 15.8 kg ha\(^{-1}\) indicating that the soil was medium to high in available phosphorus content. The highest (15.8 kg ha\(^{-1}\)) available P was found in treatment \(T_7\) receiving 50% N fertilizers + 50% N ha\(^{-1}\) FYM + 100% P\(_2\)O\(_5\) ha\(^{-1}\) fertilizers and it was found to be at par with the treatments \(T_6\) i.e. 50% N fertilizers + 50% N gliricidia + 100% P\(_2\)O\(_5\) ha\(^{-1}\) fertilizers and \(T_8\) i.e. 100% N ha\(^{-1}\) gliricidia + 100% P\(_2\)O\(_5\) ha\(^{-1}\) fertilizers. The higher values of available potassium in treatments \(T_6, T_7\) and \(T_8\) may be due to the application of potassium through gliricidia green leaf manuring might be due to the fact that gliricidia leaves contains higher amount of K and it is deposited in the soil and due to applied K through gliricidia green leaf manure, the solubilizing action of certain organic acids produced during decomposition and it results in greater capacity to hold K in the available form.

Similar results were observed by Hadvani and Gundalia (2003), Goud and Konde (2007) and Vidyavathi et al., (2012).

The data pertaining to seed cotton and stalk yield and greengram grain and straw yield in intercropping system under long term effect of organics and fertilizers is presented in Table 2. The seed cotton yield as well as greengram yield was found statistically significant under different treatments during the year 2015-16.

### Yield of cotton and greengram

The data (Table 1) on available K content of soil varied significantly from 280.0 to 362.1 kg ha\(^{-1}\) indicating that the soil was high to very high in available K content. Data indicated that highest available K content (362.1 kg ha\(^{-1}\)) was observed in treatment \(T_7\) receiving 50% N fertilizers + 50% N ha\(^{-1}\) FYM + 100% P\(_2\)O\(_5\) ha\(^{-1}\) fertilizers and \(T_7\) was found to be at par with the \(T_6\) i.e. 50% N fertilizers + 50% N gliricidia + 100% P\(_2\)O\(_5\) ha\(^{-1}\) fertilizers and \(T_8\) i.e. 100% N ha\(^{-1}\) gliricidia + 100% P\(_2\)O\(_5\) ha\(^{-1}\) fertilizers.

The higher values of available potassium in treatments \(T_6, T_7\) and \(T_8\) may be due to the application of potassium through gliricidia green leaf manuring might be due to the fact that gliricidia leaves contains higher amount of K and it is deposited in the soil and due to applied K through gliricidia green leaf manure, the solubilizing action of certain organic acids produced during decomposition and it results in greater capacity to hold K in the available form.

Similar results were observed by Hadvani and Gundalia (2003), Goud and Konde (2007) and Vidyavathi et al., (2012).

### Yield of cotton

The significantly highest seed cotton yield (1179.9 kg ha\(^{-1}\)) was recorded with the application of 50% N through FYM + 50% N through inorganics + 100% P\(_2\)O\(_5\) ha\(^{-1}\) fertilizers.
(T7) followed by application of 50% N through gliricidia + 50% N through inorganics + 100% P2O5 ha⁻¹ fertilizers (T6) which were found to be on par with each other. The lower seed cotton yield (648.0 kg ha⁻¹) was recorded in control (T1) treatment. The significantly highest cotton stalk yield (2207.3 kg ha⁻¹) was recorded with the application of 50% N through FYM + 50% N through inorganics + 100% P2O5 ha⁻¹ fertilizers (T7) followed by application of 50% N through gliricidia + 50% N through inorganics + 100% P2O5 ha⁻¹ fertilizers (T6) which were found to be on par with each other. The lowest stalk yield (1608.7 kg ha⁻¹) was recorded in the treatment T1 control.

**Table.1 Effect of long term INM on soil fertility**

| Treatments | Available Nutrients(kg ha⁻¹) |
|------------|-----------------------------|
|            | N  | P  | K   |
| T1 Control | 209.1 | 10.3 | 280.0 |
| T2 100% N + 100% P2O5 ha⁻¹ fertilizers | 240.4 | 13.3 | 317.3 |
| T3 50% N + 50% P2O5 ha⁻¹ fertilizers | 236.6 | 12.5 | 313.6 |
| T4 50% N ha⁻¹ gliricidia | 234.2 | 11.3 | 324.8 |
| T5 50% N ha⁻¹ FYM | 238.3 | 12.2 | 326.7 |
| T6 50% N fertilizers + 50% N gliricidia + 100% P2O5 ha⁻¹ fertilizers | 250.9 | 15.1 | 358.4 |
| T7 50% N fertilizers + 50% N ha⁻¹ FYM + 100% P2O5 ha⁻¹ fertilizers | 257.2 | 15.8 | 362.1 |
| T8 100% N ha⁻¹ gliricidia + 100% P2O5 ha⁻¹ fertilizers | 242.5 | 14.9 | 339.7 |
| SE (m) ± | 6.4 | 0.6 | 11.7 |
| CD at 5% | 19.0 | 1.9 | 34.6 |

**Table.2 Yield of cotton + greengram under (1:1) intercropping system**

| Treatments | Cotton yield (kg ha⁻¹) | Greengram yield (kg ha⁻¹) |
|------------|------------------------|---------------------------|
|            | Seed cotton | Stalk | Grain | Straw | Seed cotton | Stalk | Grain | Straw |
| T1 Control | 648.0 | 1608.7 | 245.4 | 179.0 | 63.1 | 112.6 | 23.4 | 13.3 |
| T2 100% N + 100% P2O5 ha⁻¹ fertilizers | 968.9 | 2132.4 | 344.8 | 247.2 | 187.4 | 334.5 | 69.6 | 39.5 |
| T3 50% N + 50% P2O5 ha⁻¹ fertilizers | 895.2 | 1833.1 | 325.6 | 209.1 | 987.7 | 1795.7 | 357.5 | 231.2 |
| T4 50% N ha⁻¹ gliricidia | 810.7 | 1683.5 | 309.8 | 194.0 | | | | |
| T5 50% N ha⁻¹ FYM | 827.5 | 1646.1 | 321.0 | 198.7 | | | | |
| T6 50% N fertilizers + 50% N gliricidia + 100% P2O5 ha⁻¹ fertilizers | 1017.6 | 2169.8 | 413.4 | 260.3 | | | | |
| T7 50% N fertilizers + 50% N ha⁻¹ FYM + 100% P2O5 ha⁻¹ fertilizers | 1179.9 | 2207.3 | 448.4 | 264.0 | | | | |
| T8 100% N ha⁻¹ gliricidia + 100% P2O5 ha⁻¹ fertilizers | 987.7 | 1795.7 | 357.5 | 231.2 | | | | |
| SE (m) ± | 63.1 | 112.6 | 23.4 | 13.3 | | | | |
| CD at 5% | 187.4 | 334.5 | 69.6 | 39.5 | | | | |
Table 3 Effect of long term INM on economics of cotton + greengram (1:1) intercropping system

| Treatment | GMR (Rs ha⁻¹) | NMR (Rs ha⁻¹) | B:C ratio |
|-----------|---------------|---------------|-----------|
| T₁ Control | 51675.69 | 28873.69 | 2.27 |
| T₂ 100% N + 100% P₂O₅ ha⁻¹ fertilizers | 75407.89 | 46161.89 | 2.58 |
| T₃ 50% N + 50% P₂O₅ ha⁻¹ fertilizers | 69999.79 | 43125.79 | 2.60 |
| T₄ 50% N ha⁻¹ gliricidia | 64524.21 | 38643.21 | 2.49 |
| T₅ 50% N ha⁻¹ FYM | 66208.75 | 35177.75 | 2.13 |
| T₆ 50% N fertilizers + 50% N gliricidia +100% P₂O₅ ha⁻¹ fertilizers | 82813.32 | 51117.32 | 2.61 |
| T₇ 50% N fertilizers + 50% N ha⁻¹ FYM + 100% P₂O₅ ha⁻¹ fertilizers | 93490.16 | 56475.16 | 2.53 |
| T₈ 100% N ha⁻¹ gliricidia + 100% P₂O₅ ha⁻¹ fertilizers | 77102.88 | 48417.88 | 2.69 |

Higher cotton yield with conjunctive application of FYM, gliricidia green leaf manure along with chemical fertilizers may be due to balanced supply of nutrients to the crops throughout the crop growth period.

Green leaf manure undergo decomposition during which series of nutrient transformation takes place which helps in their higher availability to the crops and higher uptake of nutrients by the crops will result in higher yield.

Similar results were also reported by Kamble et al., (2009), Sonawane et al., (2009), Mankar and Nawlakhe (2009) and Sonune et al., (2012).

Yield of greengram

The significantly highest grain yield (448.4kg ha⁻¹) of greengram was recorded by the treatment T₇ receiving 50% N through fertilizers + 50% N ha⁻¹ through FYM + 100% P₂O₅ ha⁻¹ through fertilizers and was found to be on par with application of 50% N fertilizers + 50% N gliricidia +100% P₂O₅ ha⁻¹ fertilizers(T₆).

Similar results were also reported by Yadav et al., (2007), Mankar and Nawlakhe (2009) and Choudhari et al., (2011).

Economics of cotton + greengram (1:1) intercropping system

The data on effect of long term IPNS on economics of cotton + greengram (1:1) intercropping system is presented in Table 3.

The data indicate that the highest gross monetary returns(GMR) of 93490.16/- Rs ha⁻¹ was obtained with application of 50% N fertilizers + 50% N ha⁻¹ FYM + 100% P₂O₅ ha⁻¹ fertilizers(T₇), followed by 8281.32 Rs ha⁻¹ with application of 50% N fertilizers + 50% N gliricidia +100% P₂O₅ ha⁻¹ fertilizers(T₆), which were found to be on par with each other.

However, the highest net monetary returns(NMR) of 56475.16/- Rs ha⁻¹ was obtained with 50% N fertilizers + 50% N ha⁻¹ FYM + 100% P₂O₅ ha⁻¹ fertilizers(T₇), followed by 51117.32 Rs ha⁻¹ with application of 50% N fertilizers + 50% N gliricidia +100% P₂O₅ ha⁻¹ fertilizers(T₆), which were found to be on par with each other.
The B:C ratio was also found to be maximum (2.61) with application of 50% N fertilizers + 50% N gliricidia +100% P₂O₅ ha⁻¹ fertilizers(T₆). The higher NMR and B:C ratio obtained with application of 50% N through fertilizers + 50% N through gliricidia +100% P₂O₅ ha⁻¹ through fertilizers(T₆) as compared to 50% N through fertilizers + 50% N ha⁻¹ through FYM + 100% P₂O₅ ha⁻¹ through fertilizers(T₇) may be due to higher cost of FYM as compared to gliricidia.

The results after 29th cycle indicated that the use of FYM followed by gliricidia green leaf manuring in conjunction with chemical fertilizers recorded higher nutrient uptake, cotton and greengram yields with maximum monetary returns and improvement in soil fertility. Hence, it is concluded that long term INM of 50% N through FYM/gliricidia + 50% N through inorganics + 100% P₂O₅ ha⁻¹ to cotton + greengram (1:1) intercropping system resulted in sustaining crop productivity and build up fertility status of Vertisols under rainfed condition.

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