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

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A B S T R A C T

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% P_2O_5 ha^{-1} fertilizers and 100% N ha^{-1}gliricidia + 100% $P_2O_5ha^{-1}$ 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% P_2O_5 ha^{-1} to cotton+greengram (1:1) intercropping system resulted in sustaining crop productivity and build up fertility status of Vertisols under rainfed condition.

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 $kgha^{-1}$ (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(29^{th} cycle).

Treatment details

T1 - Control

T2 - 100% N + 100% P_2O_5 ha^{-1} fertilizers

T3 - 50% N + 50% P_2O_5 ha^{-1} fertilizers

T4 - 50% N ha-1gliricidia

T5 - 50% N ha^{-1} FYM

T6 - 50% N Fertilizers + 50% N gliricidia+100% P_2O_5 ha^{-1} fertilizers

T7 - 50% N Fertilizers + 50% N ha^{-1} FYM + 100% P_2O_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 to257.2kg ha^{-1}. The higher available N (257.2kg ha^{-1}) was observed in treatmentT_7 receiving 50% N fertilizers + 50% N ha^{-1} FYM + 100% P_2O_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_2O_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).

It is evident from the data in Table 1 that 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 treatmentT_7 receiving 50% N fertilizers + 50% N ha^{-1} FYM + 100% P_2O_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_2O_5 ha^{-1} fertilizers and T_8 i.e.100% N ha^{-1}gliricidia + 100% P_2O_5 ha-1 fertilizers. The lower value of P was found in treatment T1 i.e. control. The increase in available phosphorus status is due to use of FYM, being direct source of phosphorus and it might have also solubilized the native phosphorus in the soil through release of various organic acids which had chelating effect, that reduced phosphorus fixation

The higher values of available phosphorus in treatment T_7 and T_6may be due to addition of phosphorus through FYM/ gliricidia in soil. Similar results were recorded by Bharambe and Tomar (2004), Goud and Konde (2007) and Vidyavathi *et al.,* (2012).

The data (Table 1) on available K content of soil varied significantly from 280.0 to 362.1kg ha^{-1} indicating that the soil was high to very high in available K content. Data indicated that highest available K content (362.1kg ha^{-1}) was observed in treatmentT_7 receiving 50% N fertilizers + 50% N ha^{-1} FYM + 100% P_2O_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_2O_5 ha^{-1} fertilizers and T_8 i.e.100% N ha^{-1}gliricidia + 100% P_2O_5 ha^{-1} fertilizers.

The higher values of available potassium in treatments T6, T7 and T8 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 and greengram

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

The significantly highest seed cotton yield (1179.9kg ha^{-1}) was recorded with the application of 50% N through FYM +50% N through inorganics+100% P_2O_5 ha^{-1} fertilizers

(T_7) followed by application of 50% N through gliricidia+50% N through inorganics+ 100% P_2O_5 ha^{-1} fertilizers (T_6) which were found to be on par with each other. The lower seed cotton yield (648.0kg ha^{-1}) was recorded in control (T_1) treatment. The significantly highest cotton stalk yield (2207.3kg ha^{-1}) was recorded with the application of 50% N through FYM +50% N through inorganics+100% P_2O_5 ha^{-1} fertilizers (T_7) followed by application of 50% N throughgliricidia+50% N through inorganics+ 100% P_2O_5 ha^{-1} fertilizers (T_6) which were found to be on par with each other. The lowest stalk yield (1608.7kg ha^{-1}) was recorded in the treatment T_1 control.

Table.1 Effect of long term INM on soil fertility

Treatments		Available Nutrients(kg ha^{-1})		
		N	P	K
T_1	Control	209.1	10.3	280.0
T_2	100% N + 100% P_2O_5 ha^{-1} fertilizers	240.4	13.3	317.3
T_3	50% N + 50% P_2O_5 ha^{-1} fertilizers	236.6	12.5	313.6
T_4	50% N ha^{-1} gliricidia	234.2	11.3	324.8
T_5	50% N ha^{-1} FYM	238.3	12.2	326.7
T_6	50% N fertilizers + 50% N gliricidia +100% P_2O_5 ha^{-1} fertilizers	250.9	15.1	358.4
T_7	50% N fertilizers + 50% N ha^{-1} FYM + 100% P_2O_5 ha^{-1} fertilizers	257.2	15.8	362.1
T_8	100% N ha^{-1} gliricidia + 100% P_2O_5 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
T_1	Control	648.0	1608.7	245.4	179.0
T_2	100% N + 100% P_2O_5 ha^{-1} fertilizers	968.9	2132.4	344.8	247.2
T_3	50% N + 50% P_2O_5 ha^{-1} fertilizers	895.2	1833.1	325.6	209.1
T_4	50% N ha^{-1} gliricidia	810.7	1683.5	309.8	194.0
T_5	50% N ha^{-1} FYM	827.5	1646.1	321.0	198.7
T_6	50% N fertilizers + 50% N gliricidia +100% P_2O_5 ha^{-1} fertilizers	1017.6	2169.8	413.4	260.3
T_7	50% N fertilizers + 50% N ha^{-1} FYM + 100% P_2O_5 ha^{-1} fertilizers	1179.9	2207.3	448.4	264.0
T_8	100% N ha^{-1} gliricidia + 100% P_2O_5 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
T_1	Control	51675.69	28873.69	2.27
T_2	100% N + 100% P_2O_5 ha^{-1} fertilizers	75407.89	46161.89	2.58
T_3	50% N + 50% P_2O_5 ha^{-1} fertilizers	69999.79	43125.79	2.60
T_4	50% N ha^{-1}gliricidia	64524.21	38643.21	2.49
T_5	50% N ha^{-1} FYM	66208.75	35177.75	2.13
T_6	50% N fertilizers + 50% N gliricidia +100% P_2O_5 ha^{-1} fertilizers	82813.32	51117.32	2.61
T_7	50% N fertilizers + 50% N ha^{-1} FYM + 100% P_2O_5 ha^{-1} fertilizers	93490.16	56475.16	2.53
T_8	100% N ha^{-1}gliricidia + 100% P_2O_5 ha^{-1} fertilizers	77102.88	48417.88	2.69
	SE (m) ±	3826.127	3826.127	-
	CD at 5%	11368.43	11368.43	-

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 T_7 receiving 50% N through fertilizers + 50% N ha^{-1} through FYM + 100% P_2O_5 ha^{-1} through fertilizers and was found to be on par with application of 50% N fertilizers + 50% N gliricidia +100% P_2O_5 ha^{-1} fertilizers(T_6).

The highest straw yield (264.0kg ha^{-1}) of greengram was recorded by the treatment T_7 receiving 50% N through fertilizers + 50% N ha^{-1} through FYM + 100% P_2O_5 ha^{-1} through fertilizers and was found to be on par with application 50% N fertilizers + 50% N gliricidia +100% P_2O_5 ha^{-1} fertilizers(T_6).

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% P_2O_5 ha^{-1} fertilizers(T_7), followed by 8281.32 Rs ha^{-1} with application of 50% N fertilizers + 50% N gliricidia +100% P_2O_5 ha^{-1} fertilizers(T_6), 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% P_2O_5 ha^{-1} fertilizers(T_7), followed by 51117.32 Rs ha^{-1} with application of 50% N fertilizers + 50% N gliriicidia +100% P_2O_5 ha^{-1} fertilizers(T_6), 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% P_2O_5 ha^{-1} fertilizers(T_6).The higher NMR and B:C ratio obtained with application of 50% N through fertilizers + 50% N through gliricidia+100% P_2O_5 ha^{-1} through fertilizers(T_6) as compared to 50% N through fertilizers + 50% N ha^{-1} through FYM + 100% P_2O_5 ha^{-1} through fertilizers(T_7) 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% P_2O_5 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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