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Effect of potash management through conjoint use of *Gliricidia* green leaf manure and mineral fertilizer on yield and nutrient uptake by rainfed cotton in vertisols

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Abstract
The green manures are a valuable potential source of nitrogen and organic matter. They play an important role in improvement of physical, chemical and biological properties of soil with increase in the microbial population in soil. Hence, a field study to know the effect of conjoint use of *Gliricidia* green leaf manure and mineral fertilizer on yield and nutrient uptake of cotton in Vertisols was conducted during *kharif* 2017 at Research field of AICRP for Dryland Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra. The results revealed that the use of *Gliricidia* green leaf manuring as a potassium in conjunction with chemical fertilizers resulted in higher seed cotton yield and nutrient uptake by cotton. The application of 100% NP + 10kg K (inorganic) +20 kg K through *Gliricidia* was found to be beneficial for higher yield and nutrient uptake by cotton in Vertisols.

Keywords: Cotton, *Gliricidia* green leaf manuring, yield, nutrient uptake, vertisols

Introduction
The cotton plant belongs to the genus *Gossypium* of the family Malvaceae. It is currently the leading plant fiber crop worldwide and is grown commercially in the temperate and tropical regions of more than 50 countries, with a total coverage of 34 million ha. It is the most important fiber and cash crop of India and plays a key role in Indian agriculture and industrial economy. It is a backbone of textile industries in India.

Gliricidia sepium plant belongs to leguminous family with subfamily Papilionoideae. It is a leguminous multipurpose tree and adopts very well in a wide range of soils. The leaves of *Gliricidia* contain N (2.4%), P (0.1%) and K (1.8%). The leaves decompose relatively fast, providing nitrogen and potassium. *Gliricidia* as green leaf manure plays important role in increasing the fertility status of soils and helps in conserving soil through reduced soil erosion also. Green manures are the crops which are returned into the soil in order to improve the growth of subsequent crops and offer considerable potential as a source of plant nutrients and organic matter. Green manure crops improve the physical, chemical and biological condition of soils. The long-term benefit of green manure crops is to stabilize yields of subsequent crops during dry seasons. The application of green manures to soil is considered a good management practice in any agricultural production system because it stimulates soil microbial growth and activity, with subsequent mineralization of plant nutrients.

Materials and Methods
A field experiment conducted on Vertisols was initiated on the research field of AICRP for Dryland Agriculture, Dr. PDKV, Akola, Maharashtra since 2009-10 and the present study was undertaken during 2017-18 with the cotton crop and considering the potassium concentration in *Gliricidia* and increasing prices of potassic fertilizers, the experiment was framed with various treatments of *Gliricidia* green leaf manure to substitute the various levels of potassium.

The details of various treatments undertaken in the experiment are T_1-Control, T_2-100% RDF(60:30:30 NPK kg ha^{-1}), T_3-100%NP + 15kg K(inorganic) +15kg K through gliricidia, T_4-100% NP + 10kg K(inorganic)+20 kg K through gliricidia, T_5-100% NP + 30kg K through gliricidia, T_6-75% N +100% P+15kg K(inorganic)+15kg K through gliricidia, T_7-75%

N +100% P+30kg K through gliricidia, T_8- 50% N +100% P+30kg K through *Gliricidia* and T_9- 100% K through gliricidia.

Results and Discussion

Seed cotton and stalk yield

The data on seed cotton and stalk yield of cotton (Table 1) was significantly influenced by various treatments. The significantly higher seed cotton yield (439.64 kg ha^{-1}) was observed with application of 100% NP + 10kg K(inorganic)+20 kg K through gliricidia(T_4) and it was found to be on par with 100% NP + 15kg K(inorganic)+15kg K through *Gliricidia* (T_3), 100% NP + 30kg K through *Gliricidia* (T_5). The lowest seed cotton yield (126.20 kg ha^{-1}) was recorded in treatment T_1 *i.e.* control.

The significantly higher cotton stalk yield (826.65 kg ha^{-1}) was observed with the application of 100% NP + 10kg K (inorganic) +20 kg K through *Gliricidia* (T_4) and it was found to be on par with most of the treatments. The lowest cotton stalk yield (246.09 kg ha^{-1}) was recorded in treatment T_1 *i.e.* control. The lowers yield of cotton was due to the low rainfall and moisture stress during crop growing period under rainfed conditions.In general, the higher seed cotton as well as cotton stalk yield was recorded with application of 100% NP + 10kg K (inorganic) +20 kg K through gliricidia. This may be due to beneficial role of potassium and green manure which increases yield. The combined application of manure and fertilizers considerably increased the seed cotton and stalk yield of cotton, as *Gliricidia* green leaf manuring in combination with fertilizers regulated the supply of nutrients in plants.

Table 1: Effect of potash management through *Gliricidia* green leaf manuring on cotton yield

Treatments		Cotton yield (kg ha^{-1})	
		Seed cotton	Cotton stalk
T_1	Control	126.20	246.09
T_2	100% RDF (60:30:30 NPK kg ha^{-1})	338.13	625.55
T_3	100% NP + 15kg K(inorganic)+15kg K through gliricidia	382.03	712.72
T_4	100% NP + 10kg K(inorganic)+20 kg K through gliricidia	439.64	826.65
T_5	100% NP + 30kg K through gliricidia	284.64	526.58
T_6	75% N +100% P+15kg K(inorganic)+15kg K through gliricidia	256.52	474.55
T_7	75% N +100% P+30kg K through gliricidia	223.59	413.65
T_8	50% N +100% P+30kg K through gliricidia	148.83	275.34
T_9	100% K through gliricidia	138.55	256.31
	SE (m) ±	23.36	42.07
	CD at 5%	70.05	126.12

Praharaj *et al*. (2009) [3] worked on the sustaining cotton productivity and soil fertility through *in-situ* management of green manure and crop residues in semi-arid irrigated condition of Coimbatore, India. They observed that the simultaneous planting of sunhemp and cotton under ridge-furrow system, followed by burying of sunhemp @ 2.5 t/ha *in-situ* before flowering followed by earthing up was optimum for higher cotton productivity (1.70 t/ha). Similar results were also reported by Sangakkara *et al.* (2008) [5], Regar *et al*. (2009) [4], Kamble *et al*. (2009) [1] and Shirale and Khating (2009) [7].

Nutrient uptake by cotton

Nitrogen uptake

The data in respect of nitrogen uptake by cotton seed and stalk and total N uptake by cotton were significantly influenced by various treatments (Table 2).

The data indicated that the significantly higher N uptake by seed (14.14 kg ha^{-1}) was observed with the application of 100% NP + 10kg K(inorganic)+20 kg K through gliricidia(T_4) and it was found to be on par with 100% NP + 15kg K(inorganic)+15kg K through *Gliricidia* (T_3), 100% NP + 30kg K through *Gliricidia* (T_5). The lowest N uptake by seed was observed in treatment T_1 *i.e.* control (3.54 kg ha^{-1}).

Table 2: Effect of potash management through *Gliricidia* green leaf manuring on nitrogen uptake by cotton

Treatments		Nitrogen uptake (kg ha^{-1})		
		Seed	Stalk	Total
T_1	Control	3.54	1.69	5.24
T_2	100% RDF (60:30:30 NPK kg ha^{-1})	10.59	4.75	15.34
T_3	100% NP + 15kg K(inorganic)+15kg K through gliricidia	12.84	5.64	18.47
T_4	100% NP + 10kg K(inorganic)+20 kg K through gliricidia	14.14	6.56	20.70
T_5	100% NP + 30kg K through gliricidia	9.24	4.05	13.28
T_6	75% N +100% P+15kg K(inorganic)+15kg K through gliricidia	8.08	3.59	11.67
T_7	75% N +100% P+30kg K through gliricidia	6.63	2.95	9.58
T_8	50% N +100% P+30kg K through gliricidia	4.56	1.84	6.40
T_9	100% K through gliricidia	4.22	1.76	5.98
	SE (m) ±	0.66	0.33	0.98
	CD at 5%	1.98	0.99	2.94

The significantly higher N uptake by stalk (20.70 kg ha^{-1}) was observed with the application of 100% NP + 10kg K(inorganic)+20 kg K through *Gliricidia* (T_4) and it was also found to be on par with the treatments T_5 and T_3. The lowest N uptake by stalk (5.24 kg ha^{-1}) was observed in treatment T_1 *i.e.* control.

The uptake of nitrogen increased due to the combined application of NPK + 25 kg K + *Gliricidia* which increase the

concentration of N in seed and stalk. The uptake of N increased due to the combined application of inorganics in combination with organics which increased the concentration of N in seed and stalk.

This may be due to addition of *Gliricidia* green leaf manuring which contains larger amount of N in their leaves and that facilitates higher rate of mineralization process, also effective root system and increased concentration of nutrients in soil solution as well as better soil physical environment coupled with sufficiency of moisture and nutrients helped in better uptake of nutrients and thus results in higher uptake of nitrogen by the plant as compared to inorganic fertilizers alone.

The results are in conformity with finding of Shirale and Khating (2009) [7] who studied the effect of organic and inorganic nutrients on yield, nutrient uptake and balance in different cropping systems in Vertisol at Parbhani and observed that the highest total grain yield was recorded by RDF followed by *Gliricidia* @1.5 t ha^{-1}+25% RDF and it was at par with each other. Similar results were also reported by Satyanarayana Rao and Janawade (2009) [6], Thimma Reddy *et al*. (2013) [8].

Phosphorus uptake

The data in respect of phosphorus uptake by cotton seed and stalk and total P uptake by cotton were significantly influenced by various treatments (Table 3). The data indicated that the significantly higher total P uptake by seed (1.94 kg ha^{-1}) was observed with the application of 100% NP + 10kg K(inorganic)+20 kg K through *Gliricidia* (T_4) and it was found to be on par with the application of 100% NP + 15kg K(inorganic)+15kg K through *Gliricidia* (T_3). The lowest P uptake by seed was observed in treatment T_1 *i.e.* control (0.48 kg ha^{-1}).

Table 3: Effect of potash management through *Gliricidia* green leaf manuring on phosphorus uptake by cotton

Treatments		Phosphorus uptake (kg ha^{-1})		
		Seed	**Stalk**	**Total**
T_1	Control	0.48	0.66	1.14
T_2	100% RDF (60:30:30 NPK kg ha^{-1})	1.82	2.48	4.29
T_3	100% NP + 15kg K(inorganic)+15kg K through gliricidia	1.76	2.60	4.36
T_4	100% NP + 10kg K(inorganic)+20 kg K through gliricidia	1.94	2.82	4.76
T_5	100% NP + 30kg K through gliricidia	1.24	1.72	2.96
T_6	75% N +100% P+15kg K(inorganic)+15kg K through gliricidia	1.08	1.51	2.59
T_7	75% N +100% P+30kg K through gliricidia	0.94	1.35	2.29
T_8	50% N +100% P+30kg K through gliricidia	0.60	0.88	1.47
T_9	100% K through gliricidia	0.58	0.79	1.37
	SE (m) ±	0.10	0.16	0.25
	CD at 5%	0.31	0.47	0.75

The significantly higher total P uptake by stalk (4.76kg ha^{-1}) was observed with the application of 100% NP + 10kg K (inorganic) +20 kg K through *Gliricidia* (T_4) and it was found to be on par with T_3. The lowest P uptake by stalk was observed in treatment T_1 *i.e.* control (1.14 kg ha^{-1}).

The application of *Gliricidia* green leaf manure with chemical fertilizers was better than the fertilizers application alone and it increased the uptake of phosphorus from soil. The improvement in soil physical condition caused due to addition of organics is beneficial for enhanced uptake in INM treatments. The organics also helps in enhancing nutrients available in soil by reducing fixation of phosphorus, which improves the efficient use of added phosphorus.

Mweta *et al.* (2007) [2] observed that the green manure from pruning and mineral fertilizer affect phosphorus adsorption and uptake by maize crop in a gliricidia-maize intercropping at Malawi. The results indicate that addition of *Gliricidia* pruning increases P availability through reduced P sorption capacity of the soil and recycling of P. Combination of *Gliricidia* pruning and inorganic P fertilizer has an added benefit compared to application of either *Gliricidia* pruning or inorganic P fertilizer alone. Similar results were also reported by Satyanarayana Rao and Janawade (2009) [6], Shirale and Khating (2009) [7] and Thimma Reddy *et al*. (2013) [8].

Potassium uptake

The data (Table 4) in respect of K uptake by cotton seed and stalk and total K uptake by cotton were significantly influenced by various treatments. The data indicated that the significantly higher total K uptake by seed (3.74 kg ha^{-1}) was observed with the application of 100% NP + 10kg K(inorganic)+20 kg K through *Gliricidia* (T_4) and it was found to be on par with the application of 100% NP + 15kg K(inorganic)+15kg K through *Gliricidia* (T_3). The lowest K uptake by seed was observed in treatment T_1 *i.e.* control (0.99 kg ha^{-1}).

The significantly higher total K uptake by stalk (12.23 kg ha^{-1}) was observed with the application of 100% NP + 10kg K (inorganic) +20 kg K through *Gliricidia* (T_4) and it was found to be on par with treatment T_3. The lowest K uptake by stalk was observed in treatment T_1 *i.e.* control (3.02 kg ha^{-1}).

The increase in total potassium uptake was due to application of *Gliricidia* green leaf manure along with inorganic fertilizers which contains larger amount of potassium and on decomposition, release of organic acids that solubilize native K and which may get available to the plant. It is attributed to greater capacity of organic colloids to hold K ions on the exchange sites which enhanced the availability of potassium resulting in more uptake.

Table 4: Effect of potash management through *Gliricidia* green leaf manuring on potassium uptake by cotton

Treatments		Potassium uptake (kg ha^{-1})		
		Seed	**Stalk**	**Total**
T_1	Control	0.99	3.02	4.01
T_2	100% RDF (60:30:30 NPK kg ha^{-1})	2.90	9.68	12.58
T_3	100% NP + 15kg K(inorganic)+15kg K through gliricidia	3.27	10.59	13.87
T_4	100% NP + 10kg K(inorganic)+20 kg K through gliricidia	3.74	12.23	15.97
T_5	100% NP + 30kg K through gliricidia	2.36	7.75	10.11
T_6	75% N +100% P+15kg K(inorganic)+15kg K through gliricidia	2.05	6.73	8.78
T_7	75% N +100% P+30kg K through gliricidia	1.79	5.75	7.53
T_8	50% N +100% P+30kg K through gliricidia	1.19	3.73	4.93
T_9	100% K through gliricidia	1.14	3.35	4.49
	SE (m) ±	0.16	0.63	0.79
	CD at 5%	0.49	1.89	2.37

Similar results were also reported by Shirale and Khating (2009) [7], Satyanarayana Rao and Janawade (2009) [6] and Thimma Reddy *et al*. (2013) [8]. In general, the

In view of the above, it can be concluded that the use of *Gliricidia* green leaf manuring in conjunction with chemical fertilizers resulted in higher seed cotton yield and nutrient uptake by cotton and the application of 100% NP + 10kg K (inorganic) +20 kg K through *Gliricidia* was found to be beneficial for higher yield and nutrient uptake by cotton in Vertisols under semi-arid conditions.

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