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Long term effect of integrated nutrient management on potassium fractions and their relationship with yield of cotton + greengram (1:1) intercropping system in Vertisols

Shivani Regulwar, VV Gabhane, Anant Fulzele, Jaipal Yadav, Ajay Shelke and SD Jadhao

Abstract
A field study was conducted during *kharif* 2019-20 at Research field of AICRP for Dryland Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra to assess the long term effect of integrated nutrient management on potassium fractions and yield of cotton+greengram(1:1) intercropping system in Vertisols. The eight treatments replicated three times in randomized block design comprised of control, 50% and 100% RDF, 50% N ha^{-1} through gliricidia/FYM, 50% N fertilizers + 50% N ha^{-1} gliricidia/FYM + 100% P_2O_5+ 100% K_2O ha^{-1} fertilizers and 100% N ha^{-1} gliricidia + 100% P_2O_5+ 100% K_2O ha^{-1} fertilizers. The results after 33rd cycle indicated that application of 50% RDN through FYM in combination with 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} through inorganics recorded higher cotton+greengram yield and was on par with the application of 50% N through gliricidia + 50% N +100% P_2O_5 + 100% K_2O ha^{-1} through fertilizers. However, the significant improvement in potassium fractions was recorded with application of 50% N through gliricidia + 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} through fertilizers and was on par with 50% RDN through FYM in combination with 50% N + 100% P_2O_5+ 100% K_2O ha^{-1} through fertilizers. Among the various potassium fractions, the exchangeable and lattice K was highly correlated with yield of crops. Hence, it is concluded that the integrated application of 50% N through gliricidia / FYM + 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} through fertilizers resulted in improvement in potassium fractions and yield of cotton + greengram (1:1) intercropping system in Vertisols under rainfed conditions.

Keywords: potassium fractions, integrated nutrient management, vertisols

Introduction
Cotton (*Gossypium spp*.) is the most important fibre crop originated in India and belongs to Malvaceae family. It is backbone of our textile industry, accounting for 70 per cent of total fibre consumption in textile sector. Among different species of cotton *Gossypium hirsutum* and *Gossypium arboreum* are commonly grown in Maharashtra and used in textile industries for manufacture of cloth. Greengram (*Vigna radiata*) is popularly known as “moong dal” and one of the main pulse crop in India. It contains 20-25% protein and is a rich source of low fat protein, has a wide amino acid profile and contains no trans and saturated fats. It is cultivated in variety of soils from red lateritic to black cotton soil. More than 70% of world’s greengram production comes from India.

Soil K exists in four different forms *viz.*, soil solution K, exchangeable K, non-exchangeable K and mineral K. Major portion of soil K exists as constituent of mineral structure and in fixed or non-exchangeable forms with minor portion as water soluble and exchangeable K. Different forms of K are correlated with each other indicating that dynamic equilibrium is maintained among these forms. Due to the dynamic equilibrium between different forms, depletion in the given form of K is likely to shift the equilibrium in the direction to replenish it. These equilibrium reactions affect the level of soluble potassium at any time and accordingly, the amount of potassium available for plants. Potassium availability to plants, in general, is governed by these different forms of K *viz.*, water soluble K, exchangeable K, fixed K and mineral K.

Recent studies have revealed that continuous use of suboptimal doses of nutrients in the intensive cropping system has led to severe depletion of nutrient reserves in soil, causing multiple nutrient deficiencies. The use of high-analysis fertilizers devoid of micronutrients has also aggravated micronutrient deficiencies causing significant decline in crop productivity. No single dose of plant nutrient applied through chemical fertilizers, organic manures, crop residues or bio-fertilizers can meet the entire nutrient need of a crop in modern intensive agriculture. Rather, these need to be used in an integrated manner following a management technology which is practicable, economically viable, socially acceptable and ecologically sound (Mahajan and Gupta, 2009) [5].

The present study was carried out to study the long term effect of FYM/gliricidia green leaf manuring and inorganic fertilizer application on potassium fractions and yield of cotton+greengram intercropping system in Vertisols.

Materials and Methods

A field experiment conducted on Vertisols was initiated on the research field of AICRP for Dryland Agriculture, Dr. PDKV, Akola since 1987-1988. The present study was undertaken during 2019-20 with the cotton+greengam (1:1) intercropping system. The eight treatments replicated three times in randomized block design comprised of control, 50% and 100% RDF, 50% N ha^{-1} through gliricidia/FYM, 50% N fertilizers + 50% N ha^{-1} gliricidia/FYM + 100% P_2O_5+ 100% K_2O ha^{-1} fertilizers and 100% N ha^{-1} gliricidia + 100% P_2O_5+ 100% K_2O ha^{-1} fertilizers.

Total K extracted by HF digestion method, Water soluble K extracted by shaking soil and water suspension (1:5) for 1 hour, Exchangeable K extracted by using 1*N* neutral ammonium acetate, Non-exchangeable K determined by treating with 1 *N* HNO_3 in 1:10 ratio and boiling for 10 minutes and K was estimated with the help of flame photometer as described by Pratt, 1965, Lattice K was calculated by subtracting the sum of above three fractions from the total potassium content (Ranganathan and Satyanarayana, 1980) [9].

Results and Discussion

Yield of cotton

The yield of cotton in cotton+greengram (1:1) intercropping system is presented in Table 1. The mean seed cotton yield ranged between 424.6 to 776.3 kg ha^{-1}. Long term application of 50% RDN through organic source *i.e.* FYM in combination with 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} through inorganics (T_7) recorded higher seed cotton yield (776.3 kg ha^{-1}) and was on par with the application of 50% N through gliricidia + 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} through fertilizers (T_6), application of 100% RDF (T_2) and application of 100% N through gliricidia + 100% P_2O_5 + 100% K_2O ha^{-1} through fertilizers (T_8).The increase in seed cotton yield with long term application of 50% RDN through organic source *i.e.* FYM in combination with 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} through inorganics (T_7) was 82.8% and 11.8% higher as compared to control (T_1) and 100% RDF (T_2) treatments, respectively. The lowest seed cotton yield (424.6kg ha^{-1}) was recorded in treatment T_1 *i.e.* control.

Table 1: Effect of long term INM treatments on cotton and greengram yield

	Treatments	Cotton yield (kg ha^{-1})		Greengram yield (kg ha^{-1})		SCEY
		Seed cotton	Stalk	Grain	Straw	(kg ha^{-1})
T_1	Control	424.6	828.1	130.9	82.0	574.94
T_2	100% RDF	694.0	1388.3	226.3	140.9	953.82
T_3	50% RDF	626.6	1220.7	190.8	121.1	845.67
T_4	50% N ha^{-1}gliricidia	546.2	1037.9	172.1	107.9	743.77
T_5	50% N ha^{-1} FYM	598.6	1158.0	175.8	110.6	800.44
T_6	50% N fertilizers + 50% N ha^{-1} gliricidia +100% P_2O_5+ 100% K_2O ha^{-1} fertilizers	774.4	1522.7	250.6	169.0	1062.17
T_7	50% N fertilizers + 50% N ha^{-1} FYM + 100% P_2O_5+ 100% K_2O ha^{-1} fertilizers	776.3	1527.7	286.2	178.6	1104.84
T_8	100% N ha^{-1}gliricidia + 100% P_2O_5+ 100% K_2O ha^{-1} fertilizers	684.6	1314.4	217.0	139.4	933.73
	SE (m) ±	38.1	70.7	16.0	9.1	37.25
	CD at 5%	113.3	210.1	47.5	27.0	110.68

The mean cotton stalk yield ranged from 828.1 to 1527.7 kg ha^{-1} and significantly higher cotton stalk yield (1527.7 kg ha^{-1}) was recorded with long term application of 50% RDN through organic source *i.e.* FYM in combination with 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} through inorganics (T_7) and was on par with the application of 50% N through gliricidia + 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} through fertilizers (T_6) and application of 100% RDF (T_2). The increase in cotton stalk yield with long term application of 50% RDN through organic source *i.e.* FYM in combination with 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} through inorganics (T_7) was 84.5% and 10% higher as compared to control (T_1) and 100% RDF (T_2) treatments, respectively. The lowest cotton stalk yield (828.1 kg ha^{-1}) was recorded in treatment T_1 *i.e.* control.

Yield of greengram

The yield of greengram in cotton+greengram intercropping system is presented in Table 1. The greengram grain yield ranged between 130.9 to 286.2 kg ha^{-1}. Long term application of 50% RDN through organic source *i.e.* FYM in combination with 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} through inorganics (T_7) recorded higher greengram grain yield (286.2 kg ha^{-1}) and was on par with the application of 50% N through gliricidia + 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} through fertilizers (T_6). The increase in greengram grain yield with long term application of 50% RDN through organic source *i.e.* FYM in combination with 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} through inorganics (T_7) was 118.6% and 26.5% higher as compared to control (T_1) and 100% RDF (T_2) treatments, respectively. The lowest greengram grain yield (130.9 kg ha^{-1}) was recorded in treatment T_1 *i.e.* control.

The greengram straw yield ranged between 82.0 to 178.6 kg ha^{-1}. Long term application of 50% RDN through organic source *i.e.* FYM in combination with 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} through inorganics (T_7) recorded higher greengram straw yield (178.6 kg ha^{-1}) and was on par with the application of 50% N through gliricidia + 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} through fertilizers (T_6). The increase in greengram straw yield with long term application of 50% RDN through organic source *i.e.* FYM in combination with 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} through inorganics (T_7) was 117.8% and 26.7% higher as compared to control (T_1) and 100% RDF (T_2) treatments, respectively. The lowest greengram straw yield (82.0 kg ha^{-1}) was recorded in treatment T_1 *i.e.* control.

Higher greengram and cotton yield with conjunctive application of FYM and gliricidia green leaf manure along with chemical fertilizers may be due to balanced supply of nutrients to the crop 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.

Seed cotton equivalent yield

The seed cotton equivalent yield in cotton+greengram intercropping system is presented in Table 1. The seed cotton equivalent yield (SCEY) ranged between 574.94 to 1104.84 kg ha^{-1}. Long term application of 50% RDN through organic source *i.e.* FYM in combination with 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} through inorganics (T_7) recorded higher seed cotton equivalent yield (1104.84 kg ha^{-1}) and was on par with the application of 50% N through gliricidia + 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} through fertilizers (T_6). The increase in seed cotton equivalent yield with long term application of 50% RDN through organic source *i.e.* FYM in combination with 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} through inorganics (T_7) was 92.2% and 15.8% higher as compared to control (T_1) and 100% RDF (T_2) treatments, respectively. The lowest seed cotton equivalent yield (574.94 kg ha^{-1}) was recorded in treatment T_1 *i.e.* control.

Higher seed cotton equivalent yield with conjunctive application of FYM and gliricidia green leaf manure along with chemical fertilizers may be due to balanced supply of nutrients to the crop 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. In general, the increase in yield of cotton and greengram was recorded with conjunctive application of FYM and gliricidia green leaf manure along with chemical fertilizers. Similar observations were recorded by, Solunke *et al.* (2011) [16], Sonune *et al.* (2012) [17], Simon *et al.* (2016) [13], Chandel *et al.* (2017) [2] and Pujar *et al.* (2018) [8].

Potassium fractions in soil

The availability of potassium to plant depends on relative mobility of the different forms of K in soil. A knowledge regarding the various forms of K in soil and the condition controlling its availability to cotton+greengram crops is important for the appraisal of the available potassium. Therefore, it is necessary to study the transformation of applied K in different forms and their influence on the yield of cotton+greengram in Vertisols. Data pertaining to distribution of various potassium fractions *viz.*, water soluble (WSK), exchangeable (EX- K), nonexchangeable (NEK), lattice K (LK) and total K (TK) and per cent contribution of different potassium fractions to total K are presented in Table 2.

Water soluble potassium

Soil solution K is the form of K that is directly taken up by plants and microbes and also is the form subject to most leaching in soil. The effect of integrated nutrient management on water soluble potassium was significant. Significantly higher water soluble potassium (23.67 mg kg^{-1}) was recorded with the application of application of 50% N ha^{-1} gliricidia + 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} fertilizers (T_6) and it was on par with application of 50% N ha^{-1} FYM + 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} fertilizers (T_7). It was also noted that 61.3% and 14.5% increase in water soluble potassium content was observed with application of 50% N ha^{-1} gliricidia + 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} fertilizers (T_6) as compared to control (T_1) and 100% RDF (T_2), respectively.

The lowest water soluble potassium (14.67 mg kg^{-1}) was recorded in control treatment (T_1).

This 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 results in greater capacity to hold K in the available form. These results are in agreement with the findings of Sharma and Verma (2000) [12], Singh *et al*. (2005) [15], Babar *et al*. (2007) [1], Singh *et al.* (2014) [14], Sujatha *et al*. (2017) [18] and Yadav *et al*. (2019) [20].

Exchangeable potassium

Exchangeable K has been generally regarded as reliable index of K removal by crops. It is held by virtue of the negative charges of organic matter and clay minerals in soil. It is easily exchanged with other cations and is relatively easily available to plants.

The effect of integrated nutrient management on exchangeable potassium was found to be significant. Significantly highest exchangeable potassium (336.00 mg kg^{-1}) was recorded with the application 50% N ha^{-1} gliricidia + 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} fertilizers (T_6) and it was on par with application of 50% N ha^{-1} FYM + 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} fertilizers (T_7) and application of 100% N ha^{-1} gliricidia + 100% P_2O_5 + 100% K_2O ha^{-1} fertilizers (T_8) as well as with 100% RDF (T_2) and 50% N ha^{-1} FYM (T_5). It was also noted that 57.9% and 7.1% increase in exchangeable potassium content was observed with application of 50% N ha^{-1} gliricidia + 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} fertilizers (T_6) as compared to control (T_1) and 100% RDF (T_2), respectively. The lowest exchangeable potassium (212.80 mg kg^{-1}) was recorded in control treatment (T_1). The higher amount of exchangeable K in the green leaf manure treated plots over the years can be attributed to the fact that green leaf manure addition could increase the CEC of soil which was responsible for holding more amount of exchangeable K and helped in the release of exchangeable K from non-exchangeable K.The contribution of exchangeable K to total K ranged between 1.87% to 2.40% which was slightly higher as compared to water soluble K. These results are in agreement with the findings of Babar *et al*. (2007) [1], Singh *et al.* (2014) [14], Sujatha *et al.* (2017) [18] and Yadav *et al*. (2019) [20].

Table 2: Long term effect of INM on potassium fractions in soil (mg/kg)

Treatments		WSK	Exch.K	Non- Ex K	Total K	Lattice- K
T_1	Control	14.67	212.80	776.67	8512.0	7507.9
T_2	100% RDF	20.67	313.60	876.67	11498.7	10287.7
T_3	50% RDF	18.33	257.60	820.00	9856.0	8760.1
T_4	50% N ha^{-1} gliricidia	17.33	283.73	826.67	9706.7	8578.9
T_5	50% N ha^{-1} FYM	19.00	306.13	860.00	9258.7	8073.5
T_6	50% N fertilizers + 50% N gliricidia +100% P_2O_5+ 100% K_2O ha^{-1} fertilizers	23.67	336.00	923.33	12394.7	11111.7

T_7	50% N fertilizers + 50% N ha^{-1} FYM + 100% P_2O_5+ 100% K_2O ha^{-1} fertilizers	22.33	328.53	916.67	12245.3	10977.8
T_8	100% N ha^{-1} gliricidia + 100% P_2O_5+ 100% K_2O ha^{-1} fertilizers	19.67	313.60	880.00	10752.0	9538.7
SE(m)±		0.68	15.55	9.77	261.71	264.17
CD at 5%		2.03	46.21	29.03	777.62	784.93

Non-exchangeable potassium

Non-exchangeable potassium is held between adjacent tetrahedral layers of dioctahedral and trioctahedral micas, vermiculites and intergrade clay minerals. It is also found in wedge zones of weathered micas and vermiculites. Non-exchangeable K is moderately to sparingly available to plants. The effect of integrated nutrient management on non-exchangeable potassium was significant. Significantly highest non-exchangeable potassium (923.33 mg kg^{-1}) was recorded with the application 50% N ha^{-1} gliricidia + 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} fertilizers (T_6) and it was on par with application of 50% N ha^{-1} FYM + 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} fertilizers (T_7). It was also noted that 18.9% and 5.3% increase in non-exchangeable potassium content was observed with application of 50% N ha^{-1} gliricidia + 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} fertilizers (T_6) as compared to control (T_1) and 100% RDF (T_2), respectively. The lowest non-exchangeable potassium (776.67 mg kg^{-1}) was recorded in control treatment (T_1). Sawarkar *et al.* (2013) [11] while studying distribution of potassium fractions also reported the non-exchangeable potassium in the range of 736 to 885 mg kg^{-1} in Vertisols. These results are in agreement with the findings of Pannu *et al.* (2001) [6], Babar *et al*. (2007) [1], Singh *et al.* (2014) [14] and Yadav *et al*. (2019) [20].

Lattice potassium

It is fraction of K that gets fixed in lattice space of 2:1 clay minerals. This form of K is distinct form of mineral K in that, it is not bonded covalently within the crystal structure of soil mineral particle but held between adjacent tetrahedral layers of dioctahedral and trioctahedral wedge zones of weathered micas and vermiculite. The effect of integrated nutrient management on lattice potassium was significant. Significantly highest lattice potassium (11111.7 mg kg^{-1}) was recorded with the application 50% N ha^{-1} gliricidia + 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} fertilizers (T_6) and it was on par with application of 50% N ha^{-1} FYM + 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} fertilizers (T_7). It was also noted that 48% and 8% increase in lattice potassium content was observed with application of 50% N ha^{-1} gliricidia + 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} fertilizers (T_6) as compared to control (T_1) and 100% RDF (T_2), respectively. The lowest lattice potassium (7507.9 mg kg^{-1}) was recorded in control treatment (T_1).

The increased lattice-K content maintained under a long term integrated nutrient management might be due to the addition of gliricidia green leaf manure which have larger amount of potassium content. Similar results were also noted by Babar *et al*. (2007) [1], Jadhao *et al.* (2015) [4] and Yadav *et al*. (2019) [20].

Total potassium

The knowledge of K fertility status is of prime importance as it indicates the total reserve of K which may become available to plants. More than 90 per cent of total K in soil is within the crystal lattice of silicate minerals, which on weathering slowly releases K in soil for plant utilization.

The effect of integrated nutrient management on total potassium was significant. Significantly highest total potassium (12394.7 mg kg^{-1}) was recorded with the application 50% N ha^{-1} gliricidia + 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} fertilizers (T_6) and it was on par with application of 50% N ha^{-1} FYM + 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} fertilizers (T_7). It was also noted that 45.6% and 7.8% increase in total potassium content was observed with application of 50% N ha^{-1} gliricidia + 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} fertilizers (T_6) as compared to control (T_1) and 100% RDF (T_2), respectively. The lowest total potassium (8512.0 mg kg^{-1}) was recorded in control treatment (T_1).

The combined application of manures and fertilizers (NPK+GLM, FYM) resulted in larger amount of SOC which adds additional amount of K and also provide sorption site for K on application of organic manure along with mineral fertilizer. These results are in agreement with the findings of Singh *et al.* (2014) [14], Jadhao *et al*. (2015) [4] and Yadav *et al*. (2019) [20].

Contribution of different potassium fractions to total K

The different potassium fractions were analyzed and contribution of each fraction was calculated against total K in percent.

Table 3: Contribution of different potassium fractions to total K

% of Total K					
Treatments		WSK	Exch.K	Non-ex K	Lattice K
T_1	Control	0.17	2.50	9.12	88.20
T_2	100% RDF	0.18	2.73	7.62	89.47
T_3	50% RDF	0.19	2.61	8.32	88.88
T_4	50% N ha^{-1} gliricidia	0.19	2.92	8.52	88.38
T_5	50% N ha^{-1} FYM	0.18	3.31	9.29	87.20
T_6	50% N fertilizers + 50% N gliricidia +100% P_2O_5+ 100% K_2O ha^{-1} fertilizers	0.21	2.71	7.45	89.65
T_7	50% N fertilizers + 50% N ha^{-1} FYM + 100% P_2O_5+ 100% K_2O ha^{-1} fertilizers	0.19	2.68	7.49	89.65
T_8	100% N ha^{-1} gliricidia + 100% P_2O_5 + 100% K_2O ha^{-1} fertilizers	0.18	2.92	8.18	88.72

The data indicated the higher contribution of lattice K to total K (87.20% to 89.65%) indicating dominant K fraction which contributed substantially to total K. Among all the fractions, water soluble (WSK) potassium contributed less *i.e.* between 0.17- 0.21%. Across different treatments the contribution of exchangeable K and non-exchangeable K towards total K under different treatments was in the range 2.50 - 3.31% and 7.45 - 9.29%, respectively.

The contribution of non-exchangeable K to total K indicate that, this form appreciably contributed to total pool indicating fixation of potassium in the interlayer, which suggest the need of application of organics, which help in release of K. The inclusion of green manure or FYM along with chemical fertilizers was found beneficial in improving the non-exchangeable K status of soil. These results are in agreement with the findings of Swapana *et al.* (2012) [19], Jadhao *et al*. (2016) [3] and Yadav *et al*. (2019) [20].

Correlation among yield and various potassium fractions

The data on correlation among seed cotton yield and potassium fractions are presented in Table 4. The seed cotton yield was significantly and positively correlated with all the potassium fractions. The coefficient of correlation ranged between 0.650** to 0.852**. The exchangeable K (r=0.852**) was highly correlated with seed cotton yield. The greengram yield was significantly and positively correlated with all the potassium fractions. The coefficient of correlation ranged between 0.598** to 0.850**. The lattice K (r=0.850**) was highly correlated with greengram yield.

The SCEY yield was significantly and positively correlated with all the potassium fractions. The coefficient of correlation ranged between 0.671** to 0.882**. The exchangeable K (r=0.882**) was highly correlated with seed cotton equivalent yield.

Table 4: Correlation among crop yield and various potassium fractions

	Seed cotton yield	Greengram yield	Seed cotton equivalent yield(SCEY)
Yield	1.000	1.000	1.000
WSK	0.806**	0.745**	0.833**
Exch. K	0.852**	0.792**	0.882**
Nonex K	0.650**	0.598**	0.671**
Lattice K	0.764**	0.850**	0.848**
Total K	0.777**	0.846**	0.838**

** Significant at 1% level of significance.

Correlation among various potassium fractions

The correlation among various potassium fractions indicated that, all the K fractions showed significant and positive correlation with water soluble K indicating rapid establishment of equilibrium between these forms.

Table 5: Correlation among various potassium fractions

	WSK	Exch. K	Nonex K	Lattice K	Total K
WSK	1.000				
Exch. K	0.746**	1.000			
Nonex K	0.885**	0.713**	1.000		
Lattice K	0.810**	0.665**	0.805**	1.000	
Total K	0.825**	0.689**	0.823**	0.999**	1.000

** Significant at 1% level of significance

Comparatively high degree of correlation of Total K with Lattice K (r=0.999**) followed by water soluble K with non exchangeable K (r=0.885**) showed rapid establishment of equilibrium between these forms. Similar type of correlation was reported by Ravankar *et al*. (2001), Babar *et al.* (2007) [1], Swapana *et al.* (2012) [19], Jadhao *et al*. (2015) [4] and Yadav *et al*. (2019) [20].

Conclusion

In view of the above, it is concluded that the integrated application 50% N through gliricidia / FYM+ 50% N + 100% P_2O_5 + 100% K_2O ha^{-1} through fertilizers resulted in improvement in soil potassium fractions and yield of cotton + greengram (1:1) intercropping system in Vertisols under rainfed conditions.

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