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Effect on nutrient uptake and fertility status of soil under greengram during *kharif* season

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Abstract
The field experiment conducted during *kharif* season 2014 on greengram. The experimental findings revealed that, the treatment with application of RDF + 40 kg K_2O ha^{-1} found significantly superior with reputes to nutrient content of nitrogen, phosphorous and potassium in seed (3.78%, 0.51%, 0.88%) and straw (0.96%, 0.20%, 0.69%), respectively. The results exposed that, the treatment with application of RDF + 40 kg K_2O ha^{-1} found significantly superior with reputes to total uptake of nitrogen (53.54 kg ha^{-1}), phosphorous (8.58 kg ha^{-1}) and potassium (21.51 kg ha^{-1}). Similarly, the application of RDF + 40 kg K_2O ha^{-1} displayed significantly improvement of soil status of available nitrogen (255.10 kg ha^{-1}), phosphorus (24.68 kg ha^{-1}) and potassium (395.42 kg ha^{-1}) over rest of treatments of other potassium doses.

Keywords: Greengram, nutrients, uptake, fertility, foliar spray

1. Introduction
Pulses are least preferred by farmers because of high risk and less remunerative than cereals; consequently, the production of the pulses is significantly low to meet the demand of pulses. Majority of Indian population is vegetarian, pulses are cheap and best source of protein for Indian diet. It contains 20-25 per cent protein, which is more than two times of cereals. India importing about 3 million tonnes and the future demand of pulses by 2015 will be 27.0 million tones (Singh *et al.*, 2011).

Greengram locally called as moong or mung [*Vigna radiata (L.) Wilczek*]. It belongs to the family leguminaceae so it has the capacity to fix atmospheric nitrogen. It's one of the important *kharif* pulse crops of India which can be grown as catch crop between *rabi* and *kharif* seasons. The seeds of greengram are highly nutritious with protein, carbohydrates, minerals and vitamins. Proteins are rich in lysine, leucine, threonine but poor in methionine, tryptophane, tyrosine. Lysine concentration is comparatively large and that is why the protein of greengram is an excellent complement to cereals particularly rice in terms of balanced human nutrition. Every 100 g of edible portion of greengram seed contains 75 mg calcium, 4.5 mg phosphorus, 24.5 g protein and 348 kilo calories energy (Meena *et al.*, 2013) [6].

India alone accounts for 65% of its world acreage and 54% of the total production. It is grown on about 3.50 Mha in the country mainly in Rajasthan, Maharashtra, Andhra Pradesh, Karnataka, Orissa and Bihar. In Maharashtra, Mung (Greengram) was sown over an area of 4.53 Lakh ha and recorded a production of 2.20 Lakh tons and yield level of 501 kg ha^{-1} (Anonymous 2018) [1].

Fertilizer is one of the most important inputs for increasing greengram yield. In legumes nitrogen requirement is less as compared to phosphorus because major portion of nitrogen is supplied through biological nitrogen fixation. Therefore phosphorus is the key nutrient for increasing productivity of pulses. Phosphorus stimulates early root development, enhances the availability of Rhizobia and increases the formation of root nodules thereby fixing more atmospheric nitrogen leading to increased yield. Legumes as such have a relatively high phosphorus requirement being utilized by plant and bacteria. Phosphorus can be applied either as soil application or foliar application

Potassium is one of the essential nutrient for plant growth and vital for sustaining modern high yield agriculture. Plant needs large quantities of potassium which not only improves the crop yield, but crop quality also. Potassium has been described as the "quality element" for crop production. Potassium increases the protein content of plants, the starch content in grains, it reduces the incidence of pests and diseases, enhances storage and shipping quality and extends shelf life. It is a prime factor for deciding the market price of green gram grown, which improve the income of farmers just by improving the quality of produce (Krishna, 1995). Potassium chloride is the most widely applied K fertilizer because of its relatively low cost and because it includes more K than most other sources: 50 to 52 percent K (60 to 63 percent K_2O) and 45 to 47 percent Cl^-. Potassium chloride rapidly dissolves in soil water. Therefore, keeping the above facts in view, a field experiment was conducted to estimate the nutrient uptake and fertility status of soil under greengram during *kharif* season".

2. Research Methodology

The field experiment entitled with "Uptake of nutrients and fertility status of soil under greengram during *kharif* season**"** was carried out at experimental farm of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *kharif* season of 2014, objective of study to find out optimum dose of potassium on nutrient uptake and fertility status of soil under greengram during *kharif* season. The soil of experimental site was clayey in texture, slightly alkaline in nature (7.9 pH), moderate in organic carbon (0.56 %), medium in available nitrogen (234.20 kg ha^{-1}), moderate in phosphorus (19.38 kg ha^{-1}) and moderately high in potassium (382.16 kg ha^{-1}). The experiment was laid out in Randomized Block Design (RBD) with six treatments and replicated four times. The treatments of potassium levels consisted viz., T_1 - RDF alone (control), T_2 - RDF + 20 kg K_2O ha^{-1}, T_3 - RDF + 30 kg K_2O ha^{-1}, T_4 - RDF + 40 kg K_2O ha^{-1}, T_5 - RDF + Foliar spray of KCL 2% (At flowering) and T_6 - RDF + Foliar spray of KCL 2% (At flowering and time of pod formation). The fertilizers were applied as per treatments. The recommended dose of fertilizer (20 kg N and 40 kg P_2O_5) was applied through urea (46% N) and Diammonium phosphate (18:46 N:P_2O_5). In case of potassium i.e. 20, 30 and 40 kg K_2O ha^{-1} were applied through Muriate of Potash (60% K) at the time of sowing. With regard to foliar application of 2 % KCL and 10 kg MOP were dissolved in 500 liters of water and sprayed respective treatments at 43 DAS.

For the determination of nutrient contents in plant samples, the samples were drawn at harvest stage. Samples were thoroughly washed, dried, powdered and these were used for uptake studies.

The following standard methods for analysis of nutrients were adopted.

i. Nitrogen: Nessler's reagent colorimetric method (Lindner, 1944)
ii. Phosphorus: Ammonium vanadomolybdate yellow colour method (Richards,1968)
iii. Potassium: Flame photometer

The nutrient uptake was calculated as below.

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content (\%) x Grain/dry matter yield (kg ha}^{-1}\text{)}}{100}$$

The Fertility status of soil can be determined by following standard methods:

i. Available Nitrogen: alkaline permanganate method (Subbiah and Asija, 1956) [9].
ii. Available Phosphorus: Olsen's method (Olsen *et. al.* 1954) [7].
iii. Available potassium: Neutral normal ammonium acetate (N, NH_4, OAC) extract of soil.

3. Results and Discussion

3.1 Nitrogen content and uptake by seed

The data regarding to nitrogen content and uptake of greengram as influenced by various treatments presented in Table 1.

3.2 Nitrogen content in seed and straw (%)

The data (Table 1) indicated that, the nitrogen content in seed and straw recorded with the value of 3.57 and 0.72 per cent, respectively. Significantly highest nitrogen content in seed (3.78 %) and straw (0.96 %) were recorded with the treatment of RDF + 40 kg K_2O ha^{-1} (T_4). But it was statistically at par with the treatments RDF + 30 kg K_2O ha^{-1} (T_3) and RDF + 20 kg K_2O ha^{-1} (T_2). Similarly, the treatment with application of RDF + 20 kg K_2O ha^{-1} (T_2) and treatment RDF + foliar spray of 2 % KCL (at flowering and time of formation) were found at par with each other. Significantly lowest nitrogen content in seed (3.31%) and straw 0.48%) displayed in control i.e. (RDF 20:40 N:P_2O_5 kg ha^{-1}).

3.3 Nitrogen uptake (Kg ha^{-1})

The data with regard to nitrogen uptake by seed and straw are presented in Table 1. Significantly highest nitrogen uptake of seed (34.92 kg ha^{-1}), straw (18.62 kg ha^{-1}) and total uptake (53.54 kg ha^{-1}) were observed in the treatment RDF + 40 kg K_2O ha^{-1} (T_4) and remained statistically at par with the treatment of RDF + 30 kg K_2O ha^{-1} (T_3). the treatment with application of RDF + 20 kg K_2O (T_2) recorded significantly highest uptake in seed, straw and its total uptake superior over the treatment control (RDF alone) (T_1) and it was at par with the treatment RDF + foliar spray of 2 % KCL (at flowering and time of pod formation) (T_6). Whereas, nitrogen uptake (kg ha^{-1}) by seed, straw and total uptake higher with application of RDF + foliar spray of 2 % KCL (at flowering) (T_5) found comparable with the treatment of control (RDF alone). The lowest nitrogen uptake was observed under the treatment of control (RDF 20:40 N:P_2O_5 kg ha^{-1}). The potassium application increased the nitrogen uptake might be due to nitrate accumulation by roots and ultimately its increased absorption and translocation in the plant.

4. Phosphorous content and uptake by greengram

The data pertaining to phosphorous content and uptake of greengram as influenced by various treatments presented in Table 2.

4.1 Phosphorus content in seed and straw (%)

The data (Table 2) revealed that, the mean content of phosphorous in seed and straw recorded with the value of 0.44 and 0.16 percent, respectively. The data specified that potassium treatments significantly influenced phosphorus content in seeds and straw. The treatment with application of RDF + 40 kg K_2O ha^{-1} (T_4) was recorded significantly highest phosphorus content in seeds (0.51%) and straw (0.20%) which was at par with treatment RDF + 30 kg K_2O ha^{-1} (T_3) and RDF + 20 kg K_2O ha^{-1}(T_2). Similarly, the treatment of RDF + 20 kg K_2O ha^{-1} (T_2) and RDF + foliar spray of 2 % KCL (T_6) were found statistically equal with each other. Whereas, the treatment of RDF + foliar spray of 2 % KCL (at flowering) and treatment of control (RDF 20:40 N:P_2O_5 kg ha^{-1}) were comparable with each other regarding to the phosphorus content in seed and straw to the treatment. The lowest phosphorus content in seed (0.37%) and straw (0.13%) registered under the treatment of RDF 20:40 N:P_2O_5 kg ha^{-1} (T_1).

4.2 Phosphorus uptake (Kg ha^{-1})

Phosphorus uptake of greengram through seed, straw and total uptake (Kg ha^{-1}) is showed in Table 2. The treatment of RDF + 40 kg K_2O ha^{-1} (T_4) was recorded significantly highest uptake in seed, straw and its total uptake of phosphorus (4.71

kg ha^{-1}), (3.88 kg ha^{-1}) and (8.59 kg ha^{-1}), respectively, it was found statistically similar with treatment of RDF + 30 kg K_2O ha^{-1} (T_3). The treatment of RDF + 20 kg K_2O ha^{-1} (T_2) recorded significantly higher phosphorus uptake in seeds (3.87 kg ha^{-1}) straw (3.22 kg ha^{-1}) and total P uptake (7.09 kg ha^{-1}) superior over control (RDF alone) (T_1), and it was statistically identical with treatment RDF + foliar spray of 2 % KCL (at flowering and time of formation) (T_6). Similarly, the phosphorus uptake (kg ha^{-1}) by seed, straw and its total uptake in the treatment of RDF + foliar spray of 2 % KCL (at flowering) (T_5) found comparable with the treatment of control (RDF alone) (T_1). The lowest phosphorus uptake was recorded in control (RDF 20:40 N:P_2O_5 kg ha^{-1}) treatment.

5. Potassium content and uptake by greengram

The data pertaining to potassium content and uptake of greengram as influenced by various treatments presented in Table 3.

5.1 Potassium content in seed and straw (%)

The data Table 2 concluded that, the mean content of potassium in seed and straw recorded with the value of 0.80 and 0.61 per cent, respectively. The highest potassium content in seed (0.88%) and straw (0.69%) were recorded with application of treatment RDF + 40 kg K_2O ha^{-1} (T_4) and it was found comparable with treatment of RDF + 30 kg K_2O ha^{-1} (T_3) and treatment of RDF + 20 kg K_2O ha^{-1} (T_2). However, the treatment T_2 and treatment T_6 found statistically at par with each other. Similarly, the treatment RDF + foliar spray of 2 % KCL (at flowering) and control (RDF alone) were found at par with other in case of potassium content in seed and straw. The treatment control (RDF 20:40 N:P_2O_5 kg ha^{-1}) was recorded lowest potassium content in seed (0.70%) and straw (0.54%).

5.2 Potassium uptake (kg ha^{-1})

The data in reverence of potassium uptake by seed, straw and total uptake is indicated in Table 3. The treatment with application of RDF + 40 kg K_2O ha^{-1} recorded significantly highest potassium uptake by seed (8.13 kg ha^{-1}), straw (13.38 kg ha^{-1}) and total uptake (21.51 kg ha^{-1}) which was superior over the treatment of control (RDF alone). However, it was found statistically at par with treatment of RDF + 30 kg K_2O ha^{-1}. Similarly, the treatment with application of RDF + 20 kg K_2O ha^{-1} recorded significantly higher potassium uptake in seed (6.98 kg ha^{-1}), straw (11.30 kg ha^{-1}) and total uptake (18.28 kg ha^{-1}) over treatment of control RDF alone and it was at par with treatment of RDF + foliar spray of 2 % KCL (at flowering and time of pod formation). The potassium uptake (kg ha^{-1}) by seed, straw and total uptake in the treatment T_5 found comparable with the treatment of T_1. The lowest potassium uptake was recorded under the treatment of control (RDF 20:40 N:P_2O_5 kg ha^{-1}).

6. Available N, P_2O_5, K_2O status in soil after harvest as influenced by various treatments of potassium levels

The data Table 4 regarding to fertility status of available N, P_2O_5, K_2O after harvest accessible the mean value of available N, P_2O_5 and K_2O were recorded 246.89, 22.29 and 386.09 kg ha^{-1} over the initial value of available N, P_2O_5 and K_2O i.e. 234.20, 19.38 and 382.16 kg ha^{-1}, respectively during course of investigation.

6.1 Available nitrogen (kg ha^{-1})

The data pertains to available nitrogen in soil after harvest of crop showed in Table 4. The nitrogen available in the soil was significantly improved by the different potassium treatments. The highest available nitrogen (255.10 kg ha^{-1}) was observed in treatment of T_4 i.e. RDF + 40 kg K_2O ha^{-1} and it was found at par with treatment of T_3 i.e. RDF + 30 kg K_2O ha^{-1} (252.21 kg ha^{-1}) followed by treatment T_2 i.e. RDF + 20 kg K_2O ha^{-1} (248.80 kg ha^{-1}) and which was found superior over the treatment T_1 i.e. control (RDF alone). The treatment T_6 i.e. RDF + foliar spray of 2 % KCL (at flowering and time of pod formation) and treatment T_5 i.e. RDF + foliar spray of 2 % KCL (at flowering) numerically increased the available nitrogen than the treatment T_1 i.e. control (RDF alone) and found comparable with each other. The treatment T_1 i.e. control (RDF alone) recorded lowest available nitrogen (240.38 kg ha^{-1}). The higher value of available nitrogen might be due to synergistic effect of potassium on nitrogen and application of potassium resulted in increasing nitrogen availability in soil. Similar results were obtained by Borse *et al.* (2002) [2] and Ibrahim *et al.* (2012) [3].

6.2 Available phosphorus (kg ha^{-1})

The data pertains to available phosphorus in soil after harvest of crop presented in Table 4. Available phosphorus in soil was significantly improved by different potassium treatments. Highest available phosphorus (24.68 kg ha^{-1}) was observed in treatment T_4 i.e. RDF + 40 kg K_2O ha^{-1} and found at par with the treatment T_3 i.e. RDF + 30 kg K_2O ha^{-1} (23.71 kg ha^{-1}) followed by treatment T_2 i.e. RDF + 20 kg K_2O ha^{-1} (22.83 kg ha^{-1}) and significantly superior over the treatment T_1 i.e. control (RDF alone) which recorded lowest available phosphorus (20.40 kg ha^{-1}). While, the treatment T_6 i.e. RDF + foliar spray of 2 % KCL (at flowering and time of pod formation) and treatment T_5 i.e. RDF + foliar spray of 2 % KCL (at flowering) numerically increased the available nitrogen than the treatment T_1 i.e. control (RDF alone) and found comparable with each other. Phosphorus content increased might due to the application of potassium which indicates better phosphorus use efficiency. Similar results were obtained by Borse *et al.* (2002) [2] and Ibrahim *et al.* (2012) [3].

6.3 Available Potassium (kg ha^{-1})

The data pertains to available potassium in soil after harvest of crop presented in Table 4. Available potassium in soil was significantly improved by different potassium treatments. The highest available potassium (395.42 kg ha^{-1}) was observed in treatment T_4 i.e. RDF + 40 kg K_2O ha^{-1} and it was at par with treatment T_3 i.e. RDF + 30 kg K_2O ha^{-1} (392.83 kg ha^{-1}). The treatment T_2 i.e. RDF + 20 kg K_2O ha^{-1} (388.61 kg ha^{-1}) was recorded higher available potassium over the treatment T_1 i.e. control (RDF alone) which recorded lowest (379.54) available potassium. The treatment T_6 i.e. RDF + foliar spray of 2 % KCL (twice), treatment T_5 i.e. RDF + foliar spray of 2 % KCL (at flowering) and the treatment T_1 i.e. control (RDF alone) were showed the depletion of the available potassium than initial recorded. Similar results were obtained by Borse *et al* (2002) [2].

Table 1: Nitrogen content and its uptake as influenced by various treatments

Treatments	N content (%)		N uptake (Kg ha^{-1})		Total N (Kg ha^{-1})
	Seed	Straw	Seed	Straw	
T_1 – RDF (20:40 N:P_2O_5 kg ha^{-1})	3.31	0.48	23.66	7.47	31.13
T_2 – RDF + 20 kg K_2O ha^{-1}	3.63	0.80	30.56	14.35	44.91
T_3 – RDF + 30 kg K_2O ha^{-1}	3.75	0.89	33.00	16.44	49.44
T_4 – RDF + 40 kg K_2O ha^{-1}	3.78	0.96	34.92	18.62	53.54
T_5 – RDF + Foliar spray of KCL 2% (at flowering)	3.41	0.52	26.35	8.44	34.79
T_6 – RDF + Foliar spray of KCL 2% (at flowering and time of pod formation)	3.56	0.70	29.08	11.94	41.02
SE (m) ±	0.07	0.08	1.05	0.82	1.68
CD at 5 %	0.21	0.25	3.16	2.47	5.06
GM	3.57	0.72	29.59	12.88	42.47

Table 2: Phosphorus content and its uptake as influenced by various treatments

Treatments	P content (%)		P uptake (kg ha^{-1})		Total P (Kg ha^{-1})
	Seed	Straw	Seed	Straw	
T_1 – RDF (20:40 N:P_2O_5 kg ha^{-1})	0.37	0.13	2.64	2.02	4.66
T_2 – RDF + 20 kg K_2O ha^{-1}	0.46	0.18	3.87	3.22	7.09
T_3 – RDF + 30 kg K_2O ha^{-1}	0.49	0.19	4.31	3.51	7.82
T_4 – RDF + 40 kg K_2O ha^{-1}	0.51	0.20	4.71	3.88	8.59
T_5 – RDF + Foliar spray of KCL 2% (at flowering)	0.39	0.14	3.01	2.27	5.28
T_6 – RDF + Foliar spray of KCL 2% (at flowering and time of pod formation)	0.43	0.16	3.51	2.73	6.24
SE (m) ±	0.02	0.01	0.18	0.17	0.37
CD at 5 %	0.06	0.03	0.54	0.52	1.11
GM	0.44	0.16	3.67	2.94	6.61

Table 3: Potassium content and its uptake as influenced by various treatments

Treatments	K content (%)		K uptake (kg ha^{-1})		Total K (Kg ha^{-1})
	Seed	Straw	Seed	Straw	
T_1 – RDF (20:40 N:P_2O_5 kg ha^{-1})	0.70	0.54	5.06	8.41	13.46
T_2 – RDF + 20 kg K_2O ha^{-1}	0.83	0.63	6.98	11.30	18.28
T_3 – RDF + 30 kg K_2O ha^{-1}	0.86	0.67	7.56	12.38	19.94
T_4 – RDF + 40 kg K_2O ha^{-1}	0.88	0.69	8.13	13.38	21.51
T_5 – RDF + Foliar spray of KCL 2% (at flowering)	0.73	0.56	5.64	9.09	14.33
T_6 – RDF + Foliar spray of KCL 2% (at flowering and time of pod formation)	0.79	0.59	6.45	10.08	16.53
SE (m) ±	0.02	0.02	0.34	0.44	0.83
CD at 5 %	0.07	0.06	1.03	1.33	2.49
GM	0.80	0.61	6.64	10.77	17.34

Table 4: Available N, P_2O_5, K_2O status in soil after harvest as influenced by various treatments

Treatment	Available nutrients (kg ha^{-1})		
	N	P_2O_5	K_2O
T_1 – RDF (20:40 N:P_2O_5 kg ha^{-1})	240.38	20.40	379.54
T_2 – RDF + 20 kg K_2O ha^{-1}	248.80	22.83	388.61
T_3 – RDF + 30 kg K_2O ha^{-1}	252.21	23.71	392.83
T_4 – RDF + 40 kg K_2O ha^{-1}	255.10	24.68	395.42
T_5 – RDF + Foliar spray of KCL 2% (at flowering)	242.08	20.98	379.78
T_6 – RDF + Foliar spray of KCL 2% (at flowering and time of pod formation)	242.76	21.16	380.23
SE (m) ±	1.99	0.51	1.73
CD at 5 %	5.99	1.54	386.06
GM	246.89	22.29	386.09
Initial value	234.20	19.38	382.16

7. Conclusion
On the basis of one year study concluded that the nutrients content in seeds and straw and their uptake via seeds and straw were found highest with application of RDF + 40 kg K_2O ha^{-1} treatment. Similarly, the fertility status of soil available Nitrogen, Phosphorus and Potassium were recorded higher in the treatment of potassium level with application of RDF + 40 kg K_2O ha^{-1}.

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