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INTEGRATED APPROACH IN NUTRIENT MANAGEMENT OF SUMMER GREEN GRAM

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ABSTRACT

A field experiment on integrated nutrient management practices for augmenting the productivity of summer green gram (*Vigna radiata* L.) was carried out in clay loam soil at Research Farm, J.N.K.V.V., College of Agriculture, Tikamgarh (Madhya Pradesh), India for two consecutive years during summer 2012 and 2013. The experiment was laid out in randomized block design replicated thrice with 10 different nutrient management treatments. The results revealed that integration of 100% RDF + Vermicompost @ 1.0 t/ha + *Rhizobium* resulted into significantly greater plant height (52.3 cm), number of primary branches/plant (5.8), higher total dry matter accumulation (19.6 g/plant)at harvest, maximum leaf area index (3.0) at 45 DAS, number of pods/plant (13.5), number of seeds/pod (10.6), 1000 seed weight (36.4 g) and seed yield (1081.1 kg/ha)in comparison to other nutrient management treatments. Application of 100% RDF + Vermicompost @ 1.0 t/ha + *Rhizobium* also recorded higher N, P and K uptakes by seed (40.3, 4.10 and 9.73 kg/ha, respectively) and stover (32.6, 4.33 and 10.8 kg/ha, respectively) as well as total uptakes (72.9, 8.43 and 20.5kg/ha, respectively) as compared to rest of treatments. Hence, it can be concluded that the application of 100% RDF + Vermicompost @ 1.0 t/ha + *Rhizobium* would be useful to enhance the productivity of summer green gram. The conjunctive use of organic manures and inorganic fertilizers alongwith biofertilizer may be suggested for higher productivity along with overall betterment of summer green gram.

INTRODUCTION

Green gram (*Vigna radiata* L.)is the third important pulse crop cultivated throughout India for its multipurpose uses as vegetable, pulse, fodder and green manure crop. Its seed is more palatable, nutritive, digestible and non-flatulent than other pulses grown in country. It occupies as good position due to its high seed protein content and ability to store the soil fertility through symbiotic nitrogen fixation. Thus, it contributed significantly to enhancing the yield of subsequent crops (Jat *et al.*, 2012). It is grown usually as rainfed crop and being a photo-sensitive and short-duration crop, can also be grown during summer season. The productivity of this crop is very low because of their cultivation on marginal and sub marginal lands of low soil fertility where little attention is paid to adequate fertilization (Saravanan *et al.*, 2013). In our farmers have a wrong conception that greengram, being a legume crop does not need fertilizers. There is very good prospect for its cultivation in summer season, but a high reduction in yield has been reported to occur due to non-use of fertilizers (Singh and Sekhon, 2008).On the other hand, with the short supply and escalating energy cost in future, chemical fertilizers will not be available at affordable price to the farmers and important constraint for increased use of inorganic fertilizers (Alim, 2012). Moreover, improper use of chemical fertilizers has caused nutritional imbalance in the soil, instability in productivity and hidden hunger, besides depletion of nutritional quality of the pulses (Bairwa *et al.*, 2009). Though, chemical fertilizers are playing a crucial role to meet the nutrient requirement of the crop, persistent nutrient depletion is posing a greater threat to the sustainable agriculture. Therefore, there is an urgent need to reduce the usage of chemical fertilizers and in-turn increase in the usage of organics, which needed to check the yield and quality levels. The biofertilizers have shown encouraging results in sustaining the crop productivity and improving the soil fertility (Govindan and Thirumurugan, 2005). Ghosh and Joseph (2008) also reported that summer green gram inoculated with *Rhizobium* culture significantly recorded higher number of pods, number of seeds, test weight and seed yield. Organic manures, on the other side provide a good substrate for the growth of micro-organisms and maintain a favourable nutrient supply environment and improve soil physical properties. However, use of organics alone does not result in spectacular increase in crop yields, due to their low nutrient status.

Therefore, the aforesaid consequences have paved way to increase the productivity of crops using the combination of organics, inorganic sources and biofertilizers. Thus, integrated approach of nutrient supply by chemical fertilizers along with organic manures and biofertilizers is gaining importance as this system not only reduces the use of inorganic fertilizers but sustaining the crop productivity by improving soil health and is also an environment-friendly approach. Integration of inorganic fertilizers and organic manures resulted in better growth, yield and nutrient uptakes in black gram (Kumpawat,2010), green gram (Mandal and Pramanick, 2014), sesame (Nayek *et al.*, 2014) and rice (Kumar *et al.*, 2014) as compared to sole application of organic manures and inorganic fertilizers. However, information on the conjunctive use of inorganic fertilizers and organic manure along with biofertilizers is lacking in many crops including summer green gram. Hence, keeping above facts in view, the present investigation was carried out to study the effect of integrated nutrient management practices on growth, yield, and nutrient uptake of summer green gram.

MATERIALS AND METHODS

The field experiment was conducted at Research Farm, J.N.K.V.V., College of Agriculture, Tikamgarh (24º43′ N latitude, 78º49′E longitude at an altitude of 358 m above mean sea level), Madhya Pradesh, INDIA during two consecutive summer seasons of 2012 and 2013. The experimental site is of sub-tropical climate characterized by hot dry summers and cool dry winter lies in the Bundelkhand Zone (Agro-climatic Zone-VIII). The average annual rainfall of this region is about 1000 mm which is mostly received between June to September and a little rainfall (90 mm) is also obtained during October to May. The average temperature ranges between 4.5ºC to 45ºC. The average humidity of the tract is about 70 per cent. The soil of experimental plot was medium to deep black and clayey loam in texture with pH 7.0, EC 0.12 dSm^{-1}, organic carbon 5.0 g/kg and available N, P and K was 266.3, 11.3 and 255.6 kg/ha, respectively.

The experiment was laid out in randomized block design having 3replications with 10 nutrient management treatments *viz.*, T_1: control, T_2: 100% recommended dose of fertilizers (RDF) + *Rhizobium*, T_3: FYM @ 4.0 t/ha + *Rhizobium*, T_4: 100% RDF + FYM @ 2.0 t/ha + *Rhizobium*, T_5: 75% RDF + FYM @ 2.0 t/ha + *Rhizobium*, T_6: 50% RDF + FYM @ 2.0 t/ ha + *Rhizobium*, T_7: Vermicompost @ 2.0 t/ha + *Rhizobium*, T_8: 100% RDF + Vermicompost @ 1.0 t/ha + *Rhizobium*, T_9: 75% RDF + Vermicompost @ 1.0 t/ha + *Rhizobium* and T_{10}: 50% RDF + Vermicompost @ 1.0 t/ha + *Rhizobium*. The green gram variety 'K851' was sown at spacing 30 cm row to row and 10 cm plant to plant on 10 April, 2012 and 12 April, 2013. The RDF of 20 kg N, 60 kg P_2O_5 and 20 kg K_2O/ha was applied as basal dose through di-ammonium phosphate (DAP) and muriate of potash (KCl) as per treatments. *Rhizobium* was applied as seed treatment just before sowing. The FYM and Vermicompost were incorporated about 20 and 4 days before sowing as per treatments, respectively. All other operations were performed as per recommendations of the crop. The data on various growth parameters, yield attributes, seed and stover yields were recorded under various treatments. Seed and stover yields were recorded after harvest of summer green gram. The representative dry samples of seed and stover were analyzed for ascertaining the nutrient (N, P and K) content. Seed and stover samples were digested in H_2SO_4 for determination of nitrogen (AOAC, 1995) and in di-acid mixture (HNO_3: $HClO_4$, 9:4 v/v) for phosphorus and potassium estimation (Bhargava and Raghupathi, 1984). The nutrients uptake by seed and stover were calculated by multiplying nutrient content with seed and stover yield (kg/ha). The results of both the years were more or less similar and hence two years data were pooled and analyzed statistically to draw suitable inference as per standard ANOVA technique described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Growth attributes

The data depicted in Table 1 showed that integrated use of inorganic, organic and biofertilizers as a source of nutrients significantly influenced the different growth characters of summer green gram. Significantly greater plant height (52.3 cm) at harvest, number of primary branches/plant (5.8) at harvest, maximum leaf area index at 30 DAS (0.90) and 45 DAS (3.00) and higher total dry matter accumulation (19.6 g/ plant) at harvest were recorded with the treatment T_8 (100% RDF + Vermicompost @ 1.0 t/ha + *Rhizobium*) as compared to application of RDF + *Rhizobium* (T_2), control (T_1), FYM @ 4.0 t/ha + *Rhizobium* (T_3), Vermicompost @ 2.0 t/ha + *Rhizobium* (T_7) and other integrated nutrient management treatments and found at par with application of 100% RDF + FYM @ 2.0 t/ha + *Rhizobium* (T_4), 75% RDF + Vermicompost @ 1.0 t/ha + *Rhizobium* (T_9) and 75% RDF + FYM @ 2.0 t/ha + *Rhizobium* (T_5). The significantly lowest plant height (43.2 cm) at harvest, leaf area index at 30 DAS (0.64) and 45 DAS (2.15) and total dry latter accumulation (133.3 g/plant) were recorded under control (T_1). These results clearly indicated the need for adding organic manures to soil conjunctive with inorganic fertilizers, which increased the availability of nutrients over a long period, have positive effect on growth of

Table 1: Effect of integrated nutrient management on growth of summer green gram (pooled over two years)

Treatments	Plant height (cm) at harvest	Number of primary branches/plant at harvest	Leaf area index		Total dry matter (g/plant) at harvest
			30 DAS	45 DAS	
T_1	43.2	4.20	0.64	2.15	13.3
T_2	48.7	5.42	0.80	2.74	17.3
T_3	45.3	5.27	0.72	2.43	15.4
T_4	51.9	5.70	0.87	2.94	18.6
T_5	51.0	5.57	0.82	2.83	18.0
T_6	47.0	5.40	0.78	2.68	16.4
T_7	45.8	5.30	0.78	2.65	16.3
T_8	52.3	5.80	0.90	3.00	19.6
T_9	51.2	5.57	0.83	2.91	18.1
T_{10}	48.1	5.41	0.79	2.73	17.2
SEm ±	0.43	0.11	0.03	0.12	0.56
CD (p=0.05)	1.27	0.32	0.09	0.36	1.63

Table 2: Effect of integrated nutrient management on yield attributes and yield of summer green gram (pooled over two years)

Treatments	Number of pods/plant	Number of seeds/pod	1000-seed weight(g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Biological yield (kg/ha)
T_1	10.3	8.9	33.9	750.3	2648.0	3398.3
T_2	12.5	10.1	36.0	1070.7	2994.4	4065.1
T_3	11.6	9.3	34.3	1011.6	2867.0	3878.6
T_4	13.1	10.4	36.3	1143.4	3030.1	4173.5
T_5	12.7	10.2	36.2	1089.8	3281.2	4371.0
T_6	12.2	9.8	35.6	1045.2	2939.3	3984.5
T_7	12.0	9.6	35.2	1026.9	2915.9	3942.8
T_8	13.5	10.6	36.4	1180.1	3119.2	4299.3
T_9	13.0	10.2	36.3	1119.6	3070.3	4189.9
T_{10}	12.5	9.9	36.0	1054.9	2951.7	4006.6
SEm ±	0.31	0.35	0.49	33.8	93.5	93.0
CD (p=0.05)	0.90	1.36	1.45	101.2	280.0	278.2

Table 3: Effect of integrated nutrient management on nutrients uptake of summer green gram (pooled over two years)

Treatments	N uptake (kg/ha)			P uptake (kg/ha)			K uptake (kg/ha)		
	Grain	Stover	Total	Grain	Stover	Total	Grain	Stover	Total
T_1	25.7	26.6	52.3	2.48	2.95	5.43	6.01	7.89	13.9
T_2	36.9	31.1	68.0	3.53	3.68	7.21	8.49	9.49	18.0
T_3	33.8	30.0	63.8	3.25	3.20	6.45	7.80	8.44	16.2
T_4	39.7	31.8	71.5	3.83	4.07	7.90	9.28	10.5	19.8
T_5	37.8	31.7	69.5	3.62	3.93	7.55	8.62	10.1	18.7
T_6	35.5	31.0	66.5	3.39	3.52	6.91	8.23	8.96	17.2
T_7	34.6	30.9	65.5	3.30	3.38	6.68	8.02	8.78	16.8
T_8	40.3	32.6	72.9	4.10	4.33	8.43	9.73	10.8	20.5
T_9	38.6	31.6	70.2	3.72	4.04	7.76	9.05	10.2	19.3
T_{10}	36.00	31.4	67.4	3.44	3.60	7.04	8.29	9.09	17.4
SEm ±	0.67	0.54	1.20	0.12	0.12	0.20	0.16	0.13	0.30
CD (p=0.05)	1.98	1.58	3.59	0.36	0.35	0.57	0.46	0.39	0.86

the plant. Also the findings of Afzal and Bano (2008) in wheat and Vadgave (2010) in green gram an accordance with the same.

Yield attributes and yield

The results summarized in Table 2 reveals that application of 100% RDF + Vermicompost @ 1.0t/ha + *Rhizobium* (T_8), 100% RDF + FYM @ 2.0 t/ha + *Rhizobium* (T_4), 75% RDF + Vermicompost @ 1.0 t/ha + *Rhizobium* (T_9) and 75% RDF + FYM @ 2.0 t/ha + *Rhizobium* (T_5) treatments were being at par to each other with respects to number of pods/plant (13.5, 13.1, 13.0 and 12.7), number of seeds/pods (10.6, 10.4, 10.2 and 10.2) and 1000-seed weight (36.4g, 36.3g, 36.3g and 36.2g) but significantly superior to application of RDF + *Rhizobium* (T_2), control (T_1), FYM @ 4.0 t/ha + *Rhizobium* (T_3), Vermicompost @ 2.0 t/ha + *Rhizobium* (T_7) and other integrated nutrient management treatments. Integrated use of organic, inorganic and biofertilizer (integrated nutrient management) resulted in better growth of plants associated with increased availability of nutrients might have resulted in greater translocation of photosynthates from source to sink site that resulted higher yield contributing characters (Barik *et al.*, 2008) under these treatments. The favourable effect of integration of organic manures, inorganic fertilizers and *Rhizobium* on yield attributes of green gram were reported by Kinkar (2007), Kumpawat (2010), Vadgave (2010) and Prajapati (2014).

The results illustrated in Table 2 also depict the yield of summer green gram as influenced by integration of organic, inorganic fertilizers and *Rhizobium*. Changes in nutritional management practices had a significant effect on seed yield of summer green gram. The maximum seed yield (1180.1 kg/ha) was observed in the treatment consisting of 100% RDF + Vermicompost @ 1.0 t/ha + *Rhizobium* (T_8), which was being at par with T_4: application of 100% RDF + FYM @ 2 t/ha + *Rhizobium* (1143.4 kg/ha), T_9: 75% RDF + Vermicompost @ 1.0 t/ha + *Rhizobium* (1119.6 kg/ha) and T_5:75% RDF + FYM @ 2.0 t/ha + *Rhizobium* (1089.8 kg/ha). On the contrary, application of nutrients either through inorganic sources (T_2: RDF + *Rhizobium*), or sole Vermicompost (T_7: Vermicompost @ 2.0 t/ha + *Rhizobium*) and sole FYM (T_3: FYM @ 4.0 t/ha + *Rhizobium*) showed poor performance with respect to seed yield. This result supports the observations of Khanda *et al.* (2005) and Kumpawat (2010). The extents of increase in seed yield of summer green gram due to application of 100% RDF + Vermicompost @ 1.0 t/ha + *Rhizobium* (T_8), 100% RDF + FYM @ 2.0 t/ha + *Rhizobium* (T_4), 75% RDF + Vermicompost @ 1.0 t/ha + *Rhizobium* (T_9) and 75% RDF + FYM @ 2.0 t/ha + *Rhizobium* (T_5) were 57.3%, 52.4%, 49.2% and 45.2%, respectively over control (T_1) and 10.2%, 6.79%, 4.57% and 1.78%, respectively over application of RDF + *Rhizobium* (T_2). Above results as an accordance with Parjapati (2014) stated that increased growth along with better expression of yield attributes might have led to increase in the seed yield under these treatments. Kumar *et al.* (2013) have also reported that integration of organic and inorganic fertilizers application significantly increased the yield in broccoli over inorganic fertilizers alone and also over control. Rajkhowa *et al.* (2002) in green gram, Sharma and Singh (2003) in pea and (Singh *et al.*, 2005) in cowpea also reported similar kind of results previously.

The minimum seed yield (750.3 kg/ha) was noticed when the crop was not given any nutrition *i.e.*, control (T_1). The reduction in the seed yield in control plots could be attributed to poor yield attributes *viz.*, number of pods/plant, number of seeds/pod and 1000-seed weight on account of decreased growth in term of biomass accumulation during vegetative phases leading to decreased bearing capacity (number of pods, number of seeds and 1000-seed weight), which ultimately decreased the seed yield. Kinkar (2007) and Vadgave (2010) had also reported the similar results, which support the results of present investigation.

The higher stover yield (3281.2 kg/ha) and biological yield (4371.0 kg/ha) was realized with treatment T_5(75% RDF + FYM @ 2.0 t/ha + *Rhizobium*), which was remained at par with treatments T_8(100% RDF + Vermicompost @ 1.0 t/ha + *Rhizobium*), T_9(75% RDF + Vermicompost @ 1.0 t/ha + *Rhizobium*) and T_4 (100% RDF + FYM @ 2.0 t/ha + *Rhizobium*). Benefits accruing from the integrated use of organic with inorganic fertilizers might be attributed to better supply of nutrients along with conducive physical environment leading to better root activity and higher nutrient absorption, which resulted better plant growth and superior yield attributes responsible for high yield (Thakur *et al.,* 2011). The positive impact of availability of individual plant nutrients and humic substances from manure and balanced supplement of nitrogen through inorganic fertilizers might have induced cell division, expansion of cell wall, meristematic activity, photosynthetic efficiency and regulation of water intake into the cells, resulting in the enhancement of yield parameters (Sekar, 2003).Improvement in yield due to combined application of inorganic fertilizer and organic manure might be attributed to control release of nutrients in the soil through mineralization of organic manure which might have facilitated better crop growth and yield (Afzal and Bano, 2008 and Katkar *et al.,* 2011).

Nutrients uptake

The results summarized in Table 3 reveal that significant variation in N, P and K uptake by seed and straw of green gram was noticed under different nutrient management treatments. Application of 100% RDF + Vermicompost @ 1.0 t/ha + *Rhizobium* (T_8), 100% RDF + FYM @ 2.0 t/ha + *Rhizobium* (T_4), 75% RDF + Vermicompost @ 1.0 t/ha + *Rhizobium* (T_9) and 75% RDF + FYM @ 2.0 t/ha + *Rhizobium* (T_5) significantly increased the N, P and K uptake by seed and stover as well as total uptakes over application of RDF + *Rhizobium* (T_2) and control (T_1).

Application of 100% RDF + Vermicompost @ 1.0 t/ha + *Rhizobium* recorded higher N, P and K uptakes by seed (40.3, 4.10 and 9.73 kg/ha, respectively) and stover (32.6, 4.33 and 10.8kg/ha, respectively) as well as total uptakes (72.9, 8.43 and 20.5kg/ha, respectively) as compared to rest of treatments. However, it was being at par with treatments T_4(100% RDF + FYM @ 2.0 t/ha + *Rhizobium*), T_9(75% RDF + Vermicompost @ 1.0 t/ha + *Rhizobium*) and T_5 (75% RDF + FYM @ 2.0 t/ha + *Rhizobium*). These treatments increased the total N uptake by 39.4%, 36.7%, 34.2% and 32.9%, respectively over control (T_1) and 7.21%, 5.15%, 3.24% and 2.21%, respectively over application of RDF + *Rhizobium* (T_2). The trend was also similar in case of P and K uptake by seed, stover and total P and K uptake in green gram. The highest P and K uptake by seed, stover and total P and K uptakes were recorded from treatments consisting of 100% RDF + Vermicompost @ 1.0 t/ha + *Rhizobium* (T_8) over rest of the treatments but found at par with application of 100% RDF + FYM @ 2.0 t ha^{-1} + *Rhizobium* (T_4), 75% RDF + Vermicompost @ 1.0 t/ha + *Rhizobium* (T_9) and 75% RDF + FYM @ 2.0 t/ha + *Rhizobium* (T_5). The significantly lowest N, P and K uptakes by seed, stover and total uptake was registered with treatment having no nutrition *i.e.*, control (T_1).

Integration of organic and inorganic fertilizers of plant nutrient elements results in more uptake of them as compared to sole use of organic or inorganic ones and control. This may be due to the fact that the balanced and combined use of various plant nutrient sources results in proper absorption, translocation and assimilation of those nutrients, ultimately increasing the dry-matter accumulation and nutrient contents of plant and thus showing more uptake of elemental nutrients. It is also a fact that improvement of physiological efficiencies of different macro and trace elements resulted from the combined application of organic and inorganic sources of nutrients produces crop with superior quality under investigation. Combined application of organic manures with *Rhizobium* + PSB + *Trichoderma* increased nutrient content in soil and nutrient uptake by plant (Ipsita Das and Singh, 2014).Similar findings were reported by Kumpawat (2010), Vadgave (2010), Anandan and Natarajan (2012) and Prajapati (2014). Beneficial effects of integration of chemical fertilizers and organic manures alongwith biofertilizers on nutrients uptake in wheat and sesame crops were also noticed by Sharma *et al.* (2013) and Nayek *et al.* (2014), respectively.

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