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Influence of System of Crop Intensification Practices on Yield and Nutrient Uptake in Greengram (*Vigna radiata* (L.) Wilczek)

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Field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore, during *kharif* and *rabi* seasons, 2010-11 to evaluate the influence of System of Crop Intensification (SCI) practices on greengram. The experiment consisted of nine treatments, viz., T_1 - Single seedling hill^{-1} at 20 x 20 cm, T_2 - Single seedling hill^{-1} at 25 x 25 cm, T_3 - Single seedling hill^{-1} at 30 x 30 cm, T_4 - Single seedling hill^{-1}at 40 x 40 cm, T_5 - Double seedlings hill^{-1}at 20 x 20 cm, T_6 - Double seedlings hill^{-1}at 25 x 25 cm, T_7 - Double seedlings hill^{-1} at 30 x 30 cm, T_8 - Double seedlings hill^{-1} at 40 x 40 cm and T_9 - Control (30 x 10 cm at two seedlings hill^{-1}). The experiment was laid out in Randomized Complete Block Design with three replications. The results revealed that single seedling hill^{-1} maintained at 25 x 25 cm (T_2) registered significantly higher grain yield (1408 kg ha^{-1}) and it was on par with double seedlings at 30 x 30 cm spacing (1323 kg ha^{-1}) and double seedlings maintained at 20 x 20 cm spacing (1309 kg ha^{-1}). The maximum N, P and K uptake was noticed with double seedlings hill^{-1} planted at a spacing of 30 x 10 cm (control). Available N and P status of the soil was the highest with single seedling maintained at 40 x 40 cm spacing (T_4).

Key words: Greengram, system of crop intensification, spacing, number of seedlings hill^{-1}, grain yield, nutrient uptake, soil available nutrients.

Greengram is the third most important pulse crop after chickpea and pigeon pea in India. About 45% of total world's greengram production is from India. The area under greengram in the country is around 3.8 million ha and the production is 1.0 million tonnes. The average productivity of greengram over globe is 577 kg ha^{-1} and in India it is 426 kg ha^{-1}, which is considered to be low (Anonymous, 2010).

System of Rice Intensification (SRI) has originated in Madagascar during 1983 and spread all over the world. By adopting the principles of SRI the production of rice has been reported to increase from 50 to 100 per cent (Uphoff, 2002). In the recent past , the successful SRI practices has been extrapolated to other crops such as wheat, Teff grass, maize, sorghum, finger millet, soybean, blackgram, kidney bean, lentil, mustard, sugarcane, tomato, brinjal, chilli, potato, carrot and onion in the name of System of Crop Intensification (SCI) (ISD, 2009). In similar lines, SCI practices have also been proved to increase the yield levels of crops more than twice (Uphoff *et al*., 2011). In pursuit of disseminating the beneficial effects of SCI, the present study has been programmed in greengram. Adoption of SCI practices in greengram may enhance the productivity and reduce the gap between per capita availability and nutritional security of the country. Therefore, a field experiment was conducted to evaluate the influence of system of crop intensification in greengram on yield, nutrient uptake and nutrients status in soil.

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Materials and Methods

Field experiments were conducted during *kharif* (2010) and *rabi* (2010-11) at Tamil Nadu Agricultural University, Coimbatore. The experimental soils were clay loamy (*kharif*) and sandy clay loamy (*rabi*) in texture, belongs to *Typic Haplustalf*. The pH of the soil was 8.24 and 8.15, EC 0.46 and 0.38 dSm^{-1}, organic carbon 0.59 and 0.22 % and available N, P and K 265 and 190 kg N ha^{-1}, 20.5 and 9.6 kg P ha^{-1}, 481.5 and 704.2 kg K ha^{-1} during *kharif* and *rabi* seasons, respectively. The experiment was laid out in a randomized complete block design with three replications. The experiment consisted of nine treatments *viz*., T_1 - Single seedling hill^{-1} at 20 x 20 cm, T_2 - Single seedling hill^{-1} at 25 x 25 cm, T_3 - Single seedling hill^{-1} at 30 x 30 cm, T_4 - Single seedling hill^{-1} at 40 x 40 cm, T_5 - Double seedlings hill^{-1} at 20 x 20 cm, T_6 - Double seedlings hill^{-1} at 25 x 25 cm, T_7 - Double seedlings hill^{-1} at 30 x 30 cm, T_8 - Double seedlings hill^{-1} at 40 x 40 cm and T_9 - Control (30 x 10 cm with two seedlings hill^{-1} at one herbicide at one hand weeding). One hand weeding (35 DAS) was done for T_1 to T_8 treatments. Greengram variety 'CO 6' was sown on 15-07-2010 and 20-10- 2010 for *kharif* and *rabi*, respectively. The recommended fertilizers *i.e.,* 25:50:25 kg NPK ha^{-1} were applied as basal through urea, diammonium phosphate (DAP) and muriate of

potash (MoP), respectively. Farmyard manure was applied @ 12.5 t ha^{-1} just before last harrowing and incorporated well into soil. All other recommended package of practices were followed to raise the crop as per the Crop Production Guide (2005). Total nitrogen, phosphorus and potassium contents in the plant sample were analyzed by Microkjeldahl method (Humphries. 1956), Vanadomolybdate method (Jackson, 1973) and Flame photometer (Jackson, 1973) method, respectively. Post harvest soil samples were taken from the experimental plots and available nitrogen, phosphorus and potassium were analyzed by Potassium permanganate-N method (Subbiah and Asija, 1956), 0.5 M $NaHCO_3$ extraction method (Olsen *et al*., 1954) and Flame photometer method (Stanford and English, 1949), respectively. The data were subjected to statistical analysis as prescribed by Gomez and Gomez, (2010).

Results and Discussion

Grain yield

The SCI practices had significant effect on grain yield of greengram (Table 1). Higher yield of greengram was recorded with single seedling hill^{-1} at 25 x 25 cm spacing (1610kg ha^{-1}) during *kharif* season and it was on par with double seedlings hill^{-1} at 40 x 40 cm (1583 kg ha^{-1}), single seedling hill^{-1} at 30 x 30 cm (1531 kg ha^{-1}) and double seedlings hill^{-1} at 30 x 30 cm (1529 kg ha^{-1}). However, during *rabi* season significantly higher grain yield was recorded with double seedlings hill^{-1} at 20 x 20 cm spacing (1263 kg ha^{-1}) and it was statistically on par with single seedling hill^{-1} at 25 x 25 cm (1207 kg ha^{-1}), double seedlings hill^{-1} at 25 x 25 cm (1187 kg ha^{-1}), single seedling hill^{-1} at 20 x 20 cm (1157 kg ha^{-1}) and double seedlings hill^{-1} at 30 x 30 cm (1117 kg ha^{-1}). Pooled data of two seasons revealed that single seedling hill^{-1} at 25 x 25 cm recorded a maximum grain yield (1408 kg ha^{-1}) and it was on par with double seedlings hill^{-1} at 30 x 30 cm (1323 kg ha^{-1}) and double seedlings hill^{-1} at 20 x 20 cm (1309 kg ha^{-1}). Optimum spacing would have effectively utilized the growth resources, particularly solar radiation as compared to narrow spacing, where plants might have suffered due to mutual shading by adjoining rows and more plants and it corroborates with the findings of Singh *et al*. (2009) in lentil. The pooled data revealed that the lowest grain yield was recorded under single seedling^{-1} at 40 x40 cm (963 kg ha^{-1}) followed by double seedlings hill^{-1} at 40 x 40 cm (1168 kg ha^{-1}) spacing. The lower plant density might have reduced the grain yield. Increasing the interplant spacing resulted in lesser pant population per unit area and reduced the yield of ricebean as reported by Zaman and Malik, (1999).

Table 1. Effect of crop geometry and number of seedlings on grain yield of greengram

Treatment	Yield (kg ha^{-1})		
	kharif	*rabi*	Pooled
T_1 - Single seedling + 20 x 20 cm	1323	1157	1240
T_2 - Single seedling + 25 x 25 cm	1610	1207	1408
T_3 - Single seedling + 30 x 30 cm	1531	1027	1279
T_4 - Single seedling + 40 x 40 cm	1310	617	963
T_5 - Double seedlings + 20 x 20 cm	1354	1263	1309
T_6 - Double seedlings + 25 x 25 cm	1383	1187	1285
T_7 - Double seedlings + 30 x 30 cm	1529	1117	1323
T_8 - Double seedlings + 40 x 40 cm	1583	753	1168
T_9 - Control (2 seedlings + 30 x 10 cm)	1307	1050	1179
SEd	103	71	50
CD (P=0.05)	219	151	106

Nutrient uptake

The uptake of nutrients is primarily a function of total biomass production and nutrient content of plant. Noticeably higher uptake of nitrogen was recorded with double seedlings hill^{-1} at 30 x 10 cm spacing (35.89 kg ha^{-1}) during *kharif* season and it was on par with double seedlings hill^{-1} at 20 x 20 cm spacing (32.42 kg ha^{-1}). On the other hand, during *rabi* season significantly higher amount of nitrogen uptake was registered with double seedlings hill^{-1} at 30 x 10 cm spacing (31.71 kg ha^{-1}) and it was statistically on par with double seedlings hill^{-1} at 20 x 20 cm spacing (30.66 kg ha^{-1}). Pooled data of two seasons revealed that double seedlings hill^{-1} at 30 x 10 cm recorded higher uptake of nitrogen (33.80 kg ha^{-1}) followed by double seedlings hill^{-1} at 20 x 20 cm (31.54 kg ha^{-1}). Higher nutrient uptake observed with two seedlings hill^{-1} at 30 x 10 cm spacing might be due to maintenance of optimum number of

Table 2. Nitrogen, phosphorus and potassium (kg ha^{-1}) uptake of greengram as influence by SCI practices

Treatment	Nitrogen (kg ha^{-1})			Phosphorus (kg ha^{-1})			Potassium (kg ha^{-1})		
	kharif	*rabi*	Pooled	*kharif*	*rabi*	Pooled	*kharif*	*rabi*	Pooled
T_1 - Single seedling at 20 x 20 cm	27.30	23.97	25.63	6.79	5.12	5.95	61.46	56.01	58.73
T_2 - Single seedling at 25 x 25 cm	24.74	21.47	23.11	6.45	4.72	5.58	56.91	51.96	54.44
T_3 - Single seedling at 30 x 30 cm	21.04	18.21	19.63	6.01	4.67	5.34	51.61	46.75	49.18
T_4 - Single seedling at 40 x 40 cm	17.33	15.16	16.25	5.59	4.26	4.92	46.86	43.52	45.19
T_5 - Double seedlings at 20 x 20 cm	32.42	30.66	31.54	6.84	5.51	6.17	67.50	65.69	66.59
T_6 - Double seedlings at 25 x 25 cm	28.80	25.98	27.39	6.82	5.49	6.15	64.27	62.32	63.30
T_7 - Double seedlings at 30 x 30 cm	25.16	23.24	24.20	6.47	5.12	5.79	56.36	52.33	54.35
T_8 - Double seedlings at 40 x 40 cm	20.98	17.89	19.43	6.03	4.70	5.36	51.99	48.99	50.49
T_9 - Control (2 seedlings at 30 x 10 cm)	35.89	31.71	33.80	7.12	5.67	6.39	76.73	68.93	72.83
SEd	1.58	0.59	0.65	0.10	0.11	0.12	2.00	0.77	0.23
CD (P=0.05)	3.34	1.24	1.38	0.21	0.25	0.24	4.22	1.64	0.26

seedlings which helped the crop in increasing the growth especially dry matter production thereby contributing to greater nutrient uptake (Table 2)

This is in concordance with the finding of Sathyamoorthi *et al.* (2007) in greengram. The pooled data revealed that the lowest nitrogen uptake was recorded with single seedling hill^{-1} at 40 x 40 cm (16.25 kg ha^{-1}) followed by double seedlings hill^{-1} at 40 x 40 cm (19.43kg ha^{-1}). Wider spacing registered the lowest nitrogen uptake and this may be due to less population per plot. Sathyamoorthi *et al*. (2007) also reported that wider spacing of greengram registered lower uptake of available nutrient due to less number of plants plot^{-1}. The trend was similar with phosphorus and potassium uptake also during *kharif* 2010 and *rabi* 2010-11 seasons.

Post harvest soil available NPK

Post harvest soil available N, P and K results were highly varying. The post harvest available K status was not significantly altered by spacing during both the seasons. But significant variation was observed in available N and P in the post harvest soil sample during *kharif 2010* and *rabi* 2010-11 (Table 3). During *rabi,* the trend in N, P and K uptake was almost similar to that of *kharif.*

Table 3. Effect of SCI practices on available soil N, P and K (kg ha^{-1}) in greengram

Treatment	Nitrogen (kg ha^{-1})			Phosphorus (kg ha^{-1})			Potassium (kg ha^{-1})		
	kharif	*rabi*	Pooled	*kharif*	*rabi*	Pooled	*kharif*	*rabi*	Pooled
T_1 - Single seedling at 20 x 20 cm	221.7	205.2	213.4	14.3	10.4	12.3	444.5	424.7	434.6
T_2 - Single seedling at 25 x 25 cm	250.6	238.5	244.6	16.7	13.4	15.0	450.7	430.0	440.4
T_3 - Single seedling at 30 x 30 cm	274.8	258.5	266.7	19.6	14.4	17.0	455.1	426.7	440.9
T_4 - Single seedling at 40 x 40 cm	300.6	250.9	275.7	22.1	19.1	20.6	459.1	438.0	448.5
T_5 - Double seedlings at 20 x 20 cm	215.8	201.9	208.8	14.1	12.6	13.4	439.4	418.0	428.7
T_6 - Double seedlings at 25 x 25cm	221.2	207.2	214.2	14.3	11.4	12.9	444.3	424.7	434.5
T_7 - Double seedlings at 30 x 30 cm	248.5	232.4	240.4	16.9	14.8	15.9	449.5	426.3	437.9
T_8 - Double seedlings at 40 x 40 cm	270.0	254.3	262.2	19.7	16.7	18.2	454.1	434.7	444.4
T_9 - Control (2 seedlings at 30 x 10 cm)	191.2	175.4	183.3	12.1	9.4	10.8	429.7	408.0	418.9
SEd	10.6	5.5	5.0	0.9	0.1	0.2	10.9	11.1	10.0
CD (P=0.05)	22.4	11.7	10.7	1.9	0.3	0.5	NS	NS	NS

Higher soil available N was registered after the harvest of greengram raised at a spacing of 40 x 40 cm (300.6 kg ha^{-1}) which was comparable with that of 30 x 30 cm spacing (274.8 kg ha^{-1}) during *kharif.* However, during *rabi* season higher amount of available soil nitrogen was recorded at spacing of 30 x 30 cm with single seedling hill^{-1} (258.5 kg ha^{-1}), which was on par with 40 x 40 cm spacing maintained with double seedlings and single seedling. The pooled data revealed that higher soil available nitrogen was registered in 40 x 40 cm spacing with single seedling hill^{-1}. Under wider spacing, comparatively less competition and loss of nutrients from the soil resulted in increased available nutrients. In both *kharif* and *rabi* seasons, depletion of available soil nutrients was noticed at a plant spacing of 30 x 10 cm with double seedlings hill^{-1}. The similar trend was observed in phosphorus and potassium also. Better growth with higher nutrient availability to crops resulted in increased nutrient uptake of N, P and K, thus depleting the soil available nutrients. This is in accordance with the results of Sarkar *et al*. (2004) in greengram.

Higher amount of post harvest nutrient status (N and P) were observed after the harvest of greengram. This may be due to the effect of root nodules and microbial activity and unutilized phosphorus through chemical fertilizer in greengram and that influenced the nutrient content in the soil. This was in accordance with the results of Muthuvel *et al*. (1985) and Manivannan *et al.* (2002). Das and Mathur (1990) also confirmed that growing of legumes helped in nodulation and ultimately enriched the soil available nutrient status.

Conclusion

The results of the pooled data over the two seasons revealed that greengram (var. CO 6) with single seedling hill^{-1} at 25 x 25cm has registered higher grain yield. Adoption of 30 x 10 cm spacing with double seedlings hill^{-1} enhanced the uptake of N, P and K. Single seedling maintained at 40 x 40 cm spacing has left higher available N and P in soil and the availability of K was not influenced by SCI practices in greengram. Hence, it is concluded that greengram raised at 25 x 25 cm spacing with single seedling hill^{-1} has proved to be a better option for getting higher productivity.

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