



## Effect of tillage and method of sowing on performance of greengram (*Vigna radiata*) varieties during summer and rainy seasons\*

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Greengram [*Vigna radiata* (L.) R. Wilczek] is grown in different seasons and cropping systems due to its shorter growth duration, and less sensitivity to photoperiod and thermal variations. Cultivation of greengram during summer is receiving wider acceptance with the availability of new varieties for additional income, improvement in soil fertility, and efficient land utilization (Prasad *et al.* 1999). The conventional rainy season crop is affected due to aberrant weather conditions and its greater vulnerability to weeds, and other insect-pests and diseases. Growth behaviour of this crop differs in different seasons due to variation in temperature, photoperiod, humidity etc. Accordingly, there are large variations among varieties with respect to growth habit, maturity duration, seed size and colour, and yield performance. Resource-conserving techniques, such as zero tillage and bed planting have been developed for improving efficiency of water, nutrients and weed control in different crops (Mishra *et al.* 2005, Sharma *et al.* 2005). Some studies indicate that conventional tillage and bed planting was better for greengram than zero tillage and flat system, respectively (Vijailakhshmi and Rajgopal, 1995, Singh and Vashist 2005). However, the information on comparative performance of greengram varieties in different seasons in response to tillage and method of sowing is lacking. Accordingly, a study was planned to evaluate the performance of different greengram varieties during different seasons under varying tillage and method of sowing.

A field experiment was conducted during summer (April to June) and rainy season (July to September) 2006 on sandy loam soil having pH 7.7, organic C 0.38%, available N 158 kg/ha, available P 10.2 kg/ha and available K 261 kg/ha. Five short-duration (60–70 days) greengram varieties, viz. Pusa

Baisakhi (released in 1971 for entire country), PS 16 (released in 1979 for entire country), Pusa 9531 (released in 2004 for north-western plains and central India), Pusa Vishal (released in 2005 for north-western plains), and SML 668 (released in 2002 for Punjab state) were selected. Seeds of these varieties were inoculated with *Rhizobium* culture and sown on 14 April (summer crop) and 10 July (rainy season crop) following different tillage and method of establishment, viz conventional tillage – flat sowing, conventional tillage – raised-bed, zero tillage – flat sowing, and zero tillage – raised bed. A split-plot design with tillage/method of establishment in main plots, and varieties in subplots (5.0 m × 2.8 m) with three replications was followed. The summer crop followed wheat, while the rainy season crop followed the summer crop in the same layout.

Conventional tillage involved three ploughings, first with a disc harrow and then by a cultivator, whereas no ploughing was done under zero tillage but paraquat was sprayed @ 0.5 kg/ha one day before sowing to suppress the established weeds. Raised beds of 70 cm width (35 cm each of bed and furrow) were made in the conventionally-tilled plots but only reshaping was done in the zero-tilled plots with DWR planter. Sowing was done manually with hand-drawn plough having *pora* system using 25 kg seed/ha for all varieties. Row spacing was 23 cm in the flat system, while three rows at 13 cm row spacing were accommodated on the bed under raised-bed system so as to have the same number of rows (12) in each plot. Pendimethalin @ 0.75 kg/ha was sprayed within two days of sowing. A plant-to-plant spacing of 5–7 cm was maintained after thinning at 15 days after sowing, and near equal plant population of about 75/m<sup>2</sup> was maintained under both the methods of establishment. A uniform dose of 18 kg N and 20 kg P/ha (100 kg diammonium phosphate) was applied before sowing. One manual weeding with hand hoe was done at 20 days of crop growth in all treatments. The summer crop sown after a pre-sowing irrigation was irrigated twice at branching (25 DAS) and flower initiation (40 DAS); while the rainy season crop was

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raised as a rainfed crop. Nutrient uptake was estimated at harvest and economic analysis was done considering the cost of inputs and price of produce.

There were large variations in the growth and yield performance of greengram varieties due to tillage and method of establishment in the two seasons (Table 1). The summer season was characterized by hot and dry weather, while the rainy season was relatively less hot and more humid. Accordingly, growth parameters, viz plant height, leaf area index as well as dry matter accumulation were considerably more in rainy than in summer season. Growth and yield parameters of greengram remained largely unaffected due to tillage in summer season, but there was a significant decrease in plant height, LAI and pods/plant under zero compared with conventional tillage in rainy season. This was due to more weed infestation in zero-tilled plots in rainy season than in summer, owing to frequent rains and wet conditions. Apparently the bed-planted crop showed better growth as revealed from significant increase in LAI compared with flat-sown crop but it was not reflected in more number of pods/plant in both seasons. The plants growing on the ridges, especially those on the side rows had greater space of the furrows to grow and thus made more efficient use of the resources like sunshine and water. Different varieties showed variable growth parameters, with Pusa 9531 and Pusa Vishal being the tallest and acquiring greater LAI than others, except SML 668 in rainy season. The plant height of SML 668 was similar to Pusa Baisakhi and 'PS 16' but it had relatively

greater LAI, pods/plant and 1000-seed weight in the rainy season. In general, all varieties showed better growth parameters in rainy than in summer season but the yield attributes, viz pods/plant and 1000-seed weight were greater in summer than rainy season.

Mean seed yield of greengram was similar under zero tillage during summer and rainy seasons but there was drastic reduction (37.9%) in summer compared with rainy season under conventional tillage conditions (Table 1). In other words, the seed yields were equal under conventional and zero tillage conditions in summer season, but zero tillage was significantly inferior to conventional tillage in the rainy season. A similar trend was observed in stover production. This was due to more favourable environment in rainy season (less temperature, more humidity and wet soil conditions), despite greater weed infestation, particularly under zero tillage condition. The crop performed equally well under zero and conventional tillage in summer but zero tillage was significantly inferior to conventional tillage in rainy season. Reduced growth of plants in terms of less height, LAI as well as dry matter accumulation and greater weed infestation led to poor performance of the crop under zero tillage condition. Many workers have reported decrease in yield of greengram due to zero tillage compared with conventional tillage (Shafiq *et al.* 1994, Sangakara 2004). Weeds did not pose a major problem in summer due to quick development of canopy cover and limited moisture available (only two irrigations are applied, and seasonal rainfall was only 110 mm), while

Table 1 Effect of tillage and method of establishment on growth and yield performance of greengram varieties during summer and rainy season

Treatment	Plant height at maturity (cm)		LAI at 45 DAS		Pods/plant		1000-seed weight (g)		Seed yield (tonnes/ha)		Stover yield (tonnes/ha)	
	Summer	Rainy	Summer	Rainy	Summer	Rainy	Summer	Rainy	Summer	Rainy	Summer	Rainy
<i>Tillage</i>												
Conventional	42.1	54.4	2.63	3.77	10.6	9.8	41.6	40.7	0.95	1.31	2.22	3.91
Zero	43.2	49.6	2.92	3.34	10.2	8.1	41.4	40.7	0.93	0.96	2.33	2.87
SEm±	0.46	0.54	0.034	0.039	0.31	0.28	0.21	0.28	0.030	0.023	0.073	0.087
CD (P=0.05)	NS	1.87	0.118	0.135	NS	0.97	NS	NS	NS	0.079	NS	0.302
<i>Method of sowing</i>												
Flat	41.9	51.4	2.57	3.42	10.1	9.0	41.3	41.0	0.91	1.14	1.91	3.12
Raised-bed	43.4	52.6	2.98	3.69	10.7	8.9	41.7	40.4	0.96	1.13	2.64	3.66
SEm±	0.46	0.54	0.034	0.039	0.32	0.28	0.21	0.28	0.030	0.023	0.073	0.087
CD (P=0.05)	NS	NS	0.118	0.135	NS	NS	NS	NS	NS	NS	0.252	0.302
<i>Varieties</i>												
Pusa Baisakhi	37.9	45.2	2.72	3.29	8.8	7.9	36.0	35.8	0.88	0.87	1.77	2.39
PS 16	40.6	47.8	2.73	3.49	11.1	7.9	35.4	36.0	0.84	0.85	1.78	2.82
Pusa 9531	48.3	58.5	2.85	3.57	10.7	8.3	38.4	40.2	0.98	1.13	2.31	3.96
Pusa Vishal	48.7	64.0	2.84	3.61	11.0	10.3	41.3	39.0	0.92	1.33	2.82	4
SML 668	37.6	44.5	2.73	3.66	10.4	10.6	56.4	52.6	1.07	1.49	2.69	3.76
SEm±	0.59	0.61	0.053	0.076	0.28	0.25	0.30	0.26	0.023	0.026	0.076	0.108
CD (P=0.05)	1.72	1.76	NS	0.219	0.81	0.72	0.86	0.75	0.066	0.075	0.219	0.313

in rainy season, there were frequent rains throughout the growth season (480 mm) providing congenial conditions for weed growth. On the other hand, bed-planted crops in both seasons gave the same yield as the flat-sown crop, despite higher stover production. The furrow-irrigated raised-bed system of cultivation resulted in saving of resources like seed, fertilizer and water without affecting the yield of crops like wheat (Chauhan *et al.* 2001). Higher yields of greengram and other pulses were also reported under ridge and furrow system compared with flat system (Vijailakshmi and Rajgopal 1995; Singh and Vashist 2005). In our study, the bed-planted crop grew profusely due to greater inter-furrow spaces but the higher biomass production did not result in more seed yield, probably because of poor translocation of photosynthates.

In general, there was no significant difference in the yield performance of greengram varieties in the two seasons, and each variety performed equally well in summer and rainy season. SML 668 was the best variety in both seasons, followed by Pusa Vishal and Pusa 9531, and all three varieties were significantly superior to PS 16 and Pusa Baisakhi. The variety SML 668 had shorter plants, broader and greener leaves, and considerably large bold seeds; and it was also not

affected by yellow mosaic virus. The varieties PS 16 and Pusa Baisakhi showed greater incidence of yellow mosaic as well as leaf spot disease. Superiority of SML 668 at Ludhiana (Singh *et al.* 2004) and Pusa 9531 at Pantnagar (Pandey and Tewari, 2004) has been reported. SML 668 has now become the most popular variety in the irrigated areas of Punjab state (PAU, 2005). Our results show that SML 668 is also suitable for cultivation in summer as well as rainy season under Delhi conditions.

Nutrient uptake was more in rainy season due to higher seed yield as well as stover production (Table 2). The uptake was maximum for N, followed by K and P. Tillage and method of sowing had no effect on concentration of N, P and K in grain and stover, although there were some differences among the varieties. Uptake of different nutrients was not affected due to tillage in summer season but it was significantly lower with zero than conventional tillage in rainy season, which was primarily due to the low yields than with conventional tillage. On the other hand, raised-bed planting caused significant increases in the uptake of all nutrients compared with flat sowing in both seasons. Although seed yields were not influenced, stover production was significantly more with raised-bed, which led to higher

Table 2 Effect of tillage and method of establishment on nutrient uptake and economics of greengram varieties during summer and rainy season

Treatment	N uptake (kg/ha)		P uptake (kg/ha)		K uptake (kg/ha)		*Cost of cultivation ( $\times 10^3$ ₹/ha)		**Net returns ( $\times 10^3$ ₹/ha)		Net B : C ratio	
	Summer	Rainy	Summer	Rainy	Summer	Rainy	Summer	Rainy	Summer	Rainy	Summer	Rainy
<i>Tillage</i>												
Conventional	52.7	80.1	13.8	21.8	38.9	62.3	9.84	9.04	9.04	18.69	0.92	2.07
Zero	54.6	62.0	12.9	15.6	36.7	44.6	8.34	7.54	10.46	12.79	1.25	1.69
SEm $\pm$	1.29	1.48	0.31	0.33	0.95	1.15						
CD ( $P=0.05$ )	NS	5.14	NS	1.15	NS	3.99						
<i>Method of sowing</i>												
Flat	48.3	68.8	12.1	17.9	34.4	52.2	8.84	8.04	8.81	15.53	1.00	1.93
Raised-bed	58.3	74.8	14.7	19.4	41.3	54.9	9.34	8.54	10.53	15.96	1.13	1.87
SEm $\pm$	1.29	1.48	0.31	0.33	0.95	1.15						
CD ( $P=0.05$ )	4.48	5.14	1.08	1.15	3.29	NS						
<i>Varieties</i>												
Pusa Baisakhi	52.1	61.1	13.1	13.9	31.6	38.9	9.09	8.29	7.83	9.71	0.86	1.17
PS 16	46.6	56.8	9.54	15.4	32.7	46.0	9.09	8.29	7.24	10.27	0.80	1.24
Pusa 9531	51.9	71.9	14.0	20.1	39.3	61.3	9.09	8.29	10.43	16.81	1.15	2.03
Pusa Vishal	58.1	83.3	15.3	21.8	41.4	58.9	9.09	8.29	10.53	19.93	1.16	2.40
SML 668	59.3	83.2	14.9	20.8	44.1	61.6	9.09	8.29	12.55	21.88	1.38	2.64
SEm $\pm$	1.36	1.40	0.29	0.25	0.99	0.95						
CD ( $P=0.05$ )	3.93	4.04	0.84	0.72	2.87	2.75						

\*Common cost of cultivation for seed, sowing, fertilizer, irrigation (in summer only), weeding, harvesting and threshing, and rental value of land: ₹ 8090/ha during summer and ₹ 7290/ha during rainy season. Treatment cost: conventional tillage – ₹ 1 500/ha, and bed making ₹ 500/ha

\*\*Price of produce: Grain - ₹ 15 200/tonne, and stover – ₹ 2 000/tonne during both seasons

nutrient uptake over flat sowing by 20.1–21.5% in summer and 5.1–8.7% in the rainy season. Bed planting resulted in better utilization of available resources like water, nutrients and sunlight due to favourable microclimate (Chauhan *et al.*, 2001; Singh and Vashist 2004). The varieties SML 668 and Pusa Vishal resulted in at par uptake of N, P and K, and were significantly superior to PS 16 and Pusa Baisakhi.

Total variable cost of cultivation was lower in rainy season than in summer due to no charges towards irrigation, despite relatively more cost of weeding in the rainy season (Table 2). Accordingly, higher yield of seed as well as stover led to higher net returns in the rainy season. However, there was a differential behaviour with respect to tillage and method of establishment. Zero tillage was more profitable in summer as it involved lower cost of cultivation and similar yields as in conventional tillage, leading to higher net returns and B : C ratio. The trend was reverse in rainy season when zero tillage was vastly inferior to conventional tillage due to poor seed and stover yields. Similarly, raised-bed planting was superior to flat sowing in summer but not in rainy season. This was due to additional cost towards bed preparation and sowing was more than compensated by the higher yield of stover. The stover of greengram is also valued (₹ 2000/tonne) as cattle feed because of its high protein content (1.7% N). Among the varieties, SML 668 gave the highest returns and B : C ratio, and it was markedly superior to all other varieties in both seasons. Pusa Vishal and Pusa 9531 were next in order. The other two varieties, viz. Pusa Baisakhi and PS 16 gave the lowest returns and were inferior to others.

#### SUMMARY

A field experiment was conducted at New Delhi during summer and rainy seasons of 2006 to evaluate the effect of tillage practices (conventional and zero) and method of sowing (flat and raised-bed) on five greengram varieties, viz Pusa Baisakhi, PS 16, Pusa 9531, Pusa Vishal and SML 668. Mean seed yield of greengram remained unaffected due to tillage practices in summer season, but zero tillage caused a drastic reduction in yield in the rainy season. Bed-planted crops gave the same yield, despite higher stover production. SML 668 gave the highest seed yield in both seasons, followed by Pusa Vishal and Pusa 9531. Zero tillage was more

profitable in summer, while conventional tillage was the best practice in the rainy season. It is recommended to grow newly-released variety SML 668 during summer as well as rainy season for higher productivity and profitability. The additional seed yield and monetary benefits with raised-bed sowing were not large, but the expected savings in irrigation water and other inputs might improve the profitability of this practice over flat sowing.

#### REFERENCES

- Chauhan D S, Sharma R K and Chhokar R S. 2001. New paradigms in tillage technologies for wheat production. *Indian Journal of Agricultural Sciences* **73**: 402–6.
- Mishra B, Shoren Jag, Chatrath R, Sharma A K, Gupta R K, Sharma R K, Singh R, Jane J and Kumar A. 2005. *Cost Effective and Sustainable Wheat Production Technologies*, p 36. Technical Bulletin No. 8. Directorate of Wheat Research, ICAR, Karnal.
- Pandey A and Tewari S K. 2004. Yield dynamics of mungbean (*Vigna radiata*) varieties in poplar-based agroforestry system. *Indian Journal of Agroforestry* **6**(2): 89–91.
- PAU. 2005. *Package of Practices for Crops of Punjab, Kharif 2005*. Punjab Agricultural University, Ludhiana.
- Prasad R, Sharma S N and Singh S. 1999. Summer moong for sustaining rice-wheat cropping system, 10 pp. Bulletin, Division of Agronomy, Indian Agricultural Research Institute, New Delhi.
- Sangakara, U.R. 2004. Effect of tillage and moisture levels on growth, yield and nodulation of common bean (*Phaseolus vulgaris*) and mungbean (*Phaseolus radiatus*) in the dry season. *Indian Journal of Agronomy* **49**(1): 60–3.
- Shafiq M, Hassan A, Ahmad N and Rashid A. 1994. Crop yields and nutrient uptake of rainfed wheat and mungbean as affected by tillage, fertilization and weeding. *Journal of Plant Nutrition* **17**(4): 561–77.
- Sharma R K, Tripathi S C, Kharub A S, Chhokar R S, Mongia A D, Shoran J, Chauhan D S and Nagarajan S. 2005. *A Decade of Research on Zero Tillage and Crop Establishment*, 36 pp. Research Bulletin No. 18. Directorate of Wheat Research, Karnal.
- Singh H and Vashist K K. 2005. Sowing time of summer mungbean under Punjab conditions. *Indian Journal of Pulses Research* **18**(1): 36–7.
- Singh M, Sekhon H S and Singh J. 2004. Response of summer mungbean (*Vigna radiata*) genotypes to different phosphorus levels. *Environment and Ecology* **22**(1): 13–7.
- Vijailakshmi R and Rajgopal A. 1995. Effect of irrigation and coir waste on greengram and succeeding fodder maize. *Indian Journal of Agronomy* **39**(3): 470–1.