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Growth and yield of summer mungbean (SML-668) under different sowing methods in Ambala (Haryana)

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■ **ABSTRACT :** Field experiment was conducted at the farmers field of Ambala during year 2014 and 2015 to assess the growth and yield of summer mungbean in different sowing methods viz., (T_1) conventional tillage and broadcasting sowing method, (T_2) conventional tillage and line sowing and (T_3) zero tillage and line sowing. The line sowing and zero tillage sowing methods recorded higher plant height, number of pods per plant, number of seeds per pod and test weight during both the years. Sowing methods significantly affected the various growth parameter of summer mungbean crop. The seed yield under CT-line sowing and ZT-sowing was significantly 15 to 20 per cent higher than CT-broadcasting sowing method in the first year. During second year of the study, it was also significantly 14-19 per cent higher than T_1-CT-broadcasting sowing method. Simultaneously, stover and biological yield (kg ha^{-1}) and harvest index (%) were also recorded better value in T_2 and T_3 than T_3. Due to the less cost of cultivation in ZT-sowing method, the B: C ratio was higher *i.e.* (2.16 and 2.18) as compared to (2.06 and 2.11) in CT-line sowing and (1.42 and 1.50) in CT-broadcasting during year 2014 and 2015, respectively.

■ **KEY WORDS :** Summer mungbean, Sowing methods, Yield, Economics

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To provide protein supplements, India is the world largest homeland of vegetarian population and world leader in pulse production, consumption and import as well. India import 2-3 million tons (MT) of pulses during 2010-11, causing huge hard foreign earning. Ironically, the country's pulse production has been hovering around 14-15 MT, coming from a near-stagnated area of 22-23 M ha, since 1990-91 (Singh *et al.*, 2013). Among other pulses, mungbean is an important pulse crop, which is grown on about 14% of area under pulses and has 11% contribution of total pulses production in India. In India, it is grown on an area of 3.3 million ha with the production of 1.1 million tonnes and the average productivity of 425 kg/ha (Anonymous, 2014).

Mungbean is also known as green gramas well as moong and it is cultivated in three different seasons in India, *viz.*, *Kharif*, *Rabi* and summer. It is grown under rain fed condition during *Kharif* and on residual moisture during *Rabi* in eastern and southern part of the country. However, it can be cultivated in spring/summer seasons. Its short maturity duration (<60 days) make the crop ideal also for catch cropping, intercropping and relay

cropping. In Haryana, due to expansion of irrigation facilities *i.e.* canal as well as tubewell, the area under cereal crops *i.e.* rice and wheat has increased. This increase in the share of rice and wheat has created imbalance in cropping pattern which has nearly eliminated the pulses from the cropping system in irrigated agroecosystem. Although rice-wheat system provides good returns to farmers, yet it has created several serious problems such as depletion of groundwater table and nutrients, deterioration of soil health and pollution etc.

During summer, a large area remains fallow after the harvesting of wheat and before the transplantation of rice. Mungbean being a less input, short duration, high value cash crop fits very well in the rice-wheat cropping system of the state and tremendous potential exists for its expansion. There is a window of 65 to 70 days for growing a crop after wheat and before the main rice crop plantation in June-July (Anonymous, 2010). The cultivation of summer mungbean as a catch crop will add to the income of farmers, improve soil fertility and avoid the early transplanting of rice resulting in tremendous saving of irrigation water. Mungbean provides 33-37 kg of nitrogen (N) to the soil after harvest and thus helps in saving of about 25 per cent nitrogen for the succeeding crop (Sekhon *et al.,* 2007).

Tillage is done to physically manipulate the soil to achieve weed control; to create aeration, porosity, and friability; and obtain optimum soil moisture to facilitate subsequent sowing. However, in the age of energy crisis, no-tillage or direct seeding of seeds into soil is becoming popular (Baker *et al.,* 1996). Gautam (2000) reported that energy output and energy input ratio is higher in no-tillage compared with conventional tillage. Sowing of mungbean in rows in flat beds is a common practice. Other planting methods like furrow irrigated raised bed system (FIRBS) and zero tillage have been found effective in solving problems related to weed control, water management, energy saving and nutrient management in various crops including mungbean (Kumar *et al.,* 2005). If there is no wheat straw *i.e.* manually harvested wheat, the summer moong can be sown with zero-till drill without preparatory tillage, which also saves time, energy and money (Anonymous, 2015). Therefore, to improve the farm income by incorporating mungbean in cereal fallow system, the on farm trial was conducted to evaluate the performance of summer mungbean under different sowing methods in farmers field of Ambala (Haryana).

METHODOLOGY

Locations, soil and climate :

Haryana is an intensively rice-wheat growing state in India. Conventional rice-wheat rotation was being followed on the field from last 15 years. Field experiment was conducted at the farmers field of Ambala (30º18´20" N and 76 º55´46" E) during year 2014 and 2015. The experimental soil (0-15 cm) was loamy sand to loam in texture, with pH 8.1, $EC_{1:2}$ 0.65 dS m^{-1}, low in organic carbon 0.34 to 0.37%. It has 125 kg N ha^{-1} available N, average 12 kg P ha^{-1} available P as 130 kg ha^{-1} available K.

The climate of the area is semiarid, with an average annual rainfall of 1100 mm (75-80% of which is received during July to September). The average maximum temperature ranged between 35.13, 39.93 and 42.13 in April, May and June month of the year 2014. It varied from 35.00, 41.50 and 39.53 in April, May and June month of the year 2015. The average minimum temperature ranged between 19.70, 23.61 and 27.80 in April, May and June month of the year 2014. It varied from 20.50, 24.77 and 27.60 in April, May and June month of the year 2015. The rainfall during these months was 15.60, 38.40 and 31.50 mm during 2014 and it was 32.00, 24.00 and 45.60 mm during 2015.

Treatment, seeding and seed rate :

The experiment comprised of three treatment combinations, *viz.*, (T_1) conventional tillage and broadcasting sowing method hereafter referred as CT+broadcasting (T_2) conventional tillage and line sowing hereafter referred as CT+line sowing and (T_3) zero tillage and line sowing hereafter referred as ZT-sowing with three replications. In CT-broadcasting method of sowing the initially the field was prepared by running disc harrow twice fallowed by cultivator and planking two times. In conventional tillage treatments, the field was prepared by running disc harrows twice followed by cultivator and planking two times. After preparing field the seed was sown with seed cum fertilizer drill. In no-tillage treatment, seed was sown directly by using ZT-drill. Before sowing the pre sowing irrigation was given and on vatter condition field was prepared except in T_3 and seed was sown in all the treatments.

Variety SML 668 was sown with seed rate of 25 kg

ha^{-1}, on April 18 in 2014 and April 20 in 2015. The row-to-row spacing of 22.5 cm, plant-to-plant spacing of about 8-10 cm and sowing depth was 4-6 cm. The crop was harvested on 22 and 23 June, respectively during 2014 and 2015. The plot area for each treatment was half acre (2000 m^2). Complete dose of fertilizer was applied at the time of sowing *i.e.* 37.5 kg ha^{-1} urea and 250 kg ha^{-1} single super phosphate. The seed was inoculated with *Rhizobium* culture @ 125 ml ha^{-1}. To control weeds pre-emergence herbicide, pendimethalin 30 EC was sprayed @ 2.5 litre ha^{-1} after sowing. The crop was harvested in two picking in the month of June.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Growth and yield attributes :

Plant height:

Among all the three treatments, the plant height under CT-line sowing (34.96 cm) and ZT-sowing (34.26 cm) were significantly higher than CT-broadcasting (33.33 cm). Though it was higher under CT-line sowing than ZT-sowing, but both were statistically at par among each other during first year. During second year of study, again the plant height under CT-line sowing (34.16 cm) and ZT-sowing (33.63 cm) were significantly higher than and CT-broadcasting (32.46 cm). However, it was higher under CT-line sowing than ZT-sowing but both were statistically at par among each other (Table 1). Non-uniform depth of sowing might be the reason for less plant height in broadcasting method. Zero tillage exhibited at par plant height with CT-line sowing and significantly higher plant height than CT-broadcasting method during both years. Similar even higher plant height and other growth parameter such as plant dry weight, crop growth rate and relative growth rate were higher than conventional sowing during both the years of study were observed by Singh *et al*. (2016). In ZT-sowing and CT-line sowing seed and fertilizer both were placed together and once dormancy of seeds was broken the seeds got the fertilizer at right time resulting into higher plant height might be the reason for the high plant height in T_2 and T_3. It was observed that in the case of no-tillage plots the emergence was earlier by one day than the tillage treatment.

Number of pods per plant:

In case of number of pods per plant, these were 12.10 in CT-broadcasting (T_1), 14.00 in CT-line sowing and 13.20 in ZT-sowing during first year (2014) of the study. It was found that both the CT-line sowing and ZT-sowing were having significantly higher pods per plant than CT-broadcasting. During second year (2015), the number of pods per plant were also significantly higher *i.e.* 14.03 in ZT-sowing and 14.60 in CT-line sowing than CT-broadcasting (12.33). Though they were higher under CT-line sowing than ZT-sowing, but both were statistically at par among each other during both the years.

Table 1 : Growth parameters in different sowing methods of summer mungbean

Treatments	Plant height (cm)		No. of pods $plant^{-1}$		No. of seeds pod^{-1}		Test weight (g)	
	2014	2015	2014	2015	2014	2015	2014	2015
CT-broadcasting	33.333	32.467	12.100	12.333	6.433	6.467	4.38	4.43
CT-line sowing	34.967	34.167	14.000	14.600	7.400	7.267	4.96	4.90
ZT-sowing	34.267	33.633	13.200	14.033	7.367	7.100	5.00	5.05
S.E. ±	0.212	0.204	0.237	0.221	0.156	0.135	0.094	0.090
C.D. (P=0.05)	0.854	0.821	0.955	0.890	0.630	0.543	0.380	0.364

Table 2 : Seed, stover, biological yield (kg ha^{-1}) and harvest index (%) in different sowing methods

Treatments	Seed yield (kg ha^{-1})		Stover yield (kg ha^{-1})		Biological yield (kg ha^{-1})		Harvest Index (%)	
	2014	2015	2014	2015	2014	2015	2014	2015
T_1	840.00	910.00	1696.67	1740.00	2536.67	2650.00	33.11	34.33
T_2	1010.00	1085.00	1773.33	1850.00	2783.33	2935.00	36.27	36.97
T_3	970.00	1040.00	1750.00	1820.00	2720.00	2860.00	35.66	36.36
S.E. ±	25.82	18.11	14.91	19.00	16.997	26.977	0.484	0.467
C.D. (P=0.05)	104.10	72.99	60.10	76.61	68.525	108.763	1.953	1.882

Number of seeds per pod:

Both the sowing methods *i.e.* CT-line sowing (7.4) and ZT-sowing (7.36) were having significantly higher seeds per pod than CT-broadcasting (6.43) in first year of the study. During second year of the study the number of seeds per pod were also significantly higher under CT-line sowing (7.26) and ZT-sowing (7.1) than CT-broadcasting (6.46). Both the sowing methods *i.e.* CT-line sowing and ZT-sowing were statistically at par in both the year among each other.

Test weight (100 seed, g):

Among all the three treatments, the test weight under CT-line sowing (4.96) and ZT-sowing (5.0) were significantly higher than CT-broadcasting (4.4) in first year. During second year of study, again the test weight under CT-line sowing (4.9) and ZT-sowing (5.0) were significantly higher than and CT-broadcasting (4.4).

Seed, stover and biological yield (kg ha^{-1}) and harvest index (%):

Sowing methods significantly affected the various growth parameter of summer mungbean crop (Table 2). The seed yield under both the sowing methods *i.e.* CT-line sowing (1010.0) and ZT-sowing (970.0) was significantly 15 to 20 per cent higher than CT-broadcasting (840.0) sowing method in the first year. During second year of the study, it was 1040.0 kg ha^{-1} and 1085 kg ha^{-1}under ZT-sowing and CT-line sowing method of sowing, respectively. The yield in T_2-CT-line sowing and T_3-ZT-sowing was significantly 14-19 per cent higher than T_1-CT-broadcasting sowing method.

Similarly the stover yield, which reflects the plant growth, was 1696.67 kg ha^{-1}, 1773.33 kg ha^{-1} and 1750.00 kg ha^{-1}, respectively in CT-broadcasting, CT-line sowing and ZT-sowing in year 2014. In year 2015, it was 1740.00 kg ha^{-1}, 1850.00 kg ha^{-1} and 1820.00 kg ha^{-1}, respectively in CT-broadcasting, CT-line sowing and ZT-sowing. Though it was higher in ZT-sowing but was statistically at par with CT-broadcasting during first year. During year 2015 it was significantly higher in CT-line sowing as well as ZT-sowing than CT-broadcasting method of sowing.

It was found that biological yield in CT-broadcasting, CT-line sowing and ZT-sowing was 2536.67 kg ha^{-1}, 2783.33 kg ha^{-1} and 2720.00 kg ha^{-1}, respectively in 2014. While it was 2650.00 kg ha^{-1}, 2935.00 kg ha^{-1} and 2860.00 kg ha^{-1} during 2015, respectively in CT-broadcasting, CT-line sowing and ZT-sowing methods. We observed that both the CT-line sowing and ZT-sowing method was having significantly higher biological yield than CT-broadcasting in both year of study. Harvest index was also affected by sowing method and significantly higher harvest index was obtained under line sowing and ZT-sowing methods as compared to broadcasting method of sowing during both the years.

In this study we found that ZT-sowing significantly higher number of pods plant^{-1}, number of seed pod^{-1}, test weight, seed yield, stover yield and harvest index than CT-broadcasting and at par with CT-line sowing sowng method. Sekhon *et al.* (2004) and (2007) also reported that no-tillage produced higher mungbean yield than tillage method of sowing. Singh *et al.* (2011) found during adaptive trials on mungbean the average yield was 3% higher with happy seeder (more new technology than zero tillage technology) sown crop compared to conventional tillage system. This practice can help save tillage costs, reduce soil temperature as well as evaporation losses. Anonymous (2015) has also recommended direct sowing of mungbean into the crop residue using happy seeder. Singh *et al.* (2016) also observed that zero tillage method of sowing significantly increased the number of pods plant^{-1}, number of seed pod^{-1}, test weight, seed yield, stover yield and harvest index as compared to conventional broadcasting method of sowing.

Economics :

Data pertaining to economics of different treatments is presented in table (Table 3). Maximum gross return was found with CT-line sowing Rs. 44440 and Rs. 48825 ha$^{-1,}$ respectively during first and second year. While in ZT-sowing method the gross return was Rs. 42680 and

Table 3 : Economics of different planting methods of summer mungbean

Treatments	Cost of production (Rs. ha^{-1})		Gross income (Rs. ha^{-1})		Net return (Rs. ha^{-1})		B:C ratio	
	2014	2015	2014	2015	2014	2015	2014	2015
CT-broadcasting	15300	16400	36960	40950	21660	24550	1.42	1.50
CT-line sowing	14500	15700	44440	48825	29940	33125	2.06	2.11
ZT-sowing	13500	14700	42680	46800	29180	32100	2.16	2.18

Rs. 46800 ha^{-1} during first and second year, respectively. The lowest gross return was with CT-broadcasting *i.e.* Rs. 36960 and Rs. 40950 ha^{-1}, respectively during year 2014 and 2015. Maximum net return was obtained in CT-line sowing (Rs. 29940 and Rs. 33125 ha^{-1}) and lowest in CT-broadcasting (Rs. 21660 and Rs. 24550 ha^{-1}) during both the years, respectively. The cost of cultivation was minimum under ZT-sowing method *i.e.* Rs. 13500.0 ha^{-1} and higher under CT-broadcasting sowing (Rs. 15300.0 ha^{-1}) during first year. Simultaneously, in the second year of study CT-broadcasting method has the higher cost of cultivation (Rs. 16400.0 ha^{-1}) than ZT-sowing (Rs. 14700.0 ha^{-1}) and CT-line sowing method (15700.0 ha^{-1}), respectively. Due to the less cost of cultivation in ZT-sowing method, the B: C ratio was higher *i.e.* (2.16 and 2.18) as compared to (2.06 and 2.11) in CT-line sowing and (1.42 and 1.50) in CT-broadcasting during year 2014 and 2015, respectively. Sekhon *et al.* (2004) and (2007) found that no-tillage seeding also saves time required for field preparation along with saves money (Rs.1500-1750/ha) and energy.

Conclusion :

After the harvest of wheat and before the transplanting of rice, the land remains fallow for 65-70 days (April to early July). This period could be used to raise a catch crop of summer mungbean The early emergence of even one day is highly beneficial in this short duration crop. This means mechanization can enable us for timely sowing by which we can earn more through reducing cost of cultivation. It also fixes nitrogen in the soil, requires less irrigation and helps maintain soil fertility and texture. Adding mungbean to the cereal cropping system has the potential to increase farm income, improve human health and promote long-term sustainability of agriculture.

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