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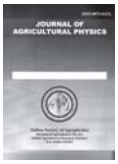

Research Article

Performance of Moong under Different Methods and Dates of Sowing

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ABSTRACT

A study was conducted at PAU, Ludhiana on moongbean crop to determine optimum date of sowing and planting methods. The treatments comprised of 3 dates of sowing (16th July, 22nd July and 29th July) and two planting methods (flat and bed planting). The treatments were replicated thrice during *kharif* 2014 and 2015. The results indicated that bed planted crop had significantly higher values of plant height, dry matter accumulation, LAI, 100-grain weight, biological yield and grain yield in both the years as compared to flat sown crop. Among dates of sowing, crop sown on 16th July had significantly higher values of plant height, dry matter accumulation, LAI, grain and biological yield. Crop sown during 2014 had better growth and higher yield than crop sown during 2015 as the year 2014 had more favourable weather for crop growth and yield. Rainfall during the physiological maturity period was more during 2015 as compared to 2014, which might had negatively affected the yield.

Key words: Moongbean, LAI, Planting methods, Sowing dates, Heat units

Introduction

Moongbean (*Vigna radiata*) is an important pulse crop. India is the world's largest homeland of vegetarian population and worldwide leader of pulse production and importer to provide dietary protein to Indians (Singh *et al*., 2012). Globally, moongbean is cultivated on about 5.5 million hactare (Weinberger, 2003), out of which 90 per cent is in Asia (Lambrides and Godwin, 2007). India alone accounts for about 65 per cent of the world's acreage and 54 per cent of the world's production of this crop. It has wider adaptability and low input requirements and the ability to fix the nitrogen (58-109 kg ha^{-1}) in symbiotic association with rhizobia, which not only enables it to meet its own nitrogen requirement but also benefits the succeeding crops (Singh *et al*., 2011). Moongbean is a short duration crop that can be grown over a range of environments. Moongbean contains about 25 per cent protein of high digestibility and quality.

Climate change and agriculture are interrelated and affect each other. The effect of climate on agriculture is related to variability in local weather rather than in global climate pattern. A change in rainfall pattern has been observed at many locations. Change in rainfall pattern has a marked effect on moongbean cultivation as rain during ripening phase may cause rotting of pods and ultimately results in poor productivity. The earth's average temperature has increased by 1ºC in just over the last century. Local or regional studies assume greater significance to understand the impact of climate change on agriculture and also for developing mitigation strategies (Kalra *et al., 2008*). The optimum temperature for growth of moongbean is 28–30 ºC (Poehlman, 1991) and in temperatures outside the limit is expected to

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inhibit its potential performance. Being a summer-season crop, moongbean plants face temperature exceeding 30 ºC, which may even go up to 45 ºC (in late April, May). Heat stress has detrimental effects at several levels of plant organisation leading to drastic reductions in growth and yield (Wahid *et al*., 2007). Optimum date of sowing of a crop is a non monetary input which can save the crop from harmful effect of rain and temperature. Moongbean being a leguminous crop requires well drained soils. Planting of crops on raised beds help in improving the soil aerations and proper drainage of rain water. Thus selecting proper date of sowing and planting the crop on raised beds has a potential to save the crop from harmful effects of rain. Scientific literature is meager in which both these factors have been studied simultaneously. Thus, keeping the above facts in mind, the present study was undertaken to find out the optimum date of sowing for planting moongbean on beds in comparison to traditional flat planting.

Materials and Methods

The field experiment was conducted at Punjab Agricultural University, Ludhiana (30°56′N, 75°52′E, altitude 247 m above mean sea level), India. The soil of the experimental site was loamy sand in texture. The experiment (split plot) comprised of three dates of sowing (July 16th, July 22nd and July 29th) in the main plot and two methods of sowing (sowing on beds and traditional flat sowing) in sub-plot. The treatments were replicated thrice during 2014 and 2015. The beds were 37.5 cm wide and have 30 cm wide furrows measured at top. Two rows of moongbean were planted at top of the beds. In flat sowing, the rows of crop were 30 cm apart. Moong variety ML-818 was used for the experiment. The crop was raised as per recommended package of practices.

The different observations on growth characteristics were recorded periodically at 10 days intervals. Leaf area index was recorded with the help of Plant Canopy Analyzer (LICOR-make).

The harvest Index (HI) was calculated by the formula:

$$HI = \frac{\text{Grain yield (kg ha}^{-1})}{\text{Biomass yield (kg ha}^{-1})} \times 100$$

Results and Discussion

The effect of different treatments on performance of moong crop is described as under:

Growth Parameters

The plant height (Table 1), dry matter (Table 2) and LAI (Table 3) of moong crop were statistically at par among different dates of sowing during initial phase of crop growth. However, at later stages different dates of sowing had a significant effect on these parameters. Near maturity (70 DAS), the maximum values of these

Table 1. Periodic plant height (cm) of moong crop under different dates of sowing and sowing methods

Treatment	2014						2015					
	20	30	40	50	60	70	20	30	40	50	60	70
	Days after sowing											
Sowing time												
16-July	28.9	41.2	62.5	72.3	75.3	76.2	26.9	38.2	62.3	67.8	72.3	72.6
22-July	27.3	38.2	59.5	66.0	70.2	71.6	26.2	37.6	58.6	66.2	69.2	70.5
29-July	26.8	36.5	55.2	61.5	66.2	68.5	26.5	36.2	56.4	63.2	65.1	67.1
CD (p=0.05)	NS	NS	2.9	3.2	3.8	2.9	NS	NS	1.5	1.6	2.1	2.0
Sowing method												
Flat	27.2	37.2	57.1	64.3	68.2	69.1	26.3	36.2	58.1	63.1	66.4	67.8
Bed	28.2	40	61.1	68.9	73	75.1	26.7	38.4	60.1	68.3	71.4	72.4
CD (p=0.05)	NS	NS	2.7	3.6	3.9	3.1	NS	NS	1.7	2.6	3.1	2.9

Table 2. Periodic dry matter (g plant^{-1}) of moong crop under different dates of sowing and sowing methods

Treatment	2014						2015					
	20	30	40	50	60	70	20	30	40	50	60	70
	Days after sowing											
Sowing time												
16-July	1.6	4.3	6.6	10.2	15.4	16.5	1.3	4.0	6.0	9.7	14.8	15.7
22-July	1.2	2.8	5.8	9.0	13.2	14.6	0.9	2.5	5.8	8.2	12.4	13.6
29-July	1.1	2.4	5.0	8.5	12.5	13.5	0.7	2.0	5.1	7.6	11.1	12.4
CD (p=0.05)	NS	NS	0.5	0.4	0.5	0.7	NS	NS	0.3	0.5	1.2	1.0
Sowing method												
Flat	1.2	2.9	5.2	8.3	12.5	13.5	0.9	2.6	5.0	7.7	11.3	12.3
Bed	1.5	3.5	6.4	10.1	15.0	16.2	1.1	3.0	6.2	9.3	14.3	15.5
CD (p=0.05)	NS	NS	1.4	1.6	1.4	1.6	NS	NS	1.0	1.5	2.0	2.0

Table 3. Periodic leaf area index attained by moong crop under different dates of sowing and varieties

Treatment	2014						2015					
	20	30	40	50	60	70	20	30	40	50	60	70
	Days after sowing											
Sowing time												
16-July	0.9	1.7	2.6	3.5	4.0	3.0	0.9	1.4	2.0	2.7	3.5	2.6
22-July	0.9	1.5	2.3	3.0	3.5	2.7	0.9	1.4	1.8	2.5	2.9	2.2
29-July	0.9	1.5	2.5	2.5	3.4	2.5	0.9	1.4	1.8	2.3	2.8	2.0
CD (p=0.05)	NS	NS	0.1	0.4	0.1	0.2	NS	NS	0.1	0.2	0.1	0.1
Sowing method												
Flat	0.8	1.4	2.4	2.9	3.5	2.4	0.8	1.2	1.7	2.5	2.9	2.1
Bed	0.9	1.8	2.6	3.1	3.7	3.0	0.9	1.6	1.9	2.9	3.4	2.5
CD (p=0.05)	NS	NS	0.2	0.1	0.1	0.2	NS	NS	0.2	0.2	0.3	0.3

parameters were noticed in 16th July sown crop and these were significantly higher than rest of the sowing dates. The higher values of growth parameters in early sown crop might be due to favourable meteorological conditions encountered by early sown crop than delayed sowing.

The methods of sowing failed to have any significant effect on these growth parameters during initial phase of crop growth (Table 1-3). However, during later crop growth phases, bed planted crop had significantly higher values of these growth parameters as compared to flat sown crop. This might have happened due to more favourable microclimatic and soil conditions present in bed planted crop (Sayre and Hobbs, 2004; Talukdar *et al*., 2002).

Yield attributes, yield and harvest index

During both years different dates and method of sowing failed to have any significant effect on 100 grain weight and harvest index of moong crop (Table 4). The biological yield (Table 4) was significantly affected by sowing time and sowing method. During both years, maximum biological yield was obtained in the crop sown on 16th July and it was significantly higher than the rest of the sowing dates. This might have happened due to higher values of growth parameters in early sown crop. Moong sown on the bed produced significantly higher biological yield of 55.3 and 47.5 q ha^{-1} during 2014 and 2015, respectively as compared to flat sown crop.

Table 4. Yield and harvest index of moong crop under different treatments at harvest during 2014 and 2015

Treatment	2014				2015			
	100-grain wt (g)	Biological yield (q ha^{-1})	Grain yield (q ha^{-1})	HI (%)	100-grain wt (g)	Biological yield (q ha^{-1})	Grain yield (q ha^{-1})	HI (%)
Sowing time								
16-July	3.6	55.8	14.3	25.6	3.5	49.0	12.3	25.1
22-July	3.6	51.4	13.1	25.5	3.4	44.8	10.7	23.9
29-July	3.5	46.2	11.6	25.1	3.4	40.3	9.5	23.6
CD (p=0.05)	NS	3.7	0.9	NS	NS	3.9	0.8	NS
Sowing method								
Flat	3.5	46.8	12.0	25.6	3.4	41.9	10.2	24.3
Bed	3.6	55.3	13.9	25.1	3.5	47.5	11.4	24.0
CD (p=0.05)	NS	5.1	1.2	NS	NS	4.6	1.1	NS

Grain yield

The grain yield (14.3 q ha^{-1} during 2014 and 12.3 q ha^{-1} in 2015) was significantly higher when crop was sown on 16th July as compared to other dates of sowing. It decreased with delay in sowing and least grain yield was recorded for the crop sown on 29th July (11.6 q ha^{-1} during 2014 and 9.5 q ha^{-1} in 2015). The grain yield decreased by 87.1 kg ha^{-1} with a delay of one day of sowing after 16th July (Fig. 1). The significantly higher grain yield of moong in early sown crop as compared to other dates of sowing might be due to significantly higher values of growth parameters observed in early sown crop. Among the sowing methods, significantly higher grain yield was found in the crop sown on bed during 2014 (13.9 q ha^{-1}) and 2015 (11.4 q ha^{-1}). This might have happened due to significantly higher values of growth parameters observed in bed planted crop and also due to favourable microclimatic conditions present in bed planted crop as reported by Ram *et al*., 2005. The higher grain yield recorded during 2014 as compared to 2015 might be due to the fact that during 2014 sunshine hours during the crop season was higher (5.8) as compared to that of during 2015 (5.3) (Fig. 3) which helped the moong crop to grow better at initial stages.

Agroclimatic indices, grain yield and heat use efficiency (HUE)

The different agroclimatic indices and heat use efficiency were worked out under different dates of sowing (Table 5). Among different sowing dates, highest AGDD and APTU were recorded in crop sown on 16th July and they

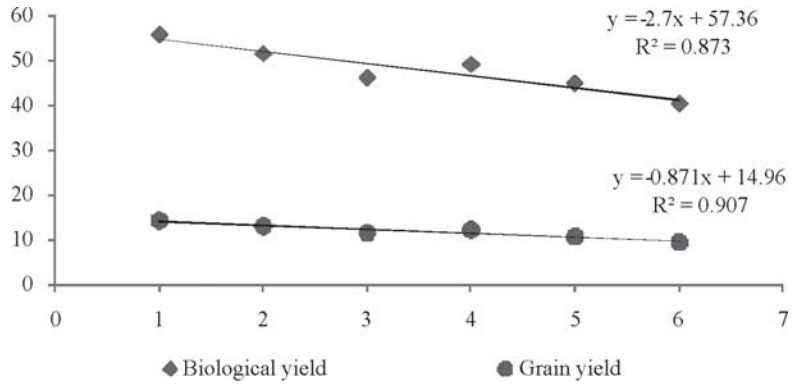

Fig. 1. Biological yield and grain yield compared to date of sowing during 2014 and 2015

Table 5. Accumulated growing degree days (AGDD), accumulated photothermal units (APTU) and heat use efficiency (HUE) of moong crop

Date of sowing	AGDD (°C day)		APTU (°C day hr)		Grain yield HUE (kg ha^{-1}°C day^{-1})	
	2014	2015	2014	2015	2014	2015
16-July	1620	1606	21250	20837	0.88	0.77
22-July	1485	1568	19166	20156	0. 88	0.68
29-July	1485	1568	18767	20156	0. 78	0.61

decreased with delay in sowing. Moong sown on 16th July acquired higher heat units in comparison to other dates of sowing and it may be the reason for higher productivity of 16th July sown crop

Heat use efficiency (HUE) was calculated to determine the number of growing degree days required to produce unit amount of grain yield per growing degree days (Table 5). The crop season on 16th July had more HUE and it utilized the available resources in a better way as compared to other dates of sowing. This explains the reason for higher productivity in the early sown crop.

Weather during crop seasons

The data of different parameters (Fig. 2, 3 and 4) had shown that maximum and minimum temperature was higher during reproductive stage in the year 2015 which adversely affect the crop yield. Rainfall recorded was more during 2015 (84 mm) in comparison to 2014 (0.0 mm), which negatively affected the yield. Similarly, sunshine hours were more during 2014 (9.2) during

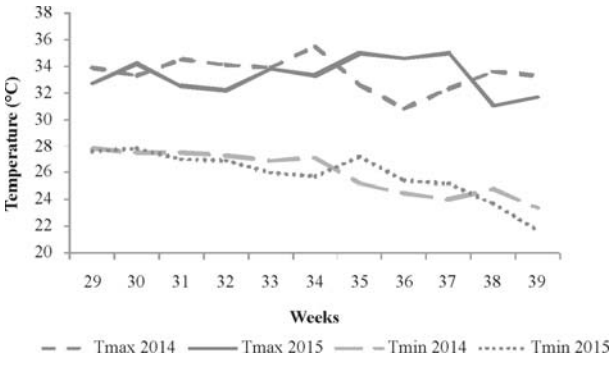

Fig. 2. Maximum and minimum temperature during *kharif* season 2014 and 2015

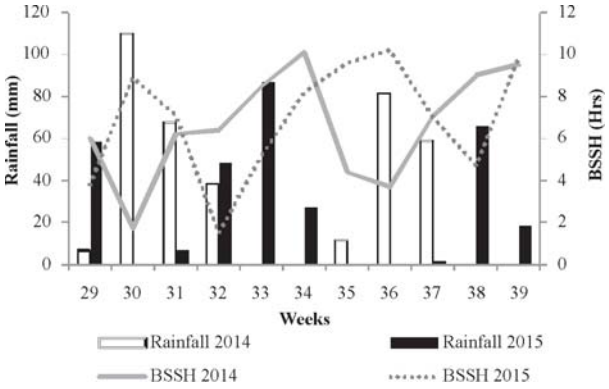

Fig. 3. Rainfall and bright sunshine hours during *kharif* season 2014 and 2015

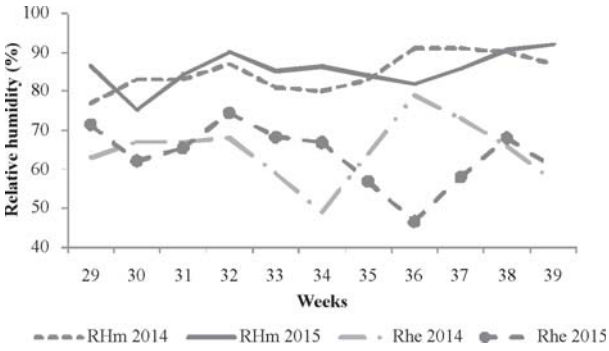

Fig. 4. Morning and evening relative humidity during *kharif* season 2014 and 2015

physiological maturity period, which also favoured the crop growth and resulted in better yield during first crop year. Morning and evening relative humidity (Fig. 4) was also recorded higher during physiological maturity period during *kharif*, 2015 which also affected the grain yield.

Conclusion

It can be concluded from the present study that for higher moong productivity, it should be

sown on raised beds and best date of sowing was 16th July. The crop sown on 16th July had more HUE and it utilized the available resources in a better way as compared to other dates of sowing. This explains the reason for higher productivity in the early sown crop.

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