

## Relationship Between Flowering Behaviour, Yield Characters and Hard Seededness in Mungbean Lines during Two Sowing Seasons

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**ABSTRACT** Two hard seeded (ML-613 and ML-131) and two non-hard seeded (NM-54 and Pusa-9972) mungbean lines were selected to study the relationship between flowering behaviour, yield characters and hard seededness during summer and *kharif* seasons. Non-hard seeded lines flowered and matured earlier than the hard seeded lines during both the seasons. Number of pods plant<sup>-1</sup>, number of seeds pod<sup>-1</sup> and seed yield were maximum in hard seeded lines. On the other hand, pod length and 100 seed weight were significantly higher in non-hard seeded lines. Higher seed yield during the *kharif* season, was accompanied by increased hard seededness as compared to that in the summer season leading to more deterioration in seed quality.

**Key words:** Mungbean, hard seededness, yield characters, sowing seasons.

Mungbean [*Vigna radiata* (L.) Wilczek], also known as green gram belongs to family Fabaceae. It is grown as *kharif* and spring/summer crop in Punjab and North India. It has a good potential to meet the rising demand of pulses. Hard seededness has been identified as one of the major problems in mungbean [1]. Seed quality is governed not only by the genetic make-up of the crop but also by environmental factors prevailing in the growing season [2]. It has been proposed that a favourable shift in flowering peak, retention and conversion of flowers after fertilization to pods provides a longer filling period to achieve synchrony in maturity [3]. The present investigation was undertaken with a view to relate the flowering behaviour with variation in hard seededness and yield parameters in mungbean lines during summer and *kharif*.

### MATERIALS AND METHODS

A preliminary experiment was conducted by screening 62 mungbean lines, seeds of which were

taken from the stored seeds of year 2004, procured from the Department of Plant Breeding, Genetics and Biotechnology, Punjab Agricultural University, Ludhiana. Screening of 62 lines was done for hard seededness as per ISTA procedure [4] by adopting rolled paper towel method. The 100 seeds in each batch were kept for germination with three replications. Seeds which did not germinate were counted as hard seeds. Per cent hard seed varied from 1-50 per cent among the 62 lines. Based on this data, lines with less than 10 per cent hard seeds were categorized as non-hard seeded and those with 35-50 per cent hard seeds were categorized as hard seeded lines. Consequently, two hard seeded (ML-613 and ML-131) and two non-hard seeded (NM-54 and Pusa-9972) mungbean lines were selected for the present study. Sowing of the selected lines was done in the field on 26<sup>th</sup> March 2006 and 29<sup>th</sup> March 2007 during summer season and on 24<sup>th</sup> July 2006 and 23<sup>rd</sup> July 2007 during *kharif* season in a randomized block design, keeping three

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replications for each line in a plot size of 4 x 4 m<sup>2</sup> during both the seasons. Row to row spacing of 22.5cm and plant to plant distance of 7.0cm was kept during summer season and row to row spacing of 30cm and plant to plant distance of 10cm was kept during *kharif* season. Five plants were selected randomly from each plot in each replication of all the four lines. Number of flowers was counted daily at 7:00 A.M. from day one of flower initiation stage till completion of flowering and flower number was computed after every 3 days from flower initiation. Observations were recorded for number of pods plant<sup>-1</sup>, pod length (cm), number of seeds pod<sup>-1</sup>, 100 seed weight (g) and seed yield plant<sup>-1</sup> (g). Per cent hard seeds were also calculated from the harvested crop based on standard germination test as per ISTA rules [4]. Results are represented as cumulative data of two years. Data was statistically analyzed according to the procedures outlined by Cochran and Cox [5].

## RESULTS AND DISCUSSION

Data on flowering and pod formation in two hard seeded (ML-613 and ML-131) and two non-hard seeded (NM-54 and Pusa-9972) mungbean lines is expressed as number of flowers and number of pods at 3 days interval and number of cumulative pods. Flower initiation in the non-hard seeded lines was observed at 33 DAS during summer season while it was delayed by a week (40 DAS) in the hard seeded lines (Fig. 1). Number of retained flowers increased up to 45 DAS in both the non-hard seeded lines and declined thereafter till harvest and maximum flowers were formed between 42-48 DAS. On other hand, flowering in hard seeded lines started at 40 DAS and number of flowers remained low till 48 DAS. Thereafter, an increase was observed in both the lines till 52 DAS after which it declined until maturity. First pod appeared at 34 and 41 DAS in the two non-hard and two hard seeded lines respectively during summer. Number of cumulative pods increased sharply from 42 DAS in the two non-hard seeded lines, whereas, this increase in the hard seeded lines was observed after 50 DAS. During the *kharif* season (Fig. 2) flowering in non-hard seeded lines initiated 32 DAS whereas in hard seeded lines it

was delayed by 6 days (38 DAS). Pod formation was also recorded early during *kharif* season as compared with that in summer in all the four lines (33 DAS in non-hard seeded and 39 DAS in hard seeded lines). However, the total number of flowers and pods remained low in *kharif* season as compared with that in summer season. Peak in flowering was observed around 40 DAS in the non-hard seeded lines and around 47 DAS in the hard seeded lines. During the *kharif* season number of cumulative pods increased sharply after 40 DAS in non-hard seeded lines and after 45 DAS in the hard seeded lines. During the summer season the hard seeded lines (ML-613 and ML-131) matured at 70 DAS while the non-hard seeded lines (NM-54 and Pusa-9972) matured at 60 DAS. However, the duration of maturity during the *kharif* season was delayed to 75 and 62 DAS in hard seeded and non-hard seeded lines respectively.

Among the yield parameters (Table 1) pod length and 100 seed weight were higher in non-hard seeded lines while number of pods plant<sup>-1</sup>, number of seeds pod<sup>-1</sup> and seed yield plant<sup>-1</sup> were significantly higher in hard seeded lines during summer as well as *kharif* seasons. Maximum pods (45) were observed in ML-131 during summer and minimum in NM-54 (25) during *kharif* season. Both the hard seeded lines recorded comparatively more seeds pod<sup>-1</sup> than the non-hard seeded lines during the two seasons. Maximum 100 seed weight was observed in NM-54 (5.76 g) followed by Pusa-9972 (5.73 g) during the *kharif* season while minimum 100 seed weight was recorded in ML-613 (3.68 g) during the summer season. Highest seed yield was recorded for ML-131 (19.91 g) in the *kharif* season and lowest in NM-54 (13.73 g) during the summer season.

Hard seed percentage was generally higher during the *kharif* season as compared to summer season in both hard and non-hard seeded lines (Table 2). Highest percentage of hard seeds was recorded in ML-131 (64.65%) during the *kharif* season and minimum in Pusa-9972 (5.35%) during the summer season.

Early flowering and maturity during the summer season is attributed to dry environmental

Table 1. Yield contributing parameters of two hard seeded and two non-hard seeded mungbean lines during summer and kharif

Lines	Pod length (cm)		No. of pods plant <sup>-1</sup>		No. of seeds pod <sup>-1</sup>		100-seed weight (g)		Seed yield plant <sup>-1</sup>	
	Summer	Kharif	Summer	Kharif	Summer	Kharif	Summer	Kharif	Summer	Kharif
<b>Hard seeded</b>										
ML-613	8.40	7.83	39.00	36.00	11.00	11.00	3.68	4.11	15.78	16.27
ML-131	8.20	7.80	45.00	43.00	10.50	10.50	3.73	4.41	17.62	19.91
<b>Non-hard seeded</b>										
NM-54	9.60	8.47	29.50	25.00	9.70	10.00	4.80	5.76	13.73	14.40
Pusa-9972	9.50	8.50	33.50	31.00	9.30	9.30	5.01	5.73	15.61	16.52
Summer x Kharif	0.33*		2.68		NS		0.26		0.27	
Hard x Non hard	0.47		3.79		NS		0.37		0.38	

\* -CD at 5% level of significance; NS-Non-significant

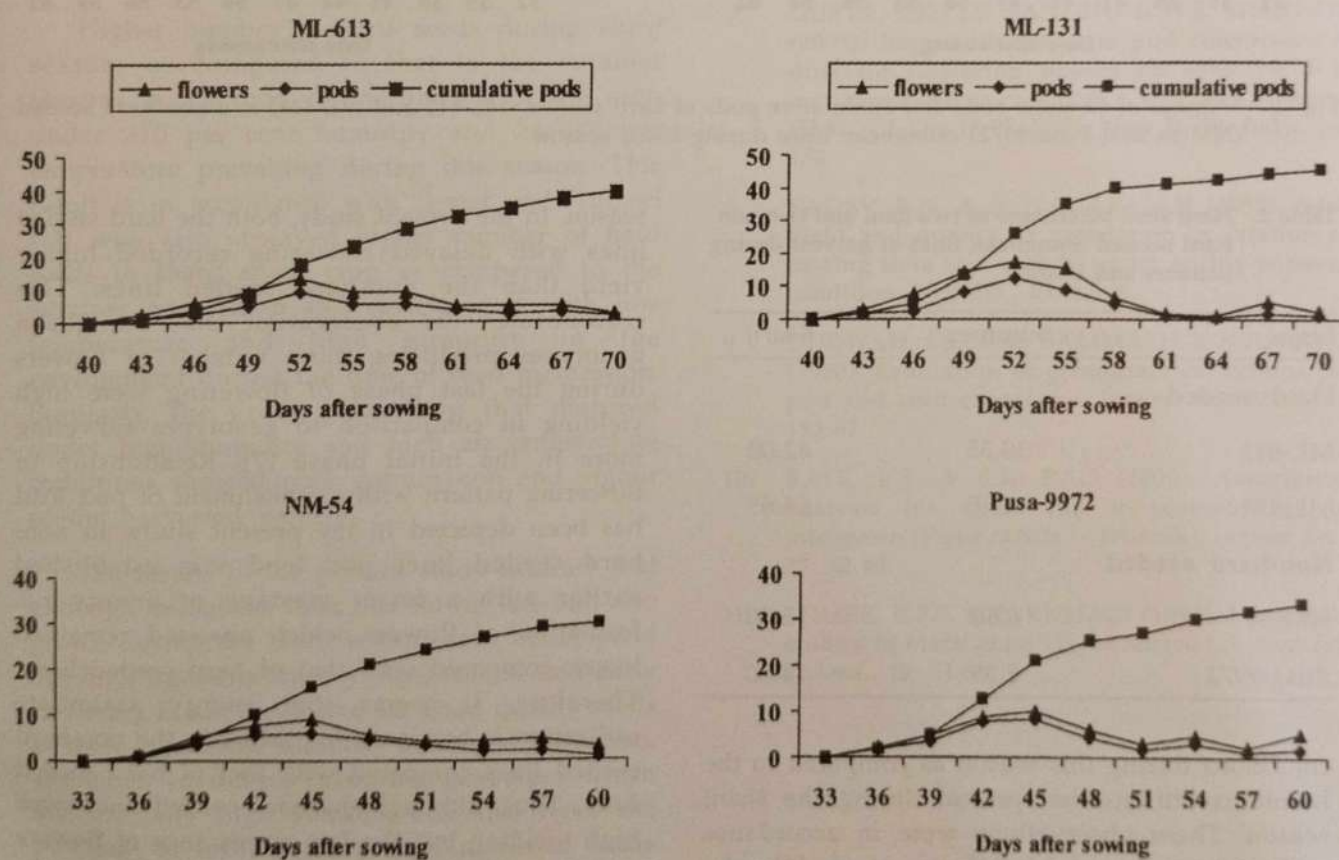


Fig. 1. Number of flowers, pods and cumulative pods of hard seeded (ML-613 and ML-131) and non-hard seeded (NM-54 and Pusa-9972) mungbean lines during summer season

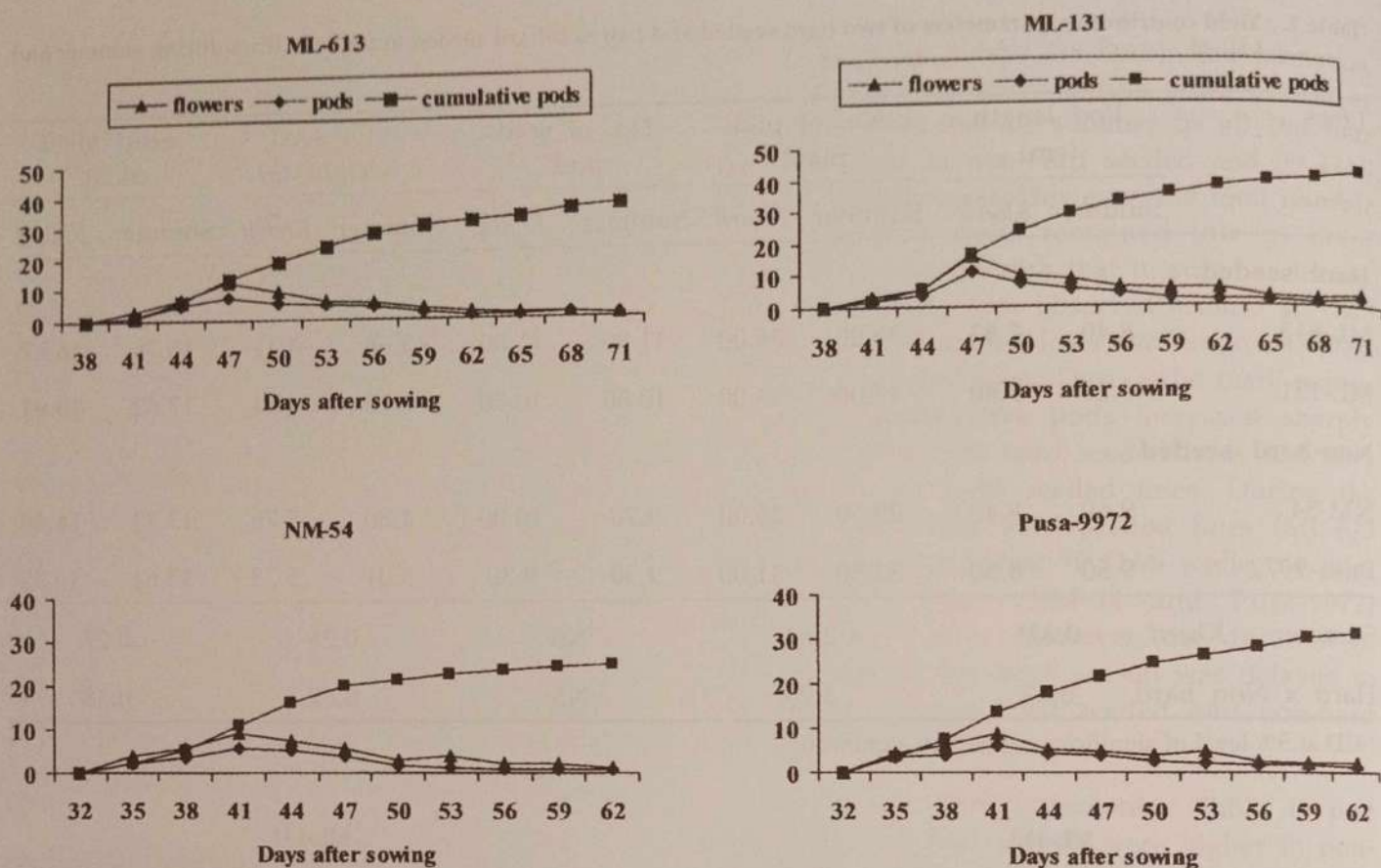


Fig. 2. Number of flowers, pods and cumulative pods of hard seeded (ML-613 and ML-131) and non-hard seeded (NM-54 and Pusa-9972) mungbean lines during *kharif* season

Table 2. Hard seed percentage in two hard and two non-hard seeded mungbean lines at harvest during summer and *kharif*

Lines	Summer	<i>Kharif</i>
<b>Hard seeded</b>		
ML-613	30.35	42.00
ML-131	44.15	64.65
<b>Non-hard seeded</b>		
NM-54	6.50	15.00
Pusa-9972	5.35	14.80

conditions during this season as compared to the humid conditions that prevail during the *kharif* season. These observations were in accordance with the results of Machikowa *et al.* [6] who reported early flowering and maturity of soybean varieties in the dry season than in the late rainy

season. In the present study, both the hard seeded lines with delayed flowering recorded higher yield than the non-hard seeded lines. This corroborates the observation that mungbean genotypes producing more number of flowers during the last phase of flowering were high yielding in comparison to genotypes flowering more in the initial phase [7]. Relationship of flowering pattern with establishment of pod load has been depicted in the present study. In non-hard seeded lines pod load was established earlier with a lesser wastage of energy i.e. formation of flowers which abscised remained lower, compared with that of hard seeded lines. Therefore, it seems that energy assimilate utilization is better accomplished in the non-hard seeded lines compared with that of hard seeded lines. Thus, although the hard seeded lines were high yielding but the late appearance of flowers and their ultimate conversion into pods which is also delayed may be one of the reasons for more percentage of hard seeds in these lines.

Important seed components namely, seeds pod<sup>-1</sup> and 100 seed weight were depressed in case of green gram varieties sown at air temperatures around 40°C and relative humidity around 30 per cent during most of the growth period [8]. This also explains the reduced yield of both hard and non-hard seeded lines in the present study during summer when temperature was high and relative humidity was comparatively lower than that recorded during the *kharif* season. 100 seed weight was recorded to be higher in non-hard seeded lines and this may be attributed to early development of potential sinks. On the contrary, total yield was recorded to be higher in hard seeded lines. Our results are in accordance with the previous findings where, 100 seed weight which is one of the most important yield attributes did not show significant association with seed yield [9]. Pods plant<sup>-1</sup> and seeds pod<sup>-1</sup> were concluded to be major components of seed yield in mungbean [10].

Higher number of hard seeds during *kharif* seasons as compared to that in the summer seasons is ascribed to maturation of the crop under >70 per cent humidity and 24-35°C air temperature prevailing during this season. This result is in accordance with Tomer and Kumari [11] who also observed higher number of hard seeds in *kharif* sown crop as compared to the summer sown crop and correlated it with low temperature and high humidity in the environment during the time of seed maturation. Similarly, the green gram crop that matured under high humidity and high air temperature conditions showed poor germination and vigour of the harvested seeds[8].

The results of the present study indicate that although mungbean lines that flower late and also grown during the *kharif* season have better yield but high humidity during *kharif* season and early flowering is not conducive for good quality seeds as these conditions stimulate hard seed formation. Therefore, conditions favouring genotypes which are not only high yielding but also have the potential to form good quality, non-hard seeds need to be given more preference.

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