The Bioscan 13(1):215-218,2018
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

# EFFECT OF POD RELATED TRAITS ON SHATTERING IN $M_3$ MUTANTS OF MUNGBEAN (*Vigna radiata* (L.)Wilczek)

**N. VAIRAM**
Department of Plant Breeding & Genetics,
Imayam Institute of Agriculture and Technology, Thuraiyur - 621 206
e-mail: vairamagri@gmail.com

**KEYWORDS**
Mutation
Mutants
Pod shattering
Shattering percentage
Tolerance

**Received on :**
24.04.2017

**Accepted on :**
16.06.2017

***Corresponding author**

**ABSTRACT**

Mutation was induced by physical mutagen and chemical mutagen, viz., Gamma rays and Ethyl Methane Sulphonate (EMS) in two mungbean genotypes *viz.,* CO (Gg) 7 and NM 65 and $M_3$ generation was raised at the research farm of Agricultural College and Research Institute, Madurai during Kharif season 2013. The objective of this study was to analyze the mean performance and association analysis of eight important pod related traits along with shattering percentage in the 22 mutants of $M_3$ generation. Pod related characters *viz.,* pod width, number of pods per plant, number of seeds per pod, hundred seed weight and single plant yield showed significant negative association with shattering percentage. Pod length, pod length: width ratio, pod width: length ratio, pods per plant and seeds per pod had direct effect on shattering percentage. The result revealed that nine mutants *viz.,* M26, M44, M46, M58, M70, M71, M84, M92 and M98 showed tolerance to pod shattering in $M_3$ generation.

## INTRODUCTION

Pulses are the principal source of dietary protein among vegetarians and are an integral part of daily diet because of their high protein content and good amino-acid balance in several forms world-wide. On account of balanced aminoacid composition of cereals and protein blend, which matches with the milk protein, pulses are often called as life line of human beings (Kamelshwar kumar *et al.* 2015). Mungbean (*Vigna radiata* L. Wilczek) (2n = 2x = 22) belonging to subgenus *Ceratotropis* is an important pulse crop in developing countries (Nirmalbharati and Sumangala bhat, 2016). Greengram commonly known as 'Moongbean' or 'moong'. It contains 24.3 per cent protein fairly rich in carbohydrates and also contains small amount of riboflavin and thiamine, also rich in phosphorus and iron (Patel *et al.,* 2013). Moreover, the seeds and sprouts have health-promoting effects in addition to their nutritive value (Tang *et al.,* 2014). Mutation breeding has become increasingly popular in recent times as an effective tool for crop improvement and an efficient means supplementing existing germplasm for cultivar improvement in breeding programmes (Usharani and Ananda Kumar, 2015). However, mutation is regarded as random and success of obtaining desired mutant trait depend on three factors such as efficiency of mutagenesis, the starting plant material and mutant screening (Hase *et al.,* 2012).

Shattering (dehiscence) is simply the splitting of dry pods to release its seeds prior to harvesting. Within the crop canopy, before and during harvest, much pod shattering occurs because of the natural movement of the canopy which results in pods knocking against each other or against the stems and branches. This problem of mechanical damage is likely to be much affected by other plant attributes such as pod angles, pod length and width (Loof and Jonson, 1970; Thompson and Hughes, 1986). The first report on pod shattering study in India was published from National Research Centre for soybean by Tiwari and Bhatnagar (1988). Though the exact estimate of extent of loss due to shattering is not available in mungbean, in soybean 50-100 percent yield loss due to pod shattering as well as disturbance of the canopy by wind during harvesting is reported (IITA, 1986). Bhara *et al.* (2013) studied the genetic variability of soyabean genotypes and associated with pod shattering traits. The association and path coefficient analysis revealed the small pod, less width and low volume/ weight of seed is tolerant to shattering. Pod shattering score showed negative correlation with all the characters measured but there was a significant negative correlation between resistance score and number of primary branches, maturity and pod length showing that these characters affect pod shattering in soybean. There was however, a weak negative correlation between pod shattering and plant height, pods per plant and grain yield. The results suggest that, it is possible to breed a low shattering variety with medium to late maturity, higher number of pods/plant and increased yield (Mohammed, 2010). In mungbean, correlation analysis showed positive correlation between pod shattering and number of twists per pod (Nirmalbharthi, 2015).

Pod shattering, when crops reach maturity in hot and dry condition could lead to serious seed yield losses (Adeyeye *et al.,* 2014). Shortage of labour and harvesting equipment can postpone harvesting when the farmer is otherwise prepared to harvest, leading to seed yield loss when harvesting is carried out late, particularly during dry weather condition. Sehrawat *et al*. (2013) reviewed that mungbean also encounters the cumulative adverse effects of other environmental factors as insects, pests, high temperature, pod-shattering along with salinity causing high yield loss. Pod shattering has been given top priority because it was found out that farmers lose their entire crop if they do not harvest as soon as the crop is mature (Tefera, 2011). So that breeding should be concentrate on development of high yielding varieties with pod shattering resistance. Field evaluation for shatter resistance is inaccurate due to varying weather conditions during harvest from one season to the next. Notes on shattering in breeding programs tend to be opportunistic. For this reason, laboratory testing for shatter resistance is required. A basic requirement for any laboratory test is that it simulates the process as it occurs under natural conditions (Kadkol, 2009). This paper deals with the evaluation of the mutants for pod shattering based on the pod related traits.

## MATERIALS AND METHODS

Two greengram genotypes viz., Co (Gg) 7 and NM 65 obtained from the Department of Pulses, Centre for Plant Breeding and Genetics, TNAU, Coimbatore. The genotypes were subjected to gamma irradiation at the doses of 300, 400 and 500 Gy and EMS treatments of 10, 20 and 30 mM. Gamma irradiation was done using cobalt 60 sources in the Gamma chamber, installed at Centre for Plant Breeding and Genetics, TNAU, Coimbatore. The chemical mutagen, ethyl methane sulphonate ($CH_3SO_2OC_2H_5$) with molecular weight 124.16, from the sigma chemical company, USA was used for treating the seeds. The treated seeds were sown with a spacing of 30 x 10 cm in a randomized block design. The trial was conducted in the research farm of Agricultural College and Research Institute, Madurai during Kharif season 2013. The $M_2$ generation was raised as individual $M_1$ plant basis. The treated and control populations of $M_2$ generation were carefully screened for pod shattering. From the macro mutant population of $M_2$ generation, 12 mutants of CO (Gg) 7 and 10 mutants of NM 65 tolerant to pod shattering were forwarded to $M_3$ generation. Mean performance and association analysis of eight important pod related traits along with shattering percentage were studied.

**Method: Screening for pod shattering resistance**

Pod shattering resistance was evaluated both in laboratory and field conditions and found out that laboratory method is not influenced by the environment and hence can only be used as a tool for identification of pod shattering resistance genotypes Agarwal *et al*. (2000). The screening was done under laboratory condition by following the methodology adopted by International Institute of Tropical Agriculture (IITA, 1986). The pod shattering resistance was recorded at physiological maturity of the pod. IITA method of calculating pod shattering under lab conditions:

1. A sample of 25 pods were collected and kept in oven at 40°C for 7 days.

2. On the 7th day, the number of shattered pods were counted and expressed in percentage as below

$$\text{Pod shattering percentage (\%)} = \frac{\text{Number of pods shattered}}{\text{Total number of pods}} \times 100$$

The genotypes were classified into different categories based on their reaction to pod shattering proposed by IITA, 1986.

| Sl.No | Category | Resistant reaction |
|---|---|---|
| 1 | No pod shattering | Shattering resistant |
| 2 | 25% pod shattering | Shattering tolerant |
| 3 | 25-50% pod shattering | Moderately shattering |
| 4 | 51-75% pod shattering | Highly shattering |
| 5 | >75% pod shattering | Very highly shattering |

## RESULTS AND DISCUSSION

**Mean performance of mutants**

Mean performance of 22 mutants for eight pod related characters *viz.,* Pod length, pod width, pod length: width ratio, pod width: length ratio, number of pods per plant, number of seeds per pod, hundred seed weight and single plant yield are analyzed (Table 1).

Nine mutants *viz.,* M9, M36, M38, M58, M70, M71, M84, M89 and M98 recorded significantly highest mean value for pod length. Significantly highest mean value for pod width was observed in nine mutants *viz.,* M18, M26, M44, M46, M55, M58, M71, M84 and M98. Two mutants *viz.,* M47 and M89 recorded significantly highest mean value for Pod length: width ratio. For pod width:length ratio, four mutants *viz.,* M18, M26, M44 and M55 recorded significantly highest mean value. 12 mutants *viz.,* M26, M44, M46, M47, M55, M58, M66, M70, M71, M77, M84 and M92 registered significantly highest mean value for number of pods per plant. Ten mutants *viz.,* M44, M46, M47, M58, M66, M70, M71, M84, M92 and M98 recorded significantly highest mean value for single plant yield.

**Correlation of pod related traits on shattering per centage**

Eight Pod related characters were correlated with shattering per centage (Table 2).

Pods per plant, seeds per pod, hundred seed weight and single plant yield showed significant positive correlation with all other traits, while pod width, number of pods per plant, number of seeds per pod, hundred seed weight and single plant yield showed significant negative association with shattering percentage. This result agree with reports by Tiwari and Bhatnagar (1991) that pod shattering showed a significant negative correlation with 100 seed weight, days to maturity and seed yield. Morgan *et al*. (1998) also reported negative correlation between the force needed to break pod ('force') with beak length, silique length and number of seeds per pod among oilseed rape lines developed from synthetic *Brassica napus*.

Mohammed (2010) reported a weak negative correlation between pod shattering and plant height, pods per plant and grain yield in soyabean. In general, it can be taken that resistance to pod shattering is related to characters such as, number of primary branches per plant, pods per plant, maturity and grain yield. This conforms to reports by Thurling (1991),

**Table 1: Mean performance of $M_3$ mutants for pod related traits**

| Mutants | Pod length (cm) | Pod width (cm) | Pod Length: Width Ratio | Pod Width: Length ratio | Number of Pods per plant | Number of Seeds per pod | Hundred seed weight (g) | Single plant yield (g) | Shattering percentage | Grade |
|---|---|---|---|---|---|---|---|---|---|---|
| M5 | 8.62 | 2.21 | 3.51 | 0.24 | 25.50 | 9.00 | 3.15 | 7.07 | 45.63 | MS |
| M9 | 10.45* | 2.04 | 5.07 | 0.20 | 30.50 | 7.50 | 3.45 | 8.30 | 64.42 | HS |
| M18 | 7.72 | 2.52* | 3.04 | 0.31* | 33.50 | 8.50 | 2.85 | 9.03 | 39.50 | MS |
| M26 | 6.85 | 2.65* | 2.54 | 0.37* | 35.50* | 11.50* | 4.25* | 9.20 | 12.01* | TO |
| M36 | 9.85* | 2.07 | 3.71 | 0.28 | 24.50 | 8.50 | 2.55 | 7.26 | 70.55 | HS |
| M38 | 10.35* | 1.95 | 4.28 | 0.24 | 24.50 | 7.00 | 2.75 | 7.56 | 57.79 | HS |
| M42 | 7.25 | 2.05 | 3.62 | 0.26 | 27.50 | 8.50 | 3.35 | 7.90 | 25.11* | MS |
| M44 | 8.45 | 2.80* | 2.89 | 0.34* | 42.50* | 11.50* | 4.45* | 15.56* | 20.85* | TO |
| M46 | 8.85 | 2.65* | 3.41 | 0.27 | 39.50* | 11.00* | 4.15* | 14.39* | 13.48* | TO |
| M47 | 8.45 | 1.15 | 7.04* | 0.13 | 41.50* | 10.50 | 3.15 | 12.15* | 33.74* | MS |
| M54 | 8.25 | 2.05 | 3.92 | 0.24 | 28.50 | 8.50 | 2.25 | 5.70 | 27.84* | MS |
| M55 | 7.75 | 2.82* | 2.75 | 0.35* | 37.50* | 7.50 | 2.75 | 8.40 | 26.58* | MS |
| M58 | 9.75* | 2.62* | 3.50 | 0.26 | 40.00* | 11.50* | 3.15 | 12.40* | 23.17* | TO |
| M66 | 7.75 | 1.55 | 4.84 | 0.20 | 36.50* | 11.50* | 3.70 | 15.30* | 25.45* | MS |
| M70 | 10.45* | 2.25 | 4.55 | 0.21 | 40.50* | 11.00* | 4.00* | 18.46* | 10.47* | TO |
| M71 | 10.05* | 2.65* | 3.74 | 0.26 | 39.50* | 12.50* | 3.65 | 17.40* | 16.64* | TO |
| M77 | 8.20 | 1.85 | 4.33 | 0.23 | 38.50* | 8.50 | 2.85 | 9.90 | 28.85* | MS |
| M84 | 9.75* | 2.82* | 3.47 | 0.28 | 36.50* | 10.50* | 3.75 | 14.20* | 22.79* | TO |
| M89 | 10.35* | 1.15 | 6.56* | 0.16 | 22.50 | 7.50 | 3.20 | 6.10 | 60.53 | HS |
| M91 | 8.70 | 2.12 | 4.14 | 0.23 | 28.50 | 7.50 | 3.85* | 9.15 | 27.62* | MS |
| M92 | 8.85 | 1.80 | 4.64 | 0.20 | 37.50* | 10.50* | 4.15* | 17.50* | 23.11* | TO |
| M98 | 9.52* | 2.48* | 3.77 | 0.26 | 31.50 | 9.50 | 3.49 | 11.21* | 22.53* | TO |
| CO (Gg) 7 | 9.44* | 1.84 | 4.48 | 0.22 | 24.50 | 7.50 | 3.57 | 7.21 | 82.13 | VHS |
| NM 65 | 8.22 | 2.05 | 3.96 | 0.25 | 28.50 | 8.50 | 3.72 | 8.71 | 60.42 | HS |
| Grand Mean | 8.91 | 2.17 | 4.07 | 0.25 | 33.14 | 9.41 | 3.42 | 10.83 | 35.05 | |
| SE | 0.10 | 0.08 | 0.74 | 0.03 | 0.57 | 0.77 | 0.17 | 0.14 | 0.20 | |

**Table 2: Correlation of pod related traits with pod shattering for mutants in $M_3$ generation**

| Traits | Pod length | Pod width | Pod Length: Width Ratio | Pod Width: Length ratio | Pods per plant | Seeds per pod | Hundred seed weight | Single plant yield | Shattering percentage |
|---|---|---|---|---|---|---|---|---|---|
| Pod length | 1 | -0.097 | 0.368* | -0.409* | -0.169 | -0.085 | -0.047 | 0.151 | 0.342 |
| Pod width | | 1 | -0.889* | 0.849* | 0.368* | 0.330* | 0.240 | 0.248 | -0.447* |
| Pod Length : Width Ratio | | | 1 | -0.929* | -0.138 | -0.173 | -0.115 | -0.020 | 0.329 |
| Pod Width: length ratio | | | | 1 | 0.184 | 0.163 | 0.106 | -0.029 | -0.309 |
| Pods per plant | | | | | 1 | 0.760* | 0.421* | 0.794* | -0.745* |
| Seeds per pod | | | | | | 1 | 0.562* | 0.813* | -0.645* |
| Hundred seed weight | | | | | | | 1 | 0.643* | -0.405* |
| Single plant yield | | | | | | | | 1 | -0.645* |
| Shattering percentage | | | | | | | | | 1 |

* Significant at 5% level

**Table 3: Effect of pod related traits on pod shattering for mutants in $M_3$ generation**

| Traits | Pod length | Pod width | Width Pod Ratio Length: | Pod Width: Length ratio | Pods per plant | Seeds per pod | Hundred seed weight | Single plant yield | Shattering percentage |
|---|---|---|---|---|---|---|---|---|---|
| Pod length | 0.295 | 0.013 | 0.192 | -0.205 | 0.060 | 0.021 | -0.003 | -0.029 | 0.342 |
| Pod width | -0.029 | -0.131 | -0.471 | 0.425 | -0.134 | -0.075 | 0.014 | -0.049 | -0.447 |
| Pod Length : Width Ratio | 0.124 | 0.135 | 0.456 | -0.438 | 0.055 | 0.051 | -0.009 | 0.004 | 0.329 |
| Pod Width : Length ratio | -0.134 | -0.122 | -0.441 | 0.454 | -0.071 | -0.042 | 0.007 | 0.006 | -0.309 |
| Pods per plant | -0.049 | -0.049 | -0.070 | 0.090 | -0.358 | -0.179 | 0.026 | -0.156 | -0.745 |
| Seeds per pod | -0.028 | -0.044 | -0.105 | 0.085 | -0.290 | -0.222 | 0.035 | -0.169 | -0.645 |
| Hundred seed weight | -0.015 | -0.031 | -0.066 | 0.053 | -0.155 | -0.131 | 0.060 | -0.130 | -0.405 |
| Single plant yield | 0.045 | -0.033 | -0.010 | -0.015 | -0.285 | -0.190 | 0.040 | -0.196 | -0.645 |

Residual effect: 0.53

that the seed loss at harvest was related to many architectural and morphological characters of both the whole plant and racemes in oilseed rape. Pod length and pod length: width ratio had non significant positive association with shattering percentage. The results are in contradiction to the findings of Bhara *et al.,* 2013 wherein significant and positive association of shattering percentage with pod width was observed in Soyabean.

In the present investigation, the trait Pod length with pod length: width ratio and pod width with pod width: length ratio, pods per plant and seeds per pod had significant positive association with them. Maximum significant positive association is recorded for number of seeds per pod with single plant yield. Pod length with pod width: length ratio, pod width with pod length: width ratio, pod length: width ratio with pod width: length ratio had significant negative association with them.

**Effect of pod related traits on shattering per centage**

Five traits *viz.,* pod length, pod length: width ratio, pod width: length ratio, pods per plant and seeds per pod had direct effect on shattering per centage (Table 3). Pods per plant showed negative high direct effect on shattering percentage as reported by Bhara *et al.,* 2013. Pod length: width ratio and pod width: length ratio had positive high direct effect while single plant yield had low negative direct effect on shattering percentage. Pod length recorded positive moderate direct effect and seeds per pod had negative moderate direct effect on shattering percentage. The indirect effect on shattering percentage for pod width through pod width: length ratio was positive and high. Pod length exhibited negative moderate indirect effect through pod width: length ratio. Seeds per pod and single plant yield had negative moderate indirect effect through pods per plant on shattering percentage. High negative indirect effect was observed for pod width through pod length: width ratio. Pod length: width ratio showed high negative indirect effect through pod width: length ratio. Pod width: length ratio had high negative indirect through pod length: width ratio on shattering percentage.

In this present investigation, it was concluded that the among different pod related traits, pod length recorded positive high direct effect on shattering percentage. Five traits *viz.,* Pod width, number of pods per plant, number of seeds per pod, hundred seed weight and single plant yield showed significant negative association with shattering percentage. Hence this pod related traits have to be given importance in further evaluation for pod shattering in mungbean. Nine mutants *viz.,* M26, M44, M46, M58, M70, M71, M84, M92 and M98 showed tolerance to pod shattering. These mutants can be forwarded for further screening in next generation or can be used as parental material for crossing work to get superior hybrids.

## REFERENCES

**Adeyeye, A. S., Togun, A. O., Akanbi, W. B., Adepoju, I. O. and Ibirinde, D.O. 2014.** Pod shattering of different soybean varieties, *Glycine max* (L) Merrill, as affected by some growth and yield parameters. *Int. J. Agric. Policy Res.* **2(1)**: 010-015.

**Agarwal, A. P., Patil, S. A. and Salimath, P. M. 2000.** Identification of potential soybean genotypes for pod shattering resistance and seed yield. *Crop Improvement.* **27:** 236-239.

**Bhara, N. Khare, D. and Shrivastava, A. N. 2013.** Studies on the factors affecting pod shattering in soybean. *Indian J. Genet.* **73(3):** 270-277.

**Hase, Y. Akita, Y. Kitamura, S. Narumi, I. and Tanaka, A. 2012.** Development of an efficient mutagenic technique using ion beam: Towards more controlled mutation breeding. *Plant Biotechnology.* **29:** 193-200.

**International Institute of Tropical Agriculture (IITA). 1986.** A laboratory method for evaluating resistance to pod shattering in soybeans. *Annu. Rep.* (1986-87). 58-59.

**Kadkol, G. 2009.** *Brassica* shatter-resistance research update. 16th *Australian Research Assembly on Brassicas.* Ballarat Victoria. pp. 1-6.

**Kamleshwar Kumar*, Yogendra Prasad, Mishra, S. B. Pandey, S. S. and Ravi Kumar. 2013.** Study on genetic variability, correlation and path analysis with grain yield and yield attributing traits in green gram [*Vigna radiata* (L.) Wilczek]. *The Bioscan.* **8(4):** 1551-1555.

**Loof, B. and Johnsson, R. 1970.** Results on investigations on resistance to shedding in rapes. *Sveriges Utsadesforening Tidskrift.* **80:** 193-205.

**Mohammed, H. 2010.** Genetic analysis of resistance to Pod Shattering in Soybean (*Glycine Max.* (L) Merrill). *M.Sc. (Ag.) Thesis,* Kwame Nkrumah University of Science and Technology, Kumasi.

**Morgan, C. L., Bruce, D. M., Child, R., Ladbrooke, Z. L. and Arthur, A. E. 1998.** Gene variation for pod shatters resistance among lines of oilseed rape developed from synthetic *Brassica napus*. *Field Crops Research.* **58:** 153 -165.

**Nirmalbharathi, M. 2015.** Selection of parents for developing the mapping populations and validation of markers for studying pod shattering in mungbean (*Vigna radiata*), *M. Sc. Thesis,* University of agricultural sciences., Dharwad (Karnataka).

**Nirmalbharati, M. and Sumangala Bhat. 2016.** Standardization of laboratory screening methods for pod shattering in mungbean (*Vigna radiata* L. Wilczek**).** *J. Farm Sci.* **29(2):** 286-287.

**Patel, H. R., Patel*, H. F., Maheriya, V. D. and Dodia, I. N. 2013.** Response of kharif greengram (*Vigna radita* L. Wilczek) to sulphur and phosphorus fertilization with and without biofertilizer application. *The Bioscan.* **8(1):** 149-152.

**Sehrawat, N., Jaiwal, P. K., Yadav, M., Bhat, K. V. and Sairam, R. K. 2013.** Salinity stress restraining mungbean (*Vigna radiata* L. Wilczek) production: gateway for genetic improvement. *Int. J. Agri. Crop Sci.* **6:** 505-509.

**Tang, D., Dong, Y., Ren, H., Li, L. and He, C. 2014.** A review of phytochemistry, metabolite changes, and medicinal uses of the common food mung bean and its sprouts (*Vigna radiata*). *Chemistry Central J.* **8**: 4.

**Tefera, H. 2011.** Breeding for Promiscuous Soybeans at IITA, Soybean - Molecular Aspects of Breeding. *ISBN: 978-953-307-240-1, InTech,* Availablefrom: http://www.intechopen.com/books/soybean-molecular-aspects-of breeding/breeding-for promiscuous soybeans-at-iita.

**Thompson, K. F. and Huges. W.G. 1986.** Breeding varieties. In: Scarisbrick D. H. Daniels, R. W.(eds). *Oilseed Rape. Collins Professional and technical,* pp. 32-82.

**Thurling, N. 1991.** Application of the ideotype concept in breeding for higher yield in oilseed Brassica. *Field crops Research.* **26**: 201-219.

**Tiwari, S. P. and Bhatnagar, P. S. 1988.** Pod shattering of soybean in India. *J. Oilseed Research.* **5:** 92-93.

**Tiwari, S. and Bhatnagar, P. S. 1991.** Pod shattering as related to other agronomic attributes in soybean. *Tropical Agriculture.* **68**: 102-103.

**Usharani, K. S. and Ananda Kumar, C. R. 2015.** Induced viable mutants in Urdbean (*Vigna mungo* (L.) Hepper). *The Bioscan.* **10(3):** 1103-1108.