Asian J Agri & Biol. 2018;6(2):259-264.

AJAB

Original Research Article

# Screening of breeding lines of *Brassica napus* L. tolerant to grain shattering

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*Received:*
*February 28, 2018*

*Accepted:*
*May 08, 2018*

*Published:*
*June 30, 2018*

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## Abstract

Shattering causes huge losses to Brassica even if harvesting is done mechanically. To study the shattering tolerance in different rapeseeds lines, a study was conducted in split plot design at experimental area of Barani Agricultural Research Institute (BARI) Chakwal, Pakistan during two winter season 2014-15 & 2015-16 under the rainfed conditions. The experimental material comprised of 10 advanced lines including one local variety of rapeseed viz: 8CBN001, 8CBN002, 10CBN003, 10CBN005, 11CBN001, 11CBN003, 11CBN009, 11CBN011, 12CBN003 and Chakwal Sarsoon The main experimental plot was harvested at four different harvesting dates (HD) including: $HD_1$ = Harvesting of each advanced line at crop maturity, HD2= 10 days after the first harvesting (DAFH), $HD_3$= 20 DAFH, $HD_4$= 30 DAFH. The comparison of difference between the grain yield of each advanced line at various harvesting dates with its seed yield at first harvesting date ($HD_1$-$HD_i$) were calculated as indices of pods shattering. Combined analysis of variance depicted that all the genotypes were significantly different for HD, harvesting date and advanced lines interaction effect, year and its interaction effects to each factors. The significant difference of genotypes into harvesting dates demonstrated various level of pods shattering of all advanced lines at different harvesting dates. The amount of grain yield due to shattering losses was increased at third and fourth harvesting dates. On the basis of shattering tolerance indices, advanced line 10CBN005 was more tolerant to shattering losses and 8CBN002 was more susceptible to shattering as compared to others promising genotypes.

**Keywords:** Shattering tolerance, Rapeseed, Harvesting date

## Introduction

Rapeseed is one of the most important oilseed crops in Pakistan and world over. For enhancement of grain yield potential of rapeseed, the important breeding strategies are the good knowledge and utilization of morphological, physiological and genetic basis of grain yield associated attributes in different climatic conditions (Bruce et al., 2002; Banga et al., 2011). Tolerance to shattering is an important attribute for rapeseed grain yield enhancement because the crop ripens and is harvested under warm environment and normally windy summer conditions (Rameeh, 2013). In rapeseed grain yield loss is usually divided into two periods, shattering before and during harvesting (chandler et al., 2005). Weather conditions prior to and

during harvesting are the main factors in the field that influence the level of shattering (Tan et al., 2006). Typically grain yield losses vary from 10 to 25 percent (Price et al., 1996). Links between pods and other canopy components during windy summer conditions have also been implicit to contribute to shattering in the field. Furthermore, insect-pest and disease damage can accelerated ripening and pod shattering (Rameeh, 2013). Peng-Fei et al., (2011) in their studies reported that in brassica species marked losses of grain yield is due to shatter during maturity and harvesting. Moreover the shed seeds may remain viable during a number of years and germinate to produce plants, which represent weeds in the following crops. Shattering involves bursting of the pod valves and detachment of seed from the replum. It could take place in ripe standing crops under windy conditions once plants become in contact other plants and in windrows from the impact of harvest machinery. (Meakin and Roberts, 1990). Overseas research work on this factors explained that genetic variation for grain shattering tolerance present among rapeseed genotypes (Wen et al., 2008). Sixty eight lines of Brassica napus were studied for pods shattering resistance using a ripping method and demonstrated that ripping force ranged from 0.59 to 2.75 N existed in different Brassica napus genotypes. It was also revealed that the inheritance of shatter resistance (SR) was determined by two genes, with heritability of 50% (Peng-Fei et al., 2011). This study concurred that genetic gain can be achieved by using conventional methods of breeding in rapeseed. However, further development is required to avoid the need to windrow. Resistance in Brassica napus was recessive and mostly governed by additive genes. They observed that correlation of pods shattering tolerant with important attributes was low, signifying that it would be viable to easily introgress the shattering resistance characters into inbred lines.

Screening of rapeseed advanced lines for shattering tolerance is difficult because pods shattering attribute is also influenced by other than the genetic factors such as timing of pod senescence, maturity, method and timing of harvesting. The goal of the present study were to evaluate the presence of genetic variability for shattering tolerance in Brassica napus advanced lines and also relationship of pods shattering at different harvesting dates and the selection of lines with more tolerant to shattering characteristics which can be used by plant breeders for improvement of shattering tolerance in their breeding program of rapeseed in future.

## Material and Methods

A study was conducted to observe shattering tolerance in different rapeseed lines at the research area of BARI, Chakwal, Pakistan which is located at 32.66° latitude and 72.51° longitude with an altitude of 575ams altitude with an average rainfall less than 600 mm under rainfed conditions. The pre sowing soil analysis indicated that the soil is deficient in organic matter (0.52 %) and phosphorus (5.0 mg $kg^{-1}$), extractable K (110 mg $kg^{-1}$) and soil pH 7.8. The research site kept fallow in kharif season during both years. The field was prepared according to standard practices used in rainfed areas. The experimental material comprised of 10 advanced lines including one local variety of rapeseed viz: 8CBN001, 8CBN002, 10CBN003, 10CBN005, 11CBN001, 11CBN003, 11CBN009, 11CBN011, 12CBN003 and Chakwal Sarsoon were sown during last week of September with seed rate @ 2 kg per acre in both years in a split plot design with four replications. The main plot harvested at four different dates including $HD_1$ = Harvesting at crop maturity of each advance line, $HD_2$= 10 days after the first harvesting (DAFH), $HD_3$= 20 (DAFH), $HD_4$= 30 (DAFH). All the treatments ($HD_1$, $HD_2$, $HD_3$, and $HD_4$) were harvested according to planned different harvesting dates and threshed by hand. Each sub plot comprised of same advance lines and consisted of 5 rows of 1.8 m long with plant to plant and row to row distance was kept at 10cm and 45 cm respectively. All the plant protection measures and cultural practices are adopted same for all the plots as per requirement of the crop. The difference of seed yield (kg/ha) of each advanced lines in various dates of harvesting with compare to first harvesting date ($HD_1$-$HD_i$) were considered as indices of shattering tolerance and compute by using the formula give as Rameeh, (2013).

Shattering Resistance= ($HD_1$-$HD_i$)

Shattering Resistance (%) = [($HD_1$-$HD_i$)/$HD_1$] x100

Where "$HD_1$" is the grain yield of each genotype in the 1st harvesting date and "$HD_i$" is the grain yield of each advanced line in subsequent harvesting dates. Combine analysis of variance on the basis of split plot design were calculated by using the Statistix software version 8.1.

## Results and Discussion

The detail of metrological data regarding total rainfall (mm), average minimum and maximum temperature (°C), average humidity (%) and average sunshine hours is shown in figure No. 1 and 2 for cropping season 2014-15 and 2015-16 respectively. From the investigation of present study, combined analysis of variance on the basis of split plot design for grain yield represented that each advanced line was different significantly from each other's. Also different harvesting dates and harvesting dates x advanced lines interaction had significant effects on grain yield which indicated that variation in grain yield of advanced lines were varied in different harvesting dates (Table-1). The table-2 depicted that on the basis of average grain yield (kg/ha) for two year results of each advanced line in different harvesting dates, the local check variety "Chakwal Sarsoon" showed highest average value at all the harvesting dates followed by 11CBN009. However value decreased in all the advance lines at subsequent harvesting dates.

The difference of seed yield of all the advanced line in first and second harvesting date varied from 76 kg/ha to 106 kg/ha in 10CBN005 and 8CBN002 respectively (Table-3). This result indicates that the 8CBN002 is more susceptible to shattering as compared to 10CBN005. Others genotypes likes 11CBN011, 10CBN009, 8CBN001 and Chakwal Sarsoon are also susceptible to shattering. Weng et al., (2008) and Rameeh, (2013) also investigated that genetic variation are present for pods shattering resistance in *Brassica napus* lines. When compare the difference of grain yield of 1st and 3rd harvesting dates, advanced lines ranged from 122 to 186 kg/ha in 10CBN003 and 8CBN002 respectively. Highest average value was determined for the 8CBN002 followed by 11CBN009 (Table-3). This investigation revealed that 8CBN002 and 11CBN009 are more susceptible to shattering. The difference of mean value of 1st and 4th harvesting dates ($HD_1$-$HD_4$) was more varied then all the others differences, so on the basis of this consequence, the ($HD_1$-$HD_4$) index is more important source for the selection of advanced lines against the shattering tolerance. The difference of grain yield of ($HD_1$-$HD_4$) index significant varied from 154 kg/ha to 266 kg/ha in 10CBN005 & 8CBN002 respectively (Table-3). On the basis of present inference from ($HD_1$-$HD_4$) index, the 8CBN002 is more susceptible to shattering then all the other advanced lines. In addition, the percentage of grain yield shattering with comparison to 1st harvesting date revealed that grain shattering at 2nd harvesting date ranged from 8.05 to 10.04 percent in 10CBN003 & 8CBN002 advanced lines respectively. However, grain shattering in 3rd harvesting date varied from 12.23 to 17.57 percent in 10CBN003 & 8CBN002 advanced lines respectively. Furthermore, the grain shattering in 4th harvesting date ranged from 16.85 to 25.15 percent in 10CBN005 & 8CBN002 advanced lines respectively (Table-4). The present investigations are in corroborated with the observations of Price et al., (1996) who reported grain yield losses ranged from 10 to 25 percent in Brassica napus lines.

In present experiment study, the genetic variation for pods shattering tolerance was found among all advance lines of rapeseed. However different methods used to determines the inheritance of shattering resistance but delaying in harvesting date in contrast to physiological maturity is also viable technique for the assessment of shattering tolerance of rapeseed advanced lines under normal conditions in rainfed areas. As the inference from the current study, the difference of grain yield of 1st and 4th harvesting dates ($HD_1$-$HD_4$) were more varied therefore, it is useful tool for the selection of rapeseed advanced lines for the shattering tolerance. Among all the advanced lines the 10CBN005 and Chakwal Sarsoon were more tolerant to shattering then all the others advanced lines and 8CBN002 & 8CBN001 were relatively more susceptible to shattering. So the lines with more tolerant to shattering characteristics can be used by plant breeders for improvement of shattering tolerance in their breeding program of rapeseed.

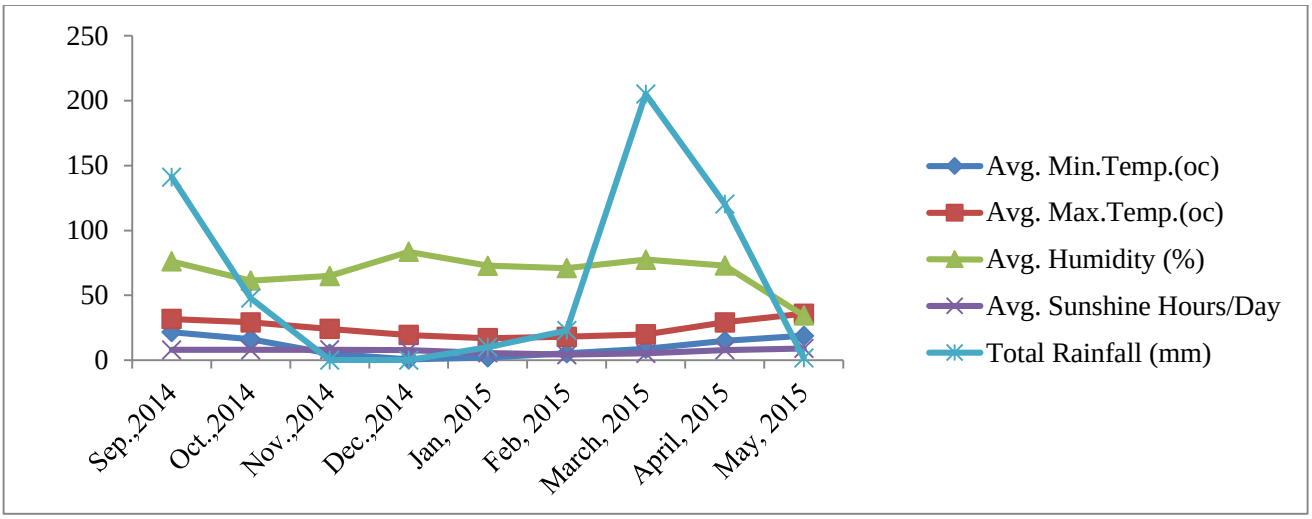


**Fig 1: Metrological data during winter season 2014-15**

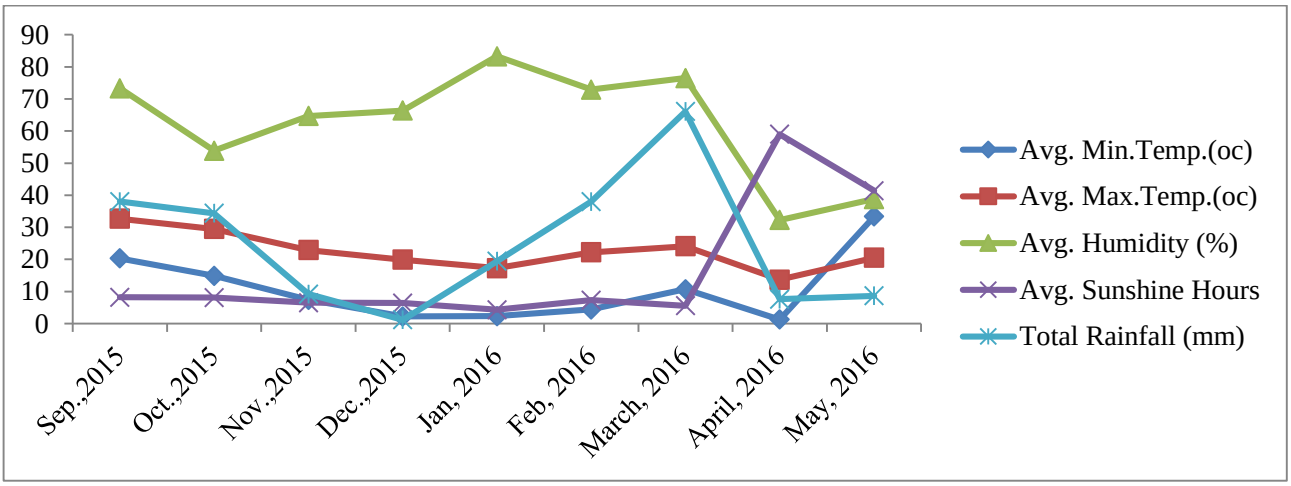


**Fig 1: Metrological data during winter season 2015-16**

**Table-1**: **Results of combine analysis of variance of two years 2014-15 & 2015-16**

| Source of Variation | Degree of Freedom | M S | F. test | P. Value |
|---|---|---|---|---|
| Y | 1 | 2936653** | 1135.52 | 0.0000 |
| R(Y) | 6 | 16687** | 5.67 | 0.0001 |
| HD | 3 | 647848** | 250.50 | 0.0000 |
| Y x HD | 3 | 15629** | 6.04 | 0.0006 |
| Error 1 | 18 | 2351 | - | - |
| PL | 9 | 110999** | 42.92 | 0.0000 |
| Y x PL | 9 | 115060** | 44.49 | 0.0000 |
| HD x PL | 27 | 4881* | 1.89 | 0.0067 |
| Y x HD x PL | 27 | 6633** | 2.56 | 0.0001 |
| Error 2 | 120 | 2771 | - | - |

* and ** Significant at 5% and 1% level respectively Y: (Year), R: (Replication), HD: (Harvesting date), PL: (Promising lines)

**Table-2**: **Average Grain Yield (kg/ha) of Rapeseed advanced lines in different harvesting dates during two rabi growing seasons 2014-15 & 2015-16**

| Advanced Lines | 1st Harvesting Date ($HD_1$) | 2nd Harvesting Date ($HD_2$) | 3rd Harvesting Date ($HD_3$) | 4th Harvesting Date ($HD_4$) |
|---|---|---|---|---|
| 8CBN001 | 966 | 874 | 825 | 730 |
| 8CBN002 | 1056 | 950 | 870 | 790 |
| 10CBN003 | 994 | 914 | 872 | 809 |
| 10CBN005 | 911 | 835 | 785 | 758 |
| 11CBN001 | 872 | 790 | 743 | 674 |
| 11CBN003 | 1025 | 937 | 885 | 822 |
| 11CBN009 | 1063 | 959 | 911 | 848 |
| 11CBN011 | 937 | 844 | 793 | 720 |
| 12CBN003 | 998 | 914 | 853 | 793 |
| Chakwal Sarsoon | 1097 | 998 | 956 | 904 |

$HD_1$ = Harvesting at maturity of crop of each Promising line, $HD_2$= 10 days after the first harvesting (DAFH), $HD_3$= 20 (DAFH), $HD_4$= 30 (DAFH)

**Table-3: Least Significant Difference (LSD) for mean grain yield (kg/ha) shattering of rapeseed advanced lines during two rabi growing seasons 2014-15 & 2015-16**

| Advanced Lines | ($HD_1$-$HD_2$) | ($HD_1$-$HD_3$) | ($HD_1$-$HD_4$) |
|---|---|---|---|
| 8CBN001 | 93** | 141** | 237** |
| 8CBN002 | 106** | 186** | 266** |
| 10CBN003 | 80* | 122** | 185** |
| 10CBN005 | 76* | 126** | 154** |
| 11CBN001 | 82** | 129** | 198** |
| 11CBN003 | 89** | 141** | 204** |
| 11CBN009 | 104** | 152** | 215** |
| 11CBN011 | 94** | 145** | 217** |
| 12CBN003 | 85** | 145** | 205** |
| Chakwal Sarsoon | 99** | 141** | 193** |

* and ** Significant at 5% and 1% level respectively $HD_1$ = Harvesting at maturity of crop of each Promising line, $HD_2$= 10 days after the first harvesting (DAFH), $HD_3$= 20 (DAFH), $HD_4$= 30 (DAFH)

**Table-4**: **Percentage of average grain yield (kg/ha) shattering of rapeseed advanced lines during two rabi growing season 2014-15 & 2015-16**

| Advanced Lines | $[(HD_1-HD_2)/HD_1]x100$ | $[(HD_1-HD_3)/HD_1]x100$ | $[(HD_1-HD_4)/HD_1]x100$ |
|---|---|---|---|
| 8CBN001 | 9.58 | 14.60 | 24.48 |
| 8CBN002 | 10.04 | 17.57 | 25.08 |
| 10CBN003 | 8.05 | 12.23 | 18.62 |
| 10CBN005 | 8.34 | 13.83 | 16.85 |
| 11CBN001 | 9.40 | 14.79 | 22.71 |
| 11CBN003 | 8.63 | 13.71 | 19.85 |
| 11CBN009 | 9.79 | 14.26 | 20.24 |
| 11CBN011 | 9.98 | 15.42 | 23.16 |
| 12CBN003 | 8.47 | 14.53 | 20.54 |
| Chakwal Sarsoon | 8.98 | 12.81 | 17.56 |

$HD_1$ = Harvesting at maturity of crop of each Promising line, $HD_2$= 10 days after the first harvesting (DAFH), $HD_3$= 20 (DAFH), $HD_4$= 30 (DAFH)

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