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Effect of sowing date on flowering and seed set of mustard (*Brassica juncea* L.)

Manju Devi and Harish Kumar Sharma

Abstract
The present study was conducted to determine the effect of sowing date on flowering and seed set of mustard (*Brassica juncea* L.). The studies were conducted in the mustard crop by inducing the plant to flower early or late through different sowing dates. The crop was sown during October- November in three different dates at an interval of fifteen days. Delay in sowing caused a significant reduction in the length of flowering period. The crop sown on D_1 had the longest flowering duration (45 days) followed by the crop sown on D_2 (41 days) and D_3 (35 days). In the present investigations, crop sown on D_1 took significantly more days from sowing to the flowering stage as compared to D_2 and D_3. Delayed sowing of mustard resulted into reduction in the seed set due to short flowering duration. Delaying sowing time resulted in significant reduction in the seed set. Seed set percentage, 1000 seed weight and seed siliqua^{-1} did not vary significantly among different dates of sowing.

Keywords: Sowing date, flowering, seed set, mustard

1. Introduction
Mustard is the major oilseed crops, traditionally grown everywhere, in the country due to their high adaptability in conventional farming systems. Time of sowing is very important for mustard production [1]. Optimum sowing time plays an important role to exploit the genetic potential of a variety as it provides optimum growth conditions such as temperature, light, humidity and rainfall [2]. Sowing dates is an important factor that determines the length of growing season and hence yields [3]. Changes in sowing time expose the crop cycle to different environmental conditions, and thus modifying the duration of phenological phases. Phenological alterations are mainly due to photoperiod and temperature changes which affect some plant structures (e.g., number of leaf primordia and rate of leaf emergence), crucial for crop phenology [4]. Delayed planting, unfavourable weather conditions during the flowering period, fertilization and pod formation can cause a decrease in duration of maturity period, the number of pods per plant, the number and weight of grains, and finally can lead to decrease in grain yield [5]. From the above points it is clear that date of sowing plays a great role in the production of mustard. Keeping in view of these facts, the present investigation was carried out to study the effect of sowing date on flowering and seed set of mustard (*Brassica juncea* L.).

2. Material and Methods
The investigations were carried out at Baghor farm, Department of Entomology, Dr. Y. S. Parmar University of Horticulture and Forestry Nauni, Solan (Himachal Pradesh) situated at 33.3° N latitude, 70.70° E longitude and 1256 m amsl. Experiment was conducted in mustard crop by inducing the plant to flower early or late through different sowing dates during 2015 (6th October (D_1), 23rd October (D_2) and 12th November (D_3) and 2016 (1st October (D_1), 17th October (D_2) and 3rd November (D_3). Observations on flower bud development, duration of flowering, days to flowering after sowing and longevity of flower were recorded. Observations on the effect of sowing date on seed set were recorded in mustard flowers exposed to all insect pollinators under open condition. Seed set was recorded on the flower basis. Hundred flower buds were marked at balloon stage for recording data on seed set. The observations on seed set were recorded after petal fall. Percent seed set was calculated from the number of flowers counted. The observation on seed set percentage was calculated as:

$$\text{Seed set (\%)} = \frac{\text{Number of pods}}{\text{Total numbers of flowers}} \times 100$$

Seed siliqua-1 and 1000 seed weight were calculated out in different sowing date. The data collected from field experiments were subjected to the analysis of variance following randomized block design.

3. Results and Discussion

3.1 Effect of sowing date on flowering

Sowing date greatly affects the flower bud development. The mean number of days for flower bud development was maximum on D_2 (11.31 days) followed by duration of flower bud development for the crop sown on D_3 (11.05 and 11.60 days) and D_1 (10.81 and 10.53 days) during 2015. Similarly during 2016 flower bud development was 10.53, 11.45 and 11.60 when crop was sown on D_1, D_2 and D_3 (Fig. 1). Among different sowing date, the crop sown on D_1 had the longest flowering duration (45 days) followed by the crop sown on D_2 (41 days) and D_3 (35 days) during 2015 (Fig. 2). Likewise during 2016 crop sown on D_1 had the longest flowering duration of 42 days and minimum in D_3 (35 days). This suggests that delay in sowing caused a significant reduction in the length of the flowering period. The possible reason for decrease in flowering duration in the late sown crop (D_3) during both the years could be that the environmental conditions for plant growth were more favourable. The crop had more time for various activities and could complete various phenological stages. However, in delayed sowing plant tends to reach reproductive and seed production stage earlier due to little aberrant environmental conditions when crop was sown on D_3. Temperature and photoperiod have been reported as the two most important environmental factors affecting phenological development [6, 7]. Late planting had also been reported by Rameeh [8] to have considerable effects on the duration of flowering of mustard crop. The present results are in agreement with the findings of Mendham *et al.* [9], who reported that delayed sowing accelerated growth and decreased day number from sowing to 50 percent flowering stage. Similar results were obtained by Khan *et al.* [10], who concluded that delayed sowing led to decreased day number to flowering and flowering duration in canola. Other workers [11-14] have also reported a significant effect of sowing date on the length of the flowering period.

The flowering was earliest (106 days) in mustard crop sown on D_2 during 2015. The crop sown on D_3 took maximum days to flowering i.e. 113 days followed by the crop sown on D_1 (Fig. 3). During 2016, mustard sown on D_1 took maximum days to flowering after sowing (107 days) followed by the crop sown on D_2 (105 days). Whereas, crop sown on D_3 took minimum number of days (98 days). In the present investigations, crop sown on D_1 took significantly more days from sowing to the flowering stage as compared to D_2 and D_3. Optimum temperature conditions in mustard crop sown on D_1 and comparatively low temperature in the crop sown on D_2 and D_3 (Fig. 8) might have resulted into early flowering during D_1. Rise in air temperature has also been reported to result beginning of growing season by Sparks *et al.* [15]; Chmielewski *et al.* [16]. Maximum flower longevity (7.63 days) was recorded on D_1 and minimum (7.36 days) in mustard crop sown on D_3 during 2015. The flower longevity was 7.70, 7.23 and 7.33 days in crop sown on D_1, D_2 and D_3 during 2016 (Fig. 4).

3.2 Effect of sowing date on percent seed set and different seed quality parameters

Higher seed set was observed in D_1 (81.6, 85.73%) as compared to D_2 (77.3 and 85.35%) and D_3 (76.8 and 84.93%) during both the year of investigations. This shows an increase of 4.8, 0.8 percent seed set under D_1, D_2 over D_3 during 2015 and 0.8, 0.42 percent during 2016 (Fig. 5). This could be due to the fact that delayed sowing resulted in reductions in seed yield due to reduction in the flowering period (Fig. 2 & 3). These results are in agreement with those of Faraji [17]; Rahnama and Bakhshandeh [18]; Shamsi *et al.* [19], who have also reported that delay in planting caused a significant reduction in the length of the flowering period of *Brassica*, and a positive and significant correlation was observed between the length of the flowering period and the components of seed yield. Delaying sowing time resulted in reduction in the seed yield and which might be due to variation in temperature in the late sown crop. Such findings have also been reported by Bukhtiar *et al.* [20]; Sattar *et al.* [21] on canola.

The seed siliqua^{-1}, 1000–seed weight did not vary significantly with advancement and delayed date of sowing. it was 15.60, 15.49 and 15.42 seed siliqua $^{-1}$ during 2015 and 15.66,15.59 and 15.48 during 2016 on D_1, D_2 and D_3 (Fig. 6). 1000-seed weight was found to be 3.07, 3.11 and 3.06 g during 2015 and 3.13, 3.12 and 3.09 g during 2016 when sown on D_1, D_2 and D_3 (Fig.7).

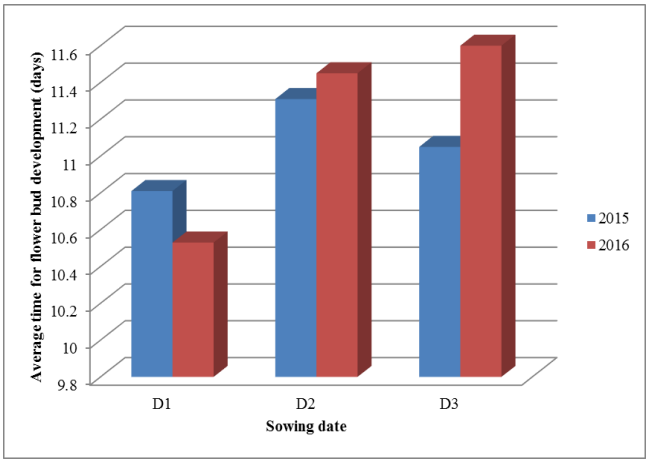

Fig 1: Effect of sowing date on flower bud development in mustard crop

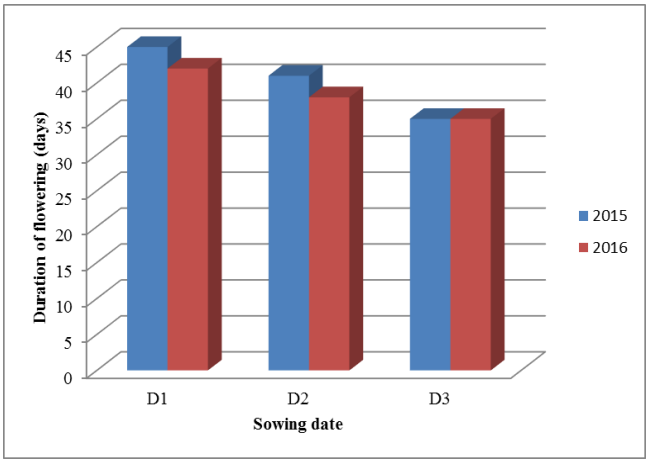

Fig 2: Effect of sowing date on duration of flowering in mustard crop

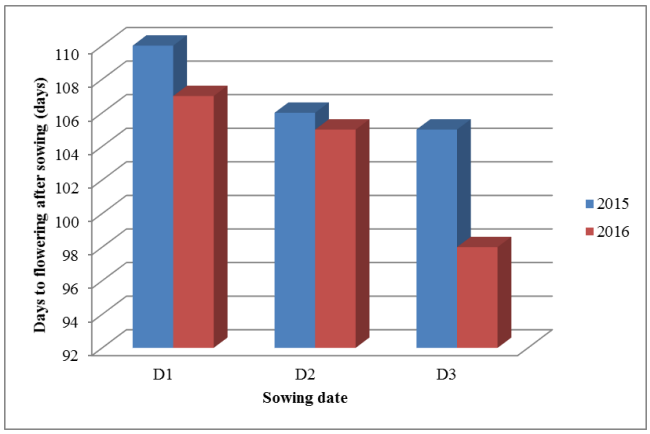

Fig 3: Effect of sowing date on days to flowering after sowing in mustard crop

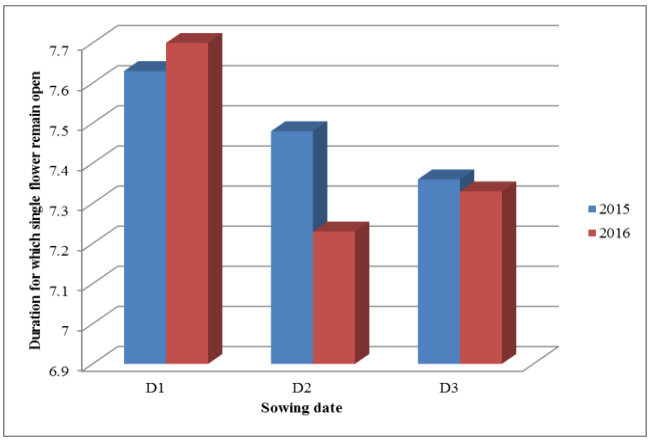

Fig 4: Effect of sowing date on flower longevity in mustard crop

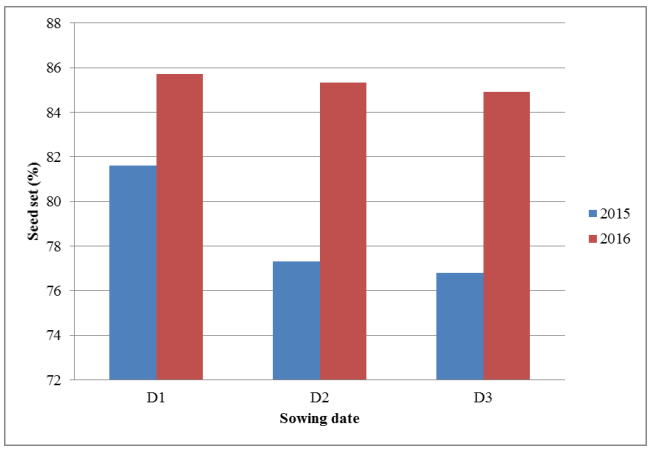

Fig 5: Effect of sowing date on seed set of mustard

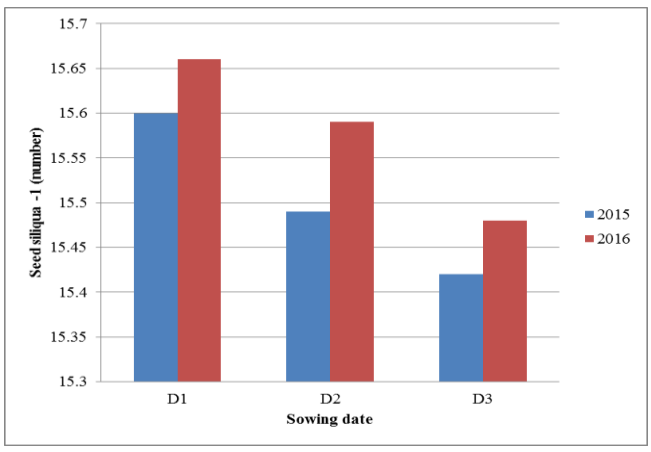

Fig 6: Effect sowing date on seed siliqua $^{-1}$

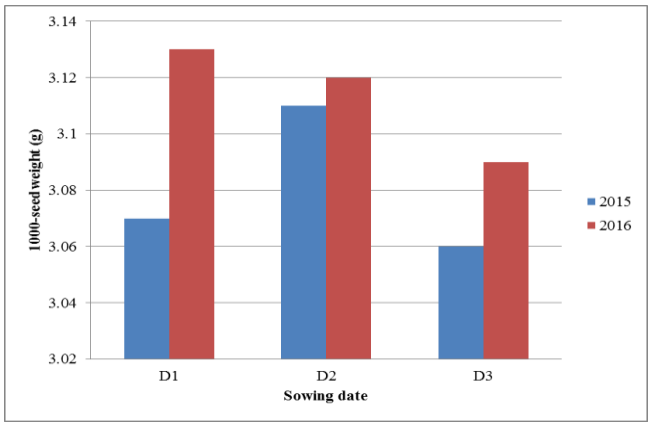

Fig 7: Effect of sowing date on 1000-seed weight

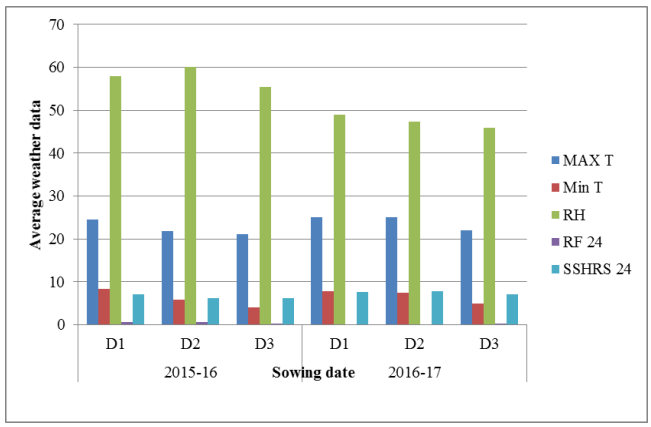

Fig 8: Average weather data during the study period (sowing to flowering) of mustard crop

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