Effect of sowing dates and nitrogen levels on total dry matter and its partitioning at different growth stages and yield of Indian mustard (Brassica juncea L.)


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Received: 20-09-2016 Accepted: 17-02-2017

ABSTRACT

A field experiment was conducted during the winter (rabi) season of 2013-14 and 2014-15 at research farm Hisar, Haryana in a split plot design having four dates (Oct 15 & 25, Nov 5 & 15) in main plots and five nitrogen levels (0, 40, 60, 80 & 100 kg N/ha) in sub plots with three replications to study the effect of sowing dates and nitrogen levels on growth and yield of Indian mustard. Results revealed that October 15 sown crop resulted in significantly higher total plant biomass and its partitioning at different growth stages, yield attributes, yields and oil content. Delaying the sowing dates from October 15 to November 15 reduced seed yield by 39.3 percent. Among the nitrogen levels, application of 100 kg N/ha led to record higher total biomass and its partitioning at all growth stages and resulted in higher yield attributes and seed yield. Oil content decreased with increased levels of nitrogen.

Key words: Dry matter partitioning, Nitrogen levels, Sowing date, Yield Indian mustard.

Rapeseed-mustard (Brassica spp.) is a major group of oilseed crops of the world with second largest acreage in India after China. Rapeseed-mustard contributed 24.5 percent in total oilseed production in the country. Indian mustard is preferred due to its high yield potential and oil content. Indian mustard has multiple uses as a spice or condiment in preparation, seasoning and stuffing of several foods and pickles. Yield potential of this crop can be explored by the use of agronomic-techniques. Among them, proper time of sowing is an important non monetary input. The optimum time of sowing can provide congenial conditions to have maximum light interception, best utilization of moisture and nutrients from early growth stage to seed filling stage. Sowing time is very important for mustard production (Mondal et al., 1999). Nitrogen is considered to be the most important nutrient for the crop to activate metabolic activity and transformation of energy, chlorophyll and protein synthesis. Nitrogen also affects uptake of other essential nutrients and it helps in better partitioning of photosynthates to reproductive parts which increased the seed: stover ratio (Singh and Meena 2004). Optimum sowing time and nitrogen management are important factors for improving crop productivity. Yet there is a lack of sufficient research information pertaining to the effect of sowing date and nitrogen level on yield of Indian mustard in western Haryana. This calls for a need to generate more information on the performance of Indian mustard to different sowing dates and nitrogen levels.

MATERIALS AND METHODS

A field experiment was conducted during winter (rabi) seasons of 2013-14 and 2014-15 at the Agronomy Research Farm of Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana. The soil of the experimental field was sandy loam in texture, having 0.57 percent of organic carbon Ec of 0.185 and pH of 8.73. It was low in available N (154.5 kg /ha), medium in available P2O5 (23.25 kg/ha) and high in available K2O (304.8 kg/ha) . The experiment consisting of four dates of sowing viz. October 15, October 25, November 5 and November 15 allocating in main plots and five nitrogen levels viz. 0, 40, 60, 80 and 100 kg N/ha in sub plots in split plot design with three replications. Seeds of Indian mustard var. ‘RH-749’ as per sowing dates were sown with the help of seed drill @ 5 kg/ha in rows 30 cm apart. Half the doses of nitrogen as per treatment in the form of urea and phosphorous @ 50 kg/ha through single super- phosphate were applied at the time of sowing. Remaining nitrogen was top dressed after the first irrigation during both the seasons. Two irrigations were given to the crop at 30 days after sowing (DAS) and silique-formation stage. Harvesting was done when more than 85 percent of silique turned yellowish in colour. Five plants from each plot were uprooted at 30, 60, 90, 120 and at harvest. The plants were divided into different parts viz., leaves, stems and silique (if present). The samples were then allowed to sun dry for 2-3 days. Thereafter, the samples were oven dried at 60 °C for 72 hours and weighed by electronic balance. The biomass partitioning among different parts was then converted to gram per plant (g plant-1). Based on biomass of different plant parts, the total biomass accumulation was obtained. Yield attributes were recorded from the five plants collected at the time of harvest. The

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crop harvested from net plot area was threshed after 4-5 days of sun drying and the seed yield of net plot was converted into kg ha\(^{-1}\). Before threshing of the harvested crop from net, the sun dried whole plant samples (biological yield) were weighed. The seed oil content of all samples was determined by nuclear magnetic resonance spectrometer (NMR) (Robertson and Morrison, 1979).

RESULTS AND DISCUSSIONS

Total biomass and its partitioning: The absolute dry matter accumulation as well as per cent contribution of different plant parts i.e. leaves, stems and siliquae increased with the advancement of crop age except leaves and stems, which declined after 90 and 120 DAS, respectively. The per cent partitioning of dry matter of leaves is highest at 30 DAS and then declined drastically till maturity. The percent contribution of stem is increased upto 90 DAS and then declined till maturity. The decreased weight of vegetative organs after anthesis might be due to contribution of vegetative reserve to final grain yield. The allocation of biomass towards reproductive plant part/sink (siliquae) kept on increasing throughout life cycle of the plant and reached maximum at fully ripened stage (maturity). The percent contribution is observed in absolute terms to the total biomass at all the growth stages. The total dry matter accumulation decreased significantly with delay in sowing dates during both the years at all the growth stages i.e. 30, 90, 120 and at harvest. However, the difference in dry matter accumulation at 60 DAS between October 25 and November 5 was statistically at par with each other (Table 2). The reduction in total dry matter accumulation and its partitioning to various plant parts under delayed sowing could be attributed to earlier sown crop (October 15 and 25) faced favorable soil moisture condition and relatively warmer temperature during vegetative phase and conducive temperature during 50 per cent flowering and pod formation stage, while delayed sown crop (November 5 and 15) faced low temperature at the time of emergence as well as at 50 per cent flowering stage. As result late-sown mustard germinated late and grew slowly during early growth period as a result shortened the reproductive phase and adversely affected the plant growth and development. The early sown crop (October 15 and 25) might be maintained better plant relations which led to higher rate of photosynthesis. This has also increased the cell division and enlargement, which led to higher growth rate. Similar findings were recorded by Kumar et al., (2013).

The dry matter partitioning of leaf at 30 DAS increased significantly with an increase in N levels, it was increased in favour of leaves with each level increase in nitrogen, although the partitioning in absolute weight and per cent contribution of leaves at 80 and 100 kg N/ha was statistically at par. In general, the increased level of nitrogen dose increased the partitioning in favour of leaves at all the growth stages. However, the partitioning in terms of per cent dry matter accumulation in different plant parts did not change much with increased fertilizer dose at all the growth stages during both the years.

The increase in nitrogen dose increased the dry matter accumulation significantly up to 100 kg N/ha at all the growth stages. However, the difference in total dry matter accumulation in 100 kg N/ha was statistically at par with 80 kg N/ha at 60 and 90 DAS (Table 2). Lowest dry matter accumulation and its partitioning was recorded in 0 kg N/ha. This low growth in this treatment may be due to low availability of plant nutrients which are necessary for the normal growth. Nitrogen being the basic constituent of chlorophyll, protein and cellulose required for the process of photosynthesis and tissue formation for proper growth. The growth at higher level of nitrogen application i.e. 100 kg N/ha were increased significantly and it was at par with recommended dose of nitrogen. The results corroborates with the findings of Kumar and Kumar (2008) and Maereka et al., (2007).

Yield attributes and yield: The yield attributes viz., siliquae/plant, seed yield/plant, seed yield, and stover yield decreased significantly with delaying the sowing dates from 25 October in both the years. However, 15 and 25 October sowings were at par. Maximum number of seeds/siliqua was recorded with 15 October which was superior to 5 and 15 November. However, test weight decreased significantly with delay in sowing from 15 October to 15 November. Harvest index could not cross the limit of significance (Table 3). The delay in sowing from October 15 to 25, Oct 15 to Nov 5, Oct 15 to November 15 at ten days interval decreased the seed yield of mustard by 7.2, 24.4, and 39.3 per cent respectively. This might be due to decrease in stover yield by 6.5, 20.4, and 34.7 per cent during both the years. The significant positive association was found between seed yield with dry matter accumulation (r=0.96) and number of siliquae per plant (0.94). The early sown crop, October 15 increased the plant growth in terms of dry matter accumulation along with increased number of siliquae per plant (Table1 and 3) which resulted in more yields. Early sown crop received the optimum environmental conditions required for better crop growth. The reduction in seed yield under delayed sowing could be attributed due to less translocation of photosynthates towards reproductive parts, rapid initiation of inflorescence, flowering, fruiting and maturity, less number of siliquae and less siliqua filling duration because of non-fulfillment of temperature demands under late sowings. High temperature and long day accelerated rapid maturity and lower the seed yield (Mondal et al., 2011).

Nitrogen application had significant effects on yield attributes and yield. Yield attributes viz. siliquae/plant, seeds/siliqua and seed yield/plant were significantly increased with increasing level of N upto 40 kg N/ha( Table 3), which
Table 1: Effect of sowing date and nitrogen levels on dry matter partitioning (g) per plant of Indian mustard at different growth stages (pooled over 2 years)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Date of sowing</th>
<th>30</th>
<th>60</th>
<th>90</th>
<th>120</th>
<th>At harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Stem</td>
<td>Leaf</td>
<td>Stem</td>
<td>Leaf</td>
<td>Siliquae</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30</td>
<td>60</td>
<td>90</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Date of sowing</td>
<td>15 Oct</td>
<td>0.23(18.3)</td>
<td>0.94(81.6)</td>
<td>3.60(44.8)</td>
<td>4.48(55.2)</td>
<td>35.8(67.0)</td>
</tr>
<tr>
<td></td>
<td>25 Oct</td>
<td>0.18(18.2)</td>
<td>0.82(81.8)</td>
<td>3.36(45.0)</td>
<td>4.12(55.0)</td>
<td>32.6(64.4)</td>
</tr>
<tr>
<td></td>
<td>5 Nov</td>
<td>0.15(16.05)</td>
<td>0.73(83.9)</td>
<td>3.24(45.5)</td>
<td>4.04(55.5)</td>
<td>25.6(60.1)</td>
</tr>
<tr>
<td></td>
<td>15 Nov</td>
<td>0.11(13.5)</td>
<td>0.63(86.5)</td>
<td>2.79(42.4)</td>
<td>3.79(57.5)</td>
<td>22.5(58.1)</td>
</tr>
<tr>
<td>CD (P=0.05)</td>
<td></td>
<td>0.02</td>
<td>0.03</td>
<td>0.12</td>
<td>0.2</td>
<td>0.92</td>
</tr>
<tr>
<td>Nitrogen levels ( N kg/ha)</td>
<td>0 kg</td>
<td>0.11(14.4)</td>
<td>0.61(86.1)</td>
<td>2.62(44.2)</td>
<td>3.26(56.3)</td>
<td>22.4(58.7)</td>
</tr>
<tr>
<td></td>
<td>40 kg</td>
<td>0.16(17.5)</td>
<td>0.72(83.2)</td>
<td>3.02(42.2)</td>
<td>4.15(58.1)</td>
<td>28.95(63.6)</td>
</tr>
<tr>
<td></td>
<td>60 kg</td>
<td>0.17(17.6)</td>
<td>0.77(82.0)</td>
<td>3.36(44.0)</td>
<td>4.32(56.2)</td>
<td>30.25(63.7)</td>
</tr>
<tr>
<td></td>
<td>80 kg</td>
<td>0.18(16.9)</td>
<td>0.87(83.0)</td>
<td>3.41(45.0)</td>
<td>4.38(55.7)</td>
<td>31.7(63.4)</td>
</tr>
<tr>
<td></td>
<td>100 kg</td>
<td>0.19(16.3)</td>
<td>0.95(84.1)</td>
<td>3.33(46.2)</td>
<td>4.44(54.4)</td>
<td>31.85(62.9)</td>
</tr>
<tr>
<td>CD (P=0.05)</td>
<td></td>
<td>0.01</td>
<td>0.04</td>
<td>0.22</td>
<td>0.11</td>
<td>0.79</td>
</tr>
</tbody>
</table>

* Values in parenthesis indicate percent contribution of different plant parts to total weight
remained at par with 60, 80 and 100 kg N/ha. Maximum test weight was recorded with 100 kg N/ha which was superior to 40 and 0 kg N/ha. Seed yield increased significantly with increase in doses of nitrogen from 0 to 100 kg N/ha, whereas stover yield increased significantly upto 80 kg N/ha, which remained at par with 100 kg N/ha. The higher seed yield of 115 per cent and stover yield of 31.3 per cent along with the harvest index (49.63 per cent) in 100 kg N/ha over control were because of more availability of nutrients for their growth and development for better yield attributes and yield. Harvest index is the parameter which dependent on seed yield (r= 0.83) and stover yield (r=0.53). This shows that harvest index was more associated with seed yield than stover yield. The harvest index can also be computed from the seed yield with regression equation (SY= -1792+185.2HI, r²=0.70, Fig. 1).

This decline in response of nitrogen at higher doses may be explained with the well established Mitscharlich equation. Singh et al., (2014) and Keivanrad et al., (2012) were also reported similar findings.

**Oil content:** Quality analysis of Indian mustard (Table 3) revealed that sowing on 15 October gave the highest oil content, against the minimum oil content, recorded with 15 November. However, reverse trend was noticed with different levels of nitrogen. The longer duration of reproductive phase under October 15 sowing had a positive influence on the development of seed and therefore, increased oil content (Tobe et al., 2013)

The maximum value of oil content was recorded with 0 kg N/ha (40.2 per cent) beyond which there was no significant increase in oil content. Presence of N compounds in seed oil complicates the procedure of oil extraction and increases the amount of undesirable materials like glucosinolates. The results are in conformity with Mirzashahi et al., (2000).
REFERENCES


Fig 1: Regression line showing the relationship of Harvest index (per cent) with Seed yield (kg/ha)