Effect of irrigation schedule and bio-regulators on yield attributes and yield of mustard [Brassica juncea (L.) Czern & Coss] crop

Ashish Shivran, BJ Patel and Manoj Gora

Abstract
The study was undertaken at Agronomy Instructional Farm, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during Rabi seasons of 2012-13 and 2013-14. The experiment was laid out in split plot design with sixteen treatments and four replications. The treatments were different levels of irrigation and different bio-regulators. It is revealed from the data that the number of silique per plant, the number of seeds per silique, 1000-seed weight (g), Seed yield per plant (g), Seed Yield (kg ha\(^{-1}\)), Stover Yield (kg ha\(^{-1}\)), Biological Yield (kg ha\(^{-1}\)) were significantly influenced by irrigation schedules and bio-regulators, which is highest in I\(_5\): CPE 0.9 and C\(_1\) (Benzyadenine 45 ppm) respectively. It is also found that Harvest index was significantly influenced by irrigation schedule and significantly not influenced by bio-regulators.

Keywords: Irrigation Schedule, Bio-regulators, Benzyladenine45 ppm, IW: CPE.

Introduction
India is one of the leading oilseed producing countries in the world. Oilseeds form the second largest agricultural commodity after cereals. Mustard [Brassica juncea (L.) Czern & Coss] is the second important edible oilseed crop after groundnut, meeting the fat requirement of about 50 per cent population in all the northern states. The mustard oil cake contains 5.1 per cent N, 1.8 per cent P\(_2\)O\(_5\) and 1.2 per cent K\(_2\)O (Anon, 2006). It is a rich source of protein (40%). But its use is limited due to the anti-nutritional factor glucosinolate. Due to scanty winter rainfall, brassica show favourable response to irrigation. About 60 per cent of the total area under brassica is under irrigation. Mustard has low water requirement ranges from 450 - 600 mm. Water is essential for this crop but poses serious problems too. This crop is more sensitive to water fluctuation and more or less at critical growth stages, which adversely influences the yield. To alleviate the injurious effects of moisture stress, bio-regulator may be used to modify the various metabolic and physiological processes inside the plant system for increasing the crop yield. The effects of the application of benzyladenine indicated that it was antagonistic to moisture stress (Virk et al., 1985)\(^{[21]}\). At the concentration of 1-2x10\(^{-4}\) M. it retarded senescence, thus increased flower longevity (Halmann, 1990)\(^{[3]}\). Thiourea is a sulphydryl compound containing one SH group (Jocelyn, 1972). The SH group has been implicated in photosynthates translocation in crop plants (Giaquinta, 1976)\(^{[4]}\). It is directly involved in light activation of photosynthetic enzymes (Salisbury and Ross, 1986)\(^{[15]}\).

Materials and Method
A field experiment was laid out in Plot B-9 at the same site during rabi season of the year 2012-13 and 2013-14 at the Agronomy Instructional Farm, S.D. Agricultural University, Sardarkrushinagar. Geographically Sardar-kushinagar is situated at 24°19’ North altitude and 72°19’ East longitude with an elevation of 154.32 m above mean sea level. The climate of the region is sub-tropical. The monsoons are warm and moderately humid. The mustard cultivar Gujarat Dantiwada Mustard-4 (GDM-4) was selected for the present investigation, the field experiment was conducted with four levels of irrigation and four levels of bio-regulators comprising 16 treatment combinations in split plot design with four replications. The details of the treatments are as under:

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Main plot: IW:CPE Ratio (I)

\[ I \leq 0.5 \]
\[ I = 0.7 \]
\[ I = 0.9 \]
\[ I = \text{Four irrigations at bud initiation, branching, pre flowering} \]
\[ \text{& pod development stage} \]

**Sub-plot: Bio-regulators (C)**

\( C_0 = \text{Control (water spray)} \)
\( C_1 = \text{Benzyladenine (45 ppm)} \)
\( C_2 = \text{Thiourea (1000 ppm)} \)
\( C_3 = \text{KCl (1000 ppm)} \)

The standard procedure as described by Gomez and Gomez (1984) were employed for analysis of variance for split plot design (SPD) in order to test the significance of the experimental results. Pooled analysis of the data was carried out to establish the trend of treatments applied. Wherever “F” test was found significant at 5 and per cent level of significance, the critical difference (C.D.) for treatment means were worked out. In order to establish inter-relationship between seed yield and various growth and yield components, correlations co-efficients were computed as per the statistical procedure given by Panse and Sukhatme (1985).

**Results and Discussion**

**Effect of irrigation schedule**

Table 2 show that the number of silique per plant and the number of seeds per silique were significantly influenced by irrigation schedules in pooled results. The number of siliques per plant and the number of seeds per silique were observed under treatment I\(_1\) (IW:CPE 0.9), remained at par with treatment I\(_1\) (IW:CPE 0.7) and produced significantly higher number of siliques per plant and the number of seeds per silique than treatments I\(_0\) (IW:CPE 0.5) and I\(_1\) (Four irrigations at bud initiation, branching, pre flowering and pod development stage) in pooled results (Table 2). The test weight and seed yield per plant were significantly influenced by irrigation schedules in pooled results. The treatment I\(_1\) (0.9 IW:CPE) produced significantly the highest seed yield and stover yield during both the years and also in pooled analysis over treatments I\(_0\) (0.5 IW:CPE) and I\(_1\) (Four irrigations at bud initiation, branching, pre flowering and pod development stages).

The biological yield and harvest index were significantly influenced by irrigation schedules in pooled results (Table 2). The treatment I\(_2\) (0.9 IW:CPE) gave significantly the highest biological yield and harvest index in pooled analysis over treatments I\(_0\) (0.5 IW:CPE) and I\(_1\) (Four irrigations at bud initiation, branching, pre flowering and pod development stage). Treatment I\(_1\) (0.7 IW:CPE) remained at par with I\(_1\) (0.9 IW:CPE) in pooled results.

Salter and Goode (1967) while summarizing the effect of water deficit at different stages of crop growth concluded that there is considerable evidence that most indeterminate crop all especially sensitive to water deficit stresses during flowering and to losses extent during fruit and seed development. Kumawat et al. (1997) [8] and Salvi (1997) [17] also concluded that seed yield was significantly reduced with water stress at pre-flowering stage.

Reproduction and seed development are seriously affected by moisture deficit stress in mustard. The most critical period with respect to water stress begins with the appearance of pollen mother cell, which decides the number of seed setting in silique. The damage occurred at reproductive stage due to water deficiency may not recover with supply of water at another stage of crop. In fact seed yield is the function of several yield components, which are dependent on complementing interaction between vegetative and reproductive growth of crop. Results of present study corroborate with the findings of Mahavar (1989) [9], Tomar et al. (1992) [20], Dobaria and Mehta (1995) [3], Kumawat (1997) [8], Bhatnagar et al. (1997) [12], Maliwal et al. (1998) [10], Mehta (2004) [11] and Meena et al. (2013) [11].

**Effect of Bio-regulators**

Bio-regulators significantly influence maximum number of siliques per plant (293.48 pooled) and number of seeds per silique (12.92) at harvest were recorded with treatment C\(_1\) (Benzyladenine 45 ppm) which was significantly superior over treatment C\(_0\) (Water spray) and C\(_3\) (KCl 1000 ppm) during both the years of the study. However, it remained at par to treatment C\(_2\) (Thiourea 1000 ppm) (Table 2). The test weight (5.30 g) and seed yield per plant (20.00 g) were recorded with the treatment C\(_1\) (Benzyladenine 45 ppm) which was significantly superior over treatments C\(_0\) (Control) and C\(_3\) (KCl 1000 ppm) during both the years of the study, however, it remained at par with treatment C\(_3\) (Thiourea 1000 ppm) during both the years of the study (Table 2). However, it remained at par with treatment C\(_2\) (Thiourea 1000 ppm) during the course of study. Maximum stover yield (5630 kg ha\(^{-1}\) pooled) was recorded with treatment C\(_1\) (Benzyladenine 45 ppm) which was significantly superior over treatments C\(_0\) (Water spray) and C\(_3\) (KCl 1000 ppm) during both the years of the study, but, it remained at par with treatment C\(_2\) (Thiourea 1000 ppm) having stover yield of 5379 kg ha\(^{-1}\) (Pooled) during the course of study (Table 2).

Table 2 also show that the maximum biological yield at harvest was recorded with treatment C\(_1\) (Benzyladenine 45 ppm) which was significantly superior over treatments C\(_0\)
(Water spray) and C₃ (KCl 1000 ppm) during both the years of the study, however, it remained at par with treatment C₂ (Thiourea 1000 ppm) during the course of study. The bio-regulators did not exert significant influence on the harvest index in the pooled data.

Significant increase in seed yield of mustard could be ascribed to cumulative effect of yield components viz., number of siliquae per plant, number of seeds per siliqua and test weight which increased seed yield per plant and ultimately led to greater seed production per unit area. These results are cognizance with the findings of Williams and Cartwright (1980) [12], Crosby et al. (1981) [3], Krishnan et al. (1999) [5], Samuel et al. (2000) [18] and Pandey et al. (2001) who reported higher yield attributes and yield with the foliar application of benzyladine in different crops.

The significant improvement in reproductive efficiency of crop, suggest profound influence of thiourea in efficient translocation of photosynthates towards sink resulting in increased number of siliquae per plant, number of seeds per siliqua and test weight. Further, improvement in test weight point out towards the capacity of developing seeds to accept carbohydrates under thiourea treatment. These results are in close conformity to the finding of Sahu and Solanki (1991) [14] who reported higher maize productivity probably on account of increased photosynthates transport as evident by improved dry matter partitioning with thiourea. These improved yield attributes cumulatively led to increased seed yield of treated plants. Similar, results were reported by Salvi (1997) [17], Sher Singh and Rathore (2001) [19] and Mehta and Sharma (2002) [13]. Improved vegetative growth, photosynthetic efficiency and translocation, delayed leaf ageing significantly account for increased stover yield of mustard. These findings on effect of thiourea on stover and biological yields are in agreement with Mehta (2004) [12] and Jat (2007) [12]. Since seed yield is a product of various yield components, the improvement in number of siliquae per plant, number of seeds per siliqua, seed weight per plant and test weight under these bio-regulators could be ascribed for higher seed yield over control. Significant enhancement in stover yield under thiourea seems to be due to their direct impact on dry matter accumulation by virtue of increase in nutrient uptake and photosynthetic efficiency and indirectly by increased plant height.

Further, significant increase in oil production due to foliar application of thiourea over control could be ascribed to significant increase in oil content as well as seed yield. Marked improvement in oil yield due to application of thiourea is in close agreement with the work of Mahavar (1989) [9] and Mehta (2004) [12].

**Table 2: Effect of Irrigation Schedule and Bio-regulators on Yield Attributes and Seed Weight**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Number of siliquae per plant</th>
<th>Number of seeds per siliqua</th>
<th>1000-seed weight (g)</th>
<th>Seed yield per plant (g)</th>
<th>Seed Yield (kg ha⁻¹)</th>
<th>Stover Yield (kg ha⁻¹)</th>
<th>Biological Yield (kg ha⁻¹)</th>
<th>HI (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>I₀</td>
<td>241</td>
<td>10.62</td>
<td>4.35</td>
<td>11.98</td>
<td>1615</td>
<td>4616</td>
<td>6231</td>
<td>24.95</td>
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<tr>
<td>I₁</td>
<td>293</td>
<td>12.90</td>
<td>5.29</td>
<td>21.77</td>
<td>2778</td>
<td>5629</td>
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<td>31.85</td>
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<td>13.14</td>
<td>5.39</td>
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<td>2933</td>
<td>5724</td>
<td>8657</td>
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<tr>
<td>I₃</td>
<td>244</td>
<td>10.74</td>
<td>4.40</td>
<td>13.18</td>
<td>1978</td>
<td>4682</td>
<td>6481</td>
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<tr>
<td>C.D. at 5 %</td>
<td>20</td>
<td>0.89</td>
<td>0.37</td>
<td>1.58</td>
<td>235.38</td>
<td>382.36</td>
<td>574.29</td>
<td>2.25</td>
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<tr>
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<td>10.31</td>
<td>4.22</td>
<td>14.58</td>
<td>1784</td>
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<td>6290</td>
<td>27.58</td>
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<tr>
<td>C₁</td>
<td>293</td>
<td>12.92</td>
<td>5.30</td>
<td>20.00</td>
<td>2657</td>
<td>5630</td>
<td>8287</td>
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<td>12.45</td>
<td>5.10</td>
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<td>4.81</td>
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<td>5136</td>
<td>7382</td>
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<tr>
<td>C.D. at 5 %</td>
<td>13</td>
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<td>0.25</td>
<td>1.11</td>
<td>302.46</td>
<td>263.35</td>
<td>357.05</td>
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References


