Effect of scheduling irrigation on mustard (*Brassica juncea* L.) in central plain zone of U.P.

Sanjiv Kumar¹, Ripudaman Singh² and Awadhesh Kumar³

¹²Department of Agronomy, ³Department of Soil Conservation and Water Management, C.S. A. University of Agriculture and Technology, Kanpur-208002

*e-mail: rsycsa@gmail.com*

(Received: December 08, 2013; Revised received: March 29, 2014; Accepted: March 30, 2014)

**Abstract:** A field experiment was conducted during the winter (*Rabi*) seasons of 2007-08, 2008-09 and 2009-10 on sandy loam soil of Students Instructional Farm of C.S. Azad University of Agriculture & Technology, Kanpur (U.P.) to study the response of irrigation scheduling on Indian mustard (*Brassica juncea* L) (Zern & Coss). The results of the study revealed that seed yield of mustard was maximum with three irrigation levels (IB+IF+SD) which was higher by 4.82, 7.04, 13.62, 21.54, 25.11, 42.27 and 63.61 per cent than IB+IF, IF+ISD, IB, IF, ISD and I treatments. The water use efficiency was calculated highest (10.75 kg ha⁻¹) in treatment IB+IF, followed by IB+SD, IB, IF, IO, IF+SD, ISD and IB+IF+SD treatments and highest net profit was achieved Rs 23840 ha⁻¹ with the IB+IF+SD treatment.

**Key words:** Irrigation scheduling, water use efficiency, siliqua development, crop scheduling

---

**Introduction**

Oilseeds play an important role in Indian agriculture and industries. Besides immense value in our diet, oils and fats are used in cosmetics, soaps, lubricants, paints and varnish industries and their medicinal and Therapeutic value. India is endowed with a wealth of vegetable oil resources in the form of cultivated annuals and perennials. Among the major oilseeds crops Indian mustard after groundnut, occupies a permanent position in the national edible oil scene.

The country shares about 23% of the world production of rapeseed and mustard. These crops are of particular significance of Rajasthan and U.P., which share about 80 percent of area and production of entire country. Despite spectacular increase in mustard production in the country as well as in the state of Rajasthan and U.P., the problem of low producing continues to be a worrying issue for agriculture planners and researchers. At national level, the average yield as high as 23.66, 15.14, 14.48 and 13.04 qha⁻¹ are being achieved in Europe, U.S.A., Canada and china, respectively. Similarly, in the state of Uttar Pradesh the average yield of mustard continues to fluctuate around 12.25 q ha⁻¹ during the past few years. Though mustard is endowed with large potentialities but unfortunately, its production potential has not been fully exploited yet, as reflected from the existing low level of its production.

Among the many reasons of low productivity, the single largest factor responsible for poor yield is that this crop is generally grown under low moisture condition and shows favourable response to irrigation. As per phonological stages, mustard responded favourable due to one irrigation at pre flowering state at Banswara (Rajasthan) two irrigation at flowering and late siliqua formation stage at Pantnagar, two irrigation at branching and silique development at Sriganganagar, three irrigation at vegetative, flowering and silique development at Navasari (Singh 1983; Kumar, 1986; Katole and Sharma 1991; Siag et al. 1993 and Ghatak et al. 1992). The present study on irrigation aspect on alluvial soil of semi arid region of the state aims to find out optimum number of irrigation with right time of its application. Since water is precious commodity and the studies on scheduling of irrigation, water use efficiency (WUE) and consumptive use of water are the direct interest for maximizing crop yield. Indian mustard is an important oil seed crop of central plain zone of Uttar Pradesh. At present very few scientific informations regarding irrigation scheduling in Indian mustard for the zone is available. The majority of the soils of central plain zone of the state are light textured and climatic conditions are different from other Indian mustard growing parts of the state. The irrigation requirement of crop in this zone might be different from other parts of the state. Next for SWCA zone more its information spreading under irrigated condition after since In view of above facts, the present study was under taken:

1) To find out the most effective irrigation schedules for higher productivity.
2) To work out at economic returns of mustard and crop susceptibility factor.

**Materials and Methods**

A field experiment was conducted at Student’s Instructional Farm, C.S. Azad University of Agriculture & Technology, Kanpur (U.P.) during *rabi* seasons of 2007-08, 2008-09 and 2009-10. The soil of
Table 1: Growth parameters, yield attributes of mustard as influenced by irrigation at different stages (mean of 3 years)

| Treatment | No. of leaves (100 DAS) | No. of primary branches | No. of secondary branches | Plant height at harvest (cm) | No. of silique plant<sup>-1</sup> | Length of silique (cm) | No. of seeds silique<sup>-1</sup> | Wt. of seeds plant<sup>-1</sup> (g) | Test wt. plant<sup>-1</sup> (g) | Biological yield (q ha<sup>-1</sup>) | Biological yield (%) | Seed yield (q ha<sup>-1</sup>) | Stover yield (%) | Harvest index |
|-----------|-------------------------|-------------------------|---------------------------|-----------------------------|-----------------------------|------------------------|--------------------------|-----------------------------|-------------------|--------------------------|-----------------|----------------|---------------|
| I<sub>0</sub> | 0.60                    | 5.13                    | 12.90                     | 154                         | 159                         | 3.60                   | 11.4                     | 53.33                      | 11.00             | 33.47                    | 5.7             | 51.05          | 13.0          |
| I<sub>B</sub> | 11.6                    | 5.80                    | 15.40                     | 165                         | 203                         | 4.00                   | 14.3                     | 71.00                      | 14.83             | 44.49                    | 6.1             | 67.66          | 17.50         |
| I<sub>F</sub> | 11.00                   | 5.60                    | 15.20                     | 164                         | 199                         | 3.90                   | 14.0                     | 70.00                      | 14.16             | 42.48                    | 6.1             | 67.00          | 17.00         |
| I<sub>S</sub>D | 9.30                    | 5.30                    | 14.50                     | 160                         | 185                         | 3.86                   | 13.30                    | 68.66                      | 13.00             | 39.00                    | 6.0             | 57.10          | 14.95         |
| I<sub>B</sub>+I<sub>F</sub> | 14.00                   | 6.50                    | 16.00                     | 170                         | 219                         | 4.23                   | 15.0                     | 77.66                      | 19.66             | 58.98                    | 6.2             | 78.91          | 20.29         |
| I<sub>B</sub>+I<sub>S</sub>D | 13.30                   | 6.30                    | 15.80                     | 167                         | 213                         | 4.13                   | 14.7                     | 75.00                      | 16.33             | 48.90                    | 6.1             | 77.61          | 19.67         |
| I<sub>F</sub>+I<sub>S</sub>D | 12.30                   | 6.20                    | 15.70                     | 166                         | 211                         | 4.03                   | 14.6                     | 72.33                      | 15.66             | 46.98                    | 6.1             | 74.32          | 18.77         |
| I<sub>B</sub>+I<sub>F</sub>+I<sub>S</sub>D | 15.30                   | 7.00                    | 16.50                     | 173                         | 221                         | 4.43                   | 15.7                     | 86.66                      | 23.50             | 71.50                    | 6.3             | 81.46          | 21.27         |
| CD at 5% | 2.76                    | 0.67                    | 1.23                      | 5.84                        | 18.8                        | 0.37                   | 0.62                     | 9.6                         | 2.42              | 2.79                     | NS              | 4.68           | 2.15          |

Table 2: Crop susceptibility factor, water use and economics of mustard as influenced by irrigation at different treatments

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Susceptibility factor</th>
<th>Consumptive use (cm)</th>
<th>Water use efficiency kg ha&lt;sup&gt;-1&lt;/sup&gt; (mm)</th>
<th>Gross return Rs. ha&lt;sup&gt;-1&lt;/sup&gt;</th>
<th>Net return Rs. ha&lt;sup&gt;-1&lt;/sup&gt;</th>
<th>B:C ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>I&lt;sub&gt;0&lt;/sub&gt;</td>
<td>0.39</td>
<td>12.40</td>
<td>10.48</td>
<td>26000</td>
<td>8800</td>
<td>0.50</td>
</tr>
<tr>
<td>I&lt;sub&gt;B&lt;/sub&gt;</td>
<td>0.18</td>
<td>17.06</td>
<td>10.66</td>
<td>35000</td>
<td>17300</td>
<td>0.97</td>
</tr>
<tr>
<td>I&lt;sub&gt;F&lt;/sub&gt;</td>
<td>0.2</td>
<td>16.00</td>
<td>10.62</td>
<td>34000</td>
<td>16300</td>
<td>0.91</td>
</tr>
<tr>
<td>I&lt;sub&gt;S&lt;/sub&gt;D</td>
<td>0.29</td>
<td>15.50</td>
<td>9.67</td>
<td>29900</td>
<td>12200</td>
<td>0.68</td>
</tr>
<tr>
<td>I&lt;sub&gt;B&lt;/sub&gt;+I&lt;sub&gt;F&lt;/sub&gt;</td>
<td>0.04</td>
<td>18.86</td>
<td>10.75</td>
<td>40980</td>
<td>22380</td>
<td>1.22</td>
</tr>
<tr>
<td>I&lt;sub&gt;B&lt;/sub&gt;+I&lt;sub&gt;S&lt;/sub&gt;D</td>
<td>0.06</td>
<td>18.80</td>
<td>10.67</td>
<td>39740</td>
<td>21540</td>
<td>1.18</td>
</tr>
<tr>
<td>I&lt;sub&gt;F&lt;/sub&gt;+I&lt;sub&gt;S&lt;/sub&gt;D</td>
<td>0.12</td>
<td>18.40</td>
<td>10.19</td>
<td>37440</td>
<td>19240</td>
<td>1.05</td>
</tr>
<tr>
<td>I&lt;sub&gt;B&lt;/sub&gt;+I&lt;sub&gt;F&lt;/sub&gt;+I&lt;sub&gt;S&lt;/sub&gt;D</td>
<td>-</td>
<td>1.02</td>
<td>0.51</td>
<td>933.82</td>
<td>698.632</td>
<td>0.70</td>
</tr>
<tr>
<td>SE(d.)</td>
<td>-</td>
<td>2.20</td>
<td>1.11</td>
<td>2002.84</td>
<td>1498.42</td>
<td>0.15</td>
</tr>
</tbody>
</table>
The growth parameters viz. plant height, th th
were observed in T treatment (IB+IF+SD) and lowest value of these growth parameters
branches + secondary branches plant (IB+IF-SD) significantly increased the plant height. Primary and
of three irrigation at branching. Flowering and siliqua development
numbers of leaves, branches plant (IB+SD), T siliqua development stage (100 DAS) (ISD), T s irrigation at initiation of branching &
flowering stages (IF+IF), T siliqua development stages (IF+ISD), T s irrigation at flowering & siliqua development stages (IF+ISD).
Effect of yield attributes and yield: The yield components viz., numbers of plant , length of siliqua, numbers of seeds siliqua ,
weight of siliqua plant , weight of seed plant , test weight, biological yield, seed yield, straw yield, and harvest index were significantly
increased in general application of three irrigation (IB+IF+ISD) significantly increased on the yield attributing characters overs the
IB+IF, IB+SD, IF+SD, IB, IF, ISD and T s (control). Treatment therefore
the yield attributing characters were not fully developed due to some stress in T, IB, IF, ISD, IB, IF, IB, IF, ISD and IF+ISD,
treatments as optimum moisture regime through out the growth and
development stages is very important for the balanced metabolic
activities of the plants. Which in turn might resulted in increased
growth of the plants yield attributing characters, Surajbhan and
Khan (1982), Samui et al. (1986) and Singh and Verma (1990).
Application of three irrigation (IB+IF+ISD) produced maximum biological yield, seed yield, stover yield and harvest
index. This might be due to higher photosynthesis and translocation of assimilates towards reproductive structure owing to sufficient soil
moisture. Increased moisture in soil might have increase the yield
significantly. The highly significant positive correlation existing
between seed yield and yield attributes. Singh et al. (1990), Kantwa

The stover yield significantly also significantly increased with the application of three irrigation (IB+IF+ISD) over
IB+IF,IB+SD,IB,IF,IF+SD and 10 treatments. This might be due to
increased availability of water at the critical growth stages of crop,
which resulted in enhanced vegetative growth. Singh & Verma
(1990), Kantwa (2000). The increase in harvest index due to
increased numbers of irrigation might be the result of increased sink

Consumptive use and waters use efficiency and susceptibility factors: The consumptive use of waters increased significantly
with increasing numbers of irrigation up three (IB+F+ISD) where
as waters use efficiency was significantly higher with IB+F over
IB+F+SD treatment. The increase in evapotranspiration and
infiltration losses due to more water application might be owing to
increasing numbers of irrigation resulted in to higher consumptive
use. Probably the increase in seed yield was more as compared to
amount of waters used for total biomass production which might
have increased water use efficiency under two irrigation as compared
to three irrigation. Frequent irrigation though some times necessary
for yield maximization, usually lowers the waters use efficiency but
increase the consumptive use. Yadav et al. (1999), Hussain (1999),
and Das and Ray (2003). The data revealed at three irrigation
(IB+IF+ISD) the crop faced no moisture stress and showed zero

Results and Discussion
Effect on growth: The growth parameters viz. plant height, numbers of leaves, branches plant (Primary and secondary
branches plant) it is evident from result that in general application of three irrigation at branching. Flowering and siliqua development
(IB+IF-SD) significantly increased the plant height. Primary and secondary branches plant and numbers of leaves plant over
IB+IF, IB+SD, IF+SD, IB, IF, ISD and IO (control) treatment. (Table-1) Significantly higher plant height, numbers of leaves plant primary
branches + secondary branches plant were observed under T s treatment (IB+IF+SD) and lowest value of these growth parameters
were observed in T, (I, control treatment). Three irrigation applied
at different crop growth stages had one, two and three additional
irrigation as compared to IB+IF, IB+SD, IF+SD, IB, IF, ISD and IO
respectively. It is well established fact that where sufficient soil
moisture for continued growth is maintained by providing irrigation,
it leads to greater development of grain tissue area and result in a
higher photosynthetic accumulation. Thus as result plant growth
improves to a higher accumulation of dry matters. Lal et al. (2000).

Effect of scheduling irrigation on mustard experimental field was sandy loam in texture having sand (0.84%),

fine sand (44%), silt (26.50%), clay (28.66%) and low in organic carbon (0.42%), low in available N (126.8 kg ha ), medium in
available P (13.5 kg ha ), medium in available K (176.0 kg ha ), neutral in reaction (pH 7.4), field capacity (20.1%), permanent
wilting point (PWP. 5.2%) and electrical conductivity (0.22 dsm ). The experiment was laid out in the randomized block design with
eight treatments and replicated three times. The treatments are T [no irrigation (control)], T [at initiation of branching [40 DAS (IB)],
T at flowering stage (60DAS) (IF)], T at siliqua development stage (100 DAS) (ISD)], T irrigation at initiation of branching &
flowering stages (IF+IF), T irrigation at initiation of branching & siliqua development stages (IB+ISD)], T irrigation at flowering &
siliqua development stages (IF+ISD)], T irrigation at at siliqua development stages (IB+F+IS)]. The variety “Urvasi” (RK 9501) of mustard was sown on flat bed with 45cm x 15cm. planting geometry on 5 Nov, 2007, 8 Nov, 2008
and 4 Nov. 2009 after giving pre sowing irrigation. The recommended dose of ferti1izer @ 90, 60, 40 kg NPK ha was affected of the Nitrogen was applied at the time of sowing, while rest half doses of nitrogen were applied at optimum soil moisture after first irrigation through area and full doses of phosphorus and potash were applied as basal before final land preparation and sowing. The crop was irrigated as per treatment schedules. First irrigation was given at initiation of branching (40 DAS), second at flowering (60 DAS) and third at siliqua development stage (100 DAS), and check basin method of surface irrigation was used for application of irrigation water. The crop was harvested on 18th, 21st April and 14th April during 2008, 2009 and 2010, respectively. 2010. Required plant
protection measures were taken as and when found necessary. Soil moisture was determined thermo gravimetrically up to 90 cm.
profile at sowing before and after each irrigation and at harvest. Profile moisture use was calculated based on depletion of soil moisture
(Mishra & Ahmad, 1987). Consumptive use of water computed suggested by Dastane (1972) and water use efficiency (WUE) was
computed according to the Viets (1961). Crop susceptibility factor is
the susceptibility of crop to water deficit and it was calculated as the fractional yield reduction from moisture treatment i.e.

\[ \text{CSI} = \frac{X - X_{0}}{X} \]

Where X - is the yield from no stress treatment; X i - yield from the treatment that was starved during the growth stage.

Research in Environment and Life Sciences May, 2014
sustainability factor but the treatment T1 (IO control) showed highest (0.39) value of sustainability factor (Table 2).

Economics: Economic analysis of data (Table 3) showed that irrigation scheduling at IB+IF+ISD was effective than other treatments of irrigation schedules in realizing higher net returns and benefit-cost ratio 1.22.

Net returns and B;C ratio were maximum with application of irrigation at IB+IF+ISD. The highest net returns and benefit cost ratio under this treatment was showing to more seed yield as compared to other irrigation treatments. Sharma (1944) were also observed the same results.

It was concluded from the 3 years study that providing three irrigation at IB+IF+ISD to mustard is promising for higher productivity, profitability and obtaining also higher water use efficiency. Based upon the result of present investigation the following conclusions may be drawn:

1. Based upon the results of the present investigation it can be concluded that from an over all consideration of seed yield, water use, water use efficiency and economics it is advised to apply irrigate to mustard (Brassica juncea L.) at branching, flowering and siliuca development for getting maximum yield.
2. If two irrigation are available, they should be applied at branching and flowering stages of mustard higher yields and water use efficiency.
3. The highest net return (Rs ha⁻¹) can be obtained with irrigation the mustard at branching flowering and siliuca stages.

References