AGRO METEOROLOGICAL INDICES FOR BROWN SARSON (BRASSICA RAPA L.) SOWN UNDER DIFFERENT DATES OF SOWING IN TEMPERATE REGION OF KASHMIR

SABIA AKHTER, LAL SINGH, AMAL SAXENA, RUBIA RASOOL, RUKHSANA JAN AND IRFANA SHOWQI

1Division of Agronomy, Sheri-Kashmir University of Agricultural Sciences and Technology of Kashmir - 190 025
2Division of Environmental Sciences, Sheri-Kashmir University of Agricultural Sciences and Technology of Kashmir - 190 025
e-mail: sabiaakhter77@gmail.com

ABSTRACT

A field experiment was conducted at KVK, Gandarbal, Shuhama, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir during 2011-12 to study the agro meteorological indices for brown saron (Brassica rapa L.) sown under different dates of sowing in temperate region of Kashmir. The experiment was laid out in split plot design, consisted of three dates of sowing (1st October, 15th October, 30th October) in main plot and four varieties (KOS-1, Gulchehin, Shalimar Brown Sarson-1 and P-3) in sub plot replicated four times. The objective of this experiment was to study the thermal regime of brown saron crop and its impact on phenology and yield. The results revealed that days taken to physiological maturity and yield reduced significantly with delayed sowing. 1st October sown crop had significantly higher yield, total thermal units (ºC day) and the thermal use efficiency (kg ha⁻¹/ºC day) than 15th October and 30th October sown crop while the thermal units were more or less similar in all the varieties irrespective of the date of sowing but thermal use efficiency was more with variety P-3 as compared to Shalimar Brown Sarson-1, KOS-1 and Gulchehin.

INTRODUCTION

Rapeseed and mustard are the major oilseed crops, traditionally grown everywhere, in the country due to their high adaptability in conventional farming systems. Rapeseed-mustard shares about 28 per cent of total oilseed production in India, with area of 6.32m ha and production of 6.12mt (Verma and Baigh, 2012). Brown saron (Brassica rapa L.) is the only crop of the rapeseed-mustard group which fits well in the oilseed - paddy rotation prevailing in the valley of Kashmir and is the dominant rabi crop of the Kashmir valley. In Jammu and Kashmir the productivity of oilseed (brown saron) is very low (6-8 q ha⁻¹) (ESJK, 2010-11). Of the several factors responsible for its low productivity, improper date of sowing, uneven topography of the valley and the farmers mainly grow the traditional varieties and land races which are not only low yielding but highly susceptible to biotic and abiotic stresses.

Time of sowing is very important for mustard production (Mondal et al., 1999) as optimum sowing time plays an important role to fully exploit the genetic potential of a variety as it provides optimum growth conditions such as temperature, light, humidity and rainfall (Iraddi, 2008). Sowing at proper time allows sufficient growth and development of a crop to obtain a satisfactory yield and different sowing dates provide variable environmental conditions within the same location for growth and development of crop and yield stability (Pandey et al., 1981). There is the variable response of rapeseed-mustard to different dates of sowing (Kumar et al., 2007). Prevailing weather conditions during the whole crop growing season have direct bearing upon the phenological events of the crop which ultimately affect the crop yield. The concept of thermal and radiation use efficiency of different varieties may be useful to find out the proper recommendation for a specific area on the basis of their local weather condition. Temperature and light play a key role in influencing crop production (Meena et al., 2013). Canola growth from seedling emergence to blooming is controlled by photo-thermal factors and from blooming to maturity by temperature (Nanda et al., 1996), so that each 1ºC increase in temperature brings about 4.6 days shortening of the periods (Nanda et al., 1994). The effect of temperature, determining the phenological behaviour during crop growth period, can be assessed by accumulated heat units (Gouri et al., 2005). The concept of heat units has been applied to correlate the phenological development of different crops to predict grain yield and physiological maturity of the crop (Swan et al., 1989). Temperature based agro meteorological indices such as Growing degree days (GDD), Heliothermal units (HTU) and Photo thermal units are based on the concept that real time to attain the phenological stage is linearly related to temperature in the range between base...
temperature and optimum temperature (Monteith, 1981). From the above points it is clear that varieties and date of sowing play a great role in the production of the rapeseed and mustard. Keeping in view of these facts, the present investigation was carried out to study the effect of date of sowing and varieties of brown sarson (*Brassica rapa* L.) on agro meteorological indices under temperate condition.

**MATERIALS AND METHODS**

A field experiment was conducted at KVK, Gandarbal, Shuhama, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir during *rabi* season 2011-12 situated at 34° 11’ N latitude and 74° 49’ E longitude at an altitude of 1639.5 meters above mean sea level. Experiment was laid out in split plot design and consisted of three dates of sowing, viz., 1st October, 15th October and 30th October in main plot and four varieties, viz., KOS-1, Gulchein, Shalimar Brown Sarson-1 and P-3 in sub plots replicated four times. The weather data were recorded at Agromet observatory of SKUAST-K, Shalimar Srinager and with the help of this data GDD, PTU, HTU were calculated at different phenological stages. Growing degree days at different phenological stages of brown sarson were calculated, using Wall et al. (1993) formula given below.

\[
GDD = \frac{(T_{\text{Max}} + T_{\text{Min}})}{2} - T_b
\]

- **T**\(_{\text{Max}}\) = maximum of temperature of the day
- **T**\(_{\text{Min}}\) = minimum of temperature of the day
- **T**\(_b\) = base temperature of brown sarson, a temperature below which no development occurs for a given plant species. At temperatures above the minimum, plant development and growth rate increases as temperature increases up to optimum. While there is only limited plant growth at temperatures slightly above freezing but germination and seedling growth do occur at temperatures between 0 and 5°C. While the majority of previous research used a canola base temperature of 5°C, but a more accurate base temperature is from 0 to 5°C. For a cool season crop like canola grown in western Canada, 0°C is often the best base temperature for predicting development (Canola Council of Canada, 2012) and as the base temperature varies with stage and seasonal conditions of the crop so GDD was modified based on the prevailing weather conditions during crop growth period in accordance with the GDD/TT expression given below (Wang 1960).

**Modification of GDD/TT expression**

**Method I**

When \(T_{\text{av}} < T_{\text{base}}\), then \(T_{\text{av}} = T_{\text{base}}\); when \(T_{\text{av}} > T_{\text{UT}}\), then \(T_{\text{av}} = T_{\text{UT}}\)

**Method II**

when \(T_{\text{max}} \leq T_{\text{base}} < T_{\text{min}}\), then \(T_{\text{max}} = T_{\text{base}}\); \(T_{\text{max}} > T_{\text{min}}\)

\[T_{\text{av}} = \text{Average temperature}\ \left[\frac{T_{\text{Max}} + T_{\text{Min}}}{2}\right]\]

- **T**\(_{\text{base}}\) = Base temperature
- **T**\(_{\text{max}}\) = Maximum temperature
- **T**\(_{\text{min}}\) = Minimum temperature
- **T**\(_{\text{UT}}\) = Upper threshold temperature

So, 5°C, 0°C and 5°C was taken as base temperatures for brown sarson. Base temperature of 5°C was taken from sowing to rosette stage; 0°C as base temperature from rosette stage to flower bud initiation stage; 5°C as base temperature from flower bud initiation stage to harvest.

The helio-thermal units (HTU), the product of GDD and corresponding actual sunshine hours for that day were computed on daily basis and summed up.

Accumulated HTU = \(GDD \times \text{Actual sunshine hours}\)

Photothermal units (PTU), the product of GDD and corresponding day length for that day were computed on daily basis and summed up:

Accumulated PTU = \(GDD \times \left(\frac{\text{length of the day/night}}{24}\right)\)

Growing degree-days, helio thermal units and photo thermal units were accumulated from the date of sowing to a particular date of phenophase to give accumulated indices

Heat use efficiency (HUE), Photothermal use efficiency (PTUE), Heliothermal use efficiency (HTUE) for yield was computed using the formulae:

\[
\text{HUE (kg ha}^{-1}/°C \text{day)} = \frac{\text{seed yield}}{\text{Accumulated heat units}}
\]

\[
\text{PTUE (kg ha}^{-1}/°C \text{day)} = \frac{\text{seed yield}}{\text{APTU}}
\]

\[
\text{HTUE (kg ha}^{-1}/°C \text{day)} = \frac{\text{seed yield}}{\text{AHTU}}
\]

**RESULTS AND DISCUSSION**

**Phenology**

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Emergence</th>
<th>Rosette stage initiation</th>
<th>Flower bud</th>
<th>Flower Initiation</th>
<th>80% plants start flowering</th>
<th>Physiological maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sowing date</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st October</td>
<td>6.4</td>
<td>46.6</td>
<td>131.3</td>
<td>159.8</td>
<td>165.5</td>
<td>225.1</td>
</tr>
<tr>
<td>15th October</td>
<td>7.4</td>
<td>57.06</td>
<td>122.1</td>
<td>156.9</td>
<td>160.4</td>
<td>221.4</td>
</tr>
<tr>
<td>30th October</td>
<td>12.4</td>
<td>67.31</td>
<td>121.5</td>
<td>145.3</td>
<td>150.9</td>
<td>208.7</td>
</tr>
<tr>
<td>Mean ± SE</td>
<td>0.11</td>
<td>0.43</td>
<td>2.0</td>
<td>1.31</td>
<td>1.1</td>
<td>0.80</td>
</tr>
<tr>
<td>CD (p = 0.05)</td>
<td>0.4</td>
<td>1.58</td>
<td>6.7</td>
<td>4.5</td>
<td>3.6</td>
<td>2.7</td>
</tr>
<tr>
<td>Varieties</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KOS-1</td>
<td>8.6</td>
<td>56.41</td>
<td>122.0</td>
<td>153.4</td>
<td>159.0</td>
<td>217.7</td>
</tr>
<tr>
<td>Gulchein</td>
<td>8.5</td>
<td>56.75</td>
<td>125.9</td>
<td>154.1</td>
<td>158.3</td>
<td>219.0</td>
</tr>
<tr>
<td>Shalimar Brown Sarson-1</td>
<td>8.5</td>
<td>57.66</td>
<td>125.5</td>
<td>154.4</td>
<td>159.3</td>
<td>218.6</td>
</tr>
<tr>
<td>P-3</td>
<td>9.1</td>
<td>57.25</td>
<td>127.1</td>
<td>153.6</td>
<td>159.0</td>
<td>218.3</td>
</tr>
<tr>
<td>Mean ± SE</td>
<td>0.18</td>
<td>0.61</td>
<td>1.8</td>
<td>1.17</td>
<td>1.6</td>
<td>1.9</td>
</tr>
<tr>
<td>CD (p = 0.05)</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>
The early sown (1st October) crop took more number of days for flowering and maturity compared to normal (15th October) and late sowing (30th October). The early, normal and late sown brown sarson matured in 225, 221 and 209 days respectively under temperate conditions of Kashmir valley (Table 1). Late sown crop took more days to complete early stages viz., emergence and rosette stage and it may be attributed to the decrease in mean temperature, while after rosette stage the late sown crop took less number of days to flower bud initiation, flowering and physiological maturity. It may be due to higher temperature after rosette stage in late sown crop which fulfill the requirement of growing degree days and thermal units of crop for achieving different phenological stages in lesser days as compared to early sown crop when day and night temperature was lower at later stages and was in agreement with the findings of Hokmalipour et al. (2011) who reported that early sowing reached to maturity later as compared to delayed sowing dates. There was no significant difference between varieties in days taken to different phenological stages. It may be attributed to their same maturity period. Similar results were obtained by Gunasekera et al. (2001) who found that Oscar and Monty varieties of mustard had no significant difference in days taken to different phenological stages.

Agro meteorological indices
The agro meteorological indices (GDD, HTU and PTU)
accumulated for attaining different phenophases are presented in Tables 2, 3 and 4. The early sown crop required more temperature based agro meteorological indices such as growing degree days (GDD), heliothermal units (HTU) and photothermal units for various phenological stages in comparison with normal and late sown crop and it might be due to availability of longer growth period for early sown crop than delayed sowing, similar results were obtained by Kingra and Kaur (2012) and Tharranum et al. (2009) who observed that earlier sown crop availed higher cumulated heat units at physiological maturity in groundnut and brassica species than delay sowing. Significantly maximum seed yield was obtained with 1st October sowing than 15th and 30th October sowing (Table 5), it might be due to the fact that the early sown crop got longer time period to utilize available resources and favourable temperature at later growth stages while shorter time available for the late sown crop to utilize the available growth factors (light, nutrients, moisture etc.). Similar results were obtained by Dinda et al. (2015) who reported higher seed yield in rapeseed and mustard with early sowing (20th October) than second (5th November) and third sowing (20th November). The higher heat use efficiency, heliothermal use efficiency and photothermal use efficiency were more in early than delay sowing. Significantly maximum seed yield was obtained with 1st October sowing than 15th and 30th October sowing (Table 5), it might be due to the fact that the early sown crop got longer time period to utilize available resources and favourable temperature at later growth stages while shorter time available for the late sown crop to utilize the available growth factors (light, nutrients, moisture etc.). Similar results were obtained by Dinda et al. (2015) who reported higher seed yield in rapeseed and mustard with early sowing (20th October) than second (5th November) and third sowing (20th November). The higher heat use efficiency, heliothermal use efficiency and photothermal use efficiency were more in early sowing than delay sowing. It might be due to the fact that the early sown crop for low rainfall cropping regions of Western Australia M. 2001. Thermal requirement of rabi groundnut in southern Telangana zone of Andhra Pradesh. J. Agrometeorology. 7(1): 90-94. Gunasekera, C. P., Martin, L. D., Walton, G. H. and Siddique, K. H. M. 2001. Indian mustard (Brassica juncea)(L.) - A Promising oil seed crop for low rainfall cropping regions of Western Australia. In: "12th Australian Research Assembly on Brassicas". Hokmalipour, S., Tobe, A., Jafarabad, B. and Darbandi, M. H. 2011. Effect of sowing date on dry matter accumulation trend, yield and some agronomic characteristics in canola (Brassica napus L.) cultivars. World Applied Sci. J. 19(7): 996-1002. Irdadi, V. S. 2008. Response of mustard (Brassica juncea L. Czem and Cosson) Varieties to date of sowing and row spacing in Northern transition zone of Karnataka. Thesis Submitted to the University of Agricultural Sciences, Dhawad in partial fulfilment of the requirements for the Degree of Master of science (Agriculture) in Agronomy. pp. 55-81. Khushu, M. K., Naseer-Ur- Rahman, Singh, M., Tiku, A. K. and Bali A. S. 2008. Thermal time indices for some mustard genotypes in the Jammu region. J. Agrometerol. 10(2): 224-227. Kingra, P. K. and Kaur, P. 2012. Effect of Dates of Sowing on Thermal Utilisation and Heat Use Efficiency of Groundnut Cultivars in Central Punjab. J. Agricultural Physics. 12(1): 54-62. Kumar, G., Adak, T., Chakravarty, N. V. K., Chamola, R., Katiyar, R. K. and Singh, H. B. 2007. Effect of ambient thermal on growth and yield of Brassica cultivars. Brassica. 9(1-4): 47-52. Meena, R. S., Yadav, R. S. and Meena V. S. 2013. Heat unit efficiency of groundnut varieties in scattered planting with various fertility levels. The Bioscan. 8(4): 1189-1192. Mondal, R. I., Biswas, M., Hydar A. M. K. and Akbar, M. A. 1999. Response of rapeseed genotype Dhal to seed rate and seeding date. Bangladesh J. Agricultural Research. 24(1): 83-90. Monteith, J. L. 1981. Climate variation and growth of crops. Quat. J. Royal, Meteorol. Soc. 107: 602-607. Nanda, R. S., Bhargava, C. and Tomar, D. P. S. 1994. Rate and

### Table 5: Yield kg ha⁻¹, total Heat use efficiency (HUE), Photothermal use efficiency (PUE) and Heliothermal use efficiency (HUE) (kg ha⁻¹/°C day) as influenced by date of sowing and varieties

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Seed yield kg ha⁻¹</th>
<th>HUE</th>
<th>PTUE</th>
<th>HTUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st October KOS-1</td>
<td>1578</td>
<td>1.29</td>
<td>0.12</td>
<td>0.26</td>
</tr>
<tr>
<td>Kulpin Shalimar Brown Sarson-1 P-3</td>
<td>1774</td>
<td>1.44</td>
<td>0.13</td>
<td>0.29</td>
</tr>
<tr>
<td>15th October KOS-1</td>
<td>1823</td>
<td>1.48</td>
<td>0.13</td>
<td>0.29</td>
</tr>
<tr>
<td>Shalimar Brown Sarson-1</td>
<td>1913</td>
<td>1.54</td>
<td>0.13</td>
<td>0.31</td>
</tr>
<tr>
<td>30th October KOS-1</td>
<td>1287</td>
<td>1.10</td>
<td>0.09</td>
<td>0.22</td>
</tr>
<tr>
<td>Gulchein Shalimar Brown Sarson-1</td>
<td>1225</td>
<td>1.05</td>
<td>0.09</td>
<td>0.21</td>
</tr>
<tr>
<td>15th October Shalimar Brown Sarson-1</td>
<td>1384</td>
<td>1.17</td>
<td>0.10</td>
<td>0.24</td>
</tr>
<tr>
<td>P-3</td>
<td>1555</td>
<td>1.32</td>
<td>0.11</td>
<td>0.27</td>
</tr>
<tr>
<td>15th October P-3</td>
<td>781</td>
<td>0.72</td>
<td>0.06</td>
<td>0.15</td>
</tr>
<tr>
<td>Kulpin</td>
<td>485</td>
<td>0.43</td>
<td>0.04</td>
<td>0.09</td>
</tr>
<tr>
<td>1st October Kulpin</td>
<td>573</td>
<td>0.53</td>
<td>0.04</td>
<td>0.11</td>
</tr>
<tr>
<td>Shalimar Brown Sarson-1</td>
<td>805</td>
<td>0.74</td>
<td>0.06</td>
<td>0.15</td>
</tr>
</tbody>
</table>

### REFERENCES


Nanda, R. S., Bhargava, C. and Tomar, D. P. S. 1994. Rate and


