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Performance of karan rai (*Brassica carinata)* in relation to rainfall pattern in northwestern Himalayas

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ABSTRACT

An effort has been made to identify a *Brassica* crop that performs well under aberrant weather conditions and makes better use of available rainfall for the production of higher seed yields. The field experiments were conducted under All India Co-ordinated Research Project on Rapeseed-mustard at Kangra and Dhaulakuan locations of CSK Himachal Pradesh Krishi Vishvavidyalaya, for four *rabi* seasons viz., 1999-2000 to 2003-04 under low and mid hill rainfed conditions. Varuna variety of mustard was evaluated for its suitability alongwith Jayanti (the released Karan rai variety) and other promising entries. The study revealed that though, the total seasonal rainfall contributes towards the seed yields; yet, it is the proper distribution of rainfall at flowering to pod formation stage that results in higher seed yields in Karan rai. About 30 percent or more of the total seasonal rainfall received at this phenological phase results in increased seed yields in Karan rai

Key words: Karan rai, flowering and podding, rainfall, seed yield

Rapeseed-mustard is currently being adopted as a useful rotation crop next to wheat in the low rainfall areas of northwestern Himalayas. The crop accounts for about 57 percent to the total oil seeds area and 60 percent to the total oilseeds production in Himachal Pradesh. The other major crops grown are sesame, linseed, soybean and groundnut. Under irrigated conditions, toria+ gobhi sarson cultivation immediately after the maize harvest has become popular for assured yields as compared to wheat under rainfed conditions. The weather based agricultural planning must help attain consistent good yields and assure the profitability of any agricultural enterprise. The attainment of higher yield and quality of any agricultural produce becomes a common goal for a Breeder and Agrometeorologist, the environment manager. These aspects still become more relevant; if the environment is harsh with low/erratic rainfall, hail storms and warm temperatures. Ethiopian mustard or karan rai is a new emerging oilseed crop for the farmers of low and mid hill rainfall areas due to its drought tolerance,

shattering and lodging tolerance and lesser bird attack. Therefore, in the present study an effort has been made to assess the performance of karan rai in rainfed northwestern Himalayan environment.

MATERIALS AND METHODS

The field experiment on karan rai was conducted under All India Coordinated Research Project on Rapeseed-mustard at Kangra and Dhaulakuan locations of CSK Himachal Pradesh Krishi Vishvavidyalaya for the four *rabi* seasons of 1999-2000 to 2003- 2004 (except for the year 2001-02) under low and mid hill rainfed situations of Himachal Pradesh. Two *Brassica* varieties viz., Jayanti (JTC-1) of *Brassica carinata* and Varuna of *Brassica juncea* were raised along with other *Brassica carinata* cultivars received from the Project Coordinator NRC on Rapeseed-mustard, Bharatpur. All the varieties were raised in Randomized Block Design in three replications by the end of October to first week of November on residual moisture during each season of the study. Recommended agronomic and cultural package of practices were followed to raise the crop. The phenological observations and seed yields were recorded. Standard statistical procedures were followed to analyse the crop yield data. Historical rainfall data were also analyzed to work out the rainfall probabilities, most probable rainfall, probability of moderate drought, probability of onset and withdrawal of winter rains and monthly percentiles during the crop growing season. To relate this information with crop yield, a critical appraisal of the rainfall relations at flowering and pod formation phenophases was taken up to find out the suitability of the varieties at both the locations.

RESULTS AND DISCUSSION

Climatic comparison

In Kangra district, 444 mm normal rainfall is received with 60 percent chance of getting rainfall between 200-600 mm and the rainfall seldom occurs below 200 mm during the *rabi* season. The chance of moderate drought (25-50% deficiency from normal) is once in 7 years (Table 1). In district Sirmour, 196 mm normal rainfall is received with 80% chance of receiving rainfall between 100- 500 mm. The rainfall in this district occurs mostly above 50 mm during the entire crop growing season. The chance occurence moderate drought is once in 5 years (Annon, 2002-03). The monsoon in district Kangra withdraws by September end whereas in Sirmour (Dhaulakuan), before October 14 in 90 percent of the years (Annon, 2003-04). The onset of winter rains occurs before January 16 at Kangra and by February 11 at Dhaulakuan in 90 percent of the years (Table 2). This indicates that the onset of winter rains is too late for raising *Brassica* crops in both the districts; therefore, the sowing of these crops should be taken up on residual soil moisture after the harvest of maize crop or after giving pre-sowing irrigation.

Seed yield comparisons

The seed yield of two varieties along with seasonal rainfall and the percentage of the seasonal rainfall received at flowering to pod formation stages are presented in Table 3. The perusal of data indicated that during all the years of the

Table 1: *Rabi* season rainfall characteristics of two major rapeseed - mustard growing districts of Himachal Pradesh

Districts	Normal rainfall (mm)	Chance (%) of getting different amount of rainfall (mm)	Most probable rainfall amount (mm)	Chance of moderate drought (25-50% deficiency from normal)
Kangra	444	60%, 200-600	⩾ 200	Once in seven years
Sirmour	196	80%, 100-500	⩾ 50	Once in five years

study, the variety Jayanti performed significantly better than the mustard variety Varuna. On an average, the variety Jayanti recorded about 127 and 115 percent higher seed yields as against Varuna both at Kangra and Dhaulakuan locations, respectively. The highest seed yield (1560 kg ha^{-1}) was obtained during 2003-04 *rabi* season which received total seasonal rainfall of 406.6 mm at Kangra. While observing the month-wise distribution of rainfall, 16 mm rainfall each was received during the months of November and December which helped in the establishment of the October last week sown crop. Likewise, 144.8 mm rainfall (35.6 percent) was also received in 10 days at flowering stage of the crop during the months of January and February which also happened to correspond to the critical irrigation stage of the crop. The lowest seed yield (1131 kg ha^{-1}) was recorded during *rabi* 2000-01. During this year, the lowest total seasonal rainfall of 267 mm was received, 39 percent of which was received during the month of April which hindered the harvesting and threshing operations and ultimately, resulted into poor quality produce. Only 33 percent rainfall was received during September (lowest amongst different years of study) giving insufficient residual moisture for germination as well as initial crop establishment.

At Dhaulakuan, the highest seed yield of 1858 kg ha^{-1} was recorded during 1999-2000 *rabi* season which received the highest total seasonal rainfall of 624.1 mm. Out of this, 61 percent of rainfall was received during the month of September alone giving sufficient residual moisture. About 34.4 percent (214.6 mm) was received at flowering stage in 13 days. On the contrary, the lowest seed yield of 647 kg ha^{-1} was exhibited in JTC-1 variety of karan rai during 2003-04. During this year, though, sufficient total seasonal rainfall of 483.4 mm was received out of which 63 percent (303.6 mm) was received during the month of September which was sufficient to ensure proper germination in the first week of November sowing. Only 136 mm (28 percent) of rainfall was received in 6 days at flowering stage. This precipitation was not sufficient enough to meet the evapo-transpiration demand of 1-2 mm per day, as the temperature during the flowering and podding was unprecedentedly warm with mean maximum monthly temperature of 31.1 °C at Dhaulakuan compared to 28.5 °C at Kangra. The number of days above 32 °C during March were as many as 15 at this

Table 2: Percentiles of onset and withdrawal of winter rains at two stations of Himachal Pradesh

Percentiles	Onset	Withdrawal	Onset	Withdrawal
	Kangra*		Dhaulakuan	
P_{10}	November 6	May 22	October 18	February 27
P_{30}	December 4	May 25	November 20	March 26
P_{50}	December 19	May 28	January 7	April 26
P_{70}	January 11	May 30	January 12	May 14
P_{90}	January 16	May 31	February 11	May 19
Mean	December 16	May 27	Jan 2	April 11
Normal (±1SD)	Between November 13 - January 14	Between May 23 – May 31	Between Dec 2 - Feb 4	Between March 10 – May 13

*The rainfall data is as per the records of the Agrometeorological Observatory, Palampur

location compared to Kangra, where the value was 12. The temperature remained above 34 °C for as many as five days at this location and value for Kangra being nil. The warmer and drier conditions might have caused record yield reduction at Dhaulakuan. This crop however, performs very well under adequate residual soil moisture. If the crop gets established in the initial stage, it can survive the drought conditions during the later stage provided well distributed rain (about 200 mm) is received at bolting to full bloom stages. Compared to Kangra, the higher seasonal rainfall variation at Dhaulakuan is perhaps the reason for higher variation in seed yield and days to maturity.

During recent years, the warming trends have been observed in Himachal Pradesh during winter (Prasad and Rana, 2006).The probability of extreme weather events, like longer dry spells, higher single day rainfall, hail and high wind velocity is likely to increase during coming years therefore, shattering, lodging and drought tolerance character of variety Karan rai fits well to the ensuing climatic conditions in the state. Also, compared to *Brassica napus* variety Sheetal, this variety does not require any chilling treatment during its initial stages of crop growth.

Likely chance of getting different amount of rainfall along with extremes during a particular month during the crop growing season is presented in Table 4. Both the locations show fairy high degree

Table 3: Yield performance and maturity duration of karan rai over mustard at Kangra and Dhaulakuan during four seasons

Seasons	Seasonal rainfall (mm)	Percent seasonal Rainfall at flowering and podding	Seed yield (kg ha^{-1})		Maturity days		% increase over Varuna	C D (5%)
			JTC-1	Varuna	JTC-1	Varuna		
			Kangra*					
1999-00	641.2	45.5	1276	799	166	148	60	97.6
2000-01	267.0	11.6	1131	425	178	148	166	142.1
2002-03	544.0	38.8	1383	601	175	153	130	120.0
2003-04	406.6	35.6	1560	534	163	143	192	139.0
Mean	464.7	-	1338	590	171	148	127	124.7
C.V. (%)	35	-	14	27	4	3	42	16
			Dhaulakuan**					
1999-00	624.1	34.4	1858	900	176	160	106	30.8
2000-01	104.4	10.8	-	742	-	127	-	-
2002-03	160.2	73.8	1265	337	156	137	275	30.0
2003-04	483.4	28.1	647	363	145	139	78	82.0
Mean	343.0	-	1257	586	159	141	115	80.9
C.V. (%)	73	-	48	48	10	10	70	61

* Sowing during last week of October ** Sowing during first week of November

of rainfall extremes. During the month of September, Kangra receives between 80.4 to 408.1 mm rainfall and Dhaulakuan 0.0 to 331.9 mm during 80% of years, indicating more probability of getting adequate rainfall and resultantly residual moisture for the sowing month of October. At the time of sowings, 80 % of years receive rainfall between 0 to 63.4 mm and 0 to 69.5 mm during the months of October and November and 0 to 101.1 mm and 0 to 21.9 mm at Kangra and Dhaulakuan, respectively. Similarly, at flowering stage the rainfall extremes were large. In order to handle this variation, either there should be assured irrigation facilities or the plant type should be such that it can adapt to this variable rainfall pattern to the largest extent possible. The variety JTC-1 has shown that it can act as a weather proofing device for large variations in rainfall at the critical stages of irrigation requirement. About 30 percent (200 mm) of the total seasonal rainfall, if received at flowering stage can result into higher seed yields.

The bolting to flowering and full bloom to pod initiation stages are the most sensitive to water deficit in karan rai causing severe reduction in seed yield. In contrast, well distributed rains received at flowering to pod initiation can increase the yields to a large extent. Karan rai followed by mustard

Table 4: Monthly rainfall (mm), 10th and 90th percentiles and rainfall extremes at Kangra and Dhaulakuan stations of Himachal Pradesh

Month	Minimum	P_{10}	P_{90}	Maximum	Minimum	P_{10}	P_{90}	Maximum
	Kangra				Dhaulakuan			
September	41.4	80.4	408.1	586.1	0.0	0.0	331.9	381.2
October	0.0	0.0	63.4	133.0	0.0	0.0	101.1	110.4
November	0.0	0.0	69.5	111.8	0.0	0.0	21.9	149.0
December	0.0	0.0	127.6	261.8	0.0	0.0	42.0	154.6
January	0.0	24.2	207.0	280.0	0.0	5.8	127.2	130.0
February	0.0	25.0	188.0	213.2	0.0	2.9	145.9	191.5
March	1.4	26.4	249.7	324.8	0.0	0.0	67.5	73.2
April	0.0	16.4	129.6	184.7	0.0	0.0	57.4	128.4

is more tolerant to moisture stress than the rapeseed. Moisture stress at critical stages (flowering and seed filling) reduces seed filling, seed size and oil content. A total of 700 mm rainfall is beneficial out of which 450 mm is the most desirable for the crop (Kumar, 2004). Though work in this aspect is limited under Indian conditions, yet similar type of yield reductions due to water deficit during early podding have been observed in faba bean (Mwanamwenge *et al,* 1999), in peas (Fougereus *et al,* 1997) and soybean (Slamet and Suyamto, 2001). Under Australian conditions, compared to mustard, early sowing and early flowering cultivars of *Brassica napus* are thought to produce higher seed yields and oils contents in low rainfall areas (Si and Walton, 2004).

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