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Thermal sensitivity of mustard (*Brassica juncea* L.) crop in Haryana

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ABSTRACT

A wide gap exists between potential and actual yields of mustard in India. Mustard is highly sensitive to weather variables and thus attempts need to be focused on determining the most yield limiting weather parameter so as to bridge the yield gap. To accomplish this task, mustard (c.v. RH-30) yields recorded for 26 *rabi* seasons (1984-85 to 2009-10) at Hisar, Haryana state were related with weather parameters during crop period. Maximum temperature during 1-6 week after sowing (WAS), minimum temperature during 1-5 WAS and again 16-20 WAS were found to influence mustard yields significantly. The mustard yields were less than 2000 kg ha^{-1} when maximum temperature was less than 30°C during 1-6 WAS and minimum temperature was less than 12°C during 1-5 WAS. Higher yields (2400 to 3000 kg ha^{-1}) was obtained when minimum temperature during 16-20 WAS was less than 6°C.

Key words: Thermal sensitivity, mustard, north india, critical temperatures, minimum temperature

Indian mustard (*Brassica juncea* L.) is one of the most important oil seed crop in the country and it occupies considerably large acreage among the *Brassica* group of oil seed crops. India stands first both in acreage and production of rapeseed and mustard in Asia. The crops are cultivated over an area of 7.0 m ha with a production of 8.1 m tonnes with an average yield of 1149 kg ha^{-1} (Anon., 2006). In the recent two decades, the area under mustard fluctuated between 4.48 m ha (2000-01) and 7.32 m ha (2004-05). Aggarwal *et al*., (2008) quantified the yield gap as 860 kg ha^{-1} relative to simulated rainfed potential yield. In future, the demand for oilseeds production is likely to go up significantly due to increase in population and income. Hence, sufficient measures should be taken to increase the production and thereby minimising the yield gap to attain self sufficiency in mustard production.

Mustard is much sensitive to changes in weather and hence climate change could have significant effect on its production. Mall *et al*. (2004) reported that crop production in winter season might become comparatively more vulnerable due to larger increase in temperature and greater uncertainties in rainfall.

An assessment of the variation in mustard yield over the years could clearly depict the anomalies with regard to climatic variability. An attempt has been made to assess the yield variability in mustard in relation to thermal regime at Hisar in Haryana state.

MATERIALS AND METHODS

Hisar (29.15° N and 75.72° E) is located in the western agroclimatic zone of Haryana. The climate of Hisar is arid with annual rainfall of 459 mm and a standard deviation of 178 mm. Although the normal sowing time of mustard in Hisar is towards the end of October, during the experimental period it was sown as early as on 28th September to as late as on 24th November. Thus it provided a vide variation in the thermal regime.

The weather and the yield data of mustard were collected from the All India Coordinated Research Project on Agrometeorology for the *rabi* seasons from 1984-85 to 2009-10. The crop (c.v.RH-30) was grown with spacing of 30 cm x 15 cm. The soil at the experimental plot is sandy loam having pH 7.9 and organic carbon 0.38 per cent. The recommended dose of fertilizer were applied in all the years uniformly @ 80 kg N and 40 kg P_2O_5 ha^{-1} and the cop was irrigated to relieve the crop from moisture stress.

The week-wise weather data during the study period from the date of sowing to date of harvest was organised and the relationship between weather parameters and yield was computed. Correlations coefficients were work out and curvefit (Cox, 1986) was used to determine the relation between mustard yield and different weather variables.

RESULTS AND DISCUSSION

The association between weekly weather parameters and mustard yield is presented in Table 1 using correlation coefficient (r) values. From the table it is obvious that the maximum temperature up to six weeks after sowing (WAS) has a significant positive correlation with the mustard yield. Likewise minimum temperature up to five weeks after sowing has a significant positive correlation with yield. But the minimum temperature from 16 to 20 WAS showed a

Table 1: Correlation coefficients between weekly weather parameters and the mustard yield

Parameters WAS	Max T	Min T	Mean T	Diurnal	SSH	RH1	RH2	EVP
1	0.54 **	0.49 *	0.53 **	0.01	0.22	-0.14	-0.09	0.37
2	0.61 *	0.40 *	0.55 **	0.17	0.19	-0.33	-0.10	0.42 *
3	0.56 **	0.41 *	0.54 **	0.33	0.26	-0.43 *	-0.36	0.45 *
4	0.51 **	0.24	0.42 *	0.42 *	0.10	-0.25	-0.45 *	0.21
5	0.56 **	0.42 *	0.47 *	0.26	0.01	-0.34	-0.37	0.28
6	0.48 *	0.28	0.38	0.31	0.19	-0.15	-0.29	0.35
7	0.43 *	0.16	0.37	0.33	0.26	-0.37	-0.33	0.27
8	0.38	0.18	0.33	0.30	0.19	-0.16	-0.34	0.29
9	0.36	0.07	0.22	0.26	0.12	-0.26	-0.40 *	0.32
10	0.28	-0.15	0.05	0.36	0.34	-0.29	-0.37	0.21
11	0.26	-0.11	0.11	0.33	0.25	0.02	-0.07	-0.07
12	-0.18	-0.19	-0.28	-0.03	-0.29	0.40 *	0.09	-0.33
13	-0.20	-0.22	-0.36	-0.12	-0.25	0.45 *	0.15	-0.53 **
14	-0.08	-0.06	-0.14	-0.09	-0.23	0.31	0.12	-0.36
15	-0.18	-0.19	-0.24	-0.08	-0.20	0.28	0.19	-0.47 *
16	-0.26	-0.44 *	-0.33	0.16	-0.09	0.49 *	0.09	-0.30
17	-0.12	-0.29	-0.20	0.26	0.17	0.15	-0.06	-0.30
18	-0.32	-0.48 *	-0.41 *	0.25	0.08	0.52 **	0.04	-0.37
19	-0.06	-0.49 *	-0.32	0.52 **	0.49 *	-0.15	-0.26	-0.31
20	-0.30	-0.46 *	-0.33	0.25	0.36	0.20	-0.04	-0.29
21	0.02	-0.05	0.05	0.17	0.00	0.17	-0.14	---

(SSH = Bright sunshine hours, RH1 = Morning relative humidity, RH2 = Afternoon relative humidity and EVP =open pan evaporation weekly total) (*Significant at 5%; **Significant at 1%)

Table 2: Effect of thermal regime during sensitive phases of mustard on seed yield

Max T during 1 to 6 WAS (°C)	Average yield (kg ha^{-1})	Min T during 1 to 5 WAS (°C)	Average yield (kg ha^{-1})	Min T during 16 to 20 WAS (°C)	Average yield (kg ha^{-1})
<30	1807.6	<12	1703.8	<6	2748.0
30-31	2837.0	12-15	2562.5	6-8	2076.6
>31	2412.7	>15	2533.5	>8	1883.9

significant negative correlation with yield. The morning RH during the period 12th, 13th, 16th and 18th WAS had a significant positive association with yield. This had a negative influence on yield during the early stages of crop growth (3 WAS). The afternoon RH also showed a negative impact during the early stage of crop growth (4th and 9th WAS). Likewise, weekly total open pan evaporation had a positive influence on crop growth in the initial stage (1 to 10 WAS) and the effect is significant during 2nd and 3rd WAS. As the crop growth progressed, the influence of evaporation was reverted and assumed a negative influence on yield. The influence being marked during the period 13th -15th WAS, coinciding with flowering stage of the crop. This suggests that higher evaporative demand of the atmosphere during flowering stage of mustard will mark a negative impact on yield, probably through decreased fertilization or flower abortion.

The influence of maximum temperature on the mustard yield for the first 6 WAS can be seen in Fig 1. The influence of minimum temperature on mustard yield for 1 to 6 WAS period and 16 to 20 WAS can be seen in Fig 2 and Fig 3, respectively. Mustard is responding positively to temperature in the early stages of crop growth. The yields decreased with increase in minimum temperature during 16 to 20 WAS.

When the maximum temperature up to 6 WAS was in the range of 30-31°C and minimum temperature up to 5 WAS was between 12°C and 15°C then maximum yield for mustard sown was realized (Table 4). This period facilitated minimum temperature of 3-4°C at maturity phase. Hence the sowing window has to be adjusted so that the initial

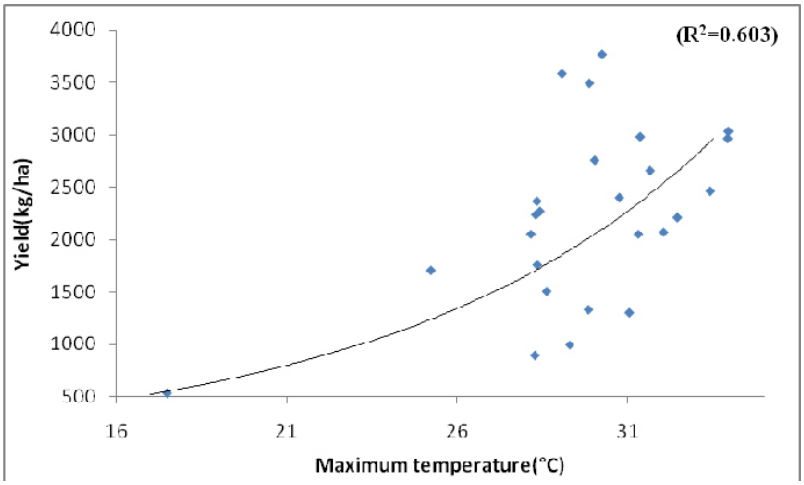

Fig 1: Yield as influenced by maximum temperature during 1to 6 WAS period

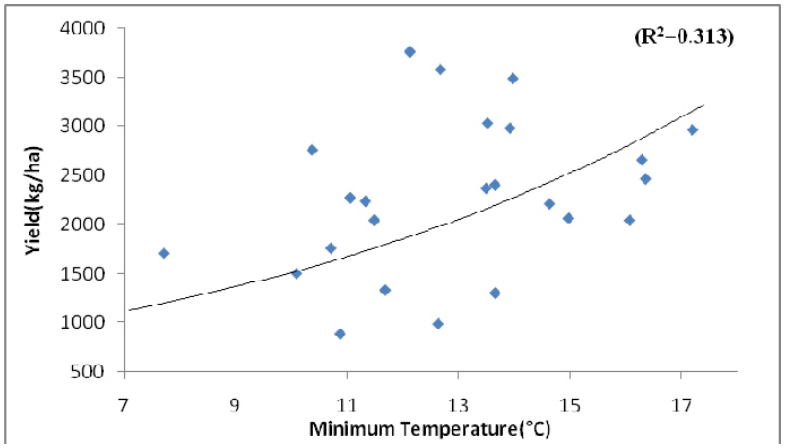

Fig 2: Yield as influenced by minimum temperature during 1 to 5 WAS period

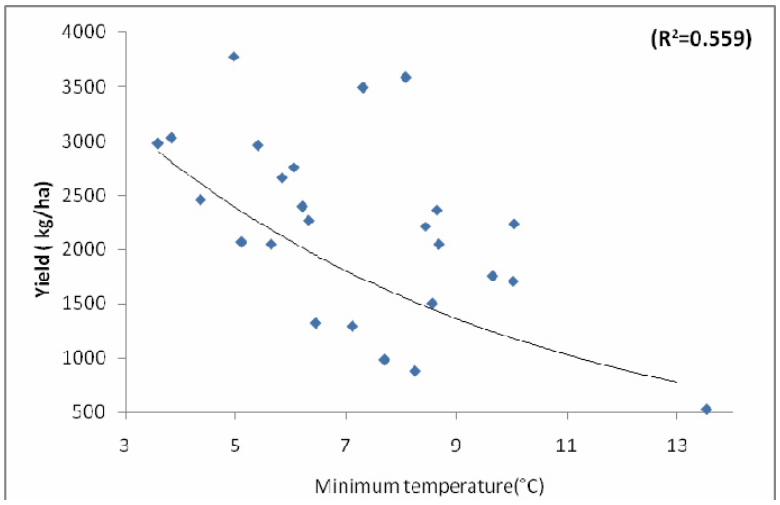

Fig 3: Yield as influenced by minimum temperature during 16 to 20 WAS period

maximum temperature during emergence to vegetative phase is higher.

SUMMARY AND CONCLUSIONS

The mustard yields were less than 2000 kg ha^{-1} even under irrigated conditions particularly when the average maximum temperature was less than 30°C during the period 1 to 6 WAS and the average minimum temperature was less than 12°C during the period 1 to 5 WAS.

It is important to consider the critical values of maximum and minimum temperatures particularly during the initial stages of crop growth up to first six weeks and the minimum temperatures during the period 16 to 20 WAS for achieving higher yields of mustard under irrigated conditions in the Hisar region.

In climatic change assessment studies involving mustard crop, uniform response to a rise in temperature cannot be expected. The critical values of weather parameters during different phases of growth above or below which the yields are get adversely affected have to be identified.

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