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Influence of environmental parameters on mustard yield and its quality

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ABSTRACT

Field experiment was conducted during five consecutive *rabi* seasons of 1997-98 to 2001-2002 at Anand Agricultural University, Anand with treatment comprising two varieties and five irrigation levels. The results revealed that there was no significant difference in the seed yield due to variety. Whereas, three irrigations produced significantly higher seed yield of mustard over I_0 (no irrigation) and I_1 (one irrigation) but it was at par with I_2 and I_4 treatments. Further, variety GM-2 recorded higher oil content and lower protein content over varuna. Flowering and pod development phases of the mustard were found to be most sensitive to weather parameters. Higher sunshine hours and maximum temperature (>30°C) and lower minimum temperature (<14 °C) during flowering and pod development stage of the crop were favorable for mustard crop. Temperature range was found to explain highest variation (92 %) in the seed yield of mustard.

Key words : Mustard, Irrigation, Weather, Yield

Oil seed crops play an important role in Indian economy. Among all the oilseed crops, rapeseed and mustard rank second in area and production after groundnut and contribute around 27 % of total oilseed production in the country. India occupies a premier position in global oilseed scenario accounting for 19 per cent of the total area cultivated under the oilseed crop in the world and 9 per cent oilseeds production (Hegde, 2000). Mustard cultivation is mostly confined to areas with limited moisture supply (Parihar *et al.*, 1981). In Gujarat, it is grown in 3.5 to 4.0 lakh ha of land and its area is increasing due to its wide adaptability and less water requirement. However, temperature, sunshine hours and moisture are limiting factors affecting crop production. The variations in the agricultural production are mostly attributed to the effect of seasonal weather conditions on plant growth (Sastry *et al.*, 2000). In most of the areas, it is grown under varying moisture conditions. Looking to the above, the present investigation was undertaken at Anand of middle Gujarat agro-climatic zone.

MATERIAL AND METHODS

Field experiments were conducted during five consecutive *rabi* seasons of the years 1997-98 to 2001-2002 at Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand. The soil of the experimental field was sandy loam in texture having pH 8.3 with low in organic carbon and high in available phosphorus and potassium. Experiment comprised ten treatment combinations of two varieties (V_1: Varuna and V_2: GM-2) assigned to main plots and five irrigations (I_0 : No irrigation, I_1 : Irrigation at vegetative growth phase (VG), I_2 : Irrigation at VG + Flowering stage (FL), I_3 : Irrigation at VG + FL + siliqua development stage (SQ), I_4 : Irrigation at VG+FL+SQ and seed development stages) were relegated in sub-plots tried in split plot design with four replications. The crop was sown on the 20th October as normal date of sowing in each year by manual dibbling keeping the spacing of 45 cm x 15 cm. The entire quantity of phosphorous (50 kg P_2O_5 ha^{-1}) in the form of di-ammonium phosphate along with 50 per cent of total amount of nitrogen (25 kg N ha^{-1}) was applied uniformly in opened furrows as basal. Remaining 50 per cent nitrogen was top-dressed in the form of urea at 30 days after sowing. Common irrigation was given just after sowing to all the treatments including I_0 for germination purpose. The locally recommended cultural practices were adopted to raise the crop during all the year. Meteorological data were collected from agrometeorological observatory situated near the experimental field. Correlation and regression analysis was performed between weather parameters during different phases of mustard and seed yield. Oil content was measured by Soxhlet extraction method while protein content was measured by Micro-Kjeldahl method as described by Sadasivam and Manickam (1996).

RESULTS AND DISCUSSION

Yield and quality

The results on seed yield (Table 1) revealed that variety varuna recorded seed yield of 2054 kg ha^{-1}, while GM-2 recorded 2074 kg ha^{-1}, the differences were non significant. However, the variation in quality parameters such as oil and protein content were found significant due to variety, wherein, variety GM-2 recorded significantly higher oil content and less protein content as compared to variety varuna.

Significant differences were observed in seed yield of mustard due to irrigation treatments (Table 1). The highest seed yield was obtained with three irrigations (2221 kg ha^{-1}) compared to I_0 and I_1 but was at par with I_2 and I_4. Seed yield increased with increase in number of irrigations up to three, beyond that, yield decreased. This decrease might be attributed to the fact that under good growth conditions, higher amount of irrigation caused higher vegetative growth, and less reproductive development, besides causing the lodging of the crop. The lodging of the crop not only affected the photosynthesis adversely during seed development phase but might

Table 1: Seed yield, oil and protein content of mustard as influenced by various treatments (Mean of 5 years)

Treatments	Seed yield (kg ha^{-1})	Oil content (%)	Protein content (%)
Variety (V)			
Varuna (V_1)	2054	36.24	23.91
GM-2 (V_2)	2074	36.63	23.60
S.Em.±	24.4	0.12	0.07
C.D. at 5%	NS	0.37	0.20
C.V.%	11.8	3.36	2.85
Irrigation (I)			
I_0	1678	36.57	23.94
I_1	2058	36.58	24.15
I_2	2187	36.70	23.60
I_3	2221	36.47	23.58
I_4	2177	35.85	23.49
S.Em. ±	48.4	0.26	0.23
C.D. at 5%	145.10	NS	NS
C.V.%	10.14	2.67	2.70
Interaction V x I	NS	NS	NS

Table 2 : Correlation Coefficients between weather parameters and seed yield of mustard

Met.Week	BSS	Tmax	Tmin	MRH	T.Range
43	-0.24	0.49	-0.16	0.11	0.38
44	-0.37	0.59	-0.33	-0.05	0.50
45	0.07	-0.25	**-0.87***	-0.51	0.57
46	0.25	0.24	-0.76	-0.42	0.54
47	-0.07	0.34	**-0.89***	-0.54	0.77
48	**0.94****	**0.94****	**-0.95****	-0.56	**0.96****
49	**0.90***	**0.78**	**-0.90***	-0.54	**0.91****
50	0.06	0.49	-0.40	-0.41	0.58
51	**0.81***	**0.90***	**-0.82***	-0.53	**0.90***
52	**0.84***	**0.88***	-0.75	-0.35	**0.85***
1	**0.93****	0.40	-0.76	-0.20	**0.95****
2	**0.89***	-0.29	-0.64	-0.28	0.55
3	-0.24	0.61	0.80	-0.51	-0.72
4	0.27	0.72	0.23	0.55	0.16
5	0.10	-0.66	-0.78	-0.16	0.57
6	-0.49	-0.78	0.04	-0.25	-0.36
7	0.26	-0.29	-0.31	-0.67	0.27
8	-0.67	0.41	0.69	-0.32	-0.44

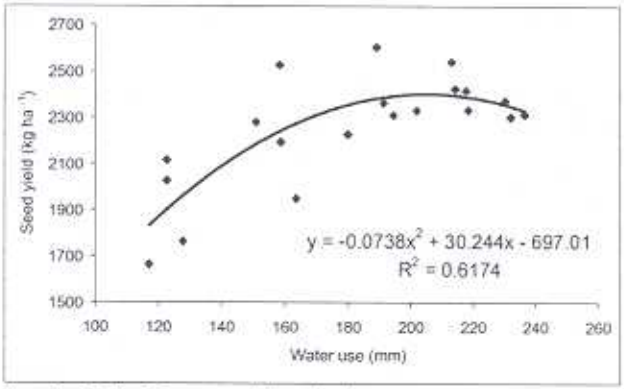

Fig. 1 : Seed yield of mustard in relation to water use

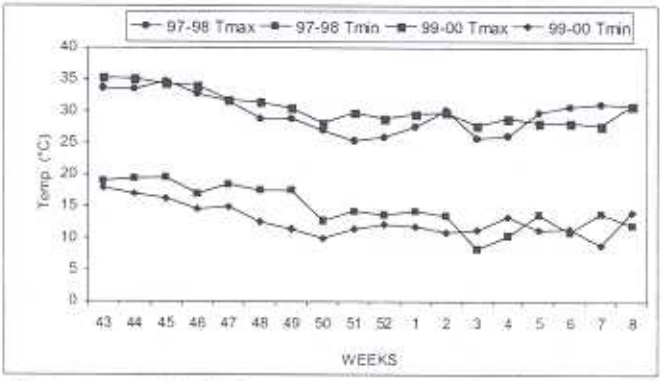

Fig. 2 : Maximum and minimum temperature during the years of lowest (1997-98) and highest (1999-00) yield

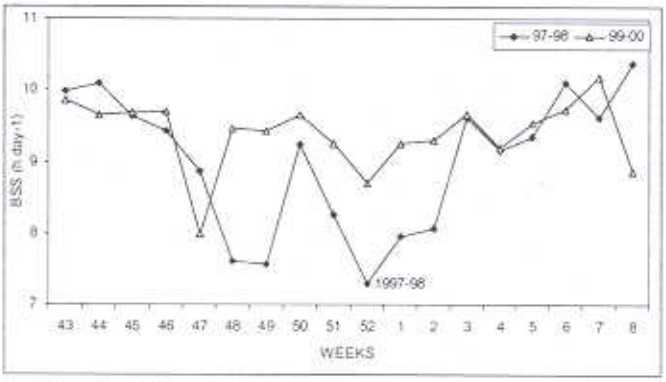

Fig. 3 : Bright Sunshine Hours (BSS) during the years of lowest (1997-98) and highest (1999-00) yield

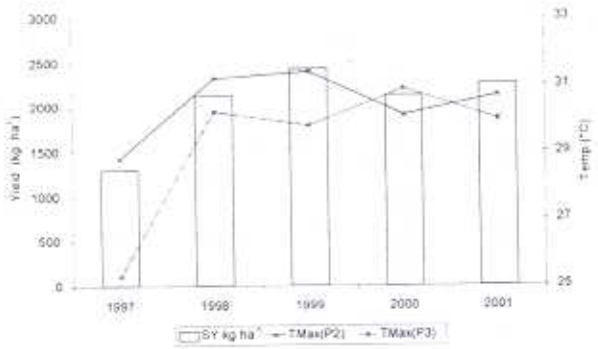

Fig. 4 : Maximum temperature during flowering (P2) and pod development (P3) phase and seed yield

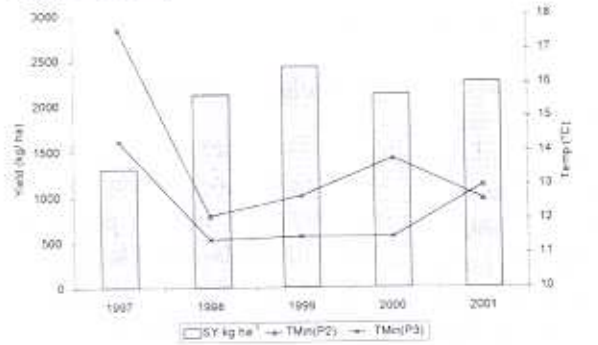

Fig. 5 : Minimum temperature during flowering (P2) and pod development (P3) phase and seed yield

have also provided congenial environment for out break of disease and pest. In contrast to general belief that irrigation affects the quality aspect, our results revealed non-significant difference either in oil content or protein due to irrigation.

Water use

Looking to the significant association between seed yield of mustard and water use, curvilinear relationships have been developed (Fig. 1). These showed that the seed yield of mustard increased initially with increase in quantity of water use upto 200 mm, decreasing thereafter. This suggests that in the soils of the Anand region 200 mm water is optimum for obtaining maximum seed yield of mustard.

Interaction with weather parameters

Weather plays an important role in growth and development of the crop. The response of crop to weather variables during different phases of the crop determines the final yield. Among all the weather parameters, maximum and minimum temperatures and bright sunshine hours were found to influence the mustard seed yield

Table 3: Regressions between weather parameters during flowering (P2) and pod development phase (P3) and seed yield of mustard.

Weather parameters	Regression models	R^2
Sunshine hours	Y = 465.27* BSS (P2) – 2210.8	0.89
	Y = 869.43* BSS (P3) – 5501.7	0.87
Maximum Temperature	Y = 394.15* Tmax (P2) - 9938.0	0.88
	Y = 176.34 * Tmax (P3) – 3091.5	0.82
Minimum Temperature	Y= -186.66* Tmin(P2) – 4628.8	0.91
	Y = -283.67* Tmin (P3) –5565.7	0.68
Temperature Range	Y = 129.27* Trange (P2) -96.1	0.92
	Y = 232.95* Trange (P3) -1710.2	0.91

significantly. Therefore, weekly variable of only these parameters are presented here. For clarity, weather during the years of the highest yield (1999-2000) and during the year of lowest yield (1997-1998) are presented in Fig. 2 and 3. It may be seen that large variation is seen in the maximum temperature in different years of mustard crop season. During 1997-98, maximum temperature was low during vegetative, flowering and pod development phases of the crop in comparison to rest of the years. The bright sunshine hours were observed to be consistently low in the year 1997-98 as compared to other years. This could have resulted in lower rate of photosynthesis and thereby lowering of the yield. The minimum temperature in 1997-98 was higher than the rest of the years during most part of the crop season. This might have resulted in higher respiration rate resulting in less net assimilates for seed production. Thus, relatively higher day temperature and relatively lower night temperature seem to be favourable for mustard crop.

Correlation studies

To ascertain the role of weather parameter correlation study was carried out between weather parameters and seed yield of mustard (Table 2). Results revealed that the bright sunshine hours and maximum temperature had significant positive correlations during flowering and pod development phases (week 48-52) while minimum temperature had significant negative correlations. BSS had also significant positive influence also during seed development phase (weeks 1-2) while minimum temperature has significant negative correlations during vegetative phase also. Relative humidity had negative but non-significant correlations. Similar results were also reported by Khushu *et al.* (2000). Diurnal variation of temperature (Trange) had highly significant positive correlations during flowering and pod development phases of mustard.

Thus, flowering and pod development phases were found to be highly sensitive to