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National Academy of Agricultural Science (NAAS) Rating : 3. 03

Chemical Based Management of Heat Stress in Mustard (*Brasicajuncea* L Czern and Coss)

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Abstract: *A field experiment was conducted on mustard (Brasica juncea L Czern & Cross) during rabi season of 2010-11 at Main Castor and Mustard Research Station, Sardarkrushinagar, Dantiwada Agricultural University, Sardarkrushinagar to study the chemical based management of heat stress in mustard. The treatments consisted 12 possible combinations of two levels of sowing dates in main plot and six levels of chemicals in sub-plot. The results revealed that the foliar application of 75 ppm salicylic acid and KH_2PO_4 with first date of sowing 20th October, 2010 when compared with the control were found superior for raceme length (13.84%), number of siliqua on main raceme (16.27%), crop growth rate (44.73%), relative growth rate (42.10%), relative water content (24.04%), seed yield per plant (19.83%) and oil content (11.52%). While in the second date of sowing 20th November, 2010 the foliar application of 75 ppm salicylic acid and KH_2PO_4 when compared with the control increased raceme length (21.49%), number of siliqua on main raceme (24.39%), relative growth rate (49.31%), seed yield per plant (21.77%) and decreased results were observed in crop growth rate (41.75%), relative water content (14.62%) and oil content (10.93%).*

Keywords: *Dates of sowing, potassium dihydrogen phosphate, mustard.*

INTRODUCTION

Mustard (Brassica juncea L Czern and Coss) is one of the most ancient oilseed crop belongs to the family cruciferous (Syn. bressicacae) and genus brassica. The crop is cultivated almost throughout the country for its high quality oil and has tremendous potential export in the world. Mustard is grown during rabi season in Gujarat. Mustard being a cool season crop requires optimum temperature range 6-26°C for better growth and development. High temperature stress adversely affects plant growth, development and crop yield. According to recent study (Lobel and Asner 2003) each degree centigrade increases in average growing season temperature reduce crop yield up to 17 percent. High temperature in Brassica inhibits plant development and caused flower abortion with appreciable loss in seed yield. Flowering stage have a strong influence on seed yield with rise of 30°C of maximum daily temperature, the seed yield decline. (Nuttall *et al.* 1992). Chemical like salicylic acid and potassium di hydrogen phosphate can play relieve high temperature effect from the mustard by increasing activity of antioxidant enzymes. Salicylic acid play diverse physiological role in plants including thermogenesis, flower induction, nutrient uptake, stomata movement photosynthesis and enzyme activities (Hayet *et al.* 2007). Potassium di-hydrogen phosphate improved accumulation of water by enhancing the leaf water potential and this might have led to higher CO_2 exchange rate and hence the positive effect of potassium as a nutrient to maintain the water status of plant, and help in osmotic adjustment there by restricts the water loss from cell. Hence the present investigation was undertaken to study the effect of chemical based management of heat stress in mustard under agro-climatic conditions of North Gujarat region.

MATERIALS AND METHODS

A field experiment was conducted during rabi season of 2010-11 at the Main Castor and Mustard Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat. The soil was

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Table 1
Effect of date of sowing and chemical treatments on physiological characters

Treatments	*Crop Growth Rate (mg/ cm²/day)*	*Relative Growth Rate (mg/g/day)*	*Relative water content*		*Raceme Length on mainraceme (cm)*	*No. of siliqua plant*	*Seed yield/ content*	*Oil (%)*
			60 DAS	*80 DAS*				
A. Main Plot (Sowing Date)								
20th October (D_1)	2.98	2.88	51.41	32.41	74.54	39.86	12.53	40.64
20th November (D_1)	2.79	2.82	48.91	30.98	71.50	33.82	10.49	36.76
SEm ±	0.03	0.05	1.38	0.71	0.56	0.43	0.12	0.40
C.D. at 5 %	0.09	NS	NS	NS	1.66	1.28	0.36	1.24
C.V. (%)	12.07	11.76	14.56	11.92	8.12	6.25	5.76	7.62
B. Sub Plot (Chemical Treatment)								
Control (F_1)	2.12	1.99	43.09	29.41	68.88	33.00	10.11	35.48
Foliar spray of water (F_2)	2.22	2.20	46.23	31.72	72.88	35.25	11.23	37.11
Foliar spray of Salicylic acid 50 ppm (F_3)	3.29	3.49	52.05	34.65	73.63	38.50	12.38	38.04
Foliar spray of Salicylic acid 75 ppm (F_4)	3.77	3.83	56.45	35.14	79.00	40.13	13.71	39.65
Foliar spray of Potassium di-hydrogen phosphate 50 ppm (F_5)	3.30	3.09	51.23	30.41	67.50	32.63	12.38	38.11
Foliar spray of Potassium di-hydrogen phosphate 75 ppm (F_6)	3.59	3.68	52.83	30.81	73.75	38.63	13.68	39.23
SEm ±	0.15	0.10	1.43	1.00	75.50	39.75	0.16	0.69
C.D. at 5 %	0.44	0.30	4.29	2.95	1.33	0.71	0.47	2.07
Interaction effects of Date of Sowing × Chemicals								
SEm ±	0.21	0.15	2.03	1.42	1.89	1.00	0.28	0.98
C.D. at 5 %	0.62	0.43	5.83	4.09	5.43	2.89	1.12	3.2
C.V. (%)	10.14	10.64	8.11	8.99	7.18	5.47	4.08	8.21

sandy in texture with PH 7.4, EC 0.18 dSm^{-1}, available N 138 kg/ha, available P_2O_5 32.93 kg/ha, available K_2O 279 kg/ha respectively. The experiment was laid out in split plot design with 4 replications. All possible 12 treatment combinations consisting of two dates of sowing *viz.*, 20th October (D_1) and 20th November (D_2) as main plot treatments, six spray levels viz., Control (F_1), Foliar spray of water (F_2), Foliar spray of Salicylic acid 50 ppm (F_3), Foliar spray of Salicylic acid 75 ppm (F_4), Foliar spray of Potassium di-hydrogen phosphate 50 ppm (F_5), Foliar spray of Potassium di-hydrogen phosphate 75 ppm (F_6) as sub plot treatments. Mustard variety GM 3 was sown in rows at 30 cm apart on 20th October and 20th November. A common irrigation was given immediately after sowing the crop for satisfactory seed germination and proper establishment of crop. Other agronomical operations were followed as per recommendations made for the mustard in the region. The five plants were randomly selected from each net plot. Each selected plant was labelled for easy identification. The same five plants were harvested separately for post-harvest study. Another five plants selected for destructive parameters. The mean of five observation plants were used for calculating sampling values of growth parameters, yield attributes and yield. The experimental data were statistically analyzed for level of significance and pooled analysis for both the dates of sowing.

RESULTS AND DISCUSSION

Effect of date of sowing on physiological characters and yield:

Significantly maximum raceme length, number of siliqua on main raceme, crop growth rate, relative growth rate, relative water content, seed yield per plant and oil content were recorded when the crop sowed at 20th October,2010 (D_1). Whereas, minimum values of physiological characters as well as yield were observed when the crop sowed at 20th November, 2010 (D_2). The mean seed yield increased under D_1 over D_2. Increase in yield under D_1 might be due to the fact that during the first date of sowing high temperature stress was not occurred. The optimum temperatures resulted in improvement in relative water content, seed yield per plant as well as increased Crop Growth Rate (CGR) and Relative Growth Rate (RGR) resulting in more efficient partitioning of dry matter to the yield attributing parts of the plant. Late sowing reduced the growth phase leading to lower photosynthesis and dry

Table 2
Interaction effect of date of sowing and chemical treatments on physiological characters.

Levels of Date of Chemical treatments sowing/	Crop Growth Rate (mg/cm²/day)		Relative Growth Rate (mg/g/day)		Relative Water Content (%)				Raceme length (cm)		No.of siliqua on main racème		Seed yield per plant (g)		Oil content (%)	
					60 DAS		80 DAS									
	D_1	D_2	D_1	D_2	D_1	D_2	D_1	D_2	D_1	D_2	D_1	D_2	D_1	D_2	D_1	D_2
F_1	2.15	2.12	2.31	1.85	41.12	39.05	29.69	27.73	70.00	60.25	36	31	11.32	10.42	37.23	33.72
F_2	2.48	2.32	2.44	2.08	51.18	41.27	32.05	31.37	72.50	65.25	40	35	11.37	11.00	38.12	34.09
F_3	3.48	3.10	3.57	3.41	54.96	49.13	39.09	30.21	77.50	70.00	41	40	12.65	12.12	39.32	36.75
F_4	3.85	3.64	3.99	3.65	57.05	55.84	38.45	31.82	81.25	76.75	43	41	14.12	13.03	42.08	37.21
F_5	3.89	2.72	3.41	2.41	53.97	50.49	31.88	30.94	73.00	72.85	35	31	12.65	12.07	38.35	37.86
F_6	3.84	3.44	3.57	3.21	55.25	48.41	29.14	32.48	74.00	73.55	41	39	14.02	13.32	39.79	38.66
S.Em ±	0.21		0.15		2.03	1.42	2.03	1.42	1.86		1.47		0.48		1.80	
C. D. at 5%	0.62		0.43		5.83	4.09	5.83	4.09	5.35		4.24		1.12		5.4	

matter accumulation. The findings are in close agreement with the results obtained by Shivani *et al*. (2002), Panda *et al*. (2004) and Loyal *et al*. (2006).

Different date of sowing schedules significantly affected the oil content which were observed 40.46% in first date of sowing as against 36.76% in schedule date of sowing. During second date of sowing high temperature stress occurred due to that reduction was registered. The results are consistent with the findings of Singh *et al*. (2002) and Bala *et al*. (2011).

Oil content was significantly increased with 75 ppm salicylic acid (F4) over rest of the treatments. Higher concentration of nutrients in seed along with higher seed yield under foliar spray of salicylic acid resulted in higher uptake of nutrients. The increment in oil content might be due to the increase in vegetative growth and monoterpins biosynthesis. The results are in conformity with the findings of Singh *et al.* (2002), Bala *et al.* (2011) and Sharma *et al.* (2013), in mustard.

Interaction effect of date of sowing and chemical treatments:

Significantly, the higher growth components, seed yield, oil content were recorded when the crop was grown on 20th October,2010 (D_1) along with the application of 75 ppm salicylic acid (F_4) ($D_1 \times F_4$). Treatment combination $D_1 \times F_6$ recorded significantly higher seed yield then the rest of the combinations, but it remained at par with $D_1 \times F_4$ combinations.

Due to early date of sowing along with application of salicylic acid might have increased physiological processes by scavenging reactive oxygen species (ROS) which usually produced during terminal heat stress. These results are in close agreement of the results obtained by Afroz *et al*. (2011) and Orabi *et al*. (2011).

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