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RESPONSE OF DIFFERENT RAPESEED-MUSTARD VARIETIES FOR GROWTH, YIELD AND YIELD COMPONENT UNDER IRRIGATED AND RAINFED CONDITION

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SUMMARY

Fourteen varieties of rapeseed-mustard. *B. juncea* (Varuna, Vaibhav, PCR-7, Rohini, RH-30, RH-819), *B. campestris* ssp. toria (PT-30 and TH-68), *B. campestris.* ssp. brown sarson (BSH-1), *B. campestris* ssp. yellow sarson (Ys Benoy), *B. carinata* (BPKR and Kiran) and *B. napus* (GSL-1 and GSL-2) were grown under irrigated and rainfed conditions, to study their growth pattern, yield and yield attributing characters. Reduced plant height, delay in flower initiation and 50% flowering were observed in almost all the species under rainfed conditions. The maximum delay in flower initiation and 50% flowering were observed in TH-68 of toria, BPKR of karan rai and BSH-1 of brown sarson. Among the species, karan rai showed the highest number of primary and secondary branches per plant under both irrigated and rainfed conditions. Yellow sarson, brown sarson, gobhi sarson and karan rai did not produce tertiary branches either under irrigated or rainfed condition. However, the Indian mustard varities produced tertiary branches under both irrigated and rainfed condition and toria produced tertiary branches only under irrigated conditions. Maximum seed yield per plant (25-34 g/plant) were observed in mustard varieties under both the conditions. Yield per plant showed maximum (35-40%) reduction in Vaibhav, Rohini and Varuna under rainfed condition. Similarly husk weight per plant was highest in *B. juncea* as compared to other species. Varieties Vaibhav, Rohini and Varuna showed 20-30% reduction in husk weight under the rainfed conditions. However, the maximum dry matter translocation (37-48%) from pod wall to seed was observed in mustard varieties whereas gobhi sarson showed minimum (17-18%) translocation rate. The translocation rate of dry matter from pod wall to seed, decreased slightly in all the varieties except BSH-1 grown under rainfed conditions.

Key words: **Growth, irrigation, rapeseed mustard, yield components.**

INTRODUCTION

In India, rapeseed and mustard are commonly cultivated in semi-arid to arid tropical zones with limited or no irrigation. Nearly 34% cropped area of rapeseed-mustard is rainfed where soil moisture stress affects the crop at one or more phenological stages. Production of rapeseed-mustard is generally limited by inadequate water availability during flowering to pod development stage, hence there is need to identify cultivar/species, tolerant to moisture stress. Effects of moisture stress on growth and yield components in *Brassica* have been well elucidated and are important selection criteria for drought tolerance (Krogman and Hobbs 1975, Richards and Thurling 1978 and Mathur and Wattal 1996). In the present investigation, performance of different rapeseed-mustard species as well as varieties within species under irrigated and rainfed conditions were studied to identify the suitable physiological factor(s) for selecting drought tolerant genotypes.

MATERIALS AND METHODS

Fourteen varieties of rapessed-mustard i.e., Varuna, Vaibhav, PCR-7, Rohini, RH-30 and RH-819 of

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B.Juncea, PT-30 and TH-68 of *B. campestris* ssp. Toria, BPKR and Kiran of *B. carinata*, Ys Benoy of *B. campestris* ssp. yellow sarson, BSH-1 of *B. campestris* ssp. brown sarson and GSL-1 and GSL-2 of *B. napus*, were grown under irrigated and rainfed conditions in randomized complete block design with three replications during 1999-2000. The distance between rows and plant to plant within rows were kept at 30 and 10 cm respectively within the plot size of 3 x 5m. Nitrogen was applied in the form of urea @ 40kg/ha and phosphorus @ 40 kg/ha in the form of DAP at the time of sowing. The remaining half of the N was top dressed @ 40kg/ha just after first irrigation to the irrigated plots. While under rainfed conditions the urea was applied @ 80kg/ha and DAP @ 40kg/ha at the time of sowing. The irrigation was given at 40 and 65 days after sowing to irrigated plots while moisture stress was created by withholding irrigations. There was no significant rain in winter during the crop season. The soil moisture content was recorded at the time of sowing, 35, 45, 65, 75, DAS and at the maturity. Soil samples from 0 to 30 and 30 to 60 cm profile were oven dried at 105°C for 72 hours and the values were expressed as percentage. Plant height at different stages was measured with the help of meter scale and days to flower initiation and 50% flowering were also noted. At maturity, five plants were harvested from each plot for recording yield and yield parameters. Branches per plant, and siliquae from different branches were separated and oven dried at 80°C. Siliquae were threshed and the seeds were cleaned and weighed.

RESULTS AND DISCUSSION

The soil moisture content declined steadily from 16.2% (0 to 30 cm) at the time of sowing to 4.7% (0 to 30 cm) and 5.7% (30 to 60 cm) at maturity under rainfed conditions. Under irrigated conditions, the soil moisture content decreased from sowing to 35 DAS. The increase in soil moisture content under irrigated condition was noted at 45 and 75 DAS as two irigations were given at 40 and 65 DAS. But soil noislure content declined by 75 DAS. Soil moisture content reached at 10.2% (0 to 30 cm) and 12.1% (30 to 60cm) at maturity stage (Table 1).

In rainfed conditions, plant height decreased in all the varieties of all the species at early growth stage. The maximum reduction in plant height at vegetative stage was observed in PT-30 of toria (12%) and Ys Benoy of yellow sarson (10.7%) while at flowering stage maximum per cent reduction was noted in GSL-1 of gobhi sarson (12.5%) and PT-30 of toria (8.0%). Thus in toria, yellow sarson and gobhi sarson plant height was adversely affected by soil moisture deficit as compared to cultivars of other species. Mustard varieties were taller under both the conditions (Table 2). The time taken for flower initiation and 50% flowering was more in rainfed conditions than in irrigated conditions. The maximum delay in flower initiation under rainfed condition was observed in Rohini and Vaibhav of mustard and GSL-1 of gobhi sarson. Normally under irrigated condition toria, yellow sarson and brown sarson cultivars took 52 to 58 days for 50 %

Table 1. Soil moisture content (%) of irrigated (I) and rainfed (R) plots recorded from 0 to 30 and 30 to 60 cm profile on dry weight basis

Treatment	Soil depth (cm)	Days after sowing					
		Sowing	35	45	65	75	Maturity
Irrigated	0 to 30	16.4	13.0	17.3	13.5	16.1	10.2
	30 to 60	17.2	14.1	18.5	14.7	17.2	12.1
Rainfed	0 to 30	16.2	12.8	9.5	7.7	5.2	4.7
	30 to 60	17.0	13.7	11.7	9.0	6.8	5.7

Table 2. Plant height, flower initiation and 50% flowering of differnt rapeseed-mustard varieties grown under irrigated (I) and rainfed (R) conditions

	Plant height (cm) at Vegetative stage		Flowering stage		Maturity stage		Days to flower initiation		Days to 50% flowering	
	I	R	I	R	I	R	I	R	I	R
Mustard										
Varuna	95.6	91.5	150.4	144.7	153.5	144.2	47.4	49.2	67.2	70.2
Vaibhav	86.3	83.9	131.7	127.5	134.2	132.2	40.5	44.3	60.1	63.4
PCR-7	94.1	89.6	133.5	129.1	140.0	133.2	44.2	45.9	63.2	67.2
Rohini	64	60.7	142.1	136.8	145.7	139.9	42.1	46.7	59.4	61.5
RH-30	86.3	82.5	140.9	135.3	143.7	141.9	45	47.3	56.4	67.8
RH-819	76.4	73.2	143.7	139.3	149.2	142.9	46.7	47.4	63.4	65.6
Toria										
PT-30	25.5	22.5	82.4	75.8	85.2	76.6	38.8	40.1	56.2	58.1
TH-68	39.1	37.2	85.1	82.8	92.5	86.2	40.1	41.8	57.6	59.3
Karan rai										
BPKR	60.1	56.5	90.0	86.6	96.8	86.2	42.2	44.1	61.1	64.2
Kiran	37.2	35.9	83.2	76.6	84.8	76.2	44.1	47.2	60.7	65.4
Y. Sarson										
Ys Benoy	35.4	31.6	85.7	82.7	86.1	83.2	35.2	38.2	52.4	54.1
B. Sarson										
BSH-1	83.5	79.9	106.5	99.5	102.7	98.9	41.5	43.7	53.5	56.3
G. Sarson										
GSL-1	36.6	33.6	86.3	75.5	89.3	79.4	47.2	51.3	70.2	73.3
GSL-2	40.1	36.7	82.7	77.5	86.3	80.3	49.1	52.4	71.5	75.4
CD (0.05)	3.7	1.9	3.1	2.6	5.8	4.9	1.3	1.7	1.4	2

flowering, while others took 59-71 days. Under rainfed conditions, the maximum delay of 4-5 days in 50% flowering was observed in PCR-7 and karan rai. In cultivars of different species 50% flowering was delayed by 2-3 days. The slow growth of cultivars under rainfed conditions could be one of the possible reasons of delay in flower initiation and time taken for 50% flowering (Kumar *et al.* 1990).

Branching pattern of different rapeseed-mustard varieties differed significantly. Among all the varieties of different species, BPKR and Kiran of karan rai had maximum parimary and secondary branches/plant irrespective of irrigated or rainfed conditions (Table 3). Per cent reduction in branches per plant under rainfed conditions varied, TH-68 of toria showed highest 29.5% reduction in primary branches, whereas PCR-7 of mustard and TH-68 of toria had highest reduction in secondary branches per plant. However, the lowest reduction in primary branches were noted in Vaibhav and BSH-1 while Rohini and Kiran showed lowest reduction in secondary branches/plant as shown in Table 3. Mustard

Table 3. Number of brancehs per plant and number of siliquae per branch of different rapeseed-mustard varieties grown under irrigated (I) and rainfed (R) conditions

	Branches per plant						Siliquae on differnt branche s							
	Primary		Secondary		Tertiary		Main		Primary		Secondary		Tertiary	
	I	R	I	R	I	R	I	R	I	R	I	R	I	R
Mustard														
Varuna	7.1	5.8(18.3)	13.6	8.6(36.76)	6.2	2.2(64.52)	53.7	40.2(25.14)	154.7	107.6(30.45)	224.7	148.0(34.13)	40.7	22.5(44.72)
Vaibhav	5.2	4.7(9.61)	14.2	9.1(35.91)	8.3	0(100)	61.9	50.5(18.42)	140.2	125.2(10.7)	254.2	181.0(28.8)	67.3	
PCR-7	5.8	4.9(15.51)	8.9	6.7(24.71)	4.4	2.3(47.73)	61.2	52.5(14.22)	248.4	168.6(32.12)	269.7	248.7(7.78)	35.7	30.3(15.12)
Rohini	7.1	5.2(26.76)	13.4	7.1(47.0)	3.2		53.5	43.8(18.13)	165.3	112.9(31.7)	156.6	109.9(29.82)	30.4	
RH-30	7.7	5.7(25.97)	16.3	11.4(30.0)	3.6		50.7	39.7(21.7)	135.3	100.2(25.94)	204.7	104.5(48.95)	39.5	
RH-819	6.7	5.1(23.88)	18.5	11.9(35.67)	4.2	3.2(23.8)	45.8	38.6(15.72)	173.2	126.5(26.96)	262.8	132.4(49.62)	45.6	33.2(27.19)
Toria														
PT-30	7.7	6.6(14.28)	12.4	8.9(28.22)	3.3		42	34.3(18.33)	169.2	142.4(15.84)	202.5	129.8(35.9)	33.7	
TH-68	7.1	50(29.58)	15.3	8.7(43.14)	2.8		60.3	18.7(19.24)	262.4	197.5(24.73)	189.1	134.5(28.87)	25.6	
Karan rai														
BPKR	19	13.5(28.59)	19.5	14.0(28.2)			22.2	18.7(15.76)	169.6	137.5(18.93)	174.3	95.2(45.38)		
Kiran	17.9	13.5(24.58)	23.2	17.4(25.0)			17.5	12.2(30.28)	22.8	136.7(40.0)	293.5	202.8(30.9)		
Y. Sarson														
Ys Benoy	5.6	4.1(26.78)	6.8	4.8(29.41)			43.4	38.6(11.06)	184.7	109.8(40.55)	218.6	135.1(38.2)		
B. Sarson														
BSH-1	6.7	6.0(10.45)	10.5	7.1(32.38)			36	31.7(11.94)	116.7	58.01(50.29)	263.7	197.7(25.03)		
G. Sarson														
GSL-1	9.2	6.7(27.18)	12	7.8(35.0)			55.7	46.5(16.52)	205	108.2(47.22)	200.9	128.5(36.04)		
GSL-2	5.6	4.4(21.43)	11.6	7.9(31.89)			65.1	53.0(18.59)	163.7	218.2(18.94)	218.2	127.5(41.57)		
CD (0.05)	1.3	1.3	1.4	1.1	0.8	0.1	3.2	1.8	9.7	4.9	4.9	70.3	6.8	18.9

*Figure in parenthesis denote per cent reduction over irrigated condition.

Table 4. Seed and husk yield (g) of different branches and total seed and husk weight per plant of different rapeseed -mustard varieties grown under irrigated (I) and rainfed (R) conditions

Varieties	Main branches				Primary branches				Secondary branches				Tertiary branches				Total weight			
	Seed		Husk		Seed		Husk		Seed		Husk		Seed		Husk		Seed / plant		Husk/plant	
	I	R	I	R	I	R	I	R	I	R	I	R	I	R	I	R	I	R	I	R
Mustard																				
Varuna	5.5	3.41	15.48	9.55	13.26	9.52	53.5	41.1	11.53	7.52	18.63	11.34	2.8	1.03	3.1	1.2	33.12	21.48	90.71	63.19
Vaibhav	5.1	3.01	10.4	6.87	11.73	8.74	61.5	51.7	9.49	6.53	12.52	9.25	3.0	—	2.8	—	30.27	18.28	87.22	67.82
PCR-7	5.4	4.09	13.57	10.63	13.27	10.46	61.3	52.8	11.18	7.34	17.97	13.95	2.2	1.22	2.9	1.41	32.0	23.11	95.74	78.79
Rohini	4.2	3.09	10.48	7.32	10.25	7.45	53.1	45.7	8.88	6.16	12.51	9.21	2.0	—	1.98	—	25.32	16.70	78.17	62.23
RH-30	4.4	2.95	10.79	6.46	11.73	7.50	50.0	39.6	8.83	7.26	13.71	10.25	2.3	—	2.47	—	27.26	17.71	76.97	56.31
RH-819	5.9	4.9	15.16	11.21	12.99	9.86	46.0	38.9	9.89	8.22	18.49	14.89	2.5	1.29	2.89	1.37	31.27	24.27	82.54	66.37
Toria																				
PT-30	3.3	2.32	10.63	6.66	6.38	4.80	40.7	33.0	5.28	4.3	12.26	7.92	1.9	—	2.22	—	16.86	11.42	65.81	47.58
TH-68	3.2	2.58	12.53	8.49	6.93	4.69	61.5	51.3	5.57	4.1	15.62	11.58	1.8	—	2 09	—	17.51	11.37	9.74	71.37
Karan rai																				
BPKR	3.9	2.67	9.56	7.02	6.23	4.29	23.7	18.5	5.33	3.98	12.34	7.98	—	—	—	—	15.52	10.94	45.60	33.50
Kiran	4.2	2.67	9.39	6.75	5.89	3.73	17.5	12.4	4.81	4.26	12.60	7.74	—	—	—	—	14.97	10.66	39.49	26.89
Y. Sarson																				
Ys Benoy	3.0	1.96	11.44	7.32	6.40	4.82	44.1	38.0	5.16	3.94	12.84	9.71	—	—	—	—	14.59	10.72	68.34	55.03
B. Sarson																				
BSH-1	4.9	2.24	6.97	5.67	7.52	5.11	36.1	29.6	4.93	4.09	10.88	7.18	—	—	—	—	17.33	11.44	53.95	42.45
G. Sarson																				
BSL-1	4.0	2.85	9.70	7.48	6.49	5.30	56.4	46.1	5.23	4.22	13.01	11.13	—	—	—	—	15.76	12.37	91.48	64.71
GSL-2	3.5	3.01	9.71	6.81	6.91	5.57	64.2	51.5	4.88	4.37	12.96	11.93	—	—	—	—	15.29	12.95	86.87	70.24
CD (0.05)	0.2	0.39	1.22	1.02	0.84	0.84	1.99	1.2	0.72	0.47	1.39	1.65	0.10	0.345	0.216	0.62	—	—	—	—

and toria varieties had tertiary branches under irrigated conditions. The three varieties of mustard i.e. Varuna, Rohini and RH-819 produced tertiary branches under rainfed condition too. Varieties of other species had no tertiary branches either under irrigated or rainfed conditions. Secondary branches under rainfed conditions reduced significantly in *Brassica juncea, B. napus* and *B. carinata* (Thukral *et al.* 1985).

Main branch of GSL-2 (gobhi sarson) PCR-7 and Vaibhav (mustard) and TH-68 (toria) produce maximum number of siliquae per plant under irrigated conditions. Similarly, the primary branches of TH-68 (toria) and PCR-7, secondary branches of Kiran (karan rai) and PCR-7 (mustard) produced the highest number of siliquae per plant under irrigated conditions. In general, the drastic reduction in siliquae number on different branches irrespective of varieties/or species was observed under rainfed conditions. Maximum per cent reduction in siliquae number on main branch was observed in Kiran, while the BSH-1 and GSL-1 showed the highest reduction in siliquae number on primary branches. Genotypes RH-30 and RH-819 of mustard showed maximum reduction in siliquae on secondary branches. According to Tak (1976) number of siliquae per plant had the largest direct contribution to the seed yield. Reduction in siliquae/plant under rainfed conditions was also observed by Thukral *et al.* (1985) in three different varieties of *B. juncea. B. juncea* varieties in general, gave the highest yield per plant under both the conditions while in the *B. carinata* varieties the yield was lowest (Table 4). Similarly, the husk weight per plant was highest in *B. juncea* varieties as compared to others. The maximum seed yield of main and primary branches per plant was observed in RH-819 while maximum seed yield of secondary branches was observed in Varuna. Seed and husk weight of different branches under rainfed conditions declined. The highest reduction in seed yield/plant (35-40%) was in Vaibhav, Varuna, Rohini and RH-30 of *B.juncea,* TH-68 and PT-30 of toria and BSH-1 brown sarson. While the highest reduction in seed yield of main branch was observed in BSH-1 followed by Vaibhav and Varuna (Table 4). Kumar *et al.* (1990) observed significantly higher number of pods and seed yield per plant in *B.juncea* varieties than the varieties of other species under rainfed conditions. Genotypic and environmental interactions were responsible for different behaviour of *Brassica* species. According to Champolivier and Merrien (1998) water stress at the end of flowering caused significant reduction in seed weight (35%) on the main stem as compared to the control. Water stress at flowering also significantly affected seeds on different branches. Henry and Dauly (1981) observed the highest mean seed yield in brown sarson with three irrigations as compared to one irrigation. Husk weight of mustard genotype Vaibhav, Rohini and Varuna showed 18-25% reduction under rainfed conditions while toria and karan rai showed 32-37% reduction in husk weight per plant Minimum reduction of husk weight/plant was observed in PCR-7, RH-819 and Ys Benoy. The soil moisture deficit decreased plant growth and reduced straw yield (Borzynski 1978). The maximum dry matter translocation (37-48%) from pod wall to seed were observed in mustard genotypes whereas gobhi sarson (17-18%) and toria (22-26%) showed minimum translocation rate. The translocation of dry matter from pod wall to seed decreased under soil moisture deficit in almost all the genotypes except BSH-1. The translocation rate of dry matter from pod wall to seed can be taken as selection criteria.

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