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Group balanced block design for comparisons among oilseed *Brassicae*

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The *brassica* genus contains the most genetically diverse collection of agriculturally important plant species, including oilseed, mustard and cruciferous species. Comparisons for seed yield and its components were drawn among brown (*Brassica rapa var. brown sarson*), gobhi (*Brassica napus*) and yellow sarson (*B. rapa var. trilocularis*). Brown sarson was found high yielder by virtue of its high siliquae number per plant and recorded maturity duration between the two. *B. napus* entries were late and showed intermediate seed yield. Significant mean squares were noted for all the traits among and within groups.

Key words: *Brassica rapa, Brassica napus,* sarson, maturity, yield.

INTRODUCTION

Brassica is a genus of the *Brassica*ceae (*Cruciferae*), commonly known as the *Cruciferae* family and are among the oldest cultivated plants known to humans with written records dating back to ca. 1500 BC (Prakash, 1980) and archaeological evidence of its importance dating back to 5000 BC (Yan, 1990) .

The *Brassica*ceae, which *currently* includes 3709 species and 338 genera (Warwick et al., 2006), is one of the ten most economically important plant families (Rich, 1991). The genus *brassica* has mainly Mediterranean distribution, but it extends to Asia and Africa, including India. Oilseed rape has been cultivated for thousands of years in Asia and the Indian subcontinent and then later in Europe.

The research carried by Morinaga (1934) revealed that *brassica*s consist of six species, three of them are monogenomic diploids viz *Brassica nigra* (n=8), *Brassica oleraceae* (n=9) and *Brassica Campestris* (n=10) while as, three are chromosome digenomic tetraploids, *Brassica carinata* (n=17), *Brassica juncea* (n=18) and *Brassica napus* (n=19), which evolved in nature through convergent allopolyploid evolution between any of the

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two diploid species. Brassica species are widely used in human diet mainly as an important source of vegetables, condiments, and edible oils (Branca and Cartea, 2011). Rapeseed-mustard seed is rich in oil and protein and contains 40 to 46% oil and 18 to 22% protein. In addition the oil content of *Brassica* seed meal contains about 40% protein with well-balanced amino acid (Miller et al., 1962) but lower than would be desired. The use of the related crops is cited in some ancient civilized regions such as in the Mediterranean and in Asia (Shaukat et al., 2014).

Rapeseed was the third largest source of vegetable oil in the world (after soybean and palm) and the second world source of protein, although it reached only a fifth of the soybean production. To assess and predict the possibilities and consequences of inter-specific hybridization, besides other factors it is important to know the flowering chronology and other important agro-morphological traits related to seed yield across different *Brassica* species (Anonymous, 1999). Usually among the three ecotypes brown sarson is more adaptable to environment in Kashmir, while gobhi sarson tends to be late.

Available germplasm of yellow sarson has shown little tolerance to cold. The study was undertaken to establish the differences with respect to yield and its component attributes within and among the genotypes in three *Brassica* species viz., *Brassica rapa var. brown sarson* (or brown sarson), *B. rapa var. trilocularis* (or yellow sarson) and *B. napus* (gobhi sarson).

MATERIALS AND METHODS

The experimental material comprised of 10 genotypes of brown (*B. rapa var. brown sarson*), gobhi (*B. napus*) and yellow sarson (*B. rapa var. trilocularis*) each were laid in a group balanced block design with 3 replications during *rabi* 2008-09 at MRCFC,Khudwani, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, India. The said experimental material was procured from Directorate of Rapeseed-mustard Bharartpur.

Each genotype was grown in a 5 m row length with three rows/plot with a crop geometry of 30 x 10 cm. The analysis of variance was performed following Gomez and Gomez (1983). The observations were recorded for 12 agro-morphological characters such as, plant height (PH), days to 50% flowering (DF), days to maturity (DM), primary branches per plant (PB), secondary branches per plant (SB), main raceme length (RL), siliquae on main raceme (SM), total siliquae per plant (TS), siliqua length (SL), 1000-seed weight (SW), seeds per siliqua (SS) and seed yield per plant (SY).

Barring DF and DM, observations for all the traits were recorded on 10 randomly selected competitive plants per entry per replication. All the recommended package and practices were adapted to raise a good crop.

RESULTS AND DISCUSSION

The perusal of the results revealed that among the three *Brassica* groups viz., brown sarson, gobhi sarson and yellow sarson, significantly high average mean values over the constituent genotypes were exhibited by brown sarson group with respect to traits PH, RL, SM and TS followed through gobhi sarson to yellow sarson (Table 1). Highest average mean values for DF and DM were recorded for gobhi sarson which established that this *Brassica* groups tend to be late in maturity (231 DAS) under Kashmir conditions while, yellow sarson matures on an average 14 days earlier than brown sarson (205 DAS).

Since gobhi sarson usually shows delayed maturity than brown sarson, at least here by 26 days, this remains perhaps the biggest deterrent to fit elite gobhi sarson germplasm in rice-rapeseed rotation. The trait SW weight exhibits highest average mean for gobhi sarson followed by yellow sarson and brown sarson sequentially. Statistically non-significant differences were recorded for SS between gobhi and brown sarson group, however, the trait recorded highest mean (27 seeds per siliqua) over the genotypes in yellow sarson group (Sinhamahapatra et al., 2003).

This was because of the tetra-locular siliquae of the genotypes in yellow sarson compared to bi-chambered nature of most of the gobhi and all the brown sarson entries. More importantly, highest average SY was exhibited by brown sarson (1167 kg/ha) against other two groups those showed yield at *par* between them. Brown sarson out-yielded two other sarson types by virtue of significantly higher SM and TS than either of the two. Similar comparisons were made between three *Brassica* groups by Varshney et al. (1986) and Shikari and Sinhamahapatra (2004).

Analysis of variance revealed that highly significant variation existed among three *Brassica* groups for all the twelve characters (Table 2). The *Brassica* species recorded significant to highly significant variability within the groups for all the characters under study except SB and SL for yellow and brown sarson respectively. Also, non-significant mean squares for DF were noted within brown sarson group.

High significant mean squares were shown by three primary yield attributes that is, SS, TS and SW among and within the groups except within yellow sarson group for TS.

Since brown sarson is the only *Brassica* oilseed grown in Kashmir valley, the comparisons made above highlights the importance of breeding early maturing gobhi sarson types with high TS, SW and SS. Yellow sarson usually remains low yielder out of the three, though could be used in hybridization for improving SW, maturity traits and oil content.

Conflict of Interest

The authors have not declared any conflict of interest.

Table 1. Comparison using Group Balanced Block Design among and within groups representing three *Brassica* species for yield and its components.

Group/ statistic	Plant height (cm)	Days to 50% flowering	Days to maturity	Number of primary branches	Number of secondary branches	Main raceme length (cm)
Range (Gobhi sarson)	68.87-97.60	164.67-175.00	226.67-235.33	3.87-5.87	5.27-8.70	34.47-40.87
Range (Yellow sarson)	34.64-63.32	136.33-158.40	164.33-203.87	3.10-5.21	2.31-3.67	17.97-35.07
Range (Brown sarson)	81.13-109.47	161.33-165.67	191.67-214.33	3.60-6.17	1.40-5.90	44.53-62.40
Mean (Gobhi sarson)	84.94	170.67	231.30	4.66	6.85	37.91
Mean (Yellow sarson)	51.97	151.00	191.30	4.07	3.02	27.37
Mean (Brown sarson)	100.64	163.37	205.43	4.62	3.57	50.96
Grand mean over groups	79.18	161.68	209.34	4.45	4.48	38.74
CD (at 5%) among groups	5.87	1.20	5.30	0.36	0.62	7.13
CD(at 5%) within groups	4.98	1.38	1.88	0.36	0.53	1.84
CV (%) among groups	7.38	0.74	2.52	7.98	13.67	18.30
CV (%) within groups	7.99	1.08	1.14	10.36	14.94	6.04

Group/ statistic	Siliqua on main raceme	Siliquae/plant	Siliqua length (cm)	1000- seed weight (g)	Seeds/ siliqua	Seed yield / hectare (kg)
Range (Gobhi sarson)	27.87-41.80	48.88-136.82	4.18-4.99	3.07-4.58	16.44-22.62	464.76-1246.00
Range (Yellow sarson)	16.67-31.67	40.43-67.58	3.11-4.06	3.27-4.20	21.30-30.93	494.56-868.05
Range (Brown sarson)	42.73-60.67	99.80-225.50	4.78-5.49	1.97-2.93	13.43-20.68	838.89-1475.00
Mean (Gobhi sarson)	34.02	97.90	4.60	3.79	18.75	753.02
Mean (Yellow sarson)	24.40	55.63	3.58	3.59	27.02	644.73
Mean (Brown sarson)	51.12	127.49	5.22	2.32	17.24	1167.81
Grand mean over groups	36.51	93.67	4.46	3.23	21.00	855.18
CD (at 5%) among groups	2.08	5.44	0.76	0.05	2.33	125.32
CD(at 5%) within groups	2.36	8.22	0.21	0.07	0.92	59.90
CV (%) among groups	5.67	5.78	16.97	1.50	11.04	14.58
CV (%) within groups	8.21	11.14	5.85	2.80	5.55	8.89

Table 2. Mean squares among and within different *Brassica* species grown in group balanced block design.

Source of variation	df	Mean sum of squares					
		Plant height (cm)	Days to 50% flowering	Days to maturity	Number of primary branches	Number of secondary branches	Main raceme length (cm)
Replications	2	46.40	0.18	20.35	0.35	0.39	62.37
Groups	2	18515.72**	2963.94**	12344.18**	3.20**	128.57**	4188.52**
Error (a)	4	34.10	1.42	27.77	0.13	0.37	50.29
Gobhi sarson	9	194.03**	30.74**	20.26**	1.03**	5.13**	20.73**
Yellow sarson	9	267.38**	194.58**	484.73**	1.34**	0.59	77.86**
Brown sarson	9	232.60**	5.96	215.93**	1.74**	5.12**	90.41**
Error (b)	54	40.06	3.06	5.67	0.21	0.45	5.48

Source of variation	df	Siliqua on main raceme	Siliquae/plant	Siliqua length (cm)	1000- seed weight (g)	Seeds/ siliqua	Seed yield / hectare (kg)
		7.99	35.87	0.58	0.01	4.34	6374.13
Groups	2	5495.88**	39122.89**	20.62**	18.92**	831.94**	2286927.22**
Error (a)	4	4.29	29.34	0.57	0.01	5.38	15553.82
Gobhi sarson	9	66.15**	1881.00**	0.17*	0.91**	13.40**	182184.68**
Yellow sarson	9	66.95**	213.54	0.24**	0.20**	25.95**	52209.25**
Brown sarson	9	89.49**	3955.99**	0.14	0.34**	22.20**	145937.57**
Error (b)	54	8.99	108.82	0.07	0.01	1.36	5784.54

** and * indicates P (<0.01) and P (<0.05) respectively.

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