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CROP PRODUCTION

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Ideotype and relationship between morpho-physiological characters and yield in indian mustard (*Brassica juncea*)

C H M VIJAYA KUMAR[1], V ARUNACHALAM[2], S K CHAKRABARTY[3] and P S KESAVA RAO[4]

Indian Agricultural Research Institute, New Delhi 110 012

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ABSTRACT

Twelve genotypes of indian mustard [*Brassica juncea* (L.) Czernj. & Cosson] were evaluated for various yield and morpho- physiological characters during 1990 and 1991. The genotypes were classified basal or non-basal branching type on the basis of the presence or absence of at least 1 productive primary branch within 30 cm height of the plant. A correlation analysis revealed that the traits related to basal branching were positively associated among themselves as well as with the seed yield. There were desirable and negative associations of basal branching characters with flowering time and plant height. Thus breeding for early maturing basal branching plant types with medium height and high yield is possible.

The plant type of indian mustard [*Brassica juncea* (L.) Czernj. & Cosson] is more open and non-compact, bearing more siliquae on secondary and tertiary branches than on main axis. In general, fruiting branches initiate at a good height from base, sometimes at 1 m. The main stem is not always strong enough to support the top heavy canopy, particularly at the time of pod development and maturity. The plant becomes highly prone to lodging in the event of a hailstorm and heavy winds, usual before harvest. It results in avoidable seed loss. Further, the leaf mass in this crop is improportionately high compared with the productive siliquae borne by it, resulting in low harvest index (often < 20%). Breeders (Jain 1984, Labana 1984) have laid emphasis on a plant type of medium height and of basal branching, possessing good compact canopy, suitable for high-density planting with harmonious source-sink relationship. There is no study on basal branching or the nature of its association with yield and other traits of interest. In this paper basal branching is defined, and its association with various morpho-physiological, yield and plant-type attributes is discussed.

[2]Head, [4]Scientist, Division of Genetics

[1]Scientist, Directorate of Rice Research, [3]Scientist, Directorate of Oilseeds Research, Rajendranagar, Hyderabad 500 030

MATERIALS AND METHODS

Twelve genotypes of *B. juncea* selected for the study were evaluated during winter season of 1990 and 1991. The experiment was conducted in randomized block design with 3 replications. Each genotype was sown in 2 rows of 5 m length each, with row-to-row spacing of 75 cm and plant-to-plant distance of 15 cm. Five plants were selected from each genotype at random to record the observations.

Data were collected on various general and specific morpho-physiological traits. The traits of general nature were days to first flowering, total number of primary branches, total number of secondary branches, seed yield/ plant, and harvest index. Those of specific nature were measured at the basal portion of the plants. A height of 30 cm from the ground was measured (H_1) and all the characters measured at H_1 were termed basal branching characters. The entry that produced at least 1 productive primary branch within 30 cm height from the ground was considered basal branching. A primary branch was considered productive if it contained at least 10% siliquae of the primary branch on the plant bearing maximum siliquae. Analysis of variance was done and correlations were calculated from the estimated variances and covariances.

RESULTS AND DISCUSSION

The genotypes showed significant differences for all the traits studied except seed yield (Table 1). Two groups based on *inter-se* phenotypic correlations among characters could be found (Table 2). All the characters related to basal branching formed group A, whereas other characters (first flowering, primary branches and secondary branches) formed group B. A general association within and between the groups was apparent, ie variables in both the groups were desirably associated among themselves. The correlation between any variable in group A with any in group B was negative. But correlations among basal branching characters were positive. The correlations between basal branching characters and seed yield harvest index were either positive or nonsignificant. Further, the basal branching characters were desirably and negatively associated with days to flowering and plant height.

The ideotype approach to crop breeding has generated considerable interest in discovering desirable plant models and associated characters (Donald 1968, Mock and Pearce 1975 , Hudges *et al.* 1979). Plant breeding studies have identified branches, pods/plant, and seeds/pod as the key characters for higher seed yield in rapeseed and indian mustard. Lack of physiologically efficient plant type in these crops has been one of the limiting factors in increasing productivity. Their low seed yield may be attributed primarily to their low harvest index (Singh and Chauhan 1984). Chatterjee and Sengupta (1984) considered 2 primary branches to be ideal for optimum translocation of dry matter in indian mustard, and reported that allowing more vegetative growth only reduced the harvest index without any significant increase in yield.

Basal-branching genotypes of indian mustard flowered early and were short in stature. They gave equal or greater harvest index than non-basal branching types. This was borne out by the strong and negative correlations of basal branching characters, days to flowering and plant height. The correlation of basal branching characters with harvest index was positive or non-significant. However, harvest index was positively associated with seed yield, which in turn showed non-significant association with days to flowering and plant height. Therefore development of early, basal-branching genotypes with short stature, high yield and high harvest index should be possible.

Bharvaga and Tomar (1982), Katiyar *et al.* (1985) and Gupta *et al.* (1987) reported high and positive correlation between plant biomass, harvest index and seed yield. Wallace *et al.* (1972) reported that increase in harvest index leads to increased physiological

Table 1 Morpho-physiological characters in 12 genotypes of indian mustard in winter season (mean values)

Genotype	Year	FT	HT	PB1	PB	SB1	SB	SY1	SY	HI1	HI
'PR 45-1'	1990	64	209	0.4	9	1.4	30	0.3	25	0.2	18
	1991	49	218	0.1	7	0.3	22	0.1	27	0.1	22
'RNBL 68-1'	1990	62	219	0.5	11	1.5	30	0.3	26	0.2	17
	1991	46	212	1.1	7	5.1	22	3.4	22	1.9	13
'DIRA 313'	1990	57	199	0.8	10	4.1	25	1.0	18	0.6	14
	1991	44	212	0.0	8	0.0	20	0.0	28	0.0	19
'JAP-NIG'	1990	59	209	0.2	9	0.7	27	0.1	23	0.1	16
	1991	45	185	0.4	5	1.8	15	1.8	31	0.9	21
'Nari Nig-1'	1990	60	214	0.1	9	4.9	33	2.1	26	1.1	14
	1991	49	227	0.5	6	2.7	18	3.1	25	2.0	17
'PR 45-2'	1990	69	210	0.0	10	0.0	32	0.2	29	0.1	23
	1991	57	251	0.1	10	0.4	30	0.2	43	0.1	24
'Nari Nig-2'	1990	75	233	0.5	13	2.7	40	0.7	29	0.4	17
	1991	54	249	0.1	11	1.0	36	0.8	29	0.4	17
'RNBL.68-2'	1990	61	207	0.8	11	3.5	36	0.5	11	0.3	10
	1991	51	258	0.1	10	0.6	34	0.4	34	0.2	17
'YN 3-1'	1990	47	163	3.1	9	12.1	28	4.5	25	6.3	18
	1991	39	152	2.8	6	11.4	19	13.3	33	9.0	24
'YN 3-2'	1990	42	161	2.8	9	11.6	27	12.7	34	5.9	18
	1991	38	151	2.1	6	5.9	15	5.5	18	6.6	22
'BN 2'	1990	49	184	1.9	9	9.4	29	7.1	26	4.0	18
	1991	44	188	0.8	7	3.9	21	3.3	26	2.3	20
'TN 3'	1990	51	164	2.6	8	9.0	21	6.0	23	5.0	21
	1991	46	175	1.8	6	4.9	15	7.8	27	6.2	24
SE	1990	2.04	5.39	0.41	0.63	1.68	NS	0.89	NS	0.82	2.21
	1991	2.61	6.74	0.37	0.82	1.64	4.34	1.93	NS	0.88	1.63

FT, First flowering; HT, plant height; PB1, primary branch from H_1 (30 cm from ground level); PB, primary branches; SB1, secondary branch from H_1; SB, secondary branches; SY1, seed yield plant at H_1; SY, seed yield/plant; HI1, harvest index at H_1; HI, harvest index

activity and translocation of photosynthates to the sink. Zhau and Liu (1987) observed that low height for primary-branch initiation was an important character for increasing seed yield. But seed yield was negatively correlated with early flowering (Thurling and Das 1980). The time to reach various growth stages and duration of growth period were not found consistently correlated with seed yield (Campbell and Kondra 1978). Thus selection for early maturity and high seed yield should be possible (Degenhart and Kondra 1984). Harvest index was positively correlated with seed yield/plot in indian mustard (Campbell and Kondra 1978), that between seed yield/plant and seed yield/plot (Thurling

Table 2 Correlation coefficients among plant-type traits in indian mustard in winter season

Character	Year	HT	PB1	PB	SB1	SB	SY1	SY	HI1	HI
FT	1990	0.84*	−0.73*	0.58*	−0.76*	0.55*	−0.76*	0.05	−0.78*	0.0
	1991	0.77*	−0.59*	0.49*	−0.52*	0.36*	−0.50*	0.13	−0.57*	−0.18
HT	1990		−0.80*	0.53*	−0.83*	0.46*	−0.74*	−0.02	−0.82*	−0.20
	1991		−0.76*	0.69*	−0.66*	0.64*	−0.67*	0.26	−0.78*	−0.31
PB1	1990			−0.17	0.94*	−0.18	0.74*	0.14	0.82*	0.08
	1991			−0.39*	0.94*	−0.32	0.92*	−0.02	0.96*	0.27
PB	1990				−0.19	0.86*	−0.26	0.30	−0.34*	−0.04
	1991				−0.34*	0.88*	−0.34*	0.50*	−0.42*	−0.02
SB1	1990					−0.08	0.83*	0.17	0.89*	0.09
	1991					−0.18	0.93*	0.09	0.88*	0.20
SB	1990						−0.16	0.40*	−0.25	0.02
	1991						−0.23	0.59*	−0.37*	−0.09
SY1	1990							0.35*	0.84*	0.26
	1991							0.13	0.93*	0.29
SY	1990								0.22	0.76*
	1991								−0.05	0.45*
HI1	1990									0.29
	1991									0.36*

*P = 0.05

For explanation of symbols, please see Table 1

1974) was positive in european mustard [*B. napus* L. subsp. *oleifera* DC]

Degenhert and Kondra (1981, 1984) found that plant height was negatively correlated with seed yield, a point in favour of developing short-statured plants. With their greater growth rate they could be more productive at higher seeding rate than other genotypes (Kasa and Kondra 1986).

In basal branching types the number of basal primary and secondary branches were significantly and desirably associated with seed yield and harvest index. This indicated that yield could be improved through selection for types with more number of basal primary and secondary branches.

The contribution of yield from basal branches to the total seed yield was considerable (15–34%) in basal-branching genotypes. The seed yield of these genotypes was equal to or more than that of some of the non-basal branching types.

The basal-branching types give relatively risk-free yield from compact plants compared with risk-prone yield from top heavy, lodging-susceptible plants of non-basal branching types. In soybean [*Glycine max* (L.) Merr.] also the seed yield and seed size near the bottom of the canopy were much higher in determinate than in indeterminate plant types (Weil *et al.* 1990).

Unbranched monoculm plants with reduced foliage would have low leaf-area index. However, with high plant population the leaf-area index could be increased, but consequently intra-plant competition will also increase (Sinha 1990). In crucifers like *Brassica*, non-branching habit is not possible, but highly branched genotypes are available in some species. It is possible to shift emphasis from highly branched, prone to lodging, non-basal plant types to high basal-branching types that are relatively free from these limitations.

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