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Effect of nitrogen application on partitioning of biomass, seed yield and harvest index in contrasting genotypes of oilseed brassicas

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ABSTRACT

Five genotypes of Indian mustard [*Brassica juncea* (L.) Czernj. & Cosson], viz. 'RH 30', 'RH 8814', 'GJM 9056', 'CS 52' and 'Kranti', and 1 genotype of Swede rape (*Brassica napus* L.) cv. 'GSH 1' were grown to assess the effect of various nitrogen levels (0,40,60 and 80 kg N/ha) on dry-matter partitioning, seed yield and harvest index during the winter seasons of 1993–94 and 1994–95. Stem and leaf constituted the major part of plant biomass up to peak flowering (66 days after sowing), onwards and siliquae continued to increase their share to plant biomass irrespective of nitrogen levels and genotypes. Total dry matter increased significantly up to 60 kg/ha. For above-ground plant biomass, 'RH 8814' was significantly superior at 66, and 108 days after sowing and at harvest than 'RH 30', 'GJM 9056', 'CS 52', 'GSH' 1 and 'Kranti. Seed yield increased significantly up to 80 kg/ha. There were non-significant differences in seed yield among *Brassica juncea* genotypes and all these were significantly superior to *Brassica napus* 'GSH 1'. Harvest index increased with the increasing nitrogen levels and 'RH 30' genotype had the better harvest index than other genotypes.

Key words : Brassicas, Partitioning, Genotypes

The productivity of Indian mustard is very low, though there is ample scope for increasing production through fertilizer use, especially nitrogen. Improvement in grain yield of cereals has been primarily achieved through increase in harvest index between tall and dwarf cultivars (Loss *et al.*, 1989). A similar increase in productivity of oilseed brassicas could also be achieved by greater allocation of assimilates from vegetative plant parts to grain (Singh *et al.*, 1990). The change in the partitioning of biomass from vegetative plant parts to grain could be altered through modification in crop architecture, particularly with fertilizer application and choosing cultivars of varied

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genetic background. Indian mustard responds to N nutrient positively in terms of biomass and seed yield but such responses could differ among cultivars. An information about the effect N fertilization on partitioning of biomass in different parts and harvest index at varietal level is lacking in oilseed brassicas, hence an attempt was made on such aspects.

MATERIALS AND METHODS

A field experiment was conducted in split-plot design with 3 replications during the winter seasons of 1993–94 and 1994–95 at the Research Farm, CCS Haryana Agricultural University, Hisar. The soil was sandy loam, slightly alkaline in reaction (pH of 1:2 soil water extract 7.9), poor in nitrogen, medium in phosphorus and rich in potash (0–30 cm soil layer contained 165,18 and 383 kg/ha available N, P and K respectively). Four levels of nitrogen (0,40,60 and 80 kg/ha) were taken as main-plot treatments and 6 *Brassica* genotypes ('CS 52', 'Kranti', 'GJM 9056', 'RH 30', 'RH 8814' and 'GSH 1') as subplot treatments. Out of 6 genotypes, 5 belonged to *Brassica juncea* and 1 to *Brassica napus* ('GSH 1'). The sowing was done on 5 November 1993 and 29 October 1994 at a row spacing of 30 cm. Half of N as per treatment along with full dose of P (40 kg P_2O_5/ha through SSP) and $ZnSO_4$ @ 25 kg/ha was applied at the time of seeding and the remaining N was top-dressed after first irrigation (35 days after sowing).

Five plants were sampled randomly in each treatment and averaged for recording the change in dry weight in leaves, stem and reproductive plant part (siliquae) separately at 3 stages of growth, i.e. full bloom/pod initiation (66 DAS), completion of pod formation (108 DAS) and at physiological maturity in different genotypes under varying nitrogen levels. These plant samples were first dried under the sun and thereafter in oven at 70°C till constant weight was recorded. A special sample was taken at flower-bud initiation on main raceme for dry-matter distribution in different vegetative above-ground plant parts. At maturity, harvest index was estimated by dividing seed yield with biological yield (seed + stem + leaf) and multiplying these values with 100.

Table 1. Mean monthly meteorological data during crop seasons of 1993–94 and 1994–95 at Experimental Station, Hisar

Month	Sunshine hr/day		Mean temperature (°C)			
	1993–94	1994–95	Maximum		Minimum	
			1993–94	1994–95	1993–94	1994–95
October (last week)	8.6	8.6	32.1	31.8	12.8	12.5
November	7.1	7.8	27.7	29.7	9.6	10.3
December	6.4	7.0	24.1	19.6	6.2	4.2
January	5.2	5.6	19.7	20.7	5.6	6.4
February	5.4	7.8	25.0	23.7	9.4	6.5
March	7.5	9.2	27.1	31.3	11.0	11.7

Mean monthly meteorological data during crop season are given in Table 1.

RESULTS AND DISCUSSION

Partitioning and accumulation of biomass

At full bloom or siliquae-initiation stage (66 DAS) of growth the mean contribution (averaged across N levels and genotypes) of different plant parts to plant dry weight was 52.7% in stem, 44.8% in leaf and 2.5% in pods during 1993–94. The corresponding values at this stage in 1993–94 were 45.2% in stem and 54.8% in leaves. Such differences in the allocation of dry matter at full bloom between 2 seasons might be due to differences in weather conditions, dates of sowing and overall poor growth in 1993–94 than 1994–95. Onwards 66 DAS, the contribution (%) of leaves to total above-ground dry mater continued to decrease gradually till maturity irrespective of various treatments. This might be because of senescence of leaves owing to their location in bottom layers of crop canopy and increased activity of green siliquae in upper profile of crop canopy with higher incident radiation.

At the time of flowering (66 DAS), the stem constituted the major proportion of the total above-ground dry matter. The contribution of stem continued to increase till completion of siliquae formation (108 DAS) irrespective of N levels and

Table 2. Partitioning of dry matter in various parts/plants (g) of *Brassica* genotypes as affected by nitrogen (pooled data of 2 years)

Treatment	Days after sowing							
	66			108			At harvest	
	Steam	Leaf	Siliquae	Stem	Leaf	Siliquae	Stem	Siliquae
Nitrogen (kg/ha)								
N_0	4.23	4.44	0.09	15.21	2.89	9.37	15.96	14.31
N_{40}	4.99	5.02	0.07	19.11	3.15	13.05	18.98	18.20
N_{60}	5.27	5.28	0.05	20.84	3.28	14.71	21.28	20.24
N_{80}	5.45	5.58	0.05	21.79	3.46	15.50	21.86	21.07
CD (P = 0.05)	0.47	0.32	0.03	0.55	0.55	0.56	0.46	0.32
Brassica *genotype*								
'CS 52'	5.94	5.82	0.00	20.76	3.53	14.28	23.38	17.18
'Kranti'	5.83	5.58	0.00	19.88	2.84	13.55	21.85	20.62
'GJM 9056'	4.08	4.73	0.00	19.98	2.74	13.14	20.99	19.68
'RH 30'	6.48	5.26	0.27	21.20	2.93	14.73	22.29	20.59
'RH 8814'	5.59	6.36	0.00	22.54	5.17	12.92	24.59	22.80
'GSH 1'	156	2.96	0.50	6.46	1.54	8.20	7.48	12.11
CD (P = 0.05)	0.66	0.85	0.07	1.01	0.98	0.67	1.01	1.23

genotypes (Table 2). The siliquae started contributing towards dry-matter accumulation from 66 DAS and continued to increase their share in total plant dry weight till maturity.

The total dry-matter accumulation/plant at the time of flowering was significantly higher at 60 kg N and 80 kg N/ha over the control, but the differences were non-significant between 60 kg and 80 kg N/ha. Similar trend was observed at the completion of pod formation (108 DAS) and at physiological maturity. The contribution of stem at harvest was 52–54% and that of siliquae was 46–48% over the pooled data of 2 years. The observations made by Mehrotra *et al* (1980) also revealed marked differences in dry-matter accumulation in different plant parts within brassica species. The existence of genetic variation in the proportion of dry-mater accumulation in different plant parts could be suitably manipulated through management strategies to attain higher harvest index and seed yield in oilseed brassicas.

At the time of flowering, among genotypes, 'RH 8814' was statistically at par with 'CS 52', 'Kranti' and 'RH 30' in total dry-matter accumulation and all these genotypes had significantly more dry-matter accumulation/plant than 'GJM 9056' and 'GSH 1' (Table 3). At the completion of

Table 3. Total dry matter (g/plant) at 66, 108 days after sowing and at harvest, total number of pod-bearing branches, seed yield and harvest index of *Brassica genotypes* as affected by varying levels of nitrogen

Treatment	Total dry matter (g)			Seed yield (kg/ha)		Harvest index (%)	
	66 days*	108 days*	At harvest	1993–94	1994–95	1993–94	1994–95
Nitrogen (kg/ha)							
N_0	8.76	27.47	30.27	403	1,259	20.82	19.93
N_{40}	10.08	35.11	37.18	7.16	1,789	21.25	23.63
N_{60}	10.60	38.83	41.52	849	2,060	21.43	25.42
N_{80}	11.08	40.75	42.93	940	2,250	21.51	26.69
CD (P = 0.05)	0.52	2.12	1.55	88	218	0.24	1.33
Brassica *genotype*							
'CS 52'	11,76	38.07	45.56	8.60	2,028	21.69	24.52
'Kranti'	11.41	36.27	42.47	822	1,920	21.50	24.56
'GJM	8.81	35.86	40.67	781	1,877	19.02	23.38
'RH 30'	11.91	38.86	42.88	8.38	1,994	25.77	25.79
'RH 8814'	11.95	40.63	47.39	8.90	2,091	20.55	23.59
'GSH 1'	5.02	16.20	19.59	169	1,127	20.18	23.76
CD (P = 0.05)	1.08	2.10	1.84	122	238	0.83	1.12

*Days, Days after sowing

Table 4. Dry-matter accumulation during pre-flowering and post-flowering phase of *Brassica* genotypes as affected by nitrogen levels

Treatment	Pre-flowering		Post-flowering	
	1993–94	1994–95	1993–94	1994–95
Nitrogen (kg/ha)				
N_0	3.6	6.7	96.4	93.3
N_{40}	5.1	7.7	94.9	92.3
N_{60}	6.3	8.6	93.7	91.4
N_{80}	7.3	9.3	92.7	90.7
CD (P = 0.05)	1.0	0.9	1.6	1.2
Brassica *genotype*				
'CS 52'	6.1	8.4	93.9	91.6
'Kranti'	4.9	6.8	95.1	93.2
'GJM 9056'	4.8	6.4	95.2	93.6
'RH 30'	5.9	8.5	94.1	91.5
'RH 8814'	6.2	8.4	93.8	91.6
'GSH 1'	6.0	8.1	94.0	91.9
CD (P = 0.05)	1.0	1.2	1.0	1.1

siliquae formation (108 DAS), 'RH 8814' was statistically at par with 'RH 30' for total dry matter/plant and the latter was at par with 'CS 52' and all these 3 genotypes were significantly superior to 'Kranti,' 'GJM 9056' and 'GSH 1'. At harvest, the genotype 'RH 8814' had accumulated significantly more dry matter/plant and was significantly superior to 'Kranti', 'GJM 9056', 'RH 30' and 'GSH 1' cultivars with respect to total dry-matter accumulation.

The total above-ground biomass produced during pre-flowering could indicate about the onward structural development of plant, since the vegetative vigour at this stage might influence the number of branches and number of siliquae during the reproductive stages of growth (Yadav *et al.*, 1978).

The distribution (%) of dry matter produced during pre-flowering increased and during post-flowering decreased with increase in N levels. In all the treatments less than 20% of the total dry matter was accumulated during the pre-flowering period (Table 4) and rest of the dry matter was accumulated during post-flowering. Similar results were also reported by Chauhan and Bhargav (1984) for rapeseed and mustard.

All the genotypes differed significantly in their distribution (%) of dry matter during vegetative (pre-flowering) and reproductive (post-flowering) stages of growth. The genotypes 'CS 52', 'RH 30', 'RH 8814' and 'GSH 1' were statistically at par and produced significantly more dry matter (%) during vegetative stage than 'Kranti' and 'GJM 9056'. In this respect, a reverse trend was followed among the genotypes during post-flowering period. This variation might be attributed to their genetic constitution.

Seed yield and harvest index

In general, the seed yield was higher in 1994–95 than 1993–94 (Table 3) due to favourable environmental conditions and higher nutrient availability. The temperature remained optimum and sunshine hours were longer in 1994–95 (Table 1). The crop was taken after a good crop of pearlmillet in 1993–94 and a very poor crop of pearlmillet in 1994–95 and, therefore, made more nutrients available. This was also reflected by significant increase in seed yield of Indian mustard with the application of N up to 80 kg/ha in 1993–94 and up to 60 kg/ha in 1994–95.

On an average, 40,60 and 80 kg N/ha resulted in 100.7 and 61.5% higher seed yield between the 2 seasons. Nitrogen application might have improved plant-water relations, light absorption, nutrient utilization, growth yield components and thereby seed yield (Reddy *et al.*, 1988). *Brassica juncea* cultivars had better yield components and therefore, yielded significantly more than *B. napus* cultivar. *Brassica juncea* cultivars did not vary significantly among themselves for seed yield.

Harvest index (%) increased significantly up to 60 kg/ha. There was no significant variation between 60 and 80 kg N/ha for harvest index. These findings confirm those of Srivastava *et al.* (1988). The harvest index was significantly more in 'RH 30' genotype than other genotypes because of its lower stover yield in proportion to seed yield which was comparable to other genotypes. The significant variations in harvest indices were due to differences in their partitioning of biomass, morphology and duration of crop maturity. Pannu *et al.* (1992) reported wide variations in harvest indices in brassicas.

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