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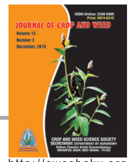

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Evaluation of seed quality status based on its position on main stem and primary branches of the plant in *Brassica* sp.

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ABSTRACT

The present investigation was undertaken to assess the quality of seeds produced at different position on both main stem and primary branches of the plant. This part of experiment was carried out for two consecutive years during 2014-15 and 2015-16 at District Seed Farm 'D' Block, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal for the field experiments to identify proper position of siliquae contributing good quality seed of Brassica genotypes. Seed quality assessment based on the position of siliqua on the plant was made; among those siliquae, length-breadth, number of siliqua at different positions, number of seeds per siliqua and 100 seeds weight (seed index) were compared and observations recorded for determination of quality status in seeds produced at different position on the plant i.e., top, middle and bottom position of both primary branch and main stem. Number of branches per plant is one of the important yield attribute in rape and mustard crop.

Keywords : branches, *Brassica* sp., position, seed quality, siliqua

Brassica oilseeds are important source of edible oil in many countries of the world, including India and China, the two big developing countries which are being confronted with ever increasing population and corresponding demand for agricultural products, but limited by the decline of arable land. India is one among the leading oil seed producing countries in the world. Oilseeds form the second largest agricultural commodity after cereals in India. Mustard is the second important edible oil seed crop after groundnut, and plays an important role in the oil seed economy of the country.

The genus *Brassica* comprises of five cultivated species *viz*., *Brassica juncea* (Indian mustard), *Brassica campestris* (Toria), *Brassica nigra* (Banarasirai), *Brassica napus* (Gobhisarson) and *Brassica carinata* (Abyesinian mustard), all of which are predominantly grown in China, India, Canada, Pakistan, USSR and Europe. Mustard [*Brassica juncea* (L.) Czern Coss], an important edible oil seed crop of India belongs to the family *Cruciferae*. Indian mustard is commonly called by several names *viz*., Brown mustard, Red mustard, Brown sarson, Yellow sarson (English), Raya or Laha (Hindi) and Sasvi (Kannada), *etc*. *Brassica campestris* (Toria) is commonly called as Rapa. When compared with other edible oils, the rapeseed-mustard oil has the lowest amount of harmful saturated fatty acids, along with adequate amount of two essential fatty acids, linoleic and linolenic, which are lacking in many other edible oils. It is used as a spice or condiment in different preparations, seasoning and stuffing of several foods and pickles in India. Apart from this, its oil is also used for treating medicinal remedies like stomach aches, bone aches, muscle pains, skin disorders, etc. It is a very good source of oil varying from 30-48 per cent, which has several anti-nutritional factors like erucic acid (22:1) and arachidic acid (20:1). Proper explicit knowledge of seed development is the pre-requisite for formulation of a successful seed production and crop improvement programme, which may provide a broad description about the mode of changes during various stages of seed development from flowering to maturity in different varieties. Observations regarding details of morphological, physiological and biochemical changes parallely help in understanding the pattern of changes in developing seeds at various stages. The metabolic input of the plant during flowering would be diverted to a rapidly increasing number of growing points in the inflorescence, with the result that there is likely to be intense intra-plant competition for metabolites between siliquae developing on main stem and newly formed shoots in the leaf axes. Siliqua locule number has been taken as a morpho-physiological character to find out the effect of bilocular and tetralocular siliqua on yield and its components of *B. rapa* var. yellow sarson. It is well established that multilocular types bear greater number of seeds per siliqua than those of bilocular types (Sinhamahapatra *et al*., 2010). Siliqua locule number is a monogenic trait, where bilocular type is dominant over multilocular type. Isolation of three distinct types for the angle of inclination of siliqua (pedicel) with respect to its bearing branch in tetralocular yellow sarson also prompted scientists to study the effect of siliqua

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orientation on seed yield and yield attributing traits. It was reported that 'upright' or 'erect' siliqua types recorded high values for all yield attributes in comparison to 'pendant' or 'horizontal' types (Shikari and Sinhamahapatra, 2004). Augmentation of yield by changing the plant architecture especially the basal branching or otherwise is a widely debated topic. Branching habit can be visualized into three different types: (i) basal branching (ii) top branching and (iii) non-branching except the normally existing mid branching type. Basal branching ideotype showed positive association and positive direct effect on seed yield per plant, while the primary branches arising on the upper half of the plant had the opposite effect (Satyavathi *et al.*, 2001). Keeping all these points in view, the present investigation was undertaken with the objective to evaluate the seed quality status based on its position on main stem (upper, middle and lower portion) and primary branches of the plant.

MATERIALS AND METHODS

The present investigationwas conducted during 2014-15 and 2015-16 at District Seed Farm 'D' Block, Bidhan Chandra KrishiViswavidyalaya, Kalyani, Nadia, West Bengal for the field experiments. Five genotypes of *Brassica* sp. *viz*., Agrani, Benoy, Jhumka, Tori Local and White Flower, having contrast characters were considered in this experiment. Seeds of those five genotypes were sown in field in Randomized Block Design with three replications to have sufficient population. Ten plants were randomly harvested from each plot and each replication of siliquae were harvested at different position on the main stem i.e., top, middle and bottom as well as from the primary branches of randomly selected five plants of each genotype. Seed quality assessment based on the position of siliqua on the plant was made on consecutive two years. Among those siliquae, length-breadth, number of siliqua at different positions, number of seeds per siliqua and 100 seeds weight were compared and observations recorded for determination of quality status in seeds produced at different position on the plant i.e., top, middle and bottom position of both primary branch and main stem. The data pertaining to various characters were statistically analyzed using the method of analysis of variance. The mean values obtained from the observations recorded on representative samples were done following Randomized Block Design (RBD) and Factorial Randomized Block Design (FRBD). The appropriate standard error (S. Em ±) was computed in each case, critical difference (CD) at 5 percent level of probability was worked out to compare to treatments means.

RESULTS AND DISCUSSION

Number of branches per plant is one of the important yield attributes in rape and mustard crop. It was found that not all the branches are equally productive, but differed significantly amongst apical, middle and bottom position both on primary branches as well as on the main stem. Seeds for three siliquae positions *viz*., top, middle and bottom from both primary branches and main stem were subjected to test for its quality status separately for five *Brassica* genotypes. The siliqua and seed characters studied included average length and breadth of siliqua, number of siliqua, number of seeds per siliqua and 100 seeds weight of seeds from different positions.

Average siliqua length was recorded as maximum for Jhumka borne on main stem in both the years followed by that of the same variety borne on primary branch, while it was the shortest one borne on primary branch of Agrani, though it was statistically at par with that on main stem during second year (Table 1). When average was made on both genotypes and main/primary branch, longest siliquae were recovered from the bottom position, which was found to be insignificantly similar with that produced in middle position. Detailed analysis on combination of three factors indicate uniqueness of individual genotypes for its siliqua length: longest siliquae were borne on middle position of the main stem of Agrani in first year, it was of statistically similar length for other combinations of both main stem and primary branch with bottom and middle position, while in second year all the combinations of middle and bottom positions were significantly similar with each other; longest pods were produced on middle position of the main stem for Jhumka irrespective of the years of experimentation followed by other combinations of top and middle position with main stem and primary branches; siliquae were longest produced on bottom position of the main stem and it was statistically at par with the combination of bottom position and primary branch followed by combinations of middle position with main stem and bottom position with primary branch. Shortest siliquae could be recovered from top position of both main stem and primary branches irrespective of the genotypes and years of experimentation, probably due to natural source-sink relationship and blooming pattern on inflorescence in rapeseed and mustard; exception could be recorded for Benoy in both the years and Agrani in first year.

Similar to siliqua length, significant variation for its diameter could be noticed among the combinations of genotype-main stem/primary branch, position of the siliquae as well as its final combinations over the years of experimentation. Maximum diameter of siliqua could be noticed for Jhumka borne on main stem in both the years followed by the same on primary branches of Jhumka, and White Flower borne on main stem; average breadth was higher for siliquae borne on main stem than that on primary branch irrespective of the genotypes and years of experimentation, exception was noticed for Tori Local in first year (Table 2). Higher magnitude of average siliquae diameter was recorded at bottom position of the plant and decreasing magnitude could be noticed with the progress towards the tip of the plant, when average was made over the genotype-main stem/ primary branch combinations.

Table 1:Siliqua length (cm) based on its position on plant

Factors	Based upon position			
	C1	C2	C3	Mean
2014-15				
A1B1	3.16	4.13	4.09	3.79
A1B2	3.60	4.40	4.20	4.07
A2B1	4.72	5.41	5.16	5.10
A2B2	4.22	5.37	5.54	5.04
A3B1	4.53	5.54	5.44	5.17
A3B2	4.60	5.99	5.56	5.38
A4B1	3.96	4.27	4.56	4.27
A4B2	4.02	4.31	4.78	4.37
A5B1	4.36	4.92	5.24	4.84
A5B2	4.42	5.27	5.62	5.10
Mean	4.16	4.96	5.02	
	A X B	C	A X B X C	
SEm (±)	0.173	0.182	0.058	
CD at 5%	0.112	0.087	0.194	
2015-16				
A1B1	3.47	4.30	4.27	4.01
A1B2	3.40	4.23	4.13	3.92
A2B1	4.90	5.57	5.20	5.22
A2B2	4.30	5.43	5.60	5.11
A3B1	4.70	5.73	5.40	5.28
A3B2	4.70	6.17	5.77	5.54
A4B1	4.07	4.40	4.93	4.47
A4B2	4.10	4.50	4.90	4.50
A5B1	4.47	5.00	5.47	4.98
A5B2	4.60	5.47	5.73	5.27
Mean	4.27	5.08	5.14	
	A X B	C	A X B X C	
SEm (±)	0.231	0.245	0.115	
CD at 5%	0.178	0.138	0.308	

A1- Agrani, A2- Benoy,
A3- Jhumka, A4- Tori local,
A5- White flower,
B1- Primary branch, B2- Main stem,
C1- Top position, C2- Middle position,
C3- Bottom position

Table 2:Siliqua diameter (mm) based on its position on plant

Factors	Based upon position			
	C1	C2	C3	Mean
2014-15				
A1B1	2.20	3.00	3.10	2.77
A1B2	3.10	3.50	4.20	3.60
A2B1	4.60	4.90	5.50	5.00
A2B2	4.11	5.32	5.91	5.12
A3B1	5.84	6.24	6.14	6.07
A3B2	6.51	8.21	8.67	7.80
A4B1	2.94	3.35	3.41	3.23
A4B2	2.96	3.21	3.42	3.20
A5B1	4.67	5.01	5.18	4.95
A5B2	5.18	5.59	5.94	5.57
Mean	4.21	4.83	5.15	
	A X B	C	A X B X C	
SEm (±)	0.854	0.507	0.073	
CD at 5%	0.096	0.074	0.166	
2015-16				
A1B1	2.40	3.20	3.40	3.00
A1B2	3.00	3.60	4.40	3.67
A2B1	4.80	5.00	5.60	5.14
A2B2	4.60	5.60	6.20	5.47
A3B1	6.00	6.80	6.20	6.33
A3B2	6.80	8.40	8.90	8.03
A4B1	3.00	3.40	3.40	3.27
A4B2	3.00	3.60	3.50	3.37
A5B1	4.80	5.20	5.40	5.14
A5B2	5.20	5.60	6.00	5.60
Mean	4.36	5.04	5.30	
	A X B	C	A X B X C	
SEm (±)	0.759	0.288	0.069	
CD at 5%	0.082	0.063	0.141	

A1- Agrani, A2- Benoy,
A3- Jhumka, A4- Tori local,
A5- White flower,
B1- Primary branch, B2- Main stem,
C1- Top position, C2- Middle position,
C3- Bottom position

Average number of siliquae was recorded as maximum for main stem of Agrani followed by the same combination for Benoy and White Flower, the number of siliquae was always recorded to be higher on main stem than that recorded on primary branch. On averaging over genotypes-main stem/primary branch combinations, highest number of siliquae (10.83) could be recovered from bottom position followed by middle and top positions in first year, while it was recorded from the middle position (11.70) followed by bottom and top position in second year, which may be resulted due to unfavorable climatic conditions prevailed during initial flowering period affecting fertilization and setting of siliquae during that period. Consideration of genotype-main stem/primary branch and position of siliquae interaction effects indicate differential response based on genotypic preference. For Agrani, number of siliquae gradually decreased with the progress towards the tip on main stem in both the years and it was highest at middle position followed by bottom and top position

Table 3: Number of siliqua based on its position on plant

Factors	Based upon position			
	C1	C2	C3	Mean
2014-15				
A1B1	5	12	7	8.00
A1B2	10	16	24	16.78
A2B1	6	9	9	8.00
A2B2	11	13	12	12.00
A3B1	7	8	8	7.67
A3B2	8	12	9	9.67
A4B1	5	9	8	7.33
A4B2	5	9	9	7.67
A5B1	6	7	8	7.00
A5B2	10	11	14	11.67
Mean	7.30	10.60	10.83	
	A X B	C	A X B X C	
SEm (±)	3.906	2.348	0.072	
CD at 5%	0.101	0.081	0.172	
2015-16				
A1B1	6	13	7	8.67
A1B2	11	17	23	17.11
A2B1	6	13	7	8.67
A2B2	12	14	13	13.00
A3B1	7	8	7	7.33
A3B2	9	14	10	11.00
A4B1	5	10	8	7.67
A4B2	5	10	9	8.00
A5B1	5	7	8	6.67
A5B2	11	11	15	12.33
Mean	7.70	11.70	10.73	
	A X B	C	A X B X C	
SEm (±)	3.623	3.048	0.069	
CD at 5%	0.099	0.077	0.172	

A1- Agrani, A2- Benoy,
A3- Jhumka, A4- Tori local,
A5- White flower,
B1- Primary branch, B2- Main stem,
C1- Top position, C2- Middle position,
C3- Bottom position

on primary branches. Higher number of siliquae on the middle position of both main stem and primary branch could be noticed for Benoy and Jhumka followed by bottom and top positions irrespective of the years of experimentation, though it was statistically at par for bottom and middle position on primary branches during first year. Unique scenario could be noticed for White Flower: number of siliquae borne on the bottom position of both main stem and primary branch were higher followed by that on middle and top positions on the main stem during the first year of experimentation, and these two were same in second year.

It could be revealed through Table 4 that number of seeds per siliqua varied significantly among genotype-main stem/primary branch combinations, position of the siliqua on main stem/branch as well as its interaction in both the years. Average number of seeds per siliqua was recorded as maximum as 31.67 and 33.33 from primary branch of Jhumka in both the years followed by that from main stem of the same genotype. Higher number

Table 4: Number of seeds per siliqua based on its position on plant

Factors	Based upon position			
	C1	C2	C3	Mean
2014-15				
A1B1	10	12	14	12.22
A1B2	9	15	15	13.22
A2B1	17	22	28	22.56
A2B2	18	26	26	23.56
A3B1	29	31	35	31.67
A3B2	13	35	38	28.67
A4B1	11	14	18	14.33
A4B2	12	15	17	14.67
A5B1	19	22	24	21.78
A5B2	11	22	23	18.67
Mean	14.93	21.53	23.93	
	A X B	C	A X B X C	
SEm (±)	2.593	5.681	0.265	
CD at 5%	0.433	0.335	0.750	
2015-16				
A1B1	11	13	16	13.33
A1B2	10	14	14	12.67
A2B1	18	24	30	24.33
A2B2	19	28	27	25.00
A3B1	30	33	37	33.33
A3B2	15	36	40	30.33
A4B1	12	15	19	15.33
A4B2	13	16	19	16.00
A5B1	20	23	25	23.00
A5B2	12	24	25	20.56
Mean	16.10	22.73	25.33	
	A X B	C	A X B X C	
SEm (±)	2.098	5.168	0.277	
CD at 5%	0.452	0.350	0.783	

A1- Agrani, A2- Benoy,
A3- Jhumka, A4- Tori local,
A5- White flower,
B1- Primary branch, B2- Main stem,
C1- Top position, C2- Middle position,
C3- Bottom position

of seeds per siliqua could also be noticed for both main stem and primary branch of Benoy and White Flower; on the other hand, minimum number of seeds per siliqua was recorded for Agrani in both the years. While number of seeds per siliqua was more in primary branches compared to that from main stem for White Flower and Jhumka, which indicated the varied nature of the genotypes concerned. Consideration of sole influence of siliqua position indicates that average numbers of seeds were highest from siliqua on the bottom position and it declined gradually towards top position. Similar trend was recorded for average influence of the siliqua position: numbers of seeds were higher for siliquae on the bottom position than that on the middle position for all the genotype-main stem/primary branch combinations. But the pattern of individual genotypes based on main stem/primary branch varied: number of seeds were higher at bottom position of primary branch for Benoy in both the years, for Tori Local and White Flower in first year only, and for Agrani in second year

Table 5: Seed index (100 seeds weight) (g) based on its position on plant

Factors	Based upon position			
	C1	C2	C3	Mean
2014-15				
A1B1	0.194	0.256	0.264	0.238
A1B2	0.250	0.299	0.302	0.284
A2B1	0.217	0.259	0.307	0.261
A2B2	0.222	0.286	0.314	0.274
A3B1	0.254	0.274	0.284	0.271
A3B2	0.251	0.341	0.361	0.318
A4B1	0.261	0.284	0.274	0.273
A4B2	0.241	0.261	0.274	0.259
A5B1	0.277	0.291	0.314	0.294
A5B2	0.293	0.323	0.396	0.337
Mean	0.246	0.287	0.309	
	A X B	C	A X B X C	
SEm (±)	0.018	0.017	0.037	
CD at 5%	0.004	0.003	0.007	
2015-16				
A1B1	0.196	0.274	0.286	0.252
A1B2	0.270	0.304	0.306	0.293
A2B1	0.224	0.272	0.310	0.269
A2B2	0.242	0.308	0.324	0.291
A3B1	0.270	0.284	0.292	0.282
A3B2	0.272	0.352	0.374	0.333
A4B1	0.270	0.288	0.272	0.277
A4B2	0.260	0.296	0.292	0.283
A5B1	0.284	0.304	0.323	0.304
A5B2	0.312	0.350	0.404	0.355
Mean	0.260	0.303	0.318	
	A X B	C	A X B X C	
SEm (±)	0.019	0.018	0.038	
CD at 5%	0.005	0.004	0.008	

A1- Agrani, A2- Benoy,
A3- Jhumka, A4- Tori local,
A5- White flower,
B1- Primary branch, B2- Main stem,
C1- Top position, C2- Middle position,
C3- Bottom position

only; it was higher at the bottom position of main stem for Jhumka in both the years and Agrani in first year only; higher number of seeds per siliqua could be recorded on main stem of Jhumka only in both the years; and it was higher at bottom position of both main stem and primary branch in second year for Tori Local and White Flower, may have been resulted in due to varying response of the genotypes towards prevailing weather condition during post-fertilization siliqua and seed development of the same year. Observation of Yadav (1988) on production of higher number of branches and number of siliqua per plant from basal branching group and its top ranking in seed yield per plant due to comparable number of seeds per siliqua and 100 seed weight may be utilized in support of clarification of the present findings.

Seed index (100 seeds weight) was found to be significantly highest for seeds produced on main stem of White Flower followed by that on main stem of Jhumka and primary branch of White Flower in both the years, and it was clearly evident from Table 5 that seeds of higher 100 seed weight were produced on main stem in comparison to that on primary branch irrespective of the genotypes and years of experimentation with an exception for Tori Local in first year. It was of significantly higher value for seeds produced on bottom position of the main stem irrespective of the genotypes, only exception could be noticed for seeds of Tori Local produced at middle position of the primary stem in first year. 100 seeds weight of seeds produced at top position of either main stem or primary branch was least, probably due to minimum translocation of photosynthates after fertilization and/or less time provided for development and maturation of those seeds. Primary branches on the upper half of the plant produced lower seed yield per plant than the same at basal portion (Satyavathi *et al*., 2001). Observation of Shikari and Sinhamahapatra (2004) can also be utilized in support of the results of present findings in the manner that significantly less seeds were produced in the apically positioned siliquae along with lower 100 seeds weights in *Brassica campestris var. yellow sarson.*

To conclude this present investigation, siliquae with maximum length were produced on main stem of Jhumka in both the years followed by those of the same variety borne on primary branch, while it was of shortest type borne on primary branch of Agrani. Average siliquae breadth with higher magnitude was recorded at bottom position of the plant and decreasing magnitude could be noticed with the progress towards the tip of the plant, when average was made over the genotype-main stem/primary branch combinations. Though average number of siliquae was recorded as maximum for main stem of Agrani followed by the same combination for Benoy and White Flower, the number of siliquae was always recorded to be higher on main stem than that recorded on primary branch. Average number of seeds was found to be highest from siliqua on the bottom position and it declined gradually towards top position, while considering sole influence of siliqua position. It was apparent that numbers of seeds per siliqua on top position were always less than those produced from middle and bottom position irrespective of the genotypes and years of experimentation, but the same varied between main stem and primary branches depending on the genetic background of individual genotypes. Highest average seed index (100 seed weight) was also recorded for seeds produced at the bottom position and then gradually declined with the progress to the top position in both the years.

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