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MORPHOLOGICAL VARIATIONS AT DIFFERENT GROWTH STAGES OF RAPESEED (*BRASSICA RAPA* VAR. TORIA) GENOTYPES UNDER RAINFED CONDITION OF ASSAM INDIA

Rajesh Chintey[1]*, Ratna Kinkor Goswami[2], Bhagawan Bharali[1], Ranjan Das[1], Ramani Kanta Thakuria[3], Raju Prasad Paswan[4], Pankaj Kumar Debchoudhury[5] and Lolesh Pegu[6]

[1]Department of Crop Physiology, Assam Agricultural University, Jorhat - 785 013, Assam, India.
[2]Department of Crop Physiology, Biswanath College of Agriculture, Assam Agricultural University, Biswanath Chariali, Assam, India.
[3]Horticultural Research Station, Assam Agricultural University, Kahikuchi, Guwahati, Assam, India.
[4]Department of Agricultural Statistics, Assam Agricultural University, Jorhat, Assam, India.
[5]Zonal Research Station, AAU, Shillongani, Nagaon, Assam, India.
[6]Department of Crop Physiology, Sarat Chandra Sinha College of Agriculture, AAU, Rangamati, Dhubri, Assam, India.
*Corresponding author E-mail : rajesh95chintey@gmail.com
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ABSTRACT

This experiment was carried out at the Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat, Assam, under rainfed condition during *rabi* seasons of the years 2021-22 and 2022-23 for evaluating morphological parameters of 22 genotypes of rapeseed (*Brassica rapa* var. Toria). The field experiment was laid out in randomized block design with three replications comprising of the genotypes TS-38 (Check), TS-46, TS-67, TS-36, TS-29, TS-75-1, TS-75-1TL, TS-75-2ME, TS-75-2-MM, TS-76-1, TS-76-2, JT-90-1, Panchali, Bhawani, CG Toria-4, TKM-20-1, TKM-20-2, JT-14-5, PT-2018-09, CG Toria-3, Tapeshwari and PT-303. The crops were grown as per the prescribed recommended package of practice. All the morphological parameters of the crops were taken following the standard methodologies. The results of the study indicated a significant variation of morphological parameters among the genotypes. The genotypes, PT-2018-09 showed the highest plant height at different growth stages. Genotypes TS-75-2ME and TS-38 exhibited highest value of number of branches and green leaves at different growth stages.

Key words : Genotypes, Morphological parameters, Rainfed, Rapeseed.

Introduction

Rapeseed (*Brassica rapa* var. Toria) is a short duration, self-pollinated and long day crop having chromosome number 2n=20 (Mahendra *et al*., 2020). The crop is one of the most popular and widely used oil seed crops among the people of Assam and North-East India. It contains 33-45% oil, 18-36% protein and other important fatty acids like linolenic acid, oleic acid, etc. It is also used as vegetable, edible oil, spices, preservatives, seed meal, fertilizer and feed. The average area, production and productivity of rapeseed in India during the period from 2017-18 to 2021-22 is 67.30 lakh hectares, 97.96 lakh tones and 14.56 quintal, respectively (Anonymous, 2023). In Assam, the crop accounts for nearly one-third of the oil produced in India, making the state as country's key edible oilseed producer. The total area under rapeseed in Assam is 2.89 lakh hectares with a total production of 1.86 lakh tones and the productivity is 6.44 quintal per hectare (Anonymous, 2022). In the North-Eastern states, Assam is the highest in terms of area of cultivation of rapeseed and has the potential to increase productivity to great extent (Deka *et al*., 2018). To fulfil the increasing demand of edible oils, appropriate interventions must be paid for improvement of existing oilseed genotypes, introduction of new species or varieties. The suitable genotype for a particular region has to be identified based on morpho-physiological efficiency and higher productivity. The important morphological parameters viz

plant height, number of branches and number of green leaves have tremendous role in productivity of rapeseed (Malek *et al*., 2012 and Mondal *et al*., 2020). Indeed, there is a need to identify the most important morphological parameters which govern the productivity of rapeseed. Keeping these points in view, to evaluate the morphological variations of different genotypes of rapeseed, the present study was conducted.

Materials and Methods

The present experiment was carried out at the Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat-13, Assam, during *rabi* seasons of 2021-22 and 2022-23. The experimental farm is situated at 26° 47 N latitude and 94° 12 E longitudes at an elevation of 86.6 m above mean sea level (MSL). The climate of experimental site of Assam Agricultural University, Jorhat is characterized by subtropical, humid climate with dry summer and cold winter. The soil of the experimental plot was sandy-loam, acidic pH with medium levels of N, P and K. The seeds were collected from the Zonal Research Station, AAU, Shillongani, Nagaon, Assam. The experiment was laid out in Randomized Block Design with 3 replications and the crops were raised following the recommended package of practices. The statistical analysis was done by the method of Panse and Sukhatme (1967). The data of both the years were pooled analysed.

Five numbers of plants (avoiding the boarder rows) were uniformly selected, tagged in each replication and all the data related to morphological parameters were taken from these plants and average values were computed.

Plant heights in cm of standing crops were measured at 30, 60 DAS and at harvest using measuring scale. The heights were taken from the base to the tip of the upper most leaf of the main branch or tip of the flowers (in case of flowering plants).

The number of primary branches was counted from the base to the top of the plant at 30, 60DAS and at harvest.

The number of young green leaves was counted from the base to the top of the plant at 30, 60 DAS and at harvest. Newly emerging underdeveloped young leaves and senesced leaves should be avoided.

Results and Discussion

Plant height at different stages of growth in rapeseed

The data on plant height at different stages of growth presented in Table 1 indicated significant differences among the rapeseed genotypes in both the years. There was an increase in plant height in all the genotypes with advancement of age from 30 DAS up to harvest. However, the rate of increase of plant height was more in between 30 to 60 DAS as compared to 60 DAS to harvest.

Among the genotypes, significantly higher plant height was found in the genotype PT-2018-09 at all the growth stages for both the years with the values of 43.47cm, 83.66cm and 92.44cm for the first year and 42.19cm, 83.67cm and 90.52cm for the second year at 30 DAS, 60 DAS and at harvest, respectively followed by the genotype TKM-20-2 with the values of 43.23cm, 80.62cm and 88.52cm for the first year and 41.46cm, 80.54cm and 89.55cm for the second year at 30, 60 DAS and at harvest, respectively. However, plant heights of both the genotypes were found *at par*. On the other hand, minimum plant height at all the growth stages were recorded in the genotype CG Toria-4 followed by JT-90-1. The pooled values of plant height for the two years also showed the similar trend as above. However, the average values for plant height were relatively less in second year as compared to first year as evidenced by mean values. Siddiqui and Fizor (2004) found significant differences of plant height among different cultivars of rapeseed which was similar with the current study. Rashid *et al*. (2010) reported a significant difference of plant height among different varieties of *Brassica campestris* L., which might be associated with the varietal characters or genetic makeup of the plant. The findings were in corroboration with the findings of the current study. Awal *et al*. (2014) also reported that the differences in plant height in the species *Brassica campestris* were attributed to their genetic differences in growth habit among the varieties which is in corroboration with our present findings. Nem *et al*. (2020) and Yadav *et al*. (2021) also reported similar results of significant variation of plant height among different genotypes of rapeseed.

Primary branches at different stages of growth in rapeseed

The numbers of primary branches at 30, 60 DAS and harvest are presented in Table 2. The number of primary branches in all the genotypes increased with advancement of age from 30 DAS up to 60 DAS for both the years. Among the genotypes, significantly higher number of primary branches was recorded in the genotype TS-75-2 ME with the values of 2.20 (30 DAS) and 6.00 (60 DAS and Harvest) followed by TS-75-2MM (2.20, 5.47and 5.47) for the first year and TS-75-2ME with the values of 2.13, 5.80 and 5.80 at 30 DAS, 60 DAS and at harvest, respectively followed by TS-75-

Table 1 : Plant height at different stages of growth in rapeseed.

Genotypes	Plant height (cm)								
	30 DAS			60 DAS			Harvest		
	1st year	2nd year	Pooled	1st year	2nd year	Pooled	1st year	2nd year	Pooled
PT-303	37.67	36.90	37.29	77.29	77.90	77.60	84.74	83.26	84.00
PT-2018-09	43.47	42.19	42.83	83.66	83.67	83.67	92.44	90.52	91.48
Panchali	42.63	38.43	40.53	80.48	79.78	80.13	87.26	87.33	87.30
Bhawani	40.57	40.07	40.32	72.12	71.00	71.56	78.00	78.66	78.33
TS-29	37.37	38.09	37.73	69.89	69.11	69.50	78.78	71.45	75.12
TS-36	36.87	36.05	36.46	70.70	68.40	69.55	79.26	79.06	79.16
TS-46	33.57	31.29	32.43	78.04	77.29	77.67	84.37	80.42	82.40
TS-67	35.20	36.86	36.03	76.33	75.59	75.96	85.54	82.40	83.97
TS-75-1	34.37	32.57	33.47	75.22	60.11	67.67	85.73	76.22	80.98
TS-75-1TL	32.27	31.55	31.91	80.44	66.11	73.28	87.23	79.80	83.52
TS-75-2ME	41.60	40.60	41.10	77.99	76.33	77.16	88.22	79.00	83.61
TS-75-2MM	34.77	33.66	34.22	77.24	74.89	76.07	84.74	84.89	84.82
TS-76-1	37.90	37.78	37.84	70.22	69.44	69.83	80.63	81.33	80.98
TS-76-2	38.93	37.67	38.30	72.44	70.74	71.59	76.92	74.40	75.66
JT-90-1	27.07	27.60	27.34	70.18	59.66	64.92	76.44	70.00	73.22
JT-14-5	38.83	40.89	39.86	73.63	71.23	72.43	76.81	71.52	74.17
TKM-20-1	28.10	27.99	28.05	78.51	72.11	75.31	87.41	87.22	87.32
TKM-20-2	43.23	41.46	42.35	80.62	80.54	80.58	88.52	89.55	89.04
Tapeswari	37.16	36.41	36.79	71.53	74.85	73.19	87.77	79.00	83.39
CG-Toria-3	41.97	41.91	41.94	72.78	72.22	72.50	83.14	74.56	78.85
CG-Toria-4	26.83	26.06	26.45	60.75	54.89	57.82	68.19	66.33	67.26
TS-38 (Check)	32.50	31.44	31.97	64.55	65.52	65.04	77.35	80.27	78.81
Mean	**36.49**	**35.79**	**36.14**	**74.76**	**71.43**	**77.60**	**82.96**	**79.41**	**84.00**
S.Ed (±)	0.75	0.87	0.83	1.02	1.33	1.16	0.72	0.79	0.76
C D (0.05)	1.51	1.76	1.61	2.07	2.70	2.42	1.02	1.60	1.44

2MM (2.07, 5.27and 5.27 at 30 DAS, 60 DAS and at harvest, respectively) for the second year, although both the genotypes were found statistically at par. On the other hand, minimum number of primary branches was found in the genotype TS-29 followed by Tapeswari at 60 DAS and at harvest for both the years. However, the genotypes did not differ statistically. The minimum number of primary branches was observed in the genotype TS-46 at 30 DAS for the first year and TS-29 followed by TS-75-1TL for the second year. The pooled values of branch number for the two years also showed the similar trend as above.

Branching was regarded as one of the important component of canopy structure which had significant influence on crop yield (Zhang *et al.*, 2011). Canopy structure determines the light distribution, light interception, and efficiency of solar energy conversion of the crop population, which ultimately affects the accumulation and distribution of photosynthetic products (Xu *et al.*, 2017). In addition, light quality is also an important factor affecting the development of axillary buds. The axillary bud development of soybean was inhibited under low light condition, which can reduce branch number (Xu *et al.*, 2021). The significant differences could be attributed as genetic factors of the different genotypes as reported by Samant *et al*. (2015). It can also be due to light quantity as well as quality received by the crops as reported by Xu *et al*. (2021), which is ultimately dependent on morphology of the crop plants. The findings of the current experiment were supported by Awal *et al.* (2014) and Helal *et al*. (2016), who found an increase in number of primary branches with advancement of maturity. However, there was no increase in number of primary branches from 60 DAS to harvest which was in corroboration with the results of Yadav *et al*. (2021).

Number of green leaves at different growth stages

Green leaves play the major role in photosynthesis as the cells of green leaves contain chloroplasts. Photosynthate supply plays an important role in pod and

Table 2 : Primary branches at different stages of growth in rapeseed.

Genotypes	Number of primary branches (No. Plant^{-1})								
	30 DAS			60 DAS			Harvest		
	1st year	2nd year	Pooled	1st year	2nd year	Pooled	1st year	2nd year	Pooled
PT-303	1.80	1.80	1.80	5.00	5.00	5.00	5.00	5.00	5.00
PT-2018-09	1.67	1.73	1.70	4.53	4.87	4.70	4.53	4.87	4.70
Panchali	2.00	1.93	1.97	4.87	4.87	4.87	4.87	4.87	4.87
Bhawani	1.47	1.60	1.54	4.60	4.67	4.64	4.60	4.67	4.63
TS-29	1.47	1.27	1.37	3.93	4.00	3.97	3.93	4.00	4.13
TS-36	1.67	1.80	1.74	5.00	4.80	4.90	4.33	4.60	4.47
TS-46	1.20	1.60	1.40	4.00	4.33	4.17	4.00	4.33	4.00
TS-67	1.40	1.47	1.44	4.93	4.80	4.87	4.27	4.47	4.37
TS-75-1	1.47	1.60	1.54	4.80	4.93	4.87	4.80	4.93	4.87
TS-75-1TL	1.27	1.40	1.34	4.00	4.13	4.07	4.00	4.13	4.07
TS-75-2ME	2.20	2.13	2.17	6.00	5.80	5.90	6.00	5.80	5.90
TS-75-2MM	2.20	2.07	2.14	5.47	5.27	5.37	5.47	5.27	5.63
TS-76-1	1.53	1.60	1.57	4.93	4.93	4.93	4.93	4.93	4.93
TS-76-2	1.33	1.47	1.40	4.20	4.20	4.20	4.20	4.20	4.20
JT-90-1	1.60	1.73	1.67	4.33	4.60	4.47	5.00	4.80	4.90
JT-14-5	1.67	1.80	1.74	5.13	5.20	5.17	5.13	5.20	5.20
TKM-20-1	1.53	1.67	1.60	4.60	4.53	4.57	4.20	4.33	4.27
TKM-20-2	1.27	1.40	1.34	4.20	4.33	4.27	4.60	4.53	4.57
Tapeswari	1.53	1.60	1.57	4.00	4.07	4.04	4.00	4.07	4.03
CG-Toria-3	1.27	1.40	1.34	4.27	4.47	4.37	4.93	4.80	4.87
CG-Toria-4	1.60	1.67	1.64	5.00	4.93	4.97	5.00	4.93	4.97
TS-38 (Chech)	1.73	1.80	1.77	5.40	5.20	5.30	5.40	5.20	5.30
Mean	**1.60**	**1.67**	**1.64**	**4.71**	**4.72**	**4.72**	**4.71**	**4.72**	**4.72**
S.Ed (±)	0.20	0.17	0.18	0.33	0.26	0.30	0.33	0.26	0.34
C D (0.05)	0.41	0.34	0.39	0.68	0.52	0.46	0.68	0.52	0.46

seed development. Increasing plant density to a certain degree increases shade to the older leaves lowering it in the canopy as plant growth progresses, leading to a reduction in canopy light capture (Boonman *et al*., 2006).

The data of numbers of primary branches at 30 and 60 DAS are presented in Table 3. The number of green leaves per plant at 30 and 60 DAS in rapeseed genotypes recorded significant differences among the genotypes for both the years. For both the years, an increase in number of green leaves in all the genotypes was found with advancement of crop growth from 30 DAS up to 60 DAS. During the first year, significantly higher leaf number was found in the genotype TS-38 (6.20) followed by CG-Toria-3 (6.07) at 30 DAS while at 60 DAS the genotype TS-75-2ME possessed significantly higher number (9.47) of leaves followed by TS-38 (9.27) although the values were statistically at par. On the other hand, minimum number of green leaves was found in the genotype JT-14-5 and TS-36 with the values of 4.40 and 5.07 respectively, at 30 DAS. At 60 DAS, the genotypes TKM-20-2 followed by TKM-20-1 had the minimum number of green leaves. During the second year, significantly higher leaf number was found in the genotype TS-38 and CG-Toria-3 (6.00 both) at 30 DAS, while at 60 DAS, the genotype JT-14-5 possessed significantly higher number (9.13) of leaves followed by TS-38 (9.00) although the values were statistically at par. On the other hand, minimum number of green leaves was found in the genotype JT-14-5 (4.60) followed by TS-67 (5.00) at 30 DAS. At 60 DAS, the genotypes TKM-20-2 (7.27) followed by JT-90-1 (7.87) had the minimum number of green leaves. So it was observed that the number of green leaves per plant at 30 and 60 DAS in rapeseed genotypes recorded significant differences among the genotypes for both the years. The pooled values of green leaf number for the two years also showed the similar trend as above. Similar results were reported by Siddiqui and Fizor. (2004), Rad *et al*. (2015) and Li *et al*. (2015). An increase in number of

Table 3 : Green leaves at 30 and 60 DAS in rapeseed.

Genotype	Green leaves (No. Plant^{-1})					
	30 DAS			60 DAS		
	1st year	2nd year	Pooled	1st year	2nd year	Pooled
PT-303	5.40	5.53	5.47	8.93	8.66	8.80
PT-2018-09	5.20	5.23	5.22	8.40	8.73	8.57
Panchali	5.47	5.67	5.57	8.53	8.47	8.50
Bhawani	5.07	5.27	5.17	8.27	8.40	8.34
TS-29	5.53	5.53	5.53	8.40	8.47	8.44
TS-36	5.07	5.13	5.10	8.40	8.40	8.40
TS-46	5.80	5.87	5.84	8.73	8.93	8.83
TS-67	5.53	5.00	5.27	8.00	8.27	8.14
TS-75-1	5.53	5.80	5.67	8.87	8.80	8.84
TS-75-1TL	5.20	5.40	5.30	8.00	8.27	8.14
TS-75-2ME	5.20	5.67	5.44	9.47	8.93	9.20
TS-75-2MM	5.33	5.40	5.37	8.27	8.67	8.47
TS-76-1	5.67	5.67	5.67	8.07	8.27	8.17
TS-76-2	5.40	5.67	5.54	8.00	8.53	8.27
JT-90-1	5.33	5.47	5.40	8.07	8.13	8.10
JT-14-5	4.40	4.60	4.50	8.93	9.13	9.03
TKM-20-1	5.27	5.07	5.17	7.87	8.27	8.07
TKM-20-2	5.67	5.87	5.77	7.27	7.73	7.50
Tapeswari	5.93	5.47	5.70	7.93	8.33	8.13
CG-Toria-3	6.07	6.00	6.04	8.27	8.47	8.37
CG-Toria-4	5.33	5.47	5.40	8.13	8.27	8.20
TS-38 (Chech)	6.20	6.00	6.10	9.27	9.00	9.14
Mean	**5.44**	**5.49**	**5.47**	**8.37**	**8.50**	**8.44**
S.Ed (±)	0.16	0.24	0.23	0.11	0.22	0.24
C D (0.05)	0.32	0.48	0.45	0.22	0.45	0.47

green leaves in all the genotypes was found with advancement of crop growth from 30 DAS up to 60 DAS and then it was decreased, which is in similar trend with the result found by Saini *et al*. (2020) in rapeseed (*Brassica campestris* var. Toria). Helal *et al*. (2016) also reported that number of leaves per plant at different days after sowing did not differ significantly up to 40 DAS but later on showed significant variation at 60 DAS and at harvest in rapeseed (*Brassica* sp.). Awal *et al*. (2014) found no or few leaves during physiological maturity of crop in *Brassica campestris* as well as in *Brassica napus*, which is same with our research.

Conclusion

The results of the study indicated a significant variation of morphological parameters among the genotypes. The genotypes, PT-2018-09 showed the highest plant height at different growth stages. On the other hand, minimum plant height at all the growth stages were recorded in the genotype CG Toria-4 followed by JT-90-1. Genotypes TS-75-2ME and TS-38 exhibited highest value of number of branches and green leaves at different growth stages. These genotypes may be suggested for further investigation for yield improvement programme of rapeseed for the region.

Conflict of interest

The authors, affiliated with Assam Agricultural University, Jorhat-13, Assam, India, declare no conflicts of interest.

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