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Blossoming Characteristics in Black Cumin Genotypes in Relation Seed Yield Influenced by Sowing Time

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Abstract

Black cumin (*Nigella sativa* L.; Family-Ranunculaceae) is an important spice crop. Mature seeds are consumed for edible and medical purposes and also used as a food additive and flavour. Seed of black cumin has great potentiality as spice crop due to nutritive and medicinal values. The experiments were carried out at Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur during 2011 to 2012 to determine optimum planting time for seed production of black cumin. The experiment was two factorials. Factor A: 4 genotypes were V_1: Exotic, Iran; V_2: BARI kalozira-1; V_3: Local, Faridpur and V_4: Local, Natore. Factor B: sowing date: D_1: 16 October; D_2: 1 November; D_3: 16 November and D_4: 1 December. Therefore, treatment combinations were 16 in total. So, in 3 replications total plot was 48. Result revealed that significantly the highest 2.37 t/ha in V_1, followed by V_2 (1.96 t/ha). V_2 and V_3 (1.97 t/ha) were statistically similar and maximum yield was obtained from D_2 (2.65 t/ha). In combined effect, maximum yield 3.00 t/ha was obtained in V_1D_2. Investigation on time of sowing revealed that performance of black cumin was better in earlier sowings (16 October, 1 November) than later ones. The highest yield (4g plant^{-1}; 2.65 tha^{-1}) was obtained when the crop was sown on 1 November. Among the genotypes, the exotic one with sowing in 1 November gave the highest seed yield (4.54 g·plant^{-1}; 3.00 t·ha^{-1}).

Keywords

Black Cumin, Flower Blooming, Capsule, Seed Yield, Sowing Time

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1. Introduction

Black cumin (*Nigella sativa* L.; Family-Ranunculaceae) is an important annual herbaceous plant. Spice crop is cultivated in widely cultivated throughout South Europe, Syria, Egypt, Saudi Arabia, Iran, Pakistan, India and Turkey [1]-[3]. For successful production of any crop, appropriate planting time is very important. Especially for seed production, sowing time is very sensitive for quality seed production. Planting controls the phonological development which influences seed production [4]. Shortening of the growing cycle decreases the amount of radiation intercepted during the growing season and thus total dry weight of plant [5] [6]. With delayed sowing, development is accelerated because the crops encounter higher temperatures during the vegetative growth [7] and decreases seed weight and the number of umbrella per plant [4] [8]. Because of occurrence lack of suddenly winter chilling, delayed sowing date is better [8] [9]. Early sowing has been favorable for disease, and leads to early flowering, resulting poor quality of seed [4]. Optimum temperature for germination is 16.19˚C to 22.14˚C [10], so black cumin is plenty during winter season in Bangladesh. To realize the full yield potential characteristics of black cumin, agricultural practices will have to be optimized for its production. Optimum sowing time of black cumin in Bangladesh has rarely investigated. This study aims 1) to assess the effect of various sowing time on flowering for seed production of black cumin genotypes, and 2) to determine the interaction effect of sowing time and genotypes.

2. Materials and Methods

The study was conducted at the Horticulture Research Field, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur during the winter season of 2011-12. The experiment having two factors was laid out in a randomized complete block design with three replications. The treatments were randomly allotted in each block. Each block consisted of 16 plots and the dimension of each plot was 1.2 m × 1.2 m (1.44 m^2) having a plot to plot and block to block distances of 0.5 m and 1.0 m, respectively. Soil of the experimental field was silty clay loam and soil P^H 5, 84. The experiment plots were manured and fertilized with Cowdung, Urea, TSP and MP at the rate of 10 t, 125, 95 and 75 kg/ha respectively [11]. The seeds were mixed with some loose soil to allow uniform sowing in rows. Then, seeds were sown in rows 15 cm apart continuously by hand @ 10 kg/ha [11], maintaining a depth of one cm. Continuous line sowing was done to maintain plant to plant distance 10 cm by thinning later on [11]. The seeds were covered with loose soil properly just after sowing and gently pressed by hands. The crop was harvested when 50% of the capsules changed color from green to straw color.The experiment was two factorials. Factor A: 4 genotypes were V_1: Exotic, Iran; V_2: BARI kalozira-1; V_3: Local, Faridpur and V_4: Local, Natore. Factor B: Sowing date: D_1: 16 October; D_2: 1 November; D_3: 16 November and D_4: 1 December. Therefore, treatment combinations were 16 in total. So, in 3 replications total plot was 48. Data were collected from the inner rows of each plot to avoid the border effect. In each unit plot, 10 plants were selected randomly for recording data. The following seed yield and yield contributing characters were recorded. **Days to 1st emergence:** Number of days required for first emergence after seed sowing was calculated from all the plots separately by close observation after seed sowing. **Days to 50% emergence:** Number of days required for 50% emergence after seed sowing was calculated from all the plots separately by close observation after seed sowing. **Days to 1st flower bud initiation:** Days to 1st flower bud initiation was recorded by calculating the days from the date of sowing to bud initiation by observing the plants every morning. **Days to flower bud initiation in 50% plants:** Days to 50% flower bud initiation was recorded by calculating the days from the date of sowing to bud initiation by observing the plants every morning. **Days to 1st flower blooming:** Days to 1st flower blooming was recorded by calculating the days from the date of sowing to bud initiation by observing the plants every morning (1st opened flower in plot). **Days to flower blooming in 50% plants:** Days to flower in 50% plant was recorded by counting the days from the date of sowing to flower in 50% plants every morning (50% of the plant in a plot opened flower).**Days to 1st capsule setting:** Days to 1st capsule setting was recorded by counting the days from the date of sowing every morning. **Days to capsule setting in 50% plants:** Days to capsule setting in 50% plants was recorded by counting the days from the date of sowing every morning. **Days to first capsule ripening:** Days to 1st capsule ripening in each plot was recorded by counting the days from the date of sowing every morning. When capsule colour was changed from green to straw, then it was counted as ripened. **Days to capsule ripening in 50% plants:** Days to capsule ripening in 50% plants in each plot was recorded by counting the days from the date of sowing every morning. When capsule colour was changed from green to straw, then it was counted as ripened. This parameter indicates whether the genotypes was short-durated or late. The collected data

were analyzed statistically using MSTAT-C computer package (Michigan State University, East Lansing, MI, USA) following the methods of [12]. The analysis of variance procedure (ANOVA), differences among treatment means were determined using the Least Significant Difference (LSD) at 5% level of significance

3. Results and Discussion

3.1. Results

The present investigation initiated to study the effect of planting time on the blossoming characters in black cumin genotypes. The results obtained are presented in tables and figures and discussed character wise under the following heads:

3.1. 1. Days to 1st Emergence

Variation among the genotypes was observed and the days to 1st emergence ranged from 7.42 to 8.58 days (**Table 1**). The V_3 genotype took the highest days (8.58 days) to 1st emergence, which had no significance difference with genotype V_2 (8.50 days) and V_4 (8.42 days). The earliest emergence was recorded in the V_1 genotype (7.42 days), which was statistically different to all. D_1 and D_2 took 7.67 and 7.83 days which was statistically similar. D_3 (8.75 days) and D_4 (8.67 days) were also statistically similar. In combined effect, statistically higher days were obtained from V_2, V_3 and V_4 with D_3 and D_4 which was 9 days. The lowest days 7 were showed from V_1D_1 and V_1D_2.

3.1. 2. Days to 50% Emergence

Evident of significant different days required for 50% emergence were observed in main effect of genotypes, ranging from 9.83 days (V_1) to 11.83 days (V_4) (**Table 1**). V_3 (11.75 days) was statistically similar to V_4. V_2 (10.75 days) showed moderate required days. Requiring the lowest days showed higher vigor of V_1. Variation also observed in date of planting. D_1 and D_2 each took 10.25 days, D_3 and D_4 each took 11.83 days. In combined effect, statistically higher 12.67 days required for V_3D_4, V_4D_3 and V_4D_4. The lowest 9 days was observed in V_1D_1 and V_2D_2. In interaction days to 50% emergence ranged from 9.00 to 12.67 days. Lowest days required was observed in V_1S_2. All combination of spacing with V_3 and V_4 showed statistically similar as well as highest days required.

3.1.3. Days to 1st Flower Bud Initiation

There was clear significant different among genotypes in 1st flower bud initiation (**Table 1**). It was the highest (51.83 days) in V_1, followed by V_3 (49.08 days). V_2 (47.92 days) and V_4 (45.42 days) were significantly different from each other. It may be controlled genetically. In case of sowing date, early sowing took higher as well as late sowing took lower time. D_1, D_2, D_3 and D_4 took 56.92, 47.42, 46.08 and 43.83 days simultaneously, which each was significantly different from each other. In interaction, V_3D_1 took the highest days (59.00 days) to 1st flower bud initiation, where the lowest 39.33 days was obtained from V_4D_4.

3.1.4. Days to Flower Bud Initiation in 50% Plants

Days to 50% flower bud initiation significantly varied among genotypes (**Table 1**). It was the highest in V_1 (60.00 days) and the lowest 54.67 days in V_2. V_2 was statistically similar to V_4 (54.92 days). V_3 (56.00 days) required statistically moderate days. On the other hand, early sowing D_1 took the highest (65.58 days) and late sowing D_4 took the lowest (50.75 days). D_2 and D_3 took 56.42 and 52.83 days. Each date was statistically different from each other. In interaction, V_1D_1 needed the highest (66.33 days) and V_4D_4 needed the lowest (48.33 days).

3.1.5. Days to 1st Flower Blooming

Significant variation was observed in V_1 with other genotype in days to 1st flower blooming (**Table 1**). V_1 took maximum days (61.75 days) which was statistically different from V_2 (60.33 days), V_3 (59.75 days) and V_4 (59.33 days). V_2, V_3 and V_4 were statistically similar. A clear different was found in various date of sowing. Maximum (70.67 days) was observed in D_1, where minimum (53.17 days) from D_4. D_2 (61.17 days) and D_3 (56.17 days) showed moderate time. Each sowing date was significantly different from each other. In interaction between genotypes and date of sowing, V_4D_1 took the highest (71.33 days) and V_4D_4 (51.67 days) took the lowest time for 1st flower blooming.

Table 1. Days to emergence and flowering characteristics in black cumin genotypes as influenced by sowing time.

Treatment		Days to					
		1st emergence	50% emergence	1st flower bud initiation	flower bud initiation in 50% plants	1st flower blooming	flower blooming in 50% plants
Genotypes							
V_1		7.42b	9.83c	51.83a	60.00a	61.75a	68.17a
V_2		8.50a	10.75b	47.92c	54.67c	60.33b	65.25b
V_3		8.58a	11.75a	49.08b	56.00b	59.75b	64.75b
V_4		8.42a	11.83a	45.42d	54.92c	59.33b	64.83b
Date of sowing							
D_1		7.67b	10.25b	56.92a	65.58a	70.67a	76.08a
D_2		7.83b	10.25b	47.42b	56.42b	61.17b	66.17b
D_3		8.75a	11.83a	46.08c	52.83c	56.17c	61.75c
D_4		8.67a	11.83a	43.83d	50.75d	53.17d	59.00d
LSD (5%)		0.199	0.319	0.992	0.759	1.228	0.897
Interaction							
V_1	D_1	7.00d	9.00e	57.00b	66.33a	70.67a	77.00a
	D_2	7.00d	9.00e	51.33d	60.33c	62.00bc	69.00c
	D_3	8.00bc	11.00c	51.00d	57.33d	58.67d	64.67d
	D_4	7.67c	10.33d	48.00ef	56.00de	55.67e	62.00e
V_2	D_1	8.00bc	10.00d	53.33c	63.33b	69.67a	74.67b
	D_2	8.00bc	10.00d	47.00e-g	55.33ef	63.00b	66.00d
	D_3	9.00a	11.33bc	46.67fg	51.00fg	55.67e	61.67e
	D_4	9.00a	11.67b	44.67hi	49.00h	53.00fg	58.67fg
V_3	D_1	8.00bc	11.00c	59.00a	66.67a	71.00a	76.33ab
	D_2	8.33b	11.00c	48.67e	55.33e	60.33cd	65.33d
	D_3	9.00a	12.33a	45.33gh	52.33f	55.33ef	60.33ef
	D_4	9.00a	12.67a	43.33ij	49.67gh	52.33g	57.00g
V_4	D_1	7.67c	11.00c	58.33ab	66.00a	71.33a	76.33ab
	D_2	8.00bc	11.00c	42.67jk	54.67e	59.33d	64.33d
	D_3	9.00a	12.67a	41.33k	50.67g	55.00ef	60.33ef
	D_4	9.00a	12.67a	39.33l	48.33h	51.67g	58.33g
LSD (5%)		0.398	0.637	1.984	1.517	2.455	1.794
CV %		2.90	3.46	2.45	1.61	2.44	1.64

Means followed by the same letter(s) in a column are not significantly different. Variety: Exotic (V_1); BARI kalozira-1 (V_2); Faridpur local (V_3); Natore local (V_4). Date of sowing: 16 Oct, 2011(D_1); 1Nov, 2011 (D_2); 16 Nov, 2011 (D_3); 1 Dec, 2011 (D_4).

3.1.6. Days to Flower Blooming in 50% Plants

There was significant variation in V_1 with other genotype in days to 50% flower blooming (**Table 1**). V_1 take maximum days (68.17 days) which were statistically different from V_2 (65.25 days), V_3 (64.75 days) and V_4 (64.83 days). V_2, V_3 and V_4 were statistically similar. A clear different was found in various date of sowing.

Maximum (76.08) days was observed in D_1, where minimum (59.00 days) from D_4. D_2 (61.17 days) and D_3 (61.75 days) showed moderate time. Each sowing date was significantly different. In interaction between genotypes and date of sowing, V_1D_1 took the highest (77.00 days) and V_4D_4 (58.33 days) took the lowest time for 50% flower blooming.

3.1.7. Days to 1st Capsule Setting

Variation in days to 1st capsule setting was observed in genotypes (**Table 2**). V_1 obtained 81.83 days which was maximum and statistically different from other genotype, where V_2 took 75.08 days which was minimum. V_3 take 78.83 days followed by V_4 (76.42 days). Each genotype was statistically different. On the other hand, sowing date D_1 obtained 87.42 days to 1st capsule setting, followed by D_2 78.83 days. D_3 took 74.33 days which was statistically different from the minimum days (71.58) obtained by D_4. In interaction, V_1D_1 showed 90.33 days

Table 2. Days to fruiting and maturation characteristics in black cumin genotypes as influenced by sowing time.

Treatment		Days to			
		1st capsule setting	capsule setting in 50% plants	1st capsule ripening	capsule ripening in 50% plants
Genotypes					
V_1		81.83a	98.58a	114.33a	121.33a
V_2		75.08d	94.33c	110.92b	118.42b
V_3		78.83b	96.50b	111.17b	118.50b
V_4		76.42c	94.58c	110.50b	118.58b
Date of sowing					
D_1		87.42a	105.42a	124.83a	132.92a
D_2		78.83b	94.83b	113.08b	121.58b
D_3		74.33c	95.17b	108.33c	115.42c
D_4		71.58d	88.58c	100.67d	106.92d
LSD (5%)		1.286	0.885	0.949	0.825
Interaction					
V_1	D_1	90.33a	110.33a	128.00a	134.33a
	D_2	83.00d	100.33d	117.67c	124.67c
	D_3	78.33ef	97.67e	111.00d-f	119.00e
	D_4	75.67gh	86.00i	100.67i	107.33i
V_2	D_1	86.00bc	102.33c	123.33b	132.33b
	D_2	76.33f-h	91.00g	112.00de	120.33de
	D_3	70.33jk	95.33f	109.67fg	116.00f
	D_4	67.67l	88.67h	98.67j	105.33j
V_3	D_1	85.00cd	105.33b	124.00b	132.33b
	D_2	79.33e	96.67ef	112.33d	121.33d
	D_3	77.00eg	95.67f	108.67g	114.67f
	D_4	74.00hi	88.33h	99.67ij	105.67j
V_4	D_1	88.33ab	103.67bc	124.00b	133.00ab
	D_2	76.67fg	91.33g	110.33e-g	120.00de
	D_3	71.67ij	92.00g	104.00h	112.00g
	D_4	69.00kl	91.33g	103.67h	109.33h
LSD (5%)		2.572	1.769	1.898	1.650
CV%		1.98	1.11	1.02	0.83

Means followed by the same letter(s) in a column are not significantly different. Variety: Exotic (V_1); BARI kalozira-1 (V_2); Faridpur local (V_3); Natore local (V_4). Date of sowing: 16 Oct, 2011(D_1); 1Nov, 2011 (D_2); 16 Nov, 2011 (D_3); 1 Dec, 2011(D_4).

which was maximum, where V_2D_4 took minimum (67.67 days).

3.1.8. Days to Capsule Setting in 50% Plants

Days to 50% capsule setting was statistically varied in genotypes (**Table 2**) ranging from 94.58 days (V_4) to 98.58 days (V_1). V_2 (94.33 days) was statistically different from V_1 and V_3 (96.50 days), but similar with V_4. Days to 50% capsule setting clearly distinguished by spacing. It increased with increasing spacing, ranged from 88.58 days (D_4) to 105.42 days (D_1). D_3 showed 94.83 days and D_3 95.17 days, which each was statistically similar. In combination effect, it ranged from 86.00 days (V_1D_1) to 110.33 days (V_1D_1). Gradually less time required from D_1 to D_4 with interaction with all genotypes.

3.1.9. Days to 1st Capsule Ripening

In days to first capsule ripening, V_1 (114.33 days) was statistically different from V_2 (110.92 days), V_3 (111.17 days) and V_4 (110.50 days). V_2, V_3 and V_4 were statistically similar (**Table 2**). In date of sowing, the highest days (124.83 days) were obtained by D_1, as well as lowest (100.67 days) by D_4. D_2 and D_3 take 113.08 and 108.33 days simultaneously. Each date was significantly different. In combined effect, V_1D_1 took maximum time (128.00 days), where minimum (103.67 days) obtained from V_4D_4.

3.1.10. Days to Capsule Ripening in 50% Plants

There was significant different in days to first capsule ripening (**Table 2**). V_1 (121.33 days) was statistically different from V_2 (118.42 days), V_3 (118.50 days) and V_4 (118.58 days). V_2, V_3 and V_4 were statistically similar. In date of sowing, highest days (132.92) were obtained by D_1, as well as the lowest (106.92 days) by D_4. D_2 and D_3 take 121.58 and 115.42 days simultaneously. Each date was significantly different. In combined effect, V_1D_1 took maximum time (134.33 days), where minimum (109.33 days) obtained from V_4D_4. The finding was nearly supported by BARI (2007) describing 135 to 145 days for ripening.

3.1.11. Plant Height (cm)

Genotypes were significantly different in plant height (**Table 3**). Maximum height 51.83 cm was obtained from V_1 and minimum 44.13 cm from V_4. V_2 (46.81 cm) and V_3 (46.46 cm) was statistically similar. Date of sowing was also significantly different from each other. Maximum height was found in D_2 (50.78 cm), and minimum (44.15 cm) from D_4. D_1 and D_3 showed 48.31 and 45.98 cm simultaneously. In combined effect of genotype and date of sowing, V_1D_2 showed 55.83 cm which was maximum, and minimum (41.20 cm) from interaction of V_4 and D_4.

3.1.12. Number of Primary Branches per Plant

Primary branches per plant are an important yield contributing character (**Table 3**). It was the highest 4.73 in V_4, which was statistically similar to V_1 (4.63). Also V_1 and V_2 (4.53) was statistically similar. Significantly the lowest primary branch 4.30 was obtained from V_3. In case of V_2, date of sowing was statistically different from each other. D_1 (4.81) and D_2 (4.82) was statistically similar, followed by D_3 (4.35). D_4 obtained 4.20 which were the lowest among dates. In interaction number of primary branch 5.00 was the highest in V_1D_1, as well as the lowest (4.00) in V_3D_4.

3.1.13. Number of Secondary Branches per Plant

It was the highest in V_1 (8.89), followed by V_2 (8.68) (**Table 3**). V_4 obtained 8.07 which was statistically different from V_3 (7.83), the lowest number of secondary branch. In case of date of sowing, D_1 (9.68) and D_2 (9.81) was statistically similar, followed by D_3 (7.27). D_4 obtained the lowest number of secondary branch (6.70) which was statistically different from D_3. In interaction, V_1D_2 (10.73) gave the highest number of secondary branch, and V_3D_4 (6.10) showed the lowest.

3.1.14. Number of Tertiary Branches per Plant

The number of tertiary branch was the highest in V_1 (20.23), followed by V_2 (17.48) (**Table 3**). V_4 obtained 16.43 which were statistically different from the lowest number of tertiary branch (15.62) which obtained from V_3. In case of date of sowing, D_1 (19.46) and D_2 (19.82) was statistically different, followed by D_3 (15.78). D_4 obtained the lowest number of tertiary branch (14.69) which was statistically different from D_3. In interaction,

Table 3. Plant height and branching characteristics in black cumin genotypes as influenced by sowing time.

Treatment		Plant height (cm)	Number of branches per plant		
			Primary	Secondary	Tertiary
Genotypes					
V_1		51.83a	4.63ab	8.89a	20.23a
V_2		46.81b	4.53b	8.68b	17.48b
V_3		46.46b	4.30c	7.83d	15.62d
V_4		44.13c	4.73a	8.07c	16.43c
Date of sowing					
D_1		48.31b	4.81a	9.68a	19.46b
D_2		50.78a	4.82a	9.81a	19.82a
D_3		45.98c	4.35b	7.27b	15.78c
D_4		44.15d	4.20c	6.70c	14.69d
LSD (5%)		0.841	0.124	0.203	0.261
Interaction					
V_1	D_1	52.73b	5.00a	10.53a	22.00a
	D_2	55.83a	4.90ab	10.73a	22.50a
	D_3	50.93c	4.40d-f	7.50d	18.40cd
	D_4	47.80d	4.20f-h	6.80e	18.00de
V_2	D_1	47.87d	4.70bc	9.80b	19.80b
	D_2	50.23c	4.70bc	9.90b	20.20b
	D_3	45.27ef	4.40d-f	7.60d	16.07f
	D_4	43.87f	4.30e-g	7.40d	13.87h
V_3	D_1	47.80d	4.50c-e	9.20c	17.50e
	D_2	50.17c	4.60cd	9.30c	17.80e
	D_3	44.13f	4.10gh	6.70e	14.17gh
	D_4	43.73f	4.00h	6.10f	13.00i
V_4	D_1	44.83f	6.03a	9.20c	18.53c
	D_2	46.87de	5.07a	9.30c	18.77c
	D_3	43.60f	4.50c-e	7.27d	14.50g
	D_4	41.20g	4.30e-g	6.50ef	13.90h
LSD (5%)		1.682	0.247	0.405	0.522
CV%		2.13	3.29	2.90	1.72

Means followed by the same letter(s) in a column are not significantly different. Variety: Exotic (V_1); BARI kalozira-1 (V_2); Faridpur local (V_3); Natore local (V_4). Date of sowing: 16 Oct, 2011(D_1); 1 Nov, 2011 (D_2); 16 Nov, 2011 (D_3); 1 Dec, 2011(D_4).

V_1D_2 (22.00) gave the highest number of tertiary branch, and V_3D_4 (13.00) showed the lowest.

3.1.15. Length of Leaf (cm)

There was no significant different among genotypes in leaf, ranged from 3.03 cm (V_4) to 3.05 cm (V_1) (**Table 4**). V_2 and V_3 showed 3.04 and 3.06 cm simultaneously. In case of date of sowing, it was the highest in D_2 (3.27 cm) which was statistically similar to D_1 (3.23 cm), followed by D_3 (2.93 cm). D_4 showed the statistically the lowest leaf length (2.75 cm). In interaction, it was the highest (3.27 cm) in V_1D_2 and the lowest (2.67 cm) in V_4D_4.

Table 4. Leaf, capsule and pedicle characteristics in black cumin genotypes as influenced by sowing time.

Treatment		Leaf		Capsule		Pedicle length (cm)
		Length (cm)	Breath (cm)	Length (cm)	Diameter (cm)	
Genotypes						
V_1		3.05	2.57a	1.17a	0.82a	7.81a
V_2		3.04	2.24b	1.10b	0.75c	5.55c
V_3		3.06	2.32b	1.00d	0.77b	5.54c
V_4		3.03	2.28b	1.02c	0.74c	5.81b
Date of sowing						
D_1		3.23a	2.58a	1.09b	0.78b	6.26b
D_2		3.27a	2.59a	1.12a	0.80a	6.83a
D_3		2.93b	2.19b	1.05c	0.75c	5.92c
D_4		2.75c	2.05c	1.03d	0.74c	5.71d
LSD (5%)		0.095	0.095	0.017	0.014	0.171
Interaction						
V_1	D_1	3.23a	2.73a	1.19a	0.84a	7.80b
	D_2	3.27a	2.73a	1.21a	0.85a	8.53a
	D_3	2.90bc	2.40c	1.15b	0.80b	7.50bc
	D_4	2.80b-d	2.40c	1.14b	0.79bc	7.40c
V_2	D_1	3.20a	2.47bc	1.12b	0.76d-f	5.50gh
	D_2	3.23a	2.50bc	1.15b	0.77c-e	6.23de
	D_3	2.97b	2.10d	1.07cd	0.74f-h	5.33hi
	D_4	2.77cd	1.90e	1.05cd	0.73g-i	5.13ij
V_3	D_1	3.27a	2.60ab	1.01ef	0.78b-d	5.77fg
	D_2	3.33a	2.60ab	1.04de	0.80b	6.20de
	D_3	2.87bc	2.17d	0.98fg	0.75e-g	5.27h-j
	D_4	2.77cd	1.90e	0.96g	0.74f-h	4.93j
V_4	D_1	3.23a	2.50bc	1.05cd	0.75e-g	5.97ef
	D_2	3.23a	2.53bc	1.08c	0.77c-e	6.33d
	D_3	2.97b	2.10d	0.98fg	0.72hi	5.57gh
	D_4	2.67d	2.00de	0.95g	0.71i	5.37hi
LSD (5%)		0.190	0.190	0.035	0.029	0.342
CV%		3.75	7.27	1.94	2.32	3.32

Means followed by the same letter(s) in a column are not significantly different. Variety: Exotic (V_1); BARI kalozira-1 (V_2); Faridpur local (V_3); Natore local (V_4). Date of sowing: 16 Oct, 2011 (D_1); 1 Nov, 2011 (D_2); 16 Nov, 2011 (D_3); 1 Dec, 2011 (D_4).

3.1.16. Breath of Leaf (cm)

In breath of leaf, Genotype V_1 (2.57 cm) was significantly different (**Table 4**) from V_2 (2.24 cm), V_3 (2.32 cm) and V_4 (2.28 cm). There was no significant different among V_2, V_3 and V_4. In case of date of sowing, D_1 (2.58 cm) and D_2 (2.59 cm) was statistically similar, followed by D_3 (2.19 cm). D_4 (2.05 cm) obtained the significantly the lowest leaf breath. In combined effect, the highest leaf breath (2.73 cm) was obtained from interaction of V_1 with D_1 and D_2, and the lowest leaf breath (2.00 cm) was found in V_4D_4.

3.1.17. Length of Capsule (cm)

Genotypes were significantly different from each other in capsule length (**Table 4**), where the highest obtained from V_1 (1.17 cm), and the lowest (1.00 cm) from V_3. Second highest capsule, length was observed in V_2 (1.10 cm), followed by V_4 (1.02 cm). Date of sowing also effect significantly in capsule length, where maximum was in D_2 (1.12 cm), followed by D_1 (1.09 cm). 1.05 and 1.03 cm capsule length were found in D_3 and D_4 simultaneously, which was statistically different. In interaction, V_1D_2 (1.21 cm) gave the highest and V_4D_4 (0.95 cm) gave the lowest capsule length.

3.1.18. Capsule Diameter (cm)

There was significant different among genotypes in capsule diameter (**Table 4**). It was maximum (0.82 cm) in V_1, followed by V_3 (0.77 cm), which was statistically different. V_2 (0.75 cm) and V_4 (0.74 cm) showed no significant different. Capsule diameter also varied in various sowing date. D_2 (0.80 cm) showed the highest followed by D_1 (0.78 cm). No significant different was observed in D_3 (0.75 cm) and D_4 (0.74 cm). In combined effect of genotype and date of sowing, capsule diameter was highest (0.85 cm) in V_1D_2 and lowest (0.71 cm) in V_4D_4.

3.1.19. Length of Pedicle (cm)

Genotypes showed significant different in pedicle length (**Table 4**). Genotype V_1 (7.81 cm) gave maximum pedicle length, where minimum was observed in V_3 (5.54 cm). No significant different was found in V_2 (5.55 cm) and V_3. V_4 (5.81 cm) showed moderate pedicle length. Pedicle length was also effected significantly by various date of sowing. D_2 (6.83 cm) showed maximum pedicle length, where D_4 (5.71 cm) showed the minimum. D_1 (6.26 cm) and D_3 (5.92 cm) showed moderate pedicle length. Each date of sowing was significantly different from each other. In combined effect, V_1D_2 showed (8.53 cm) highest and V_3D_4 (4.93 cm) showed the lowest pedicle length.

3.1.20. Fresh Weight per Plant (g)

It indicates plant size and vigor (**Table 5**). There was significant different among genotypes in fresh weight per plant (**Table 5**) which varied from 9.39g (V_4) to 13.87g (V_1). V_2 showed 10.11g and V_3 9.76g. Each genotype was significantly different from each other. Shah (2011), in India reported less fresh weight per plant 3.36 ± 0.27g. Date of sowing was also effect on fresh weight per plant. D_1 (12.95 g) gave the highest and D_4 (9.47 g) the lowest. D_2 and D_3 gave moderate fresh weight per plant which was 10.83 and 9.88g. Each date of sowing was statistically different from one another. In interaction, maximum fresh weight was obtained from V_1D_1 (16.15 g) and minimum from V_4D_4 (8.40 g).

3.1.21. Number of Seeds per Capsule

Different was found among genotypes in number of seed per capsule (**Table 5**). V_1 (95.77) and V_4 (95.51) showed higher and significantly similar number of seed per capsule. V_2 (93.53) and V_3 (89.58) were significantly similar. In date of sowing, D_4 (98.24) was higher followed by D_1 and D_2 which each was 95.35. D_3 (89.58) was significantly lower in number of seed per capsule. In combined effect of genotypes and date of sowing, maximum number of seed per capsule was obtained from V_1D_4 (100.67) and minimum from V_3D_3 (88.73).

3.1.22. Number of Capsule per Plant

Among yield contributing characters, number of capsule per plant is one of the most important. There was significant different among species in number of capsule per plant (**Table 5**), which was maximum 20.28 in V_1 and minimum 16.61 in V_4. V_2 (17.38) and V_3 (17.22) was statistically similar. On the other hand, date of sowing also effect on capsule per plant. It was maximum in D_2 (22.06) followed by D_1 (21.55), D_3 (14.88) and D_4 (12.99). In combined effect, the highest 24.17 was obtained from V_1D_2, and the lowest (12.17) from V_4D_4.

3.1.23. Fresh Seed Weight per Capsule (g)

There was no significant different among genotypes in fresh seed weight per capsule (**Table 5**). Maximum weight (0.21 g) was obtained from V_1. V_2, V_3 and V_4 gave same fresh seed weight which was 0.20 g. But in case of sowing date D_1 (0.21 g), D_2 (0.22 g) and D_3 (0.21 g) was statistically similar and was different from D_4 (0.17 g). In interaction, maximum weight was 0.22 g which was found in V_1 combination with D_2 and D_3. Minimum

Table 5. Plant weight and capsule characteristics contributing to yield in black cumin genotypes as influenced by sowing time.

Treatment		Fresh weight per plant (g)	No of Seed per capsule	Capsule per plant	Fresh seed weight per capsule (g)	Fresh seed yield per plant
Genotypes						
V_1		13.87a	95.77a	20.28a	0.21	4.27a
V_2		10.11b	93.53b	17.38b	0.20	3.55b
V_3		9.76c	93.73b	17.22b	0.20	3.52c
V_4		9.39d	95.51a	16.61c	0.20	3.30d
Date of sowing						
D_1		12.95a	95.35b	21.55b	0.21a	4.58b
D_2		10.83b	95.35b	22.06a	0.22a	4.77a
D_3		9.88c	89.58c	14.88c	0.21a	3.10c
D_4		9.47d	98.24a	12.99d	0.17b	2.19d
LSD (5%)		0.355	0.904	0.314	0.012	0.026
Interaction						
V_1	D_1	16.15a	96.10cd	23.93a	0.21a	5.02b
	D_2	14.65b	96.20c	24.17a	0.22a	5.40a
	D_3	12.76c	90.10f	17.67f	0.22a	3.89g
	D_4	11.90d	100.67a	15.33g	0.18bc	2.76j
V_2	D_1	12.29cd	94.10e	21.17cd	0.22a	4.66c
	D_2	10.14e	94.00e	21.90b	0.21a	4.60d
	D_3	9.19fg	89.50f	14.33h	0.20ab	2.86i
	D_4	8.83gh	96.50bc	12.13j	0.16c	1.94m
V_3	D_1	11.75d	94.20e	20.93cd	0.21a	4.40e
	D_2	9.63ef	94.30de	21.40bc	0.22a	4.71c
	D_3	8.90gh	88.73f	14.20h	0.21a	2.98h
	D_4	8.75gh	97.67bc	12.33j	0.17c	2.10l
V_4	D_1	11.60d	97.00bc	20.17e	0.21a	4.23f
	D_2	8.90gh	96.90bc	20.77de	0.21a	4.35e
	D_3	8.65gh	90.00f	13.33i	0.20ab	2.67k
	D_4	8.40h	98.13b	12.17j	0.16c	1.95m
LSD (5%)		0.709	1.808	0.628	0.024	0.053
CV%		3.95	1.15	2.11	6.39	0.68

Means followed by the same letter(s) in a column are not significantly different. Variety: Exotic (V_1); BARI kalozira-1 (V_2); Faridpur local (V_3); Natore local (V_4). Date of sowing: 16 Oct, 2011 (D_1); 1 Nov, 2011 (D_2); 16 Nov, 2011 (D_3); 1 Dec, 2011 (D_4).

0.16 g was obtained from V_4D_4.

3.1.24. Fresh Seed Yield per Plant (g)

Genotypes were statistically different from each other in fresh seed yield per plant (**Table 5**). Maximum yield was observed in V_1 (4.27 g) and minimum in V_4 (3.30 g). V_2 and V_3 were moderate as 3.55 and 3.52 g simultaneously. Date of sowing also effect significantly in fresh seed yield per plant. Maximum yield was obtained in D_2 (4.77 g), followed by D_1 (4.58 g), which was statistically different. D_3 (3.10 g) was moderate and D_4 (2.19 g)

was minimum which was statistically different. In interaction, maximum yield was obtained from V_1D_2 (5.40 g) and minimum from V_4D_4 (1.95 g).

3.1.25. Dry Weight per Plant (g)

There was significant different among all genotypes in dry weight per plant (**Table 6**). It was maximum in V_1 (9.01 g), and minimum in V_4 (6.10 g). V_2 (6.58 g) and V_3 (6.34 g) showed moderate dry weight per plant. Date of sowing was also significantly different from each other in dry weight per plant. D_1 (8.42 g) was maximum and D_4 (6.16 g) was minimum, where D_2 (7.04 g) and D_3 (6.42 g) were moderate. In combined effect, maximum dry weight per plant was observed in V_1D_1 (10.50 g) and minimum 5.46 g in V_4D_4.

Table 6. Yielding characteristics in black cumin genotypes as influenced by sowing time.

Treatment		Dry weight per plant (g)	Dry seed weight per capsule (g)	1000 seed weight (g)	Seed yield per plot (g)	Stover yield t/ha)	Harvest index (%)
Genotypes							
V_1		9.01a	0.18	2.40a	344.25a	4.48b	52.39c
V_2		6.58b	0.17	2.34ab	283.52c	3.26c	58.86b
V_3		6.34c	0.17	2.38ab	285.92b	3.15c	62.00a
V_4		6.10d	0.17	2.27b	266.16d	4.66a	39.06d
Date of sowing							
D_1		8.42a	0.18ab	2.46a	369.13b	4.69a	56.00b
D_2		7.04b	0.19a	2.51a	384.32a	3.89b	70.23a
D_3		6.42c	0.18b	2.55a	259.00c	3.56c	49.76c
D_4		6.16d	0.14c	1.88b	176.40d	3.42d	36.33d
LSD (5%)		0.230	0.008	0.126	1.663	0.115	1.818
Interaction							
V_1	D_1	10.50a	0.18ab	2.40b	404.85b	5.22b	53.29e
	D_2	9.52b	0.19ab	2.52ab	435.52a	4.73c	63.64c
	D_3	8.30c	0.19ab	2.69a	313.92i	4.12ef	52.62e
	D_4	7.74d	0.15c	1.97c	222.72l	3.84g	40.01f
V_2	D_1	7.99cd	0.19a	2.60ab	376.00d	3.97fg	65.34c
	D_2	6.59e	0.18ab	2.48ab	370.88e	3.27h	78.12b
	D_3	5.97fg	0.17b	2.48ab	230.72k	2.96ij	53.91e
	D_4	5.74gh	0.13c	1.84c	156.48o	2.85j	38.06fg
V_3	D_1	7.64d	0.18ab	2.45ab	354.56f	3.79g	64.54c
	D_2	6.26ef	0.19a	2.56ab	379.84c	3.11hi	84.33a
	D_3	5.79gh	0.18ab	2.60ab	240.00j	2.87j	57.86d
	D_4	5.69gh	0.14c	1.91c	169.28n	2.83j	41.29f
V_4	D_1	7.54d	0.18ab	2.38b	341.12h	5.76a	40.84f
	D_2	5.79gh	0.19ab	2.46ab	351.04g	4.42d	54.81de
	D_3	5.62gh	0.17b	2.44ab	215.36m	4.30de	34.64g
	D_4	5.46h	0.14c	1.79c	157.12o	4.17ef	25.96h
LSD (5%)		0.460	0.017	0.253	3.327	0.230	3.635
CV%		3.94	6.45	6.46	0.68	3.57	4.11

Means followed by the same letter(s) in a column are not significantly different. Variety: Exotic (V_1); BARI kalozira-1 (V_2); Faridpur local (V_3); Natore local (V_4). Date of sowing: 16 Oct, 2011 (D_1); 1 Nov, 2011 (D_2); 16 Nov, 2011 (D_3); 1 Dec, 2011 (D_4).

3.1.26. Dry Seed Weight per Capsule (g)

There was no significant different among genotypes in dry seed weight per capsule (**Table 6**). It was the highest in V_1 (0.18 g), followed by V_2, V_3 and V_4 which each was 0.17 g. Date of sowing significantly effect on dry seed weight per capsule. It was maximum in D_2 (0.19 g) which was statistically similar to D_1 (0.18 g). D_1 also was statistically similar to D_3 (0.18 g), but different from D_4 (0.14 g). A variation was observed in interaction. Maximum dry weight was found in V_2D_1 (0.19 g) and minimum 0.13 g in V_2D_4.

3.1.27. 1000 Seed Weight (g)

1000 seed weight is an important yield contributing character. It was maximum in V_1 (2.40 g) which was statistically similar to V_2 (2.34 g) and V_3 (2.38 g) (**Table 6**). V_2 and V_3 were also statistically similar to V_4 (2.27 g). In case of date of sowing, D_1 (2.46 g), D_2 (2.51 g) and D_3 (2.55 g) was statistically similar. D_4 (1.88 g) was statistically different from D_1, D_2 and D_3. In combined effect of genotypes and date of sowing maximum 1000 seed weight 2.69 g was obtained from the interaction of V_1 and D_3, where minimum 1.79 g in V_4D_4.

3.1.28. Dry Seed Yield per Plant (g)

Yield of per plant contribute directly in total yield. Genotype each was significantly different from each other in dry seed yield per plant. Maximum yield was found in V_1 (3.59 g), followed by V_2 (2.98 g) (**Figure 1(a)**). V_3 (2.95 g) showed moderate and V_4 (2.77 g) was minimum in yield per plant. In case of date of sowing (**Figure 1(b)**), it was the highest in D_2 (4.00 g) which was statistically different from D_1 (3.85 g). Also D_3 (2.60 g) and minimum D_4 (1.84 g) was statistically different. In combined effect (**Figure 2**), maximum (4.54 g) yield was found in V_1D_2 and minimum (1.64 g) in V_4D_4.

3.1.29. Stover Yield (t/ha)

There was significant different among genotypes in stover yield (**Table 6**). Significantly maximum stover yield was found in V_4 (4.66 t/ha) and minimum in V_3 (3.15 t/ha). V_1 (4.48 t/ha) and V_2 (3.26 t/ha) was statistically different, where V_2 and V_3 was statistically similar. On the other hand, date of sowing clearly effect on stover

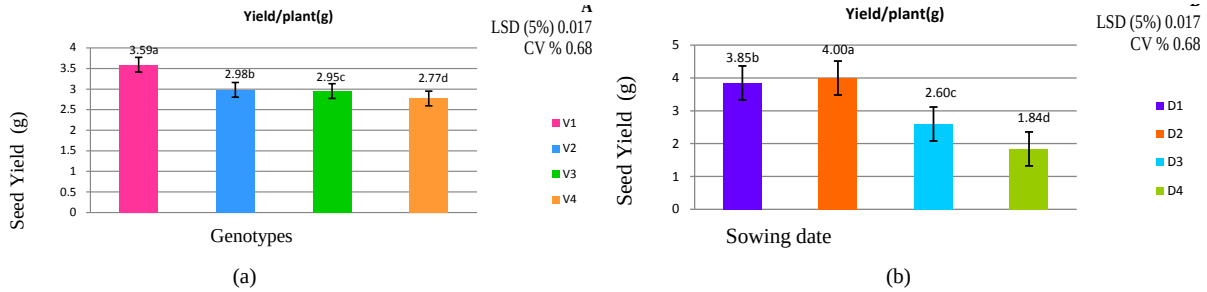

Figure 1. Seed yield per plant of black cumin as influenced by genotype (a) and date of sowing (b).

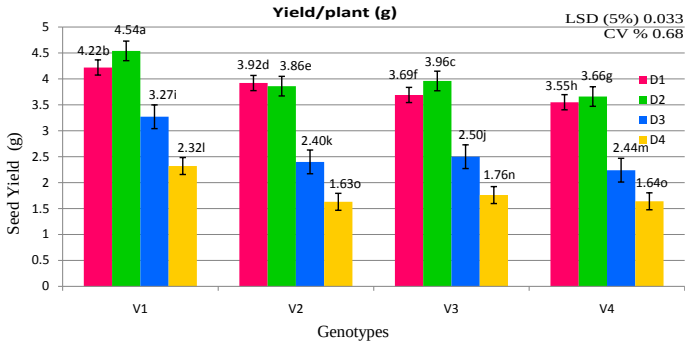

Figure 2. Seed yield per plant of black cumin as influenced by interaction of genotype and date of sowing. Vertical bars represent standard error of treatment means. Means followed by the same letter(s) in a column are not significantly different. Variety: Exotic (V_1); BARI kalozira-1 (V_2); Faridpur local (V_3); Natore local (V_4). Date of sowing: 16 Oct, 2011 (D_1); 1 Nov, 2011 (D_2); 16 Nov, 2011 (D_3); 1 Dec, 2011 (D_4).

yield. Early sowing gave higher stover yield. It gradually decreased in late sowing. D_1 (4.69 t/ha), D_2 (3.89 t/ha), D_3 (3.56 t/ha) and D_4 (3.42 t/ha) was statistically different from each other. In combination of genotype and date of sowing, the highest stover yield was obtained from V_4D_1 (5.76 t/ha), and the lowest (2.83 t/ha) from V_3D_4. In every genotype, gradually late sowing gave gradually lower stover yield.

3.1.30. Harvest Index (%)

It is the indicator of efficient use of nutrients (**Table 6**). Each genotype was statistically different from each other in harvest index, where it was the highest in V_3 (62.00%), and the lowest (39.06%) in V_4. V_1 (52.39%) and V_2 (58.86%) showed moderate harvest index. Date of sowing also effect on harvest index. D_2 (70.23%) showed maximum harvest index, followed by D_1 (56.00%). D_3 (49.76%) showed moderate and D_4 (36.33%) showed minimum harvest index. In interaction, V_3D_2 (84.33%) showed maximum and V_4D_4 (25.96%) showed the minimum.

3.1.31. Seed Yield (t/ha)

Seed yield per hectare is the ultimate goal. It was significantly the highest 2.37 t/ha in V_1, followed by V_2 (1.96 t/ha) (**Figure 3(a)**). V_2 and V_3 (1.97 t/ha) were statistically similar. The lowest yield was found in V_4 (1.84 t/ha). In some places of Bangladesh, seed yield observed up to 1.5 t/ha (www.stoppressbd.com/news_details/638). In case of date of sowing, it effect significantly in yield. Maximum yield was obtained from D_2 (2.65 t/ha), where minimum in D_4 (1.22 t/ha). D_1 (2.55 t/ha) and D_3 (1.73 t/ha) was statistically different (**Figure 3(b)**). In combined effect, maximum yield 3.00 t/ha was obtained in V_1D_2 and minimum 1.08 t/ha in V_2D_4 and V_4D_4 (**Figure 4**).

3.1.32. Correlation among Characters

Correlation co-efficient values and level of significance among 10 yields, yield attributing and other characters influenced by genotypes spacing are presented in **Table 7**. There was moderate and strong positive correlation

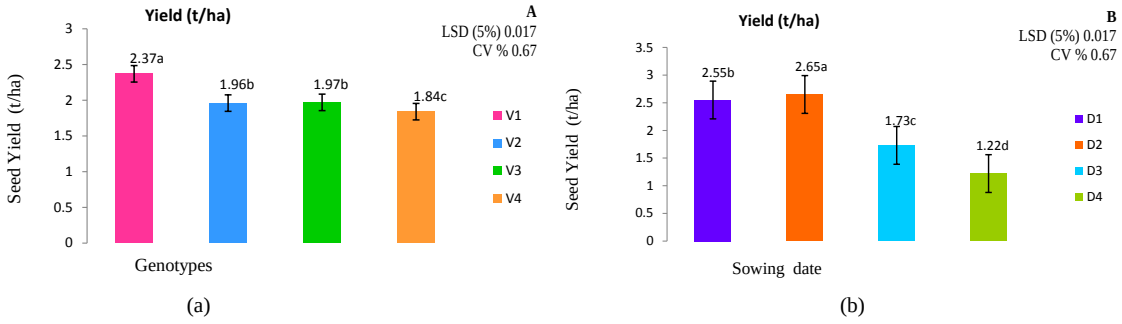

Figure 3. Seed yield ha^{-1} of black cumin as influenced by genotype (a) and date of sowing (b).

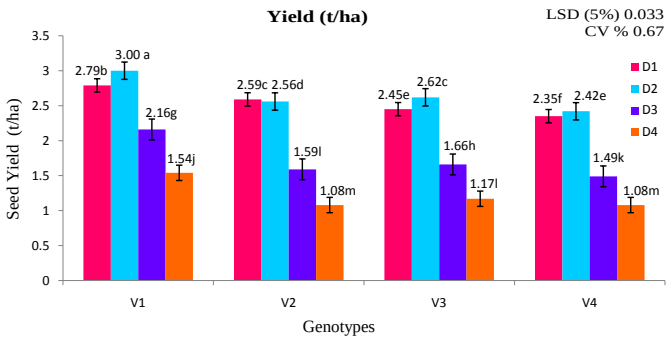

Figure 4. Seed yield ha^{-1} of black cumin as influenced by interaction of genotype and date of sowing. Vertical bars represent standard error of treatment means Means followed by the same letter(s) in a column are not significantly different. Variety: Exotic (V_1); BARI kalozira-1 (V_2); Faridpur local (V_3); Natore local (V_4). Date of sowing: 16 Oct, 2011 (D_1); 1 Nov, 2011 (D_2); 16 Nov, 2011 (D_3); 1 Dec, 2011 (D_4).

Table 7. Correlation coefficients among seed yield, yield determinants, plant height and number of branches in black cumin as influenced by genotypes and time of sowing.

Characters	SY	PH	NPB	NSB	NTB	PL	SPC	CPP	TSW	STY
PH	0.82**									
NPB	0.57*	0.27								
NSB	0.90**	0.75**	0.67**							
NTB	0.87**	0.89**	0.58*	0.89**						
PL	0.58*	0.87**	0.30	0.53*	0.80**					
SPC	0.02	0.05	0.19	0.84	0.15	0.21				
CPP	0.97**	0.83**	0.63**	0.96**	0.93**	0.63**	0.10			
TSW	0.67**	0.51*	0.33	0.55*	0.53*	0.30	−0.67**	0.61**		
STY	0.43	0.31	0.80**	0.49	0.57**	0.54*	0.28	0.51*	0.18	
HI	0.74**	0.63**	0.12	0.65**	0.55*	0.23	−0.28	0.70**	0.69**	−0.21

*Correlation is significant at the 5% level. **Correlation is significant at the 1% level, SY = Seed yield (t/ha); PH = Plant height (cm); NPB = Number of primary branches per plant; NSB = Number of secondary branches per plant; NTB = Number of tertiary branches per plant; PL = Pedicle length (cm); SPC = Seed per capsule; CPP = Capsule per plant; TSW = Thousand seed weight (g); STY = Stover yield (t/ha); HI = Harvest index (%).

except seed per capsule. Relation with plant height at harvest (0.82**), Number of primary branch per plant (0.57*), number of secondary branch per plant (0.90**), number of tertiary branch per plant (0.87**), pedicle length (0.58*), seed per capsule (0.02), capsule per plant (0.97**), 1000 seed weight (0.67**), stover yield (0.43) and harvest index (0.74**). Plant height also had shown mostly positive strong and moderate correlation with character except seed per capsule (0.05). Number of primary, secondary and tertiary branch per plant showed strong positive correlation with almost characters but positive and week with seed per capsule. Pedicle length showed strong positive correlation with most characters but week seed per capsule (0.21), 1000 seed weight (0.30) and harvest index (0.23). Seed per capsule showed almost weak and sometime negative (1000 seed weight and harvest index). Capsule per plant exhibited mostly moderate positive correlation except seed per capsule. 1000 seed weight had moderate to week positive correlation with all characters. Stover yield (t/ha) exhibited moderate to week but positive correlation with all characters except harvest index (−0.21). Harvest index showed moderate to week positive correlation with most character, except seed per capsule (−0.28) and stover yield (−0.21).

3.2. Discussion

The minimum period required to 1st emergence may be due to high vigor of seed, and maximum period due to low vigor. Variation also observed in date of planting. Early sowing took significantly lower, and late sowing higher days, may be due to early sowing get upper temperature than late sowing which influenced 1st emergence (**Figure 5**) and than late sowing which influenced 50% emergence. Bud initiation, days to 1st flower blooming and days to 50% flower blooming are influence by environment**.** Combination effect might be depended on genetical as well as environment. For flowering, a certain cool and humid weather was needed. Variation in days to 1st capsule setting was observed in genotypes. Days to 50% capsule setting was statistically varied in genotypes. and gradually less time required from D_1 to D_4 with interaction with all genotypes. In days to first capsule ripening in early sowing, the highest days were obtained by D_1, as well as lowest D_4. D_2 and D_3 take simultaneously. In combined effect, V_1D_1 took maximum time (134.33 days), where minimum (109.33 days) obtained from V_4D_4. The finding was nearly supported by [11] describing 135 to 145 days for ripening. It might be due to comparatively high temperature and humid weather. Plant height is an important factor. Genotypes were significantly different in plant height. This result of plant height was in partial conformity in case of V_2 with the findings of [11], where it was reported that height laid between 55 to 60 cm. The result also partially similar to finding of Shah *et al.*, (2006) [13] who found height 41.12 to 46.51 cm. [14]) Valadabadi and Aliabadi (2011) found plant height 58 to 82 cm [15]. Tuncturk *et al.*, (2005) found plant height 34.68 to 40.68 cm. But [16] Toncer and

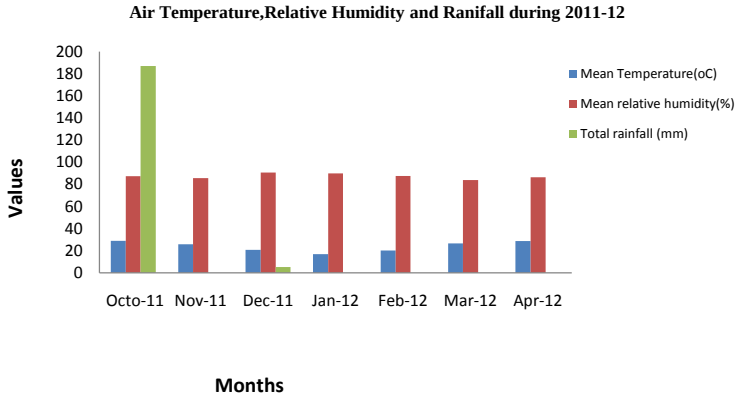

Figure 5. Meteriological parameters of the experimental period (2011-12). Source: Weather Station, BSMRAU, Gazipur-1706.

Kizil (2004) found an upper range 64.9 to 71.5 cm, and [17] Rahnavard *et al.*, (2010) observed a lower range, up to 15.01 cm. Plant heights might be controlled genetically, also environment could effect. Date of sowing was also significantly different from each other. Maximum height was found in D_2 (50.78 cm), and minimum (44.15 cm) from D_4. D_1 and D_3 showed 48.31 and 45.98 cm simultaneously. The result was supported by [18] Rasem *et al.*, (2005) who reported that delay sowing significantly reduce the plant height. Primary branches per plant are an important yield contributing character. In case of V_2, it was almost similar with finding of [11], where it was reported that number of primary branch was 5 to 7. Also [16] Toncer and Kizil (2004) reported number of branch 4.7 to 6.8 per plant, which was almost similar to finding [19]. Tuncturk *et al.*, (2011) reported 3.76 branches per plant. It might be depended on genetical as well as environment. In case of number of secondary branch [20], Shah and Samiullah (2007) observed 7.2 to 11.74 branches per plant. Leaf area is the indicator of photosynthesis. Photosynthesis influences capsule setting, number of seed per capsule as a results production is increases. This result number of seed per capsule was in partial conformity with the findings of [16] Toncer and Kizil (2004) who reported that, number of seed per capsule varied from 90.7 to 92.8. Also, in case of V_2, report from [11] BARI (2007) showed 75 to 80 seeds per capsule [15] Tuncturk *et al.*, (2005) and [13] Shah *et al.*, (2006) reported a few lower seed per capsule 66.45 to 71.72 and 52.01 to 52.17 respectively. It might be controlled genetically. In date of sowing, finding was supported by [17] Rahnavard *et al.*, (2010) and [9] Sadeghi *et al.*, (2009), who reported that, seed per capsule was higher in early sowing [18]. Rasem *et al.*, (2005) found that delay sowing significantly reduced seed per capsule. Among yield contributing characters, number of capsule per plant is one of the most important. From this finding Slightly lower report were obtained from [21] Shah (2011) (16.45 ± 1.2), 15.12 by [22] Shah (2007), 9.48 to 14.65 by [15] Tuncturk *et al.*, (2005) and 15.26 to 16.50 by [13] Shah *et al.* (2006). But very few number of capsule per plant (4.68) was reported by [19] Tuncturk *et al.*, (2011), and very higher (42.13) by [23] Sardooyi *et al.*, (2011). It might be controlled genetically. On the other hand, date of sowing also effect on capsule per plant. Finding was supported by [17] Rahnavard *et al.*, (2010) and [9] Sadeghi *et al.*, (2009), who reported that, capsule per plant was higher in early sowing [18]. Rasem *et al.*, (2005) found that delay sowing significantly reduced capsule per plant. Each was statistically different from each other. 1000 seed weight is an important yield contributing character. The result was similar to finding of [19] Tuncturk *et al.*, (2011) who reported 1000 seed weight was 2.28 g. Also the result was similar to [13] Shah *et al.*, (2006) (2.45 to 2.50 g). In another experiment, [20] Shah and Samiullah (2007) described 1000 seed weight as 2.40 to 2.91 g. The result also mostly supported by [15] Tuncturk *et al.*, (2005), who described 1000 seed weight as 2.40 to 2.65 g. A slightly low 1000 seed weight 1.79 to 1.89 g was found by [16] Toncer and Kizil (2004), and some higher as up to 5g, and up to 7g by [23] Sardooyi *et al.*, (2011) and [11] BARI (2007) respectively. That might be due to genetic. In case of date of sowing, finding was supported by [17] Rahnavard *et al.*, (2010), [9] Sadeghi *et al.*, (2009), [18] Rasem *et al.*, (2005) and [23] Sardooyi *et al.*, (2011) who reported that, date of sowing had no significant effect or little on 1000 seed weight. Seed yield per hectare is the ultimate goal. The finding was supported by [24] Abdolrahimi *et al.*, (2012), who observed seed yield up to 2.15 t/ha [20]. Shah and Samiullah (2007) described seed yield up to 1.55 t/ha. [14] Valabadi and Aliabadi (2011) found up to 1.43 t/ha. In case of date of sowing, finding was supported by [17] Rahnavard *et al.*, (2010), [9] Sadeghi *et al.*

(2009) and [23]) Sardooyi *et al.*, (2011) who reported that, early sowing gave higher yield. In case of stover yield, the finding was supported by [14] Valadabadi and Aliabadi (2011), who reported stover yield 3.49 to 4.23 t/ha. On the other hand, date of sowing clearly effect on stover yield. Finding was supported by [17] Rahnavard *et al.*, (2010) and [9] Sadeghi *et al.*, (2009) who reported that aboveground biomass was higher in early sowing. In every genotype, gradually late sowing gave gradually lower stover yield. Harvest index (%) is the indicator of efficient use of each genotype was statistically different from each other in harvest index. The finding was similar to observation of [23] Sardooyi *et al.* (2011), who reported 51% harvest index. [17] Rahnavard *et al.* (2010) also found 45% harvest index. But the findings of [20] Shah and Samiullah (2007), [13] Shah *et al.* (2006) and [24] Abdolrahimi *et al.*, (2012) were few lower as 30.30% to 32.91%, 30.01% to 30.21% and 23.93 to 25.84% respectively, might be due to genotypic character. In an experiment in Azerbaijan, [24] Abdolrahimi *et al.*, (2012) found strong correlation of seed with stem weight (0.99^{**}), capsule weight (0.99^{**}), seed weight (0.99^{**}), 1000 seed weight (-0.69^{**}), which support current findings [17]. Rahnavard *et al.*, (2010), in his experiment showed strong correlation ($r = 0.91^{**}$) between seed yield and aboveground biomass, but a negative one ($r = -0.68^{*}$) between aboveground biomass and harvest index, which strongly support current finding. Finding of [9] Sadeghi *et al.*, (2009), in Iran was strong correlation ($r = 0.91^{**}$) between seed yield and above biomass, but a negative ($r = -0.68^{*}$) with harvest index. Also these finding strongly support current findings. Correlation among various characters indicated that all these characters had significant contribution to seed yield and yield would be increased by improving these yield attributes.

4. Conclusion

The effect of planting time with genotypes was investigated to find out the suitable planting time in each genotype. The genotypes of black cumin showed variation in growth and yield behavior. Genotype V_1 (Exotic) was found suitable for higher seed production. Genotype V_4 (Natore local) was found as short durated and V_1 long durated crop. Seeds of V_1 (Exotic) and V_2 (BARI kalojeera1) showed higher germination and higher vigor sowing in 1 November followed by 16 October obtained the highest yield, and sowing in 16 October took maximum duration for harvest.

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