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Influence of Sowing Dates and Sowing Methods on Growth and Seed Yield of Black Cumin (*Nigella sativa* L.)

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Abstract

Nigella sativa L. is widely used medicinal plant throughout the world. In Bangladesh it is mainly used as spices in preparing various food items. Sowing time and sowing methods are the influential factors to produce higher seed yield of black cumin. Therefore, this study was undertaken to find out a suitable sowing date and method to produce higher seed yield of black cumin. The two-factor experiment comprised with four sowing dates (1st November, 15th November, 1st December and 15th December) and two sowing methods (line sowing and broadcast seeding). The experiment was carried out following randomized complete block design with three replicates. Results showed that plant growth, yield contributing traits and yield of black cumin significantly influenced by sowing dates and methods. It was observed that the line sowing method compared to broadcast seeding and 1st December sowing among the other sowing dates exhibited higher plant growth with greater production of seed. The combine effect of sowing time and sowing methods showed significantly influenced on black cumin seed production. It was observed that the 1st December sowing with line sowing method increased the seed yield as compared to other sowing dates and methods. From the findings of this study it can be concluded that 1st December following line sowing method would maximize plant growth, yield contributing traits and seed yield of black cumin in Bangladesh.

Keywords: Growth, *Nigella sativa*, seed yield, yield contributing traits.

Introduction

Black cumin (*Nigella sativa* L.) is an annual spicy herb and belongs to the family Ranunculaceae. It is also referred to as black seeds in the world (Rahman, 2014; Koli, 2013). The word *Nigella* originated from the Latin word *niger* which means *blackish* referring to its seed colour. The word *sativa* derived from the Latin word '*serere*' which meaning it is *sown, planted or cultivated* (Jansen, 1981). It is believed to have originated in the Mediterranean region and subsequently spread to Europe, Asia and Africa (Zohary et al., 2012). It is cultivated in many parts of the world including the Middle East, North Africa and Asia where maximum diversity is found (Tierra, 2005). The major producing countries are India, Sri Lanka, Bangladesh, Afghanistan, Pakistan, Egypt, Iran, Iraq, Syria, Turkey and Ethiopia (Malhotra, 2004; Wallace, 2013). Black cumin is commonly known as 'Kalozira' in Bangladesh and some other countries of the world and is cultivated in the winter season. In Bangladesh, it is grown well in Faridpur, Sariatpur, Madaripur, Pabna, Sirajganj, Jessore, Kusthtia and Natore districts (Ali et al., 2015). Recently cultivation of Kalozira is gaining popularity in Bangladesh mainly because of its demand as a commodity for export. The area and production of black cumin are 42 thousand acres and 17 thousand tons, respectively (BBS, 2016). As herb, black cumin has a rich nutritional value; it contains monosaccharides. The seed is rich in fatty acids, proteins and carbohydrates. It contains all essential amino acids and rich source of vitamins and minerals (Atta, 2003).

Various factors are responsible for improving the growth and yield of black cumin per unit area. Among them, sowing dates and methods are the most important factors for affecting the growth and yield of black cumin. For successful production of any crop, appropriate planting time/sowing time is very important (Haq et al., 2015). Mahmood et al. (2012) revealed that the early sowings were the best for black cumin seed yield while Sadeghi et al. (2009) also reported that early sowing as compared to late resulted in higher seed yield. However, early sowing has been favorable for disease, and leads to early flowering, resulting poor quality of seed (Sharangi and Roychowdhury, 2014). The optimum temperature for germination is 16.19˚C to 22.14˚C for black cumin in Bangladesh reported by (Saeidnejad et al., 2012).

Planting or sowing date is also one of the most important agronomic factors involved in producing high yielding small grain cereal crops, which affects the timing and duration of the vegetative and reproductive stages. Fahim et al. (2017) reported that it is generally cultivated as a relay crop or in the fallow land by broadcasting in Bangladesh. Few research works have been done so far on black cumin production. However, to realize the yield potential of black cumin, agricultural practices will have to be optimized for its production. Sowing date is the key factor affecting the yield and yield components of cumin (Fahim et al., 2017). Mahmood et al. (2012) also reported that the different planting methods improved the seed yield up to 38% than that of direct (broadcast seeding) sowing. From the above aspect, the study is therefore, conducted to find out the influence of different sowing dates and methods on the growth and yield attributes of black cumin.

Materials and Methods

Experimental Site

The study was conducted at the Horticulture Farm, Department of Horticulture, Bangladesh Agricultural University, Mymensingh during November 2016 to April 2017. The experimental area is located at 24.60^0 N and 90.50^0 E latitude. The elevation of the area is approximately 19 m from average sea level. The soil of the experimental area was sandy loam belonged to the Old Brahmaputra Floodplain Alluvial Tract. The experimental site was medium high elevation and the pH of the soil was 6.7. The study area was situated in the sub–tropical zone, characterized by heavy rainfall during the months of April to September and scanty rainfall during October to March. *Rabi* season (October to March) is characterized by low temperature but plenty of sunshine.

Planting Materials, Treatments and Experimental Design

The seed of BARI Kalozira-1 was collected from the Spice Research Centre (SRC), Bangladesh Agricultural Research Institute (BARI), Bogra. The two-factor experiment having four sowing dates (D_1: 1st November, D_2: 15th November, D_3: 1st December and D_4: 15th December) and two sowing methods (M_1: Line sowing and M_2: Broadcast seeding method). The experiment was laid out in randomized complete block design with three replications. Each block was divided into eight-unit plots and all treatment combinations were assigned randomly. The size of a unit plot was 1.5 m x 1.0 m. The line to line distance and block to block distances were 20 cm and 50 cm, respectively.

Experimentation and Data Collection

The land was ploughed to bring a good tilth condition. Weeds and stubbles were removed from the field. At the time of first ploughing, cow dung was applied at the rate of 5 $t.ha^{-1}$. The land was fertilized with 125, 95 and 75 $kg.ha^{-1}$ of urea, triple super phosphate (TSP) and muriate of potash (MoP).ha^{-1}, respectively. Before seed sowing the seeds were soaked in tap water for 48 hours. Seeds were treated with Bavistin @ 2 $g.kg^{-1}$ of seeds before sowing. The seeds were sown 20 cm apart according to the treatments in both line and broadcast methods. Seeds were covered with good pulverized soil just after sowing and gently pressed by hands to help the quick germination of seeds. Seed sowing was done as per treatment. After sowing slight watering was provided for quick germination.

Seed germination completed within 7 days and excess plants were thinned out twice at 15 and 30 days after seed sowing maintaining a spacing of 5 to 8 cm between the plants. Weeding was done to keep the plots free from weeds. Irrigation was provided immediately after weeding it was continued till the establishment of the plants. Mature seed capsules were harvested at different dates according to maturity of capsule as per treatments. Harvesting started from 14th March 2017 and continued up to 4th April, 2017. After harvest, the capsules were sun dried and seeds were collected.

Data Collection

Plant height was measured in centimeter (cm) by a meter scale from the ground level to the tip of the tallest leaves. The data on plant height was recorded at 30, 45, 60, 75, 90 and 105 days after sowing (DAS). Days to 50% flowering, fruit setting and harvesting were counted from the date of sowing. The number of capsules per plant, number and weight of seeds per capsule, per plant and per plot were recorded.

Statistical Analysis

The collected data on various parameters were statistically analyzed. Analysis of variance was done with the help of MSTAT–C computer package program. The mean differences among the treatments were evaluated with least significant difference (LSD) test at both 1 and 5% level of significance.

Results

Plant Height

The plant height of black cumin at different days after sowing showed significant variations among the sowing dates. At 105 DAS, it was found that 1st December sowing produced the highest plant height (43.20 cm) followed by 15th November (35.53 cm) and the lowest plant height (29.38 cm) recorded from 15th December sowing (Figure 1). In case of sowing methods, plant height was always higher in line sowing method as compared to broadcast seeding method (Figure 2).

The combined effects of sowing dates and methods at different DAS was statistically significant. At 105 DAS, the highest plant height (44.47 cm) obtained when line sowing was applied in 1st December (D3M1) the lowest plant height (29.88 cm) recorded from 15th December sowing in broadcast seeding (D4M2) (Table 1).

Days to 50% Flowering, Fruit Setting and Harvesting

Seed sowing time significantly influenced flowering, fruit setting and even harvesting of black cumin**.** Days to 50% flowering showed significant different among

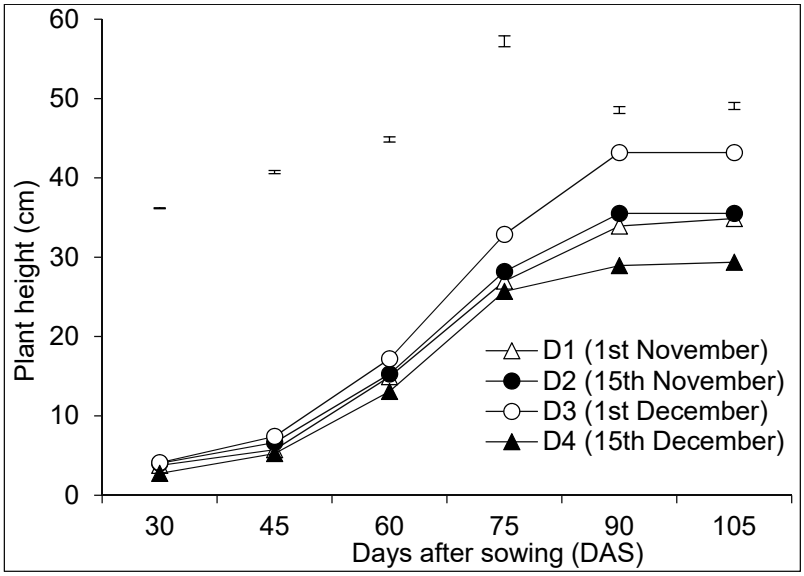

Figure 1. Effect of sowing dates on plant height of black cumin at different days after sowing. Vertical bars represent LSD at 5% level of probability.

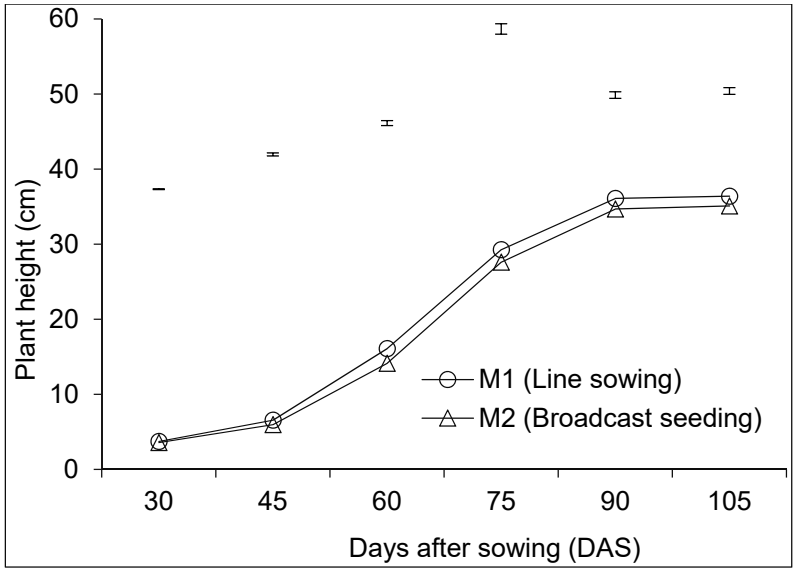

Figure 2. Effect of sowing methods on plant height of black cumin at different days after sowing. Vertical bars represent LSD at 5% level of probability.

Table 1. Combined effects of sowing dates and methods on plant height of black cumin at different days after sowing (DAS)

Treatment combinations		Plant height (cm) at different DAS					
		30	45	60	75	90	105
D1 (1st November)	M1 (Line sowing)	3.77	6.26	15.77	27.81	35.12	36.97
	M2 (Broadcast seeding)	3.74	5.24	14.11	26.18	32.77	34.80
D2 (15th November)	M1 (Line sowing)	4.18	6.96	16.22	28.42	36.28	37.28
	M2 (Broadcast seeding)	3.85	6.37	14.37	27.98	34.78	35.78
D3 (1st December)	M1 (Line sowing)	4.23	7.48	17.50	33.33	43.47	44.47
	M2 (Broadcast seeding)	4.00	7.36	16.90	32.42	42.93	43.93
D4 (15th December)	M1 (Line sowing)	2.80	5.57	14.95	27.50	29.57	30.87
	M2 (Broadcast seeding)	2.71	4.93	11.20	23.88	28.33	29.88
$LSD_{0.01}$		0.11	0.37	0.61	1.31	0.82	0.85
Level of significance		**	**	**	**	**	**

Note: ** indicates significant at 1% level of probability

the sowing dates. It was noticed that the earlier sowing D1(1st November) required longer time for days to 50% flowering (75 days), 50% fruit setting (89.50 days) and days to harvesting (133.00 days). The late sowing D4 (15th December) gave earlier flowering (71.50 days), fruit setting (86.67 days) and harvesting (112.50 days) (Table 2).

Sowing methods also significantly impacted flowering, fruit setting and harvesting of black cumin. It was observed that broadcast seeding produced early flowering, fruit setting and harvesting as compared to line sowing method (Table 3).

The combined effects of sowing dates and methods significantly influenced on flowering time, fruit setting as well as harvesting of black cumin. It was found that the combination of late sowing with broadcast seeding (D4M2) produced early flowering, fruit setting and harvesting as compared to early sowing following line sowing method (D1M1) (Table 4).

Number and Weight of Capsule

The number of capsules per plant and weight of capsule of black cumin significantly affected by the effect of sowing dates and sowing methods. The highest number of capsule per plant(11.40) and weight of individual capsule (0.267 g) produced from the 1st December sowing (D3) plant while those traits were

Table 2. Effect of sowing dates on days to flowering, fruit setting and harvest of black cumin

Sowing dates	Days to 50% flowering	Days to 50% fruit setting	Days to harvest (days)
D1(1st November)	75.00	89.50	133.00
D2(15th November)	74.00	88.50	128.50
D3(1st December)	73.00	87.50	121.00
D4(15th December)	71.50	86.67	112.50
$LSD_{0.01}$	0.41	0.39	1.10
Level of significance	**	**	**

** indicates significant at 1% level of probability

Table 3. Effect of sowing methods on days to flowering, fruit setting and harvest of black cumin

Sowing methods	Days to 50% flowering	Days to 50% fruit setting	Days to harvest (days)
M1 (Line sowing)	74.50	89.42	126.00
M2 (Broadcast seeding)	72.25	86.67	121.50
$LSD_{0.01}$	0.29	0.28	0.78
Level of significance	**	**	**

Note: ** indicates significant at 1% level of probability

Table 4. Combined effects of sowing dates and methods on days to flowering, fruit setting and harvest of black cumin

Treatment combinations		Days to 50% flowering	Days to 50% fruit setting	Days to harvest (days)
D1 (1st November)	M1 (Line sowing)	76.00	91.00	135.00
	M2 (Broadcast seeding)	74.00	88.00	131.00
D2 (15th November)	M1 (Line sowing)	75.00	90.00	130.00
	M2 (Broadcast seeding)	73.00	87.00	127.00
D3 (1st December)	M1 (Line sowing)	74.00	89.00	124.00
	M2 (Broadcast seeding)	72.00	86.00	118.00
D4 (15th December)	M1 (Line sowing)	73.00	87.67	115.00
	M2 (Broadcast seeding)	70.00	85.67	110.00
$LSD_{0.01}$		0.58	0.55	1.56
Level of significance		**	**	**

Note ** indicates significant at 1% level of probability

the lowest (6.13 per plant and 0.218g from the 15th December sowing (D4) (Table 5). Similarly, the plants produced from line sowing method (M1) produced significantly the highest number of capsules per plant (9.42) and weight of single capsule (0.255g) than that of broadcast seeding method (M2) (Table 6).

Significant variations were observed on number of capsule per plant and single capsule weight due to the combined effects of sowing dates and methods. The number of capsules per plant and single capsule weight were highest in the combination of line sowing at 1st December (D3M1) while it was lowest with broadcast seeding at 15th December (D4M2) (Table 7).

The weight of capsule per plant was significantly influenced by the effect of sowing time. It was found that the 1st December sowing plant showed the highest weight of capsules per plant (2.35 g) while 15th December sowing plant recorded the lowest weight of capsules per plant (1.38 g) (Figure 3). There was a significant variation for weight of per plant due to the effect of sowing method. It was observed that the line sowing method produced the highest (1.89 g) and broadcast seeding gave the lowest (1.64 g) weight of capsules per plant (Figure 4). Significant variation was found due to the combined effects of sowing dates and methods of sowing on weight of capsule. The highest weight of capsule (2.48 g per plant) was recorded from the line sowing method at

Table 5. Effect of sowing dates on number and weight of capsules of black cumin at harvest

Sowing dates	No. of capsules per plant	Weight of single capsule (g)
D1(1st November)	7.47	0.227
D2(15th November)	9.77	0.253
D3(1st December)	11.40	0.267
D4(15th December)	6.13	0.218
$LSD_{0.01}$	0.34	0.02
Level of significance	**	**

Note: ** indicates significant at 1% level of probability

Table 6. Effect of sowing methods on number and weight of capsules of black cumin at harvest

Sowing methods	No. of capsules per plant	Weight of single capsule (g)
M1 (Line sowing)	9.42	0.255
M2 (Broadcast seeding)	7.97	0.228
$LSD_{0.01}$	0.24	0.012
Level of significance	**	**

Note: ** indicates significant at 1% level of probability

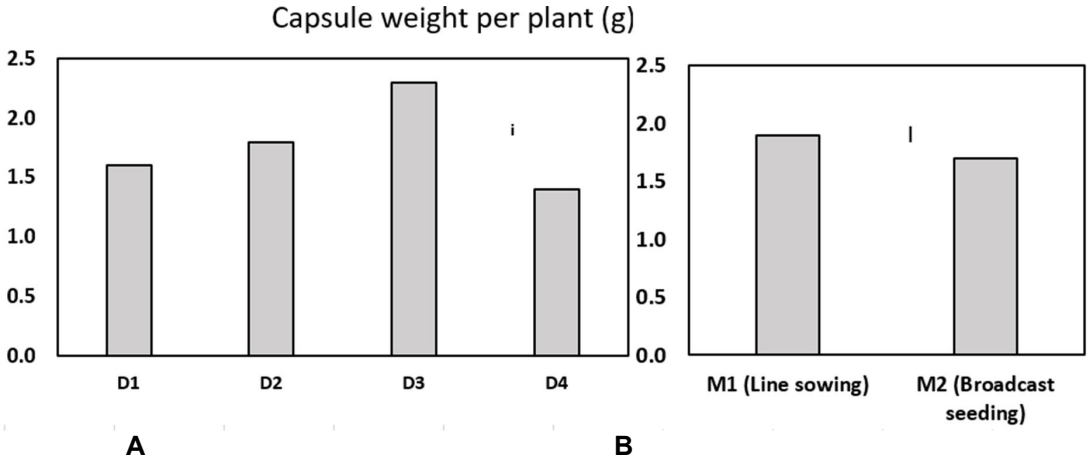

Figure 3. Effect of sowing dates (A) and sowing methods (B) on capsule weight of black cumin at harvest. Vertical bar represents LSD at 5% level of probability.

1st December sowing (D3M1) followed by broadcast seeding at the same date of sowing (2.21 g per plant) while the broadcast seeding at 15th December (D4M2) gave the lowest weight of capsules (1.37 g per plant) (Table 7).

Yield Contributing Traits and Yield of Black Cumin

Significant variations observed in number of seeds per capsule, weight of seeds per plant, per plot as well as per hectare due to the effect of sowing dates, methods and their combinations. Among the sowing dates, 1st December sowing produced the highest seeds per capsule (68.60) and the maximum seed weight (1.60 g per plant, 64.31g per plot and 428.73 kg.ha^{-1}, respectively). Those parameters were the lowest in case of the 15th December planting (51.97 seeds per capsule, 0.67 g per plant, 40.49 g per plot and 269.94 kg.ha^{-1}, respectively) (Table 8 and Figure 4). Sowing methods significantly impacted the yield contributing traits and seed yield of black cumin. It was noticed that the maximum number of seeds (61.93 per capsule), seed weight (1.17 g per plant, 59.61 g per plot and 397.43 kg.ha^{-1}, respectively) obtained in line sowing method as compared to broadcast seeding method (58.65 per capsule, 1.01 g per plant, 40.49 g per plot and 269.94 kg.ha^{-1}, respectively) (Table 9 and Figure 4).

The combined effects of sowing dates and sowing methods were significantly impacted on yield contributing traits and yield of black cumin seeds. The highest number of seeds (71.73 per capsule) and the maximum seed weight (1.66 g per plant, 78.33 g per plot and 522.22 kg.ha^{-1}, respectively) obtained when black cumin sown in 1st December following line sowing method (D3M1). All the traits performed inferior from the combination of D4M2 (15th December sowing with broadcast seeding) and resulted the minimum seeds (51.47 per capsule, 0.61 g per plant, 35.68 g per plot and 237.84 kg.ha^{-1}, respectively) (Table 10).

Discussion

Sowing dates and methods are the most important factors for desirable plant height. Plant height of black cumin had statistically significant due to sowing date and method as singly or their interactions where 1st December sowing under line sowing method as singly or their interaction were more efficient than other factor(s) affecting in the present study while plant height increased significantly in increasing days after sowing. The result also revealed that the delay sowing at 15th December decreased the plant height. This result revealed that the third sowing date D3 (1st December) had more significant for enhance the plant height in this study which might be due to the proper environment prevailing at this time which ultimately enhance the growth of plant. Similar observations were also reported by Giridha (2015); Jafari (2013) and more other scientists at home and abroad. Similarly, black cumin grown under line sowing method received proper space which might increase the photosynthesis activity by using sufficient light from the atmosphere and also received more nutrients from the soil. Our results are in agreement with the findings of Fahim et al. (2017); Mahmood et al. (2012).

Days to 50% flowering, fruit setting and harvest also influenced significantly due to the individual or their interaction effect of sowing dates and methods while Haq et al. (2015); El–Mekawy (2012) noticed due to sowing times and Fahim et al. (2017); Mahmood et al. (2012); claimed due to sowing methods were obtained significant performance for black cumin.

Table 7. Combined effects of sowing dates and methods on number and capsule weight of black cumin at harvest

Treatment combinations		No. of capsules per plant	Weight of capsule (g per plant)	Weight of single capsule (g)
D1 (1st November)	M1 (Line sowing)	7.87	1.74	0.237
	M2 (Broadcast seeding)	7.07	1.38	0.217
D2 (15th November)	M1 (Line sowing)	10.47	1.95	0.273
	M2 (Broadcast seeding)	9.07	1.59	0.233
D3 (1st December)	M1 (Line sowing)	12.80	2.48	0.283
	M2 (Broadcast seeding)	10.00	2.21	0.250
D4 (15th December)	M1 (Line sowing)	6.53	1.39	0.227
	M2 (Broadcast seeding)	5.73	1.37	0.210
$LSD_{0.01}$		0.49	0.20	0.024
Level of significance		**	**	**

Note: ** indicates significant at 1% level of probability

Table 8. Effect of sowing dates on seed yield of black cumin

Sowing dates	No. of seeds per capsule	Seed weight per plot (g)	Seed yield ($kg.ha^{-1}$)
D1(1st November)	55.03	46.87	312.44
D2(15th November)	65.57	51.15	340.97
D3(1st December)	68.60	64.31	428.73
D4(15th December)	51.97	40.49	269.94
$LSD_{0.01}$	1.14	3.15	17.12
Level of significance	**	**	**

Note ** indicates significant at 1% level of probability

Table 9. Effect of sowing methods on seed yield of black cumin

Sowing methods	No. of seeds per capsule	Seed weight per plot (g)	Seed yield ($kg.ha^{-1}$)
M1 (Line sowing)	61.93	59.61	397.43
M2 (Broadcast seeding)	58.65	41.79	278.62
$LSD_{0.01}$	0.81	2.23	12.11
Level of significance	**	**	**

Note: ** indicates significant at 1% level of probability

Above researcher reported that the early sowing always superior than that of delay sowing while line or bed sowing perform well than other sowing methods. These findings are in agreement with those of Haq et al. (2015); El–Mekawy (2012); Mahmood et al. (2012). Similarly, plants in line sowing get more sunlight and other favorable conditions from the atmosphere, proper soil nutrient from the soil which ultimately delayed flowering, fruit setting and harvest time of black cumin. Similar observations with the present study were also reported by Fahim et al. (2017) and Mahmood et al. (2012).

Number of capsules of black cumin was also statistically significant due to the effect of sowing dates and methods where third sowing at 1st December was more effective to get more number of black cumin capsule. The higher capsule number with December sowing may be due to the favorable environment during the cultivation of black cumin, enabled the plant to acquire higher growth and production of photosynthates in the source and better partitioning to the sink. Similar observations were reported by Abad et al. (2015); Haq et al. (2015); Islam and Akhtar (2013); Meena et al. (2011) and more other scientists at home and abroad. The decrease in capsule number was also recorded in delay sowing at 15th December. A month delay in sowing caused severe reduction in the number of capsules per plant and hence early sowing was reported to be

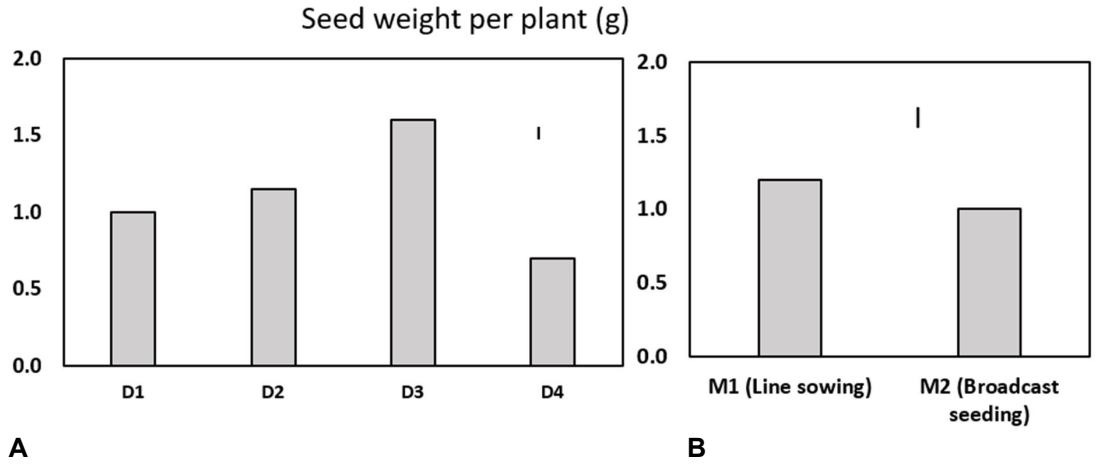

Figure 4. Effect of sowing dates (A) and sowing methods (B) on seed weight of black cumin at harvest. Vertical bar represents LSD at 5% level of probability.

critical in *Nigella* reported by Giridha (2015); Jafari (2013); El-Mekawy (2012) which is also supported the present findings. Decrease in capsule number due to delay sowing was also reported by Haq et al. (2015); Vaseghi et al. (2013); Islam and Akhtar (2013); Meena et al. (2012). Besides, line sowing had higher capacity to enhance the number and weight of capsules in black cumin plant also reported by Fahim et al. (2017) and Mahmood et al. (2012) while their findings are strongly supported the present findings. They found that the line or bed sowing get more favorable weather condition and soil nutrient from the soil comparatively than that of broadcast seeding which ultimately resulted the higher production of capsule of black cumin.

Seed production of black cumin as number and weight were also affected significantly by the effect of sowing dates and methods. This study showed that the third sowing at 1st December had highly efficient to produce more seeds per capsule or per plant, per plot or hectare. The above result revealed that the third sowing at 1st December growing plant might be get proper or favorable weather condition which enhanced the adaptability with the growing region as well as they produced more number and highest weight of seeds. Besides, higher adaptable plant can also accumulate the more soil nutrients to the root zone which ultimately enhanced the growth plant growth and confirm the higher number of weight of seeds. Results obtained from the study were in compatible with Haq et al. (2015); Jafari (2013); Islam and Akhtar (2013); Meena et al. (2012). In another observation, line sowing had also more effective to produce more seeds as number and weights as compared to that of broadcast seeding. This results might be due to growing plant in line sowing method get proper space which was helpful for getting the proper air and sunlight, proper humidity, appropriate soil nutrient etc. which improved the growth of plant and finally seed yield is increased. Our results are in agreements with many previous findings of Fahim et al. (2017); Mahmood et al. (2012). Besides, tallest plant with numerous branches facilitated more capsules per plant increased seed number and weight per unit area enhanced the final yield of black cumin seed were also reported by Mahmood et al. (2012) and Meena et al. (2011 and 2012) in black cumin.

Conclusion

Plant growth and seed yield of black cumin varied based on the sowing dates and sowing methods. The proper growth and development of black cumin plants are somehow restricted in broadcast seeding method while line sowing method in 1st December sowing provided favorable space for the growth of plants which ultimately enhance higher crop growth and better seed yield of black cumin. This study showed that 1st December sowing following the line sowing method improve plant growth as well as seed yield of black cumin in Bangladesh.

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Table 10. Combined effects of sowing dates and methods on seed yield of black cumin

Treatment combinations		No. of seeds per capsule	Seed weight per plant (g)	Seed weight per plot (g)	Seed yield ($kg.ha^{-1}$)
D1 (1st November)	M1 (Line sowing)	56.00	1.10	56.66	377.71
	M2 (Broadcast seeding)	54.07	0.87	37.08	247.18
D2 (15th November)	M1 (Line sowing)	67.53	1.19	58.16	387.73
	M2 (Broadcast seeding)	63.60	1.02	44.13	294.20
D3 (1st December)	M1 (Line sowing)	71.73	1.66	78.33	522.22
	M2 (Broadcast seeding)	65.47	1.55	50.29	335.24
D4 (15th December)	M1 (Line sowing)	52.47	0.72	45.31	302.04
	M2 (Broadcast seeding)	51.47	0.61	35.68	237.84
$LSD_{0.01}$		1.61	0.08	4.46	24.21
Level of significance		**	**	**	**

** indicates significant at 1% level of probability

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