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RESEARCH PAPER

Effect of sowing time on growth and yield of black cumin

Md. Zafar Ahmed[1], Mohammad Zakaria[2], Moriom Akter Mousumi[3], Esmat Jahan Ami[4]

1 Agriculture Officer, Department of Agricultural Extension, Ministry of Agriculture, Bangladesh.
2 Professor, Department of Horticulture, Bangabandhu Sheikh Mujibur Rahman Agricultural University.
3 Department of Plant Pathology, Patuakhali Science and Technology University, Dumki, Patuakhali-8602, Bangladesh.
4 Farm Broadcasting Officer, Agriculture Information Service, Ministry of Agriculture, Bangladesh.

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*Corresponding author:
zafar.pstu5@gmail.com

ABSTRACT

An experiment was conducted in the experimental field of Department of Horticulture, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Salna, Gazipur during 20th October, 2012 to 30th April, 2013 to determine optimum sowing time for obtaining maximum yield of black cumin. There were four different sowing time viz. D_1 (November 01), D_2 (November 10), D_3 (November 20) and D_4 (November 30). The treatment effects were statistically analyzed and found significant in most of the characters studied. Early sowing D_1 (November 01) took significantly lower days to first emergence, 50% emergence, 1st flower bud initiation, 1st flower blooming. The highest plant height (62.28cm), highest number of primary branches (7.42), highest number of secondary branches (12.80), highest number of tertiary branches (20.39), highest leaf length (4.58cm) at 75 DAS were obtained from early sowing D_1 (November 01). The maximum seed yield per hectare (1.78 t) was recorded in D_1 (November 01) and lowest was recorded in D_4 (November 30).

Key words: Black cumin, Field emergence, Sowing time, Cop Yield

Introduction

The black cumin (*Nigella sativa* L.), belonging to the family Ranunculaceae, is a very ancient crop which originated in the Eastern-southern Europe is generally short- lived annual herbaceous crops. It is an important spice crop known as ‘Kalojeera’ in Bangla is cultivated in winter (Rabi) season in Bangladesh. It is widely cultivated throughout South Europe, Syria, Egypt, Saudi Arabia, Iran, Pakistan, India and Turkey (Riaz et al., 1996). The genus *Nigell*a has 22 species among which N. Sativa is cultivated commercially. It has rich nutritional value and has many medicinal usages. Not only because of its culinary delighting properties to enhance the taste of the recipe, but also because of its high nutritional value content. A table-spoon full black cumin seeds that weigh about 6.7gm has Calories – 22, Fat – 1gm, Sodium – 1mg, Potassium – 91mg, Total carbohydrates – 3gm, Dietary fibre – 3gm, Protein – 1g (Tierram, 2005). The seed is rich in fatty acids, proteins and carbohydrates. It contains all essential amino acids and rich source of vitamins and minerals (Abu-Jadayil et al., 1999). Seeds are used both as a condiment in bread and cakes and in the preparation of traditional sweet dishes, pastry, pickles, and used as candies and liquors (Luetijohann, 1998; Thippeswamy and Naidu, 2005). The black cumin is extensively used in traditional medicine, for healing various respiratory and gastrointestinal diseases in our country. The whole seeds or their extracts have antidiabetic, antihistaminic, antihypertensive, anti-inflammatory, antimicrobial, antitumor, galactagogue and insect repellent effects (Arslan, 1994). It is claimed that the prophet Muhammad said about the black cumin seeds, "Use the black seed, which is a healing for all diseases except As-Sam” (A1-Bukhari, 1976; Bukhari, 1985). 'As-Sam' is death". The seeds are used as seasoning for vegetables, legumes and different types of baked products (Atta, 2003). It has been used as an herbal medicine for more than 2000 years. It is also used as a food additive and flavor in many countries. *N. sativa* volatile oil has recently been shown to possess 67constituents, many of which are capable of inducing beneficial pharmacological effects in humans (Aboutabl et al., 1986). Black cumin seeds and oil has always been an important and active part of daily cuisines, all around the world (Baytop, 1984). In various studies, the volatile oil has been shown to have insecticide, bronchodilator, immunomodulative (El-Kadi and Kandil, 1987), antibacterial (Hanafy and Hatem, 1991), hypotensive (Zaoui et al, 2000), choleretic, antitumoral, antifungal, antelmentic and antiastmatic (El-Tahir et al, 1993). Its seeds contain thymoquinone and monoterpenes, and a variety of therapeutic effects on digestive disorders, gynecological diseases and the respiratory system (Boskabady and Shahabi, 1997). Antioxidants present in black cumin mitigate diabetic

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complications arising due to free radical production and elevated cholesterol level (Mansi, 2005, 2006; Kaleem et al., 2006). Black cumin is produced in 3530 hectares of land, with total annual production 3675 tons. Main production areas are Faridpur, Sariatpur, Madaripur, Natore, Pabna, Sirajganj and Rajbari (Anonymous, 2012). Soil pH 7.0 to 7.5 is favorable for its production. Therefore, the crop can be grown in Bangladesh. By fulfilling our demand, the surplus produces can be export to the abroad to earn foreign currency. As for example, presently Iran is an important black cumin exporter, constituting 40% of world market (Barros et al., 2004) and earning a huge amount of foreign currency. But, unfortunately due attention has not been given to black cumin regarding research and development in Bangladesh.

Only one improved variety of black cumin named BARI Kalozira-1 released in 2009, which production is only 0.8-1.0 t/ha though seed is not available. One variety of a particular crop is not enough for production of that crop. Most of the farmers of Bangladesh use land races for black cumin cultivation and as such per hectare yield is very low. In farmers' field of some places of Bangladesh, yield is 1.19 to 1.48 t/ha (12-15 mound per acre) though average production 0.8 to 1.0 t/ha (Anonymous, 2007a) which can be increased up to 2.0 t/ha or above by using modern technology, high yielding variety and also the method of production. Sowing time and spacing influence the growth and yield of black cumin. Time of planting enables a crop to enjoy suitable climatic conditions favorable for its emergence, growth and development which largely influence its yield. Sadeghi et al. (2005) evaluated the effect of sowing time and plant density on yield and yield components of black cumin under dry farming and reported that earlier sowing resulted higher seed yield. Yadwar and Dahama (1998) found higher seed yield of black cumin from early sown crop (15 November) than that of late sown (30 November) crop. Several authors also reported the effect of sowing time and spacing on growth and yield of different crops. Late sowing and high temperature resulted in lower yield than the normal. For successful production of any crop, appropriate planning time is very important. Shortening of the growing cycle decreased the amount of radiation intercepted during the growing season and thus total dry weight of plant decreases (Andrade, 1995). With delayed sowing, development is accelerated because the crops encounter higher temperatures during the vegetative growth (Damato et al., 1994). Delayed sowing decreases seed weight and the number of umbrella per plant (Ehteramian, 2003). Yield loss due to unfavorable sowing date has been reported in many crops such as sunflower (Barros et al., 2004) and fennel (Bianco et al., 1994 and Kafi, 1990). On the other hand, spacing is another important factor affecting the yield and yield contributing character, which can be manipulated to maximum yield (Babu and Mitra, 1989). The number of plant per unit area is the most important among yield components (Kafi, 2003). In suitable plant density, plants completely use environmental conditions (water, air, light and soil) and inter or intra-specific competition is minimum (Sadeghi et al., 2009). As the result, higher seed yield as well as higher cost-benefit ratio is found. The number of capsule per plant which depends on density of plant has the second rank of importance in yield components. The number of seed per capsule is affected by environmental, field management and its number significantly varied depended on plant densities (Salomi et al., 1992). It is clear that sowing time have positive role in attaining higher growth and yield of black cumin. Although there is a great scope of growing black cumin throughout the country, it has got very little research attention. Considering the above facts the present study was undertaken with the following objective such as to observe the effect of sowing time on growth and yield of black cumin.

Materials and Methods

The experiment was conducted at the Horticulture Research Farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur during the period from 20 October, 2012 to 15th April, 2013. The site was previously a shal forest, which was cleaned and developed for research purpose (Anonymous, 1989). The details of materials used and methods adopted in the present investigation are presented in this chapter.

The experimental area is located in medium high land. The soil is clay loam in texture having a P^H of 6.2. The experiment consisted of one factor as treatment such as sowing time. The details of different treatments of sowing time were as follows- D_1= November 01, D_2 = November 10, D_3 = November 20, D_4 = November 30. The field experiment having two factors was laid out in Randomized Complete Block Design (RCBD) with three replications.

BARI kalojeera-1 was used as plant material collected from Bangladesh Agricultural Research Institute, Gazipur. The seeds were soaked in water for 24 hours to facilitate germination. They were dried and treated by Bavistine @ 2 g/kg of seed to minimize the primary seed- borne diseases (Anonymous, 2007a).

The land was well prepared by deep ploughing. Manures and fertilizers such as cow dung (10 t/ha.), MP (45 kg/ha K_20) and TSP (46 kg/ha P_20_5) and Urea (48 kg/ha N) were applied (Anonymous, 2007a) at final land preparation. The remaining Urea was applied at 40 days after sowing (DAS) of seeds as top dress followed by irrigation. The seeds were mixed with some loose soil to allow uniform sowing in rows. Continuous line sowing was done to maintain plant to plant and row to row distance by thinning later on (Anonymous, 2007a). The seeds were covered with loose soil properly just after sowing and gently pressed by hands.

Irrigation, Weeding and thinning were done at regular intervals to break the soil crust and keep the land weed free after each irrigation. Bavistine @ 2 g/l was sprayed to control damping off.

The crop was harvested during 10 April to 28 April 2013. It is harvested when 50% of the capsules changed from green to straw color, stalks with capsule were dried in the sun. Seed from capsule were separated by beating with sticks and cleaned by winnowing and dried properly (8% moisture of seed).

Data were collected on days to 1st emergence, days to 50% emergence, days to 1st flower bud initiation, days to 50% flower bud initiation, days to 1st blooming, days to blooming in 50% plants, days to 1st capsule setting, days to capsule setting in 50% plants, days to 1st capsule ripening, days to capsule ripening in 50% plants, plant height (cm), number of primary branches per plant,

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number of secondary branches per plant, number of tertiary branches per plant, length of leaf, breath of leaf, length of capsule, capsule diameter, length of pedicle, number of seeds per capsule, number of capsule per plant, fresh seed weight per capsule, fresh seed yield per plant, dry seed weight per capsule, dry seed yield per plant, 1000 seed weight, seed yield (t/ha).

The mature seeds of all plots were harvested, cleaned and dried. Seed weight was measured with an appropriate spring scale balance and thus plot yield was obtained in kg. Then plot yield was converted into per hectare in tons.

Results and Discussion

Present study was conducted to determine the effect of sowing time on the growth and yield of black cumin. The results have been presented, discussed and possible interpretations have been made under the following heads.

Days to 1st emergence

The variation in first emergence is influenced by sowing date (Table 2). The highest days (9.42) to first emergence was recorded in D_4 (November 30) which was significantly different from others. On the other hand, the lowest number of days (7.42) was required to first emergence in D_1 (November 01) which was statistically similar to D_2 (November 10). Early sowing took significantly lower days and late sowing higher days which may be due to prevailing higher temperature at early sowing.

Days to 50% emergence

Sowing date showed significant influence on the number of days to 50% emergence of black cumin (Table 2). The highest days (12.00) to 50% emergence was recorded in D_4 (November 30) which was significantly different from each other. On the other hand, the lowest number of days (9.42) regarding in D_1 (November 01). Early sowing took significantly lower days may be due to getting higher temperature compare to late sowing.

Days to 1st flower bud initiation

Sowing date showed significant influence on the number of days to 1st flower bud initiation of black cumin (Table 2). The highest days (48.33) to 1st flower bud initiation was recorded in D_4 (November 30) which was significantly different from others. On the other hand, the lowest number of days (45.17) was observed to 1st flower bud initiation in D_1 (November 01).

Days to 50% flower bud initiation

The number of days required to 50% flower bud initiation of black cumin showed significant difference due to influence of sowing time (Table 1). The maximum days (54.67) to 50% flower bud initiation was recorded in D_4 (November 30) which was significantly different from others. On the other hand, the lowest number of days (52.33) was observed to 50% flower bud initiation in D_2 (November 10) which was statistically similar to D_1 (November 01). Early sowing took lower days may be due to early completion of vegetative growth in presence of relatively higher temperature at early sowing.

Table 1. Effect of sowing time on emergence and flower bud initiation in black cumin

Sowing time	Days to			
	1st emergence	50% emergence	1st flower bud Initiation	50% flower bud initiation
D_1 (November 01)	7.42 c	9.42 d	45.17 d	51.92c
D_2 (November 10)	7.83 c	10.17 c	46.25 c	52.33 c
D_3 (November 20)	8.83 b	11.42 b	47.58 b	53.83 b
D_4 (November 30)	9.42 a	12.00 a	48.33 a	54.67 a
Level of significance	*	*	*	*
CV %	7.06	5.62	1.87	1.86

Means bearing same letter (s) in a column do not differ significantly at 5% level of probability by DMRT

Days to 1st blooming

Significant influence on the number of days to 1st blooming of black cumin (Table 2) was observed due to different sowing time. The highest days (60.75) to 1st blooming was recorded in D_4 (November 30) which was significantly different from others. On the other hand, the lowest number of days (58.42) to 1st blooming was observed in D_1 (November 01) which was statistically similar to D_3 (November 20) and D_2 (November 10).

Days to 50% blooming

The effect of sowing time on days to 50% blooming was found insignificant (Table 2). However, numerically the maximum days (65.58) to 50% blooming was found in D_4 (November 30) and the minimum days (63.92) to 50% blooming was found in D_1 (November 01).

Days to 1st capsule setting

The effect of different sowing time on days to 1st capsule setting was found insignificant in black cumin (Table 2). However, numerically the maximum days (73.67) to 1st capsule setting was found in D_3 (November 20) and D_4 (November 30) while the minimum days (72.17) 1st capsule setting was found in D_2 (November 10).

Table 2. Effect of sowing time on blooming and capsule setting in black cumin

Sowing time	Dates to		
	1st blooming	50% blooming	1st capsule setting
D1 (November 01)	58.42 b	63.92	72.67
D3 (November 10)	58.83 b	64.42	72.17
D3 (November 20)	59.58 b	64.83	73.67
D4 (November 30)	60.75 a	65.58	73.67
Level of significance	*	NS	NS
CV%	2.34	3.25	2.47

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Days to 50% capsule setting

The effect of sowing time on days to 50% capsule setting was found insignificant (Table 3). However, numerically the maximum days (83.42) to 50% capsule setting was found in D_3 (November 20) and the minimum days (82.42) to 50% capsule setting was found in D_2 (November 10).

Days to 1st capsule ripening

Significant influence on the number of days to 1st capsule ripening of black cumin (Table 3) was observed due to different sowing time. The highest days (104.3) to 1st capsule ripening was recorded in D_1 (November 01) which was followed by D_2 (November 10) and D_3 (November 20). On the other hand, the lowest number of days (102.7) to 1st capsule ripening was observed in D_4 (November 30).

Days to 50% capsule ripening

Sowing time had significant influence on the number of days to 50% capsule ripening in black cumin (Table 3). The maximum days (114.7) to 50% capsule ripening was recorded in D_3 (November 20) which was similar to D_2 (November 10) and D_1 (November 01). On the other hand, the lowest number of days (112.6) to 50% capsule ripening was observed in D_4 (November 30).

Table 3. Effect of sowing time on capsule setting and capsule ripening in black cumin

Means bearing same letter (s) in a column do not differ significantly at 5% level of probability by DMRT. NS-Non Significant.

Plant height (cm)

Plant height an important growth contributing characters was recorded at 45, 65 and 85 days after sowing (DAS). Sowing time has significant influenced on the height of plant (Fig. 1). At 45 DAS, the maximum height (14.45 cm) was recorded in D_1 (November 01) which was significantly different from other, whereas minimum plant height (10.09 cm) was observed from D_3 (November 20). At 65 DAS, the highest plant height (39.15cm) was found in D_1 (November 01) and minimum plant height (32.03 cm) was found in D_3 (November 20). At 85 DAS, the highest plant height (62.28 cm) was also found in D_1 (November 01) and minimum plant height (54.81) was found in D_4 (November 30). The result was supported by Rasem *et al*. (2005) who reported that delay sowing significantly reduces the plant height.

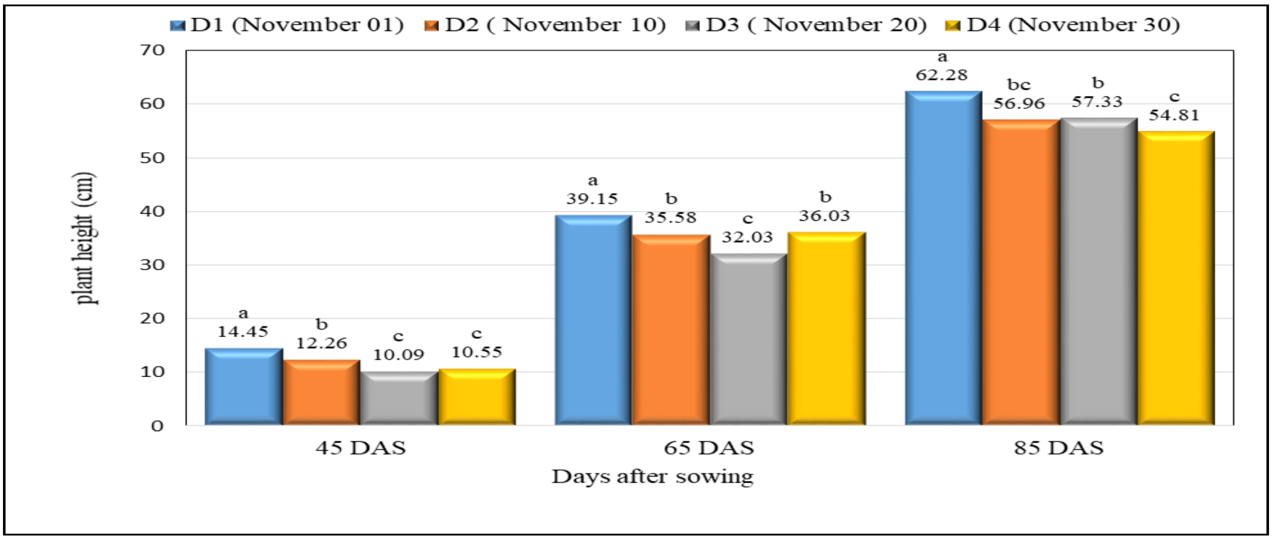

Fig.1. Effect of sowing time on plant height at different DAS.

Number of primary branches per plant

Sowing time had significant influence on the number of primary branches per plant of black cumin (Fig.3). The maximum number (7.42) was recorded in D_1 (November 01) which was statistically different from others. On the other hand, the lowest (6.30) was observed in D_4 (November 30) followed by D_3 (November 20) and D_2 (November 10). Early sowing had significantly higher number of primary branches per plant may be due to early completion of vegetative growth in presence of favourable environment.

Number of secondary branches per plant

Sowing time had significant influence on the number of secondary branches per plant (Fig.2). The maximum number (12.80) was recorded in D1 (November 01) which was statistically different from others. On the other hand, the lowest number of primary branches (8.78) was observed in D_3 (November 20) which was statistically similar to D_4 (November 30). Early sowing had significantly higher number of Secondary branches per plant may be due to early completion of vegetative growth in presence of favourable environment.

Number of tertiary branches per plant

The number of tertiary branches per plant varied significantly due to influence of sowing time (Fig.2). The highest number (20.39) was observed in D_1 (November 01) which was statistically different from others. The lowest number (12.45) was found in D_4 (November 30) which was similar to D_3 (November 20). Early sowing had significantly higher number of tertiary per plant may be due to early completion of vegetative growth in presence of favourable environment.

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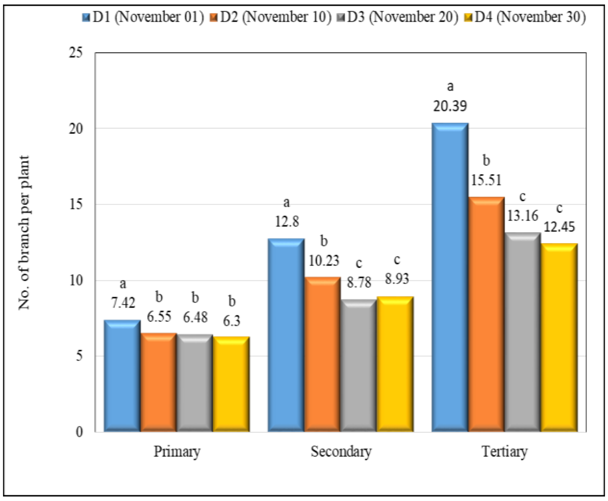

Fig.2. Effect of sowing time on the number of branch per plant.

Length of leaf

The length of leaf significantly influenced by different sowing time (Table 4). At 45 DAS, the maximum leaf length (8.45 cm) was recorded in D_1 (November 01) which was statistically different from others. On the other hand, the lowest (6.63 cm) was observed in D_4 (November 30. At 75 DAS, the maximum leaf length (4.58 cm) was recorded in D_1 (November 01) which was statistically different from others and the lowest (3.70 cm) was observed in D_4 (November 30). Leaf length decreased with delay in sowing may be due to higher temperature in late sowing causes water stress resulting less vegetative growth. Irrespective of sowing time the plant at old stage produced smaller leaf may be due to presence of higher temperature as well as little bit water stress causes hamper in normal development of leaves.

Table 4. Effect of sowing time on the leaf length of black cumin

Sowing time	Leaf length (cm)	
	45 DAS	75 DAS
D_1 (November 01)	8.45 a	4.58 a
D_2 (November 10)	7.47 b	4.28 b
D_3 (November 20)	7.32 b	4.03 c
D_4 (November 30)	6.63 c	3.70 d
Level of significance	*	*
CV %	4.01	4.79

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Breadth of leaf

The breadth of leaf significantly influenced by different sowing time (Table 5). At 45 DAS, the maximum leaf breadth (4.22 cm) was recorded in D_1 (November 01) which was statistically different from others. On the other hand, the lowest (3.42 cm) was observed in D_4 (November 30) which was statistically similar to D_2 (November 10) and D_3 (November 20). At 75 DAS, the maximum (2.64 cm) was recorded in D_1 (November 01) which was statistically similar to D_2 (November 10) and D_3 (November 20). The lowest (2.10 cm) was observed in D_4 (November 30). Leaf breadth decreased with delay in sowing may be due to higher temperature in late sowing causes water stress resulting less vegetative growth. Irrespective of sowing time the plant at old stage produced smaller leaf may be due to presence of higher temperature as well as little bit water stress causes hamper in normal development of leaves.

Table 5. Effect of sowing time on the breadth of leaf in black cumin

Sowing time	Leaf breadth (cm)	
	45 DAS	75 DAS
D_1 (November 01)	4.22 a	2.64 a
D_2 (November 10)	3.63 b	2.55 a
D_3 (November 20)	3.68 b	2.42 ab
D_4 (November 30)	3.42 b	2.10 b
Level of significance	*	*
CV %	8.12	6.71

Means bearing same letter (s) in a column do not differ significantly at 5% level of probability by DMRT.

Capsule length

Sowing time had significant influence on the length of capsule (Table 6). The maximum capsule length (1.27 cm) was recorded in D_1 (November 01) which was statistically different others. On the other hand, the lowest capsule length (1.14 cm) was recorded in D_3 (November 20). Early sowing had significantly higher capsule length may be the consequence of higher vegetative growth of the plant in early sowing.

Capsule diameter

Sowing time had significant influence on the diameter of capsule (Table 6). The maximum capsule diameter (0.77 cm) was recorded in D_1 (November 01) which was statistically different from other. The lowest (0.69 cm) was recorded in D_4 (November 30). Early sowing had significantly higher capsule diameter may be the result of higher vegetative growth of the plant in early sowing.

Pedicle length

Sowing time had significant influence on the length of pedicle (Table 19). The maximum pedicle length (6.47 cm) was recorded in D_1 (November 01) which was statistically different from others. The lowest pedicle length (5.56 cm) was recorded in D_4 (November 30).

Table 6. Effect of sowing time on capsule length, diameter and pedicle length in black cumin

Sowing time	Capsule		Pedicle length (cm)
	Length	Diameter	
D_1 (November	1.27 a	0.77 a	6.47 a
D_2 (November	1.19 b	0.72 b	5.99 b
D_3 (November	1.14 c	0.71 bc	5.83 b
D_4 (November	1.15 bc	0.69 c	5.56 c
	**	**	**
Level of			
CV %	4.55	3.81	3.65

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Number of capsule per plant

The number of capsule per plant of black cumin had significantly influence by sowing time (Table 22). The maximum number of capsule (24.27) was recorded in D_1 (November 01) which was statistically different from others. The lowest number of capsule (18.00) was observed in D_4 (November 30) which was statistically similar to D_3 (November 20). Early sowing had significantly higher number of capsule may be due to higher number of branches per plant in early sowing. Finding was supported by Rahnavard *et al*. (2010) and Sadeghi *et al.* (2009) who found that capsule per plant was higher in early sowing. Rasem *et al.* (2005) found that delay sowing significantly reduced capsule per plant which also corroborates the present findings.

Number of seeds per capsule

Sowing time significantly influence by the number of seeds per capsule of black cumin (Table 7). The maximum number of seeds (116.7) was recorded in D_1 (November 01) which was statistically different from others. On the other hand, the lowest number (69.37) was observed in D_4 (November 30). Early sowing had significantly higher number of seed may be due to proper growth of the plant. Finding was supported by Rahnavard *et al*. (2010) and Sadeghi *et al*. (2009) who found that seed per capsule was higher in early sowing. Rasem *et al*. (2005) found that delay sowing significantly reduced seed per capsule. It was also supported by Tuncturk *et al.* (2005) who reported that seed per capsule was higher in early sowing.

Table 7. Effect of sowing time on number of capsule per plant and number of seeds per capsule in black cumin

Sowing time	No. of capsule per	No. of seeds per
D_1 (November	24.27 a	116.7 a
D_2 (November	20.70 b	85.22 b
D_3 (November	18.83 bc	78.65 c
D_4 (November	18.00 c	69.37 d
Level of	*	*
CV %	11.28	4.18

Means bearing same letter (s) in a column do not differ significantly at 5% level of probability by DMRT.

Fresh seed yield per plant

Sowing time had significant influence on fresh seed yield per plant (Fig.3). The maximum fresh seed yield (5.22gm) was recorded in D_1 (November 01) which was statistically different from others. The lowest fresh seed yield (4.24gm) was recorded in D_4 (November 40). Early sown plants performed vigorously in vegetative stage and hence produced higher seed yield per plant. The effect of plant spacing on fresh seed yield per plant also found (Fig.6).

Dry seed yield per plant

Sowing time had also significant influence on dry seed yield per plant (Fig.3). The maximum dry seed yield (4.35g) was recorded in D_1 (November 01) which was statistically different from others and the lowest (3.88g) was recorded in D_4 (November 30).

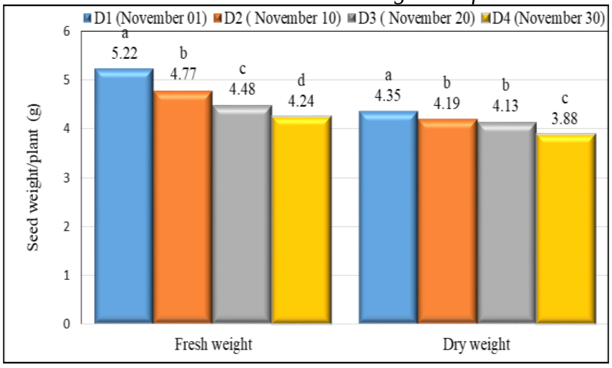

Fig.3. Effect of sowing time on fresh seed yield and dry seed yield per plant.

Fresh seed weight per capsule

Sowing time had significant influence on fresh seed weight per capsule (Fig.4). The maximum fresh seed weight per capsule (0.26g) was recorded in D_1 (November 01) which was statistically different from others. The lowest (0.20g) was recorded in D_4 (November 30) and D_3 (November 20) which was statistically similar to D_2 (November 10).

Dry seed weight per capsule

Sowing time had significant influence on dry seed weight per capsule (Fig.4). The highest dry seed weight (0.21g) was recorded in D_1 (November 01) which was statistically different from others. The lowest dry seed weight (0.17g) was recorded in D_4 (November 30) which was statistically similar to D_1 (November 01), D_2 (November 10) and D_3 (November 20).

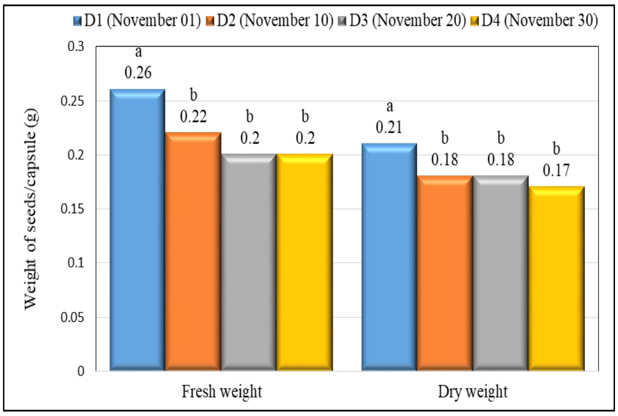

Fig.4. Effect of sowing time on fresh seed weight and dry seed weight per capsule.

1000 seed weight

Thousands seed weight is an important yield contributing character. Sowing time had significant effect on 1000 seed weight (Fig. 5). Highest 1000 seed weight (2.55gm) was found in D_1 (November 01) which was statistically different from others and the lowest 1000 seed weight (2.22g) was found in D_4 (November 30). The result was similar to Rahnavard *et al.* (2010) and Sadeghi *et al.* (2009) who found 1000 seed weight as 2.30 to 2.6og. Tuncturk *et al.* (2011) also reported that 1000 seed weight was 2.28g.

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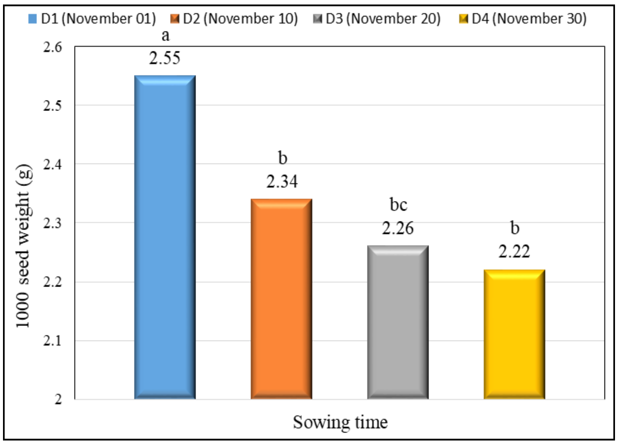

Fig.5. Effect of sowing time on 1000 seed weight.

Seed yield per plot

Seed yield per plot varied significantly due to influence of sowing time (Fig.6). The maximum seed yield per plot (256.20g) was recorded in D_1 (November 01) which was statistically different from others. On the other hand, the lowest seed yield per plot (230.7g) was recorded in D_4 (November 30) which was statistically different. Early sown crop had better vegetative growth and hence showed higher seed yield per plot.

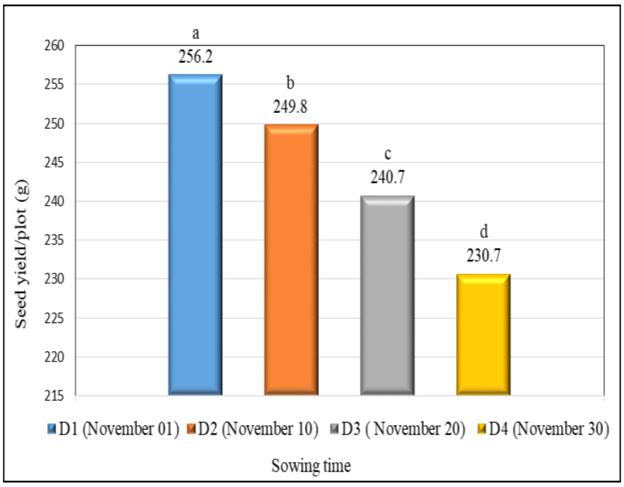

Fig.6. Effect of sowing time on seed yield per plot

Seed yield (t/ha)

The yield per hectare significantly influenced by different sowing time (Fig.7). Maximum seed yield per hectare (1.78 t) was recorded in D_1 (November 01) which was statistically different from others. The lowest seed yield (1.60 t) was recorded in D_4 (November 30). Early sown crop performed better in relation to plant height, number of branches, number of capsule per plant, number of seeds per capsule and 1000 seed weight and hence better seed yield (t/ha) was found in early sowing. The result was supported by Rahnavard *et al.* (2010) and Sardooyi *et al.* (2011) who reported that early sowing gave higher yield.

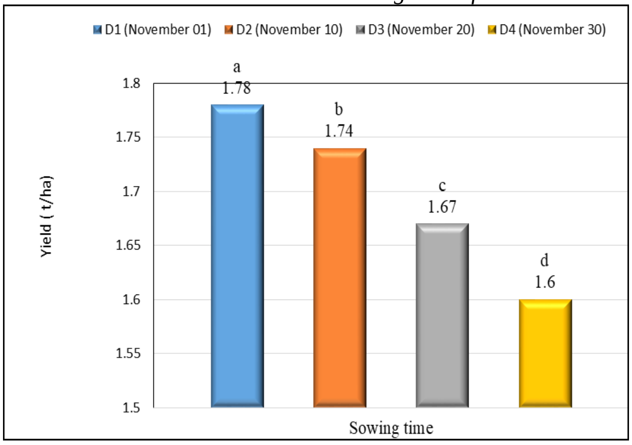

Fig.7. Effect of sowing time on seed yield (t/ha).

Conclusion

On the basis of the results of the experiment stated above, following conclusion could be drawn: Plant height, number of primary branches, number of secondary branches, number of tertiary branches, highest leaf length, capsule length, pedicle length, number of capsule, number of seed, fresh seed yield, seed yield per hectare was maximum in early sowing D_1 (November 01).

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