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PLANTING TIME EFFECT ON QUALITY SEED PRODUCTION OF THREE VARIETIES OF CARROT (*Daucus carota* L.)

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Abstract

Crop management like planting time is a crucial factor for maximizing yield especially for seed production. Seed production of carrot is greatly influenced by temperature as it requires adequate periods of cool temperature (vernalization) for flowering and seed production. To find out optimum planting time of carrot steckling for quality seed production the experiment was conducted at the Field Laboratory of Horticulture Farm, Bangladesh Agricultural University, Mymensingh during the period from October 2015 to May 2016.Three planting time viz. 05 January, 15 January and 25 January on the seed production of three carrot varieties viz. BA (Brasillia Agroflora), PA (Prima Agroflora) and NK (New Kuroda) which constituted 9 treatment combinations were included in the experiment. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Planting time had significant effect on most of the parameters studied. The January 05 planting of steckling gave the highest seed yield (527.92 kg ha^{-1}) and the lowest was in January 25 planting of steckling (314.75 kg ha^{-1}). Among the varieties BA gave the highest seed yield (448.73 kg ha^{-1}) and the lowest yield for New Kuroda (395.35 $kgha^{-1}$.) Considering interaction of planting time and variety the highest seed yield (572.37 kg ha^{-1}) was obtained from the treatment combination of early planting (05 January) with the variety of BA and the lowest (279.77 kg ha^{-1}) was recorded from the late planting (25 January) in variety PA. Hence, BA carrot variety planting on 5 January may be recommended for carrot seed production in Mymensingh region in Bangladesh.

Introduction

Carrot (*Daucus carota* var. *sativus*) is a member of the family Apiaceae (Peirce, 1987) and considered to be native of Mediterranean region (Shinohara, 1984) and its cultivation as a crop also began in that region. Carrot is one of the most ancient vegetables grown all over the temperate regions in spring, summer and autumn. But in tropical and sub-tropical countries, carrots are produced during winter. Carrot is important for its high nutritional value and possible diversified used in making different palatable dishes and long-term storage. It contains appreciable amount of carotene (10 mg/100g), thiamin (0.04 mg/g) and riboflavin (0.05 mg/g) (Sharfuddin and Siddique, 1985), and it is an excellent source of iron, carbohydrate vitamin-B, vitamin-C and sugar. In carrot roots sucrose is most abundant with endogenous sugar contents, 10 times more than those of glucose and fructose. Further, it has some important medicinal value. Carrot roots play an important role to protect the blindness in children providing vitamin A. The area of carrot cultivation in Bangladesh is 5085 acre with a total production of 19246 MT (BBS, 2020). Carrot is grown in Bangladesh during winter season. It usually requires

relatively low temperature for flowering. The climatic condition of Bangladesh is not very suitable for the production of seeds of most of the high yielding exotic varieties. Moreover, a number of popular exotic cultivars are hybrid varieties. Consequently, it has become a regular task for the Government and Private seed supplying organizations of Bangladesh to import the seeds of high yielding carrot verities from abroad every year. Almost entire production of carrot in Bangladesh is based upon imported seeds. The imported seeds are relatively expensive which are not always available in time for sowing. Hence, cultivation of good quality carrot becomes an uncertainty every year. On the other hand, locally produced seeds cannot cope with the requirement. To boost up carrot production in the country timely supply of quality seed in desired quantity should be ensure, which is possible only by improving local seed production technology.

Time of planting is an important factor for the quality of carrot seed production. The proper planting time depends on the existing cropping pattern and prevailing environment. It is the key factor for successful carrot seed production. Carrot is a biennial crop and it seed production is greatly influenced by temperature (Bose and Som, 1986). It requires adequate periods of cool temperature (vernalization) for flowering and seed production. Carrots should have sufficient vegetative growth prior to cool temperature exposure as vernalization successfully induces flower formation. The variation in flowering characters among the sowing dates could probably be related to the level and activity of endogenous gibberellins, substances known to enhance flowering characters in low temperatures (Rubatzky *et al*., 1999). Cold temperature (4-10ºC) for 4 to 8 weeks to initiate flowers and produce seeds depending on the cultivar. Elongation of inflorescence, flowering and seed development requires warm temperature. Whereas seed maturity and harvesting needs dry weather. Early planting causes winter killing or late season pest infestations. Planting too late results in a lack of vernalization, this limits flowering and thus reduces seed yield. Growers tend to manipulate planting time in order to obtain better growth, more flower formation and finally higher production of quality seed. Similarly, variety is another important factor for seed production. In Bangladesh, there is no recommended variety of carrot. Most of the seed companies of the world produce carrot seeds to suit their own climatic conditions and if the seeds are used without adaptability test, the growers may face economic losses. In this case, varietal selection plays an important role in carrot seed production. There is a vast scope for increasing the yield of carrot per hectare by using seeds of high yielding variety. Many countries have developed good quality high yielding varieties even through introduction. Hence, the present study was undertaken to find out the optimum planting time of steckling and suitable variety for maximum seed production of carrot.

Materials and Methods

The present research work was conducted at the Field Laboratory of Horticulture Farm of Bangladesh Agricultural University, Mymensingh during the period from October 2007 to May 2008. The experimental area is located at 24.6^{o}N and 90.5^{o}E latitude and at an altitude of 18 m from the sea level. The soil of the experimental area was sandy loam type and belonged to the Old Brahmaputra Flood Plain Alluvial Tract (UNDP, 1988). The analytical data of the soil sample collected from the experimental area were determined in the Humboldt Soil Testing Laboratory, Department of Soil Science, Bangladesh Agricultural University, Mymensingh. The soil texture was silt loam consists of sand-35.40%, silt-62.60% and clay-6.15%. The experimental site was medium high land and the chemical properties of soil was presented in Table 1.

The experimental area is situated in the sub-tropical zone, characterized by heavy rainfall during the months of April to September and Scanty rainfall during October to March (Anon, 1999). Rabi season is characterized by low temperature but plenty of sunshine. The detailed metrological data in respect of air temperature, relative humidity, total rainfall and soil temperature recorded by the Weather Yard, Department of Irrigation and water management. Bangladesh Agricultural University, Mymensingh during the period of study have been presented in Figure 1.

The two-factor experiment was laid out in the randomized complete block design (RCBD) with three replications. Each block was divided into nine unit plots each measuring 1.5 m × 1.0 m. The block to block and plot to plot distances were 1 m and 50 cm respectively. In each block nine treatments were placed randomly. Thus, there were 27 (9×3) unit plots altogether in the experiment. The experiment consists of two factors viz., Factor A: three dates of transplanting of steckling, P_1 = Early planting (05 January 2016); P_2 = Mid planting (15 January 2016) and P_3 = Late planting (25 January 2016) and Factor B: three varieties, V_1 = Brassilia Agroflora (BA); V_2 = Prima Agroflora (PA) and V_3 = New Kuroda (NK).

Ploughing and cross ploughing by power tiller was done followed by laddering to obtain a good tilth condition. The land was fertilized Cow dung, Urea, TSP (Triple Super Phosphate) and MoP (Muriate of Potash) were applied @ 10 tons, 150 kg, 105 kg and 175 kg per hectare, respectively. The total quantity of cow dung was applied during land preparation. Half of the recommended quantity of Urea, total quantity of TSP and half of MoP were applied as top dressing after 30 days and the remaining halves of Urea and MoP after 45 days of seed sowing

Seed of three carrot varieties were sown on 5, 15 and 25 November 2015, respectively. Irrigation, weeding and other intercultural operation was done according to need for proper growth and development of carrot root.

Carefully uprooted plants were pruned as per required extent (1//2 root and $3/4^{th}$ shoot) of the treatment. Prior to transplanting, the cut stecklings were kept in the solution of Dithane M-45 @ 2 g per litter of water for 5 minutes to prevent fungal infestation at the cut surface. The prepared stecklings of carrot were transplanted on 5, 15 and 25 January 2016 maintaining a spacing of 30 and 25 cm between the rows and stecklings, respectively. A little portion of the root was kept above the ground level at the time of transplanting. The transplanting was done in the afternoon. Irrigation was given just after transplanting so that the roots get established properly in the soil, and it was continued given at 7-10 days interval. Flowering and fruit setting are critical period for irrigation. Thereafter it has stopped to enhance umbel maturity. Weeding and mulching were done for four times during the experimental period to keep the plots free from weeds for conservation of moisture and better soil aeration and to break the soil crust. Roughing was done at the time of flowering to maintain varietal purity.

Ten plants were selected randomly from each plot and data on different seed yield parameters were collected on individual plant basis from the selected plants. The data collected from the experimental plots were statistically analyzed. The mean values of all treatments were calculated and the analysis of variance for most of the characters was accomplished by F variance test. The significance of difference among the treatment means was evaluated by least significant difference (LSD) test at 5% levels of probability (Gomez and Gomez, 1984).

Table 1. Initial soil status of the experimental plot

Soil properties/constituents	Values	Critical level
Soil pH	6.7	-
Organic carbon (%)	0.86	-
Total nitrogen (%)	0.16	0.12
Available phosphorus (ppm)	17.05	10.00
Available potassium (me/100g soil)	0.10	0.15
Zinc (ppm)	10.35	1.15
Sulphur (ppm)	5.85	8.00
Boron (ppm)	5.85	8.00
Molybdenum (ppm)	0.063	0.10

Source: Agrivarsity Humboldt Soil Testing Laboratory, Department of Soil Science, Bangladesh Agricultural University, Mymensingh

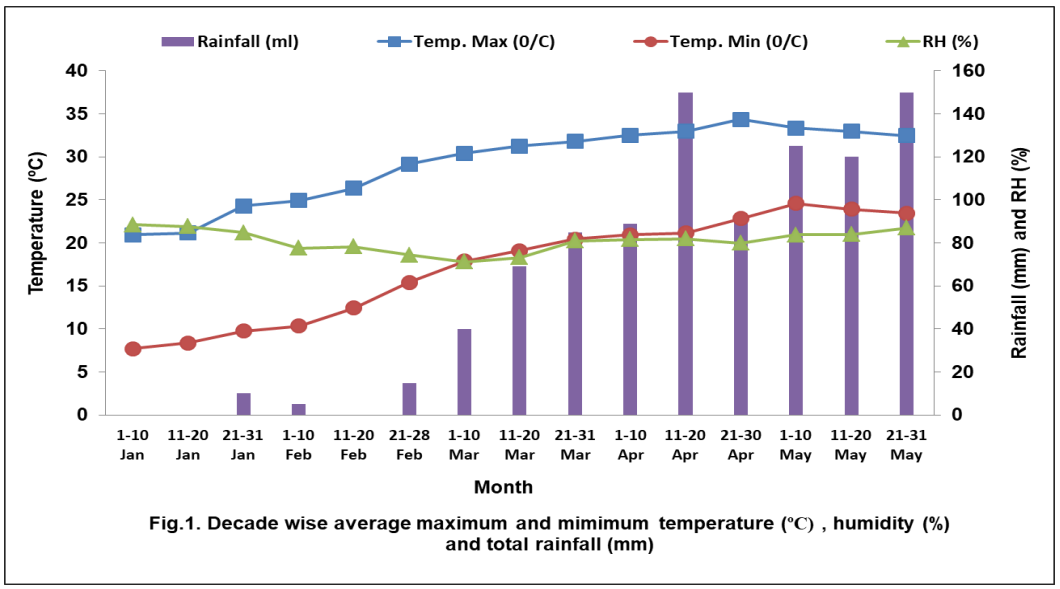

Fig.1. Decade wise average maximum and mimimum temperature (°C) , humidity (%) and total rainfall (mm)

Results and Discussion

Plant height

The influence of three different planting dates was found to be significant in respect of plant height at root harvest. It was observed that plant height decreased gradually with the advancement of planting time. The tallest plant (84.56cm) was obtained from P_1 and the shortest plant (76.34 cm) was recorded from P_2 (Table 2). Gogoi *et al*. (2016) obtained the similar results in broccoli. But varietal effect had no significant effect on plant height. The interaction of planting time and variety on the plant height was found to be significant. However, the highest plant height (86.41 cm) was observed in P_1V_1 and the lowest plant height (74.13 cm) was found in P_3V_3.

Days to 50% flowering and 50% fruit set

The effect of planting time, variety and their interaction on days required to 50% flowering and 50% fruit set was found to be significant (Table 2). However, P_3 required the longest period for flowering (143.92 days) and fruiting (159.83 days) while P_1 required shortest period for flowering and fruiting. This finding agrees with the reports of Roberts *et al*. (1997) who stated that if cold temperatures are experienced early in growth stages, flowering of most biennial vegetable species is increased. Lengthening the exposure of carrot to low temperatures increases vernalization response (Sakr and Thompson, 1942; Dickson and Peterson, 1958; Hiller and Kelly, 1979). Contrary, the longest time required to 50% flowering (144.84 days) and fruiting (163.38 days) was found in the variety V_3 while the shortest time for flowering (138.36 days) and fruiting (151.37 days) was in V_1 (Table 2). Rashid (1976) reported the similar results regarding this parameter. In case of interaction effect, P_3V_3 required the longest period for flowering (146.80 days) and fruiting (165.20 days) whereas, P_1V_1 required the shortest period for flowering (136.08 days) and fruiting (148.60 days).

Days required from flowering to fruit set

Planting time had no significant effect on days taken from flowering to fruit set but effect of variety was significant. The maximum days (18.54) was required for variety V_3 and the minimum days (13.01 days) required in the varicty V_1. On the contrary, interaction of planting time and variety on days

required from 50% flowering to 50% fruit set was significant. The longest period (18.88 days) was found in the treatment combination P_2V_3 and the shortest period (12.52 days) was in P_1V_1.

Number of primary and secondary umbels per plant

The effect of planting time had significant effect on the number of primary and secondary umbels per plant but not significant for variety (Table 2). Nevertheless, the maximum number of primary umbels (9.25) was found in early planting (P_1) while it was the minimum (7.18) in the late planting (P_3). These results were agreed with Elballa and Cantliffe (1996) who reported that the number of primary umbels decreased with the increasing temperature in late planting. Flowering characteristics expressed as umbel size and number of umbellets, were observed to decline progressively along with the respective planting dates. Similar trend was found for secondary umbels per plant. Interestingly, varietal effect was not significant. The interaction of planting time and variety was highly significant in respect of number of primary umbels and secondary umbers per plant. The maximum numbers of primary umbels (9.62) per plant was obtained from the treatment interaction P_1V_1 which was statically identical with the interaction of P_1V_2 while the minimum number of primary umbels (7.13) per plant was found in the combination of P_3V_3. Similarly, the maximum number of secondary umbels (8.38) was found in the treatment combination of P_1V_1 and the minimum number of umbels (6.01) was found in combination P_3V_3.

Table 2. Effect of planting time, variety and their interaction on plant height and floral characters of carrot for seed production

Treatments	Plant height at 90 days (cm)	Days to 50% flowering	Days to 50% fruit set	Days required from flowering to fruit set	No. of primary umbels/ plant	No. of secondary umbels/ plant
P_1	84.56	139.93	155.83	15.89	9.25	7.69
P_2	81.35	142.01	158.25	16.23	8.26	6.91
P_3	76.34	143.92	159.97	16.04	7.18	6.09
Level of sig.	**	**	**	NS	**	**
$LSD_{(0.05)}$	3.01	1.95	2.10	0.30	0.23	0.24
CV (%)	5.13	1.41	1.32	1.06	12.58	11.60
V_1	83.07	138.36	151.37	13.01	8.47	7.26
V_2	80.06	142.67	159.30	16.62	8.22	6.92
V_3	79.11	144.84	163.38	18.54	8.03	6.51
Level of sig.	NS	*	**	**	NS	**
$LSD_{(0.05)}$	3.68	5.48	5.03	0.50	0.28	0.29
CV (%)	2.56	2.32	3.86	7.49	2.68	5.45
P_1V_1	86.41	136.08	148.60	12.52	9.62	8.38
P_1V_2	84.07	140.83	157.40	16.57	9.18	7.65
P_1V_3	83.20	142.90	161.50	18.60	8.96	7.04
P_2V_1	83.02	138.60	151.82	13.22	8.54	7.27
P_2V_2	81.04	142.70	159.30	16.60	8.33	6.96
P_2V_3	80.00	144.75	163.63	18.88	7.92	6.50
P_3V_1	79.80	140.40	153.70	13.30	7.25	6.13
P_3V_2	75.09	144.50	161.20	16.70	7.16	6.15
P_3V_3	74.13	146.80	165.20	18.14	7.13	6.01
Level of sig.	*	*	**	**	**	**
$LSD_{(0.05)}$	5.20	3.33	5.62	2.45	0.93	0.79
CV (%)	5.02	2.35	3.56	15.24	11.27	11.48

P_1 = 5 January 2016, P_2 = 15 January 2016, P_3 = 25 January 2016 V_1= BA (Brassilia Agroflora), V_2= PA (Prima Agroflora), V_3= NK (New Kuroda) and NS Non-significant

Number of single umbels per compound umbel

Number of single umbels per compound umbel was significantly influenced by the time of planting, variety and their interaction. The maximum number (86.88) of single umbels per compound umbel was observed in P_1 planting while it was minimum (76.71) in P_3 planting (Table 3). On the other hand, the highest number of single umbels (85.44) per compound umbel was recorded from the variety V_1 while the variety V_3 produced the lowest number of single umbels (78.36) per compound umbel. It was possible due to the higher number of primary and secondary umbels produced in the plant grown from BA variety. Conversely, the maximum number of single umbels (91.47) was found in P_1V_1 combination and the minimum number of umbels (73.78) was in P_3V_3.

Number of flowers per single umbel

The variation caused by the effect of planting time on number of flowers per single umbel was statistically significant. The maximum number of (53.51) of flowers per single umbel was observed in P_1 planting and the minimum (49.21) was in P_3 (Table 3). The maximum number of flowers per single umbel (53.46) was found in the variety V_1 and the minimum number of flowers (49.37) was in the variety V_2. The interaction effect on the number of flowers per single umbel was also significant for the same parameters. However, Maximum number of flowers (55.20) per single umbel was found from the treatment combination of P_1V_1 whereas, the minimum number of flowers (48.62) was recorded from the combination of P_3V_3 (Table 3).

Table 3. Effect of planting time, variety and their interaction on umbel characteristics of carrot for seed production

Treatments	No. of single umbels/compound umbel	No of flowers/single umbel	Diameter of main umbel (cm)	Diameter of primary umbel (cm)	Diameter of secondary umbel (cm)
P_1	86.88	53.51	14.82	8.77	4.86
P_2	80.96	51.17	14.01	8.54	4.49
P_3	76.71	49.21	13.30	8.40	4.12
Level of sig.	**	**	**	*	**
$LSD_{(0.05)}$	3.52	2.49	0.58	0.26	0.16
CV (%)	6.27	4.20	1.94	2.18	8.24
V_1	85.44	53.46	14.71	8.41	5.53
V_2	80.75	49.37	13.99	9.07	4.45
V_3	78.36	51.05	13.55	8.22	4.69
Level of sig.	**	**	*	**	*
$LSD_{(0.05)}$	4.31	3.05	0.72	0.32	0.20
CV (%)	4.42	4.01	3.00	5.21	11.60
P_1V_1	91.47	55.20	15.43	8.64	4.85
P_1V_2	86.00	51.60	14.89	9.23	4.76
P_1V_3	83.19	53.73	14.13	8.45	4.98
P_2V_1	84.30	53.60	14.83	8.33	4.45
P_2V_2	80.46	49.12	13.70	9.08	4.40
P_2V_3	78.12	50.18	13.50	8.21	4.62
P_3V_1	80.56	51.60	13.79	8.28	4.30
P_3V_2	75.80	47.41	13.40	8.92	4.20
P_3V_3	73.78	48.62	13.01	8.02	4.47
Level of sig.	**	**	**	**	**
$LSD_{(0.05)}$	5.43	2.62	0.43	0.42	0.26
CV (%)	6.66	5.11	3.13	4.90	5.74

P_1 = 5 January 2016, P_2 = 15 January 2016, P_3 = 25 January 2016 V_1= BA (Brassilia Agroflora), V_2= PA (Prima Agroflora), V_3= NK (New Kuroda)

Diameter of main umbel

Different planting time, variety and their interaction had significant effect on the diameter of main umbel (Table 3). However, the longest diameter (14.82 cm) was found in P_1 planting and the shortest diameter (13.30 cm) was found in P_3 planting. These results are in agreement with the findings of Ali *et al*. (2014). Similarly, the highest diameter of main umbel (14.71 cm) was found in the variety V_1 and the lowest diameter (13.55cm) was in the variety V_3. The interaction of P_1V_1 produced the maximum diameter of main umbel (14.43 cm) while P_3V_3 combination produced the minimum diameter (13.01 cm).

Table 4. Effect of planting time and variety and their interaction on seed yield of carrot

Treatments	**Seed yield in main umbel (g)**	**Seed yield in primary umbel (g)**	**Seed yield in secondary umbel (g)**	**Seed yield plant^{-1} (g)**
P_1	1.76	2.74	1.62	6.18
P_2	1.47	2.13	1.05	4.68
P_3	1.24	1.54	0.76	3.68
Level of sig.	***	**	***	***
$LSD_{(0.05)}$	0.23	0.22	0.24	0.58
CV (%)	14.63	8.60	7.80	5.54
V_1	1.58	2.35	1.27	5.24
V_2	1.50	2.06	1.08	4.67
V_3	1.39	2.00	1.07	4.62
Level of sig.	NS	*	NS	*
$LSD_{(0.05)}$	0.25	0.22	0.25	0.48
CV (%)	15.63	10.68	8.80	5.90
P_1V_1	1.85	2.90	1.75	6.70
P_1V_2	1.80	2.72	1.62	6.17
P_1V_3	1.63	2.60	1.50	5.67
P_2V_1	1.70	2.30	1.25	5.38
P_2V_2	1.50	2.10	1.00	4.57
P_2V_3	1.20	2.00	0.89	4.10
P_3V_1	0.95	1.85	0.83	3.66
P_3V_2	1.45	1.20	0.62	2.37
P_3V_3	1.33	1.59	0.83	4.11
Level of sig	*	NS	**	**
$LSD_{(0.05)}$	0.94	2.01	1.37	1.97
CV (%)	17.96	12.47	15.02	7.95

P_1 = 5 January 2016, P_2 = 15 January 2016, P_3 = 25 January 2016 V_1= BA (Brassilia Agroflora), V_2= PA (Prima Agroflora), V_3= NK (New Kuroda) and NS Non-significant

Diameter of primary and secondary umbel

The effect of planting time on the diameter of primary and secondary umbel was found significant. The early planting (P_1) gave the highest diameter (8.77 cm and 4.86 cm) of primary and secondary umbel and late planting (P_3) gave the lowest diameter (8.40 cm and 4.12 cm) of primary and secondary umbel. The diameter of primary and secondary umbel was also statistically influenced by three varieties of carrot. However, the maximum diameter of primary umbel (9.07 cm) was found in V_2 and the minimum diameter (8.22 cm) was in the variety V_3. On the contrary, the maximum diameter of

secondary umbel (5.53 cm) was found in the variety V_1 and minimum (4.45 cm) in variety V_2. The interaction effect of planting time and variety exhibited significant effect on the diameter of primary and secondary umbel. The maximum diameter of primary umbel (9.23 cm) of was found in the treatment combination of P_1V_2 and the minimum diameter (8.02 cm) was obtained from the combination of P_3V_3 treatment. Similarly, the maximum diameter (4.98 cm) of secondary umbel was found in the treatment combination of P_1V_3 and the minimum diameter (4.20 cm) was obtained from the combination of P_3V_2 treatment.

Seed yield per plant

Significant variation was found on seed yield in main umbel, primary umbel and secondary umbel per plant respectively due to the different planting time. The highest seed yield in main umbel (1.76 g), primary umbel (2.74 g) and secondary umbel (1.62 g) was recorded at early planting (P_1). A similar report was revealed by Cardoso (2000), who stated that seeds in the primary umbels were of better seed yield and quality than the seeds of secondary umbel. The seed yield per plant is the total seed yield in main, primary and secondary umbels. The results of the planting time on the seed yield per plant showed that there was great variation in seed yield among the plants raised from different planting dates. Seed yield was gradually decreased with the mid and late planting. Early planting (P_1) produced the highest seed yield (6.18 g) per plant followed by mid and late planting. The reasons of higher yield may be attributed to favorable temperature that prevailed during early planting. This result is in agreement with the finding of Baljit and Malik (1986). Similarly, there was a significant effect among the three varieties of carrot. The maximum seed yield per plant (5.24 g) was obtained from the variety V_1 possibly, due to the presence of higher number of single umbels per compound umbel and maximum number of flowers in every single umbel and the minimum seed yield (4.62 g) was found from the variety V_3 which was statistically similar to V_2. In case of interaction effect, the highest seed yield per plant (6.70 g) was found in the treatment combination of P_1V_1 and the lowest (2.37 g) was in combination of P_3V_2 (Table 4).

Seed yield per hectare

Planting time, variety and their interaction effect on seed yield per hectare was noticed significant. The highest seed yield (527.92 kg ha^{-1}) was found in early planting (P_1) and the trend was gradually decreased with the advancement of planting time (Fig. 2), and the lowest seed yield (314.75 kg ha^{-1}) was found in late planting (P_1). Mengistu and Yamoah (2010) reported that low temperature in early planting enhanced maximum seed yield as earlier planting seemed to obtain favorable climate for maximizing seed yield. This result is also in agreement with the findings of Hossain *et al*. (2015). Similarly, the highest seed yield (448.43 $kgha^{-1}$) was produced by the variety V_1 and the lowest seed yield (395.35 kg ha^{-1}) was produced by V_3 (Fig. 2). This might be due to the fact that the variety Brasilia Agroflora had a good genetic potential which enhanced more cell division and cell elongation resulting best performance. Malek *et al*. (2013) stated that the highest seed yield was recorded from Brasilia Agroflora and the quality of seed was produced from the same variety. Mohanty and Prusti (2001) reported that seed yields vary with the cultivars. However, the treatment combination of P_1V_1 produced the highest seed yield (572.37 $kgha^{-1}$) and P_3V_2 produced the lowest (279.77 kg ha^{-1}) seed yield of carrot (Fig. 3).

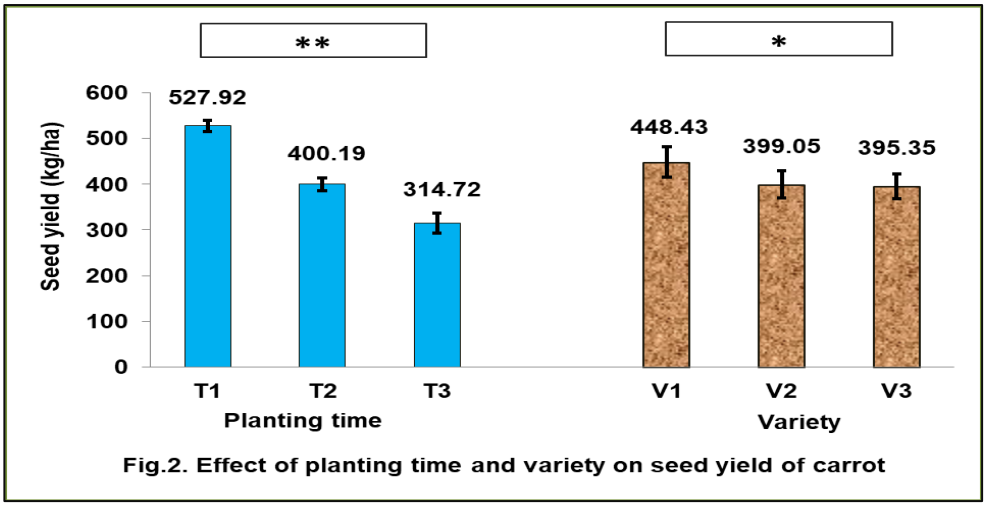

Fig.2. Effect of planting time and variety on seed yield of carrot

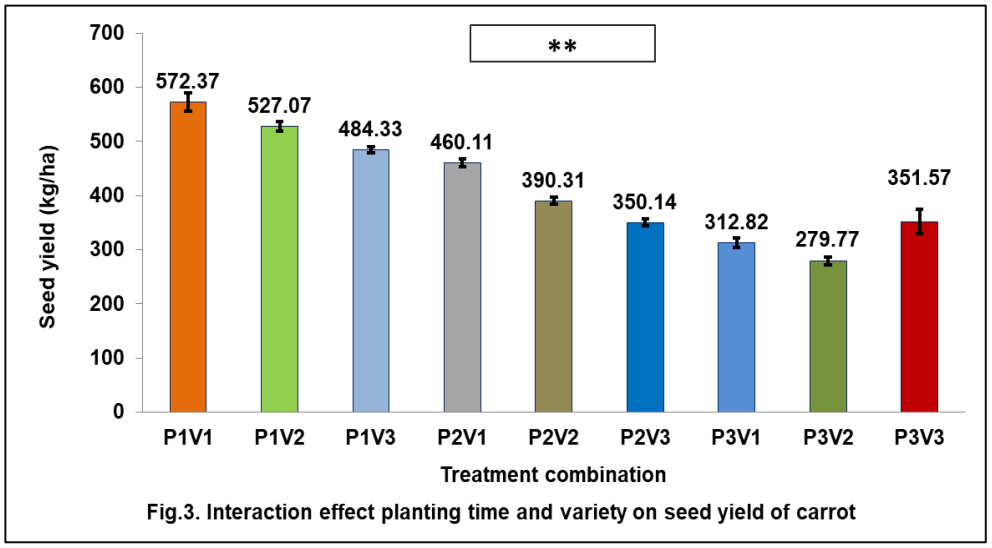

Fig.3. Interaction effect planting time and variety on seed yield of carrot

Seed quality parameters

The term seed quality incorporates several attributes of seeds among which thousand seed weight and germination percentage were used in this study.

1000-seed weight

Planting time showed significant effect on 1000-seed weight. The maximum 1000-seed weight (1.75 g) was found in P_1 planting time and minimum (1.43 g) in P_3 planting time. These results are agreed with the finding of Gray (1984). Weight of 1000 seeds also varied significantly among the varieties of carrot. The highest 1000-seed weight (1.81g) was found in the variety V_1 followed by V_2 (1.56g) and the lowest (1.39 g) was recorded in the variety V_3 (Table 5). Malik *et al*. (1988) found 1000-seed weight of carrot 0.96g. This result is in agreement with this finding. The interaction effect of planting time and variety also showed significant effect on 1000-seed weight. Nonetheless, the maximum 1000-seed weight of (1.98 g) was found in the combination of P_1V_1 and the minimum weight (1.28g) was in P_3V_3 combination.

Table 5. Effect of planting time, variety and their interaction on seed quality of carrot

Treatments	1000-seed weight (g)	Seed germination (%)
P_1	1.75	87.32
P_2	1.56	80.84
P_3	1.44	75.77
Level of sig.	**	**
$LSD_{(0.05)}$	0.05	3.32
CV (%)	2.30	14.07
V_1	1.81	87.32
V_2	1.56	80.84
V_3	1.39	75.77
Level of sig.	**	**
$LSD_{(0.05)}$	0.06	4.08
CV (%)	2.33	15.96
P_1V_1	1.98	91.54
P_1V_2	1.73	86.52
P_1V_3	1.53	83.92
P_2V_1	1.87	82.60
P_2V_2	1.54	81.20
P_2V_3	1.28	78.72
P_3V_1	1.60	78.45
P_3V_2	1.43	75.12
P_3V_3	1.28	73.76
Level of sig	**	**
$LSD_{(0.05)}$	0.11	5.78
CV (%)	5.38	16.88

Germination percentage

The percentage of germination varied with different planting dates. The maximum germination (87.32%) was found in the seeds of P_1 planting and the lowest (75.77%) was in P_3 planting (Table 5). Verma *et al*. (1993) obtained maximum (90.12-92.93%) and minimum (60%) germination due to climatic variations. The variation among the varieties on seed germination percentage was also significant. The variety V_1 gave the highest germination percentage (84.19) followed by V_2 (80.94%) and the lowest (78.80%) was obtained from the variety V_3. Malek *et al*. (2012) reported that the highest quality of seed (germination and vigour) was exhibited in Brasilia Agroflora followed by Prima Agroflora and the lowest quality of seed was observed in New Kuroda variety. This might be due to higher thousand seed weight which enhanced the speed of germination. In case of interaction, the highest germination (91.54%) was recorded in the seeds produced from the treatment combination of P_1V_1 whereas the lowest germination (73.76%) was found from P_3V_3 treatment combination.

Conclusion

The findings of this experiment revealed that the seed yield of carrot was significantly affected by different dates of steckling planting and carrot variety. Brassilia Agroflora (BA) planted on 5 January was suitable combination for maximum seed yield of carrot in Mymensingh region of Bangladesh.

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