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Effect of planting time on the seed production of three varieties of carrot

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ABSTRACT

An experiment was carried out at the Field Laboratory of Horticulture Farm, Bangladesh Agricultural University, Mymensingh during the period from October, 2007 to May, 2008 to examine the effects of three different planting time viz. 05 January, 15 January and 25 January on the seed production of three carrot varieties viz. BA (*Brasilia Agroflora*), PA (*Prima Agroflora*) and NK (New Kuroda) which constituted 9 treatment combinations. The experiment was laid out in Randomized complete Block Design (BCBD) 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 (17.63 g/plant and 2014.64 kg/ha) and the lowest was in January 25 planting of steckling (9.05 g/plant and 1207.31 kg/ha). Among the varieties *Brasilia Agroflora* (BA) gave the highest seed yield (15.45 g/plant and 1812.90 kg/ha) and the lowest yield for New Kuroda (11.72 g/plant and 1365.53 kg/ha.) Considering combined effect of planting time and variety the highest seed yield (19.68 g/plant and 2324.26 kg/ha) was obtained from the treatment combination of the variety BA with early planting (05 January) and the lowest (7.86 g/plant and 1057.35 kg/ha) was recorded from the late planting (25 January) in variety New Kuroda.

INTRODUCTION

The carrot (*Daucuscarota* 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.

Among all vegetables, carrot is important for its high nutritional value and possible diversified used in making different palatable dishes and long term storage. Carrot is cultivated in some countries for its seed, which is the source of an essential oil-the carrot seed oil.

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.

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Time of planting is an important factor for the quality of carrot seed production (Srivastava et al. 1976). 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. Fairly 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.

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.

Carrot seeds are produced in two ways (i) "seed-to seed" method (plants raised in- situ) and (ii) "root-to seed" method. Planting biennial seed, allowing the resulting plant without being transplanted, does "Seed-to-seed" method. It does not permit selection or rouging of root or other genotypic characters. A majority of the carrot seed is produced by this method which is less expensive and simple. This method is the commonly employed procedure in the seed trade. One the other hand highest seed yields of carrot are obtained from the closely spaced plants by root to seed procedure (Malik et al; 1988; Sharma and Singh, 1981). Root-to-seed method is done by planting seed, uprooting the resulting plant from the soil and transplanting. To support optimum fruit and seed development under the climatic conditions of Bangladesh, it is necessary to ensure sufficient vegetative development and flowering so that seed of carrot can be produced within short period of winter season.

With the above perspective, the present experiment was undertaken to investigate the effect of planting time on seed production of three varieties of carrot to find out optimum planting time suitable variety and combined effect of planting time and variety of carrot steckling for production of quality seeds.

MATERIALS AND METHODS

Experimental area

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 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). Robi season is characterized by low temperature but plenty of sunshine. The soil of the experimental area was sandy loam type and belonged to the Old Brahmaputra Flood Plain Alluvial Tract (UNDP, 1988). Sonatola series, non-calcarious dark grey soil. The experimental site was medium high land and the pH of the soil was 6.7. The morphological Characters of soil of the experimental plots as indicated by FAO (1998).

Variety

The carrot varieties used for the study were BA (Brasilia Agroflora), PA (Prima Agroflora) and NK (New Kuroda). The seeds were collected from the laboratory of Allium Project, Department of Horticulture, Bangladesh Agricultural University, Mymensingh which were imported from USA.

Raising of carrot plants (stecklings)

Land preparation

The land which was selected to conduct the experiment was prepared by a number of deep ploughing and cross ploughing with the help of tractor and power tiller followed by laddering for breaking up the soil clods, leveling and pulverizing the field for bringing a good tilth condition, which was necessary for proper plant growth and root development. All weeds and stubbles were removed from the field. The manure and fertilizer doses (Cowdung 10 tons, Urea 100 kg, TSP105 kg, MP 175 kg) recommended by Rashid (1983) were applied. The total quantity of cowdung was applied during land preparation. Half of the recommended quantity of urea, total quantity of TSP and half of MP were applied as top dressing after 30 days and the remaining halves of urea and MP after 45 days of seed sowing.

Cultivation

The seeds were soaked in water for 24 hours and the soaked seeds were sown uniformly in the finally prepared land at 30 cm apart in rows and covered with loose soil to help the quick germination of seed. Seed germination occurred within 7 days and excess plants were thinned twice at 15 and 30 days after seed sowing maintaining a spacing of 5 to 8 cm between the plants for proper growth and development of the remaining plants. The crop was irrigated twice by flood irrigation followed by mulching.

Preparation of the stecklings

When the plants were 75 days old and the roots were ant the marketable stage (7.5 cm in length and 3.7 cm in diameter on average), the roots were uprooted, transplanted after pruning.

Treatments of the experiment

Date of transplanting of steckling were done as P_1 = 1st transplanting (05 January, 2008), P_2 = 2nd transplanting (15 January, 2008) and P_3 = 3rd transplanting (25 January, 2008). The varieties were marked as V_1 = *Brasilia Agroflora* (BA), V_2 = *Prima Agroflora* (PA) and V_3 = New Kuroda (NK).

The experiment

The land for steckling planting was prepared and manure and fertilizers were applied as recommended above except using urea at 150 kg per hectare. The total quantity of cowdung was applied during land reparation. Half of the recommended quantity of urea, total quantity of TSP and half of MP were applied 7 days before transplanting of stecklings. Rest halves of the urea and MP were applied at 15 and 30 days after transplanting.

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 I 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.

Transplanting of stecklings

Carefully uprooted plants were pruned as per required extent (1//2 root and 3/4th shoot) of the treatment. Prior to transplanting the cut stecklings were kept in the solution of Dithane M-45 @ 2 g per liter 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, 2008 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.

Other practices like irrigation, weeding and mulching, pest and disease management, staking, harvesting of seed, drying, cleaning, and seed collection were performed as per common practice.

Data collection

Five sample plants were selected randomly from each plot and data were recorded on individual plant basis from the selected plants in respect of Plant height (cm), number of days taken for flowering and fruit set, number of days required from flowering to fruit set, number of single umbels per compound umbel, Number of flowers

per single umbel, Number of primary umbels per plant, Number of secondary umbels per plant, Size of main umbel (cm), Size of primary umbel (cm), size of secondary umbel (cm), seed yield in main, primary and secondary umbels (g), seed yield per plant (g), seed yield per plot (g), seed yield per hectare (kg), weight of 1000 seeds (g) and germination percentage of seeds.

Statistical analysis

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% and 1% levels of probability (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Effect of planting time on carrot seeds production

Plant height

The influence of three different planting dates was found to be significant in respect of plant height at 100 days (Table 1). It was observed that plant height decreased gradually with the advancement of planting time January 05 planting (early planting) gave maximum plant height while it was minimum at January 25 planting (late planting). The tallest plant (84.56cm) was obtained from January 05 planting and the shortest plant (76.34 cm) was recorded from January 25 planting (Table 1). The present results were in accordance with the findings of others (Anonymous, 1983).

Days to 50% flowering

The effect of planting time on days required to 50% flowering was found to be statistically non-significant. The longest period (143.92 days) was required to complete 50% flowering at late planting of January 25 while it was the shortest time (139.93 days) at January 05 planting (Table 1).

Days to 50% fruit set

Planting time had non-significant effect on 50& fruit set. It was found that January 25 planting took the longest period (159.83 days) to complete 50% fruit set and the shortest period (155.83 days) was at January 05 planting (Table 1).

Days required from flowering to fruit set

The influence of planting date on days required from flowering to fruit set was found to be statistically significant. The longest period (16.23 days) was at January 15 planting and the shortest period (15.89 days) was at January 05 planting (Table 1).

Number of primary umbels per plant

The effect of planting time was highly significant on the number of primary umbels per plant. The maximum number of primary umbels (9.25) was found in early planting (05 January). While it was the minimum (7.18) from the late planting of 25 January (Table 1). This result agrees with Elballa et al. (1996) who reported that the number of primary umbels decreased with the increasing temperature in late planting.

Number of secondary umbels per plant

The effect of number of secondary umbels per plant was significantly influenced by the time of planting**.** The maximum number of secondary umbels (7.69) was recorded from early planting (05 January) followed by mid (15 January) and late (25 January) planting (Table 1).

Table 1: Main effect of planting time on plant height and floral characters of carrot for seed production

Planting time	Plant height at 1000days (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
LSD0.05	3.009	4.477	4.108	0.30	0.234	0.243
LSD0.01	4.211	6.276	5.76	0.32	0.328	0.340
Level of significance	**	NS	NS	**	**	**

NS = Non- significant, ** = Significant at 1% level of probability

Number of single umbels per compound umbel

Number of single umbels per compound umbel was significantly influenced by the time of planting. The maximum number (86.88) of single umbels per compound umbel was observed in 05 January planting time (early planting) while it was minimum (76.71) in 25 January planting (late planting) (Table 2).

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 variation. The maximum number of (53.51) of flowers per single umbel was observed in January 05 planting and the minimum (49.21) was in late planting (25 January) (Table 2). Similar results were found by Msikita et al. (1997) who observed earlier and higher number of flowers at earlier planting.

Diameter of main umbel

Different planting time had non-significant effect on the diameter of main umbel. However, the longest diameter (13.95 cm) was found in 05 January planting and the shortest diameter (13.44 cm) was found in 25 January.

Diameter of primary umbel

The effect of planting time on the diameter of primary umbel was found significant. The early planting (05 January) gave higher diameter (8.77 cm) and late planting (25 January) gave the lowest diameter (8.40 cm) (Table 2).

Diameter of secondary umbel

The diameter of secondary umbel was significantly influenced by the time of planting. Early planting (05 January) gave the highest diameter of secondary umbel (4.86cm) which followed by mid (4.49cm) and late (4.32cm) planting (Table 2).

Table 2: Effect of planting time on umbel characters of carrot for seed production

Planting time	No. of single umbels/compound umbel	No fo flowers/single umbel	Diameter of main umbel (cm)	Diameter of primary umbel (cm)	Diameter of secondary umbel (cm)
P_1	86.88	53.51	13.95	8.77	4.86
P_2	80.96	51.17	13.57	8.54	4.49
P_3	76.71	49.21	13.44	8.40	4.32
LSDO.05	3.525	2.492	0.589	0.266	0.165
LSDO.01	4.94	3.49	0.825	0.303	0.123
Level of Significance	**	**	NS	*	**

NS Non-significant; *= Significant at 5% level of probability; **= Significant at 1% level of probability

Seed yield in main umbel

Statistically significant variation was found on seed yield in main umbel due to the different planting time. The highest seed yield (9.46 g) was recorded at early planting (05 January) and the lowest (5.69 g) seed yield was recorded at late planting in 25 January (Table 3).

Seed yield in primary umbel

The effect of planting time on the yield of seeds in primary umbel was found to be significant. The highest yield of seeds in primary umbel (11.46 g) was recorded at the early planting in early planting and the lowest seed yield (6.40 g) was found in the late planting of 25 January (Table 3).

Seed yield in secondary umbel.

Seed yield in secondary umbel was statistically significant in different planting time. The highest seed yield in secondary umbel (8.79 g) was found in the early planting 05 January and the lowest seed yield (4.77 g) was found from the late planting 25 January (Table 3).

Seed yield per plant

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 (05 January) produced highest seed yield (17.63 g) followed by mid and late planting (Table 3).

Table 3: Main effect of planting time on carrot seed production

Planting time	Seed yield in main umbel (g)	Seed yield in primary umbel (g)	Seed yield in secondary umbel (g)	Seed yield/plant (g)	Seed yield/plot (g)	Seed germination (%)
P_1	9.46	11.46	8.79	17.63	302.19	87.32
P_2	7.55	8.50	6.74	13.28	230.48	80.84
P_3	5.69	6.40	4.77	9.05	181.35	75.77
LSDO.05	0.446	0.396	0.299	0.579	17.49	3.32
LSDO.01	0.626	0.555	0.420	0.812	24.52	4.078
Level of Significance	**	**	**	**	**	**

**= Significant at 1% level of probability.

Seed yield per plot

Seed yield per plot was significantly affected by different planting times of carrot Early planting (05 January) gave the height seed yield (302.19 g) and the lowest (181.35g) was in late planting (Table 3). 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).

Seed yield per hectare

Seed yield per hectare was highly significant due to different planting times of carrot. The highest seed yield per hectare (2014.64 kg) was found in early planting (05 January) and the lowest seed yield per hectare (1207.31kg) was found in late planting (25 January) (Fig. 1) Msikita et al. (1988) also reported that low temperature in early planting enhanced maximum seed yield per hectare as earlier planting seemed to obtain favorable climate for and seed yield.

Weight of 1000 seeds

Planting time showed significant effect on 1000 seed weight. The maximum 1000 seeds weight of 1.74 g was found in 05 January plantingtime, on the other hand 25 January planting time produced 1.43 g

Germination percentage

The effect of planting time was found to be statistically significant in respect of germination percentage. The percentage of germination varied with different planting dates. The maximum germination (87.32%) was found in the seeds of 05 January planting and the lowest (75.77%) was in 25 January planting (Table 3). Vermaet al, (1993) obtained maximum (90.12-92.93%) and minimum (60%) germination due to climatic variations.

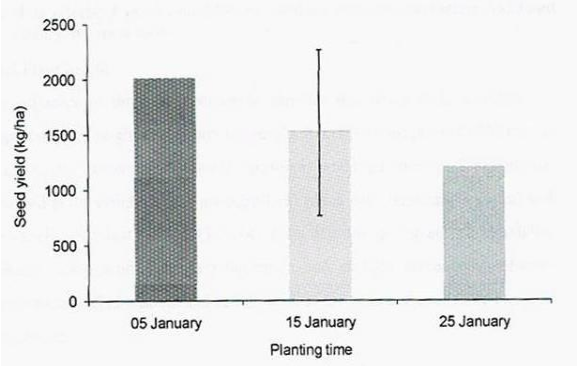

Figure 1: Main effect of planting time on seed yield (kg/ha) of carrot (Vertical bar represents LSD at 5% level

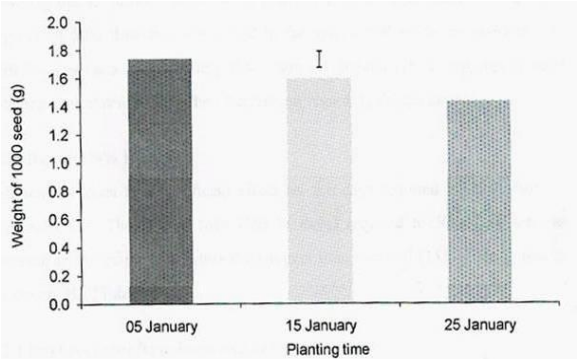

Figure 2: Main effect of planting time on weight of 1000 seeds of carrot (Vertical bar represents LSD at 5% level

Effects of variety on carrot seeds production

Plant height

The influence of three different carrot varieties was found to be significant in respect of plant height at 100 days. The tallest plant (83.07 cm) was found in the variety BA (Brassilia Agroflora) while the shortest (79.11cm) was observed in the variety PA (prima Agroflora) which was statistically identical with the variety NK (New kuroda) (Table 4) Plant depends upon genotypic variability. Climatic components such as temperature and sunlight presumably enhanced meristematic cell elongation and cell division of the plant and eventually increased plant height.

Days to 50% flowering

There was statistically significant a variation in respect of days required to 50% flowering due to different varieties. The longest time (144.84 days) required to 50% flowering was found in the variety NK while the shortest time (138.36 days) was in the variety BA (Table 4). Rashid (1976) reported to have obtained similar results from their experiment regarding this parameter.

Days to 50% fruit set

Different varieties had significant effect on the days required to 50% fruit set. The longest time (163.38 days) required to 50% fruit set was observed in the variety NK while the shortest time required (151.37 day) was in the variety BA (Table 4).

Days required from flowering to fruit set

The variation among the three varieties was found statistically significant in respect of days required from 50% flowering to 50% fruit set. The maximum time required (18.54 days) was found in the varicty NK and the minimum time (13.01 days) was required in the varicty BA (Table 4).

Number of primary umbels per plant

The number of primary umbels per plant among the three varieties was affected significantly. However, the maximum number (8.47) of priamry umbels per plant was found in the variety BA and the minimum number (8.03) was recorded in the variety NK.

Number of secndary umbels per plant

As in the case of secondary umbels there was significant variation among the different varieties of carrot. However, the highest number of secondary umbels (7.26) per plant was found in

the variety BA and the minimum number (6.5) was recorded in the variety NK (Table 4).

Number of single umbels per compound umbel

Varietal difference in respect of single umbels per compound umbel per plant was found statistically significant among the three different varieties. The highest number of single umbels (85.44) per compound umbel was recorded from the variety BA while the variety NK 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 (Table 5).

Table 4: Main effect of variety on plant growth, and floral characters of carrot for seed production

Variety	Plant height at 100 days (cm)	Days to 50% flowering	Days to 50% fruit set	Days Required from flowering to fruit set	No. of primary umbel/plant	No. of Secondary umbels/ plant
V_1 (BA)	83.07	138.36	151.37	13.01	8.47	7.26
V_2 (PA)	80.06	142.67	159.30	16.62	822	6.92
V_3 (NK)	79.11	144.84	163.38	18.54	8.03	6.51
LSD0.05	3.680	5.483	5.032	0.5	0.287	0.297
LSD0.01	5.158	7.687	7.054	0.58	0.402	0.417
Level of significance	*	*	**	**	**	**

*=Significant at 5% level of probability, **=Significant at 1% level of probability

Number of flowers per single umbel

The variation in the number of flowers per single umbel was affected significantly. The maximum number of flowers per single umbel (53.46) was found in the variety BA and the minimum number of flowers (49.37) was in the variety PA (Table 5).

Diameter of main umbel

Diameter of main umbel among the different varieties of carrot had non-significant effect. However, the highest diameter (14.06 cm) was found in the variety BA and the lowest diameter (13.24cm) was in the variety NK which was statistically identical with the variety PA (Table 5).

Diameter of primary umbel

The diameter of primary umbel was statistically influenced by three varieties of carrot. However, the maximum diameter of primary umbel (9.07 cm) was found in the variety PA and the minimum diameter (8.22 cm) was in the variety Nk followed by (4.45 cm) the variety BA (Table 5).

Table 5: Main effect of variety on plant growth, and floral characters of carrot for seed production

Variety	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)
V_1 (BA)	85.44	53.46	14.06	8.41	5.53
V_2 (PA)	80.75	49.37	13.66	9.07	4.45
V_3 (NK)	78.36	51.05	13.24	8.22	4.69
LSD0.05	4.317	3.053	0.7215	0.325	0.202
LSD0.01	6.05	4.28	1.012	0.456	0.284
Level of significance	**	**	NS	**	*

NS= Non-significant; *=Significant at 5% level of probability, **=Significant at 1% level of probability

Diameter of secondary umbel

There was significant variation among the three varieties of carrot in respect of the diameter of secondary umbel. However, the maximum diameter (4.69 cm) was recorded in the variety NK and the minimum diameter (4.45 cm) was observed in the variety PA (Table 5).

Seed yield in main umbel

The result on the main effect of variety revealed that the yield of seeds in main umbel was influenced significantly by the three varieties of carrot. The highest yield of seed in main umbel (8.63 g) was found from the variety BA and the lowest yield (6.53 g) was recorded in the variety NK. A similar report was revealed by Cardoso (2000) who stated that seeds from main and primary umbels were of better yield and quality than the seeds of secondary umbel (Fig.3).

Seed yield in primary umbel

There was a significant effect of varieties on the yield of seeds in primary umbel. The highest seed yield in primary umbel (9.37 g) was obtained from the variety BA and the lowest yield (8.40 g) was found from the variety NK (Fig.3) possibly, due to the presence of higher number of simple umbels per compound umbel and maximum number of flowers in every simple umbel. The seed yield of primary umbel was increased in BA variety.

Seed yield in secondary umbel

Seed yield in secondary umbel was statistically significant in different varieties of carrot. The highest seed yield in secondary umbel (7.73 g) was obtained from the variety BA and the lowest yield (6.18g) was recorded from the variety NK possibly, the seed yield in secondary umbel of BA variety was increased as the six and umber of secondary umbels in the same variety was higher (Fig.3)

Seed yield per plant

There was highly significant effect among the three varieties of carrot. The maximum seed yield per plant (15.45 g) was obtained from the variety BA and the minimum seed yield (11.72 g) was found from the variety NK. The maximum seed yield per plant from the variety BA was probably due to the production of highest number of main, primary and secondary umbels (Fig. 3)

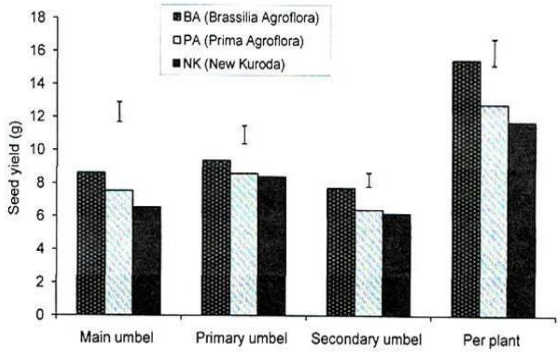

Figure 3: Main effect of variety on seed yield of different umbels and per plant of carrot (Vertical bar represents LSD at 5% level

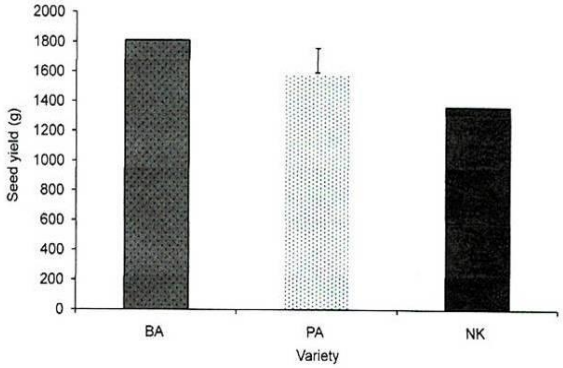

Figure 4: Main effect of variety on seed yield (kg/ha) of carrot (Vertical bar represents LSD at 5% level

Seed yield per plot

Seed yield per plot was significantly affected by different varieties of carrot. The variety BA gave the highest seed yield (271.93 g) followed by PA (237.27 g). The NK variety produced lowest amount of seed (204.83 g) per plot. The highest yield of seed per plot from the variety BA increased as the yield per plant was the highest (Table 6).

Seed yield per hectare

Seed yield per hectare was highly significant due to the different varietal effects. The highest seed yield per hectare (1812.90 kg) was given by the variety BA and the lowest seed yield per hectare (1365.33 kg) was found in the variety NK (Fig.4).

Weight of 1000 seeds

Weight of 1000 seeds varied significantly among the varieties of carrot. The highest weight of 1000 seeds (1.81g) was found in the variety BA followed by PA (1.56g) and the lowest (1.39 g) was recorded in the variety NK (Table 6).

Germination percentage of seed

The variation among the varieties on seed germination percentage was highly significantly. The variety BA gave the highest germination percentage (84.19) followed by PA (80.94%) and the lowest (78.80%) was obtained from the variety NK (Table 6).

Combined effect of planting time and variety on carrot seeds production

Plant height

There was significant combined effect of planting time and variety on the plant height of cannot but their interaction was found to be non-significant. However, the highest plant height (86.41 cm) was observed in the treatment P_1 V_1 (early planting and variety BA) and the lowest height (74.13 cm) was found from P_3 V_3 (late planting and variety NK combination) (Table7).

Table 6: Main effect of variety on the seed yield of carrot

Variety	Seed yield/plot (g)	Weight of 1000 seeds	Seed germination (%)
V_1 (BA)	271.93	1.81	84.19
V_2 (PA)	237.27	1.56	80.94
V_3 (NK)	204.83	1.39	78.80
LSD0.05	21.42	0.056	4.087
LSD0.01	30.03	0.078	5.73
Level of significance	**	**	**

**=Significant at 1% level of probability

Table 7: Combined effect of plating time and variety on plant growth and floral characteristics of carrot for seed production.

Factor (A-B) X	Plant height at 100 days (cm)	Days to 50% fruit flowering	Days to 50% fruit set	Days required from flowering to fruit set	No of primary umbels/ plant	No of secondary umbels/plant
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
LSD0.05	5.204	7.754	90.071	1.586	0.477	0.421
LSD0.01	7.296	10.87	12.72	2.224	0.669	0.5902
Level of significance	**	NS	**	**	**	**

NS= Non-significant **=Significant at 1% level of probability

Days to 50% flowering

The combined effect of planting time and variety was non-significant on the days to 50% flowering and their interaction was too. The longest period (146.80 days) was required in the combination P_3V_3 and the shortest period (136.08 days) was found in P_1V_1 (Table 7)

Days to 50% fruit set

The interaction and combined effects of planting time and variety on the days to 50% fruit set was found statistically significant. The longest period (165.20 days) required for 50% fruit set was observed from the treatment combination P_3 V_3 and shortest period (148.60 days) was found in the combination P_1V_1 (Table 7)

Days required from flowering to fruit set

Interaction and the combined effects of planting time and variety on the time required from 50% flowering to 50% fruit set were 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 (Table 7).

Number of primary umbels per plant

The combined effect of planting time and variety was highly significant in respect of number of primary umbels but their interaction was not significant. The maximum numbers of primary umbels (9.62) per plant was obtained from the treatment combination P_1V_1 which was statically identical with the combination of P_1V_2 while the minimum number of primary umbels (7.13) per plant was found in the combination of P_3V_3 (Table 7).

Number of secondary umbels per plant

The combined effect of planting and variety was varied significantly on the number of secondary umbels per plant and their interaction effect also showed significant variation. 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 7).

Number of single umbels per compound umbel

The number of single umbels per compound umbel was varied significantly as a result of combined effect of planting time and different varieties and their interaction effect showed non-significant variation. 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 (Table 8).

Number of flowers per single umbel

Planting time and variety showed non-significant interaction effect on the number of flowers per single umbel but their combined effect was highly significant for the same parameters. 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 8).

Diameter of main umbel

The combined effect of planting time and variety exhibited non-significant effect on the diameter of main umbel and their interaction effect was non-significant too.The maximum diameter (14.43 cm) was found in the treatment combination of P_1V_1 and the lowest diameter (13.01 cm) was in P_3V_3 (Table 8).

Diameter of primary umbel

There was significant combined effect of planting time and variety on the diameter of primary umbel but their interaction effect was not significant on the same parameter. The maximum diameter (9.23 cm) was found in the treatment combination of P_1V_2whereas, the minimum diameter (8.02 cm) was obtained from the P_3V_3 treatment combination (Table 8).

Diameter of secondary umbel

The combined effect of planting time and variety exhibited significant effect on the diameter of secondary umbel but their interaction effect was not significant. 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 (Table 8).

Seed yield in main umbel

The combined effect of planting time and variety showed significant variation in the yield of seeds in main umbel but their interaction effect was found non-significant. The highest seed yield in main umbel (10.95g) was observed in combination of P_1V_1 whereas the lowest yield (4.98g) was in P_3V_3 treatment combination (Table 9).

Table 8: Combined effect of plating time and variety on the umbel characteristics of carrot for seed production

Factor (A× B)	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_1V_1	91.47	55.20	14.43	8.64	4.85
P_1V_2	86.00	51.60	13.89	9.23	4.76
P_1V_3	83.19	53.73	13.53	8.45	4.98
P_2V_1	84.30	53.60	13.83	8.33	4.45
P_2V_2	80.46	49.12	13.70	9.08	4.40
P_2V_3	78.12	50.18	13.20	8.21	4.62
P_3V_1	80.56	51.60	13.92	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
LSD0.05	6.105	4.317	1.411	0.634	0.457
LSD0.01	8.559	6.052	1.978	0.888	0.641
Level of significance	**	**	NS	**	**

NS= Non-significant **=Significant at 1% level of probability

Table 9: Combined effect of plating time and variety on the umbel characteristics of carrot for seed production

Factor (A× B)	Seed yield in main umbel (g)	Seed yield in primary umbel (g)	Seed yield in secondary umbel (g)	Seed yield per plant (g)	Seed yield/per plot (g)	Wt of 1000 seeds (g)	Seed germination (%)
P_1V_1	10.85	12.45	9.80	196.68	348.64	1.98	91.54
P_1V_2	9.12	11.02	8.52	17.20	297.88	1.73	86.52
P_1V_3	8.42	10.91	8.07	16.01	260.07	1.53	83.92
P_2V_1	8.64	8.76	7.59	15.74	268.48	1.87	82.60
P_2V_2	7.82	8.47	6.37	12.82	227.16	1.54	81.20
P_2V_3	6.20	8.28	6.28	11.30	195.82	1.28	78.72
P_3V_1	6.42	6.92	5.81	10.95	1998.69	1.60	78.45
P_3V_2	5.69	6.25	4.32	8.35	186.77	1.43	75.12
P_3V_3	4.98	6.03	4.19	7.86	158.60	1.28	73.76
LSD0.05	1.110	1.051	0.722	1.399	39.38	0.1125	5.780
LSD0.01	1.556	1.473	1.013	1.961	55.20	0.157	8.103
Level of significance	**	**	**	**	**	**	**

NS= Non-significant **=Significant at 1% level of probability

Seed yield in primary umbel

The interaction effect of planting time and variety showed non-significant effect on the seed yield in primary umbel but their combined effect was highly significant. The maximum seed yield (12.45g) was found in the treatment combination of P_1V_1 while the minimum yield (6.03g) was found in P_3V_3 treatment (Table 9).

Seed yield in secondary umbel

Highly significant variation was observed in the combined effect of planting time and variety on the seed yield in secondary umbel but their interaction effect was non-significant. The maximum seed yield (9.80g) was recorded in the treatment combination of P_1V_1 and the minimum yield (4.19g) was found in combination P_3V_3 (Table 9).

Seed yield per plant

The combined effect of planting time and variety on the seed yield per plant was statistically significant and the interaction effect was found non-significant. The maximum yield of seeds (19.68g) was found in the treatment combination of P_1V_1 and the minimum (7.86g) was in combination of P_3V_3 (Table 9).

Seed yield per plot

Highly significant result was observed from the combined effect of planting time and variety on seed yield per plot but their interaction effect was not significant. The maximum seed yield (348.64g) was found in the treatment combination of P_1V_1 and the lowest yield (158.60g) was obtained from P_3V_3 treatment combination (Table 9).

Seed yield per hectare

The estimated seed yield per hectare was increased significantly by the combined effect of planting time and variety but their interaction effect was not significant. The highest seed yield (2324.26kg) was calculated from the treatment combination of P_1V_1 and the lowest (1057.33kg) was recorded in P_3V_3 (Fig. 5).

Weight of 1000 seeds

The interaction effect of planting time and variety showed non-significant effect on weight of seeds but their combined effect was highly significant. The maximum weight of 1000 seeds (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 9).

Germination percentage

The interaction effect of planting time and variety showed non-significant effect on the germination percentage of seed but their combined effect was varied significantly on the same parameter. 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 (Table 9).

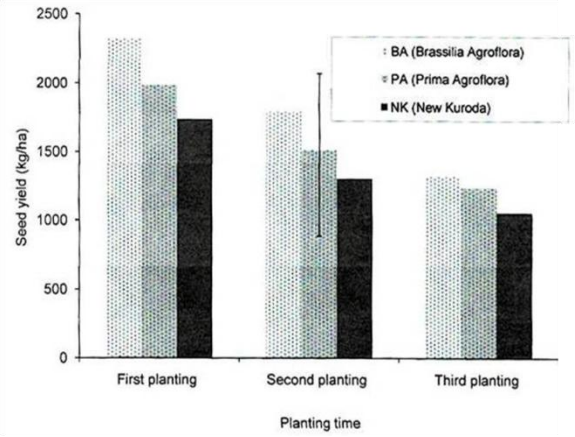

Figure 5: Combined effect of planting time and variety on seed yield of carrot (Vertical bar represents LSD at 5% level)

CONCLUSION

The results revealed that the three planting dates showed significant vitiation for all the parameters studied except days to 50% flowering days to 50% fruit set and diameter of main umbel. There was great variation in seed yield due to planting time. The highest seed yield/plant (17.63g) and seed yield/ha (2014.64kg) were found in early planting. Weight of 1000 seeds (1.74g) and seed germination (87.32%) were also highest in 25 January planting.

Variety had also significant influence on almost all the parameters under study for the seed production of carrot. The combined effect of planting time and variety had highly significant effect on all the parameters except days to 50% flowering and diameter of main umbel. On the other hand but their interaction effect showed non-significant variation on most of the parameters except number of secondary umbels/plant.

From the present study it may be suggested that higher seed yield of carrot can be obtained from the early planting (05 January) with the variety BA (V1) under the climatic conditions of Horticulture Farm, Bangladesh Agricultural University, Mymensingh. However, the experiment may be repeated in other locations which in necessary to make a general recommendation for the successful seed production of carrot.

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