Journal of Tikapur Multiple Campus
Vol.7; February 2024
ISSN: 2382-5227
Published by Research Management Cell (RMC)
Tikapur Multiple Campus, Kailali, Nepal

Effect of Sowing Date on Growth and Yield of Different Carrot Varieties (*Daucus carota* L.)

D. Giri[1], A. Srivastava[1], A. K. Shrestha[1], S. K. Raut[2], H. N. Giri[2]

[1]Agriculture and Forestry University, Nepal
[2]Far Western University, Nepal
Corresponding Author's Email: sanjay.raut@fwu.edu.np

Abstract

A study was conducted at Agriculture and Forestry University, Rampur, Chitwan, from October 2019 to March 2020 to evaluate the effect of sowing date on the growth and yield of four different carrots (*Daucus carota* L.) varieties. The experimental treatments were three different sowing dates (19th October, 13th November, and 8th December) and four varieties (New Kuroda, Nepa Dream, SK3, and Taki) which constituted 12 treatments. The experiment was set up using a randomized complete block design with three replications. The results revealed that sowing dates and varieties significantly influenced the growth and yield of carrots. But interaction effect was not significant. Maximum plant height, number of leaves per plant, leaf length, leaf breadth, canopy diameter, root length (15.37 cm), root diameter (2.74 cm), and fresh root weight (133 g) were obtained with Nepa Dream variety. Similarly, the highest plant height, number of leaves per plant, leaf breadth, canopy diameter, root diameter (3.27 cm), root length (16.23 cm), and fresh root weight (162.60 g) was obtained with first sowing (19th October) which might be due to favorable condition available during the growing condition and also early sowing possibly attributed to maximum photosynthesis with longer growth period than the later sowing. The combined effect of sowing date and varieties was significant with the number of leaves per plant, cortex diameter, and core-to-cortex ratio. So based on the results of the experiment, Nepa Dream sown on 19th October was economically better for the optimum yield and quality production in Chitwan, Nepal.

Keywords: Agro-morphological traits, crop performance, variety selection, harvest time

Introduction

Carrot (*Daucus carota* L.) is one of the most common herbaceous annual for fresh root and biennial plants for seed production belonging to the family Apiaceae. It is mainly a temperate crop grown during spring through autumn in temperate countries and during winter in tropical and subtropical countries of the world (Bose et al., 1993).

Carrot is used as salad, in cooked vegetables, in soup, stew, and curries also used for the preparation of pickles, jam, sweet dishes and also available in the market as a canned product (Kabir et al., 2000).

Bose et al. (1993) reported the nutritive content of carrots per 100 g edible portion as carbohydrates (10.6 g), protein (0.9 g), fat (0.2 g), niacin (0.5 mg), riboflavin (0.02 mg), carotene (1890 µg), vitamin- A (16706 IU), vitamin -C (3 mg), vitamin -K(13.2 µg), potassium (320 mg), Ca (80 mg), Fe (2.2 mg) and phosphorus (30 mg). Carrot roots are rich in carotene and play an important role to protect against blindness in children. It helps in the elimination of uric acid from the body. It has medicinal value as essential oil extracted from carrot roots has antibacterial properties (Bose et al., 1993). Zhang & Hamauzu (2004) reported that the consumption of carrot minimizes the risk of heart diseases, stomach diseases, and many types of cancer. It is also reported that carrot has anti-diabetic, cholesterol-lowering, anti-hypertensive, hepatoprotective, cardiovascular disease reducing and wound-healing benefits.

The total cultivated area of carrot in Nepal is about 2,898 ha with a production of 32,308 mt and a productivity of 11.15 mt/ha (MoALD, 2020/021). In Chitwan, carrot is heavily produced i.e. cultivated on 150 ha with a production of 2025 mt and productivity of 13.50 mt/ha (MoALD, 2020/021).

According to Latha et al. (2015), carrot is very sensitive to temperature and photoperiod and concluded that the root yield has been greatly affected by different sowing date. The environmental conditions in the different crop seasons and locations may influence the adaptability as well as stability of varieties.

Extending the availability of carrot during the early and late period of the growing season and sowing date may play a critical role. Selection of the right varieties for sowing at the optimum date is the key factor for successful carrot production.

The varieties fail to give the best performance if there is a slight deviation in their sowing date. Proper sowing date depends on the varieties and prevailing environmental conditions. Therefore, the present investigation was to find out the optimum sowing time and suitable variety for high yields under Chitwan.

Methods

The experiment was conducted at Rampur **(**27° 37ʾ N; 84° 25ʾ E), Chitwan. The soil was sandy loam with a pH of 5.6. The soil is medium in organic matter content (3.91 %), available nitrogen content (0.15 %), and phosphorous content (33.3 kg/ ha) but high in available potassium content (395.3 kg/ ha).

Two factorial experiments were laid out in Randomized complete block design (RCBD) with three replications. There were twelve treatment combinations comprising four varieties (New Kuroda, Nepa Dream, SK3 and Taki) with three dates of sowing (19th October, 13th November and 8th December). The net size of each plot was 1.8 m^2 (1.8 m × 1 m) with 6 rows having 10 plants in each row. The net experimental area was 64.8 m^2. The space between the plots and replications was 0.5 m and 1m respectively.

The recommended dose of manure and fertilizer @1500 kg FYM, 5:5:5 kg Urea, DAP and MoP per ropani were applied in the experimental field. Line sowing @ 300 g seed per ropani was done with the spacing of 30 cm × 10 cm on three different dates. The sprinkler irrigation system was used for the irrigation of plants. Krishi Diary, (2079)

Data regarding days to germination, plant height, number of leaves per plant, leaf length, leaf breadth, edible root length, root diameter, yield, and root-to-shoot ratio were determined.

Data were entered in Microsoft Excel and analysis was done by using the software GEN STAT 18th edition. The significant difference between treatments mean was compared by Duncan`s Multiple Range Test (DMRT) at 5% level of significance.

Results

The result is presented with necessary tables for discussion, comprehension and understanding.

Days to Germination

The result of statistical analysis showed that there was a significant effect of sowing dates and varieties on days to germination (Table 1).

Table 1

Effect of Sowing Date and Varieties on Days to Germination of Carrot

Treatments	Days to germination	
	50% germination	80% germination
Factor A (Sowing date)		
19th October	4.67[c]	5.52[c]
13th November	5.42[b]	6.24[b]
8th December	6.59[a]	7.42[a]
SEM (±)	0.06	0.09
F-test	**	**
$LSD_{0.05}$	0.19	0.27
Factor B (Variety)		
New Kuroda	5.03[c]	5.88[c]
Nepa Dream	5.03[c]	5.83[c]
SK3	6.36[a]	7.23[a]
Taki	5.80[b]	6.62[b]
SEM (±)	0.07	0.11
F-test	**	**
$LSD_{0.05}$	0.22	0.32
CV (%)	4.10	5.20
Grand mean	5.55	6.39

Means with the same letter in the column are not significantly different at p = 0.05 by DMRT. *significant at 5% ($p < 0.05$), and **significant at 1% ($p < 0.01$) at 5% ($p > 0.05$). SEM = Standard error of mean, LSD = Least significant difference and CV = Coefficient of variation.

Among sowing dates, the seed sown on 19th October took minimum days to germinate i.e. 4.66 and 5.52 days to 50 % and 80 % germination respectively followed by sowing on 13th November.

Days to germination differed significantly among the varieties at $p<0.01$. For 50% germination, significantly maximum days (6.36 days) were recorded in SK3 whereas significantly minimum days (5.03 days) were recorded in New Kuroda. Similarly, for 80 % germination significantly maximum days were noted in SK3 (7.243 days) whereas significantly minimum days were noted in Nepa Dream (5.83 days).

Plant Height

The plant height of the carrots at various growth stages is influenced by the sowing date and varieties as displayed in Table 2. At 40 DAS, plant height was significantly taller on 19th October, (24.83 cm). At 60 DAS, plant height was significantly taller on 19th October, (40.42 cm). At 80 DAS, the plant height was significantly taller at first sowing (43.37 cm). Similarly, at harvest, plant height was significantly taller at the first sowing (45.43 cm) followed by the second sowing (34.73 cm).

Table 2

Effect of Sowing Date and Varieties on Plant Height of Carrot

Treatments	Plant height (cm)			
	40 DAS	60 DAS	80 DAS	At harvest
Factor A (Sowing date)				
19th October	24.83[a]	40.42[a]	43.37[a]	45.43[a]
13th November	11.16[b]	19.22[b]	32.26[b]	34.73[b]
8th December	5.42[c]	13.02[c]	30.53[b]	34.53[b]
SEM (±)	0.39	0.63	0.81	0.76
$LSD_{0.05}$	1.14	1.84	2.39	2.25
F-test	**	**	**	**
Factor B (Variety)				
New Kuroda	12.84[b]	24.09[ab]	35.92[a]	38.63[a]
Nepa Dream	14.71[a]	25.41[a]	36.47[a]	40.86[a]
SK3	13.13[b]	22.15[b]	31.47[b]	34.24[b]
Taki	14.54[a]	25.24[a]	35.65[a]	39.20[a]
SEM (±)	0.45	0.72	0.94	0.88
F-test	*	*	**	**
$LSD_{0.05}$	1.32	2.13	2.77	2.60
CV (%)	9.80	9.00	8.00	7.00
Grand mean	13.81	24.22	35.38	38.23

Means with same letter in column are not significantly different at p = 0.05 by DMRT. *significant at 5% ($p < 0.05$) and **significant at 1% ($p < 0.01$) at 5% ($p > 0.05$). SEM = Standard error of mean, LSD = Least significant difference, CV = Coefficient of variation and DAS = Days after sowing

Plant height differed significantly at $p<0.01$ among the varieties on days to sowing. At 40 DAS significantly taller (14.71 cm) was recorded in Nepa Dream whereas significantly shorter plant height (12.84 cm) was recorded in New Kuroda. At 60 DAS, significantly taller (25.41 cm) was recorded in Nepa Dream whereas significantly shorter plant height (22.15 cm) was recorded in SK3. Likewise, at 80 DAS significantly taller height was recorded in Nepa Dream (36.47 cm) and significantly shorter height (31.47 cm) was recorded in SK3. Similarly at harvest, significantly taller height (40.86 cm) was recorded in Nepa Dream which was statistically similar to Taki (39.20 cm) whereas significantly shorter plant height (34.24 cm) was recorded in SK3.

Leaf Length and Breadth

The result showed significant effect of sowing dates and varieties on leaf length and breadth (Table 3). At 40 DAS, leaf length (12.31cm) and breadth (11.55 cm) values were significantly higher with the first sowing, 19th October whereas significantly lower values for leaf length (2.49 cm) and breadth (2.43) were recorded on 8th December. A similar result was seen in 60 DAS, 80 DAS, and at harvesting where higher values for leaf length and breadth were seen with the first sowing, 19th October and the least value on 8th December.

Leaf length and breadth differed significantly at $p<0.01$ among the varieties on days to sowing. At 40 DAS significantly longer (7.47 cm) and wider leaf (6.97) was recorded in Nepa Dream whereas less value for the length (6.06 cm) and width (5.59 cm) was recorded in New Kuroda. At 60 DAS significantly longer (14.87 cm) and wider (11.06 cm) leaf was recorded in Nepa Dream whereas shorter and narrower leaf was recorded in SK3 with a value of 12.97 cm and 9.70 cm respectively. Likewise, at 80 DAS significantly longer leaf was recorded in New Kuroda (21.63 cm) followed by Taki (20.03 cm) whereas a shorter leaf was recorded in SK3 (18.22 cm) and a wider leaf was recorded in Taki (15.21cm) whereas narrower leaf was recorded in SK3 (10.90 cm). Similarly, at harvest, the significantly longer leaf was recorded in Nepa Dream (22.81 cm) whereas a shorter leaf was recorded in SK3 (18.62 cm) and a wider leaf breadth was recorded in Taki (15.30 cm) whereas a narrower leaf was recorded in SK3 (11.93 cm).

Table 3

Effect of Sowing Date and Varieties on Leaf Length and Breadth of Carrot

Treatments	Leaf length (cm)				Leaf breadth (cm)			
	40 DAS	60 DAS	80 DAS	At harvest	40 DAS	60 DAS	80 DAS	At harvest
Factor A (Sowing date)								
19th October	12.31^{a}	22.80^{a}	24.81^{a}	25.38^{a}	11.55^{a}	19.07^{a}	17.57^{a}	17.75^{a}
13th November	4.90^{b}	11.58^{b}	18.12^{b}	20.08^{b}	4.63^{b}	7.30^{b}	11.28^{b}	11.31^{b}
8th December	2.49^{c}	7.31^{c}	17.18^{b}	19.21^{b}	2.43^{c}	5.65^{c}	10.32^{b}	10.32^{b}
SEM (±)	0.18	0.37	0.43	0.51	0.25	0.29	0.40	0.57
F-test	**	**	**	**	**	**	**	**
$LSD_{0.05}$	0.54	1.099	1.261	1.484	0.74	0.85	1.18	1.67
Factor B (Variety)								
New Kuroda	6.06^{b}	14.19^{ab}	21.63^{a}	22.77^{a}	5.59^{b}	10.86^{b}	13.59^{b}	12.90^{b}
Nepa Dream	7.47^{a}	14.87^{a}	20.01^{b}	22.81^{a}	6.97^{a}	11.06^{a}	12.53^{b}	12.37^{b}
SK3	6.37^{b}	12.97^{ab}	18.22^{c}	18.62^{c}	6.00^{b}	9.70^{b}	10.90^{c}	11.93^{b}
Taki	6.38^{b}	13.56^{b}	20.03^{b}	21.03^{b}	6.27^{ab}	11.02^{a}	15.21^{a}	15.30^{a}
SEM (±)	0.21	0.43	0.49	0.58	0.29	0.34	0.46	0.66
F-test	**	*	**	**	*	*	**	*
$LSD_{0.05}$	0.62	1.26	1.45	1.71	0.85	0.98	1.36	1.93
CV (%)	9.70	9.30	7.40	8.10	14.10	9.50	10.70	15.10
Grand mean	6.57	13.90	20.03	21.56	6.21	10.67	13.06	13.13

Means with same letter in column are not significantly different at p = 0.05 by DMRT. *significant at 5% ($p < 0.05$) and **significant at 1% ($p < 0.01$) at 5% ($p > 0.05$). SEM = Standard error of mean, LSD = Least significant difference, CV = Coefficient of variation and DAS = Days after sowing

Number of Leaves Per Plant

The effect of the sowing date on the number of leaves per plant was significant at all the growth stages of carrot as displayed in Table 4. At 40 DAS, significantly higher number of leaves per plant was recorded with first sowing (5.19). At 60 DAS, significantly higher number of leaves per plant was recorded with the first sowing (7.97) whereas significantly lower number of leaves (5.63) was noticed with the third

sowing (8th December). Similarly, at 80 DAS significantly higher number of leaves per plant was recorded in the first sowing (9.81) which was statistically at par with the second sowing (9.53). Likewise, at harvest, significantly higher number of leaves per plant was recorded with the first sowing (12.06) whereas the lower number of leaves was recorded with the third sowing (9.87) which was statistically similar with the second sowing (10.49).

The effect of varieties on the number of leaves per plant was non-significant at 40 DAS. At 60 DAS, the maximum number of leaves was recorded in Taki (7.40) being statistically at par with Nepa Dream (7.03) whereas a minimum number of leaves (6.37) was recorded in SK3. Similarly, at 80 DAS maximum number of leaves was recorded in Taki (9.74) being statistically at par with New Kuroda (9.45). Likewise, at harvest, maximum number of plants was recorded in Taki (11.65) being statistically similar to New Kuroda (11.40) and Nepa Dream (10.80).

Table 4

Effect of Sowing Date and Varieties on the Number of Leaves per Plant of Carrot

Treatments	Number of leaves per plant			
	40 DAS	60 DAS	80 DAS	At harvest
Factor A (Sowing date)				
19th October	5.19[a]	7.97[a]	9.81[a]	12.06[a]
13th November	3.72[b]	7.17[b]	9.53[a]	10.49[b]
8th December	2.58[c]	5.63[c]	8.50[b]	9.87[b]
SEM (±)	0.07	0.10	0.18	0.29
F-test	**	**	**	**
$LSD_{0.05}$	0.21	0.30	0.53	0.87
Factor B (Variety)				
New Kuroda	3.74	6.90[b]	9.45[a]	11.40[a]
Nepa Dream	3.94	7.03[a]	9.17[ab]	10.80[a]
SK3	3.76	6.37[c]	8.76[b]	9.38[b]
Taki	3.87	7.40[a]	9.74[a]	11.65[a]
SEM (±)	0.08	0.11	0.20	0.34
F-test	Ns	**	*	**
$LSD_{0.05}$		0.34	0.61	1.00
CV (%)	6.60	5.10	6.70	9.50
Grand mean	3.83	6.92	9.29	10.80

Means with same letter in column are not significantly different at p = 0.05 by DMRT. *significant at 5% (p < 0.05), **significant at 1% (p < 0.01) and ns: not significantly different at 5% (p > 0.05). SEM = Standard error of mean, LSD = Least significant difference, CV = Coefficient of variation and DAS = Days after sowing

Interaction effects of sowing date and variety on the number of leaves were non-significant at 40 DAS and at harvest as displayed in Table 5. At 60 DAS, a significantly higher number of leaves was recorded in variety Taki (8.70) with first sowing (19th October). Similarly, at 80 DAS, a significantly higher number of leaves was recorded in Taki (10.43) with the first sowing (19th October).

Table 5

Interaction Effect of Sowing Date and Varieties on the Number of Leaves per Plant of Carrot

Interaction effect of sowing date and variety	Number of leaves per plant			
	40 DAS	60 DAS	80 DAS	At harvest
19th October × New Kuroda	5.20	8.23^{ab}	10.23^{ab}	13.33
19th October × Nepa Dream	5.43	8.06^{b}	9.83^{abc}	9.28
19th October × SK3	5.16	6.90^{c}	8.76^{cde}	12.33
19th October× Taki	4.10	8.70^{a}	10.43^{a}	13.31
13th November × New Kuroda	3.56	7.00^{c}	8.76^{cdef}	10.33
13th November × Nepa Dream	3.53	6.86^{c}	9.53^{abc}	9.33
13th November × SK3	3.70	7.40^{c}	10.06^{ab}	10.94
13th November × Taki	2.70	7.43^{c}	9.76^{abc}	11.33
8th December × New Kuroda	2.46	5.46^{de}	9.36^{abc}	10.52
8th December × Nepa Dream	2.70	5.63^{de}	8.00^{defg}	9.53
8th December × SK3	2.60	5.36^{e}	7.63^{eg}	9.12
8th December × Taki	2.56	6.06^{d}	9.03^{bcd}	10.30
SEM (±)	0.14	0.20	0.36	0.59
F-test	Ns	*	*	Ns
$LSD_{0.05}$	-	0.60	1.06	-

Means with same letter in column are not significantly different at p = 0.05 by DMRT. *significant at 5% (p < 0.05), **significant at 1% (p < 0.01) and ns: not significantly different at 5% (p > 0.05). SEM = Standard error of mean, LSD = Least significant difference, CV = Coefficient of variation, DAS= Days after sowing

Edible Root Length

The result showed that there was a significant effect of sowing dates and varieties on edible root length (Table 6). Maximum root length (16.23 cm) was observed under the first sowing (19th October). The minimum edible root length (11.35 cm) was observed on the third sowing (8th December).

Similarly, a significantly longer root was recorded in Nepa Dream (15.37 cm), followed by New Kuroda (13.83 cm) and whereas a significantly shorter root was recorded in SK3 (12.64 cm)

Root Diameter

Root diameter differed significantly at $p<0.01$ among the different sowing dates and varieties as displayed in Table 6. At the first sowing (19th October), a significantly higher root diameter (3.27 cm) was recorded whereas a significantly lower root diameter (1.87 cm) was recorded at the third sowing (8th December).

Table 6

Effect of Sowing Date and Varieties on Root Length and Root Diameter of Carrot

Treatments	Root length (cm)	Root diameter (cm)
Factor A (Sowing date)		
19th October	16.23[a]	3.27[a]
13th November	14.02[b]	2.38[b]
8th December	11.35[c]	1.87[c]
SEM (±)	0.15	0.03
F-test	**	**
$LSD_{0.05}$	0.46	0.09
Factor B (Variety)		
New Kuroda	13.83[b]	2.46[b]
Nepa Dream	15.37[a]	2.74[a]
SK3	12.64[c]	2.35[c]
Taki	13.61[b]	2.49[b]
SEM (±)	0.18	0.03
F-test	**	**
$LSD_{0.05}$	0.54	0.11
CV (%)	4.50	4.50
Grand mean	13.86	2.51

Means with same letter in column are not significantly different at p = 0.05 by DMRT. *significant at 5% ($p < 0.05$) and **significant at 1% ($p < 0.01$) at 5% ($p > 0.05$). SEM = Standard error of mean, LSD = Least significant difference and CV = Coefficient of variation

Significantly higher root diameter (2.74 cm) was recorded in Nepa Dream. Significantly lower root diameter (2.35 cm) was recorded in SK3.

Fresh Root Weight per Plant

The result showed fresh root weight differed significantly at $p<0.01$ among the different sowing dates and varieties (Table 7). At the first sowing (19th October), a significantly higher fresh root weight (162.60 g) was recorded whereas a significantly lower fresh root weight (103.30 g) was recorded in the third sowing (8th December).

A significantly higher fresh root weight (133.50 g) was recorded in Nepa Dream. A significantly lower fresh root weight (124.30 g) was recorded in SK3.

Fresh Leaf Weight per Plant

Fresh leaf weight differed significantly at $p<0.01$ among the different sowing dates and varieties (Table 7). At first sowing (19th October), a significantly higher fresh leaf weight (66.24 g) was recorded. It was followed by the second sowing (37.83 g) which was statistically at par with the third sowing (32.81 g).

Significantly higher fresh leaf weight (54.54 g) was recorded in SK3 followed by New Kuroda (47.84 g) which was statistically at par with Taki (45.62 g). Significantly lower fresh leaf weight (34.51 g) was recorded in Nepa Dream.

Root-to-shoot ratio

Root to shoot ratio of the carrots at harvest differed significantly at $p<0.01$ among the different sowing dates and varieties as displayed in Table 7. At first sowing (19th October), a significantly higher root to shoot ratio (3.40) was recorded. A significantly lower ratio (2.58) was recorded in the third sowing (8th December).

A significantly higher root to shoot ratio (4.07) was recorded in Nepa Dream followed by Taki (3.04) which was statistically similar to New Kuroda (2.81).

Table 7

Effect of Sowing date and Varieties on Yield Parameters per Plant of Carrot

Treatments	Yield parameter per plant		
	Root weight (g)	Leaf weight (g)	Root to shoot ratio
Factor A (Sowing date)			
19th October	162.60[a]	66.24[a]	3.40[a]
13th November	121.40[b]	37.83[b]	3.23[a]

8th December	103.30[c]	32.81[b]	2.58[b]
SEM (±)	1.83	1.85	0.11
F-tesR	**	**	**
$LSD_{0.05}$	5.38	5.43	0.35
Factor B (Variety)			
New Kuroda	129.10[ab]	47.84[b]	2.81[b]
Nepa Dream	133.50[a]	34.51[c]	4.07[a]
SK3	124.30[b]	54.54[a]	2.35[c]
Taki	129.50[ab]	45.62[b]	3.04[b]
SEM (±)	2.12	2.14	0.13
F-test	*	**	**
$LSD_{0.05}$	6.21	6.27	0.40
CV (%)	4.90	14.10	13.50
Grand mean	129.10	45.60	3.07

Means with same letter in column are not significantly different at p = 0.05 by DMRT. *significant at 5% ($p < 0.05$) and **significant at 1% ($p < 0.01$) at 5% ($p > 0.05$). SEM = Standard error of mean, LSD = Least significant difference and CV = Coefficient of variation

Yield

The yield of the carrots at harvest time is influenced by the sowing date and varieties as displayed in Table 8. At the first sowing (19th October), a significantly higher biological yield (44.82 mt/ha) was recorded and a lower biological yield (26.07 mt/ha) was recorded at the third sowing (8th December). Similarly, a significantly higher economic yield (34.27 mt/ha) was recorded in the first sowing (19th October) and a low economic yield (19.28 mt/ha) was recorded in the third sowing (8th December).

Biological yield and economic yield differed significantly at $p<0.01$ among the different varieties. A significantly high biological yield (36.71 mt/ha) was recorded in Nepa Dream and a lower biological yield (30 mt/ha) was recorded in SK3.

Table 8

Effect of Sowing date and Varieties on Yield of Carrot

Treatments	Yield (mt/ha)	
	Biological	Economic
Factor A (Sowing date)		
19th October	44.82[a]	34.27[a]
13th November	29.48[b]	21.87[b]
8th December	26.07[c]	19.28[c]
SEM (±)	1.07	0.73
F-test	**	**
$LSD_{0.05}$	3.16	2.14
Factor B (Variety)		
New Kuroda	32.77[bc]	24.34[b]
Nepa Dream	36.71[a]	29.67[a]
SK3	30.00[c]	20.58[c]
Taki	34.35[ab]	25.97[b]
SEM (±)	1.24	0.84
F-test	*	**
$LSD_{0.05}$	3.65	2.48
CV (%)	11.20	10.10
Grand mean	33.46	25.14

Means with same letter in column are not significantly different at p = 0.05 by DMRT. *significant at 5% ($p < 0.05$) and **significant at 1% ($p < 0.01$) at 5% ($p > 0.05$). SEM = Standard error of mean, LSD = Least significant difference and CV = Coefficient of variation

Discussion

Effect of Sowing date on Growth Parameters

The results in Table 1 revealed that there was a significant influence of the sowing date on days to germination. Seed sown on 19th October took fewer days to germinate whereas delayed sowing took more days to germinate. This variation in germination might be due to environmental conditions, especially temperature. This result *is per* the finding of Sumrah *et al.,* (2003) in Beet root, Lavanya et al. (2014) in radish.

The results in Table 2 explained that there was a significant influence of different sowing dates on plant height. A significantly taller plant was obtained in the

first sowing (19th October). There was a decrease in plant height from 19th October to 8th December. The increase in plant height in early sowing might be due to optimum environmental conditions, especially temperature. This result is similar to the finding of Sahu et al. (2018) who observed a higher plant height (32.26 cm) when the seed was sown on 25th October. Similar results were reported by Sumrah et al. (2013) in Beet root.

The result in Table 3 revealed that there was a significant influence of different sowing dates on leaf length as well as on leaf breadth at all the growth stages. Significantly longer and wider leaves were obtained in the first sowing (19th October) whereas leaf length and breadth decreased thereafter. This result *is per* the finding of Ali et al. (2016) who reported that increase in leaf length (46.4 cm) and leaf width (1 cm) when seeds were sown on 26th October in Onion. A similar result was reported by Ebrahim et al. (2013) in radish.

The result in Table 4 revealed that there was a significant influence of different sowing dates on the number of leaves per plant. A significantly higher number of leaves per plant was obtained at first sowing (19th October) and the number of leaves per plant decreased at later sowing. The variation in a number of leaves per plant as affected by the sowing date might be due to variations in environmental conditions during the growing period (Kabir et al., 2013) and also this result is following the finding of Sahu et al. (2010) in radish.

Effect of Varieties on Growth Parameters

The results in Table 1 revealed that there was a significant influence of variety on days taken to germination. The germination in Nepa Dream was earlier than the other varieties. The variation in germination might be due to varieties responding differently to environmental factors based on genetic makeup and their adaptation ability (Kabir et al., 2013). This result is following the finding of Verma (2014).

There was an increase in plant height with the advancement of the growth period, variety Nepa Dream recorded a significantly taller plant height at all stages of growth whereas a significantly shorter plant height was recorded in SK3. The difference in plant height might be due to the genetic makeup of varieties. This result is following the finding of Latha et al. (2011) in carrot and Malek et al. (2011) in radishes which reported a significant influence of varieties on plant height.

The result revealed a significant effect of varieties on leaf length and leaf breadth (Table 3). Variety Nepa Dream recorded significantly longer and wider leaves than other varieties. The differences in the leaf length and leaf breadth among the varieties might be due to the differences in their genetic traits. Similar results were reported by Alam et al. (2010) and Ibrahim et al. (2013) in radish.

The effect of varieties on the number of leaves per plant was significant (Table 4). Variety Nepa Dream at 60 DAS and Taki at 80 DAS and harvest time recorded a significantly higher number of leaves per plant compared to other varieties. The difference in the number of leaves might be due to varieties responding differently to environmental factors based on genetic makeup and their adaptation ability Kabir et al. (2013). This finding is in accordance with Pervez et al. (2003) in radish and Amur et al. (2019) in radish.

Combined Effect of Sowing date and Variety on Growth Parameters

The combined effect of sowing date and varieties indicated a non-significant influence on plant height, days to germination, canopy diameter, leaf length and breadth.

Interaction effects of the date of sowing and variety on the number of leaves were significant at 60 DAS and 80 DAS. The significantly higher number of leaves was recorded in Taki with the first sowing (19th October) whereas a significantly lower number of leaves was noted in SK3 with the third sowing (13th November). This result is following the finding of Ebrahim et al. (2013) in radish.

Effect of Sowing date on Yield and Yield Parameters

The results presented in Table 7 revealed that there was a significant influence of sowing date on the edible root length of carrot. The first sowing (19th October) was significantly superior over other sowing dates in terms of edible root length. This might be due to favorable conditions available during the growing conditions and also early sowing possibly attributed to maximum photosynthesis with a longer growth periods than the later sowing (Ladumor et al. 2020). The present result conforms with the finding of Dhaiya et al. (2007) and Latha et al. (2012) on carrot.

Similarly, the results presented in Table 7 indicated that there was a significant influence of the sowing date on the root diameter of carrot. The first sowing (19th

October) was significantly superior in root diameter of carrot over another date. The rapid increase in the root diameter of carrot might be due to more vegetative growth in earlier sowing which supply more photosynthates from leaf to root (Ladumor et al., 2020). A similar finding was reported by Latha et al. (2014) in carrot.

Leaf fresh weight is one of the most important yield contributing parameters that indicates the leafage of the plant. The leafage, in turn, indicates the size of the photosynthetic system. Significantly highest fresh leaf weight of carrot was obtained on 19th October and the lowest fresh leaf weight was obtained on 8th December.

Early sowing resulted in higher fresh root weight because of the congenial growing conditions leading to a higher volume of root (Laudmor et. al., 2020). This result is per the finding of Kabir et al. (2013) in carrot. A significantly higher root-to-shoot ratio was obtained on 19th October whereas a lower root-to-shoot ratio was obtained on 8th December. This conforms with the finding of Arora et al. (1969) and Madhavi Latha et al. (2015) on carrot.

The result presented in Table 8 indicated that there was a significant influence of the sowing date on yield. The significantly higher biological as well as economic yield in first sowing (19th October) might be due to better plant stand and favorable environmental conditions for growth and development of root as well as leaf (Lavanya et al. 2014). The similar findings had been reported by Dhaiya et al. (2007), Latha et al. (2014) and Ladumor et al. (2020) in carrot.

Effect of Varieties on Yield and yield Parameters

The result revealed that there was a significant effect of varieties on edible root length, root diameter, root weight as well as root-to-shoot ratio (Table 7 and Table 8). Variety Nepa Dream recorded significantly longer edible root lengths and wider root diameters than other varieties. This difference might be due to genetic composition in the expression of growth potentials. Similar variation in root length and diameter among the varieties was reported by Latha et al. (2014) and Lauumor et al. (2020) in carrot.

Significantly higher root weight was recorded in Nepa Dream followed by Taki and New Kuroda. Higher root length and diameter might have resulted in higher fresh root weight. Similar findings were reported by Pervez et al. (2003) and

Ladumor et al. (2020) in carrot and Ebrahim et al. (2013) in radish. A significantly higher root-to-shoot ratio was obtained in Nepa Dream and this might be due to the high fresh root weight. This result conforms with the finding of Arora et al. (1969) and Verma (2014) in radish.

The result presented in Table 8 revealed that there was a significant influence of varieties on yield. Nepa Dream was significantly superior in terms of biological as well as economic yield. This varietal difference is attributed due to the growth and potential genetic makeup of the variety (Latha et. al., 2014). This result is following the finding of Pervez et al. (2003) and Ladumor et al. (2020) in carrot.

Combined Effect of Sowing date and Variety on Yield and Yield Parameters

Combined effects of sowing date and varieties revealed a non-significant influence on edible root length, root diameter, and fresh root weight as well as root to shoot ratio of carrot. Similarly, combined effects of sowing date and varieties had a non-significant influence on biological as well as economic yield. Lath et al. (2014) studies the effect of various sowing dates on the growth and yield of carrot variety where no significant interaction of sowing date and variety on yield parameters was noted. Similar results were observed by Al-Harbi et al. (1997) in carrot.

Conclusion

Seed sown on 19th October produced higher vegetative growth as compared to other sowing dates. As the root yield is directly related to plant growth. Seed sowing on 19th October produced high root length, root diameter and economic yield than other sowing dates. Root yield was decreased from 34.27 mt/ha to 19.28 mt/ha as the sowing date was delayed from 19th October to 8th December (43.74 % yield decreased). Root qualities were in decreasing trend when seeds were sown from 19th October to 8th December.

Among varieties, the performance of Nepa Dream was found to be superior in terms of growth, yield and quality parameters followed by Taki, New Kuroda and SK3. The combined effect of sowing date and varieties was significant only with the number of leaves per plant, cortex diameter and core-to-cortex ratio.

Thus, the exploitation of Nepa Dream in further yield trials will contribute to the national carrot breeding programs of Nepal.

References

Ahmad, T.A. (2012). Socio-economic study of carrot cultivation at farm level in the Punjab province of Pakistan. *African Journal of Agricultural Research, 7*(6), 867-875

Alam, M. K., Farooque, A. M., Nuruzzaman, M., & Jamal, U. (2010). Effects of sowing time on growth and yield of three radish (*Raphanus sativus* L.) varieties. *Bangladesh Research Publication*, *3*(3), 998-1006.

AL-Harbi, A. R., Alsadon, A. A., & Khalil, S. O. (1997). Influence of planting date upon growth and objective component of two carrot varieties grown in Riyad region of Saudi Arabia. *Journal of the Saudi Society of Agricultural Sciences, 9*(2), 257-266.

Bose, T. K., Som, M. G., & Kabir, J. (1999). *Vegetable crops*. Naya prokash. BidhanSarani, Culcutta.

Bose, T. K., Som, M. G., & Kabir, J. (1993). *Vegetable Crops*. Naya Prokash. 206 BidhanSarani, Culcutta, India. pp. 492-493.

Dahiya, M. S., Yadav, Y. C., Singh, Y. P., & Malik, Y. S. (2007). Effects of time and method of sowing on root quality of carrot cv. Hissar Garlic. *Haryana Journal of Horticultural Sciences, 36*(3 & 4), 377-378.

Ebrahim, M., Hassandokht, M. R., & Payvast, G. H. (2013). Effects of sowing dates on some quantitative and qualitative traits of three landraces of black radish. *Advances in Environment Biosciences,7* (1), 136-140.

Kabir, A., Ali, A., Waliullah, M. H., Rahman, M. M. U., & Rashid, A. (2013). Effect of spacing and sowing time on growth and yield of carrot (*Daucus carrota* L.). *International Journal of Sustainable Agriculture*, *5*, 29-36.

Kabir, J., Sen, H., Bhattacharya, N., Panda, P. K., & Bose, T. K. (2000). Production technology of vegetable crops. In *Tropical Horticulture* (vol. 2nd, ed).

Krishi Diary, 2079. Ministry of Agriculture and Livestock Development, GON, Hariharbhawan, Lalitpur.

Ladmor, R. G., Nandre, B. M., Sharma, M. K., Wankhade, V. R., & Joshi, P. C. (2020). Performance of different varieties of carrot with respect to yield, quality and chemical compositions under varying sowing times. *International Journal Current Microbiology, APP. Sci., 9*(2), 126-132.

Latha, M., Reddy, S., & Reddy, V. (2015). Influence of sowing dates on growth and yield of carrot. *Annals of Plant Soil Research, 17*, 35-37.

Latha, P. M., Reddy, S. S., Vani, S., & Reddy, R. (2012). Studies on the effect of sowing dates on growth and root yield of certain carrot varieties. *Agriculture: Towards a New paradigm of Sustainbility,* 116-119.

Lavanya, A. V. N., Sudha Vani, V., Syam Reddy, P., & Chaitanya, K. (2014). Root yield of radish as affected by sowing dates and spacing. *Plant Archives, 14*(1), 615-18.

Malek, M.A., Mohammed, D., Sikdar, M., & Rahman, M.S. (2011). Effects of variety and growing condition on yield and quality of carrot seed. *Journal of Environmental Science Natural Resources, 5*(2), 301-306.

MoALD. (2021). *Statistical Information on Nepalese Agriculture 2020/21.* Singha Durbar, Kathmandu: GON, Ministry of Agricultural Development.

Pinapati, P. (2015). Effect of dates of sowing and cultivars on growth, yield, and quality of beet root (*Beta Vulgaris* L.). *Krishikosh*, 57-58.

Prevez, M. A., Ayyub, C. M., Iqbal, M. Z., & Saleem, B. A. (2003). Growth and yield response of various radish varieties under Faisalabad conditions. *Pakistan Journal of Life and Social Sciences, 1*(2), 155-157.

Sahu, G., Singh, V. K., & Singh, T. (2018). Effects of sowing dates and plant spacing on growth and yield of radish. *Journal of Pharmacognosy and Phytochemistry,* 546-548.

Sumarah, M. A., Bakhsha, A., & Ahmad, S. (2018). Effects of sowing time on growth behavior of beet root in sub-mountainous climatic conditions. *Asian Journal of Plant Sciences, 2*(3), 354-357.

Sumrah, M.A., Bakhash, A., & Ahmand, S. (2003). Effects of sowing time on growth behavior of beer root in sub mountainous climatic conditions. *Asian Journal of Plant Science, 2*(3), 354-57.

Verma, L. R. (2014). *Varietal evaluation of radish on different sowing methods.* LAP Lambert Academic Publishing.

Zhang, D., & Hamauzu, Y. (2004). Phenolic compounds and their antioxidant properties in different tissues of carrots (*Daucus carota* L.). *Journal Food Agriculture Environment*, 2, 95-100.