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Growth, Yield Attributes and Yield of *rabi* Fennel (*Foeniculum vulgare* Mill.) as Influenced by Different Time of Sowing, Variety and Spacing

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A B S T R A C T

A field experiment was conducted on loamy sand soil at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during *rabi* 2015-16 to study the effect of sowing time (3rd week of October, 1st week of November and 3rd week of November), variety (Gujarat Fennel-2, Gujarat Fennel-11 and Gujarat Fennel-12) and spacing (45 cm and 60 cm) on growth, yield attributes and yield of *rabi* fennel. The experiment evaluated in split plot design with four replications by keeping time of sowing as main plot and combination of variety and spacing as sub plots. The result showed that the crop sown in 3rd week of October (D_1) recorded significantly superior growth parameters, yield attributes and highest seed yield (1423 kg ha^{-1}) and stover yield (4080 kg ha^{-1}). While, variety GF-12 (V_3) noticed higher values of growth parameters, yield attributes and maximum seed yield (1411 kg ha^{-1}) and stover yield (4030 kg ha^{-1}). Similarly, superior growth parameters, yield attributing characters and seed yield (1346 kg ha^{-1}) and stover yield (3914 kg ha^{-1}) were registered with 45 cm (S_1) row spacing as compared to wider row spacing *i.e.* 60 cm (S_2). The harvest index was not remarkably influenced by different times of sowing and spacing but marked effect of various verities on harvest index was recorded. This study revealed that higher growth, yield attributes and yield can be achieved by sowing the fennel variety GF-12 during 3rd week of October at 45 cm row spacing under North Gujarat Agro-climatic condition.

Introduction

Seed spices are known as an integral part of Indian culture that's why India is known as home of spices. India is the world's largest producer, consumer and exporter of seed spices. Gujarat and Rajasthan together contribute more than 80 per cent of the total seed spices production in the country and thus, both the states together are known as

"Seed Spices Bowl" of India. Fennel (*Foeniculum vulgare* Mill.) commonly known as variyali or saunf is native of Mediterranean countries and belonging to the family of Apiaceae. Gujarat alone account for more than 90 per cent of the fennel production in the country. The area, production and productivity of fennel in India during 2014-15 were 54,000 hectares, 70,000 metric tonnes and 1296 kg ha^{-1}, respectively (Anon, 2015a). Gujarat produced 63,845 tonnes from 30,200 ha area with average productivity of 2114 kg ha^{-1} (Anon, 2015b). Gujarat ranks first in average productivity not only in India, but at international level also. India earned Rs. 132 crores through export of fennel during 2015, which was 599 per cent higher than 2001 (Anon, 2015c). The leaves and seeds are useful for digestion and control the cough, flatulence, colic, thirst, constipation, dysentery and diarrhea (Randhawa *et al.*, 1978). The main constituents of fennel oil are anethole and fenchone (Singh *et al.*, 1990).

Fennel is a cold weather crop and comes up well under dry and cold climate. It is cultivated mainly as transplanted crop in India. Selection of superior variety having resistance to biotic and abiotic stresses plays an important role for enhancing the crop yield. Optimum plant geometry being non-monetary inputs exhibits dominant in increasing the yield of fennel crop. A wider spacing increased photosynthetic area along with availability of more sunlight and minimize the competition within the crop plants for nutrient, air and water, but reduced plant population. Time of sowing is an important factor to decide growth and production. Adjustment in sowing time creates favourable environmental condition for better performance of all physiological processes in plant and for escaping from pest and diseases which provides great opportunity to maximize the production. Very meager information is available on optimum time of sowing, variety and spacing in fennel. Therefore, the investigation was conducted with an objective to find out suitable variety, optimum time of sowing and spacing for realizing higher growth and yield of *rabi* fennel. So the present study was conducted to study the effect of sowing time, variety and spacing on growth, yield attributes and yield of *rabi* fennel.

Materials and Methods

A field experiment was conducted at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during *rabi* season at the year 2015-16 to study the "effect of sowing time, variety and spacing on growth, yield attributes and yield of *rabi* fennel". Eighteen treatment combinations comprising of three sowing times *i.e.,* 3rd week of October, 1st week of November and 3rd week of November, three varieties *viz.,* Gujarat Fennel-2, Gujarat Fennel-11 and Gujarat Fennel-12 as well as two spacings *viz.,* 45 cm and 60 cm were evaluated in split plot design with four replications by keeping time of sowing as main plot and combination of variety and spacing as sub plots.

Geographically, Sardarkrushinagar is situated at 24°/19' North latitude and 72°/19' East longitude with an elevation of 154.52 meters above mean sea level. The climate type of this area is sub-tropical. The soil of experimental plot was loamy sand in texture (Sand-84.02%, Silt-5.56% and Clay-9.07%), neutral in pH (7.0), low in organic carbon (0.17 %), and available nitrogen (159 kg ha^{-1}), medium in available phosphorus (39 kg ha^{-1}) and potash (274 kg ha^{-1}) content. Whereas, EC (0.09 dS m^{-1}) was very low showing that the soil was free from salinity hazard. International Pipette method, Piper, 1966 for physical properties, Schofield method (Jackson, 1973) for EC,

Potentiometric method (Jackson, 1973) for soil pH, Walkley and Black's method (Jackson, 1973) for organic carbon, Alkaline Potassium Permanganate method (Jackson, 1973) for available nitrogen, Olsen's method (Olsen *et al.,* 1954) for available phosphorus, Flame Photometer method (Jackson, 1973) for available potash.

The crop was fertilized with recommended dose of fertilizer *i.e.* 90 kg N and 30 kg P_2O_5 per hectare. As per treatments, the required quantity of seeds of fennel varieties *viz*., GF-2, GF-11 and GF-12 were taken by keeping uniform seed rate of 5 kg per hectare. To save the crop from disease *viz*., Rumularia blight and pest *viz.,* Aphid during the life cycle of crop, adequate and timely plant protection measures were taken by spraying recommended fungicide, *i.e.* Dithane-M-45 (0.2 %) and pesticide *i.e.* Dimethoate (0.03 %) in the field. The five plants were selected from each plot for recording various growth and yield attributes. The harvesting of rows of net plot was done manually. Harvest index was calculated by using the formula given by Donald and Hamblin (1962). The net plot wise yield was recorded and converted in kg per hectare. The statistical analysis of data for each characters studied in the experiment was carried out as per design of the experiment and simple correlation coefficient ('r') of each character was calculated.

Results and Discussion

Effect of time of sowing

The data presented in Table 1 revealed that plant height at 30, 60, 90 as well as 120 DAS and at harvest was significantly influenced by different time of sowing. The crop sown 3rd week of October (D_1) recorded significantly higher plant height of 11.46, 47.02, 127.56, 145.15 and 155.68 cm at 30, 60, 90, 120 DAS and at harvest, respectively over late sowing *i.e.* 3rd week of November (D_3), while it was found at par with treatment D_2 (1st week of November). Whereas, plant population was not significantly affected due to different sowing times. At harvest, the tallest plants were found under the early sown crop *i.e.* 3rd week of October (D_1) which were 2.9 and 10.0 per cent higher over late sown crop *i.e.* 1st week of November (D_2) and 3rd week of November (D_3), respectively. Prevalence of favourable climatic condition throughout the crop season under early sowing might have increased vegetative growth in terms of plant height. The dwarfest plants under late sown crop could be due to early start of reproductive growth and unfavourable climatic condition during all the growth stages. The results are in full agreement with those of Mohan *et al.,* (2001), Singh *et al.,* (2005), Ayub *et al.,* (2008), Soleimani *et al.,* (2011) and Sharangi and Roychowdhury (2014).

The results in (Table 2) revealed that the significantly maximum number of primary (6.82), secondary (6.43) and tertiary (5.03) branches per plant, days to 50 per cent flowering (110.92), number of umbels per plant (20.39) and number of umbellates per umbel (19.78) were recorded under early sowing *i.e.* 3rd week of October (D_1) and was at par with treatment D_2 (1st week of November) over late sowing *i.e.* 3rd week of November (D_3). As compared to late sown crop *i.e.* 3rd week of November (D_3), percentage increase in number of umbels per plant and umbellates per umbel 7.3 and 6.0 with 1st week of November sowing (D_2) and 16.3 and 12.0 with 3rd week of October (D_1), respectively. Similar kind of reports resulted by Patel (2000), Singh *et al.,* (2005), Singh *et al.,* (2006) and Selim *et al.,* (2013). Due to favourable climatic conditions and availability of more sunshine hours for vegetative growth might have helped to increase number of branches per plant and

matched properly with its growth stages thereby production of more photosynthates as well as its translocation to the sites.

The data presented in Table 3 revealed that number of seeds per umbellate, seed yield per plant as well as seed and stover yields were significantly influenced by different time of sowing. The significantly maximum number of seeds per umbellate (20.53), seed yield per plant (26.10 g), seed yield (1423 kg ha^{-1}) and stover yield (4080 kg ha^{-1}) recorded under early sown crop. *i.e.* 3rd week of October (D_1) over late sowing *i.e.* 3rd week of November (D_3) and it was found at par with treatment D_2 (1st week of November). Whereas, harvest index was not significantly affected due to different sowing times. Percentage increase in seed and stover yield with early sowing *i.e.* 3rd week of October (D_1) was 7.7 and 31.8 per cent and 2.1 and 21.2 over late sowings D_2 (1st week of November) and D_3 (3rd week of November), respectively. Favourable climatic condition throughout the crop season under early sown crop and availability of more sunshine hours for vegetative growth might have production of more photosynthates as well as its translocation to the sites enhanced growth and yield attributing characters which showed significantly positive correlation with seed and stover yield. Delay sowing suppressed the initial vegetative growth and ultimately poor reproductive growth. Moreover, increase in temperature at latter stage brought forced for early maturity in late sown crop consequently reduced seed yield. These results are with line of work reported by Singh *et al.,* (2005), Ayub *et al.,* (2008), Singh *et al.,* (2009), Bagari *et al.,* (2010) and Meena *et al.,* (2015).

Effect of variety

The results in (Table 1) revealed that the plant height at 30, 60, 90 as well as 120 DAS and at harvest was significantly influenced by different varieties. The significantly higher plant height was observed with variety GF-12 (V_3) at 30 (11.05 cm), 60 (46.12 cm), 90 (128.80 cm), 120 (143.38 cm) DAS as well as at harvest (153.16 cm) over GF-2. Whereas, plant height at 30, 90 120 and at harvest were statistically at par with GF-11. But varieties could not exhibit any influence on plant population at initial and at harvest. Cultivar GF 12 (V_3) measured 3.5 and 8.4, 3.0 and 6.5, 4.6 and 9.6, 3.6 and 5.9 as well as 2.7 and 4.8 per cent taller plants over GF-11 (V_2) and GF-2 (V_1) at 30, 60, 90 and 120 DAS as well as harvest, respectively. Inherent characteristic of particular variety plays a vital role on growth and development of crop which might be responsible for plant growth in terms of plant height. These findings are in close agreement with those of Malik *et al.,* (2009), Singh *et al.,* (2009) and Sengupta *et al.,* (2014).

The data presented in Table 2 revealed that number of branches per plant, days to 50 per cent flowering, number of umbels per plant and number of umbellates per umbel were significantly influenced by different varieties. The significantly maximum number of primary (6.78), secondary (6.35) and tertiary (4.97) branches per plant and days to 50 per cent flowering (111.08), number of umbels per plant (20.42) and number of umbellates per umbel (20.62) were observed under GF-12 over GF-2. Whereas, days to 50 per cent flowering was statistically at par with GF-11. As compared to GF-2 (V_1), cultivar GF-11 (V_2) and GF-12 (V_3) recorded 5.7 and 15.6 as well as 12.2 and 20.2 per cent higher number of umbels per plant and number of umbellates per umbel, respectively. The higher yield attributes recorded under GF-12 (V_3) might be due to genetic potential of particular variety. Similar results were observed by Singh *et al.,* (2003), Malik *et al.,* (2009) and Sengupta *et al.,* (2014).

The different varieties significantly influenced the number of seeds per umbellate, seed yield per plant, harvest index as well as seed and stover yields (Table 3) and revealed that the significantly maximum number of seeds per umbellate (20.75), number of seed yield per plant (26.12 g), harvest index (25.89 %) as well as seed (1411 kg ha^{-1}) and stover (4030 kg ha^{-1}) yields over GF-2. While, stover yields were statistically at par with GF-11. The maximum seed and stover yield secured with GF-12 (V_3) was 10.9 and 23.9 as well as 4.4 and 13.4 per cent higher over GF-11 (V_2) and GF-2 (V_1), respectively. Taller plants with more number of branches per plant were observed under GF-12 (V_3) and GF-11 (V_2) is contributed to genetic setup of particular variety, which could have increased stover yield of that cultivar. Better vegetative and reproductive growth of GF-12 is attributed to inherent build up and thereby produced higher seed yield. These findings are in close agreement with those of Malik *et al.,* (2009), Singh *et al.,* (2009), Meena and Singh (2013) and Sengupta *et al.,* (2014).

Effect of spacing

The data presented in Table 1 revealed that the significantly higher plant population (324.65) and plant height at 60 (45.75 cm), 90 (126.50 cm), 120 (141.27 cm) DAS and at harvest (151.89) were recorded with 45 cm (S_1) row spacing as compared to wider row spacing *i.e.* 60 cm (S_2).

Plant height at 30 DAS was not differed remarkably due to different spacings. Per cent increase in plant height with 45 cm (S_1) were 4.7, 5.6, 3.3 and 3.3 at 60, 90, 120 DAS and harvest, respectively over wider row spacing of 60 cm. This might be due to availability of comparatively less space for each plant which increased the competition for light within the plants. The results are in agreement with those reported by Patel (2000), Amin *et al.,* (2005) and Mehta *et al.,* (2011).

The different spacings significantly influenced the number of branches per plant, number of umbels per plant and number of umbellates per umbel (Table 2) and revealed that the significantly maximum number of primary (6.46), secondary (5.89), tertiary (4.78) branches per plant, days to 50 per cent flowering (107.92), number of umbels per plant (19.63) and number of umbellates per umbel (19.09) were recorded with 45 cm (S_1) row spacing as compared to wider row spacing *i.e.* 60 cm (S_2). Inter row spacings did not cause any positive or negative effect on days to 50 per cent flowering.

As compared to 60 cm row spacing (S_2), the percentage rise in umbels per plant and umbellates per umbel with 45 cm row spacing (S_1) were 7.9 and 4.0, respectively. Optimum space available for individual plants *i.e.* 45 cm (S_1) might have resulted in better utilization of resources *viz.,* space, nutrients, moisture, carbon dioxide and radiant energy to improve vegetative growth in terms of number of branches per plant and consequently reproductive growth. These findings are corroborate with the results of Patel (2000), Yadav *et al.,* (2000), Singh (2001), Amin *et al.,* (2005), Singh *et al.,* (2009) and Bhuva *et al.,* (2017).

The results in (Table 3) revealed the significantly maximum number of seeds per umbellate (19.87), seed yield per plant (24.92 g) as well as seed (1346 kg ha^{-1}) and stover (3914 kg ha^{-1}) yields were recorded with 45 cm (S_1) row spacing as compared to wider row spacing *i.e.* 60 cm (S_2).

Harvest index was not differed remarkably due to different spacings. The increase in seed and stover yield due to sowing of crop at 45 cm apart (S_1) was 11.9 and 5.4 per cent, respectively than wider row spacing of 60 cm (S_2).

Table.1 Effect of sowing time, variety and spacing on growth parameters of *rabi* fennel

Treatments	Plant population		Plant height (cm)				
	Initial	At harvest	30 DAS	60 DAS	90 DAS	120 DAS	At harvest
Times of sowing (D)							
D_1:3rd week of October	284.18	274.80	11.46	47.02	127.56	145.15	155.68
D_2: 1st week of November	274.88	266.70	10.71	45.10	126.65	140.19	151.18
D_3: 3rd week of November	275.45	265.87	9.74	42.02	115.06	131.68	141.44
S.Em.±	7.20	7.07	0.29	1.06	3.00	2.97	3.11
C.D. at 5%	NS	NS	1.00	3.65	10.37	10.28	10.76
C.V. %	12.67	12.86	13.38	11.57	11.93	10.46	10.19
Varieties (V)							
V_1: GF 2	276.58	263.87	10.19	43.28	117.44	135.28	146.09
V_2: GF 11	277.87	270.83	10.67	44.74	123.03	138.36	149.05
V_3: GF 12	280.06	272.67	11.05	46.12	128.80	143.38	153.16
S.Em.±	4.93	5.99	0.22	0.71	2.06	1.89	1.58
C.D. at 5 %	NS	NS	0.62	2.04	5.86	5.39	4.50
Spacings (S)							
S_1: 45 cm	324.65	312.16	10.87	45.75	126.50	141.27	151.89
S_2: 60 cm	231.69	226.09	10.39	43.67	119.68	136.74	146.99
S.Em.±	4.03	4.89	0.18	0.58	1.68	1.54	1.29
C.D. at 5%	11.47	13.94	NS	1.66	4.78	4.40	3.67
Sig. interaction	-	-	-	-	-	-	D × S
C.V. %	8.69	10.91	10.04	7.82	8.18	6.66	5.17

Table.2 Effect of sowing time, variety and spacing on growth and yield parameters of *rabi* fennel

Treatments	Number of branches per plant			Days to 50 per cent flowering	Number of umbels per plant	Number of umbellates per umbel
	Primary	Secondary	Tertiary			
Times of sowing (D)						
D_1: 3rd week of October	6.82	6.43	5.03	110.92	20.39	19.78
D_2: 1st week of November	6.32	5.90	4.73	109.38	18.81	18.71
D_3: 3rd week of November	5.74	4.88	4.25	102.46	17.53	17.65
S.Em.±	0.16	0.16	0.10	1.98	0.52	0.41
C.D. at 5%	0.54	0.57	0.33	6.87	1.80	1.43
C.V. %	12.22	13.99	10.12	9.04	13.46	10.85
Varieties (V)						
V_1: GF 2	5.98	5.25	4.41	104.71	17.65	17.15
V_2: GF 11	6.12	5.62	4.64	106.96	18.66	18.37
V_3: GF 12	6.78	6.35	4.97	111.08	20.42	20.62
S.Em.±	0.14	0.12	0.07	1.55	0.37	0.29
C.D. at 5 %	0.39	0.34	0.21	4.43	1.06	0.83
Spacings (S)						
S_1: 45 cm	6.46	5.89	4.78	107.92	19.63	19.09
S_2: 60 cm	6.12	5.59	4.57	107.25	18.19	18.34
S.Em.±	0.11	0.10	0.06	1.27	0.30	0.24
C.D. at 5%	0.31	0.27	0.17	NS	0.87	0.68
Sig. interaction	D × S	D × V	-	-	D × S	-
C.V. %	10.54	10.07	7.57	7.07	9.63	7.62

Table.3 Effect of sowing time, variety and spacing on yield parameters and yield of *rabi* fennel

Treatments	Number of seeds per umbellate	Seed yield per plant (g)	Harvest index (%)	Yield (kg ha^{-1})	
				Seed	Stover
Times of sowing (D)					
D_1: 3rd week of October	20.53	26.10	25.79	1423	4080
D_2: 1st week of November	19.68	24.09	24.85	1321	3996
D_3: 3rd week of November	18.14	22.26	24.31	1079	3365
S.Em.±	0.44	0.67	0.52	33	105
C.D. at 5%	1.53	2.33	NS	115	362
C.V. %	11.15	13.68	10.24	12.82	13.45
Varieties (V)					
V_1: GF 2	18.33	22.33	24.24	1138	3552
V_2: GF 11	19.28	24.00	24.83	1272	3860
V_3: GF 12	20.75	26.12	25.89	1411	4030
S.Em.±	0.33	0.54	0.46	25	71
C.D. at 5 %	0.94	1.54	1.32	72.36	202
Spacings (S)					
S_1: 45 cm	19.87	24.92	25.52	1346	3914
S_2: 60 cm	19.03	23.38	24.45	1202	3713
S.Em.±	0.27	0.44	0.38	21	58
C.D. at 5%	0.76	1.26	NS	59.08	165
Sig. interaction	-	D × S	-	D × S	D × S
C.V. %	8.27	10.95	9.08	9.76	9.10

Table.4 Interaction effect of time of sowing and variety (D x V)

Treatments	Secondary branches per plant		
Spacings (S)	**V_1: GF 2**	**V_2: GF 11**	**V_3: GF 12**
Times of sowing (D)			
D_1: 3rd week of October	5.43	6.35	7.51
D_2: 1st week of November	5.60	5.63	6.48
D_3: 3rd week of November	4.71	4.88	5.05
S.Em.±	0.17		
C.D. at 5%	0.48		
C.V. %	10.07		

Table.5 Interaction effect of time of sowing and spacing (D x S)

Treatments	Plant height at harvest (cm)		Primary branches per plant		Number of umbels per plant	
Spacings (S)	**S_1: 45 cm**	**S_2: 60 cm**	**S_1: 45 cm**	**S_2: 60 cm**	**S_1: 45 cm**	**S_2: 60 cm**
Times of sowing (D)						
D_1: 3rd week of October	157.73	153.64	6.88	6.76	20.61	20.18
D_2: 1st week of November	156.90	145.46	6.78	5.85	20.31	17.31
D_3: 3rd week of November	141.03	141.86	5.72	5.76	17.96	17.10
S Em±	2.73		0.19		0.64	
C.D. at 5%	7.79		0.55		1.84	
C.V. %	5.17		10.54		9.63	

Table.6 Interaction effect of time of sowing and spacing (D x S)

Treatments	Seed yield per plant (g)		Seed yield (kg ha^{-1})		Stover yield (kg ha^{-1})	
Spacings (S)	**S_1: 45 cm**	**S_2: 60 cm**	**S_1: 45 cm**	**S_2: 60 cm**	**S_1: 45 cm**	**S_2: 60 cm**
Times of sowing (D)						
D_1: 3rd week of October	28.30	23.91	1549	1296	4318	3842
D_2: 1st week of November	23.78	24.40	1377	1265	4085	3907
D_3: 3rd week of November	22.69	21.83	1111	1046	3339	3390
S.Em.±	0.94		43.96		122.70	
C.D. at 5%	2.67		125		349.82	
C.V. %	10.95		9.76		9.10	

Table.7 The values of correlation coefficient 'r' between seed yield and growth as well as yield attributing characters

Sr. No.	Characters	'r'
1.	Plant height	0.8625**
2.	Number of primary branches per plant	0.8029**
3.	Number of secondary branches per plant	0.9034**
4.	Number of tertiary branches per plant	0.8776**
5.	Number of umbels per plant	0.7709**
6.	Number of umbellates per umbel	0.8152**
7.	Number of seeds per umbellate	0.8264**
8.	Seed yield per plant	0.8819**

* = Significant at 5 per cent level
** = Significant at 1 per cent level

Optimum availability of space with adequate number of plants per unit area under 45 cm row spacing (S_1) increased growth and yield which showed significant positive correlation with seed and stover yield. These findings are in conformity with results reported by Patel (2000), Singh (2001), Yadav and Khurana (2000), Amin *et al.,* (2005) and Singh *et al.,* (2009).

Interaction effect of sowing time and variety (D x V)

Interaction effect between time of sowing and variety was found significant for number of secondary branches per plant (Table 4). The significantly maximum number of secondary branches (7.51) per plant were recorded when GF 12 sown early *i.e.* 3rd week of October (D_1V_3). Whereas, it was the minimum (4.71) with variety GF 2 grown on 3rd week of November (D_3V_1). Particular variety got favourable climatic condition may exploit better vegetative growth in terms of number of secondary branches per plant.

Interaction effect of sowing time and spacing (D x S)

Interaction effect between time of sowing and spacing was found significant for plant height at harvest, primary branches per plant, number of umbels per plant, seed yield per plant as well as seed yield and stover yield (Table 5 & 6). Significantly the highest plant height at harvest (157.73 cm), primary branches per plant (6.88), number of umbels per plant (20.61), seed yield per plant (28.30 g) as well as seed yield (1549 kg ha^{-1}) and stover yield (4318 kg ha^{-1}) were recorded when crop sown in 3rd week of October keeping 45 cm row spacing (D_1S_1). Whereas in plant height at harvest, number of primary branches per plant and umbels per plant it was found statistically at par with treatment combinations of D_2S_1 and D_1S_2 but in stover yield it was found statistically at par with D_2S_1 only. Availability of optimum space and favourable climatic condition during vegetative growth period might have increased vegetative and reproductive growth. While, the favourable climatic condition with availability of optimum space for individual plants and optimum plants per unit area increased seed and stover yield. The results are fully supported by those of Mehta *et al.,* (1990), Patel (2000), Singh *et al.,* (2005), Singh *et al.,* (2006), Ayub *et al.,* (2008) and Selim *et al.,* (2013).

Correlation coefficient

The correlation coefficient ('r') between seed yield and growth as well as yield attributing character was worked out as per (Table 7). It was noticed that growth as well as yield attributing parameters *viz.* plant height at harvest, number of primary, secondary and tertiary branches per plant, number of umbels per plant, umbellates per umbel, seeds per umbellate, seed yield per plant showed positive significant correlation with seed yield.

On the basis of field experiment conducted at Sardarkrushinagar it is concluded that, higher growth and yield can be achieved by sowing the fennel variety GF 12 during 3rd week of October at 45 cm row spacing under North Gujarat Agro-climatic condition.

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