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EFFECTS OF TRANSPLANTING DATES ON VEGETATIVE GROWTH, YIELD AND HEAD QUALITY OF SOME BROCCOLI CULTIVARS IN EGYPT

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ABSTRACT

Two field experiments were conducted to study the effect of three transplanting dates, i.e., 1st October, 1st November and 1st December in the 1997-1998 season, and 1st September, 1st October and 1st November in the 1998-1999 season, on vegetative growth and head quality and yield of three broccoli cultivars; namely, $F_1$0175, Landmark and Sprouting Broccoli Create, under the conditions of Kalyoubeyia governorate. The results reveal that early planting increased number and weight of leaves per plant, stem diameter, average weight and diameter of the main head as well as head contents of ascorbic acid. The early transplanting prolonged the harvesting period, which led to an increase in the total yield of main and side heads. On the contrary, late transplanting on 1st November or 1st December increased the head contents of dry matter, total carbohydrates, total protein, nitrogen, potassium and phosphorus. The broccoli cultivars performed differently concerning the different physical and chemical characters under study.

INTRODUCTION

Broccoli (*Brassica olerace* L. group italica) is a very popular vegetable crop around the world, especially in USA and Europe. Besides its appreciable contents of thiamin, riboflavin, niacin, calcium, potassium, magnesum iron and protein, broccoli is fairly high in vitamin A and C and folic acid (Yamaguchi, 1983). It is a hardy, cool-season vegetable crop of the cruciferae family, which is closely related to cauliflower. Both crops are grown for clusters of unopened flower and their cultural requirements are similar. However, the temperature requirements for broccoli head formation are less stringent than those recommended for cauliflower curd formation (Wien and Wurr, 1997). Moreover, broccoli is harvested over a long period since the side shoots develop small marketable heads after the removal of the central head (Splittstoesser, 1979). Furthermore, broccoli cultivars vary in their vegetative growth, number of leaves per plant (Diputado and Nichols, 1989), harvesting time (Heij, 1989), head diameter and weight (Heji, 1989; Albarracin *et al.*, 1995; Guan *et al.*, 1995), number and weight of branch heads (Guan *et al.*, 1995), total yield (Albarracin *et al.*, 1995; Esiyok, 1996), head chemical contents of ascorbic acid (Lisiewska, 1987; Schonhof and Krumbein, 1996), chlorophyll and carotenoids (Hidaka *et al.*, 1992; Schonhof and Krumbein, 1996; Schreiner *et al.*, 1998), total protein (Lisiewska, 1987) and total sugars (Schonhof and Krumbein, 1996).

Planting date has a remarkable effect on the vegetative growth, head characters and chemical contents of both broccoli and cauliflower heads. In

this respect, it is noticed that summer cauliflower cultivars produce 20-25 leaves at low temperature, whereas this number rises to 40 and 80 leaves at 10°C and 22°C, respectivly (Hasani *et al.*, 1987). The low temperature of late planting reduces the yield of broccoli, and may cause floral initiation at a younger physiological age. Plants, therefore, develop heads before reaching full size and the heads are small and take a long time to reach maturity (Chung and Strickland, 1986). In Egypt, transplanting broccoli on 15th September produced larger head, and higher primary and secondary total yield compared with its transplanting on 15th of October (Esmail, 1997). Nevertheless, very high temperatures increase foliage development, delay flower head formation and reduce head quality (Hasani *et al.*, 1987), average head weight (Moel, 1992) and lower both the primary and secondary total head yield (Esmail, 1997).

Whereas the time to head initiation appeares to be dependent on a heat unit summation above 1°C, the rate of head growth is related to a heat unit summation above 3°C (Diputado and Nichols, 1989).

Although broccoli has exceptional health benefits (ADA, 1992) it is not yet a popular crop in Egypt and is grown in a very limited area. Thus, because of the lack in preharvest information, this work was done to study the effects of transplanting dates of three broccoli cultivars on vegetative growth, yield, head quality and maturity.

MATERIALS AND METHODS

Three broccoli cultivars, namely, $F_1$0175 (Royal Sluis Co., Holland), Landmark (Takii Co., Japan), and Sprouting Broccoli Create (Sakata Co., Japan), were transplanted at Kaha experimental station- Kalyoubeyia, Horticulture Research Institute, Agriculture Research Center, on the 1st of October, 1st of November and 1st of December 1997, and on the 1st of September, 1st of October and 1st of November 1998. The plants were grown in rows of 4 meters long and 70 cms width each. Within each row, the distances between the plants were 40 cms. The experiment was conducted using three replicates in a split-plot design. The three transplanting dates were represented in the main plots, whereas the three cultivars were randomly arranged in the sub-plots. The sub-plot consisted of 7 rows and its surface area was 20 m^2. The following characters were investigated.

Vegetative growth characters. Weight and number of leaves / plant, leaf length and stem diameter, weight and length were measured on 15 plants / plot and data were recorded.

Central head formation and yield. Number of days from transplanting to 50% anthesis, from anthesis to formation of central head, from transplanting to harvesting of the central head and from transplanting to flowering as well as harvesting period and early yield (i.e., weight of first harvested heads) and total yield of central heads were registered on all plants in each mid 5 rows / plot.

Central head physical characters. Weight and diameter of the main central head were recorded on 15 plants / plot.

Side head characters. Plants of 3 rows / plot were left to produce side heads after removal of the central heads. Thereafter, number, average weight and diameter of side heads, as well as total yield of side heads / plant were recorded.

Total yield. Total yield of central and side heads / feddan was recorded.

Chemical contents of central head. Chemical contents of central head were determined at harvest on 3 heads / plot. These traits include total chlorophyll, (Ranganna, 1979), ascorbic acid (Ranganna, 1979), total carbohydrates (Dubois *et al.*, 1956), total protein and nitrogen (Koch and McMeekin, 1924), phosphorus (Jacksan, 1958) and potassium (Rowe, 1973).

The maximum and minimum temperatures in the first season (1997-1998) were 29.5°C and 15.6°C in October, 25.8°C and 13.1°C in November, 20.0°C and 8.4°C in December, 18.7°C and 7.3°C in January, 20.2°C and 8.3°C in February and 21.4°C and 8.0°C in March, respectively. Whereas, in the second season (1998-1999), the tempretures were 37.1°C and 22.5°C in September, 32.0°C and 18.3°C in October, 26.6°C and 15.2°C in November, 21.5°C and 11.4°C in December, 20.9°C and 8.7°C in January and 20 6°C and 8.4°C in February, respectively.

Statistical Analysis: The experiment was a split-plot design with three replicates. The data were tabulated and analyzed for statistical significant differences using the LSD test at 0.05 level of significance, according to Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

Vegetative growth. The present study demonstrate that the transplanting date has a remarkable effect on the vegetative growth of broccoli plants (Table 1). Early planting, which induced increments in the number and weight of leaves / plant and increased stem weight, revealed the importance of relatively high temperature during the vegetative growth phase. In Albania, temperature during the first and second week after planting was critical for head development of cauliflower (Hasani *et al.*, 1987).

Although the highest value of stem diameter was achieved at the October planting in both seasons, the longest stems were recorded at the November planting in the first season, and at the September planting in the second season. Meanwhile, for Landmark and $F_1$0175, the longest leaves were recorded at the October planting in the first season, and at the September planting in the second season. On the other hand, for Sprouting Broccoli Create, the longest leaves were recorded at the November planting in the first season, and at the October planting in the second season.

Also, while the weight and length of leaves were higher for Landmark than $F_1$0175, both cultivars produced comparable numbers of leaves per plant (Table 1). The diameter and length of stems of landmark and $F_1$0175 were also similar in both seasons. On the other hand, the plants of Sprouting Broccoli Create were the shortest of the 3 studied cultivars, and produced the lowest weight and number of leaves (Table 1). A similar study demonstrated that broccoli cultivars varied in the number of leaves per plant (Diputado and Nichols, 1989).

Table 1: Effects of transplanting dates on vegetative growth of broccoli cultivars.

Cultivars	Transplanting dates	Leaves weight (g)/plant	Leaves number / plant	Leaf length (cm)	Stem weight (g)	Stem diameter (cm)	Stem length (cm)
	Season 1997 - 1998						
F_1 0175	1/10	953.47	19.00	49.03	310.89	3.78	25.67
	1/11	513.40	18.23	45.90	203.94	3.63	25.78
	1/12	570.94	15.60	46.63	209.64	2.40	23.47
	Mean	679.27	17.61	47.19	241.49	3.27	24.97
Landmark	1/10	1130.53	20.83	54.20	368.53	3.78	26.45
	1/11	954.00	17.50	53.13	261.12	3.28	25.78
	1/12	806.83	16.33	49.21	176.30	2.40	23.47
	Mean	963.79	18.22	52.18	268.68	3.15	25.23
Sprouting Broccoli Create	1/10	525.07	12.86	24.13	138.11	2.42	15.49
	1/11	527.99	14.30	35.70	171.19	2.73	22.47
	1/12	166.52	12.93	16.40	81.13	1.80	20.33
	Mean	406.53	13.36	25.41	130.14	2.32	19.43
Average	1/10	869.69	17.56	42.45	272.54	3.33	22.54
	1/11	665.13	16.68	44.91	212.08	3.21	24.68
	1/12	514.76	14.95	37.41	155.69	2.20	22.42
L.S.D. at 0.05 for	Date (D)	60.33	0.71	3.10	26.32	0.45	1.28
	Cvs. (C)	64.23	0.72	2.45	41.73	0.18	0.46
	(DxC)	111.30	1.25	4.24	72.29	0.31	0.80
	Season 1998 – 1999						
F_1 0175	1/9	1369.73	22.13	55.90	560.20	4.50	32.00
	1/10	514.87	15.53	48.70	342.23	4.56	22.50
	1/11	551.00	14.77	46.43	262.50	4.53	23.83
	Mean	811.87	17.48	50.34	388.31	4.53	26.11
Landmark	1/9	1271.23	20.00	57.63	373.66	4.50	27.00
	1/10	1234.80	16.53	55.53	359.03	4.73	26.43
	1/11	1054.63	19.40	58.17	353.35	4.33	25.67
	Mean	1186.69	18.64	57.11	362.01	4.52	26.37
Sprouting Broccoli Create	1/9	827.20	19.70	27.20	180.77	2.63	19.67
	1/10	537.77	15.00	44.33	138.73	3.60	17.60
	1/11	468.53	20.10	32.60	167.60	3.40	20.03
	Mean	611.17	18.27	34.71	162.37	3.21	19.10
Average	1/9	1156.05	20.61	46.91	371.54	3.88	26.22
	1/10	762.48	15.69	49.52	280.00	4.30	22.18
	1/11	691.39	18.09	45.73	261.15	4.09	23.18
L.S.D. at 0.05 for	Date (D)	54.70	1.28	1.28	5.49	0.29	0.69
	Cvs. (C)	61.45	1.32	1.30	9.37	0.17	0.62
	(DxC)	106.40	2.28	2.26	16.23	0.29	1.08

Central head formation, harvesting and flowering. The present study reveal that the October planting led to early appearance of the first bud of the main head (Table 2). The early appearance of the first bud in October, compared with other transplanting dates, may be atributed to the relationship between juvenility of broccoli plants and certain temperature and day length.

Table 2: Effects of transplanting dates on some characters of the central head of broccoli cultivars.

Cultivars	Trans planting dates	Days from transplanting to 50% antithesis	Days from antithesis of first bud to full formation	Days required for harvesting	Days from transplanting to flowering	harvesting periods (days)
	Season 1997 - 1998					
F1 0175	1/10	71.67	14.70	86.33	111.00	25.00
	1/11	77.67	13.30	91.00	100.33	10.00
	1/12	66.33	9.50	75.89	86.67	11.00
	Mean	71.89	12.50	84.41	99.33	15.33
Landmark	1/10	66.67	24.00	90.67	103.00	12.00
	1/11	80.67	18.70	99.33	110.67	11.00
	1/12	61.67	23.30	85.00	95.33	10.00
	Mean	69.67	22.00	91.67	103.00	11.00
Sprouting Broccoli Create	1/10	44.33	7.30	51.67	59.67	9.00
	1/11	62.00	11.70	73.67	82.33	10.00
	1/12	61.00	8.00	69.00	77.33	9.00
	Mean	55.78	9.00	64.78	73.11	9.33
Average	1/10	60.89	15.33	76.22	91.22	15.33
	1/11	73.45	14.57	88.00	97.78	10.33
	1/12	63.00	13.60	76.63	86.44	10.00
L.S.D. at 0.05 for	Date (D)	1.23	0.60	1.55	1.89	1.40
	cvs. (C)	1.68	1.10	1.22	1.55	2.00
	(DxC)	2.91	1.90	2.11	2.68	3.50
	Season 1998 - 1999					
F1 0175	1/9	72.67	19.30	92.00	118.33	26.00
	1/10	72.00	14.00	86.00	111.67	25.00
	1/11	76.33	8.00	84.33	98.67	14.00
	Mean	73.67	13.77	87.44	109.56	21.67
Landmark	1/9	71.67	24.30	96.00	107.00	11.00
	1/10	67.00	26.00	93.00	105.33	12.00
	1/11	78.00	21.70	99.67	113.00	13.00
	Mean	72.22	24.00	96.22	108.44	12.00
Sprouting Broccoli Create	1/9	59.33	8.00	67.33	78.67	11.00
	1/10	44.00	10.00	54.00	61.00	7.00
	1/11	61.50	9.80	71.33	80.33	9.00
	Mean	54.94	9.27	64.22	73.33	9.00
Average	1/9	67.89	17.20	85.11	101.33	16.00
	1/10	61.00	16.67	77.67	92.67	14.67
	1/11	71.94	13.17	85.11	97.33	12.00
L.S.D. at 0.05	Date (D)	1.66	2.10	3.20	1.19	1.80
	Cvs. (C)	1.79	2.40	2.07	1.51	1.80
	(DxC)	3.10	4.20	3.59	2.62	3.10

Also, except for Sprouting Broccoli Create, the period from anthesis of the first bud tc complete formation of the central head decreased with delaying planting date. Low temperature prevailing during head formation, speeded both formation and inflorescence initiation. According to (Wurr *et al.*, 1981), the duration and number of days of each phase is more or less influenced by the environmental conditions.

In contrast, with only few exceptions, the harvesting period was prolonged and head flowering was delayed with the early planting, due to prevalence of moderate temperature during head formation. Similar results indicated that the time of head formation is affected by various transplanting dates (Salter *et al.*, 1984; Chung, 1985 and Esmail, 1997). The low temperature may cause floral initiation at a younger physiological age (Chung and Strickland, 1986).

The $F_1$0175 was the latest cultivar in the anthesis of the first bud of the central head, where it needed 71.9 to 73.7 days. However, its heads have required a short time (12.5 to 13.8 days) to be harvested (Table 2). Its plants were harvested 84.4 to 87.4 days from transplanting. The number of days required for harvesting $F_1$0175 was a bit less than that for Landmark, but more than that for Sprouting Broccoli Create. On the other hand, the Landmark and $F_1$0175 heads flowered very late in the both seasons, compared with Sprouting Broccoli Create, which revealed the importance of the interaction between cultivars and the prevailing temperature on flowering of broccoli. Meanwhile, the harvesting period of the main head was significantly longer for $F_1$0175 than that of Landmark. On the contrary, Sprouting Broccoli Create required significantly less days for anthesis, full formation, harvesting and flowering of the main head. However, this cultivar was characterized by its very short harvesting period (Table 2). The present results are in agreement with those reported by Heij (1989), who observed variation in the harvesting time of different broccoli cultivars.

Central head physical characters and yield. The present results indicate that early transplanting on 1st September, followed by 1st October increased average weight and diameter of main heads and consequently, increased the total yield of broccoli heads as compared with transplanting on 1st November or 1st December (Table 3). It is concluded from the present results that broccoli plants favorite average temperatures range between 22.6°C and 25.2°C at the vegetative growth and between 14.2°C and 20.9°C to produce early and high yield of heads. The present results are in agreement with those of Esmail (1997) who found that transplanting broccoli in Egypt on 15th September produced large heads and high primary total yield as compared with transplanting on 15th August and October 1st and 15th. Similarly, in Louisiana, Bracy and Constantine (1991) reported that transplanting in early autumn produced greater head weight than transplanting during late October and November. Also, in Netherlands, Moel (1992) found that early planting on 30th May produced heads of 375 g average weight that was associated with high temperatures during harvesting. On the other hand, late transplanting on 30th July yielded average head weight of 572 g, which was attributed to the relatively low temperature during head formation and development.

Regarding early yield of main head, the data show that 1st of November transplanting increased early yield as compared with 1st of October in both seasons. Moreover, transplanting on 1st of September improved early yield over that of October, but its early yield was still lower than that obtained from transplanting on 1st of November.

Table 3: Effects of transplanting dates on some physical characters and yield of the central head of broccoli cultivars.

Cultivars	Transplanting dates	Fresh weight (g)	Diameter (cm)	Early yield (ton/fed)	yield (ton/fed)
	Season 1997 – 1998				
F1 0175	1/10	476.83	20.51	2.270	6.812
	1/11	371.97	20.40	2.649	5.314
	1/12	251.11	13.97	1.789	3.587
	Mean	366.64	18.29	2.236	5.237
Landmark	1/10	589.08	22.55	4.209	8.415
	1/11	657.91	18.17	4.706	9.398
	1/12	217.09	15.23	1.549	3.101
	Mean	488.03	18.65	3.488	6.971
Sprouting Broccoli Create	1/10	98.07	9.56	0.699	1.401
	1/11	43.99	8.68	0.309	0.628
	1/12	51.58	7.99	0.369	0.737
	Mean	64.55	8.74	0.459	0.922
Average	1/10	387.99	17.54	2.393	5.542
	1/11	357.96	15.75	2.555	5.113
	1/12	173.26	12.40	1.236	2.475
L.S.D. at 0.05 for	Date (D)	45.34	1.25	0.176	0.648
	cvs. (C)	55.73	0.64	0.192	0.796
	(DxC)	96.52	1.10	0.333	1.379
	Season 1998 – 1999				
F1 0175	1/9	536.73	23.17	2.559	7.667
	1/10	413.53	19.50	1.970	5.907
	1/11	337.27	16.83	2.409	4.818
	Mean	429.18	19.83	2.313	6.131
Landmark	1/9	588.83	22.60	4.209	8.411
	1/10	585.80	22.27	4.179	8.368
	1/11	603.93	22.17	4.309	8.627
	Mean	592.85	22.35	4.232	8.469
Sprouting Broccoli Create	1/9	45.53	8.50	0.330	0.650
	1/10	91.43	9.00	0.650	1.306
	1/11	87.43	9.17	0.619	1.249
	Mean	74.80	8.89	0.533	1.068
	1/9	390.36	18.09	2.366	5.576
	1/10	363.59	16.92	2.266	5.194
	1/11	342.88	16.06	2.446	4.898
L.S.D. at 0.05 for	Date (D)	10.95	0.43	0.041	0.156
	Cvs. (C)	38.14	0.70	0.113	0.545
	(DxC)	66.06	1.22	0.195	0.944

Concerning cultivars, Sprouting Broccoli Create produced the smallest heads, early and total yield of main heads. Meanwhile, the weight and diameter of the main head of $F_1$0175 were medium, but less than those of Landmark. Thus, it could be observed that Landmark was the superior cultivar concerning weight, diameter and yield of the main heads (Table 3). Similar results were reported by Heij (1989); Albarracin *et al.* (1995) and Guan *et al.* (1995), who recorded variations among broccoli cultivars in head diameter, weight and yield.

Side head physical characters, yield and total head yield. The results in Table 4 show that there was no constant effect for transplanting date on the size and number of side heads. In the first season, transplanting on 1st November led to producing the highest side heads yield, which was attributed to production of the largest size and highest number of side heads. Meanwhile, the yield of the $F_1$0175 side heads was significantly larger for transplanting at December 1st than at October 1st, and vice versa for Landmark. In the second season, it was clear that the earlier the transplanting date, the higher the side heads yield, in terms of total number and side heads size. Hence, the highest values of side head characters were recorded at September transplanting, followed by October and November.
Likewise, this trend was also observed on the total yield of main and side heads per feddan, where the highest total yield was recorded at October planting, followed by November and December, for $F_1$0175 and Sprouting Broccoli Create but not Landmark, in the first season, and at September planting, followed by 1st of October and 1st of November, for $F_1$0175 and Landmark but not Sprouting Broccoli Create, in the second season. The results of Esmail (1997) in this respect revealed that transplanting broccoli in Egypt on 15th September produced larger heads and higher secondary head yield as compared with transplanting on October 1st and 15th.

Concerning the effect of cultivars, the data show that Sprouting Broccoli Create did not produce any secondary heads after harvesting the main heads. These results may be attributed to the fact that it produced only a small central heads. On the other hand, average fresh weight of side heads of Landmark was significantly larger than that of $F_1$0175, which led also to greater yield of side heads / plant. Likewise, Landmark exceeded $F_1$0175 in the diameter and number of side heads / plant. However, the differences between the two cultivars regarding these two characters were mostly significant in the second season. Generally, the highest significant total head yield per feddan, i.e., main and side heads, was achieved by Landmark, followed by $F_1$0175 then, Sprouting Broccoli Create. The present results are in agreement with those reported by Guan *et al.* (1995) who recorded destinct variation among different broccoli cultivars in number of branch curd and average weight of branch heads.

Correlation among different characters. The results indicate that fresh weight, diameter of main head, and consequently the total yield of heads are correlated with all other morphological and physical characters, (Table 5). The present results are in harmony with those of Guan *et al.*(1995) who found a significant correlation between plant weight and head weight, and between leaf area / plant and head weight.

Chemical contents of central head.

The present results indicate that there was a significant effect for transplanting dates on the different contents of head. Late planting led to increment in head contents of dry matter, total carbohydrates, total protein, nitrogen, and phosphorus, in both seasons.

Table 4: Effects of transplanting dates on some physical characters of side heads and total yield of central and side heads of broccoli cultivars.

Cultivars	Transplanting dates	Fresh weight (g)	Diameter (cm)	Number / plant	Yield / plant	Total Yield (central+side) ton/fed
	Season 1997 – 1998					
F1 0175	1/10	19.20	5.80	6.30	120.83	8.538
	1/11	18.90	7.60	7.90	149.93	7.455
	1/12	22.70	6.00	6.70	153.66	5.782
	Mean	20.27	6.47	6.97	141.47	7.258
Landmark	1/10	22.20	6.60	6.30	141.55	10.437
	1/11	40.00	6.50	9.90	397.54	15.077
	1/12	22.70	7.20	4.90	113.75	4.726
	Mean	28.30	6.77	7.03	217.61	10.080
Sprouting Broccoli Create	1/10	-	-	-	-	1.401
	1/11	-	-	-	-	0.628
	1/12	-	-	-	-	0.737
	Mean	-	-	-	-	0.922
Average	1/10	20.70	6.20	6.30	131.19	6.792
	1/11	29.45	7.05	8.90	273.74	7.720
	1/12	22.70	6.60	5.80	133.71	3.748
L.S.D. at 0.05 for	Date (D)	4.60	NS	0.72	30.53	0.928
	Cvs. (C)	4.93	NS	NS	47.38	1.254
	(DxC)	12.19	NS	1.42	69.94	2.031
	Season 1998 – 1999					
F1 0175	1/9	38.50	6.70	9.30	297.90	11.923
	1/10	13.80	6.30	8.00	110.23	7.482
	1/11	16.90	5.30	7.00	119.83	6.530
	Mean	23.07	6.10	8.10	175.99	8.645
Landmark	1/9	23.50	7.70	12.70	359.43	13.546
	1/10	29.70	7.30	8.90	266.42	12.174
	1/11	26.30	7.20	7.30	192.70	11.380
	Mean	26.50	7.40	9.63	272.85	12 367
Sprouting Broccoli Create	1/9	-	-	-	-	0.650
	1/10	-	-	-	-	1.306
	1/11	-	-	-	-	1.249
	Mean	-	-	-	-	1.068
Average	1/9	31.00	7.20	11.00	328.67	8.706
	1/10	21.75	6.80	8 45	188.33	6.987
	1/11	21.60	6.25	7.15	156.27	6.386
L.S.D. at 0.05 for	Date (D)	0.41	0.86	1.23	28.94	0.502
	Cvs. (C)	1.87	0.36	1.40	49.52	1.068
	(DxC)	2.03	0.61	2.37	65.84	1.602

These results may be due to prevailing of low temperature during head formation, which encouraged the accumulation of carbohydrates, protein and potassium in the main head. Similar results were reported by Rosa *et al.* (1996) who found that low temperature during head formation increased these characters. On the other hand, early transplanting, i.e. September and October planting, increased ascorbic acid content. In this regard, Gamuzov (1989) reported that early planting gave the best results with regard to the chemical composition of the heads.

Table 5: Correlation between some physical characters of *broccoli cultivars*.

Characters	Leaves weight	Stem weight	Stem length	Leaves number	Leaf length	Stem diameter	Head weight	Head diameter	Time of bud appearance	Days for head formation	Time of flowering	Plant weight
Plant weight	0.96	0.93	0.75	0.65	0.87	0.69	0.93	0.92	0.65	0.83	0.83	-
Time of flowering	0.75	0.83	0.90	0.58	0.80	0.63	0.86	0.91	0 92	0.95	-	
Days for head formation	0.72	0.78	0.94	0.54	0.81	0.56	0.87	0.86	0.96	-		
Time of bud appearance	0.56	0.61	0.85	0.58	0.66	0.50	0.72	0.75	-			
Head diameter	0.82	0.88	0.84	0.53	0.85	0.65	0.94	-				
Head weight	0.82	0.83	0.82	0.47	0.85	0.56	-					
Stem diameter	0.70	0.72	0.52	0.82	0.71	-						
Leaf length	0.82	0.82	0.81	0.55	-							
Leaves number	0.72	0.60	0.47	-								
Stem length	0.66	0.74	-									
Stem weight	0.90	-										
Leaves weight	-											

According to the present results, there were significant differences among cultivars. Heads of Landmark had the highest contents of total carbohydrates, ascorbic acid, potassium and phosphorus, whereas those of Sprouting Broccoli Create contained the highest amount of dry matter, total protein and total nitrogen, in both seasons, in addition to total chlorophyll in the first season. Similar results were reported by Schreiner *et al.* (1998), who recorded differences in head contents of chlorophyll in different broccoli cultivars. Schonhof and Krumbein (1996) also found that the concentrations of ascorbic acid, sugars and chlorophyll differed significantly among broccoli types. Also, Kulikova (1981) found differences among cultivars in vitamins, dry matter, protein, potassium, magnesium and phosphorus contents.

Table 6: Effects of transplanting dates on some chemical characters of the central head of broccoli cultivars

Cultivars	Trans-planting dates	Total chloro-phyll (mg)	Ascorbic acid (mg)	Dry matter %	Total carbo-hydrates (g)	Total protein (g)	Nitro-gen (mg)	Phos-phorus %	Potass-ium %	Calcium %	Mag-nesium %
	Season 1997 – 1998										
F1 0175	1/10	30.67	111.65	15.39	12.20	32.56	5.20	0.18	1.66	0.50	0.41
	1/11	27.41	111.49	18.63	13.62	29.02	4.64	0.12	1.77	0.48	0.44
	1/12	29.61	106.62	16.08	16.31	31.63	5.06	0.10	1.86	0.53	0.40
	Mean	29.23	109.92	16.70	14.04	31.07	4.97	0.13	1.76	0.50	0.42
Landmark	1/10	24.15	115.69	16.53	13.69	34.08	5.45	0.14	1.72	0.51	0.44
	1/11	31.13	112.52	18.83	13.81	31.46	5.03	0.18	1.86	0.52	0.39
	1/12	25.35	113.00	16.20	16.47	25.54	4.08	0.12	1.92	0.48	0.37
	Mean	26.88	113.74	17.19	14.66	30.36	4.85	0.15	1.83	0.50	0.40
Sprouting Broccoli Create	1/10	24.28	108.17	18.74	12.12	37.21	5.95	0.09	2.02	0.48	0.39
	1/11	39.81	110.82	15.13	13.16	46.79	7.47	0.14	1.92	0.50	0.43
	1/12	34.51	106.47	23.80	15.41	26.51	4.24	0.16	1.45	0.48	0.36
	Mean	32.87	108.49	19.22	13.56	36.84	5.89	0.13	1.80	0.49	0.39
Average	1/10	26.37	111.84	16.89	12.67	34.62	5.53	0.14	1.80	0.50	0.41
	1/11	32.78	111.61	17.53	13.53	35.76	5.71	0.15	1.85	0.50	0.42
	1/12	29.82	108.70	18.69	16.06	27.89	4.46	0.13	1.74	0.50	0.38
L.S.D. at 0.05 for	Date (D)	0.11	1.13	0.79	1.02	0.23	0.04	N.S	0.03	N.S	N.S
	cvs. (C)	0.10	0.63	0.99	0.79	0.15	0.03	N.S	0.04	N.S	N.S
	(DxC)	0.17	1.09	1.72	1.37	0.26	0.06	0.06	0.06	N.S	N.S
	Season 1998 – 1999										
F1 0175	1/9	29.90	106.77	17.08	10.60	32.30	5.16	0.09	2.19	0.48	0.37
	1/10	30.62	108.11	14.14	13.37	33.09	5.29	0.18	1.67	0.49	0.41
	1/11	28.73	119.52	17.63	16.14	29.15	4.66	0.12	1.78	0.51	0.43
	Mean	29.75	111.47	16.28	13.37	31.51	5.04	0.13	1.88	0.49	0.40
Landmark	1/9	25.16	118.20	13.83	13.72	33.53	5.36	0.13	2.22	0.50	0.38
	1/10	25.68	111.84	11.65	13.67	34.34	5.49	0.16	1.68	0.52	0.43
	1/11	26.05	108.00	18.60	15.54	30.30	4.84	0.18	1.89	0.51	0.37
	Mean	25.63	112.68	14.69	14.31	32.72	5.23	0.16	1.93	0.51	0.39
Sprouting Broccoli Create	1/9	17.70	115.68	19.81	13.62	33.24	5.32	0.08	1.58	0.51	0.38
	1/10	18.33	110.13	19.06	13.19	36.14	5.78	0.10	2.03	0.53	0.38
	1/11	33.57	105.34	19.19	12.16	49.58	7.93	0.14	1.32	0.52	0.37
	Mean	23.20	110.38	19.35	12.99	39.65	6.34	0.11	1.64	0.52	0.38
Average	1/9	24.25	113.55	16.91	12.65	33.02	5.28	0.10	2.00	0.50	0.38
	1/10	24.88	110.03	14.95	13.41	34.52	5.52	0.15	1.79	0.51	0.41
	1/11	29.45	110.95	18.47	14.61	36.34	5.81	0.15	1.66	0.51	0.39
L.S.D. at 0.05 for	Date (D)	0.06	1.56	0.32	1.11	0.22	0.04	0.04	0.03	N.S	N.S
	cvs. (C)	0.06	1.27	0.45	1.16	0.13	0.03	0.04	0.04	N.S	N.S
	(DxC)	0.10	2.19	0.79	2.01	0.23	0.06	0.08	0.06	N.S	N.S

REFRENCES

American Dietetics Association (ADA) (1992). Handbook of Cilnical Dietetics Yale University Press,New Haven.

Albarracin, M.; C. Berbin and W. Machado (1995). Agronomic evaluation of broccoli cultivars. *Revista de la Facultad de Agronomia*, Universidud Central de Venezuela, 21: 71- 83.

Bracy, R. P. and R. J. Constantin (1991). Extending the production season of broccoli in southeast Louisiana Agriculture, 34:17-19.

Chung, B. (1985). The effect of sowing time and plant density on the once-over harvest yields of broccoli. Hort. Sci., 60: 57 – 64.

Chung, B. and H. L. Strickland (1986). Effect of sowing times on the once over harvest yield of broccoli in northwest Tasmania. Austratien Journal of Experimental Agriculture, 26: 497-500.

Diputado, M. T. Jr. and M. A. Nichols (1989). The effect of sowing date and cultivar on the maturity characters of broccoli. Acta Horticulturae, 247:59-66.

Dubois, M.; K. A. Gilles; J. K. Hailton; P. A. Rebers and F. Smith (1956). Colorimetric method for determination of sugars and related substances. Analytical Chemistry, 28: 350-356.

Esiyok, D. (1996). A study to determine suitable broccoli cultivars in Bornova region, Ege Universitesi Ziraat Fakultesi Dergisi 33: 55-62. Hort. Abst. 67: 372.

Esmail, A. A. M. (1997). Studies on growth, production and storage of broccoli. "*Brassica oleracea var. italica*" Ph.D. Thesis Department of Horticulture Faculty of Agriculture Al-Azhar University.

Gamuzov, G. Zh. (1989). Effect of planting date on productivity and chemical composition in the humid, subtropical of cauliflowers conditions of western Georgia. Instituta-Rastenievodstva-Imeni-N.I.-Vavilova., 188: 56-57.

Guan, P.; Y. Chen and X. Yang (1995). The observation of broccoli curd development characters with its breeding investigation. Acta Horticultura, 402: 194-199.

Hasani, A.; X. Islami and P. Pasko (1987). Study of sowing dates for early midseason and late cauliflower in the field. Buletini, i., Shkencave Bujgesore, 26 : 13-21.

Heij, G. (1989). Broccoli. A shorter duration of culture and once-over harvesting do not make the crop profitable Groenten en Fruit, 45: 42-43.

Hidaka, T.; N. Fukuda and K. Taniguchi (1992). Contents of lipids, fatty acids, carotenoids and chlorophylls in broccoli (*Brassica oleracea*, L. var. Italica Plen). Journal of the Japanese Society for food Science and Technology, 39: 425-428.

Jackson, M. L. (1958). "Soil chemical analysis" Contable, Co. LTD, London, England, pp. 498.

Koch, F. C. and T. L. McMeekin (1924). The chemical analysis of food and food products. J. Amer. Chem. Soc., 46: 2066.

Kulikova, N. T. (1981). Chemical composition of the heads of cauliflower in the polar region. Trudy Pola Prikladoni, Botanike, Genetike, I, Selektsii, 70: 102-108.

Lisiewska, Z. (1987). Characters of the chemical composition of the heads of 8 broccoli varieties. Acta Agraria et Silvestria, Agraria, 25. 209-220

Moel, C. D. E. (1992). Research on broccoli. Stem less brocooli (a new comer full of promise). Groentent fruit, Vollegrand-Sgroenten, 2:12-13

Ranganna, S. (1979). Manual of analysis of fruit and vegetable products. Central Food Technological Research Institute. Ph D. Published by Tata Mc Graw-Hil Publishing Company limited, 12/4 Asaf Ali Road, New Delhi 110002, and printed at Raj Bandhu Industrial Company, C-61, May a puri, phase 11, New Delhi 1100064.

Rosa, E.; D. Almeida; J. S. Dias; I. Crute and A. A. Monteiro (1996). The influence of growing season on protein and mineral content of several brassica crops. Acta Horticulturae., 40:261-268

Rowe, G. J. (1973). " Food analysis by atomic Absorption spectroscopy" Varian, Techtron. Australia, USA, Switzerland, pp.89.

Satler, P. D.; D. J. Andrews and J. M. Akehurst (1984). The effects of plant density spatial arrangement and sowing date on yield and read characters of a new form of broccoli. J. Hort. Sci., 59:79– 85.

Schonhof, I. and A. Kiumbein (1996). Content of essential substances of different broccoli (*Brassica oleracea*, L. var. Italica Plenck). types. Gartenbauwissenschaft, 61: 281-288. Hort. Abstr. 67:4006.

Schreiner, M.; I. Schonhof and A. Kiumbein (1998). New dimension in product quality – bioactive substances in vegetables. Gemuse (Munchen) 34: 80-84.

Snedecor, G.W. and W.G. Cochran (1989). Statistical methods, 8th Ed. Iowa State Univ. Press, Ames, Iowa, USA.

Splittstoesser, W. E. (1979). Vegetable Growing Handbook, AVI Publishing Company, INC. Westport, Connecticut, 166-168.

Wien, H. C. and D. C. E. Wurr (1997). Cauliflower, Broccoli, Cabbage and Brussels Sprouts. In. H.C. Wien (Ed.) The Physiology of Vegetable Crops. CAB International, New York, NY, 511-525

Wurr, D. C. E.; Y. Rosemar; E. J. Allen and J. E. Patel (1981). Studies of the growth and development of winter. Heading cauliflower, S. J. Agric. Sci. Camb., 97: 404 – 419.

Yamaguchi, M. (1983). World vegetables, principles, production and nutritive values. Ellis Horwood limited-Publishers, pp 415.

تأثيرات مواعيد الشتل على النمو الخضري والإنتاج والجودة لبعض أصناف البروكلي فى مصر

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اجريت تجربتان حقليتان تحت ظروف محافظة القليوبية لدراسة تأثير ثلاثة مواعيد للزراعة هي أول أكتوبر ، أول نوفمبر ، أول ديسمبر ، وذلك فى موسم ١٩٩٧-١٩٩٨ ، أول سبتمبر ، أول أكتوبر ، أول نوفمبر ، وذلك فى موسم ١٩٩٨-١٩٩٩ ، على النمو الخضري والإنتاج والجودة لثلاثة أصناف من البروكولي هي:

($F_1$0175 , Landmark , Sprouting Broccoli Create).

وقد أظهرت النتائج ما يلي:

- أدت الزراعة المبكرة إلي زيادة وزن وعدد الأوراق للنبات وكذلك قطر الساق ومتوسط وزن وقطر القرص الرئيسي والمحتوى من حامض الاسكوربيك.
- أدت الزراعة المبكرة أيضا إلى إطالة فترة الحصاد مما أدى إلى زيادة إنتاج الرؤوس الرئيسية والجانبية ، وعلى العكس أدت الزراعة المتأخرة فى أول نوفمبر وأول ديسمبر إلى زيادة محتوى القرص من المادة الجافة والكربوهيدرات الكلية والبروتين والنيتروجين والبوتاسيوم والفوسفور.
- وجدت اختلافات بين أصناف البروكولى تحت الدراسة فى الصفات الطبيعية والكيماوية.