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Effect of Sowing Dates and Number of Cuttings on Yield and Quality of Spinach (*Spinacia oleraceae* L.)

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ABSTRACT

Two field experiments were carried out in clay loam soil at Experimental farm, Baramon, Dakahlia Governorate during the two winter seasons of 2010/11 and 2011/12 to investigate the effect of four sowing dates (15 Oct., 1 Nov., 15 Nov. and 1 Dec.) and three harvesting patterns (without cutting C_0, one cutting C_1 and two cuttings C_2) as well as their interaction on yield and quality of spinach cv. Balady. The experiments were laid out in a split plot design with three replicates where sowing dates were the main factor and the number of cuttings was the secondary factor. The obtained results indicated that sowing date at mid October followed by first of November promoted vegetative growth characters, which showed a significant increase in plant height, number of leaves/plant and average leaf area. In addition, early sowing at mid October and first of November produced the greatest fresh foliage weight/plant, fresh yield and total fresh yield. Moreover, early sowing dates increased dry matter content in spinach leaves but showed the least values for total chlorophyll content. Harvesting spinach plants without cutting led to an increase in plant height and average leaf area, whereas the second cutting exhibited the largest number of leaves/plant. Harvesting plants without cutting showed the largest means of plant height, average leaf area, foliage fresh foliage weight/plant and fresh yield, while total fresh yield was increased by cutting spinach plants twice. The interaction between sowing dates and number of cuttings showed significant differences for all studied characters in both seasons of the study. Generally, it could be concluded that the suitable treatment to maximize spinach yield was sowing spinach at mid October or first of November and cut plants twice. Otherwise, delaying sowing date causes a reduction in vegetative growth and consequently total yield production

INTRODUCTION

Spinach (*Spinacia oleraceae* L.) is a cool season leafy crop that belongs to the family *Amaranthaceae* (APG II, 2003 ; Salk *et al*., 2008). It is a popular leafy crop in Egypt. The total area devoted for spinach in Egypt in 2013/2014 winter season was 3480 feddans and the total production was 24072 tons/fed., with an average yield of 6.917 ton/fed.(Bulletin of Agricultural statistics, 2015)

Spinach is well known for its nutritional value due to its high content of vitamins A, C, E, B6, B9, folic acid and minerals (Fe, Ca, Mg) and dietry fiber (Maeda *et al*, 2010). It is particularly distinguished for its high vitamin C content, minerals, especially Fe, riboflavin and its low calories. Moreover, it is one of the most important anti- oxidative vegetables and is one of the most highest oxygen radical absorbance capacity (Lomnitski *et al*. 2003; Cho *et al*. 2008)

The leaves are generally consumed after cooking or take part into food processing as a frozen product, canned or dried (Panda, 2013; Hui and Evranuz, 2015). It is usually consumed after boiling either fresh or frozen leaves.

There are several factors affect the growth and productivity of spinach plants. Environmental factors greatly affect plant growth and yield. Sowing date is an important factor that affects plant growth and production. It is related to environmental conditions e.g., temperature, day length, light intensity and humidity.

The suitable sowing date provides the optimum environmental conditions for spinach growing. Sowing at mid October exhibited the highest vegetative growth values and yield of spinach plants as compared to sowing at November. (Waseem and Nadeem, 2001; Ramadan, 2004; Ibrahim *et al*, 2010 and Sensoy *et al*., 2011). Delaying sowing date after October cause a decrease in spinach yield (Ramadan, 2004; Sensoy *et al*., 2011; Ibrahim *et al*., 2012). Plants subjected to long days especially coupled with high temperatures above 25º C induce bolting which reduce the production of spinach crop (Changoo *et al*. 2001; Hata *et al*, 2006). So, spring sowing encountered the problem of bolting which is detrimental to production of spinach.

The yield of spinach depends on vegetative growth. It may be expressed in terms of number of leaves, size and weight. For obtaining additional vegetative yield, repeated cuttings of plants are carried out so that new vegetative growth would occur. In this respect, Waseem *et al*. (2001) pointed out that the cuttings treatments showed significant difference for plant height, fresh and dried foliage yield, whereas the cuttings showed a non-significant behavior for number of leaves. First cutting gave the maximum number of leaves, fresh and dried foliage yield.

Waseem and Nadeem (2001) studied the effect of three cuttings on spinach. They reported that the third cutting showed the highest fresh and dried yield followed by second cutting and first cutting, respectively. Moreover, Awan *et al*. (2016) reported that the second cutting showed maximum plant height, fresh biomass (Kg/ha), and dried biomass.

In the same manner, the effect of frequent cuttings has been studied for spinach beet (*Beta vulgaris* L.). Bharad *et al*. (2013) proved that one cutting exhibited higher records rather than in two cuttings for plant height, leaf area and leaf chlorophyll, while three cuttings exhibited the least values. On the other hand, three cuttings exhibited the highest values for number of leaves/plant and total yield. Singh *et al*. (2015), on spinach beet, found that plant height was decreasing in second and third cuttings and the second cutting produced greater green leaf yield than the third and first cuttings, respectively.

The aim of the current investigation is to make the best use of unit area and maximize foliage yield of spinach. Therefore, the present study was carried out to investigate the effect of different planting dates and

frequency of cuttings on vegetative growth, yield and quality of spinach cv. Balady.

MATERIALS AND METHODS

This investigation was conducted in a clay loam soil at the experimental farm , Baramon, Dakahlia Governorate during the two winter seasons of 2010/11 and 2011/12 , using the spinach cv. Balady.

The monthly average maximum (Max.) and minimum (Min.) temperatures during the growth seasons of spinach plants are shown in Table (1)*:

Table 1. The maximum and minimum temperatures during 2010/11 and 2011/12 seasons.

Months	Air Temperature (°C)			
	2010/11		2011/12	
	Max.	Min.	Max.	Min.
October	29.3	20.4	28.2	19.4
November	25.9	13.3	25.4	13.5
December	22.5	10.5	20.1	11.5
January	19.8	10.2	17.6	10.2
February	20.5	11.4	20.2	12.1

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A split plot design based on randomized complete blocks with three replicates was used. Four sowing dates (15 Oct., 1 Nov., 15 Nov., and 1 Dec.) were assigned to main plots; whereas the sub-plots were devoted to three frequencies of cuttings (No cutting C_0, one cutting C_1 and two cuttings C_2). At the marketable stage, spinach plants, grown from seeding, were rooted up 50 days after sowing (without cutting C_0) or were cut 5 cm above the soil surface (one cutting C_1). Plant cutting was performed twice, so that the second cutting was carried out 25 days after the first cutting (two cuttings C_2).

Each experimental sub-plot consisted of four rows. Each row was 4 m long and 0.6 m width. The other common agricultural practices for spinach growing were followed according to the technical recommendations of Ministry of Agriculture.

At the marketable stage, ten plants from each experimental plot were randomly taken for recording data on plant height (cm), number of leaves/ plant, average leaf area (cm^2) according to method described by Koller, 1972, fresh foliage weight/plant (gm), fresh foliage weight/ plant (gm), dry matter content (%) , as well as total chlorophyll content according to AOAC (1990).

To estimate dry matter content, fresh leaves from each treatment were cut into slices then dried in an oven at 70º C until constant weight and the dried slices of leaves were weighted then the dry matter percentage was calculated as follow:

Dry matter content (%) = weight of dried leaves/weight of fresh leaves x 100.

After harvesting, fresh yield (ton/fed.) was determined from harvesting plot yield for each treatment, whereas total yield (ton/fed.) were obtained by summing the fresh yield of cuttings for plot; hereafter the total yield per feddan was calculated from yield of plots. Hence, the total yield for two cuttings is obtained by adding fresh yield of the second cutting C_2 to the fresh yield of the first cutting C_1, to gain the total yield for the two cuttings.

All obtained data were subjected to statistical analysis of variance (ANOVA), using split-plot design according to Gomez and Gomez, 1984. Comparison among means of treatments was made using LSD at 5% level of probability.

RESULTS AND DISCUSSION

1. Effect of sowing date

Vegetative characters

Results in Table 2 illustrate the effect of sowing date on plant height, number of leaves and average leaf area in 2010/11 and 2011/12 winter seasons. Sowing at 15 October significantly exhibited the highest mean values in both seasons for plant height, number of leaves per plant and average leaf area, whereas delaying sowing date after October decreased all studied vegetative characters. It is evident that the earlier sowing date at 15 October promotes vegetative growth when compared to delayed planting at November and December. The promoting effect of early planting on studied vegetative characters may be attributed to the favorable air temperature (Table 1), day length and light intensity prevailing during growth season. These findings were reinforced by by (Waseem *et al*, 2000; Waseem and Nadeem, 2001, Ramdan, 2004; Ibrahim *et al*., 2010 Sensoy *et al*., 2011; and Ibrahim *et al*, 2012).

Table 2. Effect of sowing dates and number of cuttings on vegetative characters of spinach plants in 2010/11 and 2011/12 seasons.

Treatment	Plant height (cm)		No. of leaves /plant		Leaf area (cm^2)	
	2010/11	2011/12	2010/11	2011/2012	2010/11	2011/12
15 Oct.	32.29	27.99	21.93	23.15	32.86	29.77
1 Nov.	29.49	27.08	20.57	21.42	29.69	31.19
15 Nov.	25.01	23.37	20.31	19.78	25.34	26.06
1 Dec.	22.17	22.29	19.79	21.68	24.49	22.58
LSD at 5%	0.82	0.48	0.63	1.02	0.54	0.98
C_0	31.29	28.26	19.36	20.04	29.45	32.62
C_1	28.69	27.70	19.59	20.65	28.75	28.75
C_2	21.75	19.83	22..92	23.76	25.42	24.43
LSD at 5%	0.93	0.39	0.49	0.38	0.61	0.18

Yield characters

Data in Table 3 demonstrate the presence of significant effects of sowing dates on yield characters. Data showed that the highest values for fresh foliage weight/plant in both seasons (159.73 and 153.42 gm.), fresh yield (5.92 and 5.46 ton/fed) and total fresh yield (8.32 and 7.45 ton/fed) were recorded when sowing at 15 October. Thus, sowing at mid October significantly produced greater total fresh yield followed by sowing at 1 November. These results may be ascribed to the favorable climatic condition existing during mid-October and 1 November as compared to 15 November and 1 December (Table 1). The relatively high temperature in October enhances vegetative growth when compared to lesser temperature in November and December. Meanwhile, sowing at 15 November and 1

December resulted in significant decrease in yield and its components characters in relation to earlier sowing dates. Several investigations confirmed that the earlier sowing dates produced larger fresh and total yields in comparison with late sowing dates. (Waseem *et al*., 2000; Ramadan, 2004; Ibrahim *et al*., 2010; Sensoy *et al*, 2011 and Ibrahim *et al*, 2012)

Table 3. Effect of sowing dates and number of cuttings on yield characters of spinach plants in 2010/11 and 2011/12 seasons.

Treatment	Fresh foliage weight/plant(gm)		Fresh yield (ton/fed.)		Total fresh yield (ton/fed.)	
	2010/11	2011/12	2010/11	2011/2012	2010/11	2011/12
15 Oct.	159.73	153.42	5.92	5.46	8.32	7.45
1 Nov.	154.74	144.90	5.65	5.12	7.99	7.02
15 Nov.	140.35	132.54	4.60	4.49	6.52	6.21
1 Dec.	131.19	129.21	4.09	3.95	5.82	5.35
LSD at 5%	0.72	1.24	0.73	0.74	1.08	0.78
C_0	157.70	148.03	6.58	6.03	6.58	6.03
C_1	154.56	144.52	6.34	5.64	6.34	5.76
C_2	127.30	127.34	2.27	2.51	8.59	7.94
LSD at 5%	1.42	0.42	0.24	0.39	0.07	0.41

Quality characters

As shown in Table 4, significant differences were detected between the various sowing dates for dry matter and total chlorophyll. These results reflect that dry matter content was greater when sowing at 15 October and 1 November in both seasons, whereas the total chlorophyll in spinach leaves exhibited the maximum values when sowing plants at 1 December (132.76 and 128.52) in the first and second seasons, respectively. The obtained data might be ascribed to the seasonal environmental conditions during growing season such as temperature, day length and light intensity. In this respect, Lefsrud *et al*. (2005) found that dry matter percentage in spinach leaves increased as the air temperatures increased from 10 to 20°C, while chlorophyll content in spinach plants decreases. On the other hand, Conte *et al*. (2008) proved that chlorophyll content in spinach leaves had slight changes due to variability in climatic conditions. These results are in agreement of those obtained by Ramdan, 2004; Ibrahim *et al*., 2010 and Ibrahim *et al*, 2012 who found that planting spinach at 15 October resulted in the highest dry matter percentage in leaves compared to sowing at 1 and 15 November.

2. Effect of number of cuttings

Vegetative characters

Effect of number of cuttings on vegetative growth characters e.g., plant height (cm), number of leaves/plant and average leaf area (cm^2) are presented in Table 2. It is obvious that the highest means for plant height were recorded when harvesting spinach plants without cutting C_0 (31.29 and 28.26 cm) or with one cutting C_1 (28.69 and 27.70 cm) in 2010/11 and 2011/12, respectively. Harvesting plants without cutting C_0 resulted in greater plant height as compared to harvesting by cutting plants one time C_1. This observation was due to that the whole plants were rooted up in the first treatment, whereas cutting plants resulted in cutting the base of plants above soil and declined the base length afterwards. The second cutting plants C_2 recorded significantly least means of plant height (21.75 and 19.83 cm) in both growing seasons. These results are in line of those reported by Waseem *et al*., 2001; Bharad *et al*., 2013 and Singh *et al*., 2016. In addition, the highest means for leaf area were resulted from harvesting plants without cutting C_0 (29.45 and 32.62 cm^2) in both seasons of the study. It is evident that leaf area decreased in the first cutting C_1 and in the second cutting C_2. On the other hand, the largest number of leaves per plant was recorded at the second cutting C_2 (22.92 and 23.76), which might be due to the pruning. Pruning encourages the development of side shoots, which resulted in increasing number of leaves/plant (Singh *et al*., 2015)

Table 4. Effect of sowing dates and number of cuttings on quality characters of spinach plants in 2010/11 and 2011/12 seasons.

Treatment	Dry matter (%)		Total chlorophyll (mg/100 gm fresh weight)	
	2010/11	2011/12	2010/11	2011/2012
15 Oct.	9.32	9.70	110.94	113.22
1 Nov.	9.41	9.68	115.23	114.85
15 Nov.	8.42	8.62	122.73	120.57
1 Dec.	8.32	7.93	132.67	128.52
LSD at 5%	1.09	0.77	1.09	1.76
C_0	8.97	9.36	126.54	124.37
C_1	8.78	9.59	124.03	123.92
C_2	8.89	9.53	113.61	110.47
LSD at 5%	0.86	0.48	2.15	2.05

Yield characters

Data illustrated in Table 3 show the effect of frequency of cuttings on yield characters. These data indicate that harvesting spinach by rooting up (C_0) significantly resulted in the highest means for fresh foliage weight per plant (157.70 and 148.03 gm) in both seasons followed by cutting plants one time C_1 (154.56 and 144.52 gm), whereas the second cutting C_2 decreased fresh foliage weight/plant (127.30 and 127.34 gm) in each season. Consequently, harvesting plants without cutting C_0 or by one cutting C_1 significantly produced the largest fresh yield, whereas the second cutting C_2 treatment produced remarkably lesser fresh yield which could be ascribed to renewing of vegetative growth which is less vigorous than vegetative growth before cutting; and prevailing of low temperature during the vegetative growth. These results are in harmony with those obtained by Waseem *et al*, 2001; Waseem and Nadeem, 2001 and Awan *et al*., 2016. Meanwhile, El-Lithy *et al*. (1998) indicated that cutting spinach plants twice caused an insignificant increase in fresh yield as compared with that without cutting.

Regarding total fresh yield, cutting spinach plants twice C_2 produced the greatest total fresh yield (8.59 and 7.94 ton/fed.) in both seasons. Despite the little fresh yield produced in the second cutting C_2 of plants (2.27 and 2.51 ton/fed), the overall fresh yield of plants was greater when the fresh yield of the second cutting was added to the fresh yield of the first cutting to obtain

the total fresh yield after two cutting of plants. It could be suggested that the total fresh yield of the spinach plants could be maximized when two cuttings are conducted to harvest spinach plants.

Quality traits

Data in Table 4 show that the differences in means of dry matter content in spinach plants were non significant in both seasons in respect of frequency of cuttings. Furthermore, the highest means of chlorophyll content was recorded when plants were rooted up C_0 and cut one time C_1, whereas the least means for total chlorophyll content was recorded in the second cutting C_2. These results was confirmed by Bharad *et al*. (2003) and Awan *et al*. (2016) who reported that leaf chlorophyll was influenced by number of cuttings and that the maximum chlorophyll content was obtained by one cutting followed by two cuttings in Indian spinach.

3. Effect of interaction between sowing dates and number of cuttings

Vegetative characters

Data of interaction effects of sowing dates and number of cuttings are shown in Table 5. The interaction of sowing dates and number of cuttings showed significant effects on plant height, number of leaves/plant and average leaf area in both seasons of the study.

Sowing plants at mid October and harvesting plants without cutting C_0 resulted in the highest mean values for plant height and leaf area in both seasons. It is suggested that sowing plants at 15 October provides suitable climatic conditions for vegetative growth, while harvesting plants without cutting C_0 led to root up plants without losing the base of the plant. Regarding number of leaves/plant, data in Table 5 indicate that performing the second cutting C_2 at mid October significantly produced the largest number of leave/plant. The increment in number of leaves could be attributed to the dual effect of climatic conditions at mid October and the promoting effect for producing additional side shoots after the first cutting.

Table 5. Effect of interaction of sowing dates and number of cuttings on vegetative characters of spinach plants in 2010/11 and 2011/12 seasons.

Treatment		Plant height (cm)		No. of leaves/plant		Leaf area (cm^2)	
Date	Cutting No.	2010/11	2011/12	2010/11	2011/2012	2010/11	2011/12
15 Oct.	C_0	36.88	31.17	20.89	22.61	32.59	31.19
	C_1	34.58	29.97	20.61	21.31	32.50	29.84
	C_2	25.41	22.18	23.96	24.87	31.49	28.28
1 Nov.	C_0	33.18	30.17	19.64	20.46	31.59	31.65
	C_1	29.91	30.17	20.42	20.08	29.69	32.90
	C_2	25.36	20.72	21.66	23.73	27.81	29.15
15 Nov.	C_0	28.93	25.18	19.07	19.23	27.57	28.42
	C_1	26.09	26.17	17.68	18.71	26.71	27.62
	C_2	20.02	19.18	22.38	21.42	21.62	22.15
1 Dec.	C_0	26.15	25.12	17.81	20.61	27.08	25.16
	C_1	24.16	23.61	19.43	20.42	25.11	24.42
	C_2	16.22	17.60	23.16	24.35	20.64	18.15
LSD at 5%		1.85	0.78	0.99	0.76	1.21	0.36

Yield characters

Data presented in Table 6 indicate the interaction of sowing dates and number of cuttings on yield characters of spinach. The statistical analysis of obtained data reveals that the differences within different interaction treatments were significant for fresh foliage weight/plant, fresh yield and total fresh yield in both seasons of the investigation.

These results prove that the combination of sowing at mid October and harvesting plants without cutting C_0 exhibited the highest fresh foliage weight /plant (171.74 and 162.82 gm), fresh yield (7.34 and 6.23 ton/fed.) in both seasons, which could be ascribed to prevalence of the optimum climatic factors in October as compared with November (Table 1) that encourages vegetative growth and consequently produced the highest yields. In addition, harvesting plants without cutting C_0 led to cut the whole plant without discarding any part of plant base above soil surface.

Concerning total fresh yield, the combination of sowing at 15 October and cut plants twice produced the maximum total fresh yield (10.14 and 9.52 ton/fed.) followed by sowing at 1 November and cut plants twice (9.64 and 9.34 ton/fed.). These findings could be explained by the favorable environmental conditions in mid October and 1 November in addition to harvesting plants twice that led to maximize total yield production. It is suggested that best sowing dates for spinach are 15 October followed by 1 November, whereas delayed sowing dates would reduce yield production.

Table 6. Effect of interaction of sowing dates and number of cuttings on yield characters of spinach plants in 2010/11 and 2011/12 seasons.

Treatment		Fresh foliage weight/plant(gm)		Fresh yield (Ton/fed.)		Total fresh yield(ton/fed.)	
Date	Cutting No.	2010/11	2011/12	2010/112	011/122	010/112	011/12
15 Oct.	C_0	171.74	162.82	7.34	6.23	7.34	6.23
	C_1	167.11	155.38	7.20	6.40	7.20	6.40
	C_2	140.12	141.72	3.22	3.34	10.14	9.52
1 Nov.	C_0	165.32	151.53	7.17	6.21	7.17	6.21
	C_1	164.21	150.73	6.92	6.10	6.92	6.10
	C_2	134.52	132.42	2.91	2.91	9.64	9.34
15 Nov.	C_0	152.14	140.62	6.36	5.91	6.36	5.91
	C_1	148.63	136.81	5.84	5.70	5.84	5.70
	C_2	120.71	119.95	1.54	1.93	7.53	7.02
1 Dec.	C_0	140.42	137.09	5.41	5.28	5.41	5.28
	C_1	138.18	134.58	5.26	4.82	5.26	4.82
	C_2	114.75	115.36	1.52	1.89	6.54	6.42
LSD at 5%		2.84	0.85	048	0.74	0.14	0.84

Furthermore, harvesting plants by cutting twice in combination with sowing at 15 October or 1 November would increase the total fresh yield. These results are in harmony with those reported by Waseem *et al*., 2001; Bharad *et al*., 2013 and Singh *et al*., 2015 on spinach beet.

Quality characters

Data of the interaction effect between sowing dates and number of cuttings are presented in Table 7. Data of the interaction showed significant effects for the

combination of sowing dates and frequency of cuttings on dry matter content and total chlorophyll content in spinach leaves. These data indicate that dry matter content increases when sowing at early sowing dates at mid October or first of November, whereas the late sowing dates afterwards decrease dry matter content. Regarding total chlorophyll, the highest records of total chlorophyll content were obtained in sowing date at 1 December and harvesting plants without cutting C_0 or with one cutting C_1 in both seasons.

Meanwhile, it is clear that total chlorophyll content decreases at later sowing dates in 15 Nov and 1 December when harvesting plants at the second cutting. These results could be explained by the cold temperature, short day and less light intensity during shoot growth.

It is recommended under the present research trial conditions, that early sowing at 15 October or 1 November and applying two cuttings is favorable treatment that leads to maximize the total fresh yield of spinach. Otherwise, delaying sowing dates cause a reduction in vegetative growth and consequently total yield.

Table 7. Effect of interaction of sowing dates and number of cuttings on quality characters of spinach plants in 2010/11 and 2011/12 seasons.

Treatment		Dry matter %		Total chlorophyll (mg/100 gm fresh weight)	
Date	Cutting No.	2010/11	2011/12	2010/11	2011/2012
15 Oct.	C_0	9.29	10.15	112.57	114.38
	C_1	9.08	10.43	112.30	115.22
	C_2	9.58	9.81	108.13	110.07
1 Nov.	C_0	9.11	10.06	118.77	119.14
	C_1	9.62	10.38	116.57	117.23
	C_2	9.47	9.53	110.48	108.18
15 Nov.	C_o	8.66	8.68	126.12	125.72
	C_1	8.11	9.03	127.60	126.03
	C_2	8.54	8.16	114.46	111.62
1 Dec.	C_0	8.75	8.56	136.80	138.25
	C_1	8.21	8.51	139.71	137.19
	C_2	7.96	8.14	121.51	120.18
LSD at 5%		1.72	0.97	5.15	4.16

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تأثير مواعيد الزراعة و عدد الحشات علي المحصول و صفات الجودة في السبانخ

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قسم بحوث الخضر – معهد بحوث البساتين – مركز البحوث الزراعية – الجيزة - مصر

اجريت تجربتان حقليتان في تربة طينية طميية بالمزرعة البحثية بالبرامون –الدقهلية خلال موسمي ١١/٢٠١٠ و ١٢/٢٠١١ بهدف دراسة تأثير كل من مواعيد الزراعة (١٥ اكتوبر -اول نوفمبر – ١٥ نوفمبر –اول ديسمبر) و عدد مرات الحش (بدون حش – الحش مرة واحدة – الحش مرتين) و التفاعل بينهم علي النمو و المحصول وبعض مواصفات الجودة في السبانخ البلدي. استخدم تصميم القطع المنشقة في ثلاث مكررات .اوضحت النتائج ان افضل ميعاد للزراعة هو الزراعة في منتصف اكتوبر ثم اول نوفمبر و ادي ذلك الي حدوث زيادة معنوية في صفات النمو الخضري حيث ازداد طول النبات و عدد الاوراق علي النبات و المساحة الورقية . كما ان الزراعة في المواعيد المذكورة ادت الي زيادة الوزن الخضري للنبات و المحصول الاخضر و المحصول الكلي ، كما اظهرت زيادة في محتوي الاوراق من المادة الجاف لكنها ادت الي اقل قيم لمحتوي الاوراق من الكلوروفيل. حصاد النباتات بدون اجراء الحش ادي الي زيادة ارتفاع النبات والمساحة الورقية بينما حش النباتات مرتين ادي الي زيادة عدد الاوراق المتكونة علي النبات. حصاد النباتات دون حش اعطي اكبر قيم لوزن النبات و المحصول الاخضر بينما الحش مرتين ازداد معه المحصول الكلي مقارنة بالحش مرة واحدة او بدون حش. كما ان التفاعل بين مواعيد الزراعة و عدد مرات الحش اظهر اختلافات معنوية لجميع الصفات المدروسة للصفات المدروسة . يمكن استنتاج ان الزراعة في منتصف اكتوبر او اول نوفمبر مع حصاد النباتات حشتين يؤدي الي زيادة المحصول الكلي كما ان تأخير الزراعة عن ذلك يؤدي الي نقص النمو الخضري و بالتالي نقص المحصول الكلي.