Zagazig J. Agric. Res., Vol. 42 No. (6) 2015
http:/www.journals.zu.edu.eg/journalDisplay.aspx?JournalId=1&queryType=Master

EFFECT OF PLANT DENSITY ON GROWTH AND YIELD OF SOME PEA CULTIVARS

Ehab I.M. Ibrahem*, A. Bardisi, H.E.M. Ismail and Sabreen Kh.A. Ibraheim

Hort. Dept., Fac. Agric., Zagazig Univ., Egypt

ABSTRACT

The field experiments were carried out during the two successive winter seasons of 2013/2014 and 2014/2015 in a Private Farm at Abo-Hammad District, Sharkia Governorate, to study the effect of plant densities on plant growth, chemical constituents of some pea cultivars. The maximum values of dry weight of roots, shoots and total dry weight / plant, chlorophyll a, b and total chlorophyll as well as carotenoides in leaf tissues, number of pods/ plant, average pod weight, yield / plant and total yield/ fad., were recorded in case of cv. Lincoln while, cv. Alaska recorded the highest values of N, P, K and total carbohydrate in shoot. Planting pea plants on one side of the ridge gave the highest values of dry weight of roots, shoots and total dry weight/ plant, chlorophyll a, b, total chlorophyll and carotenoides in leaf tissues, N, P, K and total carbohydrate in shoots, number of pods/ plant, average pod weight and yield /plant. Whereas, planting on three or four sides of the ridge increased total yield/ faddan. Planting cv Lincoln on one side of the ridge gave the highest values of dry weight of roots, shoots and total dry weight/ plant, chlorophyll a, b, total chlorophyll and carotenoides in leaf tissues, number of pods/ plant, average pod weight and yield/ plant. Whereas, planting Alaska cv. on one side of the ridge increased N, P, K and total carbohydrate in shoots. Planting Lincoln cv. on three or four sides of the ridge and planting Master B cv. on four sides of the ridge increased significantly the total yield/ faddan.

Key words: Pea, cultivars, Lincoln, Master B, Alaska, plant densities, yield.

INTRODUCTION

Pea (*Pisum sativum* L.) is one of the most important and popular legume vegetable crops grown in Egypt and many countries allover the world. It has many nutritional values such as high content of protein, carbohydrate, phosphorus, iron, calcium and vitamins A and B (Hassan, 1997). Increasing the production of peas green pods with high quality is considered an important aim and this aim could be achieved through using different plant densities.

Many researchers found that there were significant differences showed among pea cultivars; *i.e.,* Alam *et al.* (2010), Sajid *et al.* (2013), Yucel (2013) and Bitew *et al.* (2014) regarding plant growth, Riad *et al.* (1986), El-Shaikh *et al.* (2010) and Gheeth *et al.* (2013) regarding yield of pea. They found that the three cultivars differed much and significantly in their fresh yield of green pods as Palmoral gave the highest yield (6.78 and 6.90 ton/fad.) followed by Jaguar (5.72 and 6.00 ton/fad.) and then Master B (4.60 and 4.66 ton/fad) in the first and second seasons, respectively .

Several studies have been conducted on the effect of plant density on growth of pea plants. The results from these studies agree that the dry weight/ plant and leaf pigments increased with the decrease in plant population (Heath *et al.*, 1991; Townley-Smith and Wright, 1994; Knott and Belcher, 1998) respecting dry weight of pea plant and Arisha and Bardisi (1999) and Khairy (2013) respecting leaf pigments on snap bean.

Green pod yield of pea and legumes crops increased with increasing plant population (Arisha and Bardisi, 1999; Pawar *et al.*, 2007;

***Corresponding author: Tel. :** +201094524237
E-mail address: ehabattaya@yahoo.com

Abubaker 2008; Mahmoud, 2008; Abbas, 2011; Kazemi *et al*., 2012; Rasaei *et al.,* 2012; Khairy, 2013).

Therefore, the aim of this work was to know the suitable cultivars and plant density for increasing green pod yield of pea.

MATERIALS AND METHODS

The field experiments were carried out during two successive winter seasons of 2013/2014 and 2014/2015 in a Private Farm at Abo-Hammad District, Sharkia Governorate, to study the effect of plant densities on plant growth, chemical constituents, and yield and its components of three pea cultivars. The physical and chemical analyses of the soil are presented in Table 1.

This experiment includeds 12 treatments which were the combinations between three cultivars of pea; *i.e.,* Lincoln, Alaska and Master B and four planting densities; *i.e.*, planting on one side of the ridge, planting on two sides of the ridge, planting on three sides of the ridge and planting on four sides of the ridge.

These treatments were arranged in a split plot design with three replications. The cultivars were randomly arranged in the main plots and planting densities were randomly distributed in the sub plots.

The seeds were sown at 10 cm apart. Sowing was done on the first week of October in both seasons.

The experimental unit area was 5.4 m^2. Each unit contained three ridges of 3 m length and 60 cm in width. One ridge was used for takin samples to measure vegetative growth, and the other two ridges were left for yield determination.

The normal agricultural practices in both seasons were carried out as commonly followed in the district.

Data Recorded

Dry weight

Five plants from every experimental unit were randomly taken after 50 days from sowing and the following data were recorded: plant height, number of leaves/ plant and number of branches/ plant. Different plant parts (roots and shoots) were oven dried at 70^{o}C till constant weight, then dry weight of roots, dry weight of shoots and total dry weight (roots +shoots) were recorded.

Photosynthetic pigments

Disk samples from the fourth upper leaf were taken at 45 days after sowing of all plots to determine chlorophyll a and b as well as carotenoids in the second season according to the method described by Wettestein (1957).

Plant chemical composition

The dry matter of roots and shoots, which were taken at 50 days after sowing in both seasons, were finely ground and wet digested with sulfuric acid and perchloric acid (3:1). Total nitrogen, phosphorus and potassium contents were determined according to the methods described by Bremner and Mulvaney (1982), Olsen and Sommers (1982) and Jackson (1970), respectively.

Yield and its components

Green pods of each plot were harvested at maturity stage, then counted and weighed for each harvest. Then, average pod weight (g), number of pods/ plant, yield / plant and total yield / faddan were calculated.

Statistical Analysis

The obtained data were subjected to proper statistical analysis of variance for the aforementioned design according to Snedecor and Cochran (1980), and means separation were done using LSD at 0.05 level of probability.

RESULTS AND DISCUSSION

Dry Weight

Effect of cultivars

The results in Table 2 indicate that there were significant differences among the three cultivars of pea in dry weight of roots, shoots and total dry weight/ plant at 50 days after sowing in both seasons. Lincoln cultivar recorded the maximum values of dry weight of roots, shoots and total dry weight/plant, followed by cv. Master B, whereas, cv. Alaska recorded the minimum values in this respect. The decreases in total dry weight / plant were about 43.98% and 61.05% for cv. Alaska and 35.64% and 19.35% for cv. Master B compared with cv. Lincoln in the 1st and 2nd seasons, respectively.

Table 1. The physical and chemical properties of soil during 2013/2014 and 2014/2015 (average of the two seasons)

Character	Value
Soil particles	
Sand (%)	**80.7**
Silt (%)	**7.7**
Clay (%)	**11.6**
Texture	**Lomy sand**
pH	**8.73**
EC (milimos / cm)	**1.83**
Soluble cations and anions (meq/100 g soil)	
Ca^{++}	**1.5**
Mg^{++}	**0.33**
Na^{+}	**0.6**
K^{+}	**0.13**
CO_3^{--}	**0.00**
HCO_3^{-}	**1.3**
Cl^{-}	**0.33**
SO_4^{--}	**0.93**

Table 2. Effect of cultivars and plant densities on dry weight of different organs of pea plants during 2013/2014 and 2014/2015 seasons

Treatments / Characters	Dry weight of roots (g)		Dry weight of shoots (g)		Total dry weight/ plant (g)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
Effect of cultivars						
Lincoln	0.268	0.265	10.29	10.70	10.55	10.96
Alaska	0.048	0.046	5.864	4.22	5.91	4.27
Master B	0.167	0.163	6.632	8.68	6.79	8.84
LSD at 0.05 level	0.03	0.11	1.37	1.05	1.41	1.05
Effect of plant density						
One side of the ridge	0.171	0.166	8.55	9.49	8.72	9.65
Two sides of the ridge	0.143	0.138	8.01	8.33	8.15	8.47
Three sides of the ridge	0.147	0.144	7.23	7.31	7.38	7.46
Four sides of the ridge	0.183	0.184	6.57	6.33	6.75	6.51
LSD at 0.05 level	0.02	0.02	0.86	0.65	0.86	0.65

1st season : 2013/2014 and 2nd season : 2014/2015

Difference in growth attributes observed among cultivars may be due to the growth habit characteristics and to genetic differences among cultivars and their ability for utilizing the environmental sources especially light, CO_2, water and nutrients (Hafiz and Damarany, 2006).

These results are in agreement with those reported by Alam *et al*. (2010), Sajid *et al*. (2013), Yucel (2013) and Bitew *et al.* (2014). All found that there were significant differences between cultivars regarding dry weight of pea plant.

Effect of plant densities

Data in Table 2 illustrate that planting pea plants at different densities (one, two, three and four sides of the ridge) had significant effect on dry weight of roots, shoots and total dry weight/ plant at 50 days of sowing in both seasons. Planting pea plants on one side of the ridge gave the highest values of dry weight of roots, shoots and total dry weight/ plant, except root dry weight in the 2nd season followed by planting on two sides of the ridge, whereas planting four sides of the ridge gave the lowest values in this respect.

It means that, low plant density allows plants to grow better that gave more space for plants which enhancing the photosynthesis process and also gave more nutrients, that effect would favor net photosynthetic on plant growth, and consequently exhibit an increase in the dry weight of different parts/plant.

The decreases in total dry weight / plant were about 6.54 and 12.23% for planting on tow sides of the ridge, 15.37 and 22.69% for planting on three sides of the ridge, 22.59 and 22.69% for planting on four sides of the ridge less than the planting one side of ridge in the 1st and 2nd seasons, respectively. So that total dry weight / plant decreased with increasing plant density up to planting four sides of ridge.

The obtained data are in harmony with those of Heath *et al*. (1991), Townley-Smith and Wright (1994) and Knott and Belcher (1998) on pea.

Effect of the interaction between cultivars and plant densities

The interaction between cultivars and plant densities reflect significant effect on dry weight of roots, shoots and total dry weight/ plant at 50 days of sowing in both seasons (Table 3). Planting cv. Lincoln on four plant densities (one, two, three and four sides of the ridge) recorded the maximum values of dry weight of roots, shoots and total dry weight/ plant, followed by planting cv. Master B at the same plant densities, whereas planting cv. Alaska recorded the minimum values of dry weight of roots, shoots and total dry weight/ plant under the same plant densities.

Planting cv. Lincoln on one side of the ridge gave the highest values of dry weight of roots, shoots and total dry weight/ plant, followed by Planting cv. Lincoln on two sides of the ridge. Whereas, planting cv. Alaska on four sides of the ridge gave the lowest values in this respect.

Total dry weight/plant of cvs Lincolin, Alaska and Master B decreased with increasing plant density up to planting four sides of the ridge.

It could be concluded that the interaction between any of the three cvs and planting on one side of the ridge were the superior regarding the dry weight of different plant parts and whole plant. Moreover, cv Lincoln with such plant density was the superior one regarding the dry weights of roots, shoots and total dry weight/ plant.

The decreases in total dry weight/plant were about 0.88% and 15.68% for planting cv. Lincoln on one side of the ridge, 58.95% and 81.11% for planting cv Alaska on four sides of the ridge less than the planting Lincolin on one side of the ridge in the 1st and 2nd seasons, respectively.

Photosynthetic Pigments

Effect of cultivars

Data in Table 4 show that cv Lincoln gave the highest concentration of chlorophyll a, b and total (a+b), and carotenoides in leaf tissues, followed by cv. Master B. Whereas cv. Alaska gave the lowest concentrations of chlorophyll a, b, total (a+b) and carotenoides in leaf tissues. The variability among the Lincoln, Alaska and Master B cultivars might be due to the heredity differences.

These results are in harmony with those reported by Ismail (2000) on snap bean.

Table 3. Effect of the interaction between cultivars and plant densities on dry weight of different organs of pea plants during 2013/2014 and 2014/2015 seasons

Characters / Treatments		Dry weight of roots (g)		Dry weight of shoots (g)		Total dry weight/ plant (g)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season
Cultivars	**Plant densities**						
Lincoln	**One side of the ridge**	0.303	0.300	11.165	12.5	11.4	12.88
	Two sides of the ridge	0.243	0.233	11.12	10.6	11.3	10.86
	Three sides of the ridge	0.230	0.213	9.547	9.82	9.77	10.04
	Four sides of the ridge	0.297	0.313	9.327	9.76	9.62	10.08
Alaska	**One side of the ridge**	0.060	0.057	6.993	5.31	7.05	5.370
	Two sides of the ridge	0.053	0.047	6.033	4.98	6.08	5.033
	Three sides of the ridge	0.040	0.040	5.787	4.21	5.82	4.253
	Four sides of the ridge	0.040	0.040	4.643	2.39	4.68	2.433
Master B	**One side of the ridge**	0.150	0.140	7.513	10.5	7.66	10.72
	Two sides of the ridge	0.133	0.133	6.887	9.39	7.02	9.530
	Three sides of the ridge	0.170	0.180	6.370	7.91	6.54	8.090
	Four sides of the ridge	0.213	0.200	5.757	6.83	5.97	7.033
LSD at 0.05 level		**0.04**	**0.06**	**1.51**	**1.12**	**1.48**	**1.12**

1st season : 2013/2014 and 2nd season : 2014/2015

Table 4. Effect of cultivars and plant densities on leaf pigments (mg/g DW) in leaves of pea plants during 2014/2015 season

Characters / Treatments	Chl. a	Chl. b	Total (a+b)	Carotenoids
		Effect of cultivars		
Lincoln	2.20	1.72	3.93	2.04
Alaska	1.71	1.25	2.97	1.10
Master B	1.94	1.35	3.29	1.65
LSD at 0.05 level	0.03	0.04	0.07	0.15
		Effect of plant density		
One side of the ridge	2.10	1.65	2.76	1.98
Two sides of the ridge	2.00	1.45	3.45	1.64
Three sides of the ridge	1.88	1.39	3.28	1.53
Four sides of the ridge	1.82	1.27	3.10	1.24
LSD at 0.05 level	0.06	0.06	0.06	0.015

Effect of plant densities

Data presented in Table 4 illustrate that, planting pea on one side of the ridge gave the highest concentration of chlorophyll a, b, total (a+b) and carotenoides in pea leaf tissues, followed by planting two sides of the ridge, whereas, planting on four sides of the ridge gave the lowest values of chlorophyll a, b, total (a+b) and carotenoides in leaf tissues.

These results suggested that, low plant density had stimulative effect on chlorophylls and carotenoides formation and that might be due to more light intensity.

Similar findings were reported by Arisha and Bardisi (1999) who found that chlorophyll a, b and total chlorophyll in leaf tissues were increased with increasing plant spacing up to 15 or 20 cm as compared to 5 or 10 cm of common bean.

Effect of the interaction between cultivars and plant densities

The interaction between cultivars and plant densities had significant effect on chlorophyll a, b, total (a+b) and carotenoides in leaf tissues (Table 5).

Planting cv. Lincoln on one side of the ridge recorded the maximum values of chlorophyll a, b, total (a+b) and carotenoides in leaf tissues. The concentration of chlorophyll a, b, total (a+b) and carotenoides in leaf tissues of Lincoln, Alaska and Master B decreased with increasing plant density up to planting on four sides of the ridge.

N,P and K Contents in Shoots

Effect of cultivars

Data presented in Table 6 illustrate that, cv Alaska recorded the highest values of N, P, K and total carbohydrate in shoots followed by cvs Lincoln and Master B.

Effect of plant densities

Results in Table 6 show that planting pea on one side of the ridge recorded maximum values of N, P, K and total carbohydrate in shoots. But, N, P, K and total carbohydrate were decreased with increasing plant densities up to planting on four sides of the ridge.

It is of great interest to note that plants grown at the low plant density (planting on one side of the ridge) recorded the greatest uptake of N, P and K by roots and shoots of pea. The enhancing effect of the least plant density (one side of the ridge) may be due to less competition between plants for minerals absorption.

Obtained results are similar to those reported by Abubaker (2008) on snap bean.

Effect of the interaction between cultivars and plant densities

Data in Table 7 show that planting cv Alaska on one side of the ridge increased N, P, K and total carbohydrate in pea shoots, followed by planting cv. Alaska on two sides.

Yield and Its Components

Effect of cultivars

Data presented in Table 8 illustrate that, there were significant differences among cvs. Lincoln, Alaska and Master B with respect to number of pods/ plant, average pod weight, yield / plant and total yield/faddan in both seasons. Cv. Lincoln gave the highest number of pods/ plant, average pod weight, yield/plant and total yield/ fad. (5.610 and 5.546 ton/fad.) in the 1st and 2nd seasons, respectively, followed by cv Master B (being 4.881 and 4.842 ton/fad.) in the 1st and 2nd seasons, respectively. Whereas, cv Alaska gave the lowest values of yield / plant and total yield/ fad. (2.559 and 2.559 ton/fad.) in the 1st and 2nd seasons, respectively.

The decreases in total yield /fad., were about 54.39% and 53.85% for cv Alaska and 13.00% and 12.71% for cv Master B, compared to cv Lincoln in the 1st and 2nd seasons, respectively.

The variability among the Lincoln, Alaska and Master B cultivars might be due to the genetic archetecher of each.

The obtained results are in accordance with those of El-Shaikh *et al.* (2010) and Gheeth *et al.* (2013). They found that the three cultivars used in the study differed much in their fresh yield of green pods as Palmoral gave the highest yield (6.78 and 6.90 ton/fad.), followed by Jaguar (5.72 and 6.00 ton/fad.) and then Master B (4.60 and 4.66 ton/fad.) in the first and second seasons, respectively.

Table 5. Effect of the interaction between cultivars and plant densities on leaf pigments (mg/g DW) of pea plants during 2014/2015 season

Characters / Treatments		Chl. a	Chl. b	Total (a+b)	Carotenoids
Cultivars	**Plant densities**				
Lincoln	**One side of the ridge**	2.41	2.07	4.48	2.72
	Two sides of the ridge	2.23	1.70	3.93	2.38
	Three sides of the ridge	2.11	1.61	3.72	1.70
	Four sides of the ridge	2.06	1.52	3.57	1.36
Alaska	**One side of the ridge**	1.83	1.43	3.26	1.02
	Two sides of the ridge	1.73	1.29	3.02	0.85
	Three sides of the ridge	1.70	1.20	2.90	1.36
	Four sides of the ridge	1.60	1.10	2.70	1.19
Master B	**One side of the ridge**	2.06	1.47	3.53	2.21
	Two sides of the ridge	2.03	1.38	3.41	1.70
	Three sides of the ridge	1.85	1.38	3.23	1.53
	Four sides of the ridge	1.81	1.20	3.01	1.19
LSD at 0.05 level		0.09	0.09	0.12	0.26

Table 6. Effect of cultivars and plant densities on chemical constituents in shoots (%) of pea plants during 2014/2015 season

Characters / Treatments	N	P	K	Total carbohydrate
		Effect of cultivars		
Lincoln	2.12	0.473	1.11	13.77
Alaska	2.26	0.508	1.20	14.84
Master B	2.11	0.397	1.11	13.81
LSD at 0.05 level	0.07	0.015	0.015	0.05
		Effect of plant density		
One side of the ridge	2.29	0.499	1.20	14.43
Two sides of the ridge	2.16	0.474	1.17	14.31
Three sides of the ridge	2.11	0.447	1.12	13.98
Four sides of the ridge	2.09	0.419	1.08	13.85
LSD at 0.05 level	0.08	0.006	0.01	0.03

Table 7. Effect of the interaction between cultivars and plant densities on chemical constituents in shoots (%) of pea plants during 2014 season

Treatments	Characters	N	P	K	Total carbohydrate
Cvs	**Plant densities**				
Lincoln	**One side of the ridge**	2.17	0.540	1.12	14.08
	Two sides of the ridge	2.14	0.500	1.13	13.90
	Three sides of the ridge	2.11	0.447	1.12	13.52
	Four sides of the ridge	2.09	0.407	1.08	13.58
Alaska	**One side of the ridge**	2.51	0.520	1.27	15.11
	Two sides of the ridge	2.22	0.517	1.25	15.06
	Three sides of the ridge	2.17	0.507	1.17	14.72
	Four sides of the ridge	2.15	0.490	1.12	14.49
Master B	**One side of the ridge**	2.19	0.437	1.21	14.10
	Two sides of the ridge	2.13	0.407	1.12	13.97
	Three sides of the ridge	2.07	0.387	1.08	13.68
	Four sides of the ridge	2.04	0.360	1.03	13.49
LSD at 0.05 level		0.14	0.009	0.2	0.06

Table 8. Effect of cultivars and plant densities on yield and its components of pea plants during 2013/2014 and 2014/2015 seasons

Characters / Treatments	Number of pods/ plant		Average pod weight (g)		Yield/ plant (g)		Total yield/ ton/fad.		The relative total yield (%)	
	2013	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Effect of cultivars										
Lincoln	7.78	7.79	6.28	6.19	49.32	48.54	5.610	5.546	00.00	0.00
Alaska	2.89	2.89	7.09	7.09	20.71	20.73	2.559	2.559	54.39	53.85
Master B	5.66	5.63	7.02	7.15	40.02	40.33	4.881	4.842	13.00	12.71
LSD at 0.05 level	0.51	0.31	0.54	0.54	6.31	3.65	0.700	0.385	--	-
Effect of plant density										
One side of the ridge	6.42	6.63	8.27	8.27	54.41	55.66	3.006	3.075	00.00	00.00
Two sides of the ridge	5.73	5.56	7.00	6.98	39.76	38.13	4.394	4.214	46.17	37.04
Three sides of the ridge	5.02	4.98	6.30	6.23	29.39	28.92	4.872	4.794	62.08	55.90
Four sides of the ridge	4.61	4.57	4.61	5.76	23.20	23.43	5.128	5.179	70.59	68.42
LSD at 0.05 level	0.26	0.22	0.38	0.26	3.56	2.52	0.404	0.168	--	--

Effect of plant densities

Planting pea plants on different plant densities (one, two, three and four sides of the ridge) reflected significant effect on number of pods/ plant, average pod weight, yield / plant and total yield/fad. in both seasons (Table 8).

In this regard planting on one side of the ridge increased number of pods/ plant, average pod weight and yield/plant. Whereas, planting three or four sides of the ridge increased total yield/ fad., (4.872 and 4.794 ton/fad. for three sides of the ridge; 5.128 and 5.179 ton/fad., for four sides of the ridge in the 1st and 2nd seasons, respectively.

The favourable effect of planting on one side of the ridge on yield/ plant may be due to that the increase of dry weight/plant (Table 2), photosynthetic pigments (Table 4), N, P and K contents in shoots (Table 6) and number of pods/ plant and average pod weight (Table 8). Whereas, the favourable effect of planting on four sides of the ridge on total yield/ fad. may be due to the increase in number of plants/faddan.

The increases in total yield /fad., were about 46.14 and 37.04% for planting on two sides of the ridge, 62.03 and 53.88% for planting on three sides of the ridge, 70.56% and 68.38% for planting on four sides of the ridge over the planting on one side of the ridge in the 1st and 2nd seasons, respectively.

These results are in accordance with those reported by Arisha and Bardisi (1999), Pawar *et al.* (2007), Abubaker (2008), Mahmoud (2008), Abbas (2011), Kazemi *et al.* (2012), Rasaei *et al.* (2012) and Khairy (2013) on pea. They found that green pod yield of pea and legumes crop increased with increasing plant population

Effect of the interaction between cultivars and plant densities

The interaction between cultivars and plant densities had enhancing significant effect on number of pods/plant, average pod weight, yield/plant and total yield/fad., in both seasons (Table 9). Planting cv. Lincoln on three or four sides of the ridge and planting Master B on four sides of the ridge increased significantly the total yield/fad., whereas planting cv. Lincoln on one side of the ridge increased significantly number of pods/ plant, average pod weight and yield/ plant. Total yield/fad., for Lincoln, Alaska and Master B increased with increasing plant densities up to four sides of the ridge.

Table 9. Effect of interaction between cultivars and plant densities on yield and its components of pea plants during 2013/2014 and 2014/2015 seasons

Treatments	Characters	Number of pods/ plant		Average pod weight (g)		Yield/ plant (g)		Total yield/ ton/ fad.		The relative yield	
		2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Lincoln	**One side of the ridge**	8.06	7.98	10.10	9.98	81.48	79.64	4.50	4.400	00.00	00.00
	Two sides of the ridge	7.69	7.75	6.61	6.42	50.84	49.70	5.62	5.492	24.79	24.82
	Three sides of the ridge	7.80	7.82	4.73	4.70	36.99	36.85	6.13	6.11	36.21	38.82
	Four sides of the ridge	7.60	7.62	3.68	3.67	27.99	27.98	6.19	6.18	.37.41	40.55
Alaska	**One side of the ridge**	3.77	3.72	7.56	7.66	28.40	28.40	1.57	1.57	00.00	00.00
	Two sides of the ridge	2.94	2.96	7.24	7.34	21.30	21.71	2.35	2.40	50.03	52.87
	Three sides of the ridge	2.53	2.55	7.23	6.98	18.37	17.80	3.05	2.95	94.14	87.96
	Four sides of the ridge	2.33	2.34	6.32	4.41	14.78	15.00	3.27	3.32	108.22	111.21
Master B	**One side of the ridge**	7.44	8.21	7.16	7.17	53.33	58.92	2.95	3.26	00.00	00.00
	Two sides of the ridge	6.58	5.98	7.16	7.19	47.13	42.99	5.21	4.75	76.76	45.92
	Three sides of the ridge	4.73	4.58	6.94	7.01	32.80	32.11	5.44	5.32	.84.49	63.51
	Four sides of the ridge	3.93	3.78	6.83	7.23	26.84	27.31	5.93	6.04	101.29	85.38
LSD at 0.05 level		0.47	0.38	0.65	0.47	6.17	4.36	0.481	0.631	--	--

At planting on four sides of the ridge, cv Lincoln gave 6.19 and 6.18 ton/fad., Alaska gave 3.27 and 3.32 ton/fad., and Master B gave 5.93 and 6.04 ton/fad. In the 1st and 2nd seasons, respectively.

Respecting cv. Lincoln, the increase in total yield were about 24.79% and 24.80% for planting on two sides of the ridge, 36.21% and 38.82% for planting on three sides of the ridge and 37.41% and 40.55% for planting on four sides of the ridge, over the planting on one side of the ridge in the 1st and 2nd seasons, respectively.

As for cv. Alaska, the increase in total yield were about 50.03 and 52.87% for planting on two sides of the ridge, 94.14% and 87.96% for planting on three sides of the ridge and 108.22% and 111.21% for planting on four sides of the ridge over the planting on one side of the ridge in the 1st and 2nd seasons, respectively.

With respect to cv. Master B, the increase in total yield were about 76.76% and 45.92% for planting on two sides of the ridge, 84.49% and 63.51% for planting on three sides of the ridge and 101.29% and 85.38% for planting on four sides of the ridge, over the planting on one side of the ridge in the 1st and 2nd seasons, respectively.

REFERENCES

Abbas, EL.EL. (2011). Influence of plant density and auxin levels on productivity of three faba bean (*Vicia faba* L.) in new reclaimed soil of North Delta. Egypt. J. Appl. Sci., 26 (7): 397-408.

Abubaker, S. (2008). Effect of plant density on flowering date, yield and quality attribute of bush beans (*Phaseolus vulgaris* L.) under center pivot irrigation system. Ame. J. Agric. and Biol. Sci., 3 (4): 666-668.

Alam, M.K., M.M. Uddin, M. Ahmed, M.A. Latif and M.M. Rahman (2010). Growth and green pod yield of garden pea varieties under different nutrient levels J. Agrofor. Environ., 4 (1): 105-107.

Arisha, H.M. and A. Bardisi (1999). Effect of nitrogen fertilization and plant spacing on growth, yield and pod quality of common bean under sandy soil conditions. Zagazig J. Agric. Res., 26 (2): 407-419.

Bitew, Y., F. Asargew and O. Beshir (2014). Effect of plant spacing on the yield and yield component of field pea (*Pisum sativum* L.) at Adet, North Western Ethiopia. Agric., Forestry and Fisheries, 3 (5): 368-373.

Bremner, J.M. and C.S. Mulvaney (1982). Total nitrogen In: Page, A.L., R.H. Miller and D.R. Keeney (Eds). Methods of soil analysis. Part 2, Ame. Soc. Agron. Madison, W. I. USA., 595- 624.

El-Shaikh, K.A.A., A.A.A. El-Dakkak and H.A. Obiadalla-Ali (2010). Maximizing productivity of some garden pea cultivars and minimizing chemical phosphorus fertilizer *via* VA-Mycorrhizal Inoculants. J. Hort. Sci. and Ornamental Plants, 2 (3): 114-122.

Gheeth, R.H.M, Y.M.M. Moustafa and W.M. Abdel-Hakeem (2013). Enhancing growth and increasing yield of peas (*Pisum sativum* L.) by foliar application of ascorbic acid and cobalt chloride. J. Novel Appl. Sci., 2 (4): 106-115.

Hafiz, N.A. and A.M. Damarany (2006). Variation in the susceptibility of some cowpea (*Vigna unguiculata* L.) genotypes to infestation with certain pests in Upper Egypt. Ass. Univ. Bul. Environ. Res., 9 (1):122-128.

Hassan, A.A. (1997). Vegetable fruits. Al- Dar Al-Arabia Publications and distribution, Cairo, Egypt, 241.

Heath, M.C., C.M. Knott, C.J. Dyer and D. Rogers-Lewis (1991). Optimum plant densities for three semi-leafless combining pea (*Pisum sativum* L.) cultivars under contrasting field conditions. Ann. Appl. Biol., 118: 671-688.

Ismail, T.B.A. (2000). Response of snap bean varieties to drip irrigation rates under sandy soil conditions. M. Sc. Thesis, Fac. Agric., Suez Canal Univ., Egypt.

Jackson, M.L. (1970). Soil Chemical Analysis. Prentic Hall, Englewood Ceiffs, N.J.

Kazemi, E., R. Naseri, Z. Karimi and T. Emami (2012). Variability of grain yield and yield

components of white bean (*Phaseolus vulgaris* L.) cultivars as affected by different plant densities in Western Iran. Ame. Eurasian J. Agric. and Environ. Sci., 12 (1): 17-22.

Khairy, E.A.F. (2013). Effect of plant population and sowing dates on growth and yield of dry bean (*Phaseolus vulgaris*, L.). Ph.D. Thesis. Fac. Agric., Suez Canal Univ.

Knott, C.M. and S.J. Belcher (1998). Optimum sowing dates and plant populations for winter peas (*Pisum sativum* L.). J. Agric. Sci., Camb., 131: 454-499.

Mahmoud, G.O. (2008). Effect of sowing date and plant density on growth and productivity of two faba bean (*Vicia faba* L.) cultivars. J. Agric. Sci. Mansoura Univ., 33(5): 3167 – 3179.

Olsen, S.R. and L.E. Sommers (1982). Phosphorus. In: Page. A.L., R.H. Miller and D.R. Keeney (Eds). Methods of soil analysis .Part 2 Ame. Soc., Agron. Madison, W.I. USA, 403-430.

Pawar, S.U., M.L. Kharwade and H.W. Awari (2007). Effect of plant density on vegetative growth and yield performance of different varieties of French Bean under irrigated condition. Karnataka J. Agric. Sci., 20 (3): 684-685.

Rasaei, A.M., E. Ghobadi and M. Ghobadi (2012). Effect of supplemental irrigation and plant density on yield and yield components of peas (*Pisum sativum* L.) in Kermanshah region. Afr. J. Agric.Res.,7 (15): 2353-2358.

Riad, W., S.M. Dossouky and I.M. Dossouky (1986). Marketability studies on some green pea cultivars. Agric. Res. Rev., 64(3):465-471.

Sajid, M., I. Hussain, I.A. Khan, A. Rab, I. Jan, F. Wahid and S.T. Shah (2013). Influence of organic mulches on growth and yield components of pea's cultivars. Green. J. Agric. Sci., 3 (8): 652-657.

Snedecor, G.W. and W.G. Cochran (1980). Statistical Methods.7th Ed. Iowa State Univ., Press, Ames., Iowa, USA.

Townley-Smith, L. and A.T. Wright (1994). Field pea cultivar and weed response to crop seed rate in Western Canada. Can. J. Plant Sci., 74: 387-393.

Wettestein, D. (1957). Chlorophyll-lethal under submicroscopic from wech selder plastiden. Exptl. Cell Reso., 12 : 427 – 500.

Yucel, D.O. (2013). Impact of plant density on yield and yield components of pea (*Pisum sativum* ssp. *sativum* L.) cultivars. arpn J. Agric. and Biol. Sci., 8 (2): 169-174.

تأثير الكثافة النباتية على النمو والمحصول لبعض أصناف البسلة

إيهـــاب إبراهيـــم محمـــود إبراهيم – عبـد الله برديســـى
هانى السيد محمد على إسماعيل - صبرين خلف الله إبراهيم

قسم البساتين - كلية الزراعة - جامعة الزقازيق- مصر

أجريت تجربتان حقليتان خلال موسمين شتويين لأعوام ٢٠١٤/٢٠١٣ و ٢٠١٥/٢٠١٤ فى مزرعة خاصة بمنطقة أبو حماد، محافظة الشرقية وذلك لدراسة تأثير الكثافة النباتية على النمو والمكونات الكيمائية والمحصول ومكوناته لبعض أصناف البسلة، وقد أوضحت النتائج أن الصنف لنكولن قد سجل أعلى القيم لكل من الوزن الجاف للجذور، الوزن الجاف للعرش، الوزن الجاف الكلى للنبات، كلورفيل أ ، ب ، الكلوروفيل الكلى، الكاروتينويدات فى أنسجة الورقة، عدد القرون على النبات، ومتوسط وزن القرن، ومحصول النبات وكذلك المحصول الكلى للفدان بينما سجل الصنف ألاسكا أعلى القيم لمحتوى العرش من النيتروجين، الفوسفور، البوتاسيوم والكربوهيدرات الكلية، كما سجلت زراعة البسلة على ريشة واحدة / خط أعلى القيم لكل من الوزن الجاف للجذور، الوزن الجاف للعرش، الوزن الجاف الكلى للنبات، كلورفيل أ ، ب، الكلوروفيل الكلى والكاروتينويدات فى أنسجة الورقة، محتوى العرش من النيتروجين والفوسفور والبوتاسيوم والكربوهيدرات الكلية، عدد القرون على النبات، متوسط وزن القرن ومحصول النبات، بينما سجلت الزراعة على ثلاثة أو أربعة ريشة/ خط زيادة فى المحصول الكلى للفدان، أعطى زراعة الصنف لنكولن على ريشة واحدة أعلى القيم لكل من الوزن الجاف للجذور، الوزن الجاف للعرش، الوزن الجاف الكلى للنبات، كلورفيل أ، ب، الكلوروفيل الكلى والكاروتينويدات فى أنسجة الورقة، عدد القرون على النبات، متوسط وزن القرن ومحصول النبات، بينما سجلت زراعة الصنف ألاسكا على ريشة واحدة/ خط أعلى محتوى للعرش من النيتروجين، الفوسفور، البوتاسيوم والكربوهيدرات الكلية، كما أدت زراعة الصنف لنكولن على ثلاثة أو أربعة ريشة/ خط أو الصنف ماستر ب على أربعة ريشة/ خط إلى زيادة معنوية فى المحصول الكلى للفدان.

المحكمون :
١- أ.د. فتحي أبو النصر أبو سديرة أستاذ الخضر – كلية الزراعة بمشتهر – جامعة بنها.
٢- أ.د. عبدالمنعـم عـامـر جـــاد أستاذ تربية نباتات الخضر المتفرغ – كلية الزراعة – جامعة الزقازيق.