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EFFECT OF PLANT POPULATION AND SOWING DATES ON GROWTH AND YIELD OF DRY BEAN (*Phaseolus vulgaris*,L) PART 2:(PIGMENTS, SEEDS CHEMICAL CONSTITUENTS AND YIELD QUALITY)

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ABSTRACT

Two field experiments were carried out during summer seasons of 2010 and 2011 at the Experimental Farm at El-Kassaien, Hort. Res. Station Ismalia Governorate, Egypt, to study the effect of sowing dates and plant density on vegetative growth, dry seed yield and its components as well as chemical constituents of dry seed for snap bean plants cv. Nebrasica grown in the newly reclaimed sandy soil. This experiment included 12 treatments, which were the combinations between three sowing dates (February 1st , March 1st and April 1st) and four plant density (56 plants/m^2, 40 plants/m^2 , 28 plants/m^2 and 20 plants/m^2) . Planting of snap been on March 1st gave the maximum values of total chlorophyll a+b, N,P and K total uptake by seed. in the two seasons. Plant, density of snap been at 20 plants / m^2 had significant effect on of total chlorophyll a+b, N,P and K total uptake by seed in both seasons. On the other hand, the interaction between sowing date on March 1st and plant density at 20 plants/m^2 significantly increased photosynthetic pigments, N, P and K total uptake by snap bean seeds.

INTRODUCTION

Common bean *Phaseolus vulgaris,* L. is one of the most important member of *Fabaceae* crops in Egypt, for local consumption and export as an out of vegetable season to European countries. In recent years, production of snap bean faced some problems, which reduced export amounts of this crop. White green pods is one of the most problem caused such a reduction in the exportation of this crop. Moreover dry bean also plays an important role for human nutrient as a good source of carbohydrates and protein.

Sowing date is one of the important factors which affects productivity through growing the timing and duration of the vegetative and reproductive stages, since, environmental factors such as temperature and light duration differ with varying sowing date. Many investigators reported that suitable sowing dates caused a significant effect on photosynthetic pigments and chemical composition (NPK), protein and total carbohydrates of dry seeds as mentioned by El-Gamiely *et al*. (1998), Nour (1999) and Abd-Alla (2000) on pea; Helal, (2006) and Abou El-Yazied, (2011) on snap bean.

Many investigators concluded that increasing plant density decreased of photosynthetic pigments and chemical composition (NPK), protein and total carbohydrates of dry seeds as mentioned by Arisha and Bardisi (1999) and Abubaker (2008) on snap bean.

MATERIALS AND METHODS

Two field experiments were carried out during the summer seasons of 2010 and 2011 at the Experimental Farm at El-Kassasin, Hort. Res. Station Ismallia Governorate, Egypt, to study the effect of sowing dates and plant density on vegetative growth, yield components and chemical constituents for dry seed of bean (cv. Nebrasica) grown in the newly reclaimed sandy soil.

The physical and chemical analysis of the soil are presented in Table 1 according to Chapman and Pratt (1982).

Table 1: The physical and chemical properties of soil during 2010 and 2011 seasons

Physical properties			Chemical properties		
	2010	**2011**		**2010**	**2011**
Sand (%)	90.5	95.6	Organic matter (%)	0.03	0.08
Silt (%)	4.7	1.6	Available K (ppm)	55	66
Clay	4.8	2.8	Available P (ppm)	5.7	6.8
Field capacity	6.8	7.2	Available N (%)	5.9	6.3
Wilting point	2.5	2.6	Calcium carbonate (%)	0.28	0.26
Available water	4.5	4.5	PH	8.1	8.1
Water holding capacity	13.9	14.6			

Sample of the soil was obtained from 25 cm soil surface.

The local meteorological data during 2010 and 2011 prevailing at El-Kassasin region are given in Table 2

Table (2): Local meteorological data at El-Kassasin region during 2010 and 2011 seasons

Month	2010 season				2011 season			
	Temperature (c º)		Relative humidity %		Temperature (c º)		Relative humidity %	
	Max.	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**
Jan.	20.30	13.19	88.19	57.83	19.22	12.70	93.02	58.54
Feb.	21.03	13.60	87.57	49.17	19.39	13.53	89.21	53.57
Mar.	22.06	15.64	84.64	56.0	19.80	14.19	87.16	57.70
April	23.62	17.03	82.86	53.20	23.00	16.36	84.53	54.60
May	26.03	19.93	81.16	55.32	25.29	19.38	85.96	56.32
June	29.65	23.34	81.93	53.75	28.33	22.56	86.6	58.76
Joule	30.2	25.23	86.16	61.26	30.67	25.09	88.61	60.25
Aug.	31.93	26.86	89.00	64.26	31.12	25.38	86.41	57.77

This experiment included 12 treatments, which were the combinations between three sowing dates and four plant populations as follows:

Sowing dates

1- February 1st
2- March 1st
3- April 1st

Plant populations

1- 56 plants/m^2 one plant/hill at 5 cm apart on two sides of the irrigation line.
2- 40 plants/m2 one plant/hill at 7 cm apart on two sides of the irrigation line.

3- 28 plants/m2 one plant/hill at10cm apart on two sides of the irrigation line.
4- 20 plants/m2 one plant/hill at14cm apart on two sides of the irrigation line.

These treatments were arranged in a split plot design with three replications. Sowing dates were assigned at random in the main plots, while, sub plots were devoted to plant populations.

The experimental unit area was 12.8 m^2 and it contained three drippers lines with 6 m length for each and 71 cm width, and the distance between drippers was 25cm. The middle dripper line was used for data collection and others were used for yield determination.

All plots received equal amounts of nitrogen, phosphorus and potassium added in the form of ammonium sulphate (20.5 % N), calcium superphosphate (15.5 % P_2O_5) and potassium sulphate (48 % K_2O) at the rates of 80 kg N, 37 kg P_2O_5 and 50 kg K_2O, respectively. One third of all fertilizers were added at the time of soil preparation with 20 m^3/fed. FYM and the rest were divided into three equal portions and added to the soil at 10 days intervals after emergence.

The other normal agricultural treatments for growing dry bean plants were practiced.

Data Recorded

Two random samples of ten plants from every experimental unit were taken after 45 and 60 days from sowing and the following data were recorded:

Photosynthetic pigments

Disk samples from the fourth upper leaf were obtained after 45 and 60 days from sowing in all plots to determine chlorophyll a and b as well as carotenoids in both seasons according to the method described by **Wettestein (1957**).

Seed Chemical constituents

Nitrogen, phosphors and potassium

The dry seeds at harvest were oven dried at 70 C^o till a constant weight, finely ground and wet digested with sulfuric acid and perchloric acid (3:1). 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.

Total protein (%): It was calculated by multiplying total nitrogen x 6.25

Total carbohydrate: It was determined calorimetrically using the method described by Dubois *et al* (1956).

Statistical analysis:

The data of these experiments were subjected to proper statistical analysis of variance according to Snedecor and Cochran (1980) and the differences among treatments were compared using LSD at 0.05 level.

RESULTS AND DISCUSSION

Photosynthetic pigments

Effect of sowing dates

The effects of three sowing dates (February 1st, March 1st and April 1st) on photosynthetic pigments contents (chlorophyll a, b, total chlorophyll a+b and carotenoids) in leaf tissues of bean plants are shown in Table 3.

It is obvious from the data that different sowing dates caused a significant effect on chlorophyll a, b, total chlorophyll (a+b) and carotenoids at 45 and 60 days after sowing in the two seasons.

The favourable sowing date which resulted in the highest values of chlorophyll a, b, total chlorophyll a+b and carotenoids was sowing on March 1st as compared to other sowing dates under study. Obtained results may be due to the suitable prevailing temperature in mid sowing date (1st of March)

In this regard, Abd-Alla (2006) found that early sowing on 1st of March of snap bean led to significant increases in all assayed photosynthetic pigment chlorophyll a, b and carotenoides) content in leaves of snap bean .

Table (3): Effect of sowing dates on leaf pigments of snap bean plants leaves during 2010 and 2011 seasons in newly reclaimed sandy soil

Characters	Chlorophyll a (mg/100 g FW)		Chlorophyll b (mg/100 g FW)		Chlorophyll a+b (mg/ 100 g FW)		Carotenoides (mg/100 g FW)	
	Days after sowing							
	45	60	45	60	45	60	45	60
Treatments	2010 season							
February 1st	116.0	119.5	51.9	51.5	164.9	170.0	86.3	90.9
March 1st	139.4	143.7	62.3	62.6	201.7	206.3	103.6	108.9
April 1st	98.6	101.6	44.1	43.7	142.7	145.3	73.4	77.1
LSD at 0.05 level	1.09	1.63	2.04	1.63	2.65	1.28	3.80	0.54
	2011 season							
February 1st	103.5	106.7	46.0	46.1	149.5	152.8	77.0	81.3
March 1st	124.3	129.1	55.6	56.0	179.9	185.2	93.3	97.3
April 1st	88.2	90.9	39.3	39.1	130.0	130.0	65.7	68.8
LSD at 0.05 level	1.33	2.12	1.58	0.74	1.70	2.25	3.34	2.31

These results agree with those reported by El-Gamiely *et al*. (1998), Nour (1999) and Abd-Alla (2000) on pea; Helal, (2006) and Abou El-Yazied, (2011) on snap bean.

Effect of plant density

Data presented in Table 4 show the effect of plant density (56, 40, 28 and 20 plants/m^2) on photosynthetic pigments (chlorophyll a, b, total chlorophyll a+b and carotenoids).

Table (4): Effect of plant density on leaf pigments of snap bean leaves (mg/ 100 g fresh weight) during 2010 and 2011 seasons in newly reclaimed sandy soil

Characters	Chlorophyll a		Chlorophyll b		Chlorophyll a+b		Carotenoides	
	Days after sowing							
	45	60	45	60	45	60	45	60
Treatments	2010 season							
56 plants/m^2	116.0	120.4	51.7	52.0	167.8	172.4	89.2	93.7
40 plants/m^2	117.7	121.1	52.1	52.1	170.0	173.4	88.2	92.6
28 plants/m^2	118.8	122.3	53.3	53.0	172.2	175.3	87.7	91.8
20 plants/m^2	119.3	122.5	54.2	53.2	173.6	175.8	86.1	91.2
LSD at 0.05 level	0.59	1.32	1.83	NS	1.36	1.26	1.46	0.49
	2011 season							
56 plants/m^2	103.7	107.0	46.2	46.4	149.9	153.5	80.8	83.6
40 plants/m^2	105.2	108.5	46.6	46.6	151.8	155.1	78.9	82.8
28 plants/m^2	106.0	109.7	47.0	47.5	153.1	157.2	78.0	82.1
20 plants/m^2	106.5	110.3	48.1	47.9	154.6	158.2	77.0	81.4
LSD at 0.05 level	0.98	1.48	1.30	0.62	1.51	1.57	1.09	1.06

It is obvious from the data that plant density had significant effect on chlorophyll a, b, total chlorophyll (a+b) and carotenoids. Planting of snap bean at 20 or 28 plants /m^2 recorded the highest values of chl. a, b and total (a+b) in both seasons, while planting at 56 plants/m^2 recorded the highest values of carotenoids in the two seasons of study.

The stimulative effect of low plant density on leaf pigments may be due to the more exposing to solar radiation, that is necessary for photosynthetic activity and photosynthetic apparatus.

Similar findings were reported by Arisha and Bardisi (1999) found that chl. a, chl. b, and total chlorophyll (a+b) 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 sowing dates and plant density

Data presented in Table 5 reveal the effect of the interaction between sowing dates (February 1st , March 1st and April 1st) and plant density (56, 40, 28 and 20plants/m^2) on photosynthetic pigments (chlorophyll a, b, total chlorophyll (a+b) and carotenoids) contents .

Table (5): Effect of the interaction between sowing dates and plant density on pigments of snap bean leaves (mg/100 g fresh weight) during 2010 and 2011 seasons in newly reclaimed sandy soil

Characters / Treatments		Chlorophyll a		Chlorophyll b		Chlorophyll a+b		Carotenoides	
		Days after sowing							
Sowing dates	Plant density	45	60	45	60	45	60	45	60
		2010 season							
February 1st	56 plants/m^2	114.2	118.7	50.9	50.7	165.2	169.4	88.0	92.1
	40 plants/m^2	115.8	118.9	51.1	51.0	167.1	170.1	86.9	91.2
	28 plants/m^2	116.7	120.0	52.6	51.9	169.3	172.0	86.3	90.5
	20 plants/m^2	117.1	120.5	53.3	52.3	170.4	172.9	84.4	89.9
March 1st	56 plants/m^2	136.7	142.6	60.8	62.2	197.5	204.9	104.9	110.5
	40 plants/m^2	139.3	143.2	61.9	61.9	201.2	205.1	104.0	109.4
	28 plants/m^2	140.5	144.5	62.7	62.9	203.3	207.5	103.4	108.3
	20 plants/m^2	141.1	144.4	64.0	63.2	205.1	207.8	102.1	107.6
April 1st	56 plants/m^2	97.3	99.9	43.4	43.2	140.7	143.1	74.9	78.2
	40 plants/m^2	98.1	101.3	43.3	43.6	141.5	145.0	73.8	77.1
	28 plants/m^2	99.4	102.3	44.5	44.2	143.9	146.7	73.3	76.7
	20 plants/m^2	99.7	102.7	45.3	44.0	145.1	146.7	71.9	76.2
LSD at 0.05 level		1.03	2.32	2.16	1.86	2.38	2.19	2.52	0.90
		2011 season							
February 1st	56 plants/m^2	102.2	105.3	45.2	45.2	147.4	150.6	79.2	82.4
	40 plants/m^2	103.2	106.2	45.4	45.6	148.6	151.9	77.1	81.5
	28 plants/m^2	104.2	106.9	46.1	46.7	150.3	153.6	76.6	80.9
	20 plants/m^2	104.5	108.2	47.4	46.8	152.0	155.1	75.1	80.5
March 1st	56 plants/m^2	121.5	126.2	54.9	55.6	176.5	181.8	96.2	98.8
	40 plants/m^2	124.7	128.8	55.1	55.2	179.9	184.0	93.8	97.7
	28 plants/m^2	125.3	130.6	55.6	56.4	180.9	187.1	92.2	96.8
	20 plants/m^2	125.8	130.9	56.7	57.0	182.6	188.0	91.2	96.0
April 1st	56 plants/m^2	87.4	89.7	38.4	38.4	125.9	128.1	67.2	69.6
	40 plants/m^2	87.7	90.4	39.2	39.0	127.0	129.5	65.8	69.2
	28 plants/m^2	88.7	91.6	39.4	39.3	128.1	131.0	65.3	68.7
	20 plants/m^2	89.1	91.8	40.2	39.8	129.3	131.6	64.6	67.9
LSD at 0.05 level		1.72	2.58	2.25	1.06	2.61	2.76	1.90	1.87

Data show that the interaction between treatments had significant effects on (chlorophyll a, b, total chlorophyll a+b and carotenoids) in both seasons.

The best interaction treatments for increasing chlorophyll a, b and total chlorophyll (a+b) contents were sowing plants on March 1st and plant density (28 and / or 20plants/m^2). On the other hand, the treatments of sowing plants on March 1st and plant density at 56 or 40 plants/ plant gave the highest values of carotenoids contents in leaf tissues in both seasons.

Chemical composition (NPK), protein and total carbohydrates of seeds.

Effect of sowing dates

The effect of three sowing dates (1st February, 1st March and 1st April) on mineral contents (NPK), protein and total carbohydrates in seeds of bean are shown in Table 6.

Table (6): Effect of sowing dates on seed quality of snap bean plants at harvesting time during 2010 and 2011 seasons in newly reclaimed sandy soil

Characters / Treatments	N (%)	P (%)	K (%)	Total protein (%)	Total carbohydrates (%)
	2010 season				
February 1st	3.24	0.519	2.01	20.30	59.60
March 1st	3.61	0.487	2.07	22.61	59.89
April 1st	2.79	0.456	1.96	17.45	60.37
LSD at 0.05 level	0.14	0.012	NS	0.91	NS
	2011 season				
February 1st	3.10	0.457	1.86	19.40	59.51
March 1st	3.24	0.481	1.83	20.30	59.23
April 1st	2.62	0.400	1.77	16.43	60.17
LSD at 0.05 level	0.25	0.038	NS	1.63	NS

It is obvious from the data that sowing dates had significantly effect on nitrogen, phosphorus and protein contents only in both seasons.

Nitrogen and total protein were significantly increased by planting of bean at the first of March as compared to other dates. While phosphorus contents significantly increased with planting on 1st Feb. and 1st March in the 1st and 2nd seasons, respectively. On the other hand, sowing dates had insignificant effect on potassium and total carbohydrates content in seeds in both seasons.

In this regard , Abd-Alla (2006) indicated that early sowing of snap bean on 1st of March significantly increased total carbohydrates and protein contents and decreased the crude fiber contents of green pods compared with the late planting either on first of April or May.

These results are in good line with those reported by many investigators Helal (2006) and Abd El-Latif *et al.* (2009) on snap bean.

Table (7): Effect of plant density on seed quality of snap bean plants at harvesting time during 2010 and 2011 seasons in new reclaimed sandy soil

Characters / Treatments	N (%)	P (%)	K (%)	Total protein (%)	Total carbohydrates (%)
	2010 season				
56 plants/m^2	3.18	0.500	1.90	19.85	59.97
40 plants/m^2	3.19	0.483	2.01	19.85	59.31
28 plants/m^2	3.23	0.487	2.06	20.18	60.37
20 plants/m^2	3.25	0.482	2.07	20.30	60.14
LSD at 0.05 level	NS	NS	0.11	NS	NS
	2011 season				
56 plants/m^2	2.78	0.444	1.71	17.41	59.47
40 plants/m^2	2.95	0.441	1.78	18.44	59.85
28 plants/m^2	3.11	0.446	1.79	19.44	59.51
20 plants/m^2	3.12	0.453	1.90	19.55	59.71
LSD at 0.05 level	0.15	NS	0.10	0.95	NS

Effect of plant density

The effect of plant density on nitrogen, phosphorus, potassium and protein as well as total carbohydrates contents in seeds of bean are presented in Table 7.

Data show that plant density caused significant effect on potassium in seasons and total nitrogen, total protein and total carbohydrates in the second season only.

Planting bean at 28 or 20 plants/ m^2 gave the highest values of potassium in both seasons and total nitrogen and total protein contents in the second season. While the lowest contents of these elements were recorded with the highest densities (56plants/m^2). On the other hand, plant density had insignificant effect on phosphorus and total carbohydrates in seeds in both seasons.

Effect of the interaction between sowing dates and plant density

Data presented in Table 8 show the effect of the interaction between sowing dates (1^{st} February, 1^{st} March and 1^{st} April) and plant density (56, 40, 28 and 20 plants/m^2) on N,P, K, total protein and total carbohydrates in dry snap bean seeds at harvest during 2010 and 2011 seasons .

Data show that the interaction between treatments had significant effects on N and total protein only in bean seeds only in both seasons. While the interaction treatments did not reflected any significant effect on P, K and total carbohydrates in dry snap seeds in both seasons.

Generally, the interaction between planting sowing of bean on 1 March at different density recorded the best results for increasing N and total protein contents in dry seeds in both seasons.

In this regard, Abd El-Latif *et al.* (2009) found that high plant density of 224000 plants/fed. gave the highest significant values in chemical composition such as, nitrogen, phosphorus, potassium, total carbohydrate, crude protein contents in seeds of cowpea plants as compared to 84000 and 168000 plants/feddan.

These results are in harmony with those reported by Arisha and Bardisi (1999) and Abubaker (2008) on snap bean.

Table (8): Effect of interaction between sowing dates and plant density on seed quality of snap bean at harvesting time during 2010 and 2011 seasons in new reclaimed sandy soil.

Sowing dates	Plant density	N (%)	P (%)	K (%)	Total protein (%)	Total carbohydrates (%)
		2010 season				
February 1st	56 plants/m^2	3.00	0.504	1.77	18.77	60.07
	40 plants/m^2	3.05	0.486	1.92	19.07	58.77
	28 plants/m^2	3.10	0.495	2.01	19.45	59.72
	20 plants/m^2	3.14	0.479	1.90	19.60	59.82
March 1st	56 plants/m^2	3.52	0.496	1.88	21.98	59.74
	40 plants/m^2	3.37	0.435	1.90	21.10	59.36
	28 plants/m^2	3.39	0.485	1.96	21.23	60.58
	20 plants/m^2	3.42	0.432	2.10	21.38	59.86
April 1st	56 plants/m^2	2.53	0.417	1.72	15.86	60.11
	40 plants/m^2	2.64	0.450	1.90	16.49	59.80
	28 plants/m^2	2.68	0.404	1.90	16.78	60.83
	20 plants/m^2	2.71	0.457	1.89	16.96	60.73
LSD at 0.05 level		0.13	NS	NS	0.83	NS
		2011 season				
February 1st	56 plants/m^2	2.79	0.476	1.72	17.46	59.16
	40 plants/m^2	3.13	0.437	1.81	19.60	60.33
	28 plants/m^2	3.24	0.450	1.94	20.27	59.31
	20 plants/m^2	3.24	0.465	1.97	20.27	59.23
March 1st	56 plants/m^2	3.16	0.471	1.75	19.77	59.06
	40 plants/m^2	3.19	0.491	1.75	19.98	59.11
	28 plants/m^2	3.29	0.480	1.91	20.56	59.33
	20 plants/m^2	3.34	0.481	1.89	20.88	59.43
April 1st	56 plants/m^2	2.40	0.385	1.66	15.00	60.20
	40 plants/m^2	2.51	0.395	1.77	15.73	60.10
	28 plants/m^2	2.80	0.406	1.81	17.50	59.90
	20 plants/m^2	2.80	0.413	1.86	17.50	60.48
LSD at 0.05 level		0.26	NS	NS	1.66	NS

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تأثير مواعيد الزراعه والكثافه النباتيه علي النمو والمحصول الجاف في الفلصوليا 2-الصبغات النباتية – التركيب الكيماوى للبذور وجودة المحصول

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أجريت تجربتان حقليتان خلال الموسم الصيفى لعامى 2010،2011م فى مزرعة التجارب البحثية بمحطة بحوث البساتين بالقصاصين – الاسماعيلية – مصر ، لدراسة تأثير مواعيد الزراعة (1 فبراير – 1 مارس – 1 إبريل) والكثافة النباتية (56نبات/م^2 – 40نبات/م^2 – 28نبات/م^2 – 20نبات/م^2) على محتوى الأوراق من صبغات التمثيل الضوئى وكذلك الصفات الكيميائية للبذور الجافه لنباتات الفاصوليا صنف (نبراسكا) النامية تحت ظروف الأرض الرملية المستصلحه حديثاً. اشتملت التجربة على 12 معاملة عبارة عن التفاعل بين ثلاثة مواعيد للزراعة (1 فبراير ، 1 مارس ، 1 إبريل) مع أربع كثافات نباتية (56نبات/م^2 – 40نبات/م^2 – 28نبات/م^2 – 20نبات/م^2) وقد تم توزيع هذه المعاملات فى تصميم قطع منشقة مرة واحدة فى ثلاث مكررات، حيث تم توزيع مواعيد الزراعة فى القطع الرئيسية والكثافة النباتية فى القطع تحت الرئيسية .

أعطت معاملة الزراعة فى الأول من مارس أعلى القيم بالنسبة الكلوروفيل الكلى (أ+ب) . وكذلك على محتوى البذور من النتروجين والفوسفور والبروتين بالنسبة لكلا موسمى الزراعة . أعطت الكثافة النباتية بمعدل 20نبات/م^2 زيادة معنوية محتوى الأوراق من كلوروفيل (أ)و(ب) وأيضاً المجموع الكلى للكلوروفيل (أ+ب) و محتوى البذور من النتروجين والفوسفور والبروتين بالنسبة لكلا موسمى الزراعة .

كان ميعاد الزراعة فى الأول من مارس مع الكثافات النباتية المختلفة قد سجل أفضل القيم بالنسبة للكلوروفيل الكلى (أ+ب) . وكذلك محتوى البذور من النتروجين والفوسفور والبروتين الكلى فى كلا موسمى النمو .