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SELECTION FOR YIELD AND ITS COMPONENTS IN EARLY GENERATIONS OF SNAP BEANS (*PHASEOLUS VULGARIS* L.) USING PARENT - OFFSPRING REGRESSION AND CORRELATION.

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ABSTRACT: *Nine offsprings of early generations F_3, F_4 and F_5 derived from 9 crosses were used to find out the correlation between 8 characters, regression between F_3,F_4 and F_4,F_5 to estimate heritability for yield and some of its components. The results showed that heritability values for pod length ranged from 0.50 to 0.61, for pod weight from 0.43 to 0.55, for number of pods per plant from 0.61 to 0.67 and for yield per plant from 0.46 to 0.58. The simple correlations in F_3, F_4 and F_5 between plant yield and number of pods per plant and pod weight were highly significant indicating that these traits were about equal in importance in contributing to plant yield. The majority of the correlations among the yield components were positive, that suggests that there should be a possibility to select for an increased value of one yield component without inducing a reduction in the value of the other components. Heritability estimates were moderatly high for most of the studied characters.*

Key words: *Selection, Regression, Correlation, Heritability and Offspring.*

INTRODUCTION

Yield of snap bean varieties (*Phaseolus vulgaris* L.) has shown in the past a gradual improvement in comparison with the substantial yield increases in varieties of many other crops. Nowadays, there are many new introduced varieties from foreign countries, which are evaluated and are used by local growers this means that Egypt would depend entirely on foreign bean introductions. So, it is urgently needed to produce new local snap bean varieties through selection programs focusing on some early segregating generations i.e., F_3, F_4 and F_5. From the available literatures, In recent years, several workers have conducted their studies on the physiology and genetics of yield in beans (Singh and Urrea, 1995; Welsh *et al.*, 1995; and Mishra *et al.*, 1996). Economic yield of snap beans is a complex character and it is related with some other components such as number of pods per plant, pod length and pod weight (Coyne, 1968). Correlation coefficient and regression among yield, yield components and early generations have been used as estimations in beans and other crops to improve and produce new genetic materials (Singh and Urrea, 1994 and Castineiras and Rivero, 1988).

The objective of the current study was to estimate heritability to distinguish the highly heritable characters and their inter-relationships with plant yield and yield components. Thus, there can be a selection criteria in breeding programs for snap beans through estimations of heritability values, correlation between yield and its components and regression between F_3, F_4 and F_5 generations.

MATERIALS AND METHODS

Materials used in the current study were derived from nine single crosses of beans (*Phaseolus vulgaris* L.) namely (Giza3 x HAB32), (Helda x Bronco), (Helda x HAB32), (HAB53 x Bronco), (HAB53 x Serbo), (Giza3 x Bronco), (Helda x Serbo), (Giza3 x Serbo) and (HAB53 x HAB32). Seed samples of progenies of F_3, F_4 and F_5 generations with their 6 parents namely (Giza3, HAB32, HAB53, Helda, Bronco and Serbo) were grown in the autumn, seasons of September 5, 2000 and September 5, 2001. Evaluation of the studied progenies was carried out at Kaha Vegetable Research Station, Kalubia governorate. The materials were arranged in a complete randomized blocks design with three replications. Each plot consisted of 3 rows. Each row was 4 meters in long and 0.6 m in width. Plants were spaced at 10 cm apart in each row. Ammonium sulphate (20%), Calcium super phosphate (15.5%) and Potasium sulphate (48%) were added as recommended doses. The normal practices for growing Phaseolus were done. Records were taken on 10 selected plants at random for each plot after 30 days from sowing date to determine the following characters, number of days to 50% flowering, number of days to maturity, pod length (cm), pod weight (g), number of pods per plant, yield per plant (g), vitamin C content(%) as well as protein content(%). Heritability was estimated based on the regression of F_3,F_4 and F_4,F_5 according to Smith and Kinman (1965).

RESULTS AND DISCUSSION

Mean performance and mean squares of parents, F_3, F_4 and F_5 generations are shown in Tables (1 a and b), (2 a and b), (3 a and b), (4 a and b) and (5). Differences among parents, F_3, F_4 and F_5 were significant for all characters in both years of study, i.e., 2000 and 2001 except for protein content which showed insignificant values. This result was in agreement with that obtained by Singh and Urrea (1994) on common bean.

Heritability values, based on regression of F_4 on F_3 and F_5 on F_4 are shown in Table (6). Moderate to high heritability values occurred for most traits. This was in line with the results of Singh and Urrea (1994) on common bean. The highest values of heritability measured based on regression of F4 on F3 and F5 on F4 were found for number of pods per plant in 2000 and 2001 seasons. The lowest values were recorded for protein content (F4 on F3) and yield per plant (F5 on F4) in both 2000 and 2001 seasons.

Table (1a): Mean values for eight characters of snap beans parents grown in the autumn season of 2000.

Character / Parent	Number of days to 50% flowering	Number of days to maturity	Pod length (cm)	Pod Weight (g)	Number of pods per plant	Yield per Plant (g)	Vitamin C content (%)	Protein content (%)
Helda (1)	49	61	19.95	8.30	25	132.07	21.28	2.32
Giza3 (2)	35	54	13.43	3.13	11	40.62	21.29	2.37
HAB53 (3)	37	53	12.47	4.16	24	86.32	19.99	2.65
HAB32 (4)	42	58	14.38	4.28	16	58.39	19.43	2.07
Bronco (5)	46	64	14.57	2.66	21	53.67	21.68	2.04
Serbo (6)	43	64	10.40	2.93	23	76.06	20.13	2.07

Table (1b): Mean values for eight characters of snap beans parents grown in the autumn season of 2001.

Character / Parent	Number of days to 50% flowering	Number of days to maturity	Pod length (cm)	Pod weight (g)	Number of pods per plant	Yield per Plant (g)	Vitamin C content (%)	Protein content (%)
Helda (1)	48	65	19.07	7.49	24	126.03	20.81	2.31
Giza3 (2)	33	61	14.22	3.87	13	46.83	21.83	2.15
HAB53 (3)	38	59	12.22	4.19	21	83.81	21.60	2.65
HAB32 (4)	44	60	14.83	3.77	19	66.85	22.05	2.08
Bronco (5)	46	61	14.59	2.95	22	62.50	22.36	2.03
Serbo (6)	44	63	9.42	2.30	24	58.06	22.23	2.24

Table (2 a): Mean values for eight characters of snap beans F_3 generation grown in the autumn season of 2000.

Genotypes	Characters							
	Number of days to 50% flowering	Number of days to maturity	Pod length (cm)	Pod weight (g)	Number of pods per plant	Yield per Plant (g)	Vitamin C content (%)	Protein content (%)
1 x 4	43	57	16.65	5.89	21	99.87	22.22	2.20
1 x 5	46	63	16.33	4.90	21	83.11	23.27	2.14
1 x 6	45	60	15.89	6.09	23	111.82	21.54	2.54
2 x 4	38	54	13.50	3.41	17	53.50	23.34	2.34
2 x 5	40	57	14.09	2.81	20	54.79	22.02	2.20
2 x 6	38	56	11.94	3.27	22	79.39	21.17	2.19
3 x 4	36	52	12.82	3.55	23	78.33	21.18	2.18
3 x 5	36	52	13.05	3.34	19	62.49	20.96	2.33
3 x 6	38	55	11.99	4.04	23	92.09	21.32	2.26

Table (2 b): Mean values for eight characters of snap beans F_3 generation grown in the autumn season of 2001.

Genotypes	Characters							
	Number of days to 50% flowering	Number of days to maturity	Pod length (cm)	Pod weight (g)	Number of pods per plant	Yield per Plant (g)	Vitamin C content (%)	Protein content (%)
1 x 4	44	57	16.10	5.31	21	99.42	22.61	2.13
1 x 5	45	61	16.45	4.04	20	83.02	23.38	2.10
1 x 6	44	59	15.68	6.11	21	113.44	23.59	2.02
2 x 4	38	53	13.61	3.38	16	52.99	23.51	2.12
2 x 5	40	55	14.33	2.85	19	54.27	23.69	2.11
2 x 6	38	55	11.92	3.07	22	78.70	23.49	2.15
3 x 4	35	51	12.89	3.45	19	76.83	23.21	2.29
3 x 5	35	51	13.07	3.22	18	60.29	23.18	2.21
3 x 6	38	55	11.87	4.01	23	93.09	23.67	2.29

Table (3 a): Mean values for eight characters of snap beans F_4 generation grown in the autumn season of 2000.

Genotypes	Characters							
	Number of days to 50% flowering	Number of days to maturity	Pod length (cm)	Pod weight (g)	Number of pods per plant	Yield per Plant (g)	Vitamin C content (%)	Protein content (%)
1 x 4	45	58	16.91	5.76	21	104.22	20.79	2.20
1 x 5	47	63	16.80	5.19	21	87.99	21.54	2.16
1 x 6	45	61	14.53	5.85	23	107.94	21.12	2.20
2 x 4	39	55	13.71	3.56	15	51.50	20.35	2.18
2 x 5	40	58	14.04	2.85	18	50.97	21.75	2.20
2 x 6	39	57	11.76	2.82	20	68.86	20.94	2.20
3 x 4	36	53	13.05	3.60	20	70.90	20.91	2.19
3 x 5	36	52	13.00	3.49	18	62.98	20.80	2.18
3 x 6	39	57	11.71	3.79	23	86.96	20.69	2.09

Table (3 b): Mean values for eight characters of snap beans F_4 generation grown in the autumn season of 2001.

Genotypes	Characters							
	Number of days to 50% flowering	Number of days to maturity	Pod length (cm)	Pod weight (g)	Number of pods per plant	Yield per Plant (g)	Vitamin C content (%)	Protein content (%)
1 x 4	44	58	16.53	5.47	20	103.93	22.02	2.08
1 x 5	46	61	16.64	5.13	21	89.64	22.48	2.08
1 x 6	44	60	15.29	5.34	22	105.41	22.56	2.15
2 x 4	38	54	13.90	3.51	15	51.58	22.73	2.17
2 x 5	40	57	14.37	2.63	18	50.80	22.89	2.07
2 x 6	38	57	11.87	2.91	20	64.57	22.76	2.16
3 x 4	35	52	13.05	3.09	18	68.07	22.46	2.24
3 x 5	35	52	13.14	3.29	17	62.47	22.45	2.24
3 x 6	38	56	11.34	3.46	23	86.01	22.79	2.10

Table (4 a): Mean values for eight characters of snap beans F_5 generation grown in the autumn season of 2000.

Genotypes	Characters							
	Number of days to 50% flowering	Number of days to maturity	Pod length (cm)	Pod weight (g)	Number of pods per plant	Yield per Plant (g)	Vitamin C content (%)	Protein content (%)
1 x 4	45	59	16.54	4.52	21	96.39	20.57	2.20
1 x 5	47	63	16.69	5.33	22	87.43	21.51	2.17
1 x 6	46	62	14.85	5.73	24	95.34	20.91	2.20
2 x 4	39	55	13.81	3.63	15	50.50	20.35	2.20
2 x 5	40	59	14.02	2.87	17	48.05	21.62	2.20
2 x 6	39	58	11.67	2.76	18	63.60	20.83	2.21
3 x 4	36	53	13.00	3.62	19	67.18	20.78	2.20
3 x 5	36	53	12.98	3.57	18	63.22	20.72	2.19
3 x 6	39	58	11.74	3.67	23	84.07	20.38	2.07

Table (4 b): Mean values for eight characters of snap beans F_5 generation grown in the autumn season of 2001.

Genotypes	Characters							
	Number of days to 50% flowering	Number of days to maturity	Pod length (cm)	Pod weight (g)	Number of pods per plant	Yield per Plant (g)	Vitamin C content (%)	Protein content (%)
1 x 4	45	59	16.74	5.55	21	96.35	21.72	2.22
1 x 5	47	62	16.74	5.17	21	88.29	22.03	2.19
1 x 6	45	61	14.60	5.12	23	95.73	22.04	2.29
2 x 4	38	54	13.71	3.50	15	50.21	22.33	2.14
2 x 5	40	57	14.39	2.69	17	48.80	22.49	2.10
2 x 6	38	57	11.84	2.83	18	58.51	22.39	2.19
3 x 4	36	52	13.14	3.32	17	66.70	22.09	2.40
3 x 5	36	52	12.85	3.33	17	63.23	22.08	2.40
3 x 6	39	57	12.08	3.35	23	84.31	22.35	2.44

Table (5): Mean squares for eight characters of snap bean parents, F_3, F_4 and F_5 grown in the autumn seasons of 2000 and 2001.

S.V.	Characters															
	Number of days to 50% flowering		Number of days to maturity		Pod length (cm)		Pod weight (g)		Number of pods per plant		Yield per Plant (g)		Vitamin C content (%)		Protein content (%)	
	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
Genotypes	49.38*	51.86*	42.89*	44.01*	12.58*	12.17*	4.99*	4.28*	28.98*	24.14*	1407.56*	1318.16*	1.98*	1.33*	0.05	0.05
Error	4.71	5.96	10.63	10.86	0.25	0.22	0.33	0.39	4.74	4.29	159.15	146.58	0.63	0.67	0.03	0.04

* Significant at 5% level.

Table (6): Heritability values for eight characters of snap bean F_3, F_4 and F_5 grown in the autumn seasons of 2000 and 2001.

Characters	F_3, F_4		F_4, F_5	
	2000	2001	2000	2001
Number of days to 50% flowering	0.59	0.61	0.55	0.55
Number of days to maturity	0.55	0.52	0.53	0.59
Pod length	0.57	0.61	0.51	0.50
Pod weight	0.55	0.51	0.43	0.52
Number of pods per plant	0.67	0.65	0.62	0.61
Yield per Plant	0.58	0.55	0.46	0.48
Vitamin C content	0.02	0.42	0.54	0.48
Protein content	0.01	0.17	0.62	0.54

Pod length, pod weight, number of days to 50% flowering, number of days to maturity, number of pods per plant and yield per plant had exhibited moderatly high heritability values in both 2000 and 2001 seasons for F4 on F3 regression. Similar results were obtained for F5 on F4 regression in both seasons for protein content, pod length, number of days to 50% flowering, number of days to maturity and number of pods per plant. The results agreed with those reported by Mebrahtu and Elmi (1993), Samal *et al.* (1995), Nandi *et al.* (1995), White *et al.* (1994), Scully *et al.* (1991) and Ranalli *et al.* (1996) on bean (*Phaseolus vulgaris* L.) for yield/plant, pod length, number of pods per plant, pod weight, number of days to 50% flowering and number of days to maturity.

Fluctuated records for F5 on F4 regression had been shown by the characters pod weight and vitamin C content exhibited moderatly high heritability in the first season and low in the other. According to Hassan (1992), fluctuation in environmental conditions, sowing date, plant population density, fertilization, irrigation, method of estimation, materials used, experimental sampling and (G x E) interaction, can influence greatly the values of heritability. Therefore, selection for a character should be based on replicated and seasonal tests, which have been followed partially in the current paper.

Correlation coefficient values between the eight characters for F_3,F_4 and F_5 generations are shown in Tables (7 a and b), (8 a and b) and (9 a and b), respectively. Correlation coefficient estimates of F_3, F_4 and F_5 generations for the characters, pod length with number of days to 50% flowering, pod length with number of days to maturity, pod weight with number of days to 50% flowering, pod weight with yield per plant, number of days to 50% flowering with number of days to maturity and number of pods per plant with yield per plant were positive and highly significant in both seasons of 2000 and 2001 for F_3, F_4 and F_5 generations. Additionally, similar results were obtained for the characters, number of days to 50% flowering with yield per plant in both seasons and number of days to maturity with number of pods per plant in the season of 2001 (F4 and F5 generations). The characters pod length with pod weight (F3) and pod weight with number of pods per plant (F5) exhibited similar results i.e. significantly positive high correlation in the season of 2000, while the characters, pod weight with number of days to maturity, number of days to maturity with yield per plant (F4) and number of days to 50% flowering with number of pods per plant (F5) showed significantly highly positive correlation in the season of 2001.

Table (7 a): Correlation coefficients between eight characters in F_3 generation of snap bean grown in the autumn season of 2000.

Characters	Yield per Plant	Number of pods per plant	Number of days to maturity	Number of days to 50% flowering	Pod weight	Pod length	Vitamin C content
Protein content	0.29	-0.09	0.02	0.11	0.36	0.13	0.15-
Vitamin C content	-0.22	-0.52	0.48	0.53	0.18	0.54	
Pod length	0.43	-0.01	0.73*	0.87*	0.78*		
Pod weight	0.86*	0.42	0.65	0.77*			
Number of days to 50% flowering	0.55	0.20	0.97*				
Number of days to maturity	0.52	0.28					
Number of pods per plant	0.79*						

* Significant at 5% level.

Table (7 b): Correlation coefficients between eight characters in F_3 generation of snap bean grown in the autumn season of 2001.

Characters	Yield per Plant	Number of pods per plant	Number of days to maturity	Number of days to 50% flowering	Pod weight	Pod length	Vitamin C content
Protein content	-0.18	0.11	-0.68*	-0.75*	-0.45	-0.72*	-0.08
Vitamin C content	-0.20	0.03	0.05	-0.09	-0.29	-0.35	
Pod length	0.35	-0.04	0.75*	0.86*	0.62		
Pod weight	0.88*	0.42	0.62	0.70*			
Number of days to 50% flowering	0.58	0.36	0.97*				
Number of days to maturity	0.61	0.47					
Number of pods per plant	0.75*						

* Significant at 5% level.

Table (8 a): Correlation coefficients between eight characters in F_4 generation of snap bean grown in the autumn season of 2000.

Characters	Yield per Plant	Number of pods per plant	Number of days to maturity	Number of days to 50% flowering	Pod weight	Pod length	Vitamin C content
Protein content	-0.15	-0.43	-0.02	0.05	0.02	0.27	0.23
Vitamin C content	0.02	0.21	0.56	0.45	0.05	0.35	
Pod length	0.46	0.15	0.59	0.79*	0.76*		
Pod weight	0.89*	0.60	0.63	0.81*			
Number of days to 50% flowering	0.70*	0.52	0.95*				
Number of days to maturity	0.60	0.55					
Number of pods per plant	0.86*						

* Significant at 5% level.

Table (8 b): Correlation coefficients between eight characters in F_4 generation of snap bean grown in the autumn season of 2001.

Characters	Yield per Plant	Number of pods per plant	Number of days to maturity	Number of days to 50% flowering	Pod weight	Pod length	Vitamin C content
Protein content	-0.35	-0.44	-0.75*	-0.73*	-0.37	-0.44	-0.06
Vitamin C content	-0.60	-0.05	-0.11	-0.36	-0.67*	-0.59	
Pod length	0.49	0.03	0.58	0.83*	0.78*		
Pod weight	0.88*	0.47	0.70*	0.85*			
Number of days to 50% flowering	0.71*	0.48	0.92*				
Number of days to maturity	0.68*	0.67*					
Number of pods per plant	0.78*						

* Significant at 5% level.

Table (9 a): Correlation coefficients between eight characters in F_5 generation of snap bean grown in the autumn season of 2000.

Characters	Yield per Plant	Number of pods per plant	Number of days to maturity	Number of days to 50% flowering	Pod weight	Pod length	Vitamin C content
Protein content	-0.34	-0.56	-0.10	-0.02	-0.07	0.26	0.28
Vitamin C content	-0.11	0.05	0.49	0.38	0.12	0.39	
Pod length	0.49	0.24	0.58	0.82*	0.72*		
Pod weight	0.80*	0.68*	0.63	0.79*			
Number of days to 50% flowering	0.71*	0.60	0.93*				
Number of days to maturity	0.58	0.61					
Number of pods per plant	0.90*						

* Significant at 5% level.

Table (9 b): Correlation coefficients between eight characters in F_5 generation of snap bean grown in the autumn season of 2001.

Characters	Yield per Plant	Number of pods per plant	Number of days to maturity	Number of days to 50% flowering	Pod weight	Pod length	Vitamin C content
Protein content	0.33	0.33	-0.42	-0.35	-0.05	-0.44	-0.24
Vitamin C content	-0.73*	-0.39	-0.19	-0.50	-0.84*	-0.65	
Pod length	0.52	0.27	0.60	0.85*	0.82*		
Pod weight	0.86*	0.62	0.63	0.85*			
Number of days to 50% flowering	0.74*	0.67*	0.92*				
Number of days to maturity	0.61	0.70*					
Number of pods per plant	0.90*						

* Significant at 5% level.

The correlation of protein content with number of days to 50% flowering and with number of days to maturity (F3 and F4 generations), vitamin C content with pod weight (F4 and F5 generations), protein content with pod length (F3 generation) and vitamin C content with yield per plant (F5 generation) was highly significantly negative in the season of 2001. These results were in line with the results recorded by Cerna and Beaver (1990), Emygdio *et al.* (1998), Vaid *et al.* (1986), Nienhuis and Singh (1986) on dry beans; Mishra *et al.* (1996), Shah *et al.* (1986), Rawat *et al.* (1984) on French bean; Garcia *et al.* (1997), Scully *et al.* (1991), Singh and Urrea (1994) on common beans; Santos *et al.* (1986), Samal *et al.* (1995), Morales and Singh (1993) on *Phaseolus* and Coyne (1968) on field bean.

It is obvious that most relationships between most studied characters specially the yield and its components which showed high positive correlation values indicating that the relationship is direct and the variation within and between the F_3, F_4 and F_5 generations were not due to chance but to genetic effect. Moreover, the fluctuation and variation in some records may be due to some environmental conditions. This may suggest that under good growing conditions and the usual plant population in the field significant negative correlation would not occur between yield and its components. That was in agreement with Coyne (1968), who found similar results on field bean. Besides, the high values of correlation could be due to more diverse parents and the use of single cross populations that have been applied here in the current paper.

It was very clear that progress could be achieved through selection because of the small effect of environmental conditions on the expression of the traits, which had moderate high heritability making them possible to identify the superiors. It is suggested that bulk population breeding would be more efficient and productive. Homozygous lines could be extracted in later generations and evaluated in replicated trials. This was in contrast to the results of Coyne (1968) on field bean. The obtained results of heritability and correlation support the use of early generation testing and selection among populations of the snap bean. Testing early generation yield and its components of bulk populations can be useful in estimating yield potential of crosses. This was in agreement with the results recorded by Singh and Urrea (1994) on common bean. It is essential to identify and discard as early as possible populations that give rise to low-yielding lines.

It could be concluded that, the most yielded offspring were (1x 4), (1 x 5), (1 x 6) and (3 x 6) for F_3, F_4 and F_5 generations in both seasons of 2000 and 2001. These mentioned genetic materials would be included in an advanced selection program to select the most promising individuals in late generations.

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الانتخاب للمحصول و مكوناته في الأجيال المبكرة للفاصوليا باستخدام الانحدار والارتباط.

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الملخص العربي

تسعة من نسل الأجيال الانعزالية المبكرة (الأجيال الثالث و الرابع و الخامس) المشتقة من تسعة هجن استخدمت لتقدير الارتباط بين ثمانية صفات والانحدار بين الجيل الثالث والرابع والجيل الرابع والخامس لتقدير درجة التوريث للمحصول وبعض مكوناته. أوضحت النتائج أن قيم درجة التوريث بالنسبة لصفة طول القرن تراوحت بين ٠,٥١ إلى ٠,٥٤ و بالنسبة لصفة وزن القرن تراوحت بين ٠,٥٢ إلى ٠,٥٨ وبالنسبة لصفة عدد قرون النبات تراوحت بين ٠,٣٩ إلى ٠,٤٨ وبالنسبة لصفة محصول النبات تراوحت بين ٠,٥٢ إلى ٠,٥٦. وقد كانت قيم الارتباط البسيط في الأجيال الثالث والرابع والخامس معنوية وعالية بين صفة محصول النبات وصفات عدد قرون النبات ووزن القرن مبينة أن تلك الصفات كانت تقريبا متساوية في أهميتها في المساهمة في صفة محصول النبات. وقد كانت معظم قيم الارتباط بين صفات مكونات المحصول منخفضة وموجبة مما يشير إلى إمكانية الانتخاب لزيادة واحدة من صفات مكونات المحصول بدون حدوث نقص في قيمة الصفات الأخرى. ولقد كانت تقديرات درجة التوريث متوسطة إلى مرتفعة بالنسبة لمعظم الصفات.