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GENETIC VARIATION, HERITABILITY AND RELATIVE CONTRIBUTION OF SOME YIELD TRAITS IN FABA BEAN PRODUCTIVITY

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ABSTRACT

Two field experiments were carried out at Nubaria Agricultural Research Station during the two winter seasons 2013/14 and 2014/15. Twelve faba bean genotypes were grown in a randomized complete block design with three replications to evaluate the performance for yield and its related traits. Variance of separate and combined analyses was computed to estimate some genetic parameters. Also, the associations among seed yield traits were studied using correlation and path analysis. Results showed significant differences among faba bean genotypes for all studied traits. Nubaria 1, Giza 716, Giza 843, 483/669/84 and 1001/543/84 gave the highest seed yield (ard/fed), 100-seed weight, number of seeds and pods per plant. Genotype x season interaction was insignificant for all studied traits except for flowering date, maturity date and 100-seed weight. This declared that the studied genotypes differed significantly for their ranks from one season to another. In the present study, the traits with high GCV% possessed high GS% percent and *vice versa* irrespective of the heritability estimates, indicating the importance of GCV%. High heritability (h^2) estimates and high genotypic coefficients of variation (GCV %) coupled with high genetic advance (GS %) indicate that these traits (number of branches per plant, number of pods per plant and 100-seed weight) seem to be highly easily fixable and can be taken as unit character for effective selection. The high estimates of GCV%, *h2* and GS % were observed for number of branches per plant, number of pods per plant and weight of 100-seeds regardless of the seasons which suggests the predominance of additive gene effects and that selection would be useful for the improvement of these traits. Correlation coefficients results suggest that selection for higher number of branches, 100-seed weight, number of seeds per plant and number of pods per plant would tend to increase seed yield in faba bean. Path analysis revealed that the traits *i.e.* number of pods, number of branches and the weight of 100 seeds gave the maximum influence directly and indirectly upon seed yield in faba bean, indicating their magnitude as selection criteria to obtain a valuable gain from selection for seed yield in faba bean.

Key Words: ***Vicia faba, Genetic Parameters, Broad-sense heritability, Correlation, Direct effect, Relative contributes, Path analysis.***

INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the oldest cultivated crops in the world as well as in Egypt. Faba bean is a grain legume grown for its high protein content (25.4%) in the seed (**Özdemir 2002**). Information on genetic variability and heritability is useful to formulate selection criteria for improvement of seed yield. Genetic variation among trials is important for breeding and in selection of desirable types. Yield stability is a major objective in any breeding program. This could be achieved through a better understanding of the components contributing to final yield. However, these components vary from year to year and from location to location, even for the same faba bean genotype. The success of a new faba bean variety depends on its yield and adaptation potential in those locations. Evaluation of stability performance and range of adaptation has become increasingly important in breeding programs (**Akçura *et al* 2006**). Genotype x Environment interactions (GEI) is of major importance, because they provide information about the effects of different environments on cultivar performance and play a key role for assessment of performance stability of the breeding materials (**Moldovan *et al* 2000**). Stable genotypes have the same reactions with high yield or performance (**Björnsson 2002**). Increasing genetic gains in yield are possible in part from narrowing the adaptation of cultivars (**Ayçiçek and Yıldırım 2006**). Thus maximizing yield in particular areas are explained by GEI (**Peterson *et al* 1989**). GEI is the differential response of genotypes evaluated under different environmental conditions. It is a complex phenomenon as it involves environmental (agroecolgical, climate & agronomic) conditions and all physiological and genetic factors that determine the plant growth and development (**Kaya *et al* 2006).**

Seed yield is a complex character which is determined by number of yield components and is frequently highly correlated. Selection is an integral part of a breeding program by which genotypes with high productivity in a given environment could be developed. However, selection high yield is made difficult because of its components of several characters, which are polygenic in inheritance and thus are highly influenced by environment. Therefore, only little progress could be made over a long span of time through direct selection for yield (**Tadesse *et al* 2011).** The improvement of faba bean production is focused on increasing both seed yield and its components.

Different statistical techniques are an important statistical procedure to evaluate breeding programs for high yield. Correlation coefficient analysis is an important statistical procedure to evaluate breeding programs for high yield. Path analysis is used to determine the amount of direct and indirect effects of the variables on the effect component. Indirect selection through yield components has been proved more effective. A greater chance of success in indirect selection for yield might come from selection for various morphological attributes such as duration of flowering, number of pods, seeds and seed size. These characters may be used in the construction of selection indices for the improvement of yield (**El-Hady *et al* 1998**). This selection criterion takes into account the information on interrelationships among agronomic characters. Nevertheless, selection for yield *via* highly correlated characters becomes easy if the contribution of different characters to yield is quantified using path coefficient analysis (**Dewey and Lu 1959**).

The aim of this work is to identify variability, correlation, and heritability estimates and some genetic parameters of plant characteristics and to determine the characteristics contributing to seed yield of faba bean.

In addition, using some statistical procedures to identify growth and plant characters related to faba bean yield.

MATERIALS AND METHODS

The present study was carried out at the Experimental Farm of Nubaria Agricultural Research Station, during 2013/14 and 2014/2015 seasons. Twelve faba bean genotypes from FCRI* **(Table 1)** were planted in a randomized complete block design with three replications. Each plot consisted of 6 rows, three meters long with 50 cm apart (plot size = 10.8 m^2). Plants were provided with normal irrigation. Cultural practices were applied as recommended. The days to flowering and maturity on a whole-plot basis, plant height (cm), number of branches/ plant, number of pods/plant, number of seeds/plant, seed yield /plant (g) and 100-seed weight (g) were recorded. The data of seed yield kg/plot were recorded from a central harvested area (1.2 m^2) and transformed to ardab/feddan.

Table 1. Pedigree and special characteristics of twelve faba bean parental genotypes.

Genotype name	Pedigree	Seed type	Characteristics
Giza 3	Cross (Giza 1 x Dutch Intr.)	*Equina*	Resistant to foliar disease, high yield potential.
Giza 674	Fam.402 x BPL582	*Equina*	Tolerant to *Orobanche*.
Giza 843	561/2076/85 × 461/845/83	*Equina*	Resistant to *Orobanche* and foliar diseases,
Giza 461	Cross (Giza3 x Colombia Intr.)	*Equina*	Resistant to foliar disease and high yield.
999/498/95	716/725/88 x 900/668/89	*Equina*	Resistant to foliar diseases.
Giza 716	461/843/83 × 503/453/84	*Equina*	Resistant to foliar diseases and early maturing.
Giza 717	503/453/83 x ILB938	*Equina*	Resistant to foliar diseases.
Nubaria 1	Spanish genotype (Rena Blanca)	*Major*	Resistant to foliar disease.
483/669/84	Individual plant selection from breeding materials.	*Equina*	Resistant to foliar diseases.
1001/543/84	716/725/88 x 900/634/89	*Equina*	Resistant to foliar disease.
756/1100/90	187/1104/80 x ILB1178	*Equina*	Resistant to foliar diseases.
952/797/93	Rena Blanca x 461/845/83	*Equina*	Resistant to foliar disease.

***FCRI: Field Crops Res. Institute**.

The statistical techniques

Statistical analysis was performed on quantitative characters for each season and pooled analysis was carried out when the errors were homogeneous. The homogeneity of variances for the two seasons was checked by use of **Levene (1960)** test. The combined data of seed yield and

its components across the two seasons of the study were analyzed. Analyses of variance were conducted and means of genotypes across seasons were determined for all traits. Least significant difference test was used to detect the significant differences among genotype means. Variance components (genotypic, phenotypic and error variance) were estimated using the formula of **Wricke and Weber (1986**) as follows:
$Vg = (MSg - MSe)/r$, $Ve = MSe$ and $Vph = Vg + Ve$ where Vg, Ve and Vph are the variances due to genotypes, error and phenotypes, respectively. MSg, MSe and r are the mean squares of genotypes, mean squares of experimental error and number of replications, respectively. Variance components of combined analyses across seasons were estimated according to **Snedecor and Cochran (1981**) as follows:
$V_g = (MS_g - MS_{gs})/ rs$, $V_{gs} = (MS_{gs} - MS_e)/ r$, $V_e = MS_e$ **and** $V_{ph} = V_g + V_{gs}/ r + V_e/ rs$**,** where V_g, V_{gs}, V_e and V_{ph} are the variances due to genotypes, genotype × seasons (G × S) interaction, experimental error and phenotypes, respectively. MS_g, MS_{gs} **and** MS_e are the mean squares of genotypes, G × S interaction and pooled error, and s denotes the number of seasons and r the number of replications. And value of broad-sense heritability of characters was by estimated the ratio of genotypic variance to phenotypic variance (σ^2_g/σ^2_p) (**Comstock and Moll 1963**).

A matrix of simple correlation coefficients between seed yield and its components were computed (**Snedecor and Cochran, 1981**). Relationships between the traits were through genotypic and phenotypic correlation and path coefficient. All correlation coefficients were worked out between all possible combinations of traits. The path coefficients analysis appeared to provide clue to the contribution of various components of yield to overall seed yield in the populations under study. It provides an effective way of finding out direct and indirect sources of correlation. Path coefficient analysis was carried out using the general formula of **Dewey and Lu (1959)** to determine the direct and indirect effects of the yield components and other morphological characters on seed yield.

RESULTS AND DISCUSSION

Data of results revealed that the studied genotypes differed significantly for all the traits in each season. The homogeneity of error across the two seasons was checked by use of **Levene (1960)** test, and then combined across the two seasons to test the significant differences among genotypes (G), seasons (S), and genotype by season interaction (G x S).

Results revealed that the studied genotypes differed significantly for all the traits (**Table 2**). The combined analysis of variance across the two seasons elucidates that seasons were significant for maturity date and number of branches/plant only. Therefore, it could be concluded that environmental effects significantly affected the performance of the present faba bean genotypes. However, the evaluation for two seasons under the same location has led to narrower environmental fluctuation, which might have resulted in insignificant effects of season on the performance of yield and some of the important components such as flowering date, plant height, number of branches/ plant, number of pods/plant, number of seeds/plant and 100-seed weight. These results are in agreement with those obtained by **El-Emam (2000) and Alghamdi (2007)**.

Results showed that genotype x season interaction were insignificant for all studied traits, except for flowering date, maturity date and 100-seed weight. This declared that the studied genotypes differed significantly for their ranks from one season to another. This result was in conformity with the results reported by **Alghamdi (2007)**.

Mean performance

Mean performance indicated the existence of diversity among the twelve genotypes in this study. **Table (2)** showed highly significant differences among the genotypes for all the studied traits.

Table 2. Mean performance of some yield traits for the twelve faba bean genotypes (combined across 2014 and 2015 seasons).

Genotype	Flowering	Maturity	Plant height (cm)	Branches	Pods /plant	Seeds /plant (g)	100-seed weight (g)	Seed yield (ard/fed)
Giza 3	46.17	160.50	123.05	2.73	18.13	52.27	80.70	7.12
Giza 674	48.83	163.67	115.02	3.31	18.15	50.32	64.42	7.30
Giza 843	47.67	162.17	108.92	3.03	24.52	71.27	86.40	9.12
Giza 461	59.33	165.00	126.95	2.80	15.15	44.33	68.18	6.73
999/498/95	43.00	164.17	130.12	2.95	15.80	45.95	63.95	7.15
Giza 716	50.83	155.00	119.53	4.07	26.02	75.12	72.80	9.22
Giza 717	50.33	160.33	115.47	3.82	14.93	42.95	58.88	5.90
Nubaria 1	71.67	170.00	101.98	7.07	13.37	54.75	122.75	9.88
483/669/84	44.33	156.50	132.27	4.32	22.97	66.08	84.00	8.35
1001/543/84	42.67	161.33	128.23	3.77	20.08	60.60	85.18	8.32
756/1100/90	41.17	157.17	120.75	2.68	22.08	66.37	79.73	8.22
952/797/93	44.50	156.51	117.25	3.28	18.62	57.17	75.40	8.12
Mean	**49.21**	**161.03**	**119.96**	**3.65**	**19.15**	**57.26**	**78.53**	**7.95**
LSD 0.05								
Season (S)	**NS**	0.81	**NS**	1.14	**NS**	**NS**	**NS**	**NS**
Genotype(G)	24.86	13.27	25.62	3.21	11.77	30.02	47.08	3.22
S x G	35.15	18.77	**NS**	**NS**	**NS**	**NS**	66.59	**NS**

Data revealed that the 756/1100/90 and 1001/543/84 genotypes possessed the earliest flowering plants (41.17 and 42.67 days), meanwhile Giza 716 and 483/669/84 had the earliest maturity date (155.00 and 156.50 days). On the other hand, Nubaria 1 possessed the latest flowering and maturity plants (71.67 and 170.00 days, respectively). The results revealed that the 483/669/84 genotype had the tallest plants (132.27 cm) across the two seasons. Regarding the number of branches per plant, the genotype (483/669/84) gave profuse branches (4.32). Results in Table (2) also showed that the genotypes (Giza 716 and Giza 843) produced the highest number of pods and seeds per plant being (26.02 and 24.52 pods) and (75.12 and 71.27 seeds), respectively. These genotypes significantly surpassed all tested genotypes considering the two previous traits. However, the heaviest weights of 100 seeds (122.75 and 86.40g) were recorded by Nubaria 1 and Giza 843.

The highest yielder genotypes combined across the two seasons were Nubaria 1, Giza 716, Giza 843, 483/669/84 and 1001/543/84 (9.88, 9.22, 9.12, 8.35 and 8.32 ard/fed) for seed yield (ard/fed), respectively. Meanwhile, the lowest one was Giza 717 and Giza 461(5.90 and 6.73 ard/fed), respectively. These results are in harmony with those reported by **Bastawisy *et al.*, (2006), Alghamdi (2007)** and **Osman *et al.* (2013)** who found significant differences among tested genotypes for seed yield and its related characters.

Genetic analysis

The variation among the genotypes was mostly due to genetics factors rather than environmental ones, as indicated by higher genetic variances which indicate that these traits were controlled by genes and are less influenced by the environment and simple in nature of their inheritance. The estimates of genetic variance (v_g), phenotypic (v_{ph}), genotypic (*GCV* %) and phenotypic (*PCV* %) coefficient of variability, broad-sense heritability and expected genetic advance under 5% selection intensity as percentage of the general mean (*GS %*) are presented in **Table (3)**. The phenotypic variance (v_{ph}) was greater than the genotypic variance (v_g) for all studied traits in both seasons and combined. For example, the flowering date scored v_{ph} and v_g variances of 223.99 and 223.00 in the first season, 232.63 and 231.63 in the second season and 74.17 and 73.74 in the combined analysis, respectively, whereas, seed yield ard/fed recorded values of 3.86 and 3.80 for the variances, in the first season, 4.27 and 4.10 in the second season and 1.37 and 1.20 in the combined analysis, respectively (**Table 3**). The phenotypic variance (v_{ph}) and genotypic variance (v_g) values for number of seeds per plant and 100-seed weight were high in both seasons and combined across seasons. These results are in confirmatory with these of **Alghamdi (2007).**

The extent of coefficient of variation indicated that high estimates of (*PCV* %) and (*GCV* %) were recorded for the number of branches/plant in both seasons and combined across seasons (46.27and 46.13), (75.01 and 74.86) and (31.51 and 31.47), respectively, for the 100-seed weight recorded (36.27 and 36.07), (36.23 and 36.02) and (21.33 and 20.98), respectively and for number of pods /plant (35.70 and 35.64), (37.85 and 37.70) and (20.94 and 20.87), respectively. That is suggesting wide spectrum of genotypic variation for these traits. Similar results were obtained by **Alghamdi (2007) and Mulualem *et al* (2013).** Meanwhile, the lowest values were scored for the maturity date in both seasons and combined across them (4.46 and 4.35), (5.00 and 4.95) and (2.71 and 2.69), respectively.

Heritability (h^2) estimates were generally different for all studied traits at separate analyses than combined one. The high broad-sense heritability was exhibited for all the studied traits. The lowest broad-sense heritability was exhibited for seed yield in combined analyses (0.87). These results indicated that the environmental factors had a small effect on the inheritance of such traits. High estimates of heritability indicated that selection based on mean would be successful in improving these traits. These results are in harmony with those obtained by **Alghamdi (2007) and Mulualem *et al* (2013).**

The high GCV recorded by the above mentioned traits alone is not sufficient for the determination of the extent of the advance to be expected by selection. **Burton (1952**) suggested that GCV together with heritability estimates would give the best picture of the extent of the advance to be expected by selection. Comparatively, the highest genetic advance as percent of mean was recorded for number of branches per plant in both seasons and combined analysis (94.73, 153.88 and 64.75), respectively, followed by number of pods per plant (73.30, 77.36 and 42.86), respectively and 100-seed weight (73.92, 73.78 and 42.49), respectively. Meanwhile, maturity date recorded the lowest genetic advance in both seasons and combined analysis (9.13, 10.08 and 5.53), respectively. These results are in harmony with those obtained by **Alghamdi (2007) and Mulualem *et al* (2013).**

In addition, the genotypic coefficient of variability was more important than heritability because characters showing maximum and minimum relative expected genetic advance possessed maximum and minimum genotypic coefficient of variability irrespective of the magnitude of heritability estimates. In the present study, it is obvious from **Table (3)** that traits with high GCV% possessed high GA percent and *vice versa* irrespective of the heritability estimates, indicating the importance of GCV%. In both seasons, high heritability (h^2) estimates and high genotypic coefficients of variation (GCV) coupled with high genetic advance (GS %) indicated that these traits (number of branches per plant, number of pods per plant and weight of 100-seeds) seem to be highly and easily fixable and can be taken as unit character for effective selection. The high estimates of GCV%, h2 and GS % were observed for number of branches per plant, number of pods per plant and weight of 100-seeds regardless of the season which suggests the predominance of additive gene effects and that selection would be useful for the improvement of these traits. Similar results were reported by several investigators such as **Alghamdi (2007), Bakheit *et al***

(2011), Fikreselassie and Seboka (2012) and Mulualem *et al* (2013) who confirmed that plant breeders can safely make their selection when they take into account high values of both heritability and genetic advance.

Table 3. Estimates of variance components, broad sense heritability (h^2), phenotypic (PCV %) and genotypic coefficients of variation (GCV %) and genetic advance as a percentage of mean (GA %) for the 12 faba bean genotypes at two seasons.

Traits	Season	Source of variance		PCV%	GCV%	h^2	GA%
		V_{ph}	V_g				
Flowering date	**1st**	223.99	223.00	30.17	30.11	99.01	61.89
	2nd	232.63	231.63	31.25	31.19	98.90	64.11
	Comb.	76.89	75.40	17.95	17.78	98.06	36.26
Maturity date	**1st**	51.19	50.80	4.46	4.45	99.00	9.13
	2nd	64.23	62.80	5.00	4.95	97.11	10.08
	Comb.	22.08	21.24	2.93	2.88	96.22	5.81
Plant height	**1st**	239.72	236.40	12.86	12.77	98.04	26.12
	2nd	248.66	240.71	13.20	12.98	96.26	26.31
	Comb.	85.47	79.66	7.71	7.44	93.20	14.80
No. of branches	**1st**	4.34	4.31	46.27	46.13	98.05	94.73
	2nd	4.41	4.39	75.01	74.86	99.00	153.88
	Comb.	1.28	1.25	31.04	30.68	97.72	62.48
No. of pods/plant	**1st**	49.63	48.47	35.94	35.52	97.67	72.31
	2nd	52.10	48.70	38.60	37.32	93.47	74.33
	Comb.	18.89	15.25	22.70	20.39	80.74	37.75
No. of seeds/plant	**1st**	360.34	348.81	33.07	32.54	96.80	65.95
	2nd	348.66	333.66	32.70	31.99	95.70	64.47
	Comb.	114.77	107.38	18.71	18.10	93.56	36.07
100-seed weight	**1st**	825.88	797.27	36.56	35.92	96.54	72.71
	2nd	728.97	689.70	34.39	33.45	94.61	67.04
	Comb.	283.24	263.33	21.42	20.66	92.98	41.04
Seed yield (ard/fed)	**1st**	4.01	3.76	23.83	23.10	93.91	46.11
	2nd	4.47	4.00	28.18	26.67	89.53	51.98
	Comb.	1.37	1.20	14.75	13.80	87.49	26.58

Correlation coefficients

Correlation coefficients for all comparisons among the studied traits are presented in **Table (4**). Significant differences were observed in the correlation coefficients in terms of magnitude and direction. The values of correlation coefficient showed that number of branches, 100-seed weight, number of seeds per plant and number of pods per plant had a highly significant and positive correlation with seed yield per plant (r=0.649**, r=0.641**, r=0.616** and r=0.511**, respectively). These results suggest that selection for higher number of branches, 100-seed weight, number of seeds per plant and number of pods per plant would tend to increase seed yield in faba bean. These findings are in agreement with those obtained by **Ulukan *et al* (2003), Alghamdi and Ali (2004**), **Alghamdi (2007**), **Tadesse *et al* (2011) and Yamani *et al* (2012).** Flowering and maturity date exhibited significant and positive correlation with seed yield (r=0.324 and r= 0.260), conversely, its association was insignificantly negative with plant height (r= - 0.155).

Table 4. Correlation coefficients among studied traits of faba bean genotypes (combined data n= 72).

Traits	Flowering date	Maturity date	Plant height	Branches	Pods /plant	Seeds /plant	100-seed weight
Maturity date	0.70**						
Plant height	-0.512**	-0.247*					
Branches	0.605**	0.396**	-0.301*				
Pods/plant	-0.397**	-0.497**	0.180	-0.056			
Seeds /plant	-0.186	-0.400**	-0.062	0.110	0.904**		
100-seed weight	0.559**	0.368**	-0.444**	0.634**	0.059	0.410**	
Seed yield /plant	0.324**	0.260*	-0.155	0.649**	0.511**	0.616**	0.641**

* and ** indicate significant at 0.05 and 0.01 level of probability, respectively.

In fact, selection decisions based only on correlation coefficients may not always be effective because it measures the mutual association between a pair of traits neglecting the complicated interrelationships among all traits (**Kang 1994**).Therefore, the correlation procedure may not provide a deep imagine about the importance of each component in the structure of seed yield. The path analysis can efficiently play this vital role.

Path analysis

The correlation coefficients were individually partitioned into direct and indirect effects. Direct and indirect effects for different significant six yield-related traits on seed yield are summarized in Table (5). It is noticed that all the direct effects were below one, suggesting that inflation due to multicolinearity was minimal (**Gravois and Helms 1992**). Positive direct effects were recorded for all seed yield traits, except flowering date (- 0.055) and number of seeds per plant (- 0.025), which were very small and negligible. The results indicated that number of pods per plant (0.712) exerted the highest positive direct effect on seed yield followed by number of branches per plant (0.428), maturity date (0.395) and 100-seed weight (0.220). **Mridula *et al* (1992), Abdelmula and Abdalla (1994), Tadesse *et al* (2011)** and **Yamani *et al* (2012)** confirmed that number of pods and number of branches were more interest which is in agreement with the present finding. From the results it can be concluded that seed yield can be increased by selecting genotypes having more 100- seed weight.

Considering the considerable components of the indirect effects, it is noted that number of seeds per plant had positive large indirect effects on seed yield through their associations with number of pods per plant (0.643). Meanwhile, a strong negative influence on seed yield was indirectly recorded by flowering date *via* the number of pods per plant (-0.283).

Regarding the weight of 100 seeds, it exhibited a considerable positive influence on seed yield through their associations with number of branches per plant.

Table 5. Direct (diagonal) and indirect effects of components traits attributing to seed yield in all studied faba bean populations at genotypic level.

Characters	Flowering date	Maturity date	Branches / plant	Pods/ plant	Seeds/ plant	100-seed weight	Correlation with seed yield
Flowering date	***-0.055***	0.277	0.259	-0.283	0.003	0.123	**0.324****
Maturity date	-0.039	***0.395***	0.170	-0.354	0.007	0.081	**0.260***
Branches/plant	-0.033	0.156	***0.428***	-0.040	-0.002	0.139	**0.649****
Pods/plant	0.022	-0.196	-0.024	***0.712***	-0.015	0.013	**0.511****
Seeds/plant	0.010	-0.158	0.047	0.643	***-0.017***	0.090	**0.616****
100-seed weight	-0.031	0.145	0.271	0.042	-0.007	***0.220***	**0.641****

Residual effect = 7.832%.

Trivial values of relative importance were observed for the other direct and indirect effects. Totally, the studied five characters explained 92.168 % of seed yield variation. In accordance, the residual part may be attributed to unknown variation (random error), committing of errors (7.832%) during measuring the studied characters and/or some other traits that were not incorporated in the present investigation.

The remainder indirect effects were very small and of low importance. An overall view on the results of path analysis, it is concluded that the traits *i.e.* numbers of pods, number of branches and the weight of 100 seeds gave the maximum influence directly and indirectly upon seed yield in faba bean. The current results are in harmony with those obtained by **Hakan *et al* (2003), Salama *et al* (2008), Tadesse *et al* (2011) and Yamani *et al* (2012)** who reported that these characters represent the main determinants of seed yield in faba bean.

The indirect effect for number of seeds per plant was more important compared to direct effects (**Tadesse *et al* 2011**). The marked parts of their effects was on seed yield *via* number of branches per plant, number of pods per plant and hundred seed weight. Then, there is a large scope of simultaneous improvement in faba bean seed yield as well as other yield components through selection taking into consideration these pairs of traits.

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التباين الوراثى وكفاءة التوريث والمساهمة النسبية لبعض الصفات الانتاجية فى الفول البلدى

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أجريت تجربتان حقليتان في محطة البحوث الزراعية بالنوبارية خلال موسمى **14/2013 – 15/2014.** وقد زرعت اثني عشر تركيبا وراثيا من الفول بتصميم القطاعات الكاملة العشوائية فى ثلاث مكررات لتقييم أداء المحصول والصفات المرتبطة به بهدف تقدير بعض المعالم الوراثية وذلك باستخدام مكونات التباين المتوقعة. كما تم دراسة معامل الارتباط البسيط والذى استخدم فى تحليل معامل المرور لتقدير الاهمية النسبية للصفات المحصولية الاكثر تاثيرا فى محصول بذور النبات. أوضحت النتائج ان هناك فروقا معنوية بين التراكيب الوراثية لجميع الصفات تحت الدراسة. واعطت النوبارية 1، الجيزة 716، الجيزة 843، 84/669/483 و84/543/1001 أعلى قيم لكل من محصول البذور (اردب/فدان) وزن-100 بذرة وعدد البذور والقرون على النبات، مما يشير الى تفوقها ويوصى بالتوسع فى إستخدامها فى برامج تربية الفول البلدى. اشارت النتائج معنوية التفاعل بين التركيب الوراثى والموسم لجميع الصفات المدروسة باستثناء ميعاد التزهير، وتاريخ النضج، ووزن- 100 بذرة. مما اوضح اختلاف ترتيب التراكيب الوراثية من موسم واحد إلى آخر. أشارت هذه الدراسة إلى الصفات العالية فى معامل الاختلاف الوراثى (GCV ٪) تكون ذات معدل تحسين وراثى عالي (GS٪) بغض النظر عن تقديرات التوريث (h^2)، مما يدل على أهمية GCV٪. أشارت هذه الدراسة إلى اهمية الجمع بين أعلى قيم من معامل الاختلاف الوراثى ودرجة التوريث مصحوبة بأعلى قيم للتحسن الوراثى المتوقع % التى تم الحصول عليها لصفات (عدد افرع النبات و عدد قرون النبات و وزن- 100 بذرة) ، حيث يمكن استخدام الانتخاب لهذه الصفات كوسيلة فعالة للتحسين. وكانت التقديرات العالية من GCV٪، h^2 و GS٪ لعدد من الفروع في النبات، عدد القرون للنبات ووزن 100 بذرة بغض النظر عن المواسم تشير إلى أن غلبة التأثيرات الجينية المضيفة وبالتالى الانتخاب لهذه الصفات يكون مفيدا للتحسين. اظهرت النتائج وجود علاقة ارتباط موجبة عالية المعنوية بين محصول بذور النبات و كل من صفة عدد افرع النبات و عدد قرون النبات و وزن- 100 بذرة مما يزيد من محصول البذور في الفول البلدى. أوضحت نتائج تحليل معامل المرور ان صفات عدد قرون النبات ، وعدد افرع النبات و كذا وزن- 100 بذرة كانت هى الاكثر إسهاما فى محصول بذور النبات سواء عن طريق التأثير المباشر او غير المباشر مما يشير إلى أهمية وضع هذه الصفات الثلاث فى الاعتبار من قبل المربى عند وضع برامج التربية لتحسين محصول الفول البلدى.