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THE RELATIVE IMPORTANCE OF SOME CHARACTERS TOWARD SEED YIELD IN THREE FABA BEAN CULTIVARS GROWN UNDER THREE FIRST IRRIGATION DATES

Abd-El hafez[*], G. A. and W. M. Fares[**]
[*] Food Legume Crops Res. Sec., Field Crops Res. Inst., ARC, Giza.
[**] Central Lab. For Design & Stat. Analysis Res., ARC, Giza.

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ABSTRACT

Two field trails were carried out at the farm of Mallawy Research Station, Minia governorate during ٢٠١٠/٢٠١١ and ٢٠١١/٢٠١٢ seasons. The study aimed to evaluate the performance of three cultivars of faba bean i.e. Misr ١, Giza ٤٢٩ and Giza ٨٤٣ under three first irrigation dates being ٢٠, ٤٠ and ٦٠ days from sowing. Simple correlation and path analysis procedures were also used to study the relationships between seed weight/plant and its components in faba bean. The experimental design used split-plot design with four replicates. The irrigation treatments were assigned to the main plots, while the sub plots were devoted to the tested cultivars. Results indicated that delaying the first irrigation date up to ٦٠ days after sowing significantly decreased all the studied characters. When the plants irrigated after ٤٠ days from sowing, all the studied characters were significantly increased giving their highest values. Giza ٨٤٣ cultivar surpassed the other two cultivars regarding most characters. Concerning to the interaction between first irrigation date and faba bean cultivars, results indicated that, Giza ٨٤٣ cultivar under irrigation condition of first irrigation (٤٠ days after sowing) recorded higher values of number of branches (٥.٠٣), pods (١٧.٢١), seeds (٤٩.٦) and seed yield (٣٤.٠ gm) per plant which reflected on seed yield (١٥.٦٣ ardab) per feddan comparing with other interactions. Accordingly,

we can recommend this treatment to faba bean growers in Middle Egypt. There was a highly significant and positive correlation between seed weight/plant and each of number of seeds, pods, and number of branches/plant, plant height, and the weight of ١٠٠ seeds. Path analysis revealed that number of seeds/plant had the highest direct and indirect influence on seed weight/plant of faba bean, followed by number of pods/plant indicating their importance as selection criteria to improve crop productivity of faba bean.

INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the most important pulse crop cultivated in Egypt. It is a basic source of high quality and inexpensive protein for middle and low income people. Furthermore, it is known as an atmospheric nitrogen fixer that enriches the soil with nitrogen and organic matter (Pala *et al*, ١٩٩٧). Since, the available water to reclaim more new lands is limited, so it is necessary to increase productivity of unit area (vertical expansion) to fill the gape between production and consumption by choosing the suitable cultural practices such as irrigation regimes, high yielding ability varieties and so on. Minguez *et al* (١٩٩٣), Abd Alla and Omran (٢٠٠٢), Ahmed *et al* (٢٠٠٨) and Al Suhaibani (٢٠٠٩) reported that the shortage of water is considered a determinant factor on faba bean vegetative growth as well as seed formation. However, Ahmed *et al* (٢٠٠٨), El-bably and Abo Mostafa (٢٠٠٨) decided that plants under unfavorable condition and low water supply, decrease photosynthesis, rate lower translocation from source to thing and thus yield and its components were decreased. Moreover, El-Shaboury (٢٠٠٧) revealed that the reduction in seed weight/plant and seed yield/feddan was related to the harmful effect of water stress during early growth stage. Several investigators such as Bastawisy *et al* (٢٠٠٦) and El-Galaly *et al* (٢٠٠٨) found significant differences among tested genotypes of faba bean for seed yield and most yield components.

Improvement of a complex and low heritable trait like yield may be fast successful using indirect selection through other yield components which showed strong association with yield and are more heritable than yield itself. Therefore, finding out the components

having the greatest effect on the yield and their relative contributions to yield variability is major importance.

Breeding decisions that based only on correlation coefficient may not always be effective since they provide only one-dimensional information neglecting the complex interrelationships among plant traits (kang, ١٩٩٤).

Path analysis separates the direct effects from the indirect effects through other traits by partitioning the simple correlation coefficient. The previous two statistical procedures were applied by many investigators in faba bean, such as Awadalla and Abdel Wahab (١٩٩٤), Ashmawy *et al* (١٩٩٨), Salama *et al* (٢٠٠٨) and Tadele *et al* (٢٠١١).

In Egypt, little efforts were done concerning the effect of water limitation on growth and seed yield of faba bean and studying the relationships between seed yield and its components under these conditions.

Therefore, the objectives of this study aimed to investigate the effect of three dates of first irrigation after sowing on yield and its components of three faba bean cultivars, and to determine the relationships between seed yield and its characters using simple correlation coefficient and path analysis. The results may help in planning appropriate selection program for improving faba bean crop.

MATERIAL AND METHODS

Two field experiments were conducted at the Agricultural Research Station farm of Mallawy, Minia governorate, during the two winter seasons of ٢٠١٠/٢٠١١ and ٢٠١١/٢٠١٢. The study aimed to investigate the effect of the first irrigation dates on nodulation, growth, seed yield and its components of three faba bean cultivars. Also, to find out the relationships between seed yield and its related characters using two statistical procedures i.e. simple correlation and path analysis .

The treatments were arranged in a split-plot design with four replications. The first irrigation application (٢٠, ٤٠ and ٦٠ days from sowing) were assigned to the main plots while the sub-plots contained

the faba bean cultivars (Misr ١, Giza ٤٢٩ and Giza ٨٤٣). Each sub-plot consisted of ٨ ridges of ٤ m long and ٠.٦m apart (plot area = ١٩.٢m^2). Sowing was done at the first week of November in both seasons. All other cultural practices were applied as recommended.

Three plants from each plot were taken after ٧٥ days from sowing to determine the number and dry weight of nodules/plant. Days to ٥٠ and ٩٠٪ flowering and maturity, respectively were recorded on the plot basis. At harvest, ten plants were randomly selected from the inner ridges to estimate the following characters: Plant height (cm), number of branches, pods and seeds/plant, ١٠٠-seed weight (gm) and seed weight/plant (gm). Seed yield (Ardab/Fadden) was determined from the yield data of the central area (٧.٢ m^2) of the plot, then the data were transformed to the unit of Ardab /Fadden.

Statistical procedures:

١-Analysis of Variance:

Data of each season were subjected to analysis of variance. Homomoginety test for error variance of the two seasons was performed according to Levene test (١٩٦٠). Then combined analysis of variance over the two seasons was carried out as suggested according to Snedecor and Cochran (١٩٨٩). Significant differences among treatment means were detected using least significant difference test (LSD) at ٥٪ probability level.

٢- Correlation matrix:

The coefficients of correlation between all pairs of the studied traits were computed as suggested by **Snedecor and Cochran (١٩٨٩).**

٣- Path analysis:

This methodology was primarily proposed by Wrights (١٩٢١ and ١٩٣٤), that was rediscovered and used by Dewey and Lu (١٩٥٩) in the agricultural researches.

In agriculture, path analysis has been usually used by plant breeders or agronomists to assist in identifying useful traits as selection criteria to improve crop yield.

The relative importance of some characters toward seed yield

The method permits to separate the simple correlation coefficient between the seed weight/plant (as a dependent variable) and all other characters, except number and dry weight of nodules/plant (as independent variables) into direct effect (path coefficient) and indirect effects.

RESULTS AND DISCUSSION

The results exhibited homogeneity of error variance over the two growing seasons for all studied characters that permits to apply combined analysis. Accordingly, the mean values of nodulation, seed yield and interrelated characters of faba bean as affected by first irrigation date and cultivars, over both seasons, are presented in Table ٢.

Effect of the first irrigation date:

Results in Table ١ indicate that nodulation, seed yield and its related characters were markedly affected by the date of first irrigation. The number and dry weight of nodules/plant significantly decreased by ٦.١٣ (٥.٢٪) and ٤٨.٠٥mg (٦.٥٪), respectively with delaying the first irrigation application from ٢٠ to ٤٠ days after sowing. Further delay in the first irrigation up to ٦٠ days caused a dramatic depression in the previous two traits by almost ٥٠٪. So, it is clear that water deficit lead to reduced faba bean root system especially lateral roots which reflected on number and dry weight of nodules.

Regarding the earliness traits i.e. days ٥٠٪ flowering and days to ٩٠٪ maturity it was noted that the irrigated plants after ٦٠ days from sowing were the latest in flowering (٥٣.٦٣ days) but the earliest in maturity (١٤٠.٤٢ days). This result is not surprise but it expected because the plants haste to make maturity under the stress conditions. No significant differences were found between the averages of days to ٥٠٪ flowering and days to ٩٠٪ maturity when the first irrigation was applied after ٢٠ or ٤٠ days of sowing. Similar results were obtained by Ahmed *et al* (٢٠٠٨) and Al-Suhaibani (٢٠٠٩) who indicated that faba bean plants under water stress conditions try to escape from these unfavorable conditions by ending their life few days earlier than those under normal or high soil moisture content.

Table ١: Means of nodulation, flowering and maturity as affected by first irrigation date and faba bean cultivars and their interaction (combined data over the two seasons ٢٠١٠/٢٠١١ and ٢٠١١/٢٠١٢).

Characters / Treatments	Nodules		Days to	
	Number	Dry weight (mg)	٥٠٪ flowering	٩٠٪ maturity
Frist Irrigation:				
٢٠ days (T١)	١١٧.٦٧	٧٣٩.٩٠	٥٠.٣٣	١٤٤.٨٣
٤٠ days (T٢)	١١١.٥٤	٦٩١.٨٥	٥٠.٣٣	١٤٣.٥٨
٦٠ days (T٣)	٥٥.٠٠	٣٣٦.٣٢	٥٣.٦٣	١٤٠.٤٢
LSD at (٥ %)	**٢.٧٣**	**٣٣.٥١**	**١.٧٠**	**٣.٢٠**
- Cultivars:				
Misr ١ (C١)	٩٣.٦٧	٥٥٧.١٤	٥٥.٤٦	١٤٥.٠٠
Giza ٤٢٩ (C٢)	٨٩.٦٧	٦١٦.٠٢	٤٥.٥٠	١٤٣.٣٣
Giza ٨٤٣ (C٣)	١٠٠.٨٨	٥٩٤.٩١	٥٣.٣٣	١٤٠.٥٠
LSD at (٥ %)	**٢.٧٠**	**٢٢.٣**	**١.٦٥**	**٢.١٩**
- Interaction:				
T١ x C١	١١٦.٢٥	٧١١.٤٠	٥٤.٦٣	١٤٧.٥٠
T١ x C٢	١١٢.٧٥	٧٧٦.٦٩	٤٥.٠٠	١٤٤.٣٨
T١ x C٣	١٢٤.٠٠	٧٣١.٦١	٥١.٣٨	١٤٢.٦٣
T٢ x C١	١٠٩.٨٨	٦٣٥.٣٣	٥٤.١٣	١٤٥.٣٧
T٢ x C٢	١٠٦.٥٠	٧٤٢.٥٥	٤٤.٦٣	١٤٣.٨٨
T٢ x C٣	١١٨.٢٥	٦٩٧.٦٦	٥٢.٢٥	١٤١.٥٠
T٣ x C١	٥٤.٨٨	٣٢٤.٦٩	٥٧.٦٣	١٤٢.١٣
T٣ x C٢	٤٩.٧٥	٣٢٨.٨١	٤٦.٨٨	١٤١.٧٥
T٣ x C٣	٦٠.٣٨	٣٥٥.٤٥	٥٦.٣٨	١٣٧.٣٨
LSD at (٥ %)	**NS**	**٣٨.٦٣**	**NS**	**NS**
CV %	**٤.٨٩**	**٦.٤٨**	**٥.٥٠**	**٢.٦٣**

Results in Table ٢ exhibit that plant height was significantly decreased by ٧.١٢cm (٤.٨٪) and ٣٤.٢٩ cm (٢٣.١٪) with delaying the first irrigation date from ٢٠ to ٤٠ and ٦٠ days of sowing, respectively. The depression in plant height may be attributed to the harmful effect of inadequate water in the early stage of plant age on cell turgor which in turn affects cell enlargement. These results are in harmony with the findings obtained by Abd Alla and Omran (٢٠٠٢), Al-Suhaibani (٢٠٠٩) who mentioned that plants under water stress are commonly shorter than those given higher amount of water.

The relative importance of some characters toward seed yield

Results in Table ٢ indicte that delaying the first irrigation to ٤٠ days from sowing significantly recorded the highest values of number of branches (٤.٦٠), pods (١٥.٨٨) and seeds (٤٥.١١) per plant as well as ١٠٠ seed weight (٦٨.٣٨ gm). Whereas, the lowest values resulted with delaying the first irrigation to ٦٠ days from planting. The present findings may be returned to the negative effect of water deficit especially at early growth stage on metabolic processes which depressed the formation of dry matter as well as its translocation from source to sink. These results are in parallel to Ahmed *et al* (٢٠٠٨), El-Bably and Abo Mostafa (٢٠٠٨) who decided that the plants under unfavorable conditions as well as low water supply led to decrease the rate of photosynthesis, lower translocation from stem and leaves to sink and thus yield and its related characters were effectively decreased.

Similarly, seed weight/plant and seed yield per feddan were significantly affected by the date of first irrigation, where they recorded the highest values (٣٠.٩٢ g and ١٤.٠٨ ardab, respectively) when the faba bean plants were irrigated after ٤٠ days from sowing. However, more delay in the first irrigation (٦٠ days after sowing) depressed both seed weight/plant and seed yield per feddan by ٤٦ and ٤٦٪, respectively (Table ٢). This reduction in both traits may be return to the harmful effect of water stress during the early growth stage which remained to affect the dry matter accumulation in the late stage of plant age and it adversely effect or yield and its components. These findings are in agreement with those reported by the El-Sitshaboury (٢٠٠٧), El-Bably and Abo Mostafa (٢٠٠٨) and Al-Suhaibani (٢٠٠٩).

Table ٢: Means of faba bean seed yield and its components as affected by first irrigation date and faba bean cultivars and their interaction (combined date over the two seasons ٢٠١٠/٢٠١١ and ٢٠١١/٢٠١٢).

Characters Treatments	Plant height (cm)	Number of			١٠٠-seed weight (gm)	Seed yield (gm) /plant	Seed yield Ard./fid.
		Branches /plant	Pods /plant	Seeds /plant			
Frist irrigation:							
٢٠ days (T١)	١٤٨.٥٨	٤.٠١	١٢.٣٩	٣٥.٥٥	٦٦.٤٩	٢٣.٦٥	١١.٢٠
٤٠ days (T٢)	١٤١.٤٦	٤.٦٠	١٥.٨٨	٤٥.١١	٦٨.٣٨	٣٠.٩٢	١٤.٠٨
٦٠ days (T٣)	١١٤.٢٩	٢.٩٨	١٠.٧٤	٢٩.٤٦	٦٤.٤١	١٨.٦٣	٧.٦٣
LSD at (٥ %)	٤.٧٤	٠.٣٣	٠.٨٨	٢.٧١	١.٣٦	١.٦٤	٠.٦٤
- Cultivars:							
Misr ١ (C١)	١٣٥.٨٨	٣.٨٩	١٣.١٥	٣٦.٨٢	٦٨.٨٠	٢٥.٢٤	١١.٢١
Giza ٤٢٩ (C٢)	١٢٤.٠٤	٣.٤٥	١١.٩٦	٣٣.٢٢	٦٤.٦٦	٢١.٣٢	٩.٤٤
Giza ٨٤٣ (C٣)	١٤٤.٤٢	٤.٢٤	١٣.٩٠	٤٠.٠٨	٦٥.٨٣	٢٦.٦٣	١٢.٢٥
LSD at (٥ %)	٤.٣٢	٠.٢٣	٠.٧٦	٢.١٠	١.٥٨	١.٥٢	٠.٧٦
- Interaction:							
T١ x C١	١٥٤.٣٨	٤.٠٠	١٢.٣٤	٣٤.٩٨	٦٩.٤٤	٢٤.٣٠	١١.٢٦
T١ x C٢	١٣٣.٧٥	٣.٥٤	١١.١٤	٣١.٤٥	٦٤.٨٠	٢٠.٤٠	٩.٥٦
T١ x C٣	١٥٧.٦٣	٤.٤٩	١٣.٦٩	٤٠.١٢	٦٥.٢٤	٢٦.٢٤	١٢.٧٨
T٢ x C١	١٤٠.٦٢	٤.٥٩	١٥.٩٦	٤٥.٦٤	٧١.٠٣	٣٢.٤٦	١٤.٣٥
T٢ x C٢	١٣٠.٠٠	٤.١٨	١٤.٤٨	٤٠.٠٩	٦٥.٦١	٢٦.٢٩	١٢.٢٥
T٢ x C٣	١٥٣.٧٥	٥.٠٣	١٧.٢١	٤٩.٦٠	٦٨.٥١	٣٤.٠٠	١٥.٦٣
T٣ x C١	١١٢.٦٣	٣.٠٩	١١.١٤	٢٩.٨٤	٦٥.٩٤	١٨.٩٦	٨.٠٣
T٣ x C٢	١٠٨.٣٨	٢.٦٤	١٠.٢٨	٢٨.١٣	٦٣.٥٦	١٧.٢٦	٦.٥٠
T٣ x C٣	١٢١.٨٨	٣.٢٠	١٠.٨٠	٣٠.٤٣	٦٣.٧٤	١٩.٦٥	٨.٣٥
LSD at (٥ %)	٧.٤٧	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CV %	٥.٤٨	١٠.١١	٩.٩٥	٩.٧٨	٤.٠٨	١٠.٦٤	١١.٨٣

Effect of cultivars:

Results in Table ٢ showed significant differences among tested cultivars for all studied characters. The results appeared that Giza ٨٤٣ had the highest number of bacterial nodules/plant (١٠٠.٨٨), while Giza ٤٢٩ gave the heaviest weight of nodules/plant (٦١٦. ٠٢). Plants of Giza ٤٢٩ were the earliest cultivar in flowering (٤٥.٥ days), while Giza ٨٤٣ was the earliest in maturity with in only ١٤٠.٥ days

from planting to ٩٥٪ maturity comparing to ١٤٥ days for Misr ١ which was the latest one in flowering and maturity.

Similar pattern of cultivars performance considering the two traits i.e. plant height and number of branches/plant. The tallest plants (١٤٤.٤٢ cm) and the highest number of branches/plant (٤.٢٤) were recorded by Giza ٨٤٣ followed by Misr ١ (١٣٥.٨٨ cm and ٣.٨٩), while Giza ٤٢٩ recorded the lowest values for these traits (١٢٤.٠٤ and ٣.٤٥), respectively. Plant height and number of branches/plant are important characters since they reflected on plant vigor, which may lead to high yield. Also, the tested cultivars were arranged in the same descending order concerning both number of pods and seeds/plant as before Giza ٨٤٣ (١٣.٩٦ and ٤٠.٠٨), Misr ١ (١٣.١٥ and ٣٦.٨٢) and Giza ٤٢٩ (١١.٩٦ and ٣٣.٢٢), respectively. Regarding ١٠٠ seed weight, Misr ١ produced the heaviest weight of ١٠٠ seed (٦٨.٨٠ g) comparing to Giza ٨٤٣ (٦٥.٨٣g) and Giza ٤٢٩ (٦٤.٦٦g).

The results indicated that Giza ٨٤٣ gave the maximum seed weight/plant and seed yield (ardab/fed) which were ٢٦.٦٣ g and ١٢.٢٥ ardab/fed, followed by Misr ١ (٢٥.٢٤ and ١١.٢١) and Giza ٤٢٩ (٢١.٣٢ and ٩.٤٤), respectively. Similar results were reported by several investigators such as Bastawisy *et al* (٢٠٠٦), El-Galaly *et al* (٢٠٠٨) who found significant differences among tested genotypes for yield and most yield components.

Interaction effect:

It is obvious to note from Tables (١ and ٢) that the interaction between first irrigation and cultivars was not significant for all studied characters except dry weight nodules/plant

It is clear that, Giza ٤٢٩ cultivar gave the highest values of dry weight of nodules (٧٧٦.٦٩ and ٧٤٢.٥٥ mg) under both irrigation conditions of first irrigation (٢٠ and ٤٠ days planting) than those other interactions (Table ١).

On the other hand, Giza ٨٤٣ cultivar under the irrigation condition of first irrigation (٤٠ days after sowing) recorded higher values of number of branches (٤.٠٣), pods (١٧.٢١), seeds (٤٩.٦) and seed yield (٣٤.٠ gm) per plant which reflected on seed yield (١٥.٦٣ ardab) per feddan comparing with other combinations (Table ٢). This

means that, this cultivar more adapted for middle Egypt and can be recommended to faba bean growers in this region.

On the other hand, estimation of coefficient of variation (CV) were located at the statistically for each character.

٢- Correlation matrix:

The matrix of simple correlation among seed weight/plant and its related characters over the two seasons (n=٧٢) is presented in Table ٣. Results showed that the most important relationships to faba bean breeder were those between seed weight/plant and each of number of seeds/plant (r=٠.٨٩٥**), number of pods/plant(r=٠.٨٢٥**), number of branches/plant (r=٠.٧٦٠**), plant height (r=٠.٦٤٤**) and ١٠٠ seed weight (r=٠.٤٠٨**). It is evident that the selection for the previous traits would improve the productivity of faba bean due to their positive and highly significant associations with yield. On the other hand characters of yield components appeared various trend of associations among themselves. The relationships between each of days to flowering and days to maturity and the most other characters were found as non-significant relationship which indicat to the yield performance was not influenced by the earliness traits.

Highly significant and positive correlation was obtained between plant height and each of number of branches, pods and seeds/plant and the weight of ١٠٠ seeds recording r= ٠.٧٢١**, r==٠.٥٤٤** r=٠.٦٢٠** and r=٠.٤٣٧** respectively. Also, number of branches/plant was highly significant positive correlated with each of number of pods/plant (r=٠.٧٦٠**), number of seeds/plant (r=٠.٧٥٦**) and the weight of ١٠٠ seeds (r=٠.٥٠٧**). Obviously, seed producing advantage of more branches resulted in giving more pods/plant. The tall and more tillering plants have large leaf area that are capable of greater photosynthetic activity lead directly to increase pods, seed formation and yield.

The relative importance of some characters toward seed yield

Table ٣: Correlation matrix of seed weight/plant and its related characters (combined date over the two seasons ٢٠١٠/٢٠١١ and ٢٠١١/٢٠١٢).

Characters	DF	DM	PH	NOB	NOP	NOS	١٠٠ SW	SWP
DF	١							
DM	٠.٢٣٧	١						
PH	٠.٠٦٥	٠.٢٢٥	١					
NOB	٠.٠٨٤	٠.٢٥٦*	٠.٧٢١**	١				
NOP	٠.٠٩٨	٠.١٧٧	٠.٥٤٤**	٠.٧٦٠**	١			
NOS	٠.٠٦٠	٠.١٤٦	٠.٦٢٠**	٠.٧٥٦**	٠.٧٠٩**	١		
١٠٠ SW	٠.٢٤٣*	٠.٢٦٠*	٠.٤٣٧**	٠.٥٠٧**	٠.٤٢٤**	٠.٤٦٦**	١	
SWP	٠.١٤٣	٠.٢١٢	٠.٦٤٤**	٠.٧٦٠**	٠.٨٢٥**	٠.٨٩٥**	٠.٤٠٨**	١

Abbreviations: NON: number of nodules, WON: dry weight of nodules, DF: days to flowering, DM: days to maturity PH: plant height, NOB: number of branches/plant, NOP: number of pods/plant, NOS: number of seeds/plant, ١٠٠ SW: ١٠٠ seed weight, SWP: seed weight/plant and SY: seed yield/feddan. * and **: Significant at ٠.٠٥ and ٠.٠١ probability levels, respectively.

Highly significant positive correlation was observed between number of pods/plant and number of seeds/plant with r value being ٠.٧٠٩**. In the same view, the associations between the weight of ١٠٠ seeds and each of number of pods/plant were positive and highly significant being r= ٠.٤٢٤** and ٠.٤٦٦**, respectively. These findings are in agreement with those reported by Ashmawy *et al* (١٩٩٨), Salama *et al* (٢٠٠٨), Tadele *et al* (٢٠١١) and Yamani *et al* (٢٠١٢).

In fact, the information from correlation coefficients between seed weight and each of related characters could give initial idea about what the important ones must be taken in consideration by breeders. Selection decisions based only on correlation coefficient may not always be effective because it measures the mutual association only between a pair of traits neglecting the complicated interrelationships among other traits (Kang, ١٩٩٤). However, such effectiveness could be extended by partitioning the simple correlation coefficient into direct and indirect effects using path analysis.

٣- Path analysis:

The matrix of direct and joint effects of the studied characters are shown in Table ٤. The maximum direct effects were observed for number of seeds/plant (٠.٦٣١), followed by the number of pods/plant (٠.٣٩١). The high positive direct effects of the previous two traits in addition to their highly significant positive coefficients of correlation proved the indirect selection for seed yield through these two traits would be effective to improve the productivity of faba bean yield. In contrast, although significant correlation coefficients were recorded between seed weight/ plant and each of plant height, number of branches/plant and the weight of ١٠٠ seeds, their direct effects were negligible. These results may be attributed to that path analysis discarded the components of indirect effects form the correlation coefficient.

Table ٤: The direct and joint effects of predictor characters on seed weight/plant (combined date over the two seasons ٢٠١٠/٢٠١١ and ٢٠١١/٢٠١٢

Characters	DF	DM	PH	NOB	NOP	NOS	١٠٠ SW	SWP
DF	**٠.٠٧٨**	٠.٠١٢	٠.٠٠٧	-٠.٠٠٥	٠.٠٣٨	٠.٠٣٨	-٠.٠٢٤	٠.١٤٣
DM	٠.٠١٨	**٠.٠٤٩**	٠.٠٢٦	-٠.٠١٧	٠.٠٦٩	٠.٠٩٢	-٠.٠٢٦	٠.٢١٢
PH	٠.٠٠٥	٠.٠١١	**٠.١١٥**	-٠.٠٤٧	٠.٢١٣	٠.٣٩١	-٠.٠٤٤	٠.٦٤٤**
NOB	٠.٠٠٧	٠.٠١٣	٠.٠٨٣	**-٠.٠٦٥**	٠.٢٩٧	٠.٤٧٧	-٠.٠٥١	٠.٧٦٠**
NOP	٠.٠٠٨	٠.٠٠٩	٠.٠٦٢	-٠.٠٤٩	**٠.٣٩١**	٠.٤٤٧	-٠.٠٤٣	٠.٨٢٥**
NOS	٠.٠٠٥	٠.٠٠٧	٠.٠٤١	-٠.٠٤٩	٠.٢٧٧	**٠.٦٣١**	-٠.٠٤٧	٠.٨٩٥**
١٠٠ SW	٠.٠١٩	٠.٠١٣	٠.٠٥٠	-٠.٠٣٣	٠.١٦٦	٠.٢٩٤	**-٠.١٠١**	٠.٤٠٨**

Abbreviations: NON: number of nodules, WON: dry weight of nodules, DF: days to flowering, DM: days to maturity PH: plant height, NOB: number of branches/plant, NOP: number of pods/plant, NOS: number of seeds/plant, ١٠٠ SW: ١٠٠ seed weight, SWP: seed weight/plant and SY: seed yield/feddan.
The direct effects occupied the diagonal cells (bold and underline).

In accordance, the components of indirect effects were more important than the direct effects considering the previous three traits. The highest values of indirect effects, for all studied characters, were recorded via each of number of pods/plant and seeds/plant. From the

current results, it is concluded that among the studied traits, number of pods/plant and seeds/plant had the greatest influence directly or indirectly upon seed weight/plant in faba bean.

In fact, the path analysis gave same what different picture from what the simple correlation did. For example, the simple correlation coefficients between seed weight/plant and each of number of branches/plant (٠.٧٦٠**) and the weight of ١٠٠ seeds (٠.٤٠٨**) was positive and highly significant giving misleading impression that the two traits had strong positive effects on seed weight/plant. The path analysis, however, exposed that number of branches/plant and the weight of ١٠٠ seeds had negative and null direct effects on seed weight/plant recording (-٠.٠٦٥ and -٠.١٠١), respectively. Therefore, the path analysis provides a true picture of the interrelationships among different traits (Bhatt, ١٩٧٣). The current results are in harmony with those obtained by Awadalla and Abdel Wahab (١٩٩٤), Ashmawy *et al* (١٩٩٨), Salama (٢٠٠٨) and Yamani *et al* (٢٠١٢).

The coefficient of determination (CD) and relative importance (RI %) for the yield components of faba been are listed in Table ٥. The results revealed that the greatest parts of seed weight/plant variation were explained by the direct effect for number of seeds/plant (٢٧.٥١٪), followed by number of pods/plant (١٠.٥٨٪). The considerable contribution of the two traits on faba bean yield proves that they may be used as selection criteria in faba bean breeding program. However, the other characters recorded small or negligible direct effects upon seed yield.

Regarding the relative importance of joint effects components, considerable parts of indirect effects were obtained by plant height on seed weight/plant through its association with each of number of pods/plant (٣.٣٨٪) and number of seeds/plant (٦.٢٢٪).

Table (٥): The coefficient of determination (CD) and relative importance (RI %) for yield components in faba bean over the two seasons.

Characters		CD	RI %
Direct effect			
Days to flowering	(X_1)	٠.٠٠٦	٠.٤١٧
Days to maturity	(X_2)	٠.٠٠٢	٠.١٦٨
Plant height	(X_3)	٠.٠١٣	٠.٩١٤
Number of branches/plant	(X_4)	٠.٠٠٤	٠.٢٩٢
Number of pods/plant	(X_5)	٠.١٥٣	١٠.٥٨
Number of seeds/plant	(X_6)	٠.٣٩٨	٢٧.٥١
١٠٠ seed weight	(X_7)	٠.٠١٠	٠.٧٠١
Total (direct)		٠.٥٨٦	٤٠.٥٨
Indirect effect			
X_1 *via*	X_2	٠.٠٠٢	٠.١٢٥
	X_3	٠.٠٠١	٠.٠٨٠
	X_4	-٠.٠٠١	٠.٠٥٩
	X_5	٠.٠٠٦	٠.٤١٢
	X_6	٠.٠٠٦	٠.٤٠٦
	X_7	-٠.٠٠٤	٠.٢٦٣
X_2 *via*	X_3	٠.٠٠٣	٠.١٧٦
	X_4	-٠.٠٠٢	٠.١٣٣
	X_5	٠.٠٠٧	٠.٤٧٢
	X_6	٠.٠٠٩	٠.٦٢٧
	X_7	-٠.٠٠٣	٠.١٧٨
X_3 *via*	X_4	-٠.٠١١	٠.٧٤٤
	X_5	٠.٠٤٩	٣.٣٨٤
	X_6	٠.٠٩٠	٦.٢١٩
	X_7	-٠.٠١٠	٠.٧٠٠
X_4 *via*	X_5	-٠.٠٣٩	٢.٦٧٠
	X_6	-٠.٠٦٢	٤.٢٨٢
	X_7	٠.٠٠٧	٠.٤٥٨
X_5 *via*	X_6	٠.٣٥٠	٢٤.١٩١
	X_7	-٠.٠٣٣	٢.٣٠٩
X_6 *via*	X_7	-٠.٠٥٩	٤.٠٩٢
Total (indirect)		٠.٣٠٦	٥١.٩٦
Total (direct + indirect)		٠.٨٩٢	٩٢.٥٤
Residuals		٠.١٠٨	٧.٤٦
TOTAL		١.٠٠	١٠٠

The bold and underline cells indicate to the highest values of direct and indirect components.

The relative importance of some characters toward seed yield

Also, there were effective indirect effects of number of branches/plant via each of number of pods/plant (٢.٦٧٪) and number of seeds/plant (٤.٢٨٪). The highest value of the indirect effects was recorded by number of pods/plant via number of seeds/plant (٢٤.١٩٪) ,while its joint effect through the weight of ١٠٠ seeds was ٢.٣١٪. Moreover, the number of seeds/plant indirectly affected seed weight/plant through its association with ١٠٠ seed weight recording (٤.٠٩٪).Totally, the studied characters accounted for ٩٢.٥٤٪ of seed weight/plant variability. The residual content (٧.٤٦٪) mug is returned to unknown factors (condom error) and/or some other traits that were not included in the present study. These results are in accordance with results obtained by Tadele *et al* (٢٠١١) and yamani *et al* (٢٠١٢).

Finally, it could be concluded from the current investigation that among the studied characters, the numbers of pods and seeds/plant are the main yield components in faba bean indicating their importance as selection criteria to obtain a considerable gain of selection for seed yield. But the number of pods/plant is more interest for plant breeder due to its relatively easy to visually selected in the field plus it is more heritable than seed yield (Kambal, ١٩٦٩).

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الأهمية النسبية لبعض مكونات المحصول فى ثلاثة أصناف من الفول البلدى منزرعة تحت ثلاثة مواعيد لربة المحاياه

جمال عبد العزيز عبد الحافظ* ، وليد محمد فارس**

* قسم بحوث المحاصيل البقولية – معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية

** المعمل المركزي لبحوث التصميم والتحليل الاحصائى – مركز البحوث الزراعية

تم إجراء تجربتان حقليتان بمحطة البحوث الزراعية بملوي – محافظة المنيا خلال الموسمين الزراعيين ٢٠١٠/٢٠١١ ، ٢٠١١/٢٠١٢ وذلك بهدف دراسة تأثير ثلاثة مواعيد للرية الأولى (االمحاياه) (٢٠،٤٠،٦٠ يوما من الزراعة) على المحصول ومكوناته لثلاثة أصناف من الفول البلدي (مصر ١ ، جيزة ٤٢٩ ، جيزة ٨٤٣) ، وقد تم استخدام تصميم القطع المنشقة مرة واحدة في أربع مكررات حيث وزعت معاملات الري في القطع الرئيسية بينما وزعت الأصناف في القطع الشقية . وقد تم استخدام البيانات المتحصل عليها في دراسة العلاقة بين المحصول ومكوناته باستخدام معامل الارتباط البسيط بينما تم استخدام تحليل معامل المرور (المسار) في تقدير المساهمة النسبية لمكونات المحصول .

أوضحت النتائج أن إعطاء الرية الأولى بعد ٦٠ يوم من الزراعة (رية المحاياه) أدى إلى انخفاض معنوي لجميع الصفات تحت الدراسة بينما أدى إعطاء الرية الاولى بعد ٤٠ يوم من الزراعة إلى زيادة معنوية لجميع الصفات المختبرة .

أظهرت النتائج إلى وجود فروق معنوية بين أصناف الفول البلدي المختبرة لجميع الصفات حيث أعطى الصنف جيزة ٨٤٣ اعلي قيم لكل من صفة محصول بذور/الفدان ، وزن بذور/نبات ، عدد أفرع/نبات ، عدد قرون/نبات و كذا عدد بذور/نبات.

أظهرت نتائج التحليل الأحصائى للتفاعل بين مواعيد إعطاء الرية الأولى وأصناف القول البلدي إلى عدم وجود فروق معنوية لجميع الصفات المدروسة عدا صفتى الوزن الجاف للعقد البكتيرية وارتفاع النبات. ورغم ذلك فقد أظهر الصنف جيزة ٨٤٣ تحت ظروف إعطاء الرية الأولى (االمحاياه) بعد ٤٠ يوم من الزراعة إلى تفوق الصفات المدروسة مقارنة بجميع التفاعلات الأخرى.

The relative importance of some characters toward seed yield

من ناحية اخرى فان نتائج تحليل معامل الارتباط البسيط قد اشارت الى وجود ارتباط موجب عالى المعنوية بين صفة وزن بذور/نبات وجميع الصفات الاخرى عدا صفتى عدد الايام حتى الترهير ، عدد الايام حتى النضج .

اظهرت نتائج معامل المرور ان صفتى عدد بذور/نبات ، عدد قرون/نبات هما الاكثر إسهاما فى صفة وزن بذور/نبات سواء عن طريق التأثير المباشر او غير المباشر مما يشير الى اهمية وضع هاتين الصفتين فى الاعتبار من قبل المربى عند وضع برامج التربية لتحسين انتاجية محصول الفول البلدى .