

Inter and Intra-Generation Correlations for some Traits of Four Faba Bean (*Vicia faba* L.) Crosses Under Three Breeding Methods

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ABSTRACT

This investigation was carried out in four winter seasons; 2017/18, 2018/19, 2019/20 and 2020/21 at Sakha Agricultural Research Station, Kafr El-Sheikh, Egypt to study inter and intra-generation correlations among and between four crosses of faba bean traits under three breeding methods i.e., pedigree, bulk and single pod descent. Positive correlations were detected between F₃ selected plants and their progenies of F₄ in pedigree method for all traits of the crosses 1, 3 and 4. Significant inter-generation correlations for all traits of the cross 1 under bulk method. Significant inter-generation correlations were detected for all traits in single pod descent. Significant inter-generation correlations in pedigree method for flowering date of the cross 1, rust disease of the cross 2, chocolate spot and No. of branches/plant of the cross 3. No Significant correlations were observed in bulk method between F₄ and F₅ for all traits of all crosses. Seed yield was negative associated with each of chocolate spot and rust disease, flowering date and plant height under bulk method of the cross 1 in the F₃. Under pedigree method in the cross 1 of F₃, seed yield was associated with No. of branches, pods and seeds/plant and 100-seed weight. Following single pod descent in the cross 1 of F₃, seed yield was associated with each of No. of pods and seeds/plant. Seed yield was negative associated with chocolate spot, positive associated with No. of branches, pods and seeds/plant and 100-seed weight under pedigree method in the cross 2 of F₃. Seed yield was associated with No. of seeds and 100-seed weight under bulk method in the cross 3 of F₃. Following pedigree in the cross 4 of F₃, seed yield was associated with plant height, No. of branches, pods, seeds/plant and 100-seed weight. Under bulk method in F₄, seed yield was associated with No. of pods, seeds/plant and 100-seed weight in the cross 1, with No. of branches, pods and seeds/plant in the cross 2 and with plant height, No. of branches, pods and seeds/plant in the cross 4; seed yield was associated with No. of branches, pods, seeds/plant and 100-seed weight in the crosses 1 and 2 under pedigree method in F₄. Seed yield was associated with F₅, seed yield was associated with No. of pods and seeds/plant in the cross 1; with chocolate spot in negative direction and No. of seeds/plant in the cross 2, with No. of pods and seeds/plant in the cross 3 and with plant height, No. of branches, pods and seeds/plant in the cross 4. Under pedigree method in the F₅, seed yield was associated with No. of branches, pods, seeds/plant and 100-seed weight in the cross 1; with No. of branches, pods, seeds/plant and 100-seed weight in the crosses 2 and 3 and with plant height, No. of branches, pods and seeds/plant in the cross 4.

1. INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the most important seed legumes in prone regions of North and East Africa, especially in Egypt and common in Northern provinces of Sudan along the Nile Vally. Not only because of its high protein content that ranged from 22% to 38% (**Griffiths and Lawes, 1978**), but also because of its use in preparing several local dishes. It plays an important role in world agriculture, owing to ability to fix atmospheric nitrogen capacity to grow and yield well on marginal lands. The national faba bean area in 2020/21 season was about 50.400 hectares with averages productivity of 281.000 ton with an average seed yield of 3.69 ton/hectare which covers about 41% of our essential need human consumption. It brings the plant breeder's attention to breed faba bean suitable to grow in arid condition with high yielding ability, high total protein content and early maturity. The relationship between seed yield and its components would be of considerable value to breeders for screening breeding materials and selecting donor parents for breeding programs. Some traits of faba bean have a positive as well as a negative correlation. For example, **Bond (1966)**, **Lawes (1974)**, **Shalaby and Katta (1976)** reported that, yield was highly correlated with number of pods/plant, number of seeds and seed weight/plant of faba bean. **Poulsen and Knudsen (1980)** determined the phenotypic correlation coefficients among weight, number of seeds/pod and seed weight. Positive relationships were obtained between weight of seeds/pod and both seed weight and number of seeds/pod. However, no correlation was found between seed weight and number of seeds/pod. **Ulukanet al. (2003)** found the direct and indirect effects of plant height, pod number/plant and seed number/pod upon biological yield. The total determination coefficient was found to be 0.636 in the model used. A significant and positive correlation was

reported between seed yield and plant height, 100-seed weight, seed weight/plant and biological yield, but a negative correlation was determined with maturity date (**Alghamdi and Ali, 2004**). The main objectives of this investigation were to evaluate inter-and intra-generation correlations for yield and some important yield components of four crosses under three breeding methods. * Source: Annual Report of Field Crop Research Institute, **ARC, Egypt., 2022**.

2. MATERIALS AND METHODS

This investigation was carried out in four winter seasons i.e., 20017/18, 2018/19, 2019/20 and 2020/21 at Sakha Agricultural Research Station, Kafr El-Sheikh governorate, Egypt to study inter and intra-generation correlations among and between yield and som of its components of three crosses of faba bean under three breeding methods. Crossing was made between parents; Giza429, Ohishima-Zaira, Giza40, Triple white and Foul Sbailabiade to produce four crosses viz. 1- Triple white x Giza429 2- Ohishima-Zaira x Giza429 3- Giza40x Giza429 and Ohishima-Zaira x Foul Sbailabiade. The breeding methods were pedigree selection, bulk method and single pod descent. Origin', botanical group and agronomic characters of used parent are shown in Table (1).

Reaction to foliar diseases was recorded in mid - February and mid- March for chocolate spot and rust diseases, respectively; according to the disease scales suggested by **Bernier et al. (1984)**.

Table1: Names,Origin', botanical group, disease reactions and agronomic characters of the parental faba bean genotypes used in this investigation.

Genotypes	Original	Botanical group	Disease reactions	Agronomic characters	
				Flowering date	Yielding level
Triple White.	Sudan	miner	Susceptible	Early	Medium
Giza429	Egypt	Equina	Moderate resistance	Early	Medium
Ohishima-Zaira	Japan	Equina	resistance	Early maturity	High
Giza40	Egypt	Equina	Susceptible	Early	High
Foul Sbailabiade	Morocco	Major	Resistance	Medium	High

Studied characters:

The following characteristics were measured for each breeding method. The data on random sample of 20 guarded plants from each plot for each cross-population of pedigree method, bulk and single pod descent breeding methods were subjected to the statistics and genetic analysis, where the characters were:

1-Chocolate spot disease reaction.

2- Rust disease reaction.

3- Flowering date (day)

4-Plant height (cm).

5- No of branches/plant.

6- No of pods /plant.

3. IV-RESULTS AND DISCUSSION

The aim of the present study was to determine inter-generation correlations among the traits of subsequent generations; (F2 , F3) , (F3, F4-)and(F4 , F5) and intera-generation correlations between the traits of each generation under three breeding methods.

Inter-generation correlation coefficients (r): Inter-generation correlation coefficients (r) were estimated to study the relationship between F2 Selected plants and their F3-progeny mean in pedigree method and among guarded plants of F2 and F3-generations in bulk and single pod descent methods for the studied traits of 4faba bean crosses (Table2). Inter-generation correlations was highly significant in positive direction for flowering date; only significant for plant height of the cross 2 and cross 4 and significant in negative direction for 100-seed weight of cross 4 in the pedigree method.

7- No. of seeds/plant.

8- Seed yield / plant (gm).

9- 100-seed weight (gm).

Statistical Analysis:

Phenotypic correlation coefficient ($r_{y.x}$) calculated between sequential generation i.e., (F2 , F3) , (F3, F4-)and(F4 , F5) generations for each trait.

Phenotypic correlation coefficients were calculated for each trait among sub-subsequent generations (inter- generation) and between trait pairs of each generation ((intra - generation) under pedigree, bulk and single-pod descent breeding methods as outlined by **Snedecor and Cochran (1969)**.

Positive correlations was recorded for plant height and negative ones for No. of seeds/plant and seed yield /plant of guarded plants of F2 and F3-generations of the cross 2 in single pod descent. Negative correlation coefficient was found for flowering date of cross4 between F2 and F3-generations. But the conclusion was not blanket for other traits.

Positive and highly significant correlation coefficients (r) were detected (Table, 3) among F3-selected plants and their F4-progenies in pedigree selection method for all studied traits of the crosses 1,3 and 4, except for flowering date. Positive and significant correlations was found only for flowering date and 100-seed weight of the cross 2.

Highly significant in positive direction of inter-generation correlation coefficients were observed for all studied traits of the cross1in the bulk method, all studied traits of the cross 2, except for No. of pods and seeds/plant. Positive and significant correlations were noticed for chocolate and

rust diseases, flowering date and plant height of the crosses 3 and 4, with one exception i.e., No. of seeds/plant of the cross3, where negative and highly significant correlation was obtained.

Highly significant inter-generation (F3,F4) correlations in positive direction (Table,3) were detected in the single pod descent method for all studied traits of the cross1, except for chocolate and rust disease reactions and flowering date and of the crosses 2,3 and 4 for chocolate and rust disease reactions, flowering date and plant height.

Inter-generation correlation coefficients (r) were computed among F4 selected plants and their F5-progenies in pedigree method and among guarded plants of F4 and F5 in bulk method for the studied traits of 4 faba bean crosses are presented in Table (4).

Significant in positive direction was detected in pedigree method for flowering date of the cross1, rust disease reaction of the cross 2, chocolate spot disease reaction and No. of branches/plant of the cross 3; significant in negative direction for chocolate spot disease reaction of cross 4 and highly significant in positive direction for No. of pods and seeds/plant and 100-seed weight of the cross4. Significant negative correlation was noticed in single pod descent for seed yield / plant of the cross 1 and significant positive correlation was observed for chocolate spot disease reaction of the cross4. However, there is no significant correlations were observed in bulk method among F4 and F5 for all studied traits of the 4 faba bean crosses. Following single pod descent method in the cross 1, it could be concluded that, seed yield was positively associated with each of No. of pods and seeds /plant and these two traits considered as indirect selection to high seed yield.

However, these correlations indicated the possibility transfer heritable factors from generation to another. Therefore, these progenies could be improve yield by effective selection among and between families from early generation specially that from F3-generation to generate pure line(s) characterized by high yielding ability with respect to pedigree selection method. On the other side, the bulk method showed significant positive relationships among F3 and F4-generations in the crosses 1 and 2 for most studied traits indicated that these traits controlled by heritable genes.

These results are in good agreement with those reported by **Brar et al. (1991)**. **El-Refaey (1992)** found significant inter-generation correlations calculated for F5 selected plants and their F6 progenies for seed yield and some of its components. **Kambar et al. (2011)** observed significant and positive inter-generation correlations among three characters across generations i.e. seed yield /plant (r F3-F4 =0.37**, F4, F5 =0.29**, F5, F56 =0.56**). Therefore, the performance of the plants in F3-generation is the reliable indicator of their progeny in subsequent generations.

Intra-generation correlation coefficients between studied traits:

a-F3-generation for the three breeding methods in the cross1:

a-1- Bulk method:

Highly significant correlation coefficients (Table, 5) were found between chocolate spot and each of rust disease reaction, flowering date and plant height in positive direction and in negative direction for No. of branches/plant, No. of pods and seeds/plant and seed yield /plant. Highly significant correlation coefficients were detected between rust disease reaction and flowering date, plant height and 100-seed weight in positive direction and in negative direction for the other studied traits.

Table (2): Inter-generation correlation coefficients among F₂ selected plants and their F₃ progeny means for pedigree method and among guarded plants of F₂ and F₃ for bulk and single pod descent methods for the studied traits of 4faba bean crosses.

Crosses		Chocolate disease reaction	Rust disease reaction	Flowering date (day)	Plant height (cm)	No of branches /plant	No of Pods /plant	No. of Seeds /plant	Seed yield /plant(g)	100-Seed Weight(g)
Cross 1	Pedigree	-0.03	0.02	0.03	-0.16	0.07	0.22	0.08	-0.05	-0.15
	Bulk	-0.07	-0.12	0.07	0.03	-0.09	0.02	-0.02	0.04	0.02
	Pod	0.08	0.03	-0.17	-0.04	0.15	-0.05	-0.06	-0.10	-0.07
Cross 2	Pedigree	0.07	-0.06	0.38**	0.29*	-0.10	-0.09	0.01	0.01	-0.21
	Bulk	0.09	0.12	-0.01	-0.07	0.23	0.28	0.03	0.08	-0.04
	Pod	0.21	-0.03	-0.06	0.36*	-0.27	-0.10	-0.31*	-0.31*	-0.08
Cross 3	Pedigree	0.26	-0.12	0.03	0.08	0.05	-0.17	-0.05	0.07	-0.09
	Bulk	0.18	0.07	0.27	-0.13	0.11	-0.23	0.06	0.15	0.00
	Pod	0.09	0.14	-0.14	-0.01	-0.07	-0.01	0.14	0.04	-0.04
Cross 4	Pedigree	0.04	-0.07	0.05	0.36*	0.20	-0.3	0.00	0.04	-0.41*
	Bulk	0.13	0.08	-0.34*	-0.09	0.01	-0.203	0.12	-0.15	0.26
	Pod	-0.09	-0.07	0.29	0.07	-0.07	-0.14	0.00	-0.06	-0.18

Table (3): Inter-generation correlation coefficients among F₃ selected plants and their F₄ progeny means, in the pedigree method and among guarded plants of F₃ and F₄ for bulk and single pod descent method for the studied traits of 4faba bean crosses.

Crosses		Chocolate disease reaction	Rust disease reaction	Flowering Date(day)	Plant height (cm)	No of branches /plant	No of pods/plant	No. of Seeds /plan	Seed yield /plant(g)	100-Seed Weight(g)
Cross 1	Pedigree	0.41**	0.37**	0.36**	0.53**	0.54**	0.59**	0.62**	0.64**	0.60**
	Bulk	0.68**	0.67**	0.85**	0.75**	0.92**	0.74**	0.72**	0.64**	0.51**
	Pod	-0.07	0.12	0.16	0.50**	0.73**	0.77**	0.91**	0.84**	0.59**
Cross 2	Pedigree	-0.18	-0.19	0.55**	-0.06	0.22	0.05	0.1	0.1	0.24*
	Bulk	0.48**	0.48**	0.69**	0.76**	0.71**	0.27	0.07	0.33*	0.51**
	Pod	0.50**	0.94**	0.72**	0.87**	-0.09	0.04	-0.21	-0.26	0.1409
Cross 3	Pedigree	0.53**	0.60**	0.13	0.44**	0.59**	0.39**	0.57**	0.49**	0.29*
	Bulk	0.90**	0.56**	0.84**	0.37**	0.14	-0.07	-0.39**	-0.09	0.05
	Pod	0.54**	0.14	0.72**	0.86**	0.01	-0.03	-0.28	-0.20	-0.19
Cross 4	Pedigree	0.38**	0.24*	0.46**	0.64**	0.68**	0.64**	0.62**	0.31**	0.61**
	Bulk	0.33*	0.40**	0.34*	0.40**	0.13	-0.23	0.01	0.02	0.19
	Pod	0.78**	0.35*	0.39**	0.63**	-0.12	0.16	0.16	0.13	0.06

Table (4): Inter-generation correlation coefficients between F₄ selected plants and their F₅ progeny means in pedigree method and between guarded plants of F₄ and F₅ in bulk and single pod descent methods for the studied traits of 4 faba bean crosses.

Crosses	Methods	Chocolate disease reaction	Rust disease reaction	Flowering date(day)	Plant height (cm)	No of branches /plant	No of Pods /plant	No. of Seeds /plant	Seed yield /plant(g)	100-Seed Weight(g)
1	Pedigree	0.08	0.17	0.34**	0.18	0.21	0.05	-0.04	-0.14	0.21
	Bulk	-0.07	-0.06	-0.03	-0.01	-0.27	-0.02	-0.17	0.22	0.00
	Pod	-0.01	0.02	0.03	0.00	0.18	-0.22	-0.13	-0.37*	-0.09
2	Pedigree	0.19	0.27*	0.18	-0.11	0.14	0.18	-0.06	-0.02	0.13
	Bulk	0.21	-0.21	0.03	0.17	-0.20	-0.05	0.07	-0.11	0.16
	Pod	0.13	-0.11	0.19	0.16	-0.19	-0.09	-0.27	-0.25	0.14
3	Pedigree	0.46**	0.25	0.29	0.01	0.44**	0.08	0.13	0.32	0.26
	Bulk	-0.13	0.06	-0.01	0.05	0.08	0.08	0.16	-0.13	0.11
	Pod	-0.06	-0.19	-0.14	0.22	0.07	-0.03	0.04	-0.11	0.00
4	Pedigree	-0.44**	-0.15	-0.13	0.22	0.01	0.50**	0.46**	0.15	0.43**
	Bulk	0.08	-0.02	0.16	-0.15	-0.21	-0.25	-0.08	0.06	-0.17
	Pod	0.29*	-0.09	0.28	0.10	-0.17	0.13	0.22	0.16	0.05

Highly significant correlation coefficients were observed between flowering date and plant height in positive direction and in negative direction for each of No. of branches/plant, No. of pods and seeds /plant and seed yield /plant. Highly significant negative correlations were recorded between plant height and each of No. of branches/plant, No. of pods /plant and seed yield /plant. Highly significant correlation coefficients in positive direction were found between No. of branches/plant and each of No. of pods and seeds /plant and seed yield /plant.

Highly significant correlation coefficients were detected between No. of pods /plant in positive direction; for No. of seeds /plant and seed yield /plant and in negative direction for 100-seed weight and highly significant correlation coefficient was observed between No. of seeds/plant and seed yield/plant.

a-2-Pedigree selection method

The data shown in (Table, 5) revealed that, highly significant correlation coefficients were recorded between chocolate spot disease reaction and rust disease reaction in positive direction and in negative direction with flowering date. Highly significant correlation coefficients were detected between rust disease reaction and flowering date in negative direction and in significant positive direction for No. of seeds and seed yield /plant. Highly significant correlation coefficients in positive direction were recorded between No. of branches/plant and each of No. of pods and seeds/plant and seed yield/plant.

Highly significant positive correlation coefficients were detected between No. of pods /plant and each of No. of seeds and seed yield/plant. Highly significant positive correlation coefficients were observed

between No. of seeds/plant and seed yield/plant and between seed yield/plant and 100-seed weight.

a-3- Single Pod descent method:

The data listed in Table (5) pointed out that, significant correlation coefficients were observed between chocolate spot disease reaction and each of No. of branches/plant and 100-seed weight in positive direction and in negative direction with No. of pods /plant. Highly significant positive correlation coefficients were detected between rust disease reaction and flowering date and 100-seed weight. Highly significant positive correlation coefficients were recorded between No. of pods /plant and No. of seeds and seed yield/plant and between No. of seeds/plant and seed yield/plant.

However, following bulk method in the cross 1, it could be concluded that seed yield was negatively associated with each of chocolate spot disease reaction, rust disease reaction, flowering date and plant height and positively associated with each of No. of branches /plant, No. of pods /plant and No. of seeds/plant which considered as selection criteria for earliness, tolerant to leave diseases and high seed yield.

Under the situation of pedigree method in the cross 1, it could be concluded that seed yield was positive associated with each of rust disease reaction, No. of branches /plant, No. of pods and seeds /plant and 100- seed weight, which considered as selection criteria for high seed yield with possibility to infected by rust disease reaction.

Following single pod descent method in the cross 1, it could be concluded that, seed yield was positively associated with each of No. of pods and seeds /plant and these two traits considered as indirect selection to high seed yield.

Table (5): Intra - correlation coefficients between nine faba bean traits in F₃ for bulk, pedigree and single pod descent methods in the cross 1.

Traits	Methods	Rust disease reaction	Flowering date(day)	Plant height (cm)	No of branches /plant	No of pods/plant	No. of Seeds /plan	Seed yield /plant(g)	100-Seed Weight(g)
Chocolate spot disease reaction	Bulk	0.84**	0.62**	0.42**	-0.59**	-0.49**	-0.54**	-0.33*	0.21
	Pedigree	0.84**	-0.21**	0.12	-0.01	0.05	0.08	0.12	0.07
	Pod	0.25	0.01	0.12	0.53**	-0.29*	-0.13	-0.25	0.36*
Rust disease reaction	Bulk		0.63**	0.49**	-0.63**	-0.48**	-0.52**	-0.30*	0.33*
	Pedigree		-0.23**	0.15	-0.01	0.08	0.16*	0.17*	0.00
	Pod		0.41**	0.02	-0.07	0.11	0.11	0.12	0.53**
Flowering Date(day)	Bulk			0.38**	-0.41**	-0.31*	-0.52**	-0.38**	0.01
	Pedigree			-0.11	-0.06	-0.03	-0.12	-0.11	0.04
	Pod			0.11	-0.07	-0.14	0.11	0.20	-0.04
Plant height (cm)	Bulk				-0.42**	-0.42**	-0.22	-0.3*	0.27
	Pedigree				0.02	0.12	0.12	0.12	-0.03
	Pod				-0.19	0.04	-0.15	-0.24	-0.13
No of branches /plant	Bulk					0.6**	0.6**	0.59**	0.03
	Pedigree					0.7**	0.56**	0.56**	0.10
	Pod					-0.10	0.08	-0.03	0.05
No of pods/plant	Bulk						0.54**	0.51**	-0.35*
	Pedigree						0.8**	0.71**	-0.09
	Pod						0.67**	0.61**	-0.11
No. of Seeds /plant	Bulk							0.73**	0.03
	Pedigree							0.9**	-0.11
	Pod							0.81**	-0.21
Seed yield /plant(g)	Bulk								0.10
	Pedigree								0.28**
	Pod								0.00

b-F₃- generation for the three breeding methods in the cross 2 :**b-1-Bulk method:**

The data listed in Table (6) indicted that, significant positive correlation coefficients between chocolate spot disease reaction and No. of pods/plant was detected; negative correlation coefficients between rust disease reaction and each of flowering date, No. of pods/plant, seed yield /plant and 100-seed weight; between No. of branches/plant and 100-seed weight; between No. of pods/plant and No. of seeds/plant and seed yield /plant and between No. of seeds/plant and seed yield/plant.

b-2-Pedigree selection method:

Significant correlation coefficients were recorded between chocolate spot disease reaction and each of rust disease reaction in positive direction and in negative direction for No. of pods/plant, No. of seeds/plant, seed yield /plant and 100-seed weight. (Table, 6). Negative correlation

coefficient was observed between plant height and 100-seed weight .Highly significant correlation coefficients were detected between No. of branches/plant and each of No. of pods and seeds/plant and seed yield /plant in positive direction; between No. of pods/plant and each of No. of seeds and seed yield /plant in positive direction and 100-seed weight in negative direction. Significant correlation coefficients were observed between No. of seeds/plant and seed yield /plant in positive direction and 100-seed weight in negative direction and between seed yield / plant and 100-seed weight in positive direction.

b-3-Single pod descent method:

The data shown in Table (6) pointed out that, highly significant positive correlation coefficients were obtained between chocolate spot disease reaction and each of rust disease reaction and plant height; between No. of branches/plant and each of

No. of seeds and seed yield /plant in positive direction; between No. of pods/plant and each of No. of seeds and seed yield /plant in positive direction and between No. of seeds /plant and seed yield /plant.

However, it could be concluded from the data listed in (Table, 6) that, seed yield under pedigree selection method in the cross 2

was highly associated with chocolate spot disease reaction in negative direction, each of No. of branches/plant, No. of pods/plant, No. of seeds/plant and 100-seed weight in positive direction, which might indicate that these traits considered as selection criteria for high yielding ability with possibility to tolerate disease reaction of chocolate spot.

Table (6): Intra- correlation coefficients between nine faba bean traits in F₃ for bulk, pedigree and single pod descent methods in the cross 2.

Traits	Methods	Rust disease reaction	Flowering Date(day)	Plant height (cm)	No of branches /plant	No of pods/plant	No. of Seeds /plan	Seed yield /plant(g)	100-Seed Weight(g)
Chocolate spot disease reaction	Bulk	0.17	0.15	0.22	-0.19	0.34*	0.03	0.07	-0.27
	Pedigree	0.86**	0.01	0.14	-0.1	-0.21**	-0.16*	-0.21**	-0.19*
	Pod	0.35*	-0.11	0.38**	0.16	-0.02	0.15	0.01	0.00
Rust disease reaction	Bulk		-0.36*	-0.09	-0.2	-0.45**	-0.17	-0.37*	-0.44**
	Pedigree		-0.04	0.16*	-0.06	-0.17*	-0.10	-0.16	-0.19*
	Pod		-0.17	-0.02	0.18	-0.22	0.25	0.15	-0.16
Flowering Date(day)	Bulk			0.08	0.29	0.16	-0.06	0.11	0.28
	Pedigree			0.06	0.02	0.08	0.03	0.03	0.02
	Pod			0.28	0.06	0.21	0.19	0.20	0.04
Plant height (cm)	Bulk				0.26	0.25	-0.05	-0.17	-0.17
	Pedigree				-0.14	0.01	0.03	-0.05	-0.23**
	Pod				-0.17	0.25	0.14	0.05	0.21
No of branches /plant	Bulk					0.02	-0.17	-0.03	0.33*
	Pedigree					0.5**	0.49**	0.52**	0.10
	Pod					0.27	0.39**	0.52**	0.18
No of pods/plant	Bulk						0.54**	0.62**	0.17
	Pedigree						0.79**	0.71**	-0.16*
	Pod						0.92**	0.84**	-0.17
No. of Seeds /plant	Bulk							0.89**	0.00
	Pedigree							0.93**	-0.18*
	Pod							0.95**	-0.06
Seed yield /plant(g)	Bulk								0.25
	Pedigree								0.16*
	Pod								0.22

Following bulk method, it could be concluded that seed yield was significantly associated with rust disease reaction in negative direction, each of No. of pods and seeds /plant in positive direction, which might indicate that these traits considered as selection criteria for high seed yield and tolerant to rust disease reaction and the selection for No. of pods and seeds with respect to bulk method in the cross 2 considered as indirect selection for high seed yield.

With respect to single pod descent method in the cross 2, seed yield was highly

associated with each of No. of branches/plant, No. of pods/plant and No. of seeds/plant, which might indicate that, these traits considered as selection criteria under this situation.

C-F₃- generation for the three breeding methods in the cross 3 :

C-1-Bulk method:

The data presented in Table (7) revealed that, highly significant correlation coefficients were observed between chocolate spot disease reaction and each of rust disease reaction, plant height and 100-

seed weight in positive direction and flowering date, No. of pods and seeds/plant in negative direction; between rust disease reaction and each of seed yield /plant and 100-seed weight in positive direction; in negative direction between flowering date and No. of branches/plant; between No. of pods/plant and No. of seeds/plant in positive direction and 100-seed weight in negative direction; between No. of seeds/plant and seed yield/plant in positive direction and between seed yield/plant and 100-seed weight in negative direction.

C-2- Pedigree selection method:

Highly correlation coefficients were found (Table, 7) between chocolate spot disease reaction and rust disease reaction in positive direction and plant height in negative direction; between rust disease reaction and each of No. of branches/plant in positive direction and plant height, No. of seeds/plant and seed yield/plant in negative direction; between flowering date and each of No. of pods and seeds/plant and seed yield /plant in negative direction; No. of branches/plant and each of No. of pods and seeds/plant and seed yield /plant ; between No. of pods/plant and each of No. of seeds/plant and seed yield /plant in positive direction and 100-seed weight in negative direction; between No. of seeds/plant and seed yield /plant in positive direction and 100-seed weight in negative direction and between seed yield /plant and 100-seed weight in negative direction.

d-F₃ generation for the three breeding methods in the cross 4 :

d-1-Bulk method:

The data presented in (Table, 8) pointed out that, significant positive correlation coefficients were detected between chocolate spot disease reaction and each of rust disease reaction and plant height; between rust disease reaction and No. of branches/plant in positive direction and No. of seeds/plant in negative direction; between flowering date and No. of branches/plant and 100-seed weight in

C-3- Single pod descent method:

Negative correlation coefficients were observed (Table,7) between flowering date and No. of branches/plant; in positive direction between No. of pods /plant and No. of seeds/plant and seed yield /plant and between No. of seeds/plant and seed yield /plant.

From the data listed in Table (7) it could be concluded that, with following pedigree method, significant correlation coefficients were recorded between seed yield /plant and each of rust disease reaction and flowering date in negative direction and each of No. of branches/plant, No. of pods and seeds/plant and and 100-seed weight in positive direction. This might indicate that, these traits which associated with seed yield considered as selection criteria for high seed yield accompanied by the tolerant to rust disease reaction and earlier flowering of the cross 3. Under bulk method, it could be concluded that, seed yield was significant positive associated with No. of seeds/plant and 100-seed weight, the two traits considered as indirect selection to raise seed yield of the cross 3.

With respect to single pod descent method, it could be concluded from the data available that, seed yield was significantly associated with No. of pods and seeds/plant. So, selection of high number of pods and seeds /plant considered as indirect selection of yield for high the cross 3.

positive direction and No. of pods /plant in negative direction; between plant height and No. of branches/plant in negative direction; between No. of branches/plant and seed yield/plant ; between No. of pods/plant and each of No. of seeds and seed yield /plant in positive direction and 100-seed weight in negative direction ; between No. of seeds /plant and seed yield /plant and between seed yield /plant and 100-seed weight.

Table (7): Intra- correlation coefficients between nine faba bean traits in F₃ for bulk, pedigree and single pod descent methods in the cross 3.

Traits	Methods	Rust disease reaction	Flowering Date(day)	Plant Height (cm)	No of branches /plant	No of pods/plant	No. of Seeds /plan	Seed yield /plant (g)	100-Seed Weight (g)
Chocolate spot disease reaction	Bulk	0.38**	-0.44**	0.3*	0.09	-0.41**	-0.38**	0.10	0.43**
	Pedigree	0.75**	0.08	-0.24**	0.15	0.08	0.12	0.14	-0.02
	Pod	0.20	0.03	0.12	-0.01	0.25	0.11	0.16	0.20
Rust disease reaction	Bulk		-0.23	-0.12	-0.06	0.05	0.15	0.37*	0.38**
	Pedigree		0.08	-0.27**	0.2*	0.1	-0.17*	-0.19*	0.01
	Pod		-0.16	0.09	0.22	0.00	0.02	-0.03	0.03
Flowering Date(day)	Bulk			-0.12	-0.43**	0.16	0.27	0.08	-0.26
	Pedigree			0.11	-0.13	-0.17*	-0.21**	-0.2*	-0.06
	Pod			0.15	-0.31*	-0.10	-0.06	-0.09	0.12
Plant height (cm)	Bulk				0.00	-0.15	-0.19	0.00	0.24
	Pedigree				-0.14	0.05	0.03	0.03	-0.04
	Pod				-0.11	-0.08	-0.14	-0.06	-0.2
No of branches /plant	Bulk					-0.01	-0.19	-0.01	0.26
	Pedigree					0.53**	0.55**	0.56**	0.08
	Pod					-0.10	0.19	0.11	-0.15
No of pods/plant	Bulk						0.37*	0.18	-0.32*
	Pedigree						0.86**	0.78**	-0.2*
	Pod						0.39**	0.38**	-0.07
No. of Seeds /plant	Bulk							0.72**	-0.07
	Pedigree							0.92**	-0.18*
	Pod							0.9**	-0.15
Seed yield /plant(g)	Bulk								0.4**
	Pedigree								0.19*
	Pod								0.04

d-2- Pedigree selection method:

Highly significant negative correlation coefficients (Table,8) were detected between chocolate spot disease reaction and each of rust disease and flowering date; between flowering date and plant height in positive direction; between plant height and each of No. of pods and seeds /plant and seed yield /plant in positive direction; between No. of branches/plant and each of

No. of pods and seeds and seed yield/plant; between No. of pods and each of No. of seeds and seed yield/plant in positive direction and 100-seed weight in negative direction; between No. of seeds/plant and seed yield/plant in positive direction and 100-seed weight in negative direction and between seed yield /plant and 100-seed weight.

d-3- Single pod descent method:

Significant positive correlation coefficients were obtained (Table,8) between chocolate spot disease and rust disease reaction and in negative direction with No. of pods and seeds /plant; between rust disease reaction and flowering date in positive direction; between plant height and 100-seed weight in negative direction; between No. of branches/plant and each of No. of pods and seeds/plant, seed yield /plant in positive direction and in negative direction between

No. of branches/plant and 100- seed weight; between No .of pods/plant , seeds and seed yield/plant in positive direction and in negative direction with 100-seed weight; between No. of seeds/plant and seed yield /plant in positive direction and 100-seed weight in negative direction and between seed yield /plant and 100-seed weight in negative direction.

However, it could be concluded from the obtained results that, with following pedigree method, seed yield was highly

significant associated with plant height ,No. of branches/plant , No. of pods and seeds /plant and 100-seed weight. This might indicated that, these yield components are considered as selection criteria for high yielding ability in the cross 4. Use bulk as a breeding method, seed yield was significant associated with No. of branches/plant and No. of pods and

seeds/plant. Under the situation of single pod descent method, seed yield was highly significant associated with No. of branches/plant and No. of pods and seeds /plant. It is well observed that, in the cross 4, selection criteria for high seed yield not wide differ from plant breeding method to another.

Table (8) :Intra- Correlation coefficients between nine faba bean traits in F₃ for bulk, pedigree and single pod descent methods in the cross 4.

Traits	Methods	Rust disease reaction	Flowering date(day)	Plant height (cm)	No of branches /plant	No of pods/plant	No. of Seeds /plan	Seed yield /plant(g)	100-Seed Weight(g)
Chocolate spot disease reaction	Bulk	0.47**	-0.06	0.3*	0.03	0.17	-0.04	-0.04	0.24
	Pedigree	0.35**	-0.40**	0.12	0.10	0.01	0.10	0.10	-0.08
	Pod	0.60**	0.12	0.20	0.13	-0.39**	-0.35*	0.25	-0.19
Rust disease reaction	Bulk		0.16	-0.05	0.32*	-0.02	-0.3*	-0.14	0.19
	Pedigree		0.04	-0.03	0.08	0.05	0.08	0.09	-0.02
	Pod		0.38**	0.25	0.17	0.06	0.18	0.12	0.06
Flowering date (day)	Bulk			-0.03	0.36*	-0.36*	-0.05	-0.04	0.40**
	Pedigree			0.36**	-0.12	0.00	0.04	-0.01	-0.13
	Pod			0.07	0.12	-0.03	-0.13	0.05	0.12
Plant height(cm)	Bulk				-0.32*	0.22	0.00	-0.04	-0.28
	Pedigree				0.09	0.24**	0.22**	0.22**	0.05
	Pod				-0.14	-0.11	0.24	0.27	-0.39**
No of branches /plant	Bulk					0.00	0.27	0.34*	0.23
	Pedigree					0.52**	0.5**	0.56**	0.13
	Pod					0.57**	0.58**	0.42**	-0.39**
No of pods/plant	Bulk						0.46**	0.56**	-0.35*
	Pedigree						0.77**	0.62**	-0.33**
	Pod						0.76**	0.7**	-0.44**
No. of Seeds/plant	Bulk							0.85**	-0.26
	Pedigree							0.88**	-0.26**
	Pod							0.75**	-0.58**
Seed yield/plant (g)	Bulk								-0.20
	Pedigree								0.17*
	Pod								-0.49**

e-F₄-generation for the three breeding methods in the cross 1:

e-1-Bulk method:

Data presented in the Table (9) revealed that, chocolate spot disease reaction was highly significant correlated with rust disease reaction and flowering date in positive direction and with plant height and No. of pods and seeds/plant in negative direction. Significant correlation coefficients between rust disease reaction and flowering date in positive direction and with No. of branches/plant and No. of pods and seeds/plant in negative direction. Flowering date was significantly correlated

with plant height and 100-seed weight in positive direction and with each of No. of branches/plant, No. of pods and seeds/plant and seed yield /plant in negative direction; with plant height and No. of pods /plant in negative direction and 100-seed weight in positive direction; with No. of branches/plant and No. of pods and seeds/plant; with No. of pods /plant and No. of seeds/plant and seed yield /plant; with No. of seeds/plant and seed yield /plant in positive direction and 100-seed weight in negative direction.

e-2-Pedgree selection method:

Highly significant positive correlation was found in Table (9) between chocolate spot disease reaction and rust disease reaction; between plant height and No. of branches/plant in negative direction and 100-seed weight in positive direction; between No. of branches/plant and each of No. of pods and seeds/plant and seed yield

/plant; between No. of pods and seeds/plant and seed yield /plant in positive direction and 100-seed weight in negative direction ; between No. of seeds/plant and seed yield /plant in positive direction and 100-seed weight in negative direction and between seed yield/plant and 100-seed weight.

Table (9): Intra- correlation coefficients between nine faba bean traits in F₄ for bulk, pedigree and single pod descent methods in the cross 1.

Traits	Methods	Rust disease reaction	Flowering date(day)	Plant height (cm)	No of branches /plant	No of pods/plant	No. of Seeds /plan	Seed yield /plant(g)	100-Seed Weight(g)
Chocolate spot disease reaction	Bulk	0.86**	0.63**	-0.04	-0.42**	-0.38**	-0.47**	-0.09	0.04
	Pedigree	0.97**	0.19*	-0.05	-0.09	-0.04	-0.05	-0.06	0.00
	Pod	0.83**	0.6**	0.31*	-0.13	0.31*	0.24	0.17	-0.1
Rust disease reaction	Bulk		0.67**	-0.02	-0.49**	-0.5**	-0.62**	-0.17	0.17
	Pedigree		0.14	-0.04	-0.08	-0.05	-0.05	-0.05	0.02
	Pod		0.56**	0.18	-0.22	0.34*	0.2	0.27	-0.01
Flowering Date(day)	Bulk			0.35*	-0.49**	-0.43**	-0.45**	-0.31*	0.54**
	Pedigree			-0.09	0.10	0.15	0.12	0.12	0.01
	Pod			0.13	-0.20	0.22	0.19	0.05	-0.08
Plant height (cm)	Bulk				-0.20	-0.32*	0.02	0.11	0.59**
	Pedigree				-0.34**	-0.07	-0.05	0.04	0.2*
	Pod				-0.17	0.05	0.18	0.07	-0.13
No of branches /plant	Bulk					0.5**	0.48**	0.29	-0.1
	Pedigree					0.54**	0.51**	0.46**	-0.08
	Pod					0.13	0.27	0.32*	0.00
No of pods/plant	Bulk						0.67**	0.38**	-0.18
	Pedigree						0.89**	0.77**	-0.24**
	Pod						0.79**	0.76**	-0.31*
No. of Seeds /plant	Bulk							0.46**	-0.12
	Pedigree							0.90**	-0.23**
	Pod							0.75**	-0.28
Seed yield /plant(g)	Bulk								0.11
	Pedigree								0.2*
	Pod								-0.02

e-3-Single pod descent method:

Significant correlation coefficients were detected (Table ,9) between chocolate spot disease reaction and each of rust disease, flowering date and plant height in positive direction and No. of pods/plant in negative direction; between rust disease reaction and flowering date in positive direction and No.

f- F₄-generation for the three breeding methods in the cross2:

f-1-Bulk method:

The data shown in Table (10) indicated that, chocolate spot disease reaction was positive significant correlation with rust disease, flowering date and plant height; rust disease was negative correlated with 100-seed

of pods/plant in negative direction; between No. of branches/plant and seed yield /plant; between No. of pods and seeds/plant and seed yield /plant in positive direction and 100-seed weight in negative direction; between No. of seeds/plant and seed yield /plant.

weight; significant positive correlations were found between No. of branches/plant and each of No. of pods and seeds/plant and seed yield /plant; between No. of pods and seeds/plant and seed yield /plant and between No. of seeds/plant and seed yield /plant.

Table: (10): Intra-correlation coefficients between nine faba bean traits in F₄ for bulk, pedigree and single pod methods in cross 2.

Traits	Methods	Rust disease reaction	Flowering date(day)	Plant height (cm)	No of branches /plant	No of pods/plant	No. of Seeds /plan	Seed yield /plant(g)	100-Seed Weight(g)
Chocolate spot disease reaction	Bulk	0.43**	0.33*	0.43**	-0.03	0.14	0.13	0.14	0.08
	Pedigree	0.95**	-0.10	0.02	0.10	0.10	0.05	0.15	0.24**
	Pod	0.40**	-0.13	0.15	0.24	0.41**	0.26	0.27	0.30*
Rust disease reaction	Bulk		0.09	0.02	0.13	0.16	-0.06	-0.17	-0.32*
	Pedigree		-0.08	0.04	0.04	0.06	0.03	0.12	0.22**
	Pod		-0.01	-0.05	-0.04	0.06	-0.16	-0.15	-0.05
Flowering Date(day)	Bulk			0.23	0.03	0.11	0.26	0.27	0.07
	Pedigree			0.00	0.01	-0.01	-0.03	-0.08	-0.12
	Pod			0.25	-0.29*	-0.02	-0.06	-0.04	0.26
Plant height (cm)	Bulk				0.07	0.02	0.08	0.06	-0.13
	Pedigree				-0.18*	0.02	0.00	0.02	0.06
	Pod				0.39**	0.22	0.16	0.27	0.15
No of branches /plant	Bulk					0.33*	0.34*	0.37**	0.01
	Pedigree					0.49**	0.45**	0.45**	0.09
	Pod					0.52**	0.59**	0.47**	-0.09
No of pods/plant	Bulk						0.69**	0.6**	-0.08
	Pedigree						0.83**	0.7**	-0.12
	Pod						0.75**	0.68**	0.3*
No. of Seeds /plant	Bulk							0.89**	-0.02
	Pedigree							0.82**	-0.19*
	Pod							0.91**	0.23
Seed yield /plant(g)	Bulk								0.28
	Pedigree								0.37**
	Pod								0.4**

f-2-Pedigree selection method:

Highly significant correlation coefficients (Table, 10) were recorded between chocolate spot and rust diseases and 100-seed weight in positive direction ; between rust disease and 100-seed weight; between plant height and No. of branches/plant; between No. of branches/plant and each of No. of pods and seeds/plant and seed yield /plant; between No. of pods and seeds/plant and seed yield /plant ; between No. of seeds/plant and seed yield /plant in positive direction and 100-seed weight in negative direction and between seed yield /plant and 100-seed weight.

f-3-Single pod descent method:

Significant correlation coefficients were detected (Table, 10) between chocolate spot and rust diseases and 100-seed weight;

between flowering date and No. of branches/plant in negative direction; between plant height and No. of branches/plant; between No. of branches/plant and each of No. of pods and seeds/plant and seed yield /plant ; between No. of pods and each of No. of seeds and seed yield/ plant and 100-seed weight; between No. of seeds/plant and seed yield /plant and between seed yield /plant and 100-seed weight.

g- F₄-generation for the three breeding methods in the cross 3:

g-1- Bulk method:

The data listed in Table (11) pointed out that, there is no significant correlations between studied traits under the situation of bulk breeding method in the cross 3.

Table (11): Correlation coefficients among nine faba bean traits in F₄ for bulk, pedigree and single pod descent methods in the cross 3.

		Rust disease reaction	Flowering Date(day)	Plant Height (cm)	No of branches /plant	No of pods/plant	No. of Seeds /plan	Seed yield /plant (g)	100-Seed Weight (g)
Chocolate spot disease reaction	Bulk	0.34	-0.38	-0.26	0.10	-0.14	0.18	0.23	-0.03
	Pedigree	0.09	-0.14	0.2	0.00	-0.13	-0.09	-0.05	0.04
	Pod	-0.17	-0.05	-0.02	0.19	0.32*	0.19	0.06	0.05
Rust disease reaction	Bulk		-0.22	0.02	0.00	-0.39	-0.39	-0.30	0.15
	Pedigree		-0.36**	0.02	0.04	-0.07	-0.06	-0.13	-0.16
	Pod		0.20	-0.23	0.00	-0.1	-0.23	-0.24	-0.26
Flowering Date (day)	Bulk			0.26	0.13	0.38	0.16	-0.03	-0.24
	Pedigree			-0.28**	0.32**	0.22*	0.16	0.29**	0.27**
	Pod			0.16	-0.07	-0.05	0.5**	0.47**	-0.02
Plant height (cm)	Bulk				0.24	0.41	0.17	0.16	0.24
	Pedigree				-0.33**	-0.07	-0.04	-0.15	-0.23*
	Pod				0.18	0.17	0.22	0.4**	0.42**
No of branches /plant	Bulk					0.08	0.31	0.32	0.11
	Pedigree					0.44**	0.37**	0.42**	0.05
	Pod					0.25	0.20	-0.08	0.18
No of pods/plant	Bulk						0.65	0.58	-0.17
	Pedigree						0.87**	0.82**	-0.14
	Pod						0.49**	0.35*	0.34*
No. of Seeds /plant	Bulk							0.89	-0.27
	Pedigree							0.91**	-0.28**
	Pod							0.70**	0.26
Seed yield /plant(g)	Bulk								-0.14
	Pedigree								0.13
	Pod								0.32*

g-2- Pedigree selection method:

Highly significant correlation coefficients were observed in Table (11) between rust disease reaction and flowering date in negative direction; between flowering date and plant height in negative direction and each of No. of branches/plant, No. of pods/plant, seed yield/plant and 100-seed weight in negative direction; between plant height and No. of branches /plant and 100-seed weight; between No. of branches/plant and each of No. of pods and seeds/plant and seed yield /plant; between No. of pods and seeds/plant and seed yield /plant and between No. of seeds/plant and seed yield/plant in positive direction and 100-seed weight in negative direction.

g-3- Single pod descent method:

Significant positive correlation coefficients were noticed between chocolate spot disease and No. of pods/plant (Table, 11); between flowering date and No. of seeds and seed yield/plant; between plant height

and seed yield /plant and 100-seed weight; between No. of pods/plant and each of No. of seeds and seed yield/plant and 100-seed weight; between No. of seeds and seed yield/plant and between seed yield/plant and 100-seed weight.

e- F₄-generation for the three breeding methods in the cross 4:**e-1- Bulk method:**

Data drawn in Table (12) indicated that, chocolate spot disease reaction was significantly correlated with 100-seed weight; with rust disease and flowering date in negative direction; with plant height and each of No. of pods and seeds /plant and seed yield /plant; with No. of branches/plant and each of No. of pods and seeds/plant and seed yield/plant; with No. of pods and seeds/plant and seed yield/plant; with No. of seeds/plant and seed yield/plant.

e-2- Pedigree selection method:

Highly significant correlation coefficients were detected (Table, 12) between chocolate spot disease reaction and each of flowering date in positive direction and No. of pods/plant in negative direction; between rust disease and each of flowering date in positive direction and No. of branches/plant and 100-seed weight in negative direction; between flowering date and each of No. of branches/plant and 100-seed weight in negative direction; between No. of branches/plant and each of No. of pods/plant, No. of seeds/plant, seed yield /plant and 100-seed weight; between No. of pods and seeds/plant and seed yield /plant in positive direction and 100-seed weight in negative direction and between No. of seeds/plant and seed yield /plant in positive direction and 100-seed weight in negative direction .

e-3- Single pod descent method:

Highly significant correlation coefficients were found between chocolate spot disease reaction and 100-seed weight in negative direction; between flowering date and each of plant height in positive direction and No. of branches/plant and pods/plant in negative direction; between No. of branches/plant and each of No. of pods and seeds/plant and seed yield /plant; between No. of pods/plant and each of No. of seeds/plant and seed yield /plant and between No. of seeds/plant and seed yield/plant.

However, it could be concluded from the obtained results concerning the four crosses of F₄-generation that, under the bulk method, seed yield was significantly associated with flowering date, No. of pods and seeds/plant and 100-seed weight in the cross 1; with No. of branches, pods and seeds/plant in the cross 2; without associated traits in the cross 3 and with plant height, No. of branches/plant and No. of pods and seeds /plant in the cross 4.

Table (12): Intra-correlation coefficients between nine faba bean traits in F₄ for bulk, pedigree and single pod descent methods in the cross 4.

Traits	Methods	Rust disease reaction	Flowering date(day)	Plant height (cm)	No of branches /plant	No of pods/plant	No. of Seeds /plan	Seed yield /plant(g)	100-Seed Weight(g)
Chocolate spot disease reaction	Bulk	0.00	-0.03	0.16	-0.01	0.14	0.10	0.10	0.30*
	Pedigree	0.00	0.22**	0.02	-0.13	-0.22**	-0.12	-0.13	-0.05
	Pod	0.00	0.05	0.11	-0.02	-0.16	-0.28	0.03	0.46**
Rust disease reaction	Bulk		-0.33*	-0.06	0.22	0.00	-0.09	-0.19	0.22
	Pedigree		0.61**	0.03	-0.24**	-0.04	0.03	-0.04	-0.24**
	Pod		-0.21	-0.22	-0.01	0.05	-0.23	0.00	0.24
Flowering Date(day)	Bulk			-0.04	-0.11	0.07	0.12	0.22	0.08
	Pedigree			0.06	-0.16*	-0.08	0.03	-0.03	-0.21*
	Pod			0.33*	-0.4**	-0.43**	-0.28	-0.20	0.02
Plant height (cm)	Bulk				0.13	0.48**	0.34*	0.37*	0.01
	Pedigree				0.00	-0.04	0.07	0.12	0.10
	Pod				-0.19	-0.28	-0.06	-0.06	0.16
No of branches /plant	Bulk					0.58**	0.60**	0.5**	-0.05
	Pedigree					0.31**	0.30**	0.37**	0.16*
	Pod					0.56**	0.46**	0.42**	-0.11
No of pods/plant	Bulk						0.66**	0.67**	-0.03
	Pedigree						0.73**	0.66**	-0.31**
	Pod						0.68**	0.59**	0.03
No. of Seeds /plant	Bulk							0.81**	-0.09
	Pedigree							0.94**	-0.31**
	Pod							0.79**	-0.01
Seed yield /plant(g)	Bulk								0.15
	Pedigree								0.01
	Pod								0.10

Following pedigree selection method, seed yield was significantly associated with No. of branches, pods and seeds/plant and 100-seed weight in the cross1; with No. of branches, pods and seeds /plant and 100-seed weight in the cross2; with flowering date, No. of branches, pods and seeds /plant in the cross3 and with No. of branches, pods and seeds /plant in the cross 4.

Under the situation of single pod descent method, seed yield was significantly associated with No. of branches, pods and seeds/plant in the cross1; with No. of branches, pods and seeds/plant and 100-seed weight in the cross2; with flowering date, plant height, No. of pods and seeds/plant and 100-seed weight in the cross 3 and with No. of branches, pods and seeds/plant in the cross4.

It could be observed that, there is no association between seed yield and each of

chocolate spot and rust disease reaction in the four crosses of F₄- generation with respect to all breeding methods, illustrating that the present genetic material not appropriate to breeding for tolerant leave spot diseases and high yield and the main associated traits with high yield were No. of branches, pods and seeds/plant in the progenies of all crosses, which considered as direct selection criteria in the F₄- generation of the present genetic material.

f- F₅-generation for the three breeding methods in the cross 1:

f-1- Bulk method:

Data shown in Table (13) revealed that, flowering date was highly significant correlated with No. of pods/plant; with No. of branches/plant and each of No. of pods and seeds/plant; with No. of pods/plant and each of No. of seeds/plant and seed yield/plant and with No. of seeds/plant and seed yield /plant.

Table (13): Intra-correlation coefficients between nine faba bean traits in F₅ for bulk, pedigree and single pod descent methods in the cross 1.

Traits	Methods	Rust disease reaction	Flowering date(day)	Plant Height (cm)	No of branches /plant	No of pods/plant	No. of Seeds /plan	Seed yield /plant(g)	100-Seed Weight(g)
Chocolate spot disease reaction	Bulk	0.10	-0.22	0.07	-0.12	0.22	0.07	0.17	-0.02
	Pedigree	0.32**	0.07	0.58**	0.10	0.15	0.12	0.09	-0.03
	Pod	-0.03	-0.05	-0.22	-0.26	-0.04	-0.11	-0.01	-0.06
Rust disease reaction	Bulk		-0.21	0.22	0.09	0.05	0.05	0.14	0.26
	Pedigree		0.10	0.17*	-0.01	0.00	0.03	-0.13	-0.34**
	Pod		0.19	0.08	0.08	0.08	0.06	0.09	-0.02
Flowering date	Bulk			-0.11	0.03	0.42**	0.07	0.11	-0.07
	Pedigree			0.03	-0.03	0.10	0.15	0.19*	0.05
	Pod			0.21	0.09	0.34*	0.36*	0.3*	-0.21
Plant height (cm)	Bulk				0.11	-0.02	0.14	0.17	0.15
	Pedigree				0.09	0.23**	0.18*	0.13	-0.06
	Pod				-0.21	-0.01	0.01	0.12	0.38**
No of branches /plant	Bulk					0.43**	0.53**	0.26	-0.12
	Pedigree					0.43**	0.49**	0.47**	0.00
	Pod					0.36*	0.39**	0.33*	-0.01
No of pods/plant	Bulk						0.65**	0.61**	-0.20
	Pedigree						0.73**	0.61**	-0.18*
	Pod						0.68**	0.64**	-0.42**
No. of Seeds /plant	Bulk							0.81**	-0.15
	Pedigree							0.87**	-0.21*
	Pod							0.8**	-0.21
Seed yield /plant(g)	Bulk								0.18
	Pedigree								0.29**
	Pod								0.00

f-2- Pedigree selection method:

Highly significant correlation coefficients (Table ,13) was observed between chocolate spot disease and each of rust disease and plant height; between rust disease reaction and plant height in positive direction and 100-seed weight in negative direction; between flowering date and seed yield/plant; between plant height and No. of pods and seeds/plant; between No. of branches/plant and each of No. of pods and seeds/plant and seed yield/plant; between No. of pods/plant and No. of seeds and seed yield/plant in positive direction and 100-seed weight in negative direction; between seed yield/plant in positive direction and 100-seed weight in negative direction and between seed yield/plant and 100-seed weight.

f-3- Single pod descent method:

Significant correlation coefficients (Table, 13) were detected between flowering date and No. of pods, seeds and seed yield/plant;

between plant height and 100-seed weight; between No. of branches/plant and each of No. of pods, seeds and seed yield/plant; between No. of pods/plant and each of No. of seeds and seed yield/plant in positive direction and 100-seed weight in negative direction and between No. of seeds/plant and seed yield /plant

g- F₅-generation for the three breeding methods in the cross 2:**g-1- Bulk method:**

Data listed in(Table, 14) pointed out that, chocolate spot disease reaction was highly significant correlated with plant height in positive direction and seed yield/plant in negative direction; with flowering date and each of No. of branches/plant and 100-seed weight ; with No. of branches/plant and No. of pods/plant in negative direction; with No. of pods/plant and No. of seeds/plant in positive direction and 100-seed weight in negative direction and with No. of seeds/plant and seed yield/plant.

Table (14): Intra-correlation coefficients between nine faba bean traits in F₅ for bulk, pedigree and single pod descent methods in the cross 2.

Traits	Methods	Rust disease reaction	Flowering date(day)	Plant Height (cm)	No of branches /plant	No of pods/plant	No. of Seeds /plan	Seed yield /plant (gm)	100-Seed Weight (gm)
Chocolate spot disease reaction	Bulk	0.17	-0.14	0.39**	0.19	-0.11	-0.14	-0.51**	-0.19
	Pedigree	0.39**	0.09	0.07	-0.02	0.04	-0.01	0	0.03
	Pod	0.81**	-0.14	-0.46**	0.19	0.13	0.07	0.17	0.27
Rust disease reaction	Bulk		-0.14	0.24	0.19	-0.23	-0.37*	-0.07	0.13
	Pedigree		0.00	0.14	-0.06	0.02	-0.03	-0.06	-0.11
	Pod		-0.25	-0.39**	0.13	-0.06	-0.01	-0.05	0.07
Flowering date(day)	Bulk			-0.16	0.35*	-0.25	-0.08	-0.01	0.42**
	Pedigree			0.09	0.06	0.00	0.04	0.02	-0.06
	Pod			-0.03	0.01	-0.18	-0.29*	-0.06	0.31*
Plant height (cm)	Bulk				0.01	-0.22	0.02	0.05	-0.07
	Pedigree				0.06	-0.08	-0.12	-0.10	0.06
	Pod				-0.17	0.04	0.18	0.01	-0.31*
No of branches /plant	Bulk					-0.45**	-0.26	-0.02	0.16
	Pedigree					0.51**	0.5**	0.5**	0.03
	Pod					0.53**	0.42**	0.64**	0.33*
No of pods/plant	Bulk						0.54**	0.13	-0.43**
	Pedigree						0.82**	0.78**	-0.10
	Pod						0.72**	0.78**	-0.05
No. of Seeds /plant	Bulk							0.56**	-0.18
	Pedigree							0.96**	-0.05
	Pod							0.74**	-0.25
Seed yield /plant(g)	Bulk								0.17
	Pedigree								0.22**
	Pod								0.28

g-2- Pedigree selection method:

Highly significant correlation coefficients (Table, 14) were obtained between chocolate spot and rust diseases; between No. of branches/plant and each of No. of pods, seeds/plant and seed yield/plant; between No. of pods/plant and No. of seeds/plant and seed yield /plant; between No. of seeds/plant and seed yield/plant and between seed yield/plant and 100-seed weight.

g-3- Single pod descent method:

Highly significant correlation coefficients (Table, 14) were recorded between chocolate disease reaction and rust disease in positive direction and plant height in negative direction; between rust disease and plant height in negative direction; between flowering date and No. of seeds/plant in negative direction and 100-seed weight in positive direction; between plant height and 100-seed weight in negative direction; between No. of branches/plant and each of

No. of pods, seeds/plant, seed yield/plant and 100-seed weight; between No. of pods/plant and each of No. of seeds/plant and seed yield/plant and between No. of seeds/plant and seed yield /plant.

h- F₅-generation for the three breeding methods in the cross 3:**h-1- Bulk method:**

The data drawn in Table(15) indicted that, significant correlation coefficients were found between chocolate spot disease and each of rust disease and 100-seed weight; between rust disease and each of No. of branches, pods and seeds/plant and seed yield/plant in negative direction and 100-seed weight in positive direction; between No. of pods/plant and each of No .of seeds/plant and seed yield/plant in positive direction and 100-seed weight in negative direction; between No. of seeds/plant and seed yield/plant and between seed yield /plant and 100-seed weight in negative direction.

Table (15): Intra-correlation coefficients between nine faba bean traits in F₅ for bulk, pedigree and single pod descent methods in the cross 3.

Traits	Methods	Rust disease reaction	Flowering date(day)	Plant Height (cm)	No of branches /plant	No of pods/plant	No. of Seeds /plan	Seed yield /plant (g)	100-Seed Weight (g)
Chocolate spot disease reaction	Bulk	0.60**	0.07	-0.05	-0.28	-0.21	-0.07	-0.07	0.45**
	Pedigree	0.62**	0.07	0.15	0.13	-0.02	-0.03	0.08	0.19
	Pod	0.96**	0.32*	0.20	0.07	0.26	0.44**	0.51**	0.27
Rust disease reaction	Bulk		-0.06	0.03	-0.37*	-0.4**	-0.39**	-0.25	0.52**
	Pedigree		0.00	0.03	0.12	-0.01	0.03	0.15	0.23*
	Pod		0.36*	0.21	0.15	0.25	0.44**	0.54**	0.33*
Flowering date (day)	Bulk			0.18	-0.21	-0.26	-0.03	-0.1	-0.03
	Pedigree			-0.11	0.10	0.10	-0.01	0.04	0.10
	Pod			-0.21	-0.29	0.03	0.09	0.14	0.25
Plant height (cm)	Bulk				-0.13	0.12	0.12	0.11	0.03
	Pedigree				-0.03	0.08	0.10	0.11	0.02
	Pod				0.23	-0.20	-0.07	0.03	0.14
No of branches /plant	Bulk					0.14	0.08	0.12	0.08
	Pedigree					0.54**	0.31**	0.28**	-0.06
	Pod					0.39**	0.47**	0.4**	-0.16
No of pods/plant	Bulk						0.75**	0.68**	-0.4**
	Pedigree						0.79**	0.64**	-0.23*
	Pod						0.7**	0.62**	-0.3*
No. of Seeds /plant	Bulk							0.65**	-0.28
	Pedigree							0.88**	-0.15
	Pod							0.9**	-0.17
Seed yield /plant(g)	Bulk								-0.3*
	Pedigree								0.32**
	Pod								0.19

h-2- Pedigree selection method:

Highly significant correlation coefficients (Table, 15) were detected between chocolate spot disease reaction and rust disease; between rust disease reaction and 100-seed weight ; between No. of branches/plant and each of No. of pods, seeds/plant and seed yield /plant; between No. of pods/plant and each of No. of seeds/plant and seed yield /plant in positive direction and 100-seed weight in negative direction; between No. of seeds/plant and seed yield/plant and between seed yield /plant and 100-seed weight.

h-3- Single pod descent method:

Highly significant correlation coefficient (Table,15) were found between chocolate spot disease and each of rust disease, flowering date, No. of seeds/plant and seed yield/plant; between rust disease reaction and each of flowering date, No. of seeds/plant, seed yield/plant and 100-seed weight; between No. of branches/plant and each of No. of pods and seeds /plant and seed yield /plant; between No. of pods and each of No. of seeds/plant and seed yield/plant in positive direction and 100-seed weight in negative direction and between No. of seeds/plant and seed yield/plant.

i- F₅-generation for the three breeding methods in the cross 4:**i-1- Bulk method:**

Data presented in (Table, 16) pointed out that, significant correlation coefficients was detected between chocolate spot disease reaction and each of flowering date, No. of pods/plant and No. of seeds/plant in negative direction; between rust disease and No. of branches/plant in negative direction; between flowering date and No. of branches/plant in positive direction; between plant height and each of No. of branches/plant, No. of pods and seeds /plant and seed yield /plant in positive direction and 100-seed weight in negative direction ; between No. of branches/plant and each of No. of pods and seeds /plant and seed yield /plant in positive direction and 100-seed weight in negative direction; between No of

pods/plant and each of No. of seeds and seed yield /plant and between No of seeds/plant and seed yield /plant.

i-2- Pedigree selection method:

Significant correlation coefficient was obtained in (Table, 16) between flowering date and 100-seed weight in negative direction; between plant height and each of seed yield/plant and 100-seed weight; between No. of branches/plant and each of No. of pods and seeds/plant and seed yield/plant; between No. of pods and seeds and seed yield /plant in positive direction and 100-seed weight in negative direction and between No. of seeds/plant and seed yield /plant in positive direction and 100-seed weight in negative direction.

i-3- Single pod descent method:

Highly significant correlation coefficient (Table, 16) was recorded between chocolate spot disease and plant height in negative direction; between rust disease and No. of branches/plant; between No. of branches/plant and No. of seeds and seed yield /plant; between No. of pods/plant and No. of seeds and seed yield /plant; between No. of seeds/plant and seed yield/plant and between seed yield /plant and 100-seed weight in negative direction.

However, it could be concluded from the obtained results concerning the four crosses of F₅-generation that, under the bulk method, seed yield was significantly correlated with No. of pods and seeds/plant in the cross 1; with flowering date in negative direction and No. of seeds/plant in positive direction in the cross 2; with No. of pods and seeds/plant in positive direction and 100- seed weight in negative direction in the cross 3 and with plant height, No. of branches/plant and No. of pods and seeds/plant in the cross 4.

Following pedigree selection method, seed yield was significantly associated with flowering date, No. of branches/plant, No. of pods and seeds /plant and 100-seed weight in the cross 1; No. of seeds /plant in the cross 2; with No. of branches/plant, No. of pods and seeds /plant and 100-seed weight in the cross 3 and with plant height,

No. of branches/plant and No. of pods and seeds /plant in the cross 4.

Under the situation of single pod descent method, seed yield was significantly associated with flowering date, No. of branches/plant, No. of pods and seeds/plant and 100-seed weight in the cross 1; with No. of branches/plant and No. of pods and seeds /plant in the cross 2 ; with chocolate spot and rust diseases , No. of branches/plant and No. of pods and seeds /plant in the cross 3 and with No. of branches/plant and No. of pods and seeds /plant and negatively associated with 100-seed weight in the cross 4 .It could be observed that, these is no negative association between seed yield and each of flowering, chocolate spot and rust diseases in the four crosses of F₅-generation, with one exception i.e., the cross 2 under bulk population method, where negative correlation between seed yield and flowering date was detected. This might indicated that, the present genetic material not appropriate to breeding for tolerant leave spot diseases and high yielding ability and the main associated

traits with high yield were No. of branches, pods and seeds/plant in the progenies of all crosses specially in the late segregating generations i.e., F₄ and F₅-generations. These results are in good agreement with those reported by **El-Refaey(1992)** who calculated correlations between yield components in F₅, F₆ and F₇-generations under pedigree method. He found positive correlation between seed yield and each of No. of pods and seeds/plant. **Al-Ghamdi and Ali (2004)** indicated that, seed yield was significantly positive correlated with each of plant height and 100-seed weight. **Al-Ghamdi (2007)** found significant positive correlation between seed yield and each of No. of pods and seeds /plant. **Ahmed et al.(2008)** indicated highly positive correlation between seed yield and each of days to maturity and No. of pods and seeds /plant under pedigree method. **Sarutayophat and Nualsri (2010)** found highest positive correlation coefficients between No. of pods/plant and pod yield in both studied populations.

Table (16): Intra-correlation coefficients between ninefaba bean traits in F₅ for bulk, pedigree and single pod descent methods in the cross 4.

Traits	Methods	Rust disease reaction	Flowering date(day)	Plant Height (cm)	No of branches /plant	No of pods/plant	No. of Seeds /plan	Seed yield /plant (g)	100-Seed Weight (g)
Chocolate spot disease reaction	Bulk	0.00	-0.34*	-0.02	-0.07	-0.33*	-0.45**	-0.26	0.03
	Pedigree	0.05	0.11	-0.07	-0.01	0.07	0.04	-0.08	-0.15
	Pod	0.02	-0.21	-0.46**	0.08	-0.17	-0.06	-0.05	0.03
Rust disease reaction	Bulk		-0.06	0.06	-0.32*	0.09	-0.14	-0.16	-0.1
	Pedigree		-0.04	0.09	-0.07	0.06	0.00	-0.06	-0.02
	Pod		-0.16	-0.04	0.42**	-0.14	0.19	0.21	-0.21
Flowering date(day)	Bulk			-0.14	-0.29*	-0.05	0.13	-0.10	-0.02
	Pedigree			-0.10	0.01	-0.04	0.03	-0.04	-0.18*
	Pod			0.10	-0.11	0.11	-0.20	-0.08	-0.08
Plant height (cm)	Bulk				0.35*	0.39**	0.43**	0.54**	-0.3*
	Pedigree				-0.01	-0.05	0.03	0.18*	0.23**
	Pod				-0.16	-0.07	-0.19	-0.26	0.14
No of branches /plant	Bulk					0.33*	0.42**	0.42**	-0.30*
	Pedigree					0.64**	0.6**	0.6**	-0.09
	Pod					0.12	0.35*	0.36*	-0.23
No of pods/plant	Bulk						0.68**	0.8**	-0.29
	Pedigree						0.9**	0.72**	-0.42**
	Pod						0.64**	0.7**	-0.27
No. of Seeds /plant	Bulk							0.82**	-0.27
	Pedigree							0.84**	-0.4**
	Pod							0.79**	-0.28

Seed yield	Bulk	-0.20
/plant(g)	Pedigree	0.09
	Pod	-0.41**

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عامل الارتباط بين الأجيال وداخل كل جيل لبعض صفات أربعة هجن من الفول البلدي تحت ثلاث طرق تربية

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الملخص

أقيمت هذه الدراسة خلال المواسم 2018/2017، 2019/2018، و2020/2019 بمحطة البحوث الزراعيه بسخا- كفر الشيخ- مصر لدراسة معامل الارتباط بين الأجيال وداخل كل جيل لصفات أربعة هجن من الفول البلدي تحت ثلاث طرق تربية وهى: سجلات النسب، طريقة التجميع وطريقة القرن /نبات .

- كان الأرتباط موجبا ومعنويا بين النباتات المنتخبة من الجيل الثالث وأنسالها فى الجيل الرابع لطريقه النسب لجميع الصفات للهجن 1، 3، 4 وكان الأرتباط بين الأجيال معنويا لجميع الصفات فى الهجن 1 باتباع طريقة التجميع.

- كان الأرتباط بين الأجيال معنويا باتباع طريقة النسب لصفات ميعاد التزهير للهجن 1، مرض الصدأ للهجن 2، مرض التبقع البنى وعدد الأفرع للنبات للهجن 3 . لم يلاحظ وجود ارتباط معنوى فى طريقة التجميع بين الجيلين الرابع والخامس لجميع الصفات وفى كل الهجن.

- كان الأرتباط معنويا وسالبا بين محصول البذور وكل من مرضى التبقع البنى والصدأ ، ميعاد التزهير وطول النبات

لطريقة التجميع فى الهجن 1 للجيل الثالث. باتباع طريقة النسبى الهجن 1 للجيل الثالث، كان الأرتباط معنويا بين محصول البذور وكلا من عدد الأفرع، عدد القرون والبذور للنبات ووزن ال100 بذرة. باتباع طريقة القرن للنبات فى الهجن 1 للجيل الثالث كان الأرتباط معنويا بين كلا من عدد القرون والبذور للنبات . كان الأرتباط سالبا بين محصول

البذور ومرض التبقع البنى وموجبا لصفات عدد الأفرع، عدد القرون والبذور للنبات ووزن ال100 بذرة باتباع طريقة النسب فى الهجن 2 للجيل الثالث .

- كان الأرتباط معنويا بين محصول البذور و عدد البذور للنبات ووزن ال100 بذرة باتباع طريقة التجميع فى الهجن 3 للجيل الثالث. باتباع طريقة النسب فى الهجن 4 للجيل الثالث كان الأرتباط معنويا بين محصول البذور وطول النبات ، عدد الأفرع والقرون والبذور للنبات ووزن ال100 بذرة. باتباع طريقة التجميع فى الجيل الرابع ، كان الأرتباط معنويا بين محصول البذور وعدد القرون والبذور ووزن ال100 بذرة فى الهجن 1. وبين محصول البذور وعدد الأفرع والقرون والبذور للنبات فى الهجن 2 وبين محصول البذور وطول النبات وعدد الأفرع وعدد القرون والبذور للنبات فى الهجن 4 .

- كان الأرتباط معنويا بين وزن البذور وكلا من عدد الفروع ، القرون و البذور للنبات ووزن ال100 بذرة فى الهجن 1 و 2 باتباع طريقة النسب فى الجيل الرابع.

- كان الأرتباط معنويا بين محصول البذور وكلا من طول النبات ، عدد القرون والبذور ووزن ال100 بذرة فى الهجن 4.

- باتباع طريقة التجميع فى الجيل الخامس. كان الأرتباط معنويا بين محصول البذور وعدد القرون والبذور فى الهجن 1 . وكان الأرتباط معنويا وسالبا بين محصول البذور ومرض التبقع البنى وموجبا بين محصول البذور وعدد

البذور للنبات فى الهجن 2 ، وبين محصول البذور وعدد القرون والبذور للنبات فى الهجن 3 وبين محصول البذور وطول النبات وعدد الأفرع والقرون والبذور للنبات فى الهجن 4 . باتباع طريقة النسب فى الجيل الخامس كان الأرتباط معنويا بين محصول البذور وكلا من عدد الأفرع، القرون، البذور ووزن ال100 بذرة فى الهجن 1 وبين محصول البذور وكلا من عدد الأفرع والقرون والبذور ووزن ال100 بذرة فى الهجينين 2 و3 وبين محصول البذور وطول النبات وعدد الأفرع والقرون والبذور للنبات فى الهجن 4