Estimation Genetic Stability of Faba bean (Vicia faba L.) Genotypes in Sallahaddin Governorate

Dawood S. Madab¹, Majid Sh. Hamdallah² and Yasieen. N. Jabor³

¹Department of Field Crop, University of Tikrit, Tikrit, Iraq.
²Department of Field Crop, University of Baghdad, Baghdad, Iraq.

Email address: dawoodobaidy@yahoo.com

Abstract
A field experiment was carried out at two locations (First: Field Crops station research Collage of agriculture university of Tikrit) and The Second in the agricultural Farm in AL-Houaish District of Salahaddin Province during 2017-2018 winter season to study the stability of some Faba bean genotypes (PO6-001FB/FL, PO6-0O3FB/FL, PO6-0O5FB/FL, PO6-O09FB/FL, PO6-011FB/FL, PO6-014FB/FL, Syrian Local large and Aguadolce) introduced from ICARDA. Three distances among plants (20, 30 and 40 cm) was used. Factorial Randomized completely Block Design with three replications was used. Result showed that: most studied genotypes can be predicted by using linear function in most traits except protein percentage. (PO6-003FB/FL) and (PO6-005FB/FL) genotypes were stable (coefficient of regression nearest to one) in individual plant seed yield, and number pods/plant¹ and number seeds/ pod, while (PO6-011FB/FL) and (PO6-014FB/FL) were stable in plant height, number pods/plant, 100 seed weight and total seed yield. Therefore, PO6-005FB/FL followed by (PO6-014FB/FL) produced high and stable seed yield also were stable in both in individual and efficiency plant yield and adapted for poor environments which can be regarded as a good stable genotype in Salahaddin Governorate environments.

Key Words: Stability Parameters, Faba bean genotypes.

1. Introduction
Faba bean one of the important, productive efficient and valuable legumes food crops [1,2]. The productivity in Iraq of fresh and dry bean attained 1541.7 and 1267.2 Kg/ha⁻¹ respectively in 2019 season [3]. It grown for fresh grain and seed drayed as a source of protein (29.57-31.83%), carbohydrate (52.26-54.6%) , Mineral elements (0.81-1.24%) and fibers (10.88-11.96%) which differ according to cultivars and their uses [4]. Growth of plant effects by environments (Salinity, temperature and moisture) , Genetic (Strains) and agricultural practices (Methods and sowing dates and fertilization), therefore, new genotypes need to be tested in stability in their traits in a wide range of environmental conditions. The differences in stability reflect the interactions of their genetic base with the environments that select and distinguish the genotypes from each other. Stability methods are important in determination the stable genotypes which resist change their traits in different environments and regard as phenotypic and genotypic stable [5,6]. Two parameters (bi: coefficient of regression means genotypes and S²di: deviation from regression line) are calculate in stability method of Eberhart and Russel [7] that explain the nature of genotypes behavior and if can be predicted or non-predicted by linear relationship. Accordingly stable genotype has coefficient of regression equal to one and no significant deviation from regression line and has high yield in each environment. Also, significant of coefficient of regression refer to the main important effects of environments then can be predicted by linear function, on the other hand the significance of deviation from regression refer to non-dependency genotypes of linear function and cant be predicted. Genotypes interactions interpretations involve three concepts: first, when their responses to the environments are similar to the general mean, second: the variation at different environments are diminish and third: low residual variances from regression [8,9]. Also Al-Sahooky [10] mentioned that parallel responses in yield or other traits to the typical line refer to the high stability of genotypes. The accuracy of determination interactions with environments which affect Faba bean seed yield and its components traits through behavior genes regarded a real challenge of plant breeder [11,12].

Stable genotypes noticed especially in number of pods/plant¹ and 100 seed yield [13]. High and constant seed yield in different environments are important in improving superior strains through breeding programs [14]. The aim of the study was to estimate the stability of Faba bean genotypes by using Eberhart and Russel [7] Model for seed yield and its components traits in Salahaddin Governorate.
2. Materials and Method

Eight genotypes of Faba bean (Vicia faba L.) as shown in table (1) were grown in three distances among plants (20, 30 and 40 cm) in two locations (First: at station research of field crops/college of agriculture/University of Tikrit (34.40 latitude N, 43.38 longitude E) and Second in agricultural farm in Al-Houaish district (34.12 latitude N, 43.48 longitude E) represents six combination of environments. During 2018 season Randomized completely Block design in split-plot arrangements

with three replications was used as the distances in main plot and genotypes in sub-plot. Experimental unit was two rows. Whole agricultural practices performed as demand. Studied traits were plant height (cm), leaf area/plant (cm²) calculated by using Watson formula, No.pods/plant-1, pod length (cm), No.seeds/pod-1, 100 seeds weight (g), individual seed yield (g), total seed yield (Kg/ha⁻¹), biological yield (Kg/ha⁻¹), protein content (%) estimated according to AOAC [16] and yield efficiency (g/cm⁻²) estimated by using Anderson and Garling formula [17].

Data analysis according to design used [18]. Stability parameters estimated for the genotypes exhibited significant interactions with environments by testing the significancy of the mean sum of squares against pooled errors and then two parameters (b and S²di) were calculated by using the following formulas (bi=[∑∑yij*Ij]/∑Ij²), S²di=[(∑σ²ij/(s²j-2)]/[Se²/r]), where bi:coefficient of regression, S²di: deviation from regression.

Table 1. Pedigree of studied genotypes.

| Symbol | Origin | Entry | Pedigree |
|--------|--------|-------|----------|
| G1     | IGARDA | PO6-001FB/FL | 2000/DSO/0405-HBP/7005-2/B7/DT |
| G2     | IGARDA | PO6-003FB/FL | 2000/DSO/0405-HBP/7106-1/B7/DT |
| G3     | IGARDA | PO6-005FB/FL | 2000/DSO/0405-HBP/7380/B7/DT |
| G4     | IGARDA | PO6-009FB/FL | SeleGation From ILB1814 |
| G5     | IGARDA | PO6-011FB/FL | 2000/DSO/0405-HBP/7038/B7/DT |
| G6     | IGARDA | PO6-014FB/FL | 0405-SP80B(DS)/7986/B7/DT |
| G7     | Syria  | Syrian LoGd Large | IL B 1814 |
| G8     | FranGe | IL B 1266 | AguadolGe |

3. Results and Discussion

Analysis of variances showed significant differences in all studied traits. Consequently the genotypes differ significantly in their responses to environments. The estimation environments+(genotypes *environments) that can be partition in to three components, first: linear environments effects, linear interaction and pooled deviation. Linear effect environments revealed high significant in all studied traits which mean the responses to the multi environments controlled by genetic part [19]. Interactions were high significant in all studied traits except No.pods/plant-1 was significant on 5% level which refer to the main reason of the different responses of stability for these traits belong to linear regression and there obvious ability of predicting changes in responses to different environments and stability. The third part of stability analysis the deviation from regression was the main influential of the genotypes differences stability [13,20]. Consequently, the significance of each linear function of interaction and that deviation were important in the explanation of the essential main effect on stability traits. Two stability parameters (coefficient of regression and deviation from regression) estimated for the genotypes have significant interactions with environments which refer to the responses of genotypes while the deviation from regression refer to the opposite meaning of no respond for changing in environments. If the coefficient regression equal to one and deviation from regression zero the genotype would be stable, other than the high and low value for the coefficient regression lead to adaptability genotypes for rich and poor environments respectively [21]. Data in table (3) showed G3 genotype has the highest value of plant height (157.72cm) which is more desirable in stress conditions or in the gypsum soils than dwarf plants in field crops. The relationship between two parameters (bi and S²di) gave a clear statistical evidence of genotypes stability of plant height such in case of G4 that have significant coefficient of regression 1.11nearest one and no significant deviation comparison to the other genotypes that possessed upper or lower coefficient of regression values. Therefore, G4 was stable and adaptive for the environments and also controlled by linear function and can be predictable. On the other hand the lower
value of coefficient of regression below one and no significant deviate in G6, G7 and G8 lead to conclude that these are adapted for poor environments as mentioned earliest [12].

Table 2. Analysis of variance of the genotypes by environment interactions.

| Traits                     | Source of variance of the genotypes en| Poole| Genotypes*environments+(genotypes=environments) | Environments (linear) | Genotypes*environments (linear) | Pooled division |
|---------------------------|---------------------------------------|------|------------------------------------------------|-----------------------|--------------------------------|----------------|
|                           | Genotypes environments                |      |                                                 |                       |                                |                |
|                           | Digree of freedom                     |      |                                                 |                       |                                |                |
|                           | Mean sum of squares                   |      |                                                 |                       |                                |                |
| Plant height (cm)         | **102.8 9                            | 5    | 35                                              | 96                    | 40                             | 1              |
|                           |                                        |      |                                                 |                       |                                |                |
| Leaf area (cm)            | **306.1 0                            | 1    | **917.20*                                       | 510 1                | 1135.98*                       | 2              |
|                           |                                        |      |                                                 |                       |                                |                |
| Leaf area index           | 0.014** 0.43** ns0.0004 0.00 03       |      |                                                 |                       |                                |                |
| Days to 50% anthesis      | **120.87 0.06ns 0.79 ns 3.11          |      |                                                 |                       |                                |                |
| No. branch s.plant-1      | **9 0.92** 13.95** ns0.13 0.13         |      |                                                 |                       |                                |                |
| No.pods.p plant-1         | **19.125 164.31** 0.85** 0.17         |      | **21.28**                                       | 821.58                | **3.64**                       | 0.57           |
| Pod length (cm)           | 45.76 ns7.64 6.71ns 7.28 ns 9        |      |                                                 |                       |                                |                |
| No.seeds. pod-1           | **0.61** 3.17** 0.02* 0.01            |      | **0.42**                                        | 15.86**               | 0.47**                         | 0.04**         |
| 100 seeds weight (g)      | **992.923 101.75** 1.26* 0.74         |      | **13.83**                                       | 508.76*               | 5.06**                         | 0.02**         |
| Individual seed yield (g)| **426.631 3018.03** 69.66** 33.9      |      | **438.21**                                      | 15090.1 7**           | 1182.19**                      | 125.75         |
| Total seed yield (K.he-1) | **3817708** .719 1635770 .407        |      |                                                 |                       |                                |                |
| Biologial yield (K.h-1)   | **1076051 656ns12 633 8702.70**       |      |                                                 |                       |                                |                |
| Protein percentage (%)    | 11.404 3.900** 0.327** 0.01          |      | **0.77**                                        | 19.50 2.04           |                                | 0.06**         |
| Relative efficiency (%)   | **0.0004 0.001** 0.00003** 0.00 001  |      |                                                 |                       |                                |                |
|                           | **0.000191 0.00625** **0.000606** ** |      |                                                 |                       |                                |                |

*,**:significant on 5 and 1% respectively

Leaf area stability analysis exhibited higher value (1661.65 cm²) in G3 than others and no significant both coefficient of variation and deviation from regression which considered stable genotype for the value of coefficient of regression (1.1) and no significant deviation. Other genotypes except G2 and G4 were not significant in each regression or deviation from regression that mean of the stable leaf area trait and adaptive for the special environments except G1 genotype which has significant deviation from regression. These results refer that the insignificant effects in most studied genotypes minimize the
usefulness in this trait [22]. The genotypes divided in to two types in numbers of pods.plant-1: first G1 and G6 have significant coefficients of regression (0.92 and 0.90 respectively) and no significant deviation from regression that clarifying their additivity for the marginal soils. Second group: G3 and G8 genotypes were possessed significant deviation from regression therefore, their responses for environments unsteady and unpredictable. Other genotypes have not significances including G2 which have high value (30.97 pod.plant \(^{-1}\)) that are stable and resist changing their ability by changing environments and these genotypes are important in improving such trait[14].

Whole genotypes didn’t have significant coefficient of regression except G4 (1.37) in No.seeds.pod \(^{-1}\) and the deviation from regression was not significant except G1. From these results can be concluded that G4 genotype adapted for favorable environments and G1 is unstable genotype and unpredictable in number of seeds.Pod \(^{-1}\). Other genotypes (G3,G5, and G7) were more stable than others, though high value (4.32 seed.pod \(^{-1}\)) in G3. These results are consistence with as demonstrated in[23,24]. Hundred seed weight was stable in most studied genotypes(as a result of no significances of stability parameters bi and S2di) except G1 which deviated significantly from regression line though high value of 100 seed weight (108.17 g) in G8. According to b values G5 and G7 are adapted in all tested environments and important of genetic concept as a result of no significant each coefficient of regression and deviation from regression [25]. Individual plant seed yield have not affected significantly by stability parameters except G1 and G8 in coefficient of regression .G2 and G3 adapted for all environments, while G4, G5 and G6 are adapted in poor environments and G7 besides G8 for favorable environments, that refer to their resistance of reducing individual yield by changing environments, though high individual seed yield in G3 and G8 (91.69 and92.78 g respectively) followed by G6 genotypes. The stability of most genotypes perhaps for their un affected by studied environment for its yield components. Higher total seed yield were in G3 and G6 (4319.07 and4259.92 Kg.ha\(^{-1}\) respectively). Total seed yield are the most important trait and didn’t deviate significantly from regression in all genotypes, though significant coefficients of regression in G3 and G4.Other genotypes (G1 and G5) are stable and adapted for all environments. While ,G8 for favorable condition and G2,G6 and G7 for poor environments. High seed yield (4259.92 Kg.he\(^{-1}\)) was in G6 genotype which was stable and adapted for poor environments.

These results from above discussion of growth and seed yield and it’s components showed the importance of studied environments and the genotypes can be predicted by linear function and the differences in stability genotypes perhaps for the different responses for the combination treatments include spacing among plants and soil conditions of two locations as a result of environments effects on studied genotypes [26,27]. The higher biological yield were in G3 and G4 (9286.57 and 9285.24 respectively). Whole genotypes can be predictable by linear function as a results of significant coefficients of regression (bi), despite significant deviation (S2di) in G1 genotype only. Other genotypes are adequate for poor environments and affect by the studied environments and controlling by linear Function.

The results of protein percentage stability confirm that whole genotypes are instable and can't be predicted by linear function except G1 and G2 genotypes that have significant coefficient of regression and no significant deviation from regression and adapted for poor environments. High protein percentage were in G3 and G6 (20.01 and 20.05% respectively) both are adapted in poor or marginal soil. Similar results were found as mentioned earliest[26]. The G8 genotype gave high value of efficiency yield (0.07) and all genotypes were not significant in coefficient of regression except G8 (1.69) which controlling by linear function and adapted to typical environments. High seed yield and other yield components led to superiority in the efficiency of yield in many genotypes (G8 followed by G3). Un important of deviation from regression for the other genotypes lead to conclude of importance of stability of genotypes in different environments and be adapted for different environments according to numerical values of coefficient of regression.

**Table 3. Stability parameters of studied genotypes.**
|                                | Bi       | S\(^\text{di}\) |
|--------------------------------|----------|-----------------|
|                                | 1.80 ns  | 1934.73 ns      |
|                                | 0.27 ns  | 220.59 ns       |
|                                | -0.12 ns | 545.46 ns       |
|                                | 0.40 ns  | 636.39 ns       |
|                                | 0.69 ns  | 588.64 ns       |
|                                | 0.46     | 209.09 ns       |
|                                | 0.40     | 166.02 ns       |
| No.pods.plnt.1                 | 30.97    | 0.9 ns          |
|                                | 27.32    | 0.9 ns          |
|                                | 27.26    | 0.9 ns          |
|                                | 26       | 0.9 ns          |
|                                | 27.88    | 0.9 ns          |
|                                | 25.36    | 0.9 ns          |
|                                | 27.73    | 0.9 ns          |
|                                | 0.46     | 0.46            |
| No.seeds.pod.1                 | 0.93 ns  | 1.80 ns         |
|                                | 0.93 ns  | 1.80 ns         |
|                                | 0.93 ns  | 1.80 ns         |
|                                | 0.93 ns  | 1.80 ns         |
|                                | 0.93 ns  | 1.80 ns         |
|                                | 0.93 ns  | 1.80 ns         |
|                                | 0.93 ns  | 1.80 ns         |
|                                | 0.93 ns  | 1.80 ns         |
|                                | 0.93 ns  | 1.80 ns         |
| 100 grains weight (g)          | 76.73    | 8.20 ns         |
|                                | 85.09    | 8.20 ns         |
|                                | 76.6     | 8.20 ns         |
|                                | 75.7     | 8.20 ns         |
|                                | 84.25    | 8.20 ns         |
|                                | 105.41   | 8.20 ns         |
| Individual plant yield (g)     | 74.01    | 75.53 ns        |
|                                | 91.69    | 75.53 ns        |
|                                | 80.73    | 75.53 ns        |
|                                | 68.43    | 75.53 ns        |
|                                | 83.79    | 75.53 ns        |
|                                | 81.28    | 75.53 ns        |
|                                | 92.78    | 75.53 ns        |
| Total seed yield K.he-1        | 2429.98  | 686.62 ns       |
|                                | 4319.07  | 686.62 ns       |
|                                | 4196.54  | 686.62 ns       |
|                                | 2684.36  | 686.62 ns       |
|                                | 4259.92  | 686.62 ns       |
|                                | 2771.33  | 686.62 ns       |
|                                | 3603.74  | 686.62 ns       |
| Biological yield (K.he-1)      | 7249.02  | 686.62 ns       |
|                                | 9286.57  | 686.62 ns       |
|                                | 9285.24  | 686.62 ns       |
|                                | 6480.56  | 686.62 ns       |
|                                | 9267.19  | 686.62 ns       |
|                                | 6321.91  | 686.62 ns       |
|                                | 6526.73  | 686.62 ns       |
| Protien percentage (%)         | 16.58    | 686.62 ns       |
|                                | 20.01    | 686.62 ns       |
|                                | 18.3     | 686.62 ns       |
|                                | 16.63    | 686.62 ns       |
|                                | 20.05    | 686.62 ns       |
|                                | 18.17    | 686.62 ns       |
| Yield efficiency (%)           | 16.58    | 686.62 ns       |
|                                | 20.01    | 686.62 ns       |
|                                | 18.3     | 686.62 ns       |
|                                | 16.63    | 686.62 ns       |
|                                | 20.05    | 686.62 ns       |
|                                | 18.17    | 686.62 ns       |
|                                | 17.66    | 686.62 ns       |
|                                | 0.15     | 686.62 ns       |
these responses in multi environments.

- Most yield components traits possessed an significant coefficient of regression and deviation from regression besides their numerical coefficients near to one that mean that genotypes are stable in most traits. Though biological yield controlled by linear function and can be predictable. Protein content trait differ among genotypes for the environmental error which shift these responses in multi environments.

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**Conclusion**

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