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Performance of newly introduced broadbean genotypes under rainfed conditions of Duhok Province

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Abstract

This experiment was conducted at Malta Agriculture Research Center, Duhok Province during growing seasons 2014/15, 2015/16, and 2016/17 to investigate the performance of twelve newly introduced genotypes of fababean under rainfed conditions of Duhok province. The lack of improved varieties and well adapted by the farmers in the study area is the main challenge for the Agricultural Research Centers in Iraqi Kurdistan Region; accordingly twelve newly introduced genotypes of fababean namely: FLIP12-153Fb, FLIP12-154fB, FLIP12-137FB, FLIP12-155FB, FLIP12-142FB, FLIP12-143FB, FLIP12-144FB, FLIP12-145FB, FLIP12-147FB, FLIP12-149FB, Aquadulce and Elisar, along with a local check variety were evaluated for their yield and yield components under rainfed conditions of Duhok province. The results indicated that there were slight variations among genotypes in all growing seasons for growth measurements. On the other hand, there were significant differences among the studied genotypes in respect to yield and its component parameters. In combine analysis where the seasons considered as replications, the higher grain yield was harvested from FLIP12-147FB variety followed by FLIP12-153Fb, FLIP12-143FB, FLIP12-155FB. Therefore, these genotypes can be recommended to the farmers located at the targeted area.

Introduction

Legumes considered as one of the main sources for feeding both human and animals, since they are rich in many nutrients such as proteins (20-40%), carbohydrates (50-60%), starch, and fibers *[1; 2]*, as well as grain legumes are able to fix atmospheric nitrogen (N2) in association with symbiotic *Rhizobium [3]*. Broadbean also known as the fababean and field bean is grown on 2.5 million ha of land globally, with Central and East Asia contributing 36% with a yield from 1805 kg/ha to 1910 kg/ha. The Middle-East and North Africa has the highest broadbean consumption, averaging 2.7 kg/person/year *[4]*. Broadbean is also the most important food legume in Iraqi Kurdistan region; it makes up the major part of the daily diet for the population. Moreover, it plays an important role in sustaining the productivity of the farming systems through the fixation of atmospheric nitrogen. The northern part of Iraq is one of the main suppliers of broadbean in the country. The crop has a multipurpose use and is consumed as dry seeds, green vegetable, or as processed food *[5]*.

Outstanding among other legumes, broadbean plays a critical role in crop rotations; *[6]* and *[3]* illustrated that broadbean fixes much higher nitrogen percentage than chickpea and the nitrogen fixation in the later stage is more sensitive to drought. Xiao *et al.,* (2004) *[7]* reported that broad bean produced 104 nodules per plant with

0.816% nitrogen in soil during harvesting stage. While *[8]* stated that the nitrogen in vegetative broad bean (2.38%) was higher than in setting or harvesting stage. The yield of broadbean is influenced either by environments or genotypes; the later has direct influence on both growth and final grain yield especially when introduced to new environments.

Nour (1982) *[9]* stated that in addition to varieties, numerous constraints limiting broadbean yield; these include water requirements, diseases, insect pests, weeds, soil salinity, arid planting, and time of harvesting. Similarly, *[10]* reported that drought is one of the major factors limiting broadbean production in Mediterranean region with irregular water distribution and moisture level below than 500 mm. Therefore, a major objective of any breeding program in this region is to develop drought tolerant genotypes of broadbean that are well adapted to a wide range of environments.

Mitiku and Mekuria (2015) and Rouphael *et al.[5; 11]* recorded significant variations among broadbean varieties for most of yield and yield components traits in a study used eight improved broadbean varieties in Ethiopia. On the other hand, *[12]* demonstrated significant differences in growth and yield traits regarding various Tunisian broadbean varieties under drought and irrigated conditions. Also, *[13]* reported a positive correlation between most of studied traits of broadbean genotypes with final seed yield. The low broadbean yield and production in Iraqi Kurdistan region is reflect the high need for introducing new varieties with reasonable seed yield and accordingly, this experiment was suggested to assess the performance of several newly introduced genotypes of broadbean parallel with the local cultivar under Duhok environmental conditions, to identify and recommend surpassed genotype for the broadbean cultivation in Duhok

Materials and Methods

This experiment was conducted at the field of Malta Agricultural Research Center, Duhok (36^{o} 50' 49" N; 42^{o} 93' 6" E and 307 above sea level) during three growing seasons (2014/15, 2015/16, and 2016/17) for investigating the performance of twelve newly introduced genotypes of broadbean from International Center for Agricultural Research in the Dry Areas (ICARDA) compared with the local Duhok variety. The genotypes included in the study were: FLIP12-153Fb, FLIP12-154fB, FLIP12-137FB, FLIP12-155FB, FLIP12-142FB, FLIP12-143FB, FLIP12-144FB, FLIP12-145FB, FLIP12-147FB, FLIP12-149FB, Aquadulce, Elisar, and local check variety.

The treatments (genotypes) were arranged in a simple randomized complete block design (RCBD) with three replications. For all seasons the field was plowed with a disk plow two weeks prior to planting and the soil was shredded by a rotavator.

The experiments were conducted under rainfed conditions; climatic data were collected from the meteorological station of the experimental site (Table 1); sowing dates were at 5/11, 8/11 and 12/12 and the first rainfall was at 16/11, 9/11 and 14/12 for 2014, 2015 and 2016 growing seasons, respectively. Soil physical and chemical analysis tests were carried out for the soil samples collected randomly from 0-40 cm depth. All soil properties analysis was conducted at the University of Duhok, College of Agriculture, Central Laboratory (Table 2). The experiments were arranged as randomized complete block design (RCBD). Plot size was about 4 m² (four rows of 4 m long and 0.3*0.2 m apart) which are matching the seeding rate of about 165 $kg.ha^{-1}$. 25 $kg.do^{-1}$ of compound fertilizer (DAP; 46%N and 18%P) was applied at the sowing; weeding was conducted manually when required. Pests mainly aphids were controlled when needed. At the time of data measurements; ten guarded plants from one of the middle rows was included and then the average per one plant was calculated. The yield was harvested within 19-25, May for all seasons. The data was analyzed using GenStat version 10 *[14]* program. Least significant differences (LSD) test at 0.05 level was used for the mean comparisons.

Table-1: Rainfall data (mm) during growing season 2014, 2015, and 2016*

Growing season	October	November	December	January	February	March	April	May	Total (mm)
2014/2015	91	163	64.5	72.5	64	61	37	1.5	554.5
2015/2016	32.4	70.8	94	116	46	105	70	12.5	546.7
2016/2017	5	24.5	90.5	41	15	83	55	9	324

** The data were recorded from Malta Research Center meteorological station*

Table -2: Soil characteristics for the experiment location (Malta R. Center)

Character[1]	value
pH	7.62
$CaCO_3$%	21.03
EC (ds^{-1})	0.278
OM (%)	0.62
Sand (%)	10.62
Silt (%)	45.96
Clay (%)	34.42
Soil type	Silty clay

OM, Organic material; EC, Electrical conductivity

Results and Discussion

Data in Table 3 clearly shows significant differences of broadbean genotypes for all growth parameters with the exception of days to flowering as the genotypes and local check variety recorded 76 to 80 days respectively from sowing to flowering. Regarding plant height, FLIP12-153Fb genotype was the tallest (131 cm) followed by FLIP12-154fB (124 cm) and FLIP12-137FB (120 cm) while each of FLIP12-149FB, FLIP12-143FB, FLIP12-144FB, Aquadulce along with the local check variety were inferior with 105, 106, 107, 109 and 113 cm, respectively. Plant height is genetically controlled by genes *[15]*, but growth conditions such as water availability and temperature can significantly influence plant height.

High variations among genotypes were observed for the height of lowest pod. Each of Aquadulce, local check variety and FLIP12-153Fb were superior for giving the highest height of first pod which can be effectively contribute with mechanical harvesting. On the other hands, FLIP12-147FB, FLIP12-149FB and FLIP12-142FB with values of 10, 11, and 14 cm recorded the lowest height of the first pod, respectively. As for the days to maturation measurement, also Table 3 shows remarkable variations among genotypes. FLIP12-147FB genotype was superior for giving longer day to maturation (164), while all other genotypes were resembled as local check variety in maturation with values ranged between 160 and 162 days. Early maturity trait is indicate as a drought avoidance mechanism of some varieties and is best suitable for the driest environments *[16]*. The obtained results are also agreed with those of *[12; 11]*.

Table-3: Growth traits for the studied broadbean genotypes as a mean of all growing seasons

Genotypes / Traits	Days to flowering	Plant height (cm)	Height of the lowest pod (cm)	Days to maturity (days)
FLIP12-153Fb	78	131	25	162
FLIP12-154fB	79	124	22	162
FLIP12-137FB	79	120	21	160
FLIP12-155FB	79	108	20	162
FLIP12-142FB	78	107	14	163
FLIP12-143FB	79	106	15	160
FLIP12-144FB	80	107	20	160
FLIP12-145FB	80	115	23	161
FLIP12-147FB	78	116	10	164
FLIP12-149FB	78	105	11	162

Aquadulce	*79*	*109*	*30*	*161*
Elisar	*76*	*116*	*25*	*161*
Local check	*80*	*113*	*30*	*161*
LSD	*7.851*	*12.233*	*8.731*	*1.612*

* *The mean of studied traits were compared at the probability of 0.05*

The analysis of variance revealed significant main effects among genotypes for seed yield and yield components (Table 4). For number of primary branches, both of FLIP12-143FB (7 branches) and FLIP12-155FB (6 branches) were significantly produced higher number of branched compared to each of FLIP12-137FB and Aquadulce in which they were inferior for giving lowest number of primary branches and both produced only 3 branches for each. Also, FLIP12-143FB, FLIP12-155FB and FLIP12-147FB were superior in number of pods per plant and each gave 57, 39 and 33 pods respectively. On the other hand, Aquadulce, FLIP12-144FB and Elisar genotypes were significantly recorded the lowest number of pods per plant. It seems that number of pods per plant is attributing directly to the final seed yield as the previously mentioned table show the superiority of these three genotypes in seed yield as compared to the other genotypes or the local check under this study. These results are highly agreed with those of *[2]*.

Regarding number of seeds per pods, Aquadulce (9 seeds.pod^{-1}) and FLIP12-155FB (5 seeds.pod^{-1}) genotypes were the best for giving higher number of seeds per pods compared to all other genotypes including local check variety. Concerning weight of 100 seeds, Aquadulce (128.35 g), Elisar (103.33 g), FLIP12-145FB (102.48 g) and FLIP12-149FB (101.36 g) along with local check (105.63 g) were significantly recorded the highest values for weight of 100 seeds compared to FLIP12-137FB, FLIP12-147FB and FLIP12-154fB genotypes were recorded lowest values of seed weight. Most of the tested genotypes along with the local check variety produced significantly good seed yield per donum (one donum is equal to ¼ hectare). Each of FLIP12-147FB, local check, FLIP12-153Fb, FLIP12-143FB, FLIP12-155FB were superior in seed yield as compared to the other genotypes and can be recommended to the farmers in Duhok area and it is clear that all yield components attributed positively to the final seed yield as well as the period of growing season as the least season had less period which reflected negatively on the final yield. These results are in harmony with those obtained by each of *[5]*, *[11]* and *[12]*.

Table-4: Yield and yield components traits for the studied broadbean genotypes as a mean of all growing seasons

Genotypes / Traits	***No. branches/ Plant***	***No. pods/ plant***	***No. seeds/ pod***	***Weight of 100 seeds (gm)***	***Seeds yield/ donum* (kg)***
FLIP12-153Fb	*4*	*26*	*3*	*92.18*	*1499.31*
FLIP12-154fB	*4*	*28*	*3*	*85.35*	*1380.79*
FLIP12-137FB	*3*	*29*	*3*	*83.05*	*1415.05*
FLIP12-155FB	*6*	*57*	*5*	*85.57*	*1475.46*
FLIP12-142FB	*3*	*31*	*4*	*99.04*	*1323.15*
FLIP12-143FB	*7*	*39*	*3*	*94.09*	*1498.38*
FLIP12-144FB	*4*	*19*	*4*	*91.55*	*1308.33*
FLIP12-145FB	*4*	*29*	*3*	*102.48*	*1321.76*
FLIP12-147FB	*4*	*33*	*4*	*85.12*	*1597.45*
FLIP12-149FB	*4*	*24*	*3*	*101.36*	*1376.16*
Aquadulce	*3*	*16*	*9*	*128.35*	*1409.49*
Elisar	*5*	*21*	*4*	*103.33*	*1342.36*
Local check	*5*	*24*	*4*	*105.63*	*1508.33*
LSD	*0.435*	*2.894*	*1.231*	*12.995*	*137.05*

* *The mean of studied traits were compared at the probability of 0.05*

* *1 donum= 2500 m^2 or ¼ hectare*

Table 5 shows the performance of tested genotypes in regards to the seed yield at all three growing seasons. It is obvious that final seed yield is highly associated with increasing of the rainfall (Table 1) and growing period as both 2014/15 and 2015/16 growing seasons significantly recorded higher seed yield compared to 2016/17 season and the yield was 1657.74, 1514.31 and 1087.01 kg.do^{-1} respectively. The most stable genotype in seed yield was FLIP12-147FB as it performed good seed yield in all growing seasons; while each of FLIP12-144FB, Aquadulce, and Elisar genotypes recorded the lowest seed yield at the driest season. Such outcomes give an idea about incompatibility of these genotypes for growing under unstable condition of Duhok province.

Table-5: Seed yield for the studied broadbean genotypes at all growing seasons (kg.do^{-1})

Genotypes / Seasons	***2014/2015***	***2015/2016***	***2016/2017***
FLIP12-153Fb	*1847.22*	*1572.22*	*1078.47*
FLIP12-154fB	*1622.22*	*1371.52*	*1148.61*
FLIP12-137FB	*1890.97*	*1290.97*	*1063.19*
FLIP12-155FB	*1390.97*	*1814.58*	*1220.83*
FLIP12-142FB	*1568.75*	*1405.55*	*995.13*
FLIP12-143FB	*1888.88*	*1507.63*	*1098.61*
FLIP12-144FB	*1522.91*	*1443.75*	*958.33*
FLIP12-145FB	*1433.33*	*1379.16*	*1152.77*
FLIP12-147FB	*1749.30*	*1782.63*	*1260.41*
FLIP12-149FB	*1495.83*	*1481.94*	*1150.69*
Aquadulce	*1752.08*	*1507.63*	*968.75*
Elisar	*1509.72*	*1532.63*	*984.72*
Local check	*1878.47*	*1595.83*	*1050.69*
Mean of growing seasons*	*1657.74*	*1514.31*	*1087.01*
LSD	*112.57*	*167.04*	*141.52*

** LSD for the mean of growing season is 157.12*

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