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Evaluation of Faba bean (*Vicia faba* L.) varieties for yield and yield contributing traits in the southern parts of Ethiopia.

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Abstract: *Faba bean (Vicia faba L.) is among the major grain legumes cultivated and used extensively as a break crop in the highlands. However, production is insufficient because crop yields are low. After all, lack of improved and farmers preferred varieties. Therefore, it is a vital issue to identify and select the best performing varieties to enhance faba bean yield. The study was conducted with aim of identifying and selecting the best yielding varieties with good adaptability and major relevant agronomic characteristics. Thirteen improved Faba bean varieties were evaluated for their adaptation and yield in Bule, Dara, and Hula districts under rain-fed conditions during the 2016 and 2017 main cropping season. The varieties were planted in four replications using the RCBD design. Combined Analysis of variance result showed that there were significant differences observed in all parameters. In the present study, the highest seed yield (kg/ha) was observed from variety Gora (3983.42kg/ha) and Dosha (3943.0kg/ha), followed by shallo (3786.0kg/ha) and the lowest seed yield was observed from variety Moti (3307.1kg/ha). Therefore in the future, it is essential to demonstrate high yielding varieties to the farmer for production through extension and demonstrations. In general the present study identified Gora, Dosha and Shallo was high yielding varieties in study area.*

Keywords: *Analysis Of Variance, Evaluation, Varieties, Vicia Faba, Yield*

1. INTRODUCTION

Faba bean (*Vicia faba* L.) is a diploid (2n = 12 chromosomes) crop that is one of the most vital food legumes ranking in the world fourth after garden pea, chickpeas and lentil. It is cultivated in the temperate and subtropical regions of the world (Torres *et al*., 2006). The inclusion of faba bean in cropping systems improves soil Fertility through atmospheric nitrogen fixation that provides agricultural sustainability (Karkanis *et al*., 2018). It also can be used by the succeeding cereal crop by its ability to break the cycle of biotic stresses (Jensen *et al*., 2010).

In Ethiopia, faba bean is among the major grain legumes cultivated and used extensively as a break crop in the highlands. Ethiopia is probably one of the primary centers of diversification for faba bean. It is produced in many regions of the country's highland and semi-highland areas with altitudes ranging from 1800-3000 m.a.s.l (Yohannes, 2000). Faba bean has been the leading grain legume in area coverage and production in Ethiopia as well as in Sidama and Southern Nations Nationalities and Peoples Regional States (SNNPRS). Even though faba bean is important crop as national and internationally, the production and productivity of faba bean in Southern Ethiopia is low 20.30 t/ha (CSA, 2020). Some improved faba bean varieties has been released by the different regional and federal research centers in the nation but they are still not adopted by farmers

However, its area and production have declined substantially in recent years mainly due to increased disease pressure and lack of identification of better performing varieties including the large seeded ones to fulfill the market demand. In general faba bean production is insufficient because crop yields are low. After all, farmers grow varieties that are susceptible to diseases, insect pests, drought and high summer temperatures (ICARDA, 2008). As a result, it is a vital issue to identify and select the best performing varieties to enhance faba bean yield. Therefore the study aimed to identify and select high yielding varieties with good adaptability and major relevant agronomic characteristics.

2. MATERIALS AND METHODS

Description of treatments and study areas

The experiment was conducted with a total of 13 released faba bean varieties at three locations for two years constituting six environments, at Bule, Dara, and Hula districts in 2016 and 2017 main cropping seasons. Twelve released and currently under production varieties were collected from Holeta, Kulumsa, Sinana ARCs, and Bule-04 which were released through Hawassa ARC were treatments used in the study. Figure 1 shows the map of the study area and Table 1 shows the description of faba bean varieties used in this study.

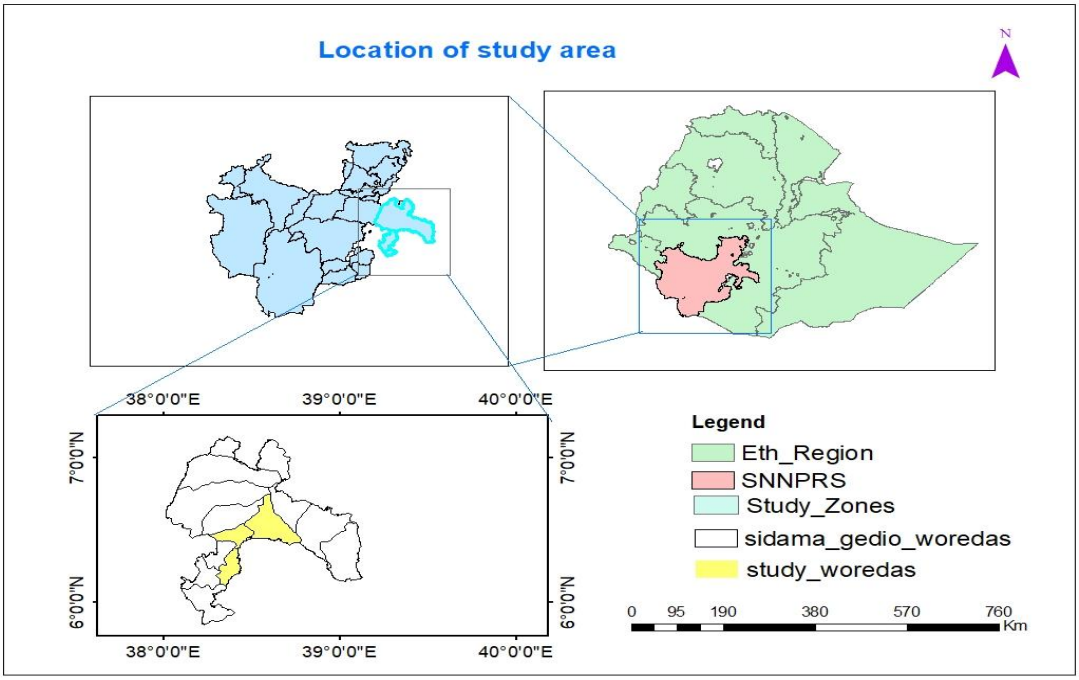

Fig1. *Map of Study Area (Source: Authors creation).*

Table1. *Description of Faba bean Varieties tested in this experiment.*

Varieties	Seed source	Year of release	Days to physiological maturity	Yield (kg/ha) on	
				Research	Farmers field
CS20DK	Holeta ARC	1977	145-160	20-40	15-30
Tumsa	Holeta ARC	2010	121-176	25-69	20-38
Dosha	Holeta ARC	2009	120-165	25-62	23-39
Obse	Holeta ARC	2007	87-166	25-61	21-35
Moti	Holeta ARC	2006	108-165	28-51	23-35
Gabelcho	Holeta ARC	2006	103-167	25-44	20-30
Degaga	Holeta ARC	2002	125	32	NA
Hachalu	Holeta ARC	2010	122-156	32-45	24-35
Walki	Holeta ARC	2008	NA	NA	NA
Gora	Kulumsa ARC	2013	126-168	22-57	20-40
Mosisa	Sinana ARC	2013	NA	NA	NA
Shallo	Sinana ARC	1999	118	37.46	NA
Bule-04	Hawassa ARC	2012			

*****Note: ARC = Agricultural Research Center,NA =Non available***

Methodology

A randomized complete block design (RCBD) with four replications was used for the study. The spacing between plants and rows was 8cm and 40cm, respectively. Each variety was planted in 4 rows 4m long where only the two central rows were used for before and after harvest data collection. Hand weeding was applied for weed management. The Number of pods per plant as well as the number of

seeds per pod was taken from two middle rows of five sampled plants. Plant height also another agronomic data taken after the plant finished its growth. The moisture content was also measured and the yield obtained was also adjusted at 10% moisture content. Hundred seed weight is also weighted to identify good varieties in terms of their seed size. The varietiy trial conducted across locations (L) and over years(Y) was analyzed using the following model.

$Yijkr = \mu + Gi + Lj + Yk + Br(LY) + (GL)ij + (GY)ik + (LY)jk + (GLY)ijk + eijkr$

Data Collected

Data were collected both on a plot and plant basis. The two central rows were used for data collection based on plots, for seed yield (kg/ha). Five plants from the central rows were randomly selected for the data collection on a plant basis and the averages of the five plants in each experimental plot were used for statistical analysis for traits such as plant height, number of seeds/pod and number of seeds/plant and hundred seed weight.

Data Analysis

Analysis of variance was done using Proc GLM procedures of SAS Software 9.0 after testing the ANOVA assumptions. Mean separations were estimated using Least Significant Difference (LSD) for the comparison among the experimental varieties at 0.05 probability level. A combined analysis of variance for both years and seasons was done to test the response of varieties to both environment and seasons after testing the homogeneity of the data.

Table2. *Mean Square Values of Yield and Yield Components of Faba bean Varieties Combined over Location and Year.*

Source of Variation	**Mean Square Values**				
	PPP	SPP	PH (cm)	HSW (gm)	YLD (Kg/ha)
Loc	464.23**	3.18*	283371.61**	2223.84**	47790459.1**
Rep (loc)	64.234ns	0.535ns	5411.68**	156.39ns	1869368.6**
Year (loc)	37.233ns	0.586ns	0.00ns	27701.73**	49350105.7**
Varieties	27.688ns	0.9065ns	7764.88**	4663.24**	1041550.9*
Location * variety	25.456*	0.519ns	6773.55ns	728.99ns	387250.3ns
Year * variety (loc)	4.158ns	0.6386ns	0.9042ns	28430.72ns	478087.1ns
Error	11.44	0.6796	223.17	46.09479	472890.2
CV	24.25%	21.59%	13.36%	9.86%	19.16%
LSD (0.05)	1.9	0.45	8.49	3.859	391.18

***Note Pods per plant, SPP = Seeds per pod, PH = Plant height, HSW = Hundred seed weight, and YLD = Yield*

For a varietiy trial conducted across locations (L) and over years(Y) the model is the following

$Yijkr = \mu + Gi + Lj + Yk + Br(LY) + (GL)ij + (GY)ik + (LY)jk + (GLY)ijk + eijkr$

Table3. *Average Values of Yield and Yield Related Attributes of Faba bean Varieties across Location and Year.*

Varieties	PPP	SPP	PH (cm)	HSW (gm)	YLD (Kg/ha)
Gora	13.8	3.9	116.9	86.8	3983.4
Dosha	14.4	3.7	112.2	70.1	3943.0
Shallo	15.8	3.9	105.4	63.8	3786.0
Degaga	14.8	3.8	116.8	54.6	3619.4
Hachalu	13.6	3.6	109.4	71.3	3610.5
Tumsa	14.7	3.8	121.9	71.1	3609.9
Mosisa	14.3	4.0	110.7	61.4	3542.4
Bule-04	12	3.8	113.1	78.7	3513.1
Gabelcho	13.4	3.9	112.0	77.546	3507.9
Obse	13.0	4.3	103.3	74.530	3470.2
Walki	14.5	3.6	108.1	60.800	3435.7
CS20DK	13.8	3.5	107.3	52.758	3328.8
Moti	13	3.8	115.6	71.396	3307.1

***Note** ppp = Pods per plant, SPP = Seeds per pod, PH = Plant height, HSW = Hundred seed weight, and YLD = Yield*

3. RESULT AND DISCUSSION

Combined analyses of data from Bule district, Dara district) and Hula district showed significant varietal differences ($p \leq 0.01$) in yield kg/ha and highly significant differences in hundred seed weight (Table 2).

Table 2 shows mean square-values of the agronomic trait across the location, years (loc), variety, location*variety, and year*variety (loc). The varieties were evaluated based on yield and other agronomic traits. The varieties revealed significant variation for plant height, hundred seed weight and yield, while non-significant for pods per plant and seeds per pod (Table 2). Even though, the location effect revealed that highly significant variation ($p \leq 0.01$) for hundred seed weight and yield. But, loc*variety showed a non-significant difference for seeds per pod, plant height, seed yield as well as hundred seed weight ($p \leq 0.01$). Concerning year*variety (loc), the agronomic traits recorded showed a non-significant variation ($p \leq 0.05$). This indicates that the varieties responded similarly to the tested locations and year for plant height, hundred seed weight and yield or the varieties respond no genotype by interaction for those traits. So, this combined analysis indicates that we could do a general recommendation for the tested location.

Accordingly, faba bean variety "Gora and Dosha was high yielder (3983.4kg/ha), 3943.0 kg/ha" respectively, followed by "Shallo (3786.0kg/ha)" was recommended for the tested location (Bule, Dara, and Hula district) to increase their production as well-income.

Hundred Seed Weight

There were significant variations ($P<0.01$) among faba bean varieties for their hundred seed weight (table 2). The highest hundred seed weight (kg/ha) was observed from variety Gora (86.8g) and followed by varieties Gebelcho (78.7g) and Bule-04 (77.5g). This is in line with reports of Gereziher et al (2018), which show variety Gora was heaviest (823.3g). Therefore, the varieties with high hundred weight have great importance for fetching local and export market with premium price. These varieties are highly demanded even for home consumption.

Plant Height (cm)

The combined data analysis for plant height were a significant difference at $p<0.01$ among tested Faba bean varieties (Table 2). Accordingly variety Tumsa (121.9m) followed by Gora (116.9m) and Degaga (116.8m) were showed the highest plant height and Obse (103.3m) revealed the shortest plant height in the tested area (Table 3). This is in line with Yirga and Zinabu (2019) which shows maximum plant height was recorded for Gora, CS-20DK, and Tumsa with mean scores of 98.30 cm, 94.50 cm, and 91.37cm, respectively.

The advantage these of varieties are, they are good for their bye products and feedings in the highland areas. Plant height is a major agronomic characteristic because of its association with lodging (Zilio et al., 2013). If the harvest period coincides with prolonged rainfall, since the pods of more upright plants do not touch the moist soil, reduction of grain quality loss, reduction of soil borne diseases, ease of mechanical harvest.

Seed Yield (kg/ha)

The combined analysis revealed that faba bean varieties were significant ($p \leq 0.05$) (Table 2). The highest seed yield (kg/ha) was observed from variety Gora (3983.42kg/ha), and Dosha (3943.0kg/ha), followed by Shallo (3786.0kg/ha), and the lowest seed yield was observed from variety Moti (3307.1kg/ha).

This result is in line with the finding of Gereziher et al (2018), which reported that significant differences were observed in seed yield (kg/ha) in tested Faba bean varieties and accordingly, Dosha shows that 3891 kg ha-1) kg/ha. Similarly, Yirga and Zinabu 2019 reported that variety Dosha was highest interms of mean yield (2197.9kg/ha).

Crop yield is one of the most important agronomic traits since it is related to cost effectiveness and food security (Gelin et al., 2004). As a result, the varieties such Gora, Dosha, and shallo preferred, due their association with cost effectiveness.

4. CONCLUSION

Faba bean is the first among pulse crops cultivated in Ethiopia and a leading protein source for the rural people and used to make various traditional dishes. Based on the present study, the performance

of all the tested faba bean varieties was found to be superior in productivity as compared to the national average. However, based on the combined data, varieties Gora, Dosha and shallo gave higher yields. Therefore, in the future, it is essential to demonstrate high yielding varieties to the farmers for production through extension and demonstrations. Based on the seed size variety Gora was recommended and this variety is best to attract the market.

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