Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.13, No.15, 2023

Evaluation and Selection of Released Small White Common bean [Phaseolus vulgaris L.] Varieties under Hararghe Condition, East Ethiopia

Shanene Haile[1*] Fantahun Adugna[2]
1. Oromia Agricultural Research Institute, Addis Ababa, Ethiopia,
Mechara Agricultural Research Center, P.O.Box,19
*Corresponding author: haileshanne@gmail.com

Abstract
Field experiment was conducted at Mechara Agricultural Research centers on-station, Habro district on Busoyitu Farmers Training Center and Fedis Agricultural Research Center's on station with objective to selecting and recommending the best adapted small white common bean varieties. The experiment was laid out using a rcbd with three replications.six improved haricot bean varieties namely Chercher, Awash-2, chore, Nezarath-2, SAB-736, LEHODE and one standard check were used under rain fed condition in 2017/18 main cropping season. The combined analysis of variance over environments showed highly significant differences among varieties, environments and varieties by environment interactions. Mean comparison for the tested varieties indicated that maximum grain yield was obtained from Awash-2 (2.2t ha^{-1}) followed by Chercher (2t ha^{-1}) and Chore (2.14t ha^{-1}). While the lowest seed yield was recorded with variety Nezarath-2 (1.6t ha^{-1}). The combined mean seed yield of Awash-2, Chercher and Chore varieties were 16%, 7% & 6% yield advantage over standard check respectively. At single location (Busoyitu site) there was high significant variations observed among the common bean varieties for the grain yield. Contrast to this, no significant variation showed in seed yield both Mechara and Fedis on station. For that reason, three improved varieties i.e. Awash-2, Chercher and Chore were showed better performance for most of the studied characters including grain yield. But variety Chore and Chercher were yield advantage variation less than 10% of standard check.
Accordingly, even though it could be possible to recommend varieties Awash-2 and Chore for respective areas of Busoyitu and Mechara while Chercher for Fedis in order to boost production and productivity of stock holders.
Keywords: Adaptation trial, Common Bean, Phaseolus vulgares, Phenological Parameters, improved Varieties. Environments, varieties by environment interactions.
DOI: 10.7176/JBAH/13-15-01
Publication date: September 30th 2023

1. Introduction

Common bean (*Phaseolus vulgaris* L.) is the most important food legume in the world (CIAT, 2001). It is an annual crop which belongs to the family Fabaceae (Daniel.et al. 2014).It grows well between 1400 and 2000meter above sea level (Fikru and Mekonnen, 2007).In Ethiopia, it is one of the fast expanding legume crops that provide an essential part of the daily diet and foreign export earnings for the country (Girma, 2009). It is cultivated primarily for dry seeds, green pods (as snap beans), and green-shelled seed. Beans offer a low cost alternative to beef and milk because bean seed is rich in protein, iron, fibers, and complex carbohydrates (Mwale et al., 2008). The crop have been cultivated for their grain which have high protein content around 22% or higher on dry matter bases (CIAT, 2002).

Wide ranges of common bean types grown in Ethiopia including mottled, red, white and black varieties (Ali et al.,2003).The most commercial varieties are pure red and pure white color beans and these are becoming the most commonly grown types with increasing market demand (Ferris and Kaganzi, 2008).

It is one of the major grain legumes widely cultivated as food and cash crop by smallholder farmers in Hararghe. Moreover, beans are important crop in farming systems and it is intercropped with sorghum, maize, coffee and 'chat' at study area. Early maturity and moderate degree of drought tolerance led the crop's vital role in farmers' strategies for risk aversion in drought prone areas of the country like Hararghe. The national average production of common bean is about 16.58t ha^{-1} (CSA, 2017). And the zonal average production of haricot bean is about 1.6t ha^{-1} (CSA, 2016).

In Hararghe shortage of high yielding varieties, resistance to biotic and abiotic factors are common bean production constraints that limit the volume of production. In addition poor yielding potential of under production varieties and unrecommended management practice of common bean is main problem yield reduction in the target area.

For that reason, there is need to adapted the recently improved common bean varieties to the target area is vital important to come up with improved productivity and production in Hararghe area. To this end, this research is initiated with the objective of selecting and recommending the best adapted small white common

bean varieties in the study area.

2. Materials and Methods

2.1 Description of the study sites

The field experiment was conducted at Mechara on station, Habro district (on Busoytu FTC) and Fedis research center of eastern Oromia in 2017/18 main cropping season.

Table 1: Description of experimented environments

Locations	Altitude (m.a.s.l)	Average Rain fall(mm)	Soil Type	Latitude	Longitude	Max.	Min.
Machera	1760	871	Alf sols	8º36'N	40'18E	23.4ºC	8.9ºC
Gelemso	1850	825	Nit sols	8º30'N		30ºC	16ºC
Fedis		1584					

Source: Mechara and Fedis Agricultural Research Center, Habro district agricultural and natural resource office

2.2 Treatments and Experimental Design

2.3 Experimental materials

Six released common bean namely Chercher, Awash-2, chore, Nezarath-2, SAB-736, LEHODE varieties and one standard check were tested. The varieties were selected based on average yield performance and agro ecological adaptation. The verities were obtained from Melkasa and Sirinka Agricultural Research center and Haramaya University.

2.4 Experimental design

The experiment was laid out in Randomized Complete Block Design with 3 replications and the plot size was 2.4m X 2.5m. The space between plots was 0.5m and 1 m between replication. Each variety was sown with recommended seed rate of the area for raw planting. Fertilizer rate of 100 kg ha^{-1} DAP was applied at time of sowing. All management practices were uniformly applied to all plots as per recommendation.

2.5 Data collected

Four central rows were harvested for determination of grain yield and Grain yield was adjusted to 10% moisture content.

2.6 Statistical Analysis

R computer software program used to analyze the data for single location and combined analysis of variance over locations. Effects were considered significant in all statistical calculations if the P-values were $P<0.05$. Mean was separated using Fisher's Protected Least Significant Difference (LSD) test.

3. Results and Discussion

The combined analysis of variance over environments showed high significant ($P\leq0.01$) differences among varieties, environments and varieties by environment interactions (Table 1). Similarly result reported by, Raffis et al. (2004), Dar et al. (2009) and Mwale et al.(2009) significant differences in genotypes by environment interaction for mean grain yield of common bean. The variance due to genotypes by environment interaction was found significant for various traits by Singh et al. (2007). This indicated that the environments had different impact on the yield performance of the varieties while the varieties had different performance in the testing environments so that they showed rank difference. Also in line with this finding, Habtamu.(2018), Kang and Juo (1986) reported that corn and common bean genotypes had responded differently across environment. Those environments have immense influence common bean production in bean growing areas of Hararghe. Different researchers account the significant influence of environment in different crops performance so far; Firew (2002) in bean, Zhe et al. (2010) in soybean and Kan et al. (2010) in chick pea are few of the authors.

Table-1: Combined ANOVA for grain yield of common bean varieties

Source of variation	**DF**	**MS**	**F value**	**Pr(>F)**
Variety	6	0.339	1.782	0.0012*
Replication	1	1.506	7.912	0.0075 **
Environment	2	18.373	96.506	3.11e-16 ***
Variety x Environment	12	0.122	0.64	0.0079**
Residuals	41	0.19		

*=Significant difference and **= highly significant difference, DF= degree freedom, MS= mean square

Mean comparison for the tested varieties indicated that maximum grain yield was obtained from Awash-2 (2.2t ha^{-1}) followed by Chercher (2t ha^{-1}) and Chore (2.14t ha^{-1}). Contrast to this, the lowest grain yield was recorded by variety Nezarath-2(1.6t ha^{-1}). The combined mean seed yield of Awash-2, Chercher and Chore

varieties were 16%, 7% & 6% yield advantage over standard check (Awash-1) respectively. Variety Chercher had the highest mean number of pod per plant(35) and seed per pod(7) whereas LEHODE had the lowest mean number of pod per plant18 and seed per pod 5 (Table 2).

Analysis of variance revealed for single location showed that highly significant (P≤0.01) difference in seed yield among common bean varieties tested at Busoytu(Table 3).This indicate the presence of variation among genotypes for yield supported by the previous work of Habte (2018) ,Biru (2014) and Yayis et al (2011),who notice variation in yield different common bean genotypes. Awash-2 was recorded superior grain yield 3.4 t ha^{-1} followed by variety Chercher, 3.1 t ha^{-1}. On the other hand, lowest seed yield was obtained by Nezarath-2 (2.3t ha^{-1}). The mean grain yield of Awash-2 and Chercher varieties were 26% & 15% yield advantage over standard check (Awash-1) respectively. Most varieties evaluated at Busoyitu site were recorded high seed yield than it's yield potential therefore, Busoyitu area is ideal environment for common bean varieties.

At Busoyitu, the analysis of variance revealed that there was highly significant (p<0.01) difference among varieties for plant height, days to maturity, pod per plant, and hundred seed weight. While number of seed per pod, days to flowering and disease reaction were revealed no significant difference between evaluated varieties (Table 3).

Contrast to this, not significant difference showed in seed yield both Mechara and Fedis(Table 4 and 5). However, there was numerical difference observed for seed yield among the tested varieties. Awash-2 (2.22t ha^{-1}) and Chore (2.26t ha^{-1}) were recorded superior grain yield followed by variety Chercher (2.10t ha^{-1}) among evaluated varieties at Mechara (Table 4). At Mechara on station, the analysis of variance revealed that there was highly significant (p<0.01) difference among varieties for plant height, days to maturity, pod per plant, seed per pod, hundred seed weigh, disease reaction and significant different((p<0.05) showed for days to 50%.while non different for insect pest.

At Fedis on station, significant difference was observed shown on pod per plant whereas no significant difference on grain yield and number of seed per pod between tested varieties (table 3). Chercher (11.25t ha^{-1}) was recorded superior grain yield whereas a Nezarath-2 variety (8.21t ha^{-1}) was obtained the lowest grain yield. There was high grain yield reduction observed for all tested varieties at Fedis; this is mainly due to moisture stress occurred at grain filling stage but not owing variety potential. Water stress during the flowering and grain filling periods reduced seed yield and seed weight and accelerated maturity of dry bean Szilagyi, L. (2003). Molina *et al., (*2001) reported that water stress reduced grain yield of common bean cultivars, by approximately 50%.

Table 2: Combined mean of grain yield and yield components of common bean varieties across three locations in 2017/18 main cropping season

Variety	NPPP	NSPP	GYD(t ha^{-1})	GYD Adv%
Awash-2	27bc	5c	2.20a	16
Chercher	35a	7abc	2.03ab	7.10
Chore	33ab	6a	2.01ab	6.00
Awash-1	32ab	6a	1.90ab	
SAB-736	19cd	5c	1.90ab	
LEHODE	18d	5c	1.70b	
Nezarath-2	32.48ab	6ab	1.64b	
CV%	**29.22**	**8.9**	**22.26**	

NB: CV=coefficient variation, ns=non significance, NPPP= number of pod per plant, NSPP=number of seed per pod, HSW=hundred seed weight (g) and GYD= grain yield (t ha^{-1})

Table 3: Mean grain yield and agronomic traits of haricot bean varieties on Busoytu FTC in 2017 main cropping season

Variety	DF	DM	PLH(cm)	LCBB(1-5)	PCBB(1-5)	IPS(1-5)	NPPP	NSPP	HSW(g)	GYD (t ha^{-1})	GYD adv.%
Awash-2	39.00	93.00ab	108.46abc	1.66	1.00	1.00b	36.66abc	6.00a	23.21cd	34.00a	26.00
Chercher	40.33	93.66ab	95.13c	1.33	1.33	1.66ab	51.66a	6.00a	25.27c	31.00ab	14.97
SAB-736	35.33	84.00d	42.80d	2.00	1.33	1.33ab	26.00bc	6.33a	43.40b	28.58abc	5.93
Chore	41.33	95.33ab	97.60bc	1.33	1.00	1.66ab	48.00a	6.66a	21.16de	28.00abc	3.78
Awash-1	39.00	88.00cd	102.00bc	1.66	2.33	1.00b	44.00a	6.66a	21.15de	26.98bc	
LEHODE	38.66	97.66a	120.80a	1.00	1.00	1.00b	20.66c	5.00b	51.14a	25.83bc	
Nezarath-2	40.33	91.33bc	111.40ab	2.33	1.66	2.00a	39.66ab	6.00a	20.40e	23.32c	
Mean	**39.14**	**91.85**	**96.88**	**1.61**	**1.38**	**1.38**	**38.09**	**6.09**	**29.39**	**28.23**	
CV%	**5.16**	**2.94**	**9.24**	**21.09**	**24.73**	**22.89**	**24.39**	**6.31**	**4.06**	**13.4**	

NB: CV=Coefficient Variation, DF=days to flowering ,Days to maturity, PH= plant height (cm), LCBB=Leaf

Common Bacteria score(1-5), PCBB= Pod Common Bacteria Blight score(1-5),IPS=Insect Pest Score(1-5), NPPP= Number of Pod Per Plant, NSPP=Number of Seed Per Pod, HSW=Hundred Seed Weight (g) and GYD= Grain Yield(t ha^{-1}).

Table-4: Mean grain yield and agronomic traits of haricot bean varieties at Mechara on station in 2017/18 main cropping season

Variety	DF	DM	PLH	LCBB	PCBB	IPS	NPP	NSP	HSW	YLD (t ha^{-1})	YLD adv.%
Chore	44.33a	86.00a	76.93c	1.00b	1.00b	1.00a	37.00a	6.33a	20.76d	22.57a	8.10
Awash-2	44.00a	84.00ab	84.93bc	1.66ab	1.33ab	1.33a	22.66ab	5.33bc	21.10cd	22.20a	6.32
Awash-1	43.66a	82.66b	77.33c	2.00ab	2.00a	1.66a	30.33ab	6.00ab	19.23d	20.88a	
Chercher	43.66a	84.66ab	72.13c	1.00b	1.00b	1.33a	36.33a	5.66abc	23.13c	18.74a	
SAB-736	41.33b	77.00d	35.53d	2.66a	1.33ab	1.33a	17.00b	5.00c	43.03b	18.44a	
Nezarath-2	44.00a	84.00ab	95.60ab	1.66ab	2.00a	2.00a	33.00a	6.00ab	19.33d	17.57a	
LEHODE	41.66b	79.33c	102.13a	1.66ab	1.00ab	1.33a	16.66b	5.00c	48.00a	15.49a	
Grand Mean	**43.23**	**82.52**	**77.8**	**1.66**	**1.47**	**1.42**	**27.57**	**5.61**	**27.8**	**19.41**	
CV%	**1.95**	**1.41**	**12.45**	**30.83**	**2.23**	**27.1**	**25.17**	**9.04**	**4.39**	**27.59**	

NB: CV=Coefficient Variation, DF=days to flowering ,Days to maturity, PH= plant height (cm), LCBB=Leaf Common Bacteria score(1-5), PCBB= Pod Common Bacteria Blight score(1-5),IPS=Pest Score(1-5), NPPP= Number of Pod Per Plant, NSPP=Number of Seed Per Pod, HSW=Hundred Seed Weight (g) and GYD= Grain Yield(t ha^{-1})

Table-5: Mean grain yield and yield components traits of haricot bean varieties at Fedis on station in 2017/18 main cropping season

Variety	PPP	SPP	YLD(t ha^{-1})	GYD Advantage
Chercher	17.44abc	5.11ab	11.25a	23.35
Awash-2	20.67abc	5ab	9.51a	4.27
Chore	15.33bc	4.77ab	9.82a	7.67
Awash-1	22.22ab	5.22ab	9.12a	
SAB-736	13.89c	4.44b	9.45a	
LEHODE	17.5abc	5.66a	9.4a	
Nezarath-2	24.78a	5.66a	8.21a	
Grand mean	**18.83**	**5.12**	**9.53**	
CV%	**23.6**	**11.17**	**28.83**	

NB: , CV=Coefficient Variation, NPPP= Number of Pod per Plant, NSPP=Number of Seed per Pod, and GYD= Grain Yield(t ha^{-1})

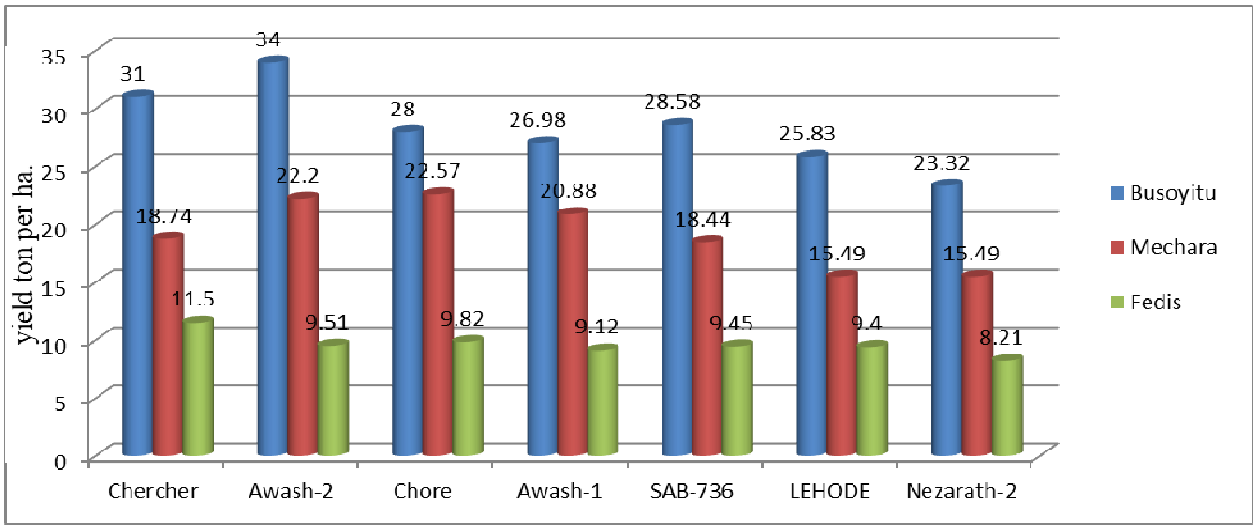

Figure 1: Mean grain yield in ton per hector at three location

6. Conclusion and Recommendation

Production of common bean by introducing improved varieties could make an important contribution enhanced agricultural production and productivity of conducted areas like Hararge where there is low practice of improved varieties of common bean. According to the results based combined analysis of variance for seed yield mean showed significant differ among varieties. The combined analysis of variance over environments showed high significant differences among varieties, environments and varieties by environment interactions. As analysis result revealed for single location showed that highly significant difference in seed yield among common bean varieties tested at Busoytu whereas at Mechara and Fedis no significant different observed. Evevnthough, numerical difference grain yield showed among tested varieties at both sites. Grain yield was an important character to be considered for variety selection to address the objective of the conducted activity. For this reason, three improved varieties i.e. Awash-2, Chercher and Chore were showed better performance for most of the studied characters including grain yield. But variety Chore and Chercher were yield advantage variation less than 10% of standard check.

Accordingly, even though it could be possible to recommend varieties Awash-2 and Chore for respective areas of Busoyitu and Mechara while Chercher for Fedis in order to boost production and productivity of stock holders.

ACKNOWLEDGEMENT

I would like to thank Oromia Agricultural Institute (IQQO), Mechara Agricultural Research Center for financial support.

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