

Yield Performance Evaluation of Common Bean (*Phaseolus vulgaris* L.) Varieties Under Rain Fed in Western Ethiopia

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Abstract: The objectives of the study were to evaluate the yield performance of common bean varieties under rain fed in east Wollega, western Ethiopia. Sixteen common bean varieties were tested for yield and yield related traits in completely randomized block design in three replications at Guto Gida district, Uke research and demonstration site in 2020/21. Data were taken from ten quantitative parameters; plant height, leaf area, inter node length, pod length, number of nodes per plant, number of pods per plant, number of seed per pod, 100-seed weight, grain yield per hectare and biomass yield per hectare. The analysis of variance showed that the varieties were significantly different for all traits except number of seed per pod, means that the traits are highly affected by variety. The highest plant height was recorded from the variety Omo-95 (120.0cm), and the lowest plant height was recorded from the variety Melka dima (34.3 cm). The highest pod length was recorded from the variety Omo-95 (22.5 cm), and the lowest was recorded from the variety Mexican-142 (8.0 cm). Grain yield was highly significant and the highest mean for grain yield was recorded from the variety Awash-1 (3.9 ton/ha) and the lowest grain yield was obtained from the variety Dursitu (1.3 ton/ha). Testing of improved varieties is among the best technologies to improve productivity and for specific area recommendation. However, the experiment should be repeated across locations and years for a wide range of recommendation. The present study revealed significant variation among genotypes for traits considered except one insignificant trait. In addition, almost all the genotypes were well adapted to the study area and hence, the high yielding genotypes could be directly used as seed sources for production of common bean.

Keywords: Analysis of Variance, Biomass Yield, Common Bean, Grain Yield

1. Introduction

Common bean (*Phaseolus vulgaris* L.) is the most commonly consumed legume worldwide, and source of protein for small scale farmers and cash crop in many lowlands and mid-altitude areas [14]. According to CSA [4], common bean takes 12.73% of the total area coverage (1,620,497.30 hectares) and 9.54% (about 30,113,480.57 quintals) of the produced grain in Ethiopia. Ethiopia had got 85% of export estimated earnings from pulses, exceeding that of other pulses such as lentils, faba bean and chickpea [15]. According to GAIN, (2018), Ethiopia exported 14% (340,000 metric tons) of pulse production and generated \$255 million US dollars.

Common bean can grow in a wide range of agro ecology of Ethiopia up to 600 meter above sea level which causes poor pod setting and a doesn't take long time to mature [10].

Bean can be produced either as sole crop or intercrop with cereals like maize and sorghum. This helps not only securing yield but also has the advantages of restoring soil fertility. Even though, the country has huge potential and the crop has tremendous advantages, the production and productivity has been challenging by low adoption of improved technologies, drought, and lack of improved varieties, poor cultural practices, disease, and environmental degradation [11, 15]. In Ethiopia, generally legumes are the major sources of protein where common bean accounts for the largest proportion next to faba bean and field pea CSA [2, 3]. It is one of the major grain legumes widely cultivated and grown as source of protein and cash by smallholder farmers by the smallholder farmers in the Southern Ethiopia [8]. Even if its production is concentrated at low land areas; but the extent of production of common bean in the target area especially in South Omo Zone is with the use of farmers' variety rather than the

improved varieties so far. The lack of the improved varieties of common bean is the bottle neck problem that aggravates for the lower yield of the common bean in the study area. The lack of improved varieties is one of the top problems for low yield of common bean [7]. Therefore, there is need to introduce the improved common bean varieties to the target area is paramount important to come up with improved productivity and production of common bean in the study area. To this end, this research is aimed with the objective of selecting the best performing common bean varieties in western Ethiopia, Uke. In addition to the above-mentioned constraints, low adoption and access to improved common bean varieties to specific growing conditions are the serious problems on the expansion of production and productivity of the crop [1]. For this low adoption of the technologies, poor linkage of stakeholders with the breeding program takes great share. Involvement of farmers before releasing a variety would facilitate the adoption and acceptance by creating awareness of the technology. This enables farmers to decide and choose which variety fits their interest [19].

Objective the study was;

To evaluate yield performance of common bean (*Phaseolus vulgaris* L.) varieties under rain fed in western Ethiopia, Uke, in cropping season of 2018.

2. Material and Methods

2.1. Descriptions of the Study Areas

The research was conducted in the main cropping season

of 2018 at Uke which is the Research and Technology Demonstration sub site of Wollega University. Uke is located in Guto Gida district of East Wollega Zone of Oromia Regional State. The center is located about 365km far away from Addis Ababa and around 40 km far away from Nekemte in the northern direction. The site is about 1700 m.a.s.l. The site is located at 8°11'52'' and 10°94'44'' north latitude and 36°97'51'' and 37°11'52'' east longitude. The area is characterized by mixed farming type dominantly by investors. The area receives rain once in a year which suitable to produce crops in once in a year. The pH of the soil is acidic with red color of Nitosol, a dominant soil type in the western Ethiopia.

2.2. Experimental Materials and Design

Sixteen varieties of small seeded common bean were used for the study. The varieties (genotypes) were grown in random complete block design in three replications with 4rows (1.6 m) x 4 m length of total plot size of (6.4 m²) of 40 cm between rows and 10 cm between plants. The two outer most rows at both ends of the plots were treated as borders leaving two middle rows of each of the genotypes for data collection. The NPS fertilizer at the rate of (100 kg/ha) were drilled at planting time. Nitrogen fertilizer in the form of urea (46% N at a rate of 50 kg/ha were applied at time of sowing by mixing with DAP. The seeds were sown by hand in the rows as uniformly as possible and covered with soil manually. Moreover, all other necessary field management practices were carried out as per the recommendation.

Table 1. Description of 16 foods and canning types of small seeded common bean varieties were used in the study in 2018.

Varieties	Year of release	Seed size	Seed sources	Major uses
Mexican 142	1973	Small	MARC	Canning type
Red welayta	1974	Small	MARC	Food type
Awash 1	1990	Small	MARC	Canning type
Roba	1990	Small	MARC	Canning type
Awash melka	1999	Small	MARC/EIAR	Canning type
Tabor	1999	Small	SRARI	Food type
Omo 95	2003	Small	SRARI	Food type
Melkadima	2006	Small	MARC/EIAR	Food type
Argane	2005	Small	MARC/EIAR	Canning type
Dimtu	2004	Small	SRARI	Food
Nazreth 2	2005	Small	MARC/EIAR	Canning type
Awash dume	2008	Small	SRARI	Food type
Dursitu	2008	Small	HU	Food type
Tr 13	2012	Small	MARC	Canning type
Ramada	2014	Small	SARI	Canning type
Awash 2	2000	Small	MARC	Canning type

Sources; Bako Agricultural Research Center (BARC), 2017.

2.3. Data Collection

Data were collected from ten quantitative traits; Plant height (cm), Pod length (cm), Leaf area (cm²), Number of nodes, Internode's length (cm), Number of pods per plant, Number of seeds per pod, 100-seed weight, Grain yield per

ha (ton/ha), Biological yield (ton/ha).

2.4. Data Analyses

Analysis of variance for all the collected parameters was performed as per the methods described by Gomez and Gomez (1984) using SAS computer software (SAS 9.3

version) for randomized complete block design and treatment mean comparison is done by Fisher's list significance difference (LSD) at 5%. Pearson's correlations among all the collected parameters were also evaluated.

Table 2. Mean Square Values due to varieties and error for Yield and Yield Components of sixteen Common Bean varieties at Uke, western Ethiopia in cropping season of 2018.

Traits	Mean square		P-values
	TRT (DF=15)	Error (DF=30)	
PH	1252.4**	0.57	<.0001
LA	181.1**	0.052	<.0001
INL	12.23**	0.65	<.0001
PL	42.04**	0.40	<.0001
NN	4.11**	0.22	<.0001
NP	44.22**	0.02	<.0001
NS	2.04 ^{ns}	1.66	0.3057
100-SW	31.07**	4.10	<.0001
GY	1.98**	0.085	<.0001
BY	12.01**	0.34	<.0001

PH-plant height, LA-leaf area, INL-inter node length, PL-pod length, NN-number of node per plant, NP-number of pod per plant, NS-number of seed per pod, 100-sw-hundred seed weight, GY-grain yield ton/ha, BY-biomass yield ton/ha, DF-degree of freedom.

3. Results and Discussion

3.1. Analysis of Variance (ANOVA)

The results from the analysis of variance for all traits of common bean showed very highly significant (<.0001) different except number of seed per pod (0.3057) in table 2. These results showed that all traits common bean except number of seed per pod were highly affected by variety.

3.2. Yield and Yield Component Characters

The highest plant height was recorded from the variety Omo-95 (120.0cm), and the lowest plant height was recorded from the variety Melka dima (34.3cm) in Table 3. The present result was agreed with the findings of [12], who also reported significant differences in plant heights among haricot bean varieties and [9]. The largest leaf area was recorded from the variety Delka dima (40.0cm²) and the lowest was recorded from varieties Mexican 142 (15.0cm²), Argane (15.0cm²), Nazareth-2 (15.0cm²), which is disagreed with the findings of [13]. The highest inter node length was obtained from the variety Omo-95 (14.4cm) and the lowest was recorded from the variety Awash-1 (8.0cm) which was agreed with the previous findings of [5].

Table 3. Mean of grain yield and yield components of common bean varieties tested at Uke, Western Ethiopia, in 2018.

Var	PH	LA	INL	PL	NN	NP	NS	100-SW	GY	BY
Mexican 142	39.0l	15.0j	14.2a	8.0g	7.3f	9.0k	5.0	16.8efgh	3.4ab	8.8de
Red welayta	60.3h	16.3i	10.0def	15.5d	8.6de	13.0g	5.0	22.2ab	2.1de	9.4d
Awash 1	66.0e	36.0b	8.0g	14.4e	9.6bc	14.0f	5.6	17.7efg	3.9a	11.6b
Roba	55.3i	27.6d	11.0cde	18.2b	8.6de	10.0j	5.3	19.9abcde	1.9ef	8.3e
Awash melka	52.3j	22.5f	14.3a	8.3g	8.6de	15.0e	6.0	18.7cde	2.5cd	9.2de
Tabor	84.7b	30.0c	12.3bcd	17.5bc	8.6de	10.0j	7.0	20.1abcde	1.8fg	6.5f
Omo 95	120.0a	18.0h	14.4a	22.5a	10.3b	14.0f	6.0	18.3def	2.1de	8.3e
Melkadima	34.3m	40.0a	9.7df	14.7de	8.3e	15.0e	5.3	21.6abcd	3.0bc	11.7b
Argane	53.0j	15.0j	11.2cd	12.3f	9.0cde	19.0c	5.0	14.0hi	1.9ef	6.8f
Dimtu	76.3d	20.0g	14.2a	18.3b	9.6bc	13.0g	5.6	21.8abc	2.8c	10.5c
Nazareth 2	46.7k	15.0j	9.9def	18.5b	10.3b	20.0b	4.3	14.4ghi	3.4ab	8.9de
Awash dume	81.3c	18.0h	9.4f	12.3f	10.3b	20.0b	7.0	22.9a	1.8efg	9.0de
Dursitu	61.6g	26.2e	12.7b	14.5de	12.3a	16.3d	7.0	19.5bcde	1.3g	6.5f
Tr 13	59.3h	27.7d	10.3def	15.6d	8.3e	11.0i	5.0	12.0i	3.4ab	10.7bc
Ramada	55.3i	22.5f	10.4def	13.9e	9.3cd	12.0h	5.0	15.1fghi	3.3b	13.8a
Awash 2	63.3f	16.0i	10.9de	16.9c	9.0cde	21.0a	6.3	19.6abcde	3.4ab	10.5c
C.V (%)	1.20	1.003	7.07	4.2	5.14	0.99	22.7	10.98	11.04	6.23
LSD	1.26	0.38	1.34	1.06	0.79	0.24	ns	3.38	0.48	0.98

PH-plant height, LA-leaf area, INL-inter node length, PL-pod length, NN-number of nodes per plant, NP-number of pods per plant, NS-number of seed per pod, 100-sw-hundred seed weight, GY-grain yield ton/ha, BY-biomass yield ton/ha, CV-coefficient of variation, LSD-least significant difference, ns-non-significant.

The highest pod length was recorded from the variety Omo-95 (22.5 cm), and the lowest was recorded from the variety Mexican-142 (8.0 cm). This result was disagreed with the findings of [18].

Number of nodes per plant was highly affected by varieties and the largest number of nodes per plant was obtained from the variety Dursitu (12.3) and the lowest was recorded from the variety Mexican-142 (7.3). Significant variation ($p < 0.0001$) was observed among varieties evaluated for number of pods per plants. Number of pods per plant was significantly affected due to varieties, the highest pod per plant was obtained from the variety Awash-2 (21.0 pod/plant) and the lowest was obtained

from the variety Mexican-142 (9.0 pod/plant). In this present study, number of seeds pod-1 was not significantly affected due to varieties. This result was agreed with the findings of [8]. 100-seed weight was highly significantly affected by variety; the highest 100-seed weight was recorded from Awash dume (22.9 g) and the lowest was recorded from the variety Dursitu (12.0 g) Table 3. This result was disagreed with the findings of [17, 6]. Grain yield was highly significant and the highest mean for grain yield was recorded from the variety Awash-1 (3.9 ton/ha) and the lowest grain yield was obtained from the variety Dursitu (1.3 ton/ha), this finding was agreed with the previous finding of [5] and contrasts the finding of [16] who stated that the seed

yield of bean is the result of many plant growth processes which ultimately influence the yield components such as pods per plant, seeds per pod, and unit weight of the seeds. The highest seed yields were obtained when all the above got maximized.

Biomass yield was highly significantly affected by varieties and the largest biomass yield was recorded from the variety Ramada (13.8 ton/ha) and the lowest was recorded from the variety Tabor (6.5 ton/ha).

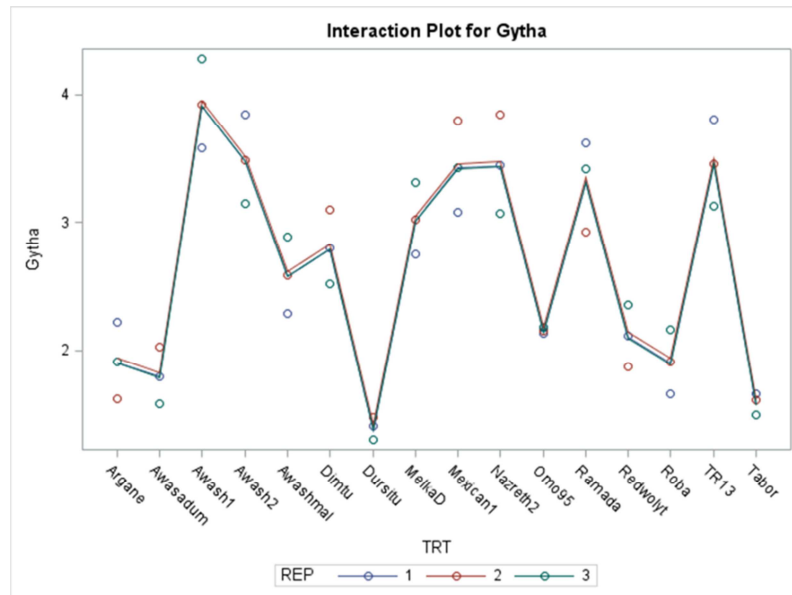


Figure 1. Distribution of Grain yield for sixteen Common bean varieties grown in western Ethiopia.

4. Conclusion

Common bean is the most important crops cultivated on large area of land in western part of Ethiopia for consumption and market purpose, also planted as intercropping with different crops. But there was scarcity of varieties for farmers. The need to improve production of common bean should focus on a number of factors. Testing of improved varieties is among the best technologies to improve productivity and for specific area recommendation. Results of this experiment

showed that Awash-1 (3.9 ton/ha) variety showed the higher grain yield but it was non-significantly different from the Mexican-142 (3.4 ton/ha), Nazareth-2 (3.4 ton/ha), TR-13 (3.4 ton/ha) and Awash-2 (3.4 ton/ha). However, the experiment should be repeated across locations and years for a wide range of recommendation. The present study revealed significant variation among genotypes for traits considered except one insignificant trait. In addition, almost all the genotypes were well adapted to the study area and hence, the high yielding genotypes could be directly used as seed sources for production of common bean.

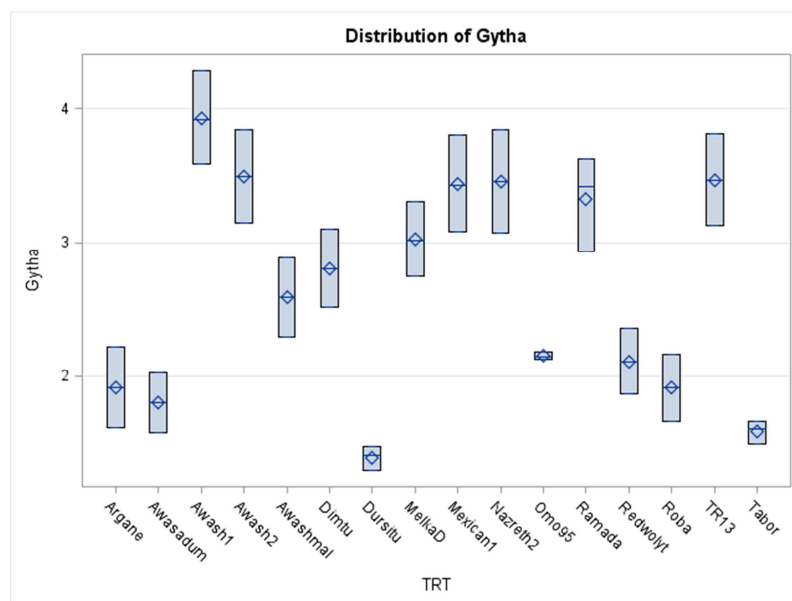


Figure 2. Distribution of Grain yield for sixteen Common bean varieties grown in western Ethiopia.

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