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Study for adaptability and agronomic traits performance of improved white type common bean (*Phaseolus vulgaris* L.) varieties in midlands to low-altitudes of Guji zones

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ABSTRACT

Aim: The main aim of this study was to identify the best adapted and high yielding variety(s) at mid-lowland areas of Guji zone during 2020 and 2021 main cropping season**.**

Materials and Methods: Field experiment was conducted on six improved white common bean varieties in randomized complete block design with three replications. The varieties were evaluated for days to flowering and maturity, plant height, number of branches, number of pods, number of seeds, thousand grain weight and grain yield.

Results: The combined analysis of variance indicated highly significant ($P \leq 0.01$) differences among varieties for all studied parameters except number of primary branches per plant. The highest mean performance was obtained from varieties Batu, Ado and Awash-1 with 2209 kg ha^{-1}, 1831 kg ha^{-1} and 1750 kg ha^{-1}, respectively.

Conclusion: It was concluded that Batu and Awash-1 are adaptable white common bean varieties for Guji zones on performance basis. Large seeded varieties were more preferred due to early maturity period and high marketable weight than small seeded varieties.

Keywords: Adaptability; Agronomic Traits; Phaseolus vulgaris; Yield performance.

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Introduction

Common bean (*Phaseolus vulgaris* L.) is the most important grain legume in nearly all lowland and mid-altitude areas of Ethiopia. It is a true diploid (2n = 2x = 22) with a small genome (580 Mbp; Broughton *et al*., 2003). It is produced primarily by smallholder farmers both for cash and consumption. According to CSA (2018), report white haricot bean was cultivated on 89,382.68 hectare of land and 1,482,128.42 Qt was produced with the productivity of 1.6 tons ha^{-1}. Its production is concentrated in two regional states: Oromia and the Southern Nation Nationality and Peoples Region (SNNPR), which accounts about 73% of the total national production (CSA, 2010) were both white canning and colored food type bean are grown. Its fastest ripening at the critical food deficit period earlier than other crops made it an ideal food deficit filler crop.

It's suitability for double or triple production per year enabled its production on off season free lands and relatively cheaper labor force. Its reasonable protein content (22%) made it the poor man's meat securing more than 16.7 million rural people against hidden hunger (Zeleke *et al*., 2016).

In Ethiopia, it is grown suitably in areas with an altitude ranging between 1200 – 2200 m above sea level with optimum temperature range of 16 – 28 ^{o}C and a rainfall of 350-500 mm well distributed over the growing season (Mekbib, 2003). It performs best on deep, friable and well aerated soil with good drainage, reasonably high nutrient content and pH range of 5.8 to 6.5. Particularly, in Southern Oromia common bean is one of the most important cash crops and source of protein for farmers in many lowlands and mid-altitude zones. Apart from being food and a source of income, common bean is also replenishes of soil fertility through biological nitrogen fixation.

Improved white common bean varieties are not yet put under production in the potential areas of Guji zones. Since the weather condition and soil type of the area is highly suitable for white common bean production. So, it is necessary to bring in the varieties to the potential areas of the zones. Therefore, this study was initiated with the objective to evaluate and select adaptable, high yielder and good agronomic traits of common bean varieties for the midlands to low-altitudes of Guji zones.

Materials and Methods

Experimental Materials and Management

The experiment was carried out in the potential common bean producing areas of Guji zone at Dole, Adola-woyu, Kiltu-sorsa and Wodera from September to December during 2020 and 2021 cropping season. Six (6) improved white common bean varieties were evaluated for the study. The trial was arranged in randomized complete block design with three replications at all locations. The plot size was 3m x 2.4m of 6 rows with 40cm spacing between rows and 10cm between plants, while the net harvested area was 4.8m^2. To reduce border effect, data was taken from the central four rows. Weeding and other management practices were done as required. The fertilizer rate of 19/38/7 N/P_2O_5/S kg/ha was applied at time of planting.

Data Collected and Analysis

Data were recorded from 8 competitive plants that selected randomly for four characters viz. plant height (cm), number of primary branches, number of pods, number of seeds per pod, while two characters viz., days to flowering and days to maturity were recorded on the plot basis from each varieties. The 1000 grain weight (g) measured from thousand randomly taken seeds and grain yield (kg) were recorded from four central rows of net harvested plot areas.

Table1. List of common bean varieties tested

No	Variety	Seed size	Seed color	Breeder/ Maintainer
1	Awash mitin	Small	White	MARC
2	Awash-2	Small	White	MARC
3	Awash melka	Small	White	MARC
4	Awash-1	Small	White	MARC
5	Batu	Large	White	MARC
6	Ado/SAB-736	Large	White	MARC

The analysis of variance for each location and combined analysis of variance over locations were computed using the SAS program (SAS institute, 2011) versions 9.3. The significance of means differences were tested by Duncan's Multiple Range Test (DMRT) as stated in Gomez and Gomez (1984).

Results and Discussion

Analysis of Variance and Mean Performances

Variety-to-variety differences in all of the parameters investigated were highly significant ($P<0.01$) except number of primary branches per plant (Table 2). Mean squares of various agronomic characters were recorded (Table 2) whereas, mean values of different traits were also recorded (Table 3).

Phenological Characters

The mean days to flowering was significantly different ($P<0.01$) between varieties with continuous variety-to-variety variation. The overall mean days to flowering was 43 days ranging from 40 days to 45 days in the variety's studied. Batu and Ado varieties had an earlier days of flowering while Awash mitin, Awash-2, Awash melka and Awash-1 were the farthest days to flowering. Analysis of variation revealed that highly significant variation in days to maturity was observed (Table 2). Varieties Batu and Ado scored the shortest days to phenological maturity while others were late to matured. The average days needed for common bean variety to maturity was three months and above. Thus, early maturing varieties have the advantage or adaptable over the late once in environments where rain begins late and ends early. Afeta et al (2020) advocated similar findings of the study.

Growth and Yield Related Traits

Common bean varieties had a significant ($P < 0.01$) effect on plant height (Table 2). The tallest plants were measured from Awash-1, Awash-2 and Awash mitin with 61.57cm, 57.33cm and 58.37 cm tall, respectively. On the other hand, shortest plant heights were recorded from Batu and Ado varieties with a height of 38.31cm and 42.33 cm, respectively. Alemayehu et al (2020) corroborated with the results of the study.

Analysis of variance showed insignificant differences among varieties for branches per plant (Table 2). The significant differences ($P < 0.05$) were also observed among varieties for number of pods per plant. Awash-1 and Awash-2 ranked first and 2nd for number of pods per plant (16 and 15). The varieties differed for the number of seeds produced per pod. Statistical analysis showed highly significant differences ($P < 0.01$) in number of seeds per pod (Table 2). Awash

mitin, Awash-2 and Awash-1 were recorded maximum number of seeds while Batu, Ado and Awash melka were minimum in number of seeds per pod (Table 3). Argaye and Bekele (2021) and Bekele (2021) also reported similar findings.

Mean square for thousand seed weight revealed highly significant differences (P<0.01) among the varieties (Table 2). The range of 1000-grain weight was from 160 g to 282 g. The maximum 1000-seed weight (282g) was observed for Batu while minimum 1000-seed weight was observed for Awash-1 (160g) (Table 3). Belachew (2021) corroborated the results of the study.

Grain Yield

Grain yield was the collective effects of yield components. The analysis of variance revealed that there were significant (P < 0.05) differences among varieties in yield of dry seed (Table 2). The highest grain yield was produced by varieties Batu, Ado and Awash-1 (small white and popular) with grain yield of 2209 kg ha^{-1}, 1831 kg ha^{-1} and 1750 kg ha^{-1}, respectively. Awash mitin produced the lowest grain yield of 1527 kg ha^{-1}. Firew and Ahmedin (2020) advocated the findings of the study.

Evaluation of Bean Varieties to Foliar Fungal and Bacterial Pathogens

In terms of disease reaction the major common bean diseases for Common Bacterial Blight and bean rust and Anthracnose were detected. The disease severity scores of tested varieties ranged from (2-4), which showed varieties being characterized as moderately resistant to moderately susceptible to the three diseases. Zhou et al (2020) corroborated with the results of the study.

Table 2. Analysis of variance for agronomic traits and grain yield

Source of variation	d.f	Mean Squares							
		DF	DM	PH	NPB	NP	SPP	TSW	GY
Replication	2	6.46	0.07	28.2	0.044	12.56	0.23	1571	241159
Variety	5	47.85**	19.35**	814.4**	0.119	92.41*	2.98**	60071**	482397*
Error	46	11.88	4.89	189.9	0.243	30.35	0.33	1872	454776
Total	53								

Key: ** = highly significant at the level of 1% probability, ns = non-significant, d.f = degrees of freedom.

Table 3. Mean values of different agronomic traits in the six evaluated common beans

Variety	DF	DM	PH(cm)	NPB	N P	SPP	TSW(g)
Awash mitin	45.22	87.06a	58.37a	0.99	13.68	5a	161.2c
Awash-2	44.33	93.67a	57.33a	1.09	15.03	5a	172.2b
Awash melka	45.34	86.28b	53.23ab	0.90	12.48	4b	174.5b
Awash-1	44.56	85.89b	61.57a	0.97	15.98	5a	160c
Batu	40.56	82.56b	38.31b	0.89	10.98	4b	282.2a
Ado/SAB-736	40.72	82.73b	42.33b	0.92	10.83	4b	233.25b
Mean	43.46	88.66	51.86	0.96	13.16	4	197.2
P-value	0.004	0.005	0.003	0.784	0.019	<.001	<.001
LSD(5%)	4.02	24.20	12.33	0.41	4.08	0.64	52.84
CV(%)	9.95	2.6	25.15	48.1	32.05	14.6	28.85

Table 4. Mean grain yield and diseases severity of white common bean varieties

Varieties	Grain yield (kg ha^{-1})							Diseases reaction (1-9 scale)		
	2020			2021				CBB	Bean Leaf Rust	Anthracnose
	Dole	Kiltu-sorsa	Wodera	Adola-woyu	Kiltu-sorsa	Wodera	Overall means			
Awash mitin	1792a-c	2125	1502	709	1201	1833	1527	4	1	3
Awash-2	1618bc	1495	1250	2054ab	1500	1722	1607	4	2	2
Awash melka	1236c	1875	1993	1027bc	1660	1937	1621	4	1	3
Awash-1	2549ab	2255	1108	1230bc	1840	1521	1750	3	2	3
Batu	2743a	2193	1441	2778a	1972	2125	2209	4	1	2
Ado/SAB-736	1812a-c	2052	1354	2517a	1660	1590	1831	4	2	2
Mean	1958.33	1999.13	1441.26	1719	1638.89	1788.19	1758	4	2	2
F-test	*	NS	NS	**	NS	NS	*	NS	NS	NS
LSD(5%)	1005.02	1258.77	955.77	1078.40	812.09	1088.31	607.68	0.45	0.62	0.69
CV(%)	28.2	34.6	36.5	34.5	27.2	33.5	36.45	24.3	22.2	19.8

Conclusions

It was concluded that Batu and Awash-1 are adaptable white common bean varieties for Guji zones on performance basis. Large seeded varieties were more preferred due to early maturity period and high marketable weight than small seeded varieties. Farmers considered large seeded varieties to be easy in raising productivity and marketing for better income. Therefore, the two varieties need to be demonstrated at the farmers level for different traits for larger scale production till other recommendation provided for the area.

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