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Common Bean (*Phaseolus vulgaris L.*) Participatory Variety Selection and Adaptation Trial in Meskan and Siltie Districts of Southern Ethiopia

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Abstract

The experiment was conducted at Meskan and Siltie districts in Southern Ethiopia with three released varieties and three candidate varieties of common bean (*Phaseolus vulgaris L.*) were tested by two cropping seasons (2014-2015) to evaluate high yielding and adaptable common bean by participatory variety selection. The experiment was arranged in a randomised complete block (RCBD) with three replications. Participatory varietal selection is the selection by which farmers evaluate finished or near-finished products from plant breeding programs on their own farms or localities. The best varieties namely Wajo, Remeda, Ibado and Tatu respectively were selected as top ranking by farmers. The same varieties had better performance and found to be promising from the analysis of researchers' collected data except Hawassa Dume. Genotypes were highly significant ($P \leq 0.01$) for all traits except days to maturity on which variety effects were not significant. Genotype effect on environment (Genotype environment) were exhibited highly significant ($P \leq 0.01$) for only plant height. Whereas non-significant for the rest traits. Statistically there were not significant differences between genotypes x location (GXE) interactions and no changes in the rank of genotypes across locations. It suggests that there were not specifically adapted varieties for each location. Even though, Wajo was the highest and stable in grain yield across locations and Ibado was the fourth and the second stable genotype across environments. But Hawassa Dume was not stable in yield, the second highest in grain yield at Siltie district and the third highest at Meskan district. The other one was Remeda was not stable in grain yield, the second highest at Meskan district and the third highest at Siltie district. Tatu and Awash Melka were the lowest in grain yield across locations respectively. Grain yield in combined analysis had positive and highly significant ($P \leq 0.01$) association with number of seeds per pod ($rg=0.945^{**}$) at genotypic level and with days to maturity ($rp=0.581^{**}$), number of pods per plant ($rp=0.447^{**}$), number of seeds per plant ($rp=0.552^{**}$) and number of seeds per pod ($rp=0.342^{**}$) at phenotypic level. These traits are important to be used as selection criteria for yield improvement of common bean.

Keywords: Genotypic and Phenotypic correlation, Participatory variety selection, *Phaseolus vulgaris L.*

Introduction

Common bean (*Phaseolus vulgaris L.*) has been one of leading grain legume in area coverage and production in Ethiopia as well as in Southern Ethiopia. It is a food and cash crop grown under sole and various intercropping systems. The Ethiopian research system has so far released 65 genotypes with special constraints of its production [1]. Bean genetic diversity on farm is much lower in Ethiopia and until the 1990s few new genotypes had been released to farmers [2]. Pulses grown in 2017/18 cropping season covered 12.61% (1,598,806.51 hectares) of the area of grain crops and 9.73% (about 2,978,588.09 tons) of the grain production. Common bean in Ethiopia is produced in almost all regional states with varying intensity. However, its production is concentrated in Oromiya and Southern Nations Nationalities and Peoples Regional (SNNPR) states, which account for about 76% of the total production. The remaining 24% comes from Amhara (22%), Benishangul-Gumuz, Tigray, Dire Dawa and Gambella [3]. Predominantly grown for cash in the central rift valley, but in other parts they are a major stable food supplementing the protein source for the poor farmers who cannot afford to buy an expensive meat. According to Hall [4], empirical approaches based on yield testing are an essential part of most breeding programs for annual grain crops. Selection for agronomic traits should be regarded as complementing and not replacing empirical approaches. Lack of research and insufficient yield testing and information on agronomic traits have been major constraints, substantial opportunities may still exist for enhancing the yield potential of grain legumes through the development of improved cultivars and management methods. Studies reported that participation in research has become a widely accepted strategy for conducting research and development projects [5].

Objective

To evaluate high yielding and adaptable common bean genotypes by participatory variety selection at Meskan and Siltie districts.

Materials and Methods

Description of the study area

This study was conducted on Worabe Aricultural Research Centre at Meskan and Siltie districts of Southern Ethiopia. At Meskan district the trial site was named Inseno, which is located geographically 38º °38'348''East and 08°08'356''North and has 1849 masl. The area receives an annual mean rain fall of 883.01 mm with mean minimum and maximum temperature of 11.13°C and 26.98°C respectively [6]. The soil type of Meskan in which the experiment was conducted has

been classified in to Vertisols (Aric Humic) soil [7]. While, Siltie site called Welleya Sidist which is located geographically 38º19'130''East and 08º00'447''North and has 2129 masl.

Experimental materials, design and procedures

Three released (Hawassa Dume, Ibado and Awash Melka) and 3 candidate varieties (AFR-702, ETAW-01-L-7-6K, ETAW-01-L-1-7A,) were used. Letter on the candidate varieties become released and named Tatu, Remeda and Wajo respectively. Ibado which is a familiar variety in the study area with its local name "Marta" were used as a check for this study Table 1. All materials are obtained from Areka Agricultural Research Centre [8].

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List of Genotypes	Source	Breeder / maintainer and Year of Release
Awash Melka	Areka Agricultural Research Centre	1998/99- MARC-EIAR
Hawassa Dume	"	SARI-AWRC, 2008
Ibado	"	SARI-ARARC, 2003
Remeda(ETAW-01-L-7-6K)	"	HwARC-SARI-2014
Tatu(AFR-702)	"	HwARC-SARI-2014
Wajo(ETAW-01-L-1-7K)	"	HwARC-SARI-2014

Table 1: Study area.

Data collected

Days to 50% flowering, days to 90% maturity, plant height, number of pods per plant, number of seeds per plant, number of seeds per pods, hundred seed weight, grain yield and farmers' assessments.

Data analysis

The data was analyzed by using Analysis of Variance (ANOVA) and tables were performed using statistical computer software for all data collected in different seasons and locations. Combined analysis of variance over seasons and locations with genotypes was done as per Gomez and Gomez, [9] using PROC GLM SAS software version 9.0. Mean separation was done by LSD (Least Significance Difference) at probability level 0.05. Correlation analysis was carried out to determine association of yield to its components. Phenotypic and genotypic correlation was computed by PROC CANDIC [10]. And farmers' selection data will be analyzed using simple ranking method in accordance with the given value. Simple ranking is a tool often used to identify promising genotypes based on farmers' preferences. The ranking procedure will be explained for participants and then each selection criterion will be ranked from 1 to 5 (5=very good, 4=good, 3=average, 2=poor and 1=very poor) for each variety.

Results and Discussion

Analysis of variance

Analysis of variance for agronomic characters on common bean (*Phaseolus vulgaris L.*) genotypes were tested by two cropping seasons (2014-2015) and two locations at Meskan and Siltie districts in Southern Ethiopia . Combined analysis of variance was carried out for grain yield and other agronomic characters as outlined by [9,10]. The mean squares of genotypes were highly significant ($P \leq 0.01$) for all traits except days to maturity on which variety effects were non-significant. The mean squares of years were significant ($P \leq 0.05$) for plant height and number of seeds per pod and highly significant ($P \leq 0.01$) for the rest traits except days to flowering and hundred seed weight on which years effects were non- significant. The mean squares of locations were significant ($P \leq 0.05$) for grain yield and highly significant ($P \leq 0.01$) for the rest traits except days to flowering, plant height and number of seeds per pod on which locations effects were non-significant. The mean square of combined analysis seasonal effect on genotypes (season genotypes) were exhibited significant ($P \leq 0.05$) for grain yield and number of seeds per pod and highly significant ($P \leq 0.01$) for number of seeds per plant. Whereas non-significant for the rest traits. The mean square of genotype effect on environment (Genotype environment) were exhibited highly significant ($P \leq 0.01$) for plant height. Whereas non-significant for the rest traits. So it was not necessary to perform analysis of variances for characters to each location. The mean square of seasonal effect on environments (season environment) were exhibited significant ($P \leq 0.05$) for number of pods per plant and highly significant ($P \leq 0.01$) for days to maturity.

Whereas non-significant for the rest traits. The mean squares of environmental and seasonal effects on genotypes (environment season genotypes) were exhibited non-significant for all the traits evaluated. The significant differences among the studied genotypes indicate the existence of large variability among genotypes, years and locations in traits measured.

Statistically there were not significant differences between genotypes x location (GXE) interactions and no changes in the rank of genotypes across locations. It suggests that there were not specifically adapted varieties for each location. Even though Wajo was the highest and stable in grain yield across locations and Ibado was the fourth and the second stable across environments. But Hawassa Dume was not stable in grain yield, the second highest at Siltie district and the third highest at Meskan district. The other one was Remeda was not stable in grain yield, the second highest at Meskan district and the third highest at Siltie district. Tatu and Awash Melka give the lowest in grain yield across locations respectively. When we compare the two locations, Siltie district is the potential area than Meskan district (Figure 1).

Stable production environments, were an important strategy in breeding grain legumes to develop a cultivar that has duration from sowing to grain maturity which fits into the available growing season, and also a date of first flowering that divides the growing season into vegetative and reproductive stages that have optimal durations [11].

Farmers variety evaluation and criteria

Selection was carried out at three different growth stages by inviting farmers at each stage i.e. at flowering, physiological maturity and harvesting. Farmers' selection criteria were plant performance,

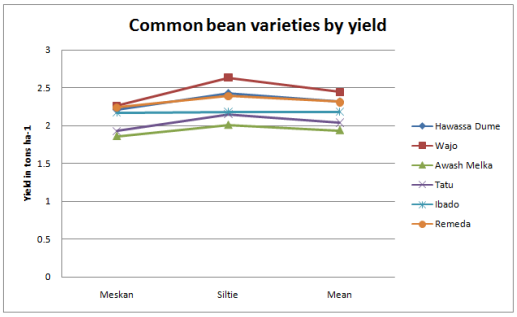

Figure 1: Grain mean yield and locations mean yield in ton ha^{-1} of 6 common bean genotypes grown at Meskan and Siltie districts of Southern, Ethiopia during 2014- 2015.

number of branches with pods, early grain filling, early maturity, seed size and colour. The farmer's group, comprising women and men, made discussion during selection. Different varieties were selected by farmers at different selection stages of the plant due to their performances in the field at selection time or stage. However, including post harvest criteria, best varieties namely Wajo, Remeda, Ibado and Tatu respectively were selected as top ranking in all groups as final selections or adapted varieties. The same varieties had better performance and found to be promising from the analysis of researchers' collected data except Hawassa Dume wich was not selected by farmers but ranks second by mean yield. Similar result was reported for Ibado from participatory variety selection done at Meskan district [12]. The study showed that participatory approaches played a significance role which is equivalent with conventional plant breeding. Farmers and the researcher used different parameters and methods to evaluate the tested genotypes. It is obvious that farmers have demonstrated the ability to select well-adapted and preferred varieties under their circumstances using their own criteria.

Correlation of yield and yield related characters

The correlation coefficients among traits computed as Spearman's coefficient of correlation among all the stability parameters. The coefficients of variations at phenotypic and genotypic levels were estimated using the formula adopted by [13]. Significance of variability for each trait was tested against tabulated F-values at 5% and 1% probability level.

Grain yield had positive and highly significant ($P \leq 0.01$) association with number of seeds per pod at genotypic level and with days to maturity, number of pods per plant, number of seeds per plant and number of seeds per pod at phenotypic level. This indicates that genotypes with higher in days to maturity, high number of pods per plant, high number of seeds per plant and higher number of seeds per pod produced high grain yield. Therefore, these traits are important to be used as indirect selection criteria for yield improvement of common bean.

Hundred seed weight had negative significant ($P \leq 0.05$) correlation with number of seeds per plant and days to flowering. Also it was negative highly significant ($P \leq 0.01$) correlation with number of pods per plant at phenotypic level. These indicate that genotypes with lower days to flowering, low number of pods per plant and minimum seeds per plant produced low hundred seed weight. This is due to the fact that late flowering plants are usually subjected for moisture deficiency that affects the photosynthetic rate in green leaves. The amount of stored assimilates in seeds is low when individual plants produced high number of pods and seeds.

Plant height had positive and highly significant ($P \leq 0.01$) association with days to flowering, number of pods per plant and number of seeds per plant at phenotypic levels. These indicate genotypes with high days to flowering, high number of pods per plant and high number of seeds per plant were taller plant height. Plant height was not correlated to grain yield. The findings of Ejigu et al. [14], correlation analysis for grain yield showed negative significant phenotypic association with plant height.

Number of seeds per plant had positive and highly significant ($P \leq 0.01$) association with days to flowering and positive significant ($P \leq 0.05$) association with number of pods per plant at genotypic level. It had positive and highly significant ($P \leq 0.01$) association with days to maturity, plant height, number of pods per plant, number of seeds per pod, grin yield and negative significance ($P \leq 0.05$) correlation with hundred seed weight at phenotypic level.

Conclusion

Participatory varietal selection is the selection by which farmers evaluate finished or near-finished products from plant breeding programs on their own farms or localities. The best varieties namely Wajo, Remeda, Ibado and Tatu respectively were selected as top ranking. The same varieties had better performance and found to be promising from the analysis of researchers' collected data except Hawassa Dume.

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