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Participatory Varietal Selection (PVS) of Lentil (Lens culinaris Medik) for Yield and Yield Components in Highlands of Guji, Southern Ethiopia

Tekalign Afeta* Demissie Alemayehu Belachew Dabalo
Oromia Agricultural Research Institute (IQQO), Bore Agricultural Research Center (BOARC), P. O. Box 21, Bore, Ethiopia

Abstract
Lentil is one of the important field crops in mid to highland agro-ecology of Ethiopia. Several improved lentil varieties has been released by Agricultural Research Centers and Universities for mid to highland Agro-ecologies. However, farmers depend on few low yield local varieties or even no get the chance to use this also even though the potential are there. Participatory variety selection was initiated to evaluate the performance of alternative improved lentil varieties and select better varieties for further seed production. The study was conducted at Bore Agricultural Research Center in highland of Guji Zone at three selected farmers' fields during 2016 main cropping season. Four improved varieties were evaluated under farmers' participatory varietal selection. Randomized complete block design (RCBD) with all three replications on Bore Agricultural Research Center main station as mother and one replication each at three other farmers' fields as baby trials was used. Significant differences ($p<0.05$) were observed among varieties in days to flowering, days to maturity, plant height, number of pods per plant, and grain yield per hectare. Grain yield ranged from 1944 $kgha^{-1}$ to 1093 $kgha^{-1}$ with grand mean 1556 $kgha^{-1}$, Alemaya (1944 $kgha^{-1}$), Ada'a (1861 $kgha^{-1}$) and Derash (1304 $kgha^{-1}$) were top yielding varieties. Farmers' ranked the varieties that performed well under their circumstances. Based on farmer's evaluation and selection plus researchers' recommendations, Alemaya and Derash varieties were found promising under Bore highlands.
Keywords: Highland of Guji, Lentil, Participatory, Variety Selection

1. INTRODUCTION

Lentil (*Lens culinaris* Medik) is one of the most ancient annual food crops that have been grown as an important food source (Fikru *et al*., 2014). It is cultivated for its seed and mostly eaten as split (Cokkizgin and Shytaya, 2013). The primary product of lentil is its seed which has relatively higher contents of protein, carbohydrate and calories compared to other legumes (Fikru *et al*., 2014). It is the most desired crop because of its high average protein content and fast cooking characteristic in many lentil producing regions. It can be used as a main dish, side dish, or in salads. Seeds can be fried and seasoned for consumption but sometimes difficult to cook because of the hard seed coat those results from excessive drying. Its flour is used to make soups, stews, purees, and mixed with cereals to make bread and cake; and as a food for infants (Abraham, 2015).

It also plays a significant role in maintenance and improvement of soil fertility. Its cultivation enriches soil nutrient status by adding nitrogen, carbon and organic matter which promotes sustainable cereal-based systems of crop production (Abraham, 2015). Both red and green lentils are produced in the region with variable proportion. It is an important crop in food**,** feed and farming systems of West Asia and North and East Africa. It has been established in a wide range of agro-ecology but production is limited to tropical areas. The spread of lentil from the center of origin has been accompanied by the selection of traits important for adaptation to environments that can be climate, soil and their impact on season length, abiotic and biotic stresses (Fikru *et al*., 2014).

Farmers as well as Seed Producer Cooperatives (SPCs) are highly demanding better yielding varieties to maximize their product, and improve the livelihood of their families. Participatory Varietal Selection (PVS) has been proposed as an option to the problem of fitting the crop to a multitude of both target environments and users' preferences (Ceccarelli *et al*. 1996). It is worth mentioning that although farmer participation is often advocated on the basis of equity, there are sound scientific and practical reasons for farmer involvement to increase the efficiency and the effectiveness of a breeding program (Ceccarelli and Grando, 2002). The present study was conducted with the objectives to evaluate and select Lentil varieties for high yield and other agronomic traits through farmer's participation in decision making during the selection process.

2. MATERIALS AND METHODS

2.1. Experimental Materials and Design

The experiment was carried out during 2016 main cropping season at Bore Agricultural Research Center, Guji Zone southern Oromia. Geographically, the experimental site is situated at the latitude of 06°23'55" N – 06°24'15" N and longitude of 38°34'45" E – 38°35'5" E at an altitude of 2728 m above sea level. The area

represents highlands of Guji Zone, receiving high rainfall and characterized by a bimodal rainfall distribution. The first rainy season is from April up to October and the second season starts in late November and ends at the beginning of March. The major soil types are *Nitosols* (red basaltic soils) and *Orthic Aerosols* (Yazachew and Kasahun, 2011; Wakene *et al*., 2014). The soil is clayey loam in texture and strongly acidic with pH value of around 5.13.

Four released Lentil genotypes were obtained from Debre Zeit Agricultural Research Center (DZARC) and was used for the study. The trial was laid down in randomized complete block design (RCBD) with all three replication on Bore Agricultural Research Center main station as for mother Trial. The three farmer fields were planted with one replication each considered as baby trial. Each genotype was planted in 8 rows of 3 m row length with 20 cm spacing between rows. The distance between blocks and plots was 1.5 m and 1 m, respectively. Di-ammonium phosphate (DAP) was applied at recommended rate of 100 kg/ha. The whole DAP was applied at sowing. Sowing was done by hand drilling at seed rate of 60-120 kg/ha seeds per row.

2.2. Data Collection

Agronomic and phenological data were collected on plot and plant basis from the mother trial. Plant height (cm), number of branches per plant, number of pods per plant, and number of seeds per pod, were evaluated on ten randomly taken plants from the middle six rows in each plot. Grain yield (kg) of the middle six rows in each plot was measured and converted to kilogram per hectare for analysis. Days to flowering and maturity were also recorded as the number of days required from planting to the time when 50% and 90% of plants in plots produced at least one flower and showed a yellow color in each plot before senescence, respectively. Farmers' evaluation and selection data were collected on plot basis from the three mother trials i.e., farmers were grouped around each host farmer of the trials.

2.3. Data Analysis

The recorded agronomic data were subjected to the analysis of variance (Gomez and Gomez, 1984) using Statistical Analysis Software GenStat discovery 15th edition. Farmers' selection data were analyzed using simple ranking method in accordance with the given value (De Boef and Thijssen, 2007). Simple ranking is a tool often used to identify promising varieties based on farmers' preferences. The ranking procedure was explained for farmer participants and then each selection criterion was ranked from 1 to 5 (5 = very good, 4 = good, 3 = average, 2 = poor and 1 = very poor) for each variety. Ranking was done on consensus where differences are resolved through discussion (De Boef and Thijssen, 2007).

3. RESULTS AND DISCUSSION

3.1. Agronomic traits of mother trial

Agronomic traits i.e., days to flowering(DF), days to maturity(DM), plant height(PH), number of branches per plant(BPP), number of pods per plant(PPP), number of seeds per pod(SPP) and grain yield(YLD) were analyzed (Table 1). The varieties significantly ($P < 0.05$) varied for days to flowering and maturity. The difference in days to flowering among the varieties range from 76 days to 80 days. Derash (76 days) was early flowering variety whereas Ada'a, Teshale and Alemaya were late flowering varieties. Similarly, the differences in days to maturity among the genotypes were ranged from 136 to 141 days. Derash (136 days) early maturing variety complete their life cycle in relatively shortest period whereas Ada'a and Alemaya varieties were matured relatively late. Thus early maturing genotypes have the advantage or advantage over late once in environments where frost occurrence late in the season.

Significant differences ($P < 0.05$) were also observed among varieties for plant height. Plant height ranged from 32.1 to 39.6 cm (Table 1.). Ada'a was the tallest genotype (39.6 cm) followed by Alemaya (33.6 cm) and Derash (32. 1 cm). The shortest variety was Teshale (31.5 cm). For branches per plant, pods per plant and seeds per pod the varieties were statistically in parity.

Table 1. Mean values of different Agronomic traits for Mother Trial

Genotypes	DF	DM	PH (cm)	BPP	PPP	SPP	YLD (kg ha^{-1})
Derash	76^{b}	136^{c}	32.08^{b}	2.7^{a}	62.3^{a}	1.4^{a}	1324^{b}
Ada'a	80^{a}	141.3^{a}	39.6^{a}	3.3^{a}	39.1^{b}	1.6^{a}	1861^{a}
Alemaya	80^{a}	140.0^{ab}	33.6^{b}	2.8^{a}	40.5^{b}	1.5^{a}	1944^{a}
Teshale	79.7^{a}	138.3^{bc}	31.5^{b}	2.9^{a}	36.1^{b}	1.4^{a}	1093^{b}
Mean	79.9	138.9	34.2	2.9	44.5	1.5	1556
LSD (5%)	1	2.6	3.3	NS	17.2	NS	533.9
CV (%)	0.6	0.9	4.8	15.6	19.4	16.1	17.2

Where DF= Days to flowering, DM= Days to maturity, PH= Plant height, BPP= Number of branches plant^{-1}, PPP= Number of pods plant^{-1}, SPP= Number of Seeds pod^{-1}, LSD= Least significant difference, CV= Coefficient of variation.

Significant variation ($P < 0.05$) was observed among varieties on pod number per plant. The highest pod number per plant was recorded for Derash (62.3) and the lowest was for Teshale (36.1). Varieties also showed significant difference ($P<0.05\%$) in grain yield performance (Table 1). Grain yield ranged from 1944 kgha^{-1} to 1093 kgha^{-1} with grand mean 1556 kgha^{-1}. Alemaya (1944 kgha^{-1}) and Ada'a (1861 kgha^{-1}) were top yielding whereas Derash (1304 kgha^{-1}) and Teshale (1093 kgha^{-1}) took the reaming ranks.

3.2. Farmers Variety Evaluation and Criteria

Farmers' selection criteria selection was carried out at physiological maturity. Farmers' selection criteria were frost tolerant (FT), Seed color (marketability) (Sc), stem strength (lodging) (St), Maturity (early) (M), shattering ability (Sh), Number of pods plant^{-1} (PPP) and Number of branches plant^{-1} (BPP). The evaluations mean score value for each genotype ranged from 7.75 to 10.75 (Table 2). Alemaya scored the highest value and the lowest was scored by Ada'a. Teshale and Derash were ranked second and third best varieties by farmers', respectively. Both women and man were participated in the selection process.

Table 2. Sum of scores at three farmer sites for each trait, overall means value of each selection criteria and ranking of genotypes

Variety	Farmer's Criteria								Mean	Rank
	FT	Sc	St	M	Sh	PPP	BPP	Total		
Derash	9	11	15	12	9	11	9	76	9.50	3
Ada'a	13	9	8	4	14	7	7	62	7.75	4
Alemaya	14	15	10	8	10	14	15	86	10.75	1
Teshale	9	10	13	14	10	12	13	81	10.13	2

Where, FT= Frost tolerant, Sc= Seed color (Marketability), St= stem strength (lodging), M= Maturity (early), Sh= shattering ability, PPP= Number of Pods plant^{-1} and BPP= Number of Branches plant^{-1} rating of the performance of variety for a given criteria: 5= very good, 4= good, 3= average, 2= poor and 1 = very poor by adopting from De Boef and Thijssen, 2007

Every farmer's group, comprising women and men, made discussion during selection. The results obtained from farmers' evaluation in three mother trials are presented in table 2. However, different varieties were selected by the different farmer at different farmers' field due to their performance in the field at selection time. However, including yielding ability criteria, best varieties namely Alemaya, Teshale and Derash were selected as top ranking in the selection /adapted varieties. Except Ada'a and Teshale the same varieties had better performance and found to be promising from the analysis of researchers' collected data of some agronomic trait. Due to late maturing and lodging characteristics of Ada'a variety get the lowest rank whereas Teshale lowest yielded variety. 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. A range of improved varieties should be available for selection under their participation. Researchers must consider farmers selection traits in their varietal development such as seed yield, seed size and overall field performance. Generally, the variety should have high yield potential, tolerance to biotic and abiotic stresses and have good marketability and consumer preferences.

4. CONCLUSION

Participatory varietal selection is the selection by which farmers evaluate finished or near-finished products from plant breeding programs on their own farms. Once identified, the seed of farmer-preferred cultivars needs to be rapidly multiplied and cost-effectively supplied to farmers. Alemaya and Derash gave the highest grain yield and showed better performance in other agronomic traits than the rest varieties in the present study. Thus, these varieties are found to be well adapted to Bore highlands conditions among the four tested varieties in both the researcher's and farmer's selection criteria. Farmers' exposure to evaluate and select new varieties is an advantage to exploit their potential knowledge of identifying adapted varieties that best meets their interest which further helps to include such selections in their varietal portfolio for seed production. The interaction of researchers and farmers will also help to design research objectives to overcome rejection of varieties developed by researchers alone, enhances the acceptance of varieties and reduces costs associated with variety development. Most farmers also recognized well that improved cultivars will perform better if accompanied by recommended cultural practices. The current selection process also demonstrated that farmers were capable of selecting important traits for grain yield (yield components) and based on those traits demonstrated to identify superior varieties adapted to their locality. Generally, PVS was effective and reliable for identifying appropriate cultivars through partnership with resource-poor farmers.

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