

Participatory Evaluation of Chickpea (*cicer arietinum* L.) Varieties in Wolayta Zone, Southern Ethiopia

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ABSTRACT

Participatory Varietal Selection (PVS) was carried out at Humbo, Damot sore and Boloso Sore Districts of Wolaita Zone, South region during 2016–2017 main cropping seasons to assess and select superior chickpea variety (ies) that satisfy the desires and choices of farmers. Eight chickpea varieties were laid out using a randomized complete block design and replicated three times. Farmers evaluated and selected the varieties depending on their criteria's that were set by themselves. The farmers selection criteria's included grain yield, seed size, seed color, disease and pest resistance, early maturity, plant height, drought tolerance, number of pods, number of branches and ground cover. Seed yield, one of farmer selected criteria, were analyzed. Combined mean values indicated that, Dimtu (2523.1 kg/ha) followed by Minjar (2447.1 kg/ha) were high yielding variety, and standard check (1834.9 kg/ha). In case of farmer's evaluation, over all higher rank was to Dimtu and (due to high yield of grain, seed colour and early maturity,), followed by Minjar varieties, respectively. The yield advantage of Dimtu and Minjar was 37.5% and 33.4% over Habru (standard check) respectively. Based on researcher and farmers selection among the tested improved varieties Dimtu and Minjar varieties were selected for production. Simultaneously, the farmer's criteria must be considered in chickpea improvement programs.

Keywords: : Criteria; Participant farmers; Released varieties; Yield advantage

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is the third largest produced food legume globally, after dry bean/ common bean (*Phaseolus vulgaris* L.) and field pea (*Pisum sativum* L.) [1]. The crop accounts for 12 % of the world pulses production [2]. It is grown in arid and semi-arid regions of the world with a total global production of 11.6 million tons from 13.2 million hectares in 2011 (FAOSTAT, 2012). Ethiopia stands first in area (213187 ha) and production (284640 tons) in Africa, but third in productivity (1335.2 kg ha⁻¹) after Egypt and Sudan (FAO, 2012). This clearly indicates the importance of chickpea in Ethiopian agriculture.

In Ethiopia, chickpea serves several purposes such as a food, cash, and a soil fertility crop [3]. Furthermore, chickpea production needs relatively lower inputs compared to cereals, it is considered as a less labor-intensive crop. Chickpea is mostly grown using residual moisture after the main season crop is

harvested from September to December. Chickpea fixes atmospheric nitrogen (N), improves soil fertility, and saves fertilizer costs in the subsequent crops. These conditions allow more intensive and productive use of land. The current chickpea production in Ethiopia is estimated to be 4,726,113.88 tons on an area of 258,486.29 ha of land giving the national average grain yield of 1.83 tons per hectare [4].

In SNNPR pulses covers over 19.8 % of grain crops cultivated land mainly faba bean, field pea, common bean and chickpea. The area covered, total production and average yield of chickpea was estimated to be 11,795.78 ha, 214,003.98 quintals and 1.81 tons ha⁻¹, respectively [5]. Therefore, it is among the important crop grown as food and cash in the region. In spite of the economic importance of the crop in achieving food security and food self-sufficiency in the region, very little have been done to change the livelihood of chickpea producing farmers through development, adaptation and promotion of chickpea

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technologies. Thus the contribution of improved varieties of chickpea is almost insignificant mainly because of poor involvement of farmers in the evaluation and selection process, poor extension service to promote improved agricultural technologies, poor agronomic practice, diseases (aschochyta, fusarium wilt) and insect pests pod borer [6]. Thus it is vital to evaluate the chickpea varieties in the region using the participatory varietal selection (PVS) approach in order to offer choices of varieties to the farmers for increasing production in their diversity of agro-ecological and socioeconomic conditions. PVS also helps to disseminate the adoption of released varieties in larger areas; allow varietal selection in targeted areas at cost-effectiveness and also in less time and as a consequence help seed production and scaling-up at community level.

Participatory varietal selection approach in Ethiopia has been done on different crops including field pea [7] faba bean [8], common bean [9], tef [10], and barley [11]. Up to now the involvement of farmers in decision making process has been observed in the region on some faba bean and common bean varieties on participatory approach, by Hawassa and Areka Agricultural Research Centers. Otherwise participatory variety selection for chickpea varieties was not done in the study areas. Hence, it was found prominent to evaluate the improved chickpea varieties for their performance and farmers' preferences for achieving good quality, high yielding and farmers' preferred varieties thereby enhancing chickpea production and productivity in the south region. Therefore, this study was conducted to evaluate and select the best performing chickpea varieties through PVS and to identify farmers' preference and selection criteria for chickpea varieties in the study areas.

MATERIALS AND METHODS

Description of the study area

The experiment was conducted at Damot sore, Boloso sore and Humbo districts, of Wolayta zone during 2016 and 2017. The zone is located at 385 km to south west from Addis Ababa, capital of Ethiopia. The Damot sore is located with the altitude range of 1400-1720 masl, receives annual rainfall of 700-1100 mm, the temperature varies from 24-30°C and the soil type is vertisol. Similarly, Boloso sore is located with the altitude of 1780 masl, receives annual rain fall of 1438 mm, the mean temperature varies from 14.2-26.2°C and the soil type is Alisols. The Humbo district is situated with the altitude range of 1320-1530 masl, receives annual rainfall of 700-1200 mm, and the temperature varies from 13.5-25.5°C.

Treatments and design

Seven chickpea varieties namely Tekatay, Minjar, Naatolii, Ejere, Dehera, Hora, Dimtu and Habru (standard check) were included in the experiment. Four farmers field were used for on farm evaluation and each farm was used as a replication. In each district, one kebele and at each kebele 4 farmers were identified to lay out the trials. The trial was designed by the researcher but laid and all cultural operations including planting, weeding and harvesting was managed by the selected farmers. The trial

varieties were planted in a randomized complete block design with four replications from the 1st week to mid of August in 2016 and 2017 cropping seasons. Plot area of the trial was 3 m*1.8 m and seeds were planted on six rows with the rate of 180 seeds per plot. Spacing was 0.3 m and 0.1 m between rows and plants respectively. The NPS fertilizer was applied with the rate of 121 kg ha⁻¹ at planting. Hand weeding was done three times after emergence.

Data collected

The data were recorded on grain yield and other farmers' preferred traits. At harvest, grain yield was taken from the four central rows and recorded in gram per plot, but it has been converted into kg ha⁻¹ for analysis.

A total of 127 farmers in three districts; 2 agricultural development agents, 24 men and 5 women farmers at Boloso sore; 3 agricultural development agents, 32 men, and 13 women farmers each at Humbo and Damot sore were invited to visit the trial site at flowering and physiological maturity.

The participated farmers have made the discussion during selection and set the selection criteria to select the promising varieties. The farmers' selection criteria were grain yield, seed size, seed color, disease and pest resistance, early maturity, plant height, drought tolerance and ground cover. Based on the selection criteria, they were asked to give the rank score of the tested varieties.

Data analysis

Data recorded were subjected to Analysis of Variance (ANOVA) using the general linear model (GLM) procedures of statistical Analysis System (SAS, 2002). Farmers' selection data were analyzed using simple ranking methods in accordance with the given value (De Boef & Thijssen, 2007).

Simple ranking is a tool often used to identify promising varieties based on farmers' preferences. The ranking procedure was explained to Kebele Agricultural development agents and farmer participants and then they set the selection criterion. 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 & Thijssen, 2007).

RESULTS AND DISCUSSION

Performance of chickpea varieties

The analysis of variance revealed significant difference ($P < 0.01$) among the varieties for seed yield, indicated the presence of variability, which could be attributed to the genetic potential of the genotypes used among the evaluated varieties for the seed yield across the three sites (Table 1) [12]. Reported different chickpea varieties significant difference for seed yield under various environments.

Table 1: Combined Analysis of variance for yield of chickpea varieties.

Source of variation	DF	SS	MS	F value	Pr>F
Location	2	3 E+07	1.5 E+07	102.7	***
Rep(Location)	9	3 E+07	3308387	22.52	***
Variety	7	1.3 E+07	1807645	12.31	***
Location*variety	14	3616592	258328	1.76	*
Error	63	9253230	146877		

In the on farm evaluations, the eight chickpea varieties significantly differed in performance across the 3 districts. Combined analysis indicated two varieties Dimtu and Minjar top yielded 2523.1 and 2447.1 kg/ha which are higher than grand mean 1953 kg/ha). Chickpea varieties means across sites ranged between 1544.4–2523.1 kg/ha (Table 2). The high yielding varieties compare very well with yields from other

studies and exceed the average farm yields (1900 kg/ha) in Ethiopia (CSA, 2015). Overall Dimtu (2523.1 kg/ha) and Minjar gave the highest grain yield while Hora (1544.4 kg/ha) the lowest. Four varieties (Dimtu, Minjar, Naatolii and Ejere) outperformed grand mean. Among these, the production of genotypes, Dimtu and Minjar were significantly improving the yield of the crop in the study area (Table 2).

Table 2: Chickpea yield and combined farmers' evaluation of chickpea varieties in three districts, Southern Ethiopia.

Variety name	Grain yield(kg/ha)				Score						
	BS	Humbo	DS	Mean	YR	YA (%)	BS	Humbo	DS	MDS	FR
Habru	1721.8	1337.9	2445.4	1834.9	5	-	5	5	4	4.7	4
Dehera	1122.6	1557.6	2006.6	1562.3	7	-	8	8	8	8	7
Dimtu	2014.3	1845.7	3709.3	2523.1	1	37.5	1	2	3	2	2
Ejere	1586.1	1450.2	2891.7	1976	4	-	5	4	5	4.7	4
Natoli	1842.9	1460	3094.2	2132.4	3	-	3	3	2	2.7	3
Minjar	2001.1	2119.2	3220.9	2447.1	2	33.4	2	1	1	1.3	1
Hora	1476.2	903.3	2253.7	1544.4	8	-	4	6	6	5.3	5
Tekatay	1323	1191.4	2309.2	1607.9	6	-	6	7	7	6.7	6
Mean	1635.95	1483.2	2741.3	1953.5							
LSD	197.7	454.31	840.4	312.7							
CV	8.2	20.8	20.8	19.6							

Note: Total respondents: (M=26, F=5) at Boloso sore (BS), (M=32, F=13) at Humbo, and (M=35, F=13) at Damot sore (DS) each, YR=Yield rank, YA=yield advantage (%), Mean derived scores and FR= Farmers rank.

The highest mean yield was recorded in Damot sore (2741.3 kg/ha) followed by Boloso sore and Humbo with 1635.9 kg/ha and 1483.2 kg/ha respectively (Table 2). The highest yield may be due to favorable environment because environment influences genetic performance of many quantitatively inherited traits including yield through genotype x environment (G×E) interaction [12]. In this study, the influence of environment on seed yield of all the chickpea varieties has been demonstrated in Damot sore showing superior production for the different genotypes [13].

Participatory varietal evaluation

For chickpea varieties the selection criteria were set by farmers based on group discussion and consensus.

The selection criteria for Boloso sore, Humbo and Damot sore were similar and they assigned a weight based on its relative importance for chickpea varieties.

The varieties were evaluated by male and female household headed farmers. The eleven selection criteria suggested are shown in Table (3).

Table 3: Ranking of farmers' selection criteria in three districts in southern Ethiopia.

Criteria	District		
	B/sore	Humbo	Damot sore
Grain yield	1	2	1
Seed size	4	4	4
Seed colour	6	7	5
Pest resistance	3	3	3
Diseases resistance	8	4	8
Early maturity	2	1	2
Number of branches	9	8	6
Number of pods	6	7	3
Plant height	7	8	9
Drought tolerance	5	4	7
Ground cover	9	7	10

*The number of farmers participated in selection were 45, 48 and 31 at Humbo, Damot sore and Boloso sore respectively.

Table 4: Spearman's rank correlation of farmers' selection and Damot sore districts. criteria among Boloso sore, Humbo

	Bolso sore	Humbo	Damot sore
Boloso sore	1		
Humbo	0.83**	1	
Damot sore	0.84**	0.66*	1

Note: *, ** = Significant at 5 and 1% probability

Farmers' selection criteria

The various criteria used by farmers to select chickpea varieties are given in Table 3. The criteria and ranks shown are those indicated by at least two groups of farmers in each district. High yield and early maturity were clearly the most important criteria as they were highly ranked by farmers groups in all districts. Pest resistance (pod borer resistance) was the third most important criterion and was highly stressed in Boloso sore and Humbo. Large seed size was fourth most important selection criterion across the three districts. The lowest ranked criteria were plant height and ground cover. The correlations among the three districts of the ranking of selection criteria were strong, positive and significant (Table 4) indicating that the rank order was consistent among the three districts.

According to direct matrix ranking at Humbo chickpea varieties, Minjar and Dimtu, were considered as best followed by Natoli and Ejere. However, Dehera and Teketay varieties were the least preferred ones (Table 5).

Similarly, at Boloso sore, Dimtu, Minjar, Naatolii and Hora varieties were preferred, while varieties of Ejere and Dehera were the least preferred (Table 5).

At Damot sore chickpea varieties, Minjar, Naatolii and Dimtu were selected by farmers as the best varieties and farmers the least preference varieties were Teketay and Dehera (Table 5).

Table 5: Farmers' preference ranking of chickpea varieties at three locations in Wolayta Zone.

No	Varieties	District			Rank sum	Overall rank
		Boloso sore	Humbo	Damot sore		
1	Haru	5	5	5	15	5
2	Dehera	8	8	8	24	8
3	Dimtu	1	2	1	4	1
4	Ejere	5	4	4	13	4
5	Natoli	3	3	3	9	3
6	Minjar	2	1	2	5	2
7	Hora	4	6	6	16	6
8	Teketay	6	7	7	20	7
Number of participants		M=26 ,F=5	M=32, F=13	M=35, F=13		

Ranking of eight chickpea varieties

During field evaluation, varieties Minjar, Dimtu, Natoli and Ejere were ranked as the top four most preferred varieties (Table 5). According to farmers' selection criteria, Dimtu and Naatoli because of its high yield, large number of pods and ground cover; Minjar and Ejere because of their earliness, large number of pods and high grain yield [14]. Farmers' evaluation was

consistent with varietal yield performance except that Dimtu and Minjar, which ranked 1st in yield and 2nd in farmer's preference, whereas Minjar was 1st ranked in farmers and 2nd in yield [15]. The ranking of the varieties based on field performance was consistent among the three study districts since the correlation among the three districts was strong, positive and significant (Table 6).

Table 6: Spearman's rank correlation of farmers' variety preference among Boloso sore, Humbo and Damot sore districts.

	Bolso sore	Humbo	Damot sore
Boloso sore	1		
Humbo	0.89**	1	
Damot sore	0.92**	0.95**	1

Note: *, ** = Significant at 5 and 1% probability

CONCLUSION AND RECOMMENDATION

This study has combined knowledge from researchers and farmers to identify potentially high yielding chickpea varieties with farmers' preferred attributes [16]. From the experiment it has been shown that an appreciable yields as high as 2523.1 kg/ha-1 can be obtained with average yield of 1953.5 kg/ha-1.

From this study, it can be concluded that: Improved chickpea Varieties Dimtu and Minjar were performed better compared to the other varieties at three test districts and they were preferred by farmers as 1st to 3rd rank at all districts.

Dehera rejected due to tall height while some farmers place their choices on Teketay. Farmers preferred Minjar due to its

earliness, high yield and red seed colour. Therefore, those selected varieties will be included in pre-extension demonstration plan to be demonstrated and popularized in the study area and similar agro ecology.

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