

Participatory Variety Evaluation for Enhanced Promotion of Improved Chickpea (*Cicer arietinum* L.) Varieties in West Gojam

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Abstract

Chickpea variety selection is crucial for improving productivity, adaptability, and overall sustainability. Participatory varietal evaluation is used to identify farmer-preferred varieties that are high-yielding, resilient, and suited to local conditions and accelerate the adoption of improved varieties by involving end-users (farmers) early in the breeding pipeline. This experiment aimed to evaluate the performance of improved chickpea varieties for seed and seed-related traits. Seven released chickpea varieties, along with one local check for kabuli and desi types in two sets, were tested using a Randomized Complete Block Design with three replications. The mother trial with all three replications was carried out at the Farmers Training Center (FTC). The baby trial, on the other hand, was conducted on farmers' fields. A farmer's field was considered a replication. ANOVA results showed significant differences ($p < 0.05$) among the tested varieties. Of the tested varieties, Natoli (3800 kg ha^{-1}) from the desi type and Shasho (1880 kg ha^{-1}) were superior in seed yield across the testing districts. The local variety had a lower yield than the kabuli type. Farmers evaluated and ranked the performance of chickpea varieties based on their selection criteria. Disease resistance, number of seeds pod⁻¹ Number of pods plant⁻¹, disease resistance, and Branch were the major farmers' selection criteria. Based on these selection criteria, varieties Teketay, Girar, and Natoli were highly preferred by farmers from the desi type, and varieties Hora, Shasho, and Koka were highly preferred by farmers from the kabuli type. Based on farmers' evaluation and selection criteria and biological data, Natoli and Shasho varieties were recommended to the midland areas of the West and North Gojam Zones. Therefore, these varieties are recommended for further popularization and scaling up in the study area and similar agroecologies.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is the third most important food legume globally, after common bean (*Phaseolus vulgaris* L.) and field pea (*Pisum sativum* L.). It is primarily grown by smallholder farmers across semi-arid regions, including West Asia, North Africa, and sub-Saharan Africa, notably Ethiopia [1]. Chickpea is a vital protein source, an important export crop, and contributes to soil health through nitrogen fixation [2].

Despite its significance, the national average yield of chickpea in Ethiopia is about 2170 Kg ha^{-1} —far below its potential of 5500 Kg ha^{-1} —due to both biotic and abiotic stresses. Drought alone accounts for 40–50% of yield losses globally [3]. In response, modern breeding techniques, including molecular markers, high-density genetic mapping, and transcriptomics, are being applied to improve drought tolerance [4]. Root traits, especially root length density and depth, are critical to enhancing drought resistance and stabilizing yield under water-limited conditions [5].

In Ethiopia, chickpea is grown mainly on vertisols using residual soil moisture. It is widely consumed in dishes such as wot and roasted grain (kolo), and is recommended for diabetics due to its low glycemic index [6]. While experimental yields exceeding 5000 Kg ha^{-1} have been achieved at research sites, such outputs are not realized on smallholder farms. The main reasons are the use of low-yielding, disease-prone varieties and shrinking landholdings caused by population pressure.

Participatory Varietal Evaluation is a research approach in which farmers actively participate in the testing, selection, and evaluation of crop varieties under real field conditions. It bridges the gap between research institutions and farming communities by incorporating farmers' preferences, indigenous knowledge, and field-level observations into the varietal selection and release process. Therefore, developing and screening of improved

chickpea varieties with high yield potential and disease resistance is critical to boosting productivity and ensuring food security [7].

Materials and Methods

Description of the Study Sites

The field experiment was conducted during the 2021–2022 main cropping season from October to February at Denbecha in North West Ethiopia. Descriptions of the geographical coordinates, climate and soil types of the testing locations are shown in Table 1.

Table 1
Argo-climatic descriptions of the study site of Denbecha.

Location	Latitude (N)	Longitude (E)	Altitude (m)	Soil type	Average T° in 2021	annual RF in 2021
Denbecha	10°33'N	37°29'E	2083	vertisols	19.68 °C	1006 mm

Source: Ethiopian metrological stations

Planting materials and trial management

Sixteen chickpea varieties (Dalota, Dimtu, Eshetie, Geletu, Girare, Natoli, Teketay and local check from Desi type and Arerti, Dhera, Ejeri, Hora, Koka, Shasho, Akaki and Local from Kabuli type) in two set were evaluated and compared for their yield and other agronomic performance separately. The trial was laid out on Randomized Complete Block Design with three replications. Each experimental plot had six rows of 4-meter length and 1.8 meter width with mother baby trail Spacing between replication, plots, rows & plants. 1m, 0.6m, 30 cm & 10 cm respectively depending on ARARI PVS guides line. NPS (38% P, 19% N and 7% S) were applied at a rate of 121 kg ha⁻¹. All NPS was applied at planting. Other agronomic practices such as land preparation, planting and weeding were applied uniformly to all treatments as per the recommendation. At all locations the land was ploughed three times by oxen and no irrigation supplement was implemented. Other agronomic management practices were also carried out at all sites following standard recommendations.

Matrix ranking was used to assess farmers’ opinion and perceptions on the varieties. Focus group interviews’ were held with group of farmers to obtain their perceptions on the chick pea varieties under evaluation. Therefore, selected farmers at each village were invited to visit the trial site at physiological maturity stage and farmers were asked for their perceptions on the chick pea varieties under evaluation based on the specific criteria they were seated. A scale of 1–5 was used to assess these traits with the definition as follows: 1 = not preferred, 2 = less preferred, 3 = moderately preferred, 4 = highly preferred 5 = very highly preferred. Farmers were asked to rank as 1, 2, 3, 4 and 5 for variety ranking representing a given trait and variety according to the above scales. Farmers’ responses were counted to get totals for each trait per variety; the largest total count was assigned first rank.

Data Collection

Data were collected from plot basis and plant basis of central rows.

Plot basis

Seed Yield (Kg ha^{-1}): The yield was measured from the harvest-able central rows. Finally, yield per plot was converted to a per hectare basis and the average yield was recorded in tone ha^{-1} .

Hundred Seed Weight: Random samples of 100 seeds were counted from the harvested plot yields immediately after grain moisture determination and were weighed in grams.

Plant basis

Number of Seeds per Pod: Five pods were randomly taken per plant from each of the ten plants after counting the numbers of seeds per pod were determined by the average of pods. Number of pods per Plant: Five plants were randomly taken per plot and from each of the five plants after counting the numbers of pods per plant were determined by the average of pods.

Plant height (cm): Five plants height were randomly taken per plot and from each of the five plants after measuring the height (cm) per plot were determined by the average of height.

Statistical Analysis

The analysis of variance (ANOVA) for each location and combined analysis of variance over locations were performed following the standard procedure given by [8] using the SAS program [9]. The homogeneity of error variance was tested using the F-max test method [10] prior to pooled analysis over locations. The F-test was used to detect significant effect while the mean separation was done using Least Significant Difference (LSD) at the 5% probability level.

Results and Discussion

Analysis of variance (ANOVA)

The analysis of variance confirmed a highly significant difference was observed among the variety in days to maturity, plant height, and hundred seed weight. However significance difference was observed in number of seed per pod. The highest seed yield was recorded by the variety Natoli with the yield 3800 Kg ha^{-1} . The lowest grain yield was obtained from local (Table 2) from desi type. The highest seed yield was recorded by the variety Shasho with the yield 1880 Kg ha^{-1} . The lowest grain yield was obtained from Dhera (Table 2) from kabuli type.

These results agree with previous findings [11] differences among varieties were significant for grain yield and some of traits. Grain yield was the first prioritized traits to farmers for selecting best adaptable chickpea variety under irrigation

A very important advantage of PVS is that the adoption of new cultivars is much faster than under the formal system, in which farmers are confronted with only a very restricted range of new cultivars [12].

Table 2

Mean grain yield and other important agronomic characters of eight Desi type and Kabuli type chickpea PVS at Denbecha 2021.

N0	Desi type						Kabuli type					
	Variety	PH	PPP	SPP	100 SW (gm)	SY(Kg ha ⁻¹)	Type	PH	PPP	SPP	100 SW (gm)	SY(Kg ha ⁻¹)
1	Dalota	41.6	30.7	1.1	20.1	1060	Akaki	33.7	17.0	1.0	30.1	330
2	Dimtu	41.3	23.4	1.1	24.4	1300	Arerti	42.8	29.8	1.2	31.0	1740
3	Eshetie	34.2	30.4	1.3	17.3	1010	Dhera	0.0	0.0	0.0	0.0	
4	Geletu	39.5	25.7	1.0	28.5	990	Ejeri	41.5	33.5	1.4	27.9	1250
5	Girare	35.1	31.8	1.0	25.9	1300	Hora	34.4	14.2	1.0	29.8	1740
6	Local	32.2	18.6	1.2	18.3	210	Koka	33.3	16.7	1.0	35.1	420
7	Natoli	40.9	43.7	1.1	29.3	3800	Local	41.2	35.9	1.3	27.6	310
8	Teketay	41.3	33.6	1.1	25.5	1420	Shasho	37.1	22.5	1.3	27.3	1880
	Mean	38.3	29.7	1.1	4.2	2370	mean	37.7	24.2	1.2	29.8	1090
Note: PH = Plant height, PPP = number of pod per plant, SPP = number of seed per pod, SW = Seed weight and SY = Seed Yield												

Farmer Preference Data Collection and Analysis with Field pea PVS Procedure for Preference Data Collection and Analysis to select their best varieties

Table 3

Pair wise ranking for weighting criteria used by farmers to select the most promising Chickpea variety to their farming environment.

Criteria	No of seeds	Pod per plant	Disease resistance	No of branches	Total	rank
No of seeds		No of seeds	Disease resistance	No of seeds	2	2
Pod per plant			Disease resistance	Pod per plant	1	3
Disease resistance				Disease resistance	3	1
No of branches					0	4

Table 3
Matrix rank result and selected Desi type varieties

Variety	Preference value (Sum of Scores X Weight)				Total preference value	Rank
	Number of seeds 2	Pod per plant 3	Disease resistance 1	Branch 4		
Natoli	26	42	12	52	132	3
Eshetie	64	96	25	80	265	8
Dimtu	48	75	16	64	203	5
Geletu	30	36	28	88	182	4
Dalota	42	57	18	120	237	7
Girare	16	27	17	60	120	2
Teketay	14	21	9	24	68	1
Local	48	78	19	88	233	6

Table 4
Matrix rank result and selected varieties of Kabuli type

Variety	Preference value (Sum of Scores X Weight)				Total preference value	Rank
	Number of seeds 2	Pod per plant 3	Disease Resistance 1	Branch 4		
Dhera	40	48	22	88	196	4
Koka	30	42	12	64	148	3
Hora	10	24	8	36	78	1
Akaki	34	54	32	96	216	5
Shasho	14	45	4	32	95	2
Arerti	60	84	19	60	223	6
Ejeri	50	63	27	96	236	7
Local	42	81	22	104	249	8

Conclusions and Recommendations

Shasho and Natoli were selected statistically and by farmers. So, they will be used for pre scale up activities at Denbecha district.

This study confirmed that extension activities influence adoption of new technologies. Farmers would not adopt an improved variety until they get awareness, and fully observe and comprehend their advantages. Thus, there is a

need to strengthen extension services provided to farmers, and help them to be aware of the released varieties and their benefits. On-farm experimentation and evaluation of technologies do not only help in fine-tuning technologies to farmers' conditions but also allows farmers to be aware of the existence of technologies and to evaluate their performances. Therefore, pre scale up activities should be enhanced through selected varieties (Natoli and Shasho).

Chickpea can be consumed at green pod stage and dry. Large seeded varieties are preferred for green pod consumption. People passing near chickpea fields may pick up and consume it without permission from the owner. Guarding chickpea fields against people is labor consuming. It is also risky for a farmer to leave his/her field unattended. Therefore, farmers are reluctant to take initiatives to grow large seeded improved varieties. Thus, community-based joint actions are required to curb the risk and its effects and to help a farmer be secured from loss due to theft.

Declarations

Data Availability

The data used to support the findings of this study are available upon request from the corresponding author.

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Author Contributions:

BZ: conceived the idea, interpreted data, analysed data, interpreted data, and wrote the manuscript; CA: generated data, reviewed literature, and supervise the trail; JE: collected data, analysed data, and reviewed literature; SA.: finance support, supervise, and Data curation; DA: collected data, and analysed data. All authors have read and agreed to the published version of the manuscript.

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Ethics declarations

Ethics approval and consent to participate

Participation was voluntary, and all participants gave their written (or verbal, where literacy was a barrier) informed consent prior to data collection. The plants used in the study were curated by breeders, from whom some of the plants were sourced, while others were obtained through collaboration with other research centers. The collection of plants used in the study adhered to local and national guidelines, and additional attribution was not required. All procedures for the collection, characterization, and documentation of landrace varieties comply with the research ethics.

Competing interests

The authors declare no competing interests.

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Figures



Figure 1

ChickPea PVS & farmers participation