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Research Article

Performance Evaluation and Variety Selection for Enhanced Promotion of Improved Chick Pea (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 (38 qt ha^{-1}) from the desi type and Shasho (18.8 qt 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.

Keywords

Baby Trial, Mother Trial, Prticipatory Varietal Evaluation

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1. 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].

2. Materials and Methods

2.1. 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°	annual RF
Denbecha	10°33′N	37°29′E	2083	vertisols	19.68 ℃	1006 mm

Source: Ethiopian metrological stations.

2.2. 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.

2.3. Data Collection

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

2.3.1. 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.

2.3.2. 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.

2.4. 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.

3. Results and Discussion

3.1. Analysis of Variance (ANOVA)

In the Participatory Variety Selection (PVS) trial conducted at Denbecha in 2021 a significant difference in performance was seen between chickpea seed types. The Desi-type germplasm out-yielded the Kabuli types by 117.4% on average. The Desi types achieved a seed yield of 23.7 qt ha^{-1} while the Kabuli types averaged only 10.9 qt ha^{-1}. This large gap in productivity is mainly due to the pod-bearing architecture of the Desi entries. The Desi types produced an average of 29.7 pods per plant (PPP) compared to 24.2 PPP for the Kabuli types. This confirms regional data showing that Desi varieties have better yield stability and higher genetic gains than Kabuli cultivars in the northwestern Ethiopian Vertisols (Table 2) [11].

Within the Desi class the variety Natoli stood out as the elite genotype. It achieved the yield in the trial at 38.0 qt/ha thanks to a very strong sinks capacity of 43.7 pods per plant. In contrast the Local Desi landrace performed poorly with a yield of 2.1 qt ha^{-1}. This low yield was due to pod development with only 18.6 pods per plant (Table 2).

On the hand the Kabuli market class showed more variation in performance. Some lines failed completely. Dhera for example had a yield of 0.0 qt ha^{-1} across all traits. This total failure highlights how vulnerable certain Kabuli lines can be to stresses such as waterlogging or viral diseases common in West Gojjam. Among the Kabuli varieties that survived Shasho (18.8 qt ha^{-1}) Arerti (17.4 qt ha^{-1}) and Hora (17.4 qt ha^{-1}) were the most reliable in terms of performance. Koka showed a source-sink tradeoff—its seeds were heavier with a 100 seed weight of 35.1 g but its grain yield was low at just 4.2 qt ha^{-1}. This was due to low pod counts (16.7 PPP) (Table 2). These results agree with previous findings [12] differences among varieties were significant for grain yield and some of traits. Disease resistance was the first prioritized traits to farmers for selecting best adaptable chickpea variety (Table 3).

These results show that Desi varieties like Natoli offer the chance for maximizing grain output ensuring high productivity and food security. However for farmers aiming to reach premium Kabuli export markets Shasho and Arerti are more dependable. These varieties support economic security and help advance pulse commercialization efforts, in Ethiopia.

Table 2. *Mean grain yield and other important agronomic characters of eight Desi type and Kabuli type chick pea PVS at Denbecha 2021.*

No	Desi type						Kabuli type					
	Variety	PH	PPP	SPP	HSW (gm)	SY (qt ha^{-1})	Type	PH	PPP	SPP	HSW (gm)	SY (qt ha^{-1})
1	Dalota	41.6	30.7	1.1	20.1	10.6	Akaki	33.7	17.0	1.0	30.1	3.3
2	Dimtu	41.3	23.4	1.1	24.4	13.0	Arerti	42.8	29.8	1.2	31.0	17.4
3	Eshetie	34.2	30.4	1.3	17.3	10.1	Dhera	0.0	0.0	0.0	0.0	
4	Geletu	39.5	25.7	1.0	28.5	9.9	Ejeri	41.5	33.5	1.4	27.9	12.5
5	Girare	35.1	31.8	1.0	25.9	13.0	Hora	34.4	14.2	1.0	29.8	17.4
6	Local	32.2	18.6	1.2	18.3	2.1	Koka	33.3	16.7	1.0	35.1	4.2
7	Natoli	40.9	43.7	1.1	29.3	38.0	Local	41.2	35.9	1.3	27.6	3.1

No	Desi type						Kabuli type					
	Variety	PH	PPP	SPP	HSW (gm)	SY (qt ha^{-1})	Type	PH	PPP	SPP	HSW (gm)	SY (qt ha^{-1})
8	Teketay	41.3	33.6	1.1	25.5	14.2	Shasho	37.1	22.5	1.3	27.3	18.8
	Mean	38.3	29.7	1.1	4.2	23.7	mean	37.7	24.2	1.2	29.8	10.9

Note; PH= plant height; PPP= Pod per Plant; SPP= Seed per Pod; HSW= Hundred Seed Weight & SY= Seed Yield.

3.2. Farmer Preference: Data Collection and Analysis

Chickpea PVS preference data recorded the choices made by the farming community during a Field Day that was organized around the stage of physiological maturity.

Table 3. *Pair wise ranking for weighting criteria used by farmers to select the most promising Chick pea 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 4. *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	48	75	16	64	203	5
Eshetie	64	96	25	80	265	8
Dimtu	26	42	12	52	132	3
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 5. *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

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		
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



Figure 1. *Chick Pea PVS farmers participation.*

Pairwise ranking showed that farmers care most about disease resistance. It was their choice. After that they focused on number of seeds pods per plant and branching. This matches what's happening in the region, where people are looking for crops that can handle climate and pest problems (Table 3) [13]. When these preferences were turned into a ranking system using a matrix ranks changed. The variety Natoli, which had the high yield, fell to fifth place. Teketay became the choice among Desi types. After Teketay came Girare and then Dimtu (Table 4).

In the Kabuli group Hora was the favorite among farmers. Shasho and Koka came next. Genotypes like Arerti, which experts liked for their agronomic traits didn't meet farmers' needs for multiple good qualities (Table 5).

These results show something. Chickpea programs can't focus on grain yield alone. If we want farmers to keep using varieties we need to give them crops that do well in yield parts, like pods and seeds but also protect them from diseases. That's what smallholder farmers value most [14, 15].

4. Conclusions

Participatory Variety Selection showed clearly the choices between how chickpea types (Desi and Kabuli) can grow and what small farmers really want in northwestern Ethiopia. From an agronomy point of view better Desi types had a genetic advantage. They gave 117.4% more than Kabuli types on average. The Desi type called Natoli had high seed yield in the trial, which was 38.0 qt/ha. When farmers made their choices they looked at more than just how much the crop grew. They cared a lot about disease resistance and how seeds they could get. This meant that even though Natoli had the yield it did not rank as high as farmers wanted. The Desi variety called Teketay and the Kabuli type called Hora were the ones farmers liked the most. They were ranked number one. These results show that just because a crop does well in a test area does not mean it will be used by farmers. This also shows that small farmers need a mix of features not just one thing, like high productivity.

5. Recommendations

1) Targeted Extension Scaling: In this zone and similar agro ecology extension packages should focus on Teketay (Desi) and Hora (Kabuli) of the high-yielding Natoli to fit the local demand and increase how many farmers adopt these options.
2) Prioritize Disease Resistance in chickpea improvement: Those who breed chickpea need to make disease resistance the main thing they look for when choosing which genotypes to grow. They should not think of it as a thought. They should include what farmers like in the stages of breeding as noted in the work.

Abbreviations

ANOVA	Analysis of Variance
FTC	Farmer Training Center
LSD	Least Significant Difference
PVS	Participatory Variety Selection
RCBD	Randomized Complete Block Design
SAS	System Analysis Software

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Author Contributions

Bantalem Zeleke: Conceptualization, Formal Analysis, Supervision, Writing – original draft, Writing – review & editing

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Dereje Abebe: Formal Analysis, Writing – original draft

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Data Availability Statement

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

Conflicts of Interest

The authors declare no conflicts of interest.

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