

Evaluation of Chick Pea (*Cicerarietinum* L.) Varieties for Yield Performance and Adaptability to Southern Ethiopia

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Abstract

The study was carried out on station and on farm in three districts of Wolayta and Hadiya Zones, south region, Ethiopia, to evaluate the chick pea varieties for yield performance and adaptability under researcher and farmer managed conditions and assess farmer's preferences during 2004 Meher Season. Both on station and on farm trials were laid in randomized complete block design with four replications. Five varieties Arerti, Shasho, habru, chefe and Dz-10-4 were planted on 4.8m² plots at spacing of 0.1m*0.3m. Twenty farmers from three districts at four villages were participated in conducting on farm trials with each farmer as a replicate. The varieties Arerti and Habru were selected both by Researchers and farmers because of its large seed size, long pod length, number of pod per plant, earliness in maturity and high yield. Those varieties were superior overall to the standard check across three districts of four villages and on stations. The top yielding varieties Arerti and Habru produced 1358.85 kg/ha-1, 1326.84kg/ha-1 of grain, 39.2 % and 35.9% more than the standard check (Dz-10-4), respectively at on farm trials. Similarly over two stations 1630.75 kg/ha-1, 1542.2kg/ha-1 of grain, 45.6 % and 37.7% more than Dz-10-4 was recorded by those two top yielding varieties. Hence, both on station and on farm trials revealed Arerti and Habru out yielding other varieties which were also ranked by farmers and Researchers as the most preferred varieties. It is therefore recommended that Arerti and Habru which had higher yields be adapted for cultivation in the study area and similar agro ecological zones of the south Ethiopia.

Keywords: adaptation, chickpea varieties, Kabuli, on farm evaluation, yield performance

Introduction

Chickpea, (*Cicerarietinum*L.) as an one of the most important food legume, has been commonly used for human nutrition and it is second most important among pulses in the world and being is cultivated on more than 11 million hectares with annual production of 9 million tons (Anon., 2007). Chickpea (*Cicerarietinum*L.) is an annual cool season legume or pulse crop commonly used as a green vegetable. Chickpea has one of the highest nutritional compositions of among any dry edible legume. On an average, chickpea seed contains 23% protein, 47% starch, 56% fat, 6% crude fiber, 6% soluble sugar, and 3% ash (www.ICRISAT.org/chickpea/chickpea.htm). Chickpea is an ancient crop that has been grown in India, the Middle East and parts of Africa for many years. Ethiopia is the largest chick pea producing country, with a production share of about 37% and 48% in Africa. Chick pea (*Cicerarietinum* L.) is one of the major high land pulse crop widely grown in highland and semi-highland region of Ethiopia mainly on clay soil. It is one of the major pulse crop cultivated in the country, which occupies about 233,440 hectares of land annually with estimated production of 3,120,800 qt (CSA, 2009/10). According to Ketema *et al.* 2005 the Ethiopian chick pea production is predominately about 95% by desi chick pea but in recent years, the interest of farmers in producing the large seeded kabuli varieties increasing due to domestic and export market. Having high protein content, it is so rich in zinc, dietary fiber, calcium, magnesium, phosphorus, potassium, iron and vitamins (Güler *et al.*, 2001). Chickpeas are increasingly being used in healthy diets in order to promote general well-being and to reduce the risk of illness. In addition, chick peas are an excellent fibre, complex carbohydrates, minerals and its fibre is known to help reduce cholesterol and regulate blood sugar. It is also an excellent source of protein; chick pea may be used as a substitute for animal protein, which is usually in short supply in Ethiopia. In the vertisol soils of Ethiopian highlands the plant and straw are used as forage, hay and silage. Some livestock feeding trials have been conducted elsewhere show chickpea to be a good source of protein for feeds, except that the amino acids methionine and cystine are deficient. Also like other pulse crops it is a good rotational crop and thus restores soil fertility.

In Southern Nations, Nationalities and Peoples Regional State (SNNPRS), chick pea is cultivated in various zones, some special woredas and pocket areas of the region. In general, in this region chick pea occupies about 5,896 hectares of land annually with estimated production of 66,363.02 quintals (CSA, 2012/13). Of the total regional area under pulse crops 1.95 % is covered by chick pea and 1.77 % total grain production was obtained from it. The national average yield of chick pea in Ethiopia is 13.36 qt/ha and the regional average yield of 11.26 qt/ha, which is far below the potential yield of 4.5tha-1. Reason for low yields in the region include the use of unimproved varieties, unreliable rainfall and pests diseases. Some researchers reported that chick pea varieties produce significantly yields at different locations emphasizing to evaluate chick pea varieties in various agro ecological zones for their adaptation, yield potential and disease reaction so as to select suitable varieties for cultivation on farmers' field. Geletu Bejiga and Yadeta Anbessa (1977-1982) adaptability research reported at

Debrzeit revealed that, in seventy chick pea germplasm tested at Debrzeit of Black soil, yield ranged from 130 to 2630kg/ha and noted that standard variety was found to inferior as performance as compared to these exotic materials. The same authors who on analyzing thirty nine and thirty seven kabuli chick pea entries at Debrezeit Agricultural Research center and Akaki testing site reported that most lines were found to be susceptible to wilt while some lines were not adaptable and the rest lines had excellent vegetative growth, large seed size with better resistance as Ethiopia was the country with the highest variation for some agro/morphological traits.

It is, therefore, crucial to understand the relationship among yield testing locations for better adaptation of the varieties to different production environments (Trethowan *et al.*, 2001). Introduction of new varieties with full participation of farmers have been found to be effective in the evaluation and selection of new varieties and other technologies (Assefa *et al.*, 2005). Sall *et al.* 1998) who reported comparison of on farm and on station results is mandatory this is due to very big yield difference between on station and on farm trials.

Therefore the objectives were to evaluate chick pea varieties for yield performance and adaptability of in three districts of four villages under farmers and research management conditions and assess farmers' preferences on the chick pea varieties in the southern parts of Ethiopia.

Materials and methods

The study was carried out both at on station and on farm. The on station study was conducted at the south Ethiopia Agricultural Research Institute's regional Research center at Hadiya Zone of Bobicho and Jewi stations. The altitudes of the study site are 2290mas.l and 1900-2100masl for Bobicho and Jewi, respectively. The annual rain fall, soil types of station are 1592.1mm, Profondic Luvisols for Bobicho and 1500-2000 mm, clay soil for Jewi station. The study involved testing of the total of five varieties for adaptation and yield performance. The trial was planted at Bobicho and Jewi stations at four rows with plot area of 4.8m² of 4m*1.2m during the Meher season of 2004. The crop was planted in mid to late august at a spacing of 30cm *10cm. Variety Dz-10-4 was used as standard check at both sites. Hand weeding was used to control weeds as per recommendation. Data on plant height, hundred seed weight, pod per plant, seed per plant, days to flowering, days to maturity and yield were recorded. Grain yield per plot were recorded and converted into kg/ha. The plant were harvested and threshed manually.

On farm:-The trial was carried out on farm in four villages, two in Lemo district of Hadiya Zone and two in Damot Gale and Offa districts of Wolayta Zone. The soil texture ranged from sandy loam-clay loam at Bobicho and Jewi on farm and black clay (vertisol) for both Mancha gogara of Offa district and Gacheno kebele of Damot Gale district. The trial comprised all the five varieties. These varieties were obtained from the Debrezeit agricultural Research to test adaptability at the study area and the farmers were more familiar with the production of Desi type chick pea than Kabuli type in the study areas. A total of twenty farmers, four farmers at each village were selected and planting started in late August and continued until early September, in 2004. Each plots comprised of four rows which were 4m long. Spacing of 30 cm between rows and 10 cm between plants was used. Matrix ranking was used to assess farmers' opinion and perceptions on the varieties. Each farm was treated as a replicate. In additional to technical support; researcher also provides seed and chemicals for pest control to farmers. Farmers provide land and labour for crop husbandry. Data was collected for plant height, pod per plant, hundred seed weight, days to flowering, and days to maturity and grain yield per hectare. Data analysis was done using GLM in Statistical Analysis system (SAS) program.

Results and discussions

On station:-Results revealed significant yield difference among varieties ($P < 0.05$) with Arerti and Habru out yielding other varieties (Table 1). The mean grain yield ranged from 1139.6 to 1643.8 kg/ha and 1101 to 1617.7 kg/ha for Bobicho and Jewi, respectively (Table 1). variety Arerti recorded the highest yield at Bobicho whereas variety Dz-10-4 yielded the lowest. In similar fashion at Jewi variety Arerti had the highest grain yield even though the two varieties were statistically at par. All varieties had higher grain yield than the standard check and also there was significant yield differences among varieties at both study sites. This finding is in line with Geletu Bejiga and Yadeta Anbessa (1977-1982).

One of the yield components measured was the mean number of pod per plant. The number of pod per plant was influenced significantly ($P < 0.05$) and different varieties of chick pea varied markedly for their pod per plant. The number of pod per plant was highest (81.75; 77) in variety Arerti, followed by varieties Habru and chefe with average number of pod per plant of (76.25; 69.5) cm and (65.75; 65) at Bobicho and Jewi, respectively. Statistically the differences between Arerti and Habru were non-significant ($P > 0.05$) and significant ($P < 0.05$) when compared with chefe. Varieties Habru and Arerti had significantly higher number of pods per plant than

the rest varieties at both stations. These results in relation to number of pod per plant are in concurrence to those of Ines C. Gonzales and Fernando R. Gonzales.2014 who found that number of pod per plant were genetically influenced by the breeding material for development of chick pea cultivars developed in different environmental conditions.

Another yield component measured was hundred seed weight. The varietal effect on the hundred seed weight was significant ($P < 0.05$) at both stations and the results (Table-1) indicated that the maximum hundred seed weight (33.75 gm and 33gm) were recorded in variety chefe, followed by varieties Habru and shasho with (29.5gm ;29.25gm) and (28.25gm;26.25) gm a Bobicho and Jewi, respectively. Hundred seed weight range from 12.5 to 33.75 and 12 to 33 for Bobicho and Jewi on station, respectively (Table 1). Variety chefe had the highest hundred seed weight followed by Habru at both station whereas cultivar Dz-10-4 had the lowest. These results are in agreement with Ketema *et al.* 2005 who was of the experience that varieties hundred seed weight range from 26 gm to 35gm.

The other yield components recorded was the plant height. Among chick pea varieties, the plant height was maximum (42.25 cm) in variety Arerti, followed by 41.50 cm plant height noted in varieties Habru, respectively (Table-1). The plant height in variety Arerti was 42.25 cm and the minimum plant height of 38.75 cm was observed in variety Dz-10-4. This indicates that variety Arerti proved to be one of the promising varieties of the future in Bobicho areas as regards its plant height. These results are further supported by Ines C. Gonzales and Fernando R. Gonzales.2014 who reported considerable variation in the plant height of different chick pea varieties when planted under various environments.

The other parameter recorded was the days to maturity. It range from 129.5 to 143 and 130.75 to 138.75 for Bobicho and Jewi on station, respectively (Table 1). Variety Arerti take the longest days to maturity at Bobicho as well as at Jewi whereas Variety Habru early maturing at both station. This variety mature nearly one and two weeks earlier than the rest late maturing varieties at Jewi and Bobicho which give it an advantage of escaping in the season characterized by the early termination of rains in the testing sites of southern region, Ethiopia

On farm:- The grain yield was significantly ($P < 0.05$) different in varieties tested in this experiment and the maximum grain yield (1358.85 kg) ha⁻¹ was recorded in variety Arerti, while Habru produced average grain yield of 1326.8 kg . On-farm trials showed similar trends (Table 2). The standard check elect gave lower yield 976 kg ha⁻¹. Overall yields were relatively lower on-farm as compared to on-station. Results from researcher's management and on-farm revealed significant differences ($P < 0.05$) among varieties. The high yielding and farmers preferred introduced varieties shows the possibility of replacing the traditional desi type chick pea variety in the area. Farmers normally adapt varieties that yield more than their locally adapted cultivars; and meet the preferred traits which differ from one community to another (Gowda *et al.*, 2000).

High yield and acceptable varieties characteristics have shown significant adoption which resulted to subsequent crop improvements elsewhere: finger millet (Gowda *et al.*, 2000; beans Assefa *et al.*, 2005) and rice (Gyawali *et al.*, 2007). In the present study show the yield advantage of 17 % was recorded (Table 2) between on-station and on-farm environments clearly indicates the inconsistent yields obtained by most farmers in Ethiopia as well as sub-Saharan Africa. These results are in agreement with Assefa *et al.*, 2005 in Ethiopia and Barron and Okwach (2005) findings in semi-arid Kenya who reported the yield advantage of 57.39% between on-station and on-farm environments were observed by most farmers in sub-Saharan Africa. The results indicate the need for site specific evaluation of new varieties for adaptation and adoption.

The average grain yield from the four on farm sites ranged 976 kg ha⁻¹ for the variety Dz-10-4 to 1358.9 kg ha⁻¹ for variety Arerti (Table 2). Habru and Arerti performed relatively better than others in all the villages. All the test varieties performed better in Gacheno village than in the rest study villages. This might be due to agro ecological suitability and better management by farmers as influenced by close supervision by the research team since the site is near to the Research center.

At Bobicho on farm, varieties Arerti, Habru and Chefe yielded significantly higher than the standard check and variety Dz-10-4 yielded significantly lower. The yield range from 902 to 122.9 kg ha⁻¹ for this site and showed similar trends observed in Jewi village, varieties Arerti, Habru and Shasho out yielded the standard check whereas the differences among them were not statistically significant.

Similarly, in Gacheno village, significant yield difference was observed between varieties Habru and Arerti and the rest of varieties. However the difference between Habru and Arerti was not statistically significant. These yields indicate that it is possible for farmers to obtain better yields with proper choice of varieties and improved

production packages.

Farmers' perception on the preference of the chick pea varieties

Farmers have their own selection criteria for new varieties which largely depend on the importance of the crop in the farming system and uses (Abebe *etal*, 2005). The ranking of chick pea varieties based on the perception of the farmers are presented in Table 3. Accordingly farmers ranked variety Habru followed by Arerti as the most preferred chick pea varieties. Farmers perceived ranked chick pea variety Habru number one as this variety produced large seed size, taste, earlier maturity, long pod length, pod number and high yield. Arerti was ranked the second among the five varieties. Farmers preferred the variety chefe thirdly as it produced attractive large seed size, Dz-10-4 was the lowest ranked because farmers don't appreciate its small seed size and low yield.

Conclusion

This study evaluated the yield performance and adaptability of chick pea varieties in Bobicho, Jewi, Offa and Gacheno districts south region, Ethiopia agro ecological environments for yield and yield components. The results show that Habru and Arerti differed significantly ($P < 0.05$) in their performance when compared to the other varieties especially Dz-10-4 that had the lowest values for all parameters assessed. Habru and Arerti had the highest yields over the others at on farm and on station trials. Observing the yield, researchers and farmer's perception, it can be concluded that Arerti and Habru are the best chick pea varieties which can improve the chick pea production and therefore should be promoted for cultivation to farmers in Wolayata and Hadiya Zones of the study districts and similar agro-ecological environments in Southern Ethiopia.

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Table 1. Mean number of pod per plant, hundred seed weight (gm), plant height (cm), days to flowering, days to maturity and grain yield (kg/ha) per kabuli chick pea varieties at Bobicho and Jewi station in 2004 meher season

Chick pea varieties	Yield(kg/ha)	Hsw(gm)	Plant height (cm)	Pod/plant	FD	MD
Bobicho on station						
Arerti	1643.8a	24.75c	42.250a	81.75a	60.0a	143.0a
Shasho	1407.3c	28.25b	39.750ab	61.75 c	57.5ab	140.0ab
Habru	1545.8b	29.5b	41.500ab	76.25ab	54.0b	129.5ab
Chefe	1322.92c	33.75a	39.000b	65.75bc	56.25ab	135.75ab
DZ-10-4	1139.58d	12.5d	38.750b	64.00bc	56.0ab	137.75b
Grand mean	1411.88	25.7	40.25	69.9	56.75	137.2
CV	4.13	4.29	4.56	5.56	5.21	2.93
LSD(0.05)	89.9	1.69	3	13.83	5.33	11.52
Jewi on station						
Chick pea varieties						
Arerti	1617.7a	24d	48a	77a	58.5a	138.75a
Shasho	1376.04b	26.25c	43.5bc	62.25b	52.5b	138a
Habru	1538.54a	29.25b	44.75ab	69.5ab	52.75b	130.75b
Chefe	1414.58b	33a	42.75bc	65b	52.75b	134.75ab
DZ-10-4	1101.04c	12e	41c	60.5b	53.5ab	136.75a
Grand mean	1409.58	24.9	44	67.45	54	135.6
CV	4.53	4.88	4.96	9.95	6.54	2.79
LSD (0.05)	98.39	1.87	3.36	10.34	5.44	5.83

Means within each column followed by the same letter are not significantly different at 5% as determined by Duncan's Multiple Range Test NB:-Hsw=Hundred seed weight, FD=Days to Flowering & MD=Days to maturity

Table 2. Mean grain yield (kg/ha) per kabuli chick pea varieties at Bobicho and Jewi on station and at Gacheno, Offa/Manchagogara, Bobicho and Jewi on farm in 2004 meher season

Chick pea varieties	Yield(kg/ha) of on station trials				Yield(kg/ha) of on farm trials					
	Bobicho	Jewi	Mean	Y.A	Gacheno	Offa	Bobicho	Jewi	Mean	Y.A
Arerti	1643.8a	1617.7a	1630.75	45.6%	1550a	1320.8a	1222.9a	1341.7a	1358.85	39.2%
Shasho	1407.3c	1376.04b	1391.67		1372.92c	1175b	997.9bc	1195.8ab	1185.41	
Habru	1545.8b	1538.54a	1542.17	37.7%	1510.42a	1322.9a	1203.13a	1270.9ab	1326.84	35.9%
Chefe	1322.92c	1414.58b	1368.75		1370.8b	1141.7b	1076.04ab	1162.5b	1187.76	
DZ-10-4	1139.58d	1101.04c	1120.31		1147.9c	918.75c	902.08c	935.4c	976.033	
G.m	1411.88	1409.58	1410.73	17%	1390.4	1175.8	1080.41	1181.3	1206.97	-
CV	4.13	4.53	-		6.08	7.24	9.45	8.04	-	
LSD (5%)	89.9	98.39	-		130.24	131.2	157.4	146.3	-	

Note:- G.m=Grand mean and Y.A=Yield advantage

Table 3. Ranking of five chick pea varieties based on farmers perception on various characters during 2004 meher season

Chick pea varieties	yield	Pod length	mat	ls	spp	ppo	gt	Total	Rank
Arerti	1	2	3	3	2	3	1	15	2
Shasho	3	4	4	3	3	2	3	22	3
Habru	1	1	1	1	2	2	2	10	1
Chefe	4	3	4	1	4	3	3	22	3
DZ-10-4	5	5	5	4	4	3	4	30	5

Key: yield=high yielding, pl=long pod length, mat=early maturity, ls=large seed size, spp=large seed number, ppo=large pod number per branch and gt-good taste -preference scale 1-5, Higher preferences=1, to lower preference=5

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