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Evaluation of Kabuli Chickpea Varieties for Adappting under Irrigation Production at Kobo, Ethiopia

Awol Mohammed, Abebe Misganaw, Sisay Bisetegn and Abay Desale
Sirinka Agricultural Research Center, P.O. Box 74, Woldia, Ethiopia

Abstract: The experiment was executed during 2019 – 2020 irrigation cropping season to evaluate adaptability and yield performance of kabuli type chickpea varieties with the involvement of farmers based on their preferences criteria. Ten improved varieties were laid out in RCB design with three replications for the mother trial and the baby trial, a single rep of mother trial, which was used for farmers' preference selections. Data on days to maturity, number of pods per plant, number of seeds per pod, number of branches, plant height, biomass, hundred seed weight and grain yield were collected and analyzed. The farmers evaluated and selected the varieties depending on their criteria's from the baby trial. The criteria's were grain productivity, earliness, seed size and free from any diseases. Farmers' selection was analyzed by Pair Wise and Matrix ranking method. The analysis of variance showed significant difference ($P<0.05$) for grain yield and most of traits. The result showed that variety Akuri was the best yielder with seed yield 2558kg/ha, followed by harbu (2300.5kg/ha) and Kobo (1922.5kg/ha), respectively. Grain yield was the first prioritized traits to farmers for selecting best adaptable chickpea variety under irrigation. Akuri was best variety based on ANOVA result and visually selected by the farmers as good for grain yield under irrigation followed by Harbu and Kobo. Therefore; based on researchers and farmers' perception Akuri and Harbu varieties will be recommended and pre-scale up for producing areas in the district and similar agro ecological zones under irrigation production system.

Keywords: Kabuli type chickpea, irrigation, Grain yield, Farmers' preferences.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is the third most important pulse crop in the world, after dry common bean and field pea (Padmavathiv, *et al*., 2013). India is the largest chickpea producing country accounting for 72 % of the global chickpea production (Ojiewo, 2016). Ethiopia is considered as one of the secondary centers of diversity for chickpea (van der Maesen, 1987). In Ethiopia, chickpea is the third largest legume crop in area and production next to faba bean and common bean (CSA, 2019).

There are two types of chickpea depending on seed color, shape, and size; *desi* and *kabuli*. According to Nigusie, *et al.*, (2017) the *kabuli* type has large, round or ram head and cream-colored seeds, and is grown in temperate regions. In Ethiopia, the kabuli type of chickpea covered 25% of the whole area coverage (Asnake, 2014). Mostly it produced based on as source of foreign currency or export purpose.

Chickpea is important for protein source and soil fertility improvement. It is also known as risk avoidance crop. Besides being an important source of human food and animal feed, it also plays an important contributor to soil fertility as it provides nitrogen to soil due to nitrogen fixation ability with help of bacteria (Gul, *et al.*, 2011). Ecologically, chickpea is known to be an efficient N_2-fixing crop due to its capability of symbiotic nitrogen fixation. Chickpea meets 80% of its nitrogen (N) requirement from symbiotic nitrogen fixation and can fix up to 140 kg N per ha from the atmosphere (ICRISAT, 2010).

In Ethiopia, chickpea produced by rain fed and irrigation production system. Ethiopia is one of the few African countries endowed with relatively abundant water resources, favorable climate and potentially huge irrigable land (Tilahun, *et al*., 2008). The country has potential suitable land and water resources for irrigation-based chickpea production surpasses many thousand hectares (Nigusie, *et al*., 2017). Most of irrigation potential areas in the country, farmers produce triple crops per season. Based on this, Kobo is one of the potential areas which have a high irrigation potential for crop production including chickpea.

According to Kobo Girana Valley Programe, in Kobo district there is more than 2100ha of land cultivated by farmers under irrigation. They produce triple crops per season, tef or maize – chickpea – onion. Not only regionally but also nationally, there is no a released chickpea variety for irrigation production system, especially kabuli type which can increase farmers income more than that of *desi* type. Due to this, farmers produce local chickpea variety which is low yielder (0.7 – 1t/ha) and fetch low income. To increase production and productivity of chickpea in this area under irrigation there is a need to recommend improved *kabuli* type chickpea variety. Therefore; the objective of this experiment was to evaluate and recommend best adaptable, high yielding and early

***Corresponding Author:** Awol Mohammed

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maturing of *kabuli* type chickpea varieties with the involvement of farmers based on their preferences for producing areas under irrigation production system in the district.

MATERIALS AND METHOD

Description of Experimental Site

The experiment was executed under irrigation production system at Kobo, which is located at $11^0$08'21", 39 18'21" and 1450masl latitude, longitude and altitude; respectively. The annual rainfall of the site is 637mm with 15.8^0c minimum and 29.1^0c maximum temperature. According to Sirinka Agricultural Research Center soil classification (unpublished), it is classified as *Eutric fluvisol.*

Experimental Materials and Methods

About 10 *kabuli* type improved chickpea varieties were evaluated for their adaptation and yield performance under irrigation during 2018 and 2019 at Kobo district. These varieties were improved and released by Sirinka and Debre Zeyt Agricultural Research Centers under rain fed condition. The experiment was done by Mother and Baby Trial form. The Mother trial was done by Random Complete Block Design with three replications. Each variety was sown in six rows at 40 cm, 10 cm and 1m spacing between, rows, plants and plots, respectively; with 4m row length. The Baby trial, a single replication of Mother Trial, was done on three different farmers' field to participate farmers to select best varieties based on their preferences. Totally 27 farmers who produce chickpea under irrigation participated variety selection process. All agronomic practices were done uniformly for all varieties as required without fertilizer application. For controlling pod borer, the insecticide *Karate at the rate of 200ml/300 lit of water* per hectare was applied at branching stage (two times within 15 days interval). The irrigation frequency was applied before sowing, at seedling, at branching and pod setting stage similar to Fitsume, *et al*., (2015).

Data Collection and Data Analyses

Agronomic data were collected from mother trial, which has three replications. The data of number of pods per plant, number of seeds per pod, hundred seed weight, plant height, biomass yield and grain yield were collected from harvestable plot area of mother trial. And biological data like biomass yield (kg/ha) and seed yield (kg/ha) were collected from harvestable plot area of mother trial. In addition to these disease data also scored. Farmers were participated the best variety selection process during 2020. Totally, 27 farmers who produce chickpea under irrigation participated variety selection process. Farmers' criteria to select best variety were grain productivity, earliness, seed size and free from any diseases. The ranking procedure was explained for participant farmers and each selection criteria was ranked from 1 to 5 (1= very good, 2= good, 3= average, 4= poor and 5= very poor). Then farmers were given the chance to rank each variety based on the attributes listed by them. The agronomic data were subjected to the analysis of variance (Gomez and Gomez, 1984) using Gen stat software eighteenth editions from mother trial. According to Ceccarelli (2012), two methods by which farmers can evaluate varieties in the PVS trials are the Pair wise ranking and the Matrix ranking method. The selection data were analyzed by Pair-Wise ranking method.

RESULTS

According to the analysis of variance (ANOVA) the variability between varieties showed significant difference ($P<0.05$) for number of pods per plant, hundred seed weight in gm., grain yield and biomass in kg per hectare in the results of the two years (Table 2 and 3). The analysis showed variety Akuri was the best yielder in both years with grain yield 2558kg/ha, followed by variety Harbu (2300.5kg/ha) (Table 3). The least grain yield scored by Dhera variety (840.5kg/ha). The influence of disease is minimal under irrigation production system (Nigusie, *et al*., 2017). The same result also occurred in this study, there was no any disease occurrence in both years trial (Table 2 and 3). In general, grain yield of chickpea under irrigation production is highly increased than rain fed production system. Similar to this study, increase in grain yield of chickpea under irrigation has been reported by many authors (Anwar, *et al*., 2003; Pacucci, *et al*., 2006; Kang, *et al*., 2008; Vinayak, *et al*., 2012 and Mansur, *et al*., (2010).

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Table 1: Mean performance of *kabuli* type chickpea varieties under irrigation at Kobo, 2019

Varieties	DM	PH	NPP	NSP	NB	BMKH	HSW	AGYKH
Kobo	98bcd	46.2	35.3a	1c	14.1	6859a	38.5a	1736cd
Akuri	94d	40	26.5b	1.1c	10.1	4899bc	35.3ab	2653a
Kassech	101abc	42.2	26.7b	1.14bc	12.1	4681bc	30.6bcd	1651cde
Yelbie	101abc	42.2	26.7b	1.14bc	12.1	4681bc	30.6bcd	1651cde
Teji	101abc	46.5	33.3a	1.1c	15.4	4595c	35.5ab	1988bc
Ejeri	102abc	42.8	34.1a	1.13	11.3	5341b	33.2abc	2234ab
Harbu	96cd	39.5	26.6b	1.13	7.7	5030bc	33.8abc	2462a
Chefe	101abc	39.5	17.8c	1.13	9.8	3785d	27.4cd	1026fg
Hora	106a	42.4	25.7b	1c	13.3	4757bc	27.9cd	1368def
Dhera	104ab	46.6	20.5c	1c	11.3	3630d	25.7e	722g
GM	101	42.2	26.8	1.14	12.1	4680.8	30.6	1650.5
DMRT 5%	*	ns	**	**	ns	**	**	**
CV%	5.3	8.0	9.0	8.4	10.7	17.8	11.6	15.9

Notes: DM= Days to maturity; PH= Plant height; NPP= Number of pods per plant; NSP= Number of seeds per pod; NB= Number of branches; BMKH= Biomass Kilo gram per hectare; HSW= Hundred seed weight; AGYKH= Adjusted grain yield kilo gram per hectare.

There was also a substantial difference between the varieties for hundred seed weight. The hundred seed weight of the varieties varied in both year's trial with range between 38.5gm for Kobo and 25.7gm for Dhera variety (Table 1 and 2).

Table 2: Mean performance of *kabuli* type chickpea varieties under irrigation at Kobo**,** 2020

Varieties	DM	PH	NPP	NSP	NB	BMKH	HSW	AGYKH
Kobo	85	51.1bc	43.2a	1.4	15ab	5620b	33.3a	2109b
Akuri	86	51.3bc	45.4a	1.6	13.5abc	6313a	29.2bc	2463a
Kassech	88	46.6bc	23.2bc	1.6	12.9bcd	3633e	30.7ab	1444cd
Yelbie	86	63.6a	43.2b	1.6	15.7a	4030d	27cd	1707c
Teji	90	47bc	24bc	1.6	8f	4400d	29.4bc	1524cd
Ejeri	90	51.1bc	18.6d	1.2	9.1ef	4968c	27.9cd	1348d
Harbu	88	54.6b	46a	1.4	14.8ab	5611b	26.5d	2139b
Chefe	88	44c	45.4a	1.2	11.5cde	4257d	27.1cd	1671c
Hora	92	45c	24bc	1.2	7.3f	3513e	26.4d	836e
Dhera	93	49.9bc	20.4cd	1	10.6de	3073f	29.4bc	959e
GM	88	50.3	31.5	1.4	11.8	4542	28.8	1619
DMRT 5%	Ns	*	**	Ns	**	**	*	**
CV	7.3	9.8	17.8	13	12.3	15.4	7.6	10.2

Notes: DF= Days to flowering; DM= Days to maturity; PH= Plant height; NPP= Number of pods per plant; NSP= Number of seeds per pod; NB= Number of branches; BMKH= Biomass Kilo gram per hectare; HSW= Hundred seed weight; AGYKH= Adjusted grain yield kilo gram per hectare

The maximum hundred seed weight for Kobo was 38.5gm followed by Teji (35.5gm) and Akuri (35.3gm) (Table 1). The days to maturity of the varieties were range 88 - 106 days, this indicate all varieties were early maturing.

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Table 3: Mean performance of *kabuli* type chickpea under irrigation in 2019 - 2020

Varieties	Mean Grain yield		
	2019	2020	Mean
Kobo	1736	2109	1922.5
Akuri	2653	2463	2558
Kassech	1651	1444	1547.5
Yelbie	1651	1707	1679
Teji	1988	1524	1756
Ejeri	2234	1348	1791
Harbu	2462	2139	2300.5
Chefe	1026	1671	1348.5
Hora	1368	836	1102
Dhera	722	959	840.5
GM	1650.5	1619	1634.75

Participatory variety selection (PVS) was also done as an option to increasing productivity and production in terms of users' preferences 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 (Mohammed A., *et al*., 2016). During 2019 trial season, Farmers participate to select best variety based on their criteria. Totally 27 farmers who produce chickpea under irrigation participated variety selection process. For chickpea variety selection farmers focused on the traits of grain productivity, earliness, seed size and free from any diseases (Table 4). All the criteria were set by farmers without contributing the researcher. According to Ceccarelli, (2012), two methods by which farmers can evaluate varieties in the PVS trials are the Pair wise ranking method and the Matrix ranking method.

Table 4: Pair-wise ranking of the criteria for *kabuli* type chickpea variety by farmers

Criteria	Prod	DR	ER	SS	Total	Rank
Productivity (Prod)	X	Prod	Prod	Prod	3	1st
Diseases Resistant (DR)		X	ER	SS	0	4th
Earliness (ER)			X	ER	2	2nd
Seed size (SS)				X	1	3rd

Notes: Prod= Productivity; DR= Disease Resistance; ER= Earliness; SS= Seed size.

The ranking procedure was explained for participant farmers and each selection criteria was ranked from 1 to 5 (1= very good, 2= good, 3= average, 4= poor and 5= very poor). Before selection process, farmers had given weight for their criteria. Based on this, grain yield productivity was the most prioritized farmers' criteria to select the best variety followed by seed color, earliness, seed size and disease free which had given 1, 2, 3, 4 and 5 weights; respectively (Table 4). Abebe, *et al.*, 2005 reported that farmers have their own selection criteria for new varieties which largely depend on the importance of the crop in the farming system and uses. Matrix ranking was used to assess farmers' opinion and perceptions on the varieties. According to Amhara Agricultural Research Institution unpublished Guideline for Participatory Varietal Selection, (2018), the variety which has the least rank index, the most desirable variety. The ranking of kabuli type chick pea varieties based on the perception of the farmers are presented in Table 5.

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Table 5: the selected *kabuli* type varieties' rank index based on farmers preferences /traits

Varieties	Traits with their weights				Total	Rank
	Prod (1)	DR (4)	ER (2)	SC (3)		
Kobo	7	31	8	19	65	3rd
Akuri	15	7	14	11	47	1st
Kassech	17	32	10	21	80	4th
Yelbie	32	29	19	14	94	7th
Teji	28	13	23	24	88	5th
Ejeri	35	26	28	22	111	6rd
Habru	9	10	7	30	56	2nd
Chefe	31	8	30	32	101	8th
Hora	22	18	34	17	91	10th
Dhera	23	21	32	26	102	9th

Notes: Prod= Productivity; DR= Disease Resistance; ER= Earliness; SS= Seed size.

As per the selection criteria set farmers ranked the overall preference ranking of varieties based on four criteria was in the order Akuri, Harbu, Kobo, Kassech, Teji, Ejeri, Yelbie, Chefe, Dhera and Hora; respectively. Farmers prefer varieties that meet multiple objectives; on chickpea (Yasin, G. and Mathios, A, 2016), on sorghum (Tulole, *et al.*, 2010); on ground nut (Tulole, *et al.*, 2008). That means that in this study Akuri (2558kg/ha), Harbu (2300.5kg/ha) and Kobo (1922.5kg/ha) best varieties under irrigation could be introduced and in the farming systems based on various subjective preference criteria. Farmers preferred the variety Kobo thirdly as it produced attractive seed size and grain yield.

CONCLUSION AND RECOMMENDATION

Ten improved *kabuli* type chickpea varieties were evaluated for yield and adaptation under irrigation at Kobo for two years. 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 *kabuli* type chickpea variety under irrigation. Akuri was best variety based on ANOVA result and visually selected by the farmers as good for grain yield under irrigation followed by Harbu and Kobo. This study also indicated that proper selection of varieties with improved management can increase farmers' income under irrigation. Therefore; based on researchers and farmers' perception Akuri and Harbu varieties will be recommended and pre-scale up for producing areas in the district and similar agro ecological zones under irrigation production system.

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