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Research Article

Evaluation of Desi Type Chickpea Varieties for Adapting under Irrigation at Kobo, Ethiopia

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ABSTRACT

The experiments were conducted during 2018 – 2019 irrigation cropping season to evaluate adaptability and yield performance of desi type chickpea varieties with the involvement of farmers based on their preferences. Ten improved varieties together with the local as (check) were laid out in RCB design with three replications for the mother trial and the baby 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, grain yield and disease data 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 color, 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 Minjar was the best yielder with seed yield 3349.9 kg/ha, followed by Dimtu (3218.9 kg/ha) and Mitik (2763.2 kg/ha), respectively. Grain yield was the first prioritized traits to farmers for selecting best adaptable chickpea variety under irrigation. Minjar was best variety based on ANOVA result and visually selected by the farmers as good for grain yield under irrigation followed by Kutaye and Mitik. Therefore; based on researchers and farmers' perception Minjar variety will be recommended and pre-scale up for producing areas in the district and similar agro ecological zones under irrigation production system.

Keywords: Desi type chickpea; Irrigation; Grain yield; Farmer's preferences

INTRODUCTION

Chickpea (*Cicerarietinum* L.) is one of the most important cool-season annual and self-pollinated leguminous plantwhich grown in more than 60 countries. India is the largest chickpea producing country accounting for 72% of the global chickpea production. The other major chickpea producing countries include Pakistan 5%, Iran 2%, Australia 6%, Turkey 4%, Myanmar 4%, Ethiopia 3.5%, Tanzania 1%, Mexico 2% and Malawi 0.5% . In Africa, chickpea is widely grown in Ethiopia, Tanzania, Malawi, Algeria, Morocco, Sudan, Tunisia and Uganda. Ethiopia is the largest producer, consumer and exporter of chickpea in Africa and shares some 4.5% of global chickpea market and more than 60% of Africa's global chickpea market [1,2].

There are two types of chickpea depending on seed color, shape, and size. The *kabuli* type has large, round or ram head and cream-colored seeds, and is grown in temperate regions. The *desi* type chickpea has a thick and colored seed coat. The common seed colors include various shades and combinations of brown, yellow, green and black. The seeds are generally small and angular with a rough surface. The flowers are generally pink and mostly grown in the semi-arid tropics. In Ethiopia, the *desi* type of chickpea covered 75% of the whole area coverage [3-5].

Chickpea is very important due to its good nutritional value having an average of 22 % protein, 63 % carbohydrate, 4.5 % fat, 8 % crude fiber, and 2.7 % ash. Besides being an important source of human food and animal feed, it is also an important contributor to soil fertility as it provides nitrogen to soil through fixation of atmospheric nitrogen [6,7].

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. The country has potential suitable land and water resources for irrigation-based chickpea production surpasses many thousand hectares. Most of irrigation potential areas in the country, farmers produce triple crops per season. Based on this, Kobo is one of the potential

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areas which havea high irrigation potential for crop production including chickpea [8,9].

According to Kobo Girana Valley Programe, in Kobo district there is more than 2100 ha 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. Due to this, farmers produce local chickpea variety which is low yielder (0.7–1 t/ha) and very susceptible to biotic and abiotic factors. To increase production and productivity of chickpea in this area under irrigation there is a need to recommend improved chickpea variety. Therefore; the objective of this experiment was to evaluate and recommend best adaptable, high yielding and early maturing of *desi* type chickpea varieties with the involvement of farmers based on their preferences for producing areas under irrigation production system in the district.

METHDOLOGY

Description of experimental site

The experiments were executed under irrigation production system at Kobo district in North Wollo Zone, which is located at 11^{0}08'21", 39 18'21" and 1450 masl latitude, longitude and altitude; respectively. The annual rainfall of the site is 637 mm with 15.8^{0}C minimum and 29.1°C maximum temperature. Agricultural Research Center soil classification (unpublished), it is classified as *Eutricfluvisol.*

Experimental materials and methods

About 10 *desi* type improved chickpea varieties, including the local variety as check, were evaluated for their adaptation and yield potential under irrigation during 2018 and 2019 at Kobo district. These varieties were improved and released by Sirinka and DebreZeyt 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 1 m 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). Egypt irrigates the crop 1-2 times during the early stage of crop emergence and during flowering and maturity, while in Sudan chickpea is irrigated 5-7 times. The irrigation frequency was applied before sowing, at seedling, at branching and pod setting stage [10].

Data collection and data analyses

Agronomic data were collected on plant and plot basis from mother trial, which has three replications. The data of number of pods per plant, number of seeds per pod, hundred seed weight (gm.) and Plant height (cm) were recorded from on randomly selected five plants from the middle four rows of each plot. 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 or traits to select best variety were grain productivity, earliness, seed color, 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 using Gen stat software eighteenth editions from mother trial. 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 [11,12].

RESULTS

According to the analysis of variance (ANOVA) and farmers selection criteria the best variety identified. The analysis of variance showed significant difference ($P<0.05$) for number of pods per plant, number of seeds per pod, hundred seed weight, grain yield and biomass in kg per hectare in the results of the two years. The analysis showed variety Minjarwas the best yielder in both years with grain yield 3349.9 kg/ha, followed by variety Dimtu (3218.9 kg/ha) and Mitik (2763.2 kg/ha). The least grain yield scored by Local (farmers') variety (1970 kg/ha). The yield advantage of Minjar and Dimtu over local variety was 70% and 63.4% respectively. The influence of disease is minimal under irrigation production system. But in this study, there was disease (Fusarium wilt) occurrence in 2019 trial due to this overall grain yield performance of the varieties during this year was very low compare to the results of in 2018. 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 (Table 1) [13-16].

There was also a substantial difference between the varieties for hundred seed weight. The hundred seedweight of the varieties varied in both year's trial with range between 31.7 gm for Dimtu and 10.7 for Local (farmers') variety.

The maximum hundred seed weight for Dimtu was 31.7 gm followed by Dalota (28.8 gm) and Teketay (25.9 gm) The days to maturity of the varieties were range 88 - 100 days, this indicate all varieties including farmers' variety were early maturing (Table 2).

Similarly, two irrigations at branching and pod formation stages were shown better seeds per pod and seed weight. Based on this, number of seeds per pod was significant difference between the varieties with the range of 2.1 (farmers' variety) – 1 (Dimtu). This result indicates the variety which has the lowest seed weight and size scored maximum number of seeds inside a pod (farmers' variety) whereas bold seeded variety scored almost a single seed in a pod (Table 3) [17,18].

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 ismuch faster than under the formal system, in which farmers are confronted with only a very restricted range of new cultivars [19]. During 2019 trial season, Farmers participate to select best variety based on their criteria. Totally 27 farmers who produce chickpea under irrigation

Table 1: Table 1 Mean Performance of *Desi* type Chickpea Varieties under irrigation.

Varieties	DM	PH	NPP	NSP	NB	BMKH	HSW	AGYKH
Minjar	94	44.7ab	56.3ab	1.3bc	14.1bcd	5904.8cd	17.2g	3804.7a
Natoli	99	44.8ab	37.7de	1.2cde	12.4d	5981b	25.4cd	2919.9abc
Mastewal	101	39bc	54.2abc	1e	16.6abc	4607.3de	22ef	2348.1cd
Fetenech	98	41ab	62.8a	1.1de	12.5d	5043.4cd	17.2g	2756.4bcd
Kutaye	96	38.7bc	56.1ab	1.8a	12.4d	4598.5de	16.8g	1936.2d
Mitik	100	41.5ab	27.4f	1.5b	13.7cd	5244.4cd	20f	2984.4abc
Teketay	99	47.4a	50.7bc	1.2bcd	17.9ab	4889.5cd	25.9c	2899.5abc
Dalota	99	43.3ab	44.5cd	1e	20.2a	5503.1bc	28.8b	2766.8bcd
Dimtu	98	44.1ab	55.1ab	1e	15.4bcd	6162b	31.7a	3620.7ab
Local	100	42.8ab	50.9bc	1.9a	17.6abc	7250.2a	10.7h	2405cd
GM	98	41.9	47.9	1.3	15.2	2768.7	21.7	2768.7
DMRT 5%	ns	*	**	**	*	**	**	**
CV	4.1	8.0	11.6	9.9	14.1	13.9	7.4	13.9

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.

Table 2: Performance of Desi type Chickpea Varieties under irrigation.

Varieties	DM	PH	NPP	NSP	NB	BMKH	HSW	AGYKH	FW (0-9)
Minjar	90cd	40	43bc	1.5cd	9.3d	5400b	18.5d	2895a	0.914ab
Natoli	93b	40.3	35c	1.3de	10.7d	4298cd	23.1c	1411f	0.724e
Mastewal	98a	43.2	55a	2ab	18a	6173.3a	17.2d	2041cd	0.740e
Fetenech	91bc	40.1	37c	1.3de	15.1abc	4440cd	17d	1856de	0.845bcd
Kutaye	92bc	40.4	37c	1.7bc	16ab	4440c	18.3d	2170c	0.778de
Mitik	88d	40	48ab	1.1e	12.8bcd	6013.3a	22.7c	2542b	0.813cde
Teketay	92bc	41.9	49ab	1.4de	15.1ab	3910ef	24.5bc	1693ef	0.857bcd
Dalota	92bc	48	48ab	1.5cd	12.1bcd	5813.3a	25.3b	2216c	0.799de
Dimtu	92bc	41.5	40bc	1.1e	10.8cd	4023de	28.1a	2817a	0.886bc
Local	90cd	42.2	56a	2.1a	12bcd	3646.7f	12.9e	1536f	0.954a
GM	91	41.7	44.7	1.5	13	4802	20.8	2117.8	0.833
DMRT 5%	*	Ns	*	**	*	**	**	**	*
CV	3.5	10.5	15.5	12.5	16.3	14.3	5.4	22.2	31.8

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; FW= Fusarium Wilt.

Table 3: Mean Performance of *Desi* type Chickpea under irrigation in 2019 – 2020.

Varieties	Mean Grain yield		
	2018	2019	Mean
Minjar	3804.7a	2895a	3349.9
Natoli	2919.9abc	1411f	2165.5
Mastewal	2348.1cd	2041cd	2194.6
Fetenech	2756.4bcd	1856de	2306.2
Kutaye	1936.2d	2170c	2053.1
Mitik	2984.4abc	2542b	2763.2
Teketay	2899.5abc	1693ef	2296.3
Dalota	2766.8bcd	2216c	2491.4
Dimtu	3620.7ab	2817a	3218.9
Local	2405cd	1536f	1970.5
GM	2768.7	2117.8	2443.3

participated variety selection process. For chickpea variety selection farmers focused on the traits of grain productivity, earliness, seed color, seed size and free from any diseases. All the criteria were set by farmers without contributing the researcher. Two methods by which farmers can evaluate varieties in the PVS trials are the Pair wise ranking method and the Matrix ranking method.

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. 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 Agricultural Research Institution unpublished Guideline for Participatory Varietal Selection, the variety which has the least rank index, the most desirable variety. The ranking of *desi* type chick pea varieties based on the perception of the farmers (Table 4).

As per the selection criteria set farmers ranked the overall preference ranking of varieties based on five criteria was in the order Minjar,

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

Criteria	Prod	DR	ER	SC	SS	Total	Rank
Productivity (Prod)	X	Prod	Prod	Prod	Prod	4	1st
Diseases Resistant (DR)		X	ER	SC	SS	0	5th
Earliness (ER)			X	SC	ER	2	3rd
Seed colour (SC)				X	SC	3	2nd
Seed size (SS)					X	1	4th

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

Kutaye, Mitik, Dimtu, Dalota, Teketay, Natoli, Fetenech, Local and Mastewal, respectively. Farmers prefer varieties that meet multiple objectives; on chickpea, on sorghum, on ground nut. This means that in present study Minjar (3349.9 kg/ha), Kutaye (2053.1 kg/ha)and Mitik (2763.2 kg/ha) best varieties under irrigation could easily be introduced and incorporated in the farming systems based on various subjective preference criteria. Farmers preferred the variety Mitik thirdly as it produced attractive seed color and grain yield, whereas Mastewal and local (farmers' variety) were ranked the lowest [20-24].

CONCLUSION AND RECOMMENDATION

Ten improved *desi* type chickpea varieties including local checks were tested for yield and adaptation under irrigation at Kobo district of North Wollo Zone 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 chickpea variety under irrigation. Minjarwasbest variety based on ANOVA result and visually selected by the farmers as good for grain yield under irrigation followed by Kutaye and Mitik. This study also indicated that proper selection of varieties with improved management can increase farmers' income under irrigation. Therefore; based on researchers and farmers' perceptionMinjar variety will be recommended and pre-scale up for producing areas in the districtand similar agro ecological zones under irrigation production system.

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