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Full Length Research Paper

Participatory evaluations of Faba bean (*Vicia faba l.*) Varieties in Enda Mekoni District, Northern Ethiopia

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Field experiment were conducted at Enda mekoni woreda (Mekan farmers training center), northern part of Ethiopia with the objective to assess and select faba bean varieties for high yield and other agronomic traits through involvement of farmer's participation during the main cropping season of 2014. Four released varieties with one local check were laid out in Randomized complete block design in three replications. The plot size of the trial was 4 m x 2.4 m with 40 cm between rows and 10 cm among plants. 1 m among plots and 1.5 m between replications maintained. Agronomic and farmer selection data were collected and analyzed. From all the tested varieties, variety Dosha was superior in grain yield (3891 kg ha^{-1}) followed by Tumsa (3437 kg ha^{-1}) variety. The lowest grain yield was obtained from Gora (2146 kg ha^{-1}) while Local variety yielded (2503 kg ha^{-1}). In case of farmer evaluation Dosha score higher mean value (4.67) followed by Tumsa (4.16) and least mean value was recorded from variety Gora (3.00) variety. Thus, based on farmer's evaluation and researcher's selection, Dosha and Tumsa varieties were found promising under Enda mekoni condition. Therefore, farmers to be found at the study district are recommended to use those varieties to raise faba bean production.

Key words: Faba bean, participatory varietal selection, Dosha, farmers training center, yield.

INTRODUCTION

Faba bean is a diploid (2*n* = 12 chromosomes) crop which is one of the most vital food legumes standing in the world fourth after garden pea, chickpeas and lentil. It is cultivated in the temperate and subtropical regions of the world (Torres *et al.,* 2006). The world's foremost producing countries for faba bean are China, Ethiopia, Egypt and the United Kingdom. Ethiopia is the leading producer of faba bean in Africa accounting for 56% of the production (FAOSTAT, 2014). It is one of the majority important cool-season food legumes grown in Ethiopia. Ethiopia is consider as the secondary center of diversity and also one of the nine major agro-geographical production regions of faba bean (Asfaw *et al.,* 1994). Giller (2001) reported that it is a worthy in protein supplement to cereals and other starchy root and tuber foods in the human nutrition, because of their high lysine and tryptophan contents, amino-acids in which cereals are shortfall.

Faba bean *(Vicia faba L.)* is among the most important pulse crop in the highlands and mid-highlands of Ethiopia. It was the first crop among the pulses grown in the country both in terms of area coverage and volume of annual production. Currently, they occupy about 443,107.88 hectares of land with an annual national production of 8,389,438.97 tones with an average yield of 1893 kg ha^{-1}. Faba beans, haricot beans (white), haricot beans (red), and chick peas were planted to 3.53 %, 1.00%, 1.57% and 1.91% of the grain crop area. The pro-

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duction obtained from faba beans, haricot beans(white), haricot beans (red) and chick peas was 3.10%, 0.75%, 1.15% and 1.70% of the grain production, in that order (CSA, 2015).

According to CSA (2015) the crop was widely cultivated in potential mid and high altitude areas of the country characterized with elevations of 1800-3000 meters above sea level and receiving average annual rainfall of 700-1100 mm. They grow in several eco-geographical regions of the country including Arsi and Bale highlands, Central highlands of Ethiopia (South-West, West and North Showa), Tigray, North and South Wollo, North and South Gondar, East and West part of Gojam, Wollega, Guji highlands, Hadiya, Sidama and Gamogofa.

Singh *et al.,* (2013) stated that as one of the top performing crops under global warming and climate change because of its distinctive capability to excel under most types of climatic situations and broad adaptability to a range of soil environments. It also good sources of currency to the farmers and generate foreign exchange to the country. In addition, it refills soil fertility as it fix considerable amounts of atmospheric nitrogen, thereby notably add to system sustainability in rotation with cereals. The crop has a multi-use and is consumed as dry seeds, green vegetable, or as processed food. Its products are a rich source of high quality protein in the human diet, while its dry seeds, green haulm and dry straw are used as animal nourishes (Sainte, 2011).

According to Ceccarelli (1996), there are quantities of significant reasons that distinguish the traditional on-farm adaptive research from the more participatory varietal selection approach. Traditional on-farm methods depend on released varieties but participatory variety selection comprises varieties irrespective whether they are non-recommended or non-released varieties or are at pre released stage if they satisfy farmers' criteria. Farmers greatly demanding better yielding varieties to increase their product, and get better the livelihood of their families. Participatory Varietal Selection (PVS) has been projected as an alternative to the problem of fitting the crop to a multitude of both target environments and users' preferences.

It is value mentioning that although farmer participation is often promoted on the basis of equity, there are sound scientific and practical motives for farmer involvement to increase the efficiency and the effectiveness of a breeding program (Ceccarelli and Grando, 2002).

In Ethiopia in spite of its enormous meaning, the productivity of faba bean is about 18 quha^{-1} still far below the crop's potential (>50 quha^{-1}) (FAOSTAT, 2014). Enda mekoni woreda is one of the production areas of faba bean in Ethiopia for green and dry seed. The production of faba bean is influenced by the lack of improved varieties, introduction of new varieties to the locality without conducting variety trial and the local varieties are vulnerable to certain biotic and abiotic factors. Therefore, growing of high yielding varieties of faba bean is key to guarantee the sustainability of the crop and food security. This can be attained by continuous pulse research to develop high yielding, pest resistance/tolerant, excellent in other agronomic traits, high quality, and widely adapted varieties that go with different cropping systems and farming conditions. Moreover, adequate seeds of released varieties should be made available to the farmers. Therefore, the present investigation was conducted with the objectives to evaluate and select faba bean varieties for high yield and other agronomic traits through farmer's participation in decision making during the selection process.

MATERIALS AND METHODS

Description of the study area

The study was conducted in northern Ethiopia, southern zone of Tigray regional state, Enda Mokoni district. Enda-Mokoni district is extends between 390 18' 10'' E to 390 39' 50'' E and 120 33' 20'' N to 120 55' 0'' N with an average altitude of 2250 meters above sea level at a road distance of 120 km from Mekelle, capital city of the Tigray region state. The area is characterized by bimodal rainfall pattern and receives a mean annual rainfall of 68.87 mm. The average minimum and maximum temperatures were 22.5 and 10.4 ^{0}C, respectively (Gidena, 2015)

Plant material and Planting

Faba bean cultivars namely Gora, Dosha, Hachalu, Tumsa and one local check were used in the trial. The seeds of the cultivars were collected from high land pulses coordinating center (Kulumsa Agricultural Research Center) in Ethiopia. Planting was done in June 2014 main cropping season. Recommended phosphorus fertilizer rate was added. Even though, the crop is nitrogen fixer in nature, starter dose of nitrogen fertilizer (Urea) was added to initiate nodulation process. Planting was done using seeds of faba bean at recommended rate per kilogram (kg) of seeds, in hills (2 seeds/hill) to guarantee the germination of the seeds on the two sides of the ridges. Thinning was practiced after emergence from sowing to secure one plants/hill. Weeding was done manually.

Experimental design

Randomized Complete Block Design (RCBD) with three replication was used in the trial. Plot size was arranged at 4 m (length) x 2.4 m (width). The plots consisted of six rows four of them sampling rows with inter and intra row spacing of 10 cm and 40 cm, respectively. 1 m and 1.5 m was maintained between plots and replications. The exp-

erimental field was managed as per the standard field plot techniques and standard agronomic practice.

Data collection

Agronomic data were collected on plot and plant basis. Plant height (cm), number of pods per plant, number of seeds per pod and hundred seed weight (g), were evaluated on five randomly taken plants from the middle four rows in each plot. Days to flowering, days to maturity, grain yield (g) of the middle four rows in each plot was measured and converted to kilogram per hectare for analysis. Farmers' evaluation and selection were on plot basis and parameters like ground cover, vigorsity, earliness, lodging, pod setting and free of disease were scored.

Farmer's Selection

Farmers evaluated and selected the varieties depending on their criteria's from the initial trial. The criteria's were Ground cover, Vigorsity, Earliness, Pod setting, Lodging and free from any diseases. The ranking procedure was explained for participant farmers and each selection criterion was ranked from 1 to 5 (1 = Very poor, 2 = Poor, 3 = Average, 4 = Good and 5 = Very good). Then farmers were given the chance to rank each variety based on the attributes listed by them. During selection process 24 farmers (11 females) had been incorporated so as to avoid gender bias.

Data Analysis

The collected data were subjected to GenStat 14 edition statistical software (Payne *et al,* 2011). Mean separation was carried out using Least Significant Difference (LSD) test at 5 % probability level (Steel and Torrie,1980). Farmer's selection data were analyzed using simple ranking method in accordance with the given value (De Boef and Thijssen, 2007).

RESULT AND DISCUSSION

Effect on Crop phenology and morphology

Days to flowering

Analysis of variance showed that there was significant difference ($p<0.001$) was observed among faba bean varieties in days to flowering. The local variety was early to flower (59.67 days) and Hachalu variety (64.00) the later. This result indicates that flowering is a genetic character of plants (Table 1). According to Wondimu (2016) flowering varies between (50 days) in local variety and (53.33 days, 55.67 days) for Dosha and Wayu varieties. Likewise Tewodros *et al,* (2015) and Tafere *et al,* (2012) reported similar results.

Days to maturity

The mean for days to maturity for tested variety ranged from 121.3 days (Dosha) to 131.7 days (Hachalu) showing highly significance difference ($P<0.05$) among the tested varieties (Table 2). Early maturing varieties complete their life cycle in relatively shorter period. Thus, early maturing varieties have advantage over the late maturity ones in environments where rain begins late and ends early. The finding of Ashanafi and Makuria (2015) reported that variety Wolki and Hachalu was took longer maturity date. Wondimu (2016) observed that there is a variation for days to maturity between varities of faba bean from 118.7 – 110 days.

Plant height

Statistical analysis showed that plant height had significantly ($P< 0.01$) affected by variety. The maximum plant height was recorded from Hachalu and Dosha varieties with a height of 120.7 cm and 110 cm respectively. Whereas, the shortest plant heights were recorded at Local and Tumsa varieties with 89.7 cm and 88.3 cm height, respectively (Table 2). The result was in line with the work of Awol *et al,* (2016) who reported that Hachalu verity was the longest and Tumsa scored shortest at Legambo site trial. Tafere *et al,* (2012) reported that plant height was significant affected by faba bean accessions.

Effect on Yield and yield components

Number of Pods per Plant

Number of pod per plant were significantly affected by varieties ($p<0.05$). Highest number of pods per plant was recorded from variety Dosha (18.00) and lowest pod per plant from variety Gora (11.67) and Hachalu (14.33) (Table 3). Ashanafi and Makuria (2015) also reported the significant difference among faba bean varieties in number of pod per plants. The maximum pods per plant were recorded from Degaga at both locations, whereas the smallest pods per plant were recorded at Tumsa and Hachalu varieties at Agarfa experimental site and Gebelcho variety at Sinana. In line with this finding Awol *et al,* (2016) and Tafere *et al,* (2012) stated that number of pods per plant was significantly affected by varieties.

Number of Seeds per Pod

Thousand Seed Weight

There were significant variations ($P<0.001$) in the values of 1000 seed weight shown by the faba bean varieties, indicating that the genetic variations among varieties. Of all tested varieties, Gora (823.3g) produced heaviest

Table 1. Faba bean varities character used during adaptation trials.

Variety	Breeding pedigree	Release year	Maturity days	Yield in research qu ha^{-1}
Dosha	COLL 155/00-3	2009	120 – 130	28 – 62
Tumsa	EH99051-3	2010	110 – 115	27 – 60
Hachalu	EH00102-4-1	2010	120 – 130	20 – 45
Gora	EK01024-1-2	2012	120 – 130	20 – 48
Local	Landrace	-	-	-

Table 2. Mean of faba bean varieties on phenology and morphology in Southern tigray.

Variety	DF	DM	PH (cm)
Dosha	58.00a	121.3a	110.0cd
Hachalu	64.00d	131.7c	120.7d
Tumsa	60.00b	126.0b	88.3a
Gora	61.00c	129.3bc	101.7bc
Local	59.67b	126.3b	89.7ab
LSD (5%)	0.48	3.8	12.5
CV (%)	0.4	1.6	6.5

Where, DF = Days to flowering, DM = Days to maturity, PH = Plant height, LSD= Least Significant Difference, CV = Coefficient of Variation.

Table 3 Mean of faba bean varieties on yield and yield related parameters in Southern tigray.

Variety	NPP	NSP	TSW (g)	GY (kg ha^{-1})
Dosha	18.00c	3.67	693.3a	3891d
Hachalu	14.33ab	3.00	727.7a	3271c
Tumsa	16.67bc	3.00	783.3b	3437c
Gora	11.67a	3.00	823.3b	2146a
Local	15.67bc	2.67	690.0a	2503b
LSD (5%)	2.96	1.03	42.67	250
CV (%)	10.4	17.9	3.1	4.3

Where, NPP = Number of pods per plant, NSP = Number of seeds per pod, TSW = Thousand seed weight, GY = Grain yield, LSD= Least Significant Difference, CV = Coefficient of Variation.

seed weight followed by Tumsa (783.3g), while, Dosha variety resulted the lowest 1000 seed weight followed by Local variety (Table 3). Tewodros *et al.* (2015) reported that Hundred seed weight ranged from the smallest local check which posses 48.509 g to the largest Hachalu variety which posses 90.08 g showing highly significance difference among the tasted varieties. The result was in line with the study of Ashenafi and Mekuria (2015), Tamane *et al*. (2014) who reported that the varieties evaluated in the study showed significant variation in test weight of the seeds.

Grain Yield

The statistical analysis shows that a significant ($P<0.001$) difference was observed on grain yield of faba bean varieties. The maximum grain yield was harvested from Dohsa variety which is (3891 kg ha^{-1}) followed by Tumsa (3437 kg ha^{-1}), while the smallest grain yield was recorded at the varieties of Gora (2146 kg ha^{-1}) followed by local variety with average grain yield of 2503 kg ha^{-1} (Table 3). Dosha variety had a yield advantage of 81% and 55.45% over Gora and Local varieties respectively.
The result was in line with Tewodros *et al.,* (2015) who reported that the highest yield were obtained on varieties Hachalu and Dosha which is 2429.5 and 2226.3 kg ha^{-1} respectively. Replacing of traditional varieties with improved ones led to gains of 18% in Egypt, 8% in Sudan and 42% in Ethiopia (ICARDA, 2008). According to Ashenafi and Mekuria (2015) Yields vary from 3703.7 – 4886.8 kg ha^{-1} and 3436.2 – 4701.6 kg ha^{-1} in Agarfa and Sinana trial sites respectively. Similar to the above findings

Table 4. Farmers preference criteria on faba bean variety selection.

Variety	Earliness	GC	Vigor	PS	Lodging	Disease	Total	Mean	Rank
Dosha	5	5	5	5	3	5	28	4.67	1
Hachalu	1	3	4	3	4	4	19	3.16	4
Tumsa	4	4	3	4	5	5	25	4.16	2
Gora	2	3	2	3	5	3	18	3.00	5
Local	5	4	3	3	5	3	23	3.83	3

Where, GC = Ground cover, PS = Pod setting, (1 = Very poor, 2 = Poor, 3 = Average, 4 = Good and 5 = Very good).

findings, Degife and Kiya (2016) and Tafere et al. (2012) stated that there were significant variations in the values of grain yield shown by the faba bean varieties.

Farmer's variety evaluation

Farmers being the end-users of agricultural technologies are the primary beneficiaries in a participatory variety selection program. The researchers benefit from the PVS process also in the form of a feedback that helps them to re-orient their research program to better meet farmers' needs. Selection was carried out at three different growth stages by organizing a field day at each stage i.e. at vegetative, flowering and physiological maturity. The evaluations mean score value for each variety ranged from 3.00 to 4.67 (Table 4). Dosha (4.67) scored the highest value followed by Tumsa variety (4.16) and the lowest was scored by Gora (3.00). The best varieties namely Dosha and Tumsa were selected as top ranking in all groups as final selections or adapted varieties. The same varieties had better performance and found to be promising from the analysis of researchers' collected data. In line to this finding Awol *et al,* (2016) and Tafere *et al,* (2012) stated that Dosha was the primary ranked variety by farmers selection.

CONCLUSION

Participatory variety selection was vital to evaluate and select new varieties is an advantage to exploit farmers indigenous knowledge of identifying adapted varieties that best meets their interest (Tafere *et al,* 2012). Dosha and Tumsa gave the highest grain yield and showed better performance in other agronomic traits than a local check in the present study. Thus, among the five tested varieties, these are found to be well adapted to Enda mekoni conditions in both the researcher's and farmer's selection criteria. Therefore, farmers to be found at the study district are recommended to use those varieties to raise faba bean production.

Conflict of Interest

The authors have not declared any conflict of interest.

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