



## Research Article

# On farm demonstration of faba bean (*Vicia faba L.*) varieties in orobanche infested areas of Ofla district, South Tigray, Ethiopia

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## Abstract

Faba bean variety demonstration was conducted at Adigollo kebele (Ofla district, South Tigray, Ethiopia in 2016 main cropping season to demonstrate the performance of the Orobanche tolerant faba bean variety. The tested materials were improved (Hashenge) and local faba bean varieties. The demonstration was conducted in six farmers' field that has plot size of 20 m by 20 m. Farmers were selected based on their interest to share their plot of land Farmers' perception was collected individually and in group discussion form to evaluate the yield and yield components of the varieties at maturity stage. Moreover, grain yield and orobanche count per plot was measured from each plot. Based on the biological data, Hashenge variety gave higher grain yield (3.54 t/ha) as compared with the local variety (1.14 t/ha). Accordingly, Hashenge variety has shown 201.5% grain yield advantage over the local variety. On the other hand, orobanche count per plot was taken from each farmer's plot. In this regard, the population of orobanche weed grown in the plots of Hashenge variety was lower as compared to the local variety grown plots (27.36 and 43.52 plants per m<sup>2</sup>, respectively). This shows more resistance to orobanche weed was recorded in the improved variety (Hashenge). Based on farmers' perception, the Hashenge variety has better yield and other yield component performance as compared to the local variety and it was appreciated by farmers for further popularization and scaling up/out. Therefore, the improved and orobanche tolerant faba bean variety should be scaled out not only to the southern zone of Tigray region but also to other orobanche infested areas (locations) of the country, like south Wollo and North Gonder of the Amhara region, Ethiopia.

## Introduction

Ethiopia is the largest producer of faba bean (*Vicia faba L.*) in Sub-Saharan Africa, and it is an important crop for smallholder farmers in the highlands of Ethiopia, which practice mixed crop-livestock farming. Faba bean is an important crop in the wheat/barley-based cropping systems of the Ethiopian highlands. It is the largest legume crop in terms of area and an important food and cash crop for many households. In 2012/13, about 4.4 million smallholder farmers planted 574,000 ha of faba bean producing 0.9 million tones at an average productivity of 1.6 tons per ha [1]. In rural areas, where diets are cereal based, faba bean is an extremely important source of household nutritional security as it is high in protein and is important in diversifying diets. Faba bean also helps to improve soil fertility

and soil health and sustain the productivity of barley and wheat through nitrogen fixation and when used as a rotational crop, it also helps reduce pest and weed infestations [2].

Crenate broomrape (*Orobanche crenata*) is occasionally known by the synonym *Orobanche speciosa*. This out-crossing species shows genetic diversity, but no clearly defined local races [3]. The parasite belongs to the class Dicotyledonae order Scrophulariales, and family Orobanchaceae. Orobanche is commonest in the Mediterranean countries, the Middle East and East Africa (Ethiopia), while other species have a wider distribution [4]. *O. crenata* is important in Ethiopia where it infests many legume crops, particularly faba bean, field pea, chickpea, lentil and dekoko (*Pisumsativum var. abyssinicum*) [5-7]. The distribution of the weed in Tigray region is increasing at alarming speed from some localized areas to almost throughout



the whole southern zone of the region [7,8]. In highly infested areas, farmers are avoiding growing food legume crops, resulting in substantial reductions to both the extent of cultivated areas and to food legume production. The parasitic weed *O. crenata*, though known to have been a problematic weed in parts of North Wello and neighboring areas in the Amahara region for quite some period, and has become a major pest of faba bean and field pea in the highlands of the southern zone of Tigray in the last two decades. The weed reduces the ability of the host plant to absorb water from the soil under moisture stress conditions, and causes drought stress and wilting of the host resulting in heavy yield loss. The effect is more pronounced in northern Ethiopia where moisture availability is limited. The total areas infested in Tigray region have been estimated more than 5000 ha in five districts. Faba bean yield losses due to this weed can reach up to 99.2 % in Tigray (unpublished data). Due to orobanche infestation measures that have been taken so far including chemical herbicide sprayings and manual weeding of *O. crenata* plants in the Tigray were not effective enough to reduce the parasitic weed population and curb further distribution of the weed and as a result it has become a major threat to faba bean production in the region and is colonizing previously un-infested neighboring districts. However, an integrated approach has to be devised to alleviate the problem that is challenging faba bean production.

Alamata Agricultural Research Center, in collaboration with ICARDA has been developed many faba bean technologies that include demonstration of orobanche tolerate faba bean variety and its management practices in southern zone of Tigray region. However, there are constraints that hinder faba bean production in the farmers of Ofla district (South Tigray, Ethiopia) which includes almost non faba bean variety that can tolerate the noxious orobanche weed except the only Hashenge variety which was developed by Alamata Agricultural research center. The variety consistently gave higher yield and lower broomrape count than local in the infested areas. Even though the problem of the orobanche weed in that areas has been serious for long times, there was no other activities carried out so far by other government and non government organizations to control or minimize this weed in the area. Therefore, it is quite important to conduct demonstration of the Hashenge variety to compared with the local variety in the orobanche infested areas of Ofla district, south Tigray, Ethiopia.

## Materials and methods

### Description of the study areas

Faba bean demonstration was carried out in the orobanche infested areas of Ofla district (Adigollo testing location), Southern Tigray during 2016 main growing season. Adigollo is located in Ofla district, south Tigray, Ethiopia which has an altitude of about 2446 meter above sea level. According to the 14 years data collected from Ofla district bureau of agriculture, the study area has maximum and minimum temperatures of 5.4 to 20.2°C, respectively (Ofla BoA, personal communication). Moreover, it is located 12° 31' N latitude and 39° 33' E longitude with its annual rainfall of about 833 mm [9]. The area represents highlands of South Tigray Zone with moderate rainfall (average

annual rainfall of 600 mm), which extends mostly from half of Jun to late- September and the dominant soil type is clay soil and slightly acidic with a pH of 6.167 [10] Table 1.

**Table 1:** Soil characteristics of the demonstration area.

pH	OM	OC	TN	C:N	P	CEC	EC	Soil Type
6.167	2.343	1.36	0.14	9.91	13.6	19.2	0.17	clay to clay loam

OM: organic matter (%); OC: Organic carbon (%); TN: Total Nitrogen (%); P: Phosphorus (ppm), CEC: Cation Exchange Capacity (cmol/kg) soil, EC: Electrical Conductivity (mS/cm)

## Treatments and design

The demonstration was conducted at Adigollo kebele of Ofla district, South Tigray in 2016 in six farmers' field using plot size of 20 m by 20 m and spacing of 40 cm between rows. Because this district is highly infested with orobanche weed that can reach up to 100% yield loss in local faba bean varieties [10]. In this research, the improved faba bean variety (Hashenge) that was released from Alamata agricultural research center and one local faba bean variety were used. About 6 farmers were selected based on their interest to share their plot of land and their perception was collected individually and in group discussion including other additional four farmers to evaluate the yield and yield components of the varieties at maturity stage. Moreover, grain yield and orobanche count per plot was measured from each variety.

## Results and discussion

### Performance of Faba bean varieties for their yield and yield components

Based on the biological data, Hashenge variety gave higher grain yield (3.54 t/ha) as compared with the local variety (1.14 t/ha). Accordingly, Hashenge variety has shown 201.5% grain yield advantage over the local variety. Even though there was yield variation among the faba bean growers of the varieties, the improved variety (Hashenge) has shown consistent grain yield performance over the local variety. This could be due to the advantage of improved management practices which include the advantage of chemical fertilizer and bio-fertilizer utilization, weeding, and more importantly, due to its tolerance to the parasitic weed (broomrape). Because different farmers had different field management or land preparation practices and soil related variation was also played the variations among farmers Figure 1.

On the other hand, Hashenge variety gave higher grain yield in the variety verification trials conducted prior to the demonstration trial. According to the Alamata Agricultural research center data [11], this variety has a yield potential that can yield more than 5 t/ha.

Orobanche count per plot was taken from each farmer's plot of the tested area (Table 2). In this regard, the population of orobanche weed in the Hashenge variety grown plots was lower as compared to the local variety grown plots. This shows more resistance to orobanche weed was recorded in the improved variety. In the field evaluations of yielding

components conducted by individual and group farmers, the varieties were rated and scored points as showed below (Table 3). Hence, farmers' response indicated that Hashenge variety scored highest result for its yield and yield components at field condition. In the farmers' discussion and interview, days to maturity (earliness), plant height, number of seeds per pod,



**Figure 1A,B:** Infestation level of Orobanche weed in the plots of local (A) and Improved (B) faba bean varieties at field condition.

**Table 2:** Mean grain yield and Orobanche number per hectare of faba bean varieties at Adigolo kebele.

Variety	GY (t/ha)	Orobanche number per m <sup>2</sup>	Remark
Hashenge	3.54	27.36	
Local	1.14	43.5	
S.E	8.35	98.81	

**Table 3:** Farmers' perception (score) on Hashenge variety compared to local variety at Adigollo kebele (Oflla district).

Variety attributes	Variety scores (0 to 10)	
	Local	Hashenge
Plant height	2	8
Number of Pods per plant	3	7
Tiller capacity	2	8
Water logging tolerance	3	7
Number of seeds per pod	4	6
Early maturing	6	4
Disease resistance/tolerance	3	7
Grain yield	2	8
Mean	3.44	6.55
S. D	1.58	1.58
T- value	4.15***	

NB: \*\*\* indicated significance level at 1% probability level

number of pods per plant, tiller capacity, disease reaction and grain yield estimation were the parameters.

### Perceptions of participant farmers towards Hashenge variety compared to the local

During group discussion and variety evaluation conducted in this trial, farmers were viewed the varieties in different parameters listed below.

Based on the farmers' perception, the Hashenge variety had better performance as compared to the local variety and selected for further popularization and scaling up/out. In the discussion, more farmers have highly preferred the improved variety for its higher grain yield, better tillering capacity, larger and export standard seed size as well as orobanche tolerance. In addition, as shown in the plant height score, the biomass of the improved variety was also highly appreciated by farmers of the group and it will be used as a means of minimizing the animal feed shortage.

### Opportunities and challenges to faba bean production in south tigray

**Opportunities:** The agro-ecology in the highland areas of south Tigray (Ethiopia) is very suitable for not only for faba bean but also for highland pulses in general. In the study district, farmers were stopped faba bean production since 1985 due to the sever problem of Orobanche weed and the finding of Alamata Agricultural research center that released the orobanche tolerant faba bean variety (Hashenge) plays an important solution for the faba bean producers existed for the last many years. More importantly, the local and export demand for faba bean crop increases from time to time and farmers are appreciated by the local government to produce this crop in large amount. In addition, since pulse crops in general plays in soil fertility enhancement and used as break crops for disease and insect pests, they are currently demanded by seed producing cooperatives at national level and individual farmers. However, the following challenges are greatly affecting faba bean production in South Tigray:

**Challenges:** Orobanche crenata is a species of broomrape, commonly known as bean broomrape. It is a common parasite of the faba bean (*Vicia faba*). It grows in the Mediterranean basin, and in North and East Africa [12]. It has no chlorophyll, and gets its carbohydrates from the host's phloem, and water and minerals from the host's xylem. In the demonstration areas, the detrimental effect of this weed in crop yield of the faba bean crop can reach up to 100% and causes total crop loss. In addition, the occurrence of other diseases of the faba bean crop such as faba bean gall, checolate spot and Ascochyta blight minimizes the tolerance of the crop to the invasive weed (*Orobanche crenata*) and causes higher yield reduction in the faba bean production areas of farmers. During this trial reductions in the faba bean biomass occurred in its vegetative and more importantly is in its reproductive organs. According to the farmers found in the study area, they perceived that the severity of the Orobanche weed increases when moisture shortage occurred not only in that specific year but also in the previous years.



A survey conducted in Ofla district has showed the adverse effect of the parasitic weed categorized as direct and indirect impacts. Among the indirect classes, reduce the fertility status of the soil and high disease pressure as the result of cereal based mono-cropping system, malnutrition of households, cost incurred for buying of legume grains and loss biodiversity these crops were the priority stated. Of the direct threats stated, it increased cost of production incurred for clearing the infested lands and force farmers to give up of the most profitable legume crops. Based on the faba bean growers of the area, the *Orobanche* infestation increases when they experienced repeated faba bean crop production year after year and this could be due to the weed seed bank enhancement in that specific soil bank. The repetition of faba bean crop production in the same field year after year comes from their fragmentation plots and less field size that they own. In this area, most farmers owned about half a hectare of land because of the high population in the highland area of the Ofla district [13-16].

Since Hashenge variety has better seed size 78.7 to 94 gram per 100 seed weight and attractive appearance, it will be appreciated to those growers who want to export their produce. Because, larger seed size (more than 80 gram per 100 seed weight) and attractive physical appearance of grain color can fulfilled the export standard. Therefore, this variety which has large seed size and good market look increases farmers' awareness to produce Hashenge faba bean variety instead of local varieties which have smaller seed size. Moreover, the demonstration trial has showed the importance of producing improved faba bean variety (Hashenge) due to its multipurpose advantages and the tolerance of this variety to the parasitic and noxious *Orobanche* weed.

## Conclusion and recommendations

In the demonstration time, Hashenge variety has showed higher grain yield and this variety has recorded a yield advantage of 201.5% over the local variety. The variety consistently gave higher yield and lower broomrape count than local variety across the demonstration areas conducted in different farmers' fields. The release of this variety further facilitates the application of integrated approach such as the use of herbicides that enhanced the tolerance or resistance level of the variety explained by higher yield and lower *Orobanche* population. Therefore, this variety is best option to continue the production of faba bean crop in the *oroobanche* infested areas of South Tigray and to enhance faba bean productivity. Hence, it is better to popularize and scaled out this *oroobanche* tolerant variety to areas where *oroobanche* infestation occurred. Moreover, this variety should also be scaled out to other *oroobanche* infested areas, such as southern Wollo and North Gonder zones of the Amhara region and needs an integrated approach with other stakeholders. Development of special seed system so as to ensure seed security and further distribution of the seed in *oroobanche* infested areas is also an important task with maximum care not to introduce the noxious parasitic weed to non infested areas.

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