

Registration of a Faba Bean variety named *Gora*

Tamene Temesgen* and Tadesse Sefera

Ethiopian Institute of Agricultural Research, Kulumsa Agricultural Research Center, P O Box, 489, Asella, Ethiopia

Abstract: *A faba bean (Vicia faba L.) variety named Gora* with the pedigree designation of EK01024-1-2 has been released by Kulumsa agricultural research center in Ethiopia. The variety is best adapted to altitudes ranging between 1900-to-2800 meters above sea level in the country. The variety was developed through hybridization between an adapted genotype 'EH91026-8-2' with bean pure line 'BPL44-1'. It has been tested at Kulumsa, Asassa, Bokoji, Koffale, Holetta, Adadi, Jeldu, Haramaya, Adet, Sinana and Shambu from 2009 to 2011 main cropping seasons. The variety is mainly characterized by a heavier seed (938 g/1000 seeds) than seeds any other faba bean varieties released to date in the country. The seed weight of this variety is 17% heavier than the seed weight of the variety used as the standard check. Based on most stability parameters, *Gora* showed relatively better grain yield performance and stability across a range of environments and years than the standard checks *Moti* and *Gebelcho*. This variety is moderately resistant to the major faba diseases such as chocolate spot and rust, and could be cultivated across a number of locations in the mid and high altitude areas of Ethiopia for increasing productivity of the crop.

Keywords: Disease resistance; Grain yield; National yield trail; Preliminary variety trial, Seed size; *Vicia faba L.*,

1. Introduction

Faba bean (*Vicia faba L.*) is the most important pulse crop in terms of both area coverage and volume of annual production in Ethiopia. Currently, it occupies about 574,061 hectares of land with an annual national production of 943,964.2 tons, with a productivity of 1.64 tons ha⁻¹ (CSA, 2013). Ethiopia is the first producer of faba bean in Africa and the second in the world next to the Peoples Republic of China (Mussa and Gemechu, 2006). The crop is mainly cultivated in mid and high altitude areas, with an elevation ranging from 1800-3000 meters above sea level (Mussa and Gemechu, 2006). The inception of faba bean breeding in Ethiopia was in the 1950's with the establishment of Arsi Rural Development Unit (ARDU) followed by Alemaya (now Haramaya) College of Agriculture. The main objectives of faba bean breeding in Ethiopia are to improve its productivity through developing and promoting improved cultivars with high and stable yield, and resistant/tolerant to major biotic and abiotic stresses (Gemechu *et al.*, 2006). A special focus has been given to improve grain yield, and diseases and water-logging resistance or tolerance. Very recently, considerable attention has been paid to develop large-seeded faba bean varieties to meet the demand of the export-market for seed quality since large-sized seeds are preferred by consumers in the local market and fetch premium prices in the international market.

2. Origin and Varietal Evaluation

The earlier adapted faba bean variety 'EH91026-8-2', which was selected from the last stage of variety trial, was crossed with bean pure line (BPL44-1) introduced from ICARDA. The crossing was done at Kulumsa Agricultural Research Center during 2001 cropping season. As faba bean is partially allogamous, screen houses were routinely used in the early generations, i.e., F₁, F₂, F₃ and F₄, of a breeding cycle to prevent bees from causing cross-pollination. During these phases, selection for traits with high heritability such as seed size, grain yielding ability, plant habit, time of flowering and resistance to major diseases such as chocolate spot and rust were undertaken. Thirty-six elite individual lines selected from the F₅ generation were promoted and evaluated for yielding ability, large seed size, disease reaction and stability at in a preliminary variety trial (PVT) conducted during the 2008 cropping season at multi-locations. From this trial, 14 promising genotypes were promoted and evaluated in a national yield trial (NVT) along with two recently released standard checks '*Moti* and *Gebelcho*' at multi-locations. The locations where the trials were conducted included Kulumsa, Asassa, Bokoji, Koffale, Holetta, Adadi, Jeldu, Haramaya, Adet, Sinana and Shambu from 2009 to 2011 main cropping seasons. The trials were replicated four times per location. Finally, EK01024-1-2 and EK01001-5-1 were selected as the most promising candidate varieties and evaluated along with two best standard checks on 10 m x 10 m plots by the national variety release technical committee at 7

*Corresponding author. E-mail: tt.tolassa@gmail.com

locations, each one on-station and two on-farm fields during the 2012 cropping season. Eventually, EK01024-1-2 was recommended for commercial production and named *Gora*.

3. Varietal Characteristics

The newly released faba bean variety '*Gora*' is characterized by an indeterminate growth habit. Its flower color is white with black spots. The seed coat and cotyledon colors are pale green and ceramic, respectively. The average number of days required by the variety to reach its 50% flowering and 95% physiological maturity were 59 and 139, respectively, with the average plant height being 131 cm (Table 1). The average number of pods per plant is 10.3 (Table 1). The appropriate planting date for this variety would range from early June to early July. For a better harvest,

the variety must receive 46 kg P₂O₅ ha⁻¹ and 18 kg ha⁻¹ N at sowing.

4. Yield and Quality Performance

The released variety '*Gora*' is mainly characterized by a heavier seed than the seeds of other hitherto released faba bean varieties in the country, which averages 938 g per 1000 seeds. The seed of this newly released variety has weight advantages of 17% and 15% over the standard checks *Moti* and *Gebelcho*, respectively. In addition to its seed size advantage, the average grain yield of the newly released variety, combined over locations and years, exceeded the average yield of *Moti* by 4.3% and that of *Gebelcho* by 10.7% (Table 1). The data on quality traits indicated in Table 1 show that the released variety '*Gora*' has a comparable quality with those of the standard checks.

Table 1. Mean grain yield, agronomic traits, quality parameters and disease reaction of '*Gora*' among two standard checks tested in 16 environments during 2009/2010-2011/2012 cropping seasons.

ENTRY	Agronomic traits				TSW (g)	Grain yield (kg/ha)	Disease reaction		Quality parameters	
	DTF	DTM	PHT (cm)	NPPP			ChS	Rust	ACP (%)	Soak-ability (%)
Moti (Check-1)	58	137	132	12.16	801	3657	30.0	27.7	22	90.2
Gebelcho (Check-2)	61	140	130	11.15	814	3447	28.5	25.8	23	83.0
Gora (EK01024-1-2)	59	139	131	10.28	938	3815	28.6	26.7	24	92.0

DTF = Days to 50% flowering; DTM = Days to 95% physiological maturity; PHT = Plant height; NPPP = Number of pods per plant; TSW = 1000 seed weight; ChS = Chocolate spot; ACP = Average crude protein.

5. Performance Stability and Adaptation Domain

The variety '*Gora*' was released for the mid-to-high altitude agro-ecologies of the country receiving 700-to-1100 mm average annual rainfall. It is well adapted to an altitude range of 1900 to 2800 meters above sea level such as Kulumsa, Holleta, Bokeji, Asassa, Jeldu, Kofele, Sinana, Adet, Haramaya and similar agro-ecologies. Based on most stability parameters, '*Gora*' showed relatively better performance stability across a range of environments. Most of the univariate parametric methods such as b_i , S^2d_i , a , λ , P_i , ASV , and the non-parametric method RS were identified '*Gora*' as the most desirable genotype (Table 2). According to Lin *et al.*, (1986), both Francis and Kannenberg's (1978) coefficient of variability (CV) and environmental variance (EV), and those methods which measure

phenotypic stability based on the amount of sum of squares contributed by each genotype into the interaction effect, for example, P^{sp} , σ_i^2 and W_i are classified into Type I stability concepts. Genotypic stability according to these parameters is heritable and its genetic mode is additive and consistent. Though having both high yield and Type I stability concept occurs rarely in multi-location trials (Karimzadeh *et al.*, 2012), it was evident that this faba bean variety demonstrated smaller values for these stability methods and was identified as the most stable genotype possessing Type I stability concept (Table 2). Furthermore, based on the stratified ranking technique of Fox *et al.* (1990) of the top three ($FT3$) parameters, *Gora* is a top yielding genotype which was ranked in the top third of the entries in 61.5% of the test environments (Table 2).

Table 2. Parametric and non-parametric stability statistics of ‘Gora’ variety among two standard checks tested across 16 environments during 2009/2010 – 2011/2012 cropping seasons.

Varieties	Parametric and non-parametric stability methods												
	Bi	S ² di	Wi	CVi	EV	σ ²	α	λ	Pi	ASV	P ⁵⁹	FT3	RS
Moti (Check-1)	1.12	0.12	2.41	29.54	1.25	0.22	0.13	2.25	0.19	0.99	0.17	61.54	18
Gebelcho (Check-2)	1.13	0.06	1.84	29.9	1.21	0.17	0.13	1.68	0.17	<u>0.47</u>	0.14	46.15	19
Gora (EK01024-1-2)	<u>1.03</u>	<u>0.01</u>	<u>1.09</u>	<u>25.49</u>	<u>0.98</u>	<u>0.10</u>	<u>0.03</u>	<u>1.09</u>	<u>0.11</u>	0.56	<u>0.11</u>	<u>61.54</u>	<u>8</u>

Bi = Regression coefficient; S²di = deviation from regression; Wi = Wricks’s ecoalance; σ² = Shukla’s stability variance; CVi = Coefficient of variation; EV = Environmental variance; α and λ = Tai’s alpha and lambda; P⁵⁹ = Plaisted and Peterson’s stability parameter; Pi = Lin and Binn’s superiority index; ASV = AMMI Stability Value; RS = Kang’s rank sum; FT3 = Number of sites at which the genotype occurred in the top third of the ranks. Underlined are the most stable.

6. Reaction to Major Diseases

Developing resistant or tolerant varieties to major diseases such as chocolate spot (*Botrytis fabae*) and rust (*Uromyces viciae-fabae*) is among the major objectives of the national faba bean breeding program. Chocolate spot and rust scores based on (1-9) scale were converted to pre-transformed percentage values, which were then used to determine the reaction of the released variety ‘Gora’ to major diseases (Little and Hills, 1978). Accordingly, the released variety ‘Gora’ showed an average reaction of 28.6 and 26.7% for chocolate spot and rust, respectively (Table 1), and is characterized as moderately resistant to these major diseases.

7. Variety Maintenance

The breeder and foundation seed will be maintained by Kulumsa Agricultural Research Center.

8. Conclusion

Grain yield is the primary trait of interest and a prime objective in faba bean breeding programs for many decades. However, also seed size has received a special attention recently. This is also what is happening at international and national levels in response to the current move to meet the export-market demand for seed quality particularly for the development of large-sized seeds that fetch high prices in the world market. Regardless of this, only few varieties that combine both high yield with large seed sizes have been released since the inception of faba bean breeding program in the country. The current variety, *Gora*, has almost 80% and 15% seed size advantages over the widely cultivated small seeded faba bean varieties, *Degaga* and *CS20DK*, and the large-seeded variety *Gebelcho* with comparable seed yield productivity, respectively. Therefore, wide cultivation of *Gora* variety will boost productivity and marketability of the crop and improve farmers’ income.

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