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Original article

Registration of “Robera” a newly released food barley (*Hordeum vulgare L.*) variety for highland altitude areas of Ethiopia

Tamene Mideksa*, Kasahun Tadese, Hiwot Sabsibe

Oromia Agricultural Research Institute, Sinana Agricultural Research Center, P.O.Box: 208, Bale-Robe, Ethiopia.

*Corresponding author; Oromia Agricultural Research Institute, Sinana Agricultural Research Center, P.O.Box: 208, Bale-Robe, Ethiopia.

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ABSTRACT

Six-rowed food barley, Robera (ACC.218956) was developed by Sinana Agricultural Research Center (SARC), Southeastern Oromia region, Ethiopia. The variety was selected from landrace line collection and released in 2016 for high altitude areas. This variety tested for two consecutive years (2013-2014) at 3 environments and proved its superiority in grain yield performance, stability and wide adaptation. This variety is characterized by early maturity, white seed color, has good physical grain quality, resistance to leaf rust and scald, moderate resistance to net blotch, moderate tolerance to barley shoot fly, lodging tolerance and good biomass yield. The variety's demonstration and seed multiplication is underway. Therefore, cultivation of the new variety in the higher altitude areas of major barley growing environments of the country is highly recommended.

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1. Introduction

Barley (*Hordeum vulgare L.*) is one of the most important staple food crops in the high lands of Ethiopia (ICARDA, 2002). Ethiopia is considered as center of diversity (Asfaw, 2000). In Ethiopia, barley is the fifth important cereal crop next to Tef, Maize, Sorghum and Wheat in total area coverage of 993, 918.89 hectares and total annual production of about 1.9 million tons in main season (CSA, 2015). In Bale, it is the second major cereal crop next to wheat (CSA, 2002). Barley can be cultivated at altitudes between 1500 and 3500m, but predominantly grown

between altitudes of 2000 to 3000m above sea level and it is cultivated in every region of the country. In Ethiopia, barley is mainly produced for human consumption, malt and animal feed (Bekele et al., 2005; Horsley and Hochhalter, 2004; Vimal and Vishwakarma, 1998). Furthermore, it also provides useful material for thatching roofs of house (Bekele et al., 2005). However, the national average yield is low (1.2ha^{-1}) (CSA, 2005) as compared to other countries. Thus, the fast growing population of the country requires crop yield increase. The most important biotic and abiotic factors that reduce yield of barley in Ethiopia are poor yielding varieties, insects, diseases, poor soil fertility, water logging, and soil acidity and weed competition (Bekele et al., 2005; Berhane et al., 1996; ICARDA, 2002). Among these, lack of improved barley variety and barley shoot fly have been an important constraints in Bale highlands for many years that reduce the yielding potential of barley varieties in the area. Improved varieties have shown highly susceptible to shoot fly. As a result of this, many barley varieties were unable to adapt to this condition except the local, Aruso. Aruso is early maturing and tolerant to shoot fly, but it is susceptible to lodging and low yielder. Therefore, to develop resistant barley varieties with better agronomic traits, barley breeding program of Sinana has been conducting research by using different breeding approaches.

2. Materials and methods

2.1. Testing location and season

The experiment was carried out at three locations for consecutive two years during main cropping season. One of the experiment was conducted at Sinana Agricultural Research center (SARC) site (on-station) and the other two sites on the farmer's field (Robe and Dinsho). The experiment was conducted for only two years at these sites (2013 to 2014) on vertisol clay loam soil under rain fed conditions during main cropping season (August to December). Sinana Agricultural research center is located at $07^{\circ}07' \text{N}$ and $40^{\circ}10' \text{E}$ in Bale zone, Southeastern Ethiopia, 463 km far away from Addis Ababa and 33 km east of Robe town at altitude of 2400 meters above sea level. The other location is located 63 km from Sinana and about 20 km from Robe in the southwest direction. Basically, barley is the most important food crops for people living in the highlands of the region because of its early maturity or drought tolerance, barley serves to relieve food shortage in the highlands during the long rainy season. The suitability of the region for barley production, it is expected that the test genotypes would express their genetic potential to a higher extent for the traits under consideration.

The new variety was released after it has been evaluated at different testing environments for subsequent years. In the yield trials about 15 genotypes, including the standard check and the local check was evaluated using randomized complete block design at three locations for two consecutive years. During this time agronomic data such as days to heading, days to maturity, plant height, stand percentage, thousand kernel weight, and grain yield/plot was collected on plot basis. The collected data subjected to analysis to select the best performing genotypes as compared to the checks. These 15 genotypes were evaluated at multi-location for two years on verti-clay loam soil to express its stability across location. The genotypes in the multi-location trial were evaluated with three replications. Fertilizer at the rate of 41/46 N/P₂O₅ kg/ha was applied and hand weeding was done twice. Agronomic parameters were collected and analyzed in order to select best genotypes out of the tested genotypes. Finally, Robera (ACC.218956) was selected and verified along with one standard check and local check. The verification trial was evaluated by the National variety releasing committee at field condition and was released fully for the highlands of Bale and similar agro-ecologies.

3. Results and discussion

3.1. Varietal characters

Robera has medium plant height, early maturity and has better tolerance to barley shoot fly and moderate tolerance to common leaf diseases (Table 1). This new variety has a better yield advantage as compared to standard check and local check. On average this variety needs 65.41days for heading and 117.04 days to reach physiological maturity (Table 1 and 2). It has plant height of 97.56 and has white seed color. The average weight of thousand kernels is 36.23 gram (Table 1).

3.2. Yield performance

The average grain yield of Robera combined over locations and over years is 2.64 t/ha which is higher than Abdane (standard check) (2.24 t/ha) and the local check (2.40 t/ha) (Table 2). The variety gives grain yield of 2.9 to 4.2 t/ha on the research field, whereas it gives 2.4 to 3.1 t/ha on a farmer's field. This variety has yield advantage of 17.5% and 10% over the standard and local checks, respectively (Table 2).

3.3. Reaction to diseases

Besides, the yield potential performance, the candidate (Acc. 218956) variety demonstrated moderate tolerance to common leaf diseases (Table 1 and 2). The resistance level of the new variety was better than the standard and the local checks for scald and leaf rust and comparable for net blotch and shoot fly. The diseases score for the variety and the checks are summarized in Table 1 and 2.

3.4. Adaptation

Robera is released for the highlands of Bale and similar agro-ecologies. It performs very well in area having an altitude of 2300 to 2600 m a.s.l and annual rainfall of 750 to 1000 mm. This variety gives a better grain yield if it is produced with recommended fertilizer rate of 100 DAP kg/ha only and seed rate of 125 kg/ha in clay-loam soil. For better performance of the variety it is better if planting is done from the mid July to mid-August in Meher and to the end March during belg season.

3.5. Variety maintenance

Breeder and pre-basic seed of the variety is maintained by Sinana Agricultural Research Center.

Table 1

Mean of grain yield, other agronomic traits, insect and disease reaction of Robera and the checks in multi-location test during 2013-2014.

Entry	DH	DM	PH (cm)	ST (%)	TKW (g)	HLW (kg/ha)	Gy (t/ha)	NB (00-99)	LR (%)	SR (%)	SC (1-5)	BSF	
												Inf.	Dead plant
Acc.218956#25	65.41	117.04	97.56	82.78	36.23	62.7	2.638	84	trms	trms	0	4.83	0.33
Abdane (St. check)	65.48	117.63	100.89	82.78	34.6	62.5	2.244	85	10ms	5ms	0	4.33	1.83
Aruso (Local check)	63.74	117.04	97.83	79.07	37.13	63.85	2.402	86	5s	10s	0	5.5	2
Mean	64.87	117.24	98.76	81.54	35.98	63.02	2.428	85				4.88	1.38

DH=Days of heading, DM= Days of maturity, PH= Plant height, ST= Stand percent, Tkw= Thousand kernel weight, HLW= Hectoliter, Gy= Grain yield, NB= Net blotch, LR= Leaf rust, SR=Stem rust, SC=Scald, BSF= Barley shoot fly, Inf. = Infestation.

Table 2

Combined mean grain yield and other agronomic traits of food barley regional variety trail over years (2013-2014) and over locations (Sinana, Dinsho and Robe).

SN	Genotypes	DH	DM	PH (cm)	ST (%)	TKW (g)	HLW (kg/ha)	Gy (t/ha)	NB (00-99)	LR (%)	SR (%)	SC (1-5)	Inf.	Dead plant
1	ACC.22071#41	66	117.81	102.04	85.74	41.38	65.1	2392	84	20s	Trms	1	3	0.3
2	ACC.228441#82	64.59	116.48	100.26	82.41	41.92	63.45	2058	83	Trms	Trms	1	4.7	0.3
3	ACC.1300#67	66.15	116.96	99.56	85.07	32.85	59.9	2187	86	15s	Trms	2	3.3	1
4	ACC.1289#90	69.63	116.44	101.19	85.37	31.62	58.1	1977	86	15s	5s	2	5.8	1.8
5	Aruso x hb-42/2010-(1)	64.52	117.3	98.96	84.26	36.06	61.05	2213	86	10s	Trms	1	4.7	1.7
6	Aruso x 27 th IBON84/99/2010-(2)	64.78	117.41	98.96	83.26	34.57	60.82	2594	85	15s	10ms	0	3.7	1.2
7	27 th IBON133/99 x Arso/2010-(3)	63.93	117.22	96.81	83.15	34.8	60.67	2719	85	Trms	5ms	0	4.7	1.8
8	ACC.218956#25	65.41	117.04	97.56	82.78	36.23	62.7	2638	84	Trms	Trms	0	4.8	0.3
9	IBCBS76/6	65.59	118.93	91.63	82.96	36.12	62.1	2653	84	20s	Trms	3	5.7	2.8
10	EMBSN 9339/06	64.93	122.26	84.65	77.22	34.01	59.5	2357	87	5s	5s	2	5.5	2.5
11	MELKASA N 81/06	68.81	124.56	92.41	76.85	36.24	61	2288	86	10ms	10s	0	7.8	2.5
12	ACC#3251	73.48	123.81	102.93	82.04	38.16	61.35	2384	88	10s	5ms	1	6.3	2.3
13	Biftu	65.11	118.85	99.87	84.37	36.19	62.9	2498	86	10ms	20s	1	5.2	1
14	Abdane	65.48	117.63	100.89	82.78	34.6	62.5	2244	85	10ms	5ms	0	4.3	2
15	Aruso	63.74	117.04	97.83	79.07	37.13	63.85	2402	86	10s	5s	0	5.5	1.8
	Mean	66.14	118.65	97.70	82.49	36.13	61.67	2373						
	CV	3.9	3	8.3	9.6	8.7		28.4						
	Lsd	4.12	5.67	12.98	12.69	5.06		1082						

DH=Days of heading, DM= Days of maturity, PH= Plant height, ST= Stand percent, Tkw= Thousand kernel weight, HLW= Hectoliter, Gy= Grain yield, NB= Net blotch, LR= Leaf rust, SR=Stem rust, SC=Scald, BSF= Barley shoot fly, Inf. = Infestation, CV=Coefficient variation and LSD=Least significant difference.

4. Conclusion

Robera is the best variety identified and verified along with standard check and local check in multi-location trials across the testing environments with superior in grain yield performance and yield stability. It has better agronomic performance with moderate tolerance to leaf diseases as compared to the standard checks. Hence, cultivation of the new variety is recommended in major barley growing areas of the country having similar agro-ecologies with the testing sites.

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Appendix I. Description of variety Robera

1. Variety: Robera (ACC.218956#25)
2. Agronomic and morphological characteristics
 - 2.1. Adaptation area: Altitude (m. a.s.l): 2300-2600m, Rainfall (mm): 750-1000
 - 2.2. Seed rate (kg/ha): 125
 - 2.3. Planting date: Mid July to early August
 - 2.4. Fertilizer rate (kg/ha): 100 DAP only
 - 2.5. Days to heading: 65.41
 - 2.6. Days to maturity: 117.04
 - 2.7. Plant height (cm): 97.56
 - 2.8. Growth habit: Erect
 - 2.9. 1000 seed weight (g): 36.23
 - 2.10. Test weight (kg/hl): 63
 - 2.11. Seed color: White
 - 2.12. Row type: Six
 - 2.13. Crop pest reaction: Resistance to disease and shoot fly
 - 2.14. Grain yield (t/ha): Research field, Farmers' field.

- 2.15. Year of release: 2016
2.16. Breeder/Maintainer: SARC/OARI

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