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Registration of Hora, Small-red Seed Food Type Common Bean (*Phaseolus vulgaris*) Varieties for Midland Areas of Bale and East Bale, Southeast Ethiopia

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Abstract: Ethiopia has suitable environmental condition for common bean production. However, the productivity of common bean is very low as compared with world average due to lack of stable, high yielding, and disease resistant genotypes. Therefore, the objective of this study was to register stable high yielding and disease resistant/tolerant common bean variety for midlands areas of Bale and other similar agro-ecologies in the country. The experiment was carried out at two locations from 2015 to 2017 main cropping season using 15 genotypes including standard checks. Eventually, two promising genotypes, "SCR-28 and SCR-8" were selected and promoted to variety verification trail with the standard check ''SCR 1 and Nasir" during the 2020/21 cropping season. The National Variety Release Technical Committee evaluated the two candidate varieties at Goro and Ginner on research stations and farmers' fields. Among the two evaluated varieties, SRC-28, 'Hora', is well adapted to altitudes ranging between 1600 and 1950 meters above sea level and gave high seed yield (1587 kg ha^{-1}) and stable performance across years and locations. It has about 29.3% yield advantage over the standard check variety, "Nasir". Hora is also resistant/ Tolerant level of reactions to Alternaria Leaf Spot, Common Bacteria Blight and Rust. Hence, Hora is released for Midland Areas of Bale, East Bale and similar agro-ecologies for its stable, high grain yield and resistant to major diseases. Therefore, farmers could be cultivated Hora for increasing productivity of the crop with its full recommended packages.

Keywords: Disease Resistance, Grain Yield, Hora, Phaseolus Vulgaris, Stability

1. Introduction

Common beans (*Phaseolus vulgaris* L) are annual pulse crop with considerable variation in habit, vegetation characters, flower color and the size, shape of pods and seeds [8, 12]. Beans need up to four months of warm weather and are not frost tolerant. They do poorly in very wet or humid tropical climates because of susceptibility to bacterial and fungal diseases. They need well-drained soils with a pH between 6.5 and 7.0 and are sensitive to deficiencies or high levels of minerals in the soil [1].

The common bean is the most important source of proteins for nearly five hundred million people in Africa, Latin America and the Caribbean (LAC) [2]; in particular, for low-income earners [11]. It is also an important source of nutrition, serving as a source of iron, potassium, magnesium, zinc, and folic acid [5]. It is one of the major food and cash crops in Ethiopia and it has considerable national economic significance and also traditionally ensures food security in Ethiopia.

Common bean ranks third as an export commodity in Ethiopia, contributing about 9.5% of total export value from agriculture. It is often grown as cash crop by small scale farmers. The majority of common bean producers in Ethiopia are small scale farmers, and it is used as a major food legume in many parts of the country where it is consumed in different types of traditional dishes [4].

In spite of the nutritional and economic importance of beans, it is a low-yield crop. These relatively low yields can be explained mainly by the many kinds of biotic and abiotic stresses that affect the bean during its cultivation [6, 9, 7].

Pulses covered 10.38% (about 2,671,843.040 tons) of the grain production. Out of this, red and white seeded common beans were planted to, 1.95% (about 244,049.94 ha) and 0.91% (about 113,249.95 ha) of the grain crop area respectively. The production obtained from common bean red and white seeded were 1.43% (380,499.453 tons) and 0.60% (159,739.484 tons) of the grain production respectively. Therefore, the total area devoted for common bean crop production and the yield obtained in Ethiopia are 357,299.89 ha and 540,238.94 tons [3]. Even though the crop has tremendous importance in country economy such as for home consumption, soil fertility improvement and etc., its improvement is highly challenged by low yield, diseases, insect pests, and prolonged drought in Ethiopia. Therefore, the objective of this study was to register the released stable high yielding and disease resistant/tolerant common bean variety for midlands areas of Bale, East Bale and other similar agro-ecologies in the country.

2. Materials and Methods

2.1. Description of the Study Area

The field experiments were carried out at two locations, i.e., Goro and Ginner, South-Eastern Ethiopia, and 490 and 568 km, far from capital city, Addis Ababa. Description of the test locations for geographical position and physico-chemical properties are summarized and tabulated hereunder (Table 1).

Table 1. *Description of the test locations for geographical position and physico-chemical properties.*

Parameter	Location	
	Goro	Ginner
Geographical position		
Latitude	6°59'20.97" N	7°10'42.02" N
Longitude	40°29'45.16" E	40°42'58.64" E
Altitude (m.a.s.l.)	1771	1972
Soil Property		
pH (by 1:2:5 soil Water)	6.89	6.82
OMC (%)	1.19	1.18
Pav (ppm)	8.43	10.23
CEC (cmol. (+) kg $soil^{-1}$)	49.46	47.46
Soil texture	Clay	Clay

Key: OMC = Organic matter content, Pav = Phosphorus availability, CEC = Cation exchange capacity.

2.2. Experimental Design and Field Management

In multi-location trials, total of 15 Small-Seeded red Bean genotypes including the standard check "SCR 1 and Nasir" were evaluated at Goro and Ginner for three years (2015 to 2017). The experimental layout was arranged in RCBD designs with 4 replications across testing site. The experimental plots have 4 (four) rows and 40 (cm) inter-rows spacing, and have a total of 3.2 (m^2) net harvesting plot size Fertilizer was applied at the rate of 100 kg ha^{-1} diammonium phosphate (18 kg N ha^{-1}, 46 kg P_2O_5 kg ha^{-1} and 0 k) and all other crop management practices were carried out as recommended. Finally, "SCR-28 and SCR-8" were selected and promoted to variety verification trail.

3. Result and Discussions

3.1. Varietal Origin and Evaluation

Hora (SCR-28) along with 14 genotypes were obtained from Melkasa Agriculture Research Center of the Ethiopian Institute of Agriculture Research. The genotypes were evaluated along with the standard check variety, "SCR 1 and Nasir", across two locations (Goro and Ginner) from 2015-2017. Two genotypes "SCR-28 and SCR-8" were selected as candidate varieties based on a combined data analysis of variance and mean performances comparison of genotypes (Tables 2 and 3). The two most promising candidate varieties were eventually promoted to a variety verification trial. The candidate varieties and standard check variety were planted in plots with a size of 10 m x 10 and evaluated by the national variety release technical committee during the 2020/21 cropping season. Finally, the national variety release technical committee selected "SCR-28" genotype for release. SCR-28 has better yield advantage, and good resistance/ Tolerant to Alternaria Leaf Spot, Common Bacteria Blight and Rust (Table 4).

3.2. Agronomic and Morphological Characteristics

Hora variety has an average plant height of 68 cm and maturity date of 94 days. The variety has high grain yield (1587kg ha^{-1}). The flower color and cotyledon colors of the variety is pink and Light white respectively, with thousand seed weight of 223.1 gm (Table 1).

3.3. Yield Performance

The average grain yield of Hora combined over locations and years were 1587kg ha^{-1}, which is higher than SCR-1 (best standard check), 1245 kg ha^{-1}. Under research field, Hora gave grain yield ranging from 2200-2600 kg ha^{-1} while on farmers' field it ranges from1300-1800 kg ha^{-1} (Table 3).

3.4. Reaction to Disease

The diseases score for the new variety and the checks are summarized in Table 4. The resistance level of the new variety was better than the standard checks for Alternaria Leaf Spot, Common Bacteria Blight and Rust.

3.5. Performance Stability and Adaptation Domain

Hora is released for the midland areas of Bale, East Bale and similar agro-ecologies. It performs very well in area having an altitude of 1600 to 1950 m a.s.l and annual rainfall of 550-650 mm. The appropriate planting date for this variety would range from end of September to early October (Table 1). For a better harvest the variety must receive 18 kg N ha^{-1}, 46 kg P_2O_5 kg ha^{-1} at sowing and seed rate of 100 kg/ha. Hora variety showed stable yield performance across tested years over location (Table 4).

3.6. Variety Maintenance

The breeder and foundation seed will be maintained by Sinana Agricultural Research Center/ Oromia Agricultural Research Institute.

Table 2. *Agronomical and Morphological Characteristics and Agro-ecological Zones of Adaptation of Hora, Small red type common bean variety.*

Variety name:		**Hora (SCR-28)**
Agro-ecological Zones of Adaptation		Goro, Ginner, Dellomena, Berbere and other similar agro-ecologies
Altitude (m.a.s.l.)		1600 – 1950
Rainfall (mm)		550 –650
Seed Rate (Kg/ha)		90
Planting date		End of September to Early October
Fertilizer Rate (NPS kg/ha)		100
Days to Flower		52
Days to Maturity		94
Plant Height (cm)		68
1000 Seed Weight (gm)		223.1
Growth habit		Portrait
Seed coat Color		Red
Seed size		Small
Cotyledon Color		Light white
Flower Color		Pink
Yield (Qt/ha)	(Research Field	22-26
	On-farmer's Field)	13-18
Disease reaction		Tolerant to Alternaria Leaf Spot, Common Bacteria Blight and Rust
Year of Release		2021
Breeder and Maintainer		SARC (IQQO)

Table 3. *Mean grain yield (kg/ha) of 15 Small Red bean genotypes (Set-II) across locations and years.*

Entry	**Goro**			**Ginner**			**Mean**	**Yield Adv. over St. check**
	2015	**2016**	**2017**	**2015**	**2016**	**2017**		
SCR 7	2328	1192	614.4	1623	853	1160	1295	
SCR 36	2618	1223	707.3	2120	837	1298	1467	
SCR 15	2486	1711	645	1733	833	1309	1453	
SCR 8	2776	1575	656.7	1764	843	1186	1467	
SCR 16	2276	1121	490.1	1697	722	1275	1263	
SCR 13	2345	1294	440.8	1705	831	1250	1311	
SCR 35	2289	1016	529.1	1730	805	1201	1262	
SCR 18	2476	1197	662.5	1754	1028	1196	1386	
SCR 9	2328	1913	424	1672	864	1487	1448	
SCR 29	2235	1131	657.5	1736	895	1508	1360	
SCR 2	2266	1246	582.5	1344	884	1133	1243	
SCR 17	2340	1739	626.5	1229	814	1828	1430	
SCR 28	2664	2112	686.7	1277	966	1818	1587	29.3%
SCR 1	1976	1212	453	1571	798	1457	1245	
Nasir	2270	815	690.5	1585	774	1235	1228	
Means	2378	1367	591.1	1636	850	1356	1363	
LSD (<0.05)	452.3	633.7	372.9	459.7	187.6	560.3	287.1	
CV	13.0	24.3	24	20.0	15.0	24.1	20.1	

Table 4. *Mean seed yield and other agronomic traits of 15 Small Red bean genotypes tested regional variety trial (Set-II) combined for two locations (Ginner and Goro) over three years (2015-2017).*

Entry	**DF**	**DM**	**Stand %**	**PH (cm)**	**NPP**	**NSP**	**TSW (g)**	**GY (kg/ha)**
SCR 7	51	94	75	63	15	4	245.1	1295
SCR 36	52	94	78	67	16	4	232.6	1467
SCR 15	52	94	75	67	17	4	242.8	1453
SCR 8	53	94	74	66	15	4	245.3	1467
SCR 16	52	93	74	64	12	4	233.8	1263
SCR 13	52	94	73	64	15	4	248.7	1311
SCR 35	52	94	72	69	16	4	235.1	1262
SCR 18	52	93	74	65	12	4	234.5	1386
SCR 9	52	94	75	62	13	5	236.4	1448
SCR 29	52	94	74	66	14	4	236.6	1360
SCR 2	52	94	73	64	14	4	256.4	1243
SCR 17	52	94	74	63	13	4	244.1	1430
SCR 28	52	94	78	68	14	4	223.1	1587
SCR 1	52	93	73	66	15	5	223.4	1245

Entry	DF	DM	Stand %	PH (cm)	NPP	NSP	TSW (g)	GY (kg/ha)
Nasir	52	95	78	65	14	4	193.4	1228
Mean	52	94	75	65	14	4	235	1363
LSD (<0.05)	1.1	1.9	9.4	6.2	4.3	0.4	13.0	287.1
CV%	3.8	3.6	22.1	16.8	22.7	16.9	9.7	20.1

Note: DF = days to 50% maturity, DM, days to 90% maturity, PH = plant height (cm), NPP = Number of pods per plant, NSP =Number of seed per plant, TSW = Thousand seed weight (g), GY = grain yield (kg).

Table 5. *Mean grain yield, agronomic traits and disease reaction of 'Hora' along with standard checks tested in two environments at varietal verification levels during 2015-2017 cropping seasons.*

Entry	Agronomic traits								Disease Reaction (1-9 scale)		
	DF	DM	Stand %	PH (cm)	NPP	NSP	TSW (g)	GY (kg/ha)	ALS	CBB	Rust
SCR 28	52	94	78	68	14	4	223.1	1587	4	3	3
SCR 8	53	94	74	66	15	4	245.3	1467	4	4	3
Nasir	52	95	78	65	14	4	193.4	1228	5	3	3
SCR 1	52	93	73	66	15	5	223.4	1245	6	4	4

Note: DF = days to 50% maturity, DM, days to 90% maturity, PH = plant height (cm), NPP = Number of pods per plant, NSP =Number of seed per plant, TSW = Thousand seed weight (g), GY = grain yield (kg), ALS = Alternaria Leaf Spot, CBB = Common Bacteria Blight.

4. Conclusion

Hora is the superior variety compared with the standard checks in grain yield performance in multilocation trails across the testing environments and yield stability. It has better agronomic performance with tolerance level of reactions to Alternaria Leaf Spot, Common Bacteria Blight and Rust as compared to the standard checks. Hence, cultivation of the new variety is recommended in mid altitudes of the major common bean growing areas of the country having similar agro-ecologies with the testing sites.

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