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

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Abstract: The name Milkesa was given to Large-red seed Food Type Common Bean (Phaseolus vulgaris) variety with the pedigree of DAB-523. The objective of this study was to register 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. Total of sixteen Large-red Seed Common Bean genotypes including the standard check "Melka dima and Red kidney" were evaluated across two locations (Goro and Ginner) for three years (2015 to 2017). One promising genotype, "DAB-523" were selected and promoted to variety verification trail with the standard check during the 2020/21 cropping season. The national variety release technical committee evaluated the candidate varieties both at Goro and Ginner. Milkesa is characterized by large-seeded with red grain color and gave high seed yield (1626kg ha^{-1}) and stable performance across years and locations. It has about 10.03% yield advantage over the best standard check variety, "Melka dima". The variety is also resistant/ Tolerant level of reactions to Alternaria Leaf Spot, Common Bacteria Blight and Rust. Milkesa is released for the Midland Areas of Bale, East Bale, and similar agro-ecologies. Therefore, farmers could be cultivated Milkesa for increasing productivity of the crop with its full recommended packages.

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

1. Introduction

Common bean (*Phaseolus vulgaris* L., 2n = 22), also referred to as dry bean, is to genus Phaseolus, species vulgaris, family Leguminosae [2, 6]. Common bean is one of the most important pulse crops grown in Ethiopia in terms of both area and quantity produced. The crop is cultivated in different parts, mainly Oromia, Amhara and Southern Nations Nationalities and Peoples Region (SNNPR). Their share of the national common bean production is 51% for Oromia, 24 % for Amhara and 21% for SNNPR [3]. Almost all common beans are produced under rainfed conditions by smallholder farmers on less than 0.5 hectares [4, 5].

The crop is one of the most important cash crops and sources of protein for farmers in many lowlands and mid-altitude zones. It is also widely intercropped with maize and sorghum to supplement farmers with additional income and to maintain soil fertility [8]. Common bean farmers preferred the crop because of its fast-maturing characteristics that enable households to get cash income required to purchase food and other household needs when other crops have not yet matured [1].

There is a wide range of common bean types grown in Ethiopia, including white, mottled, red, and black varieties. The most commercial varieties are pure red and pure white colored beans and these are becoming the most commonly grown types with increasing market demand [3, 7].

Common bean production is constrained by several biotic and abiotic environmental stresses. Biotic (field and post-harvest pests and plant diseases) and a biotic (drought, excessive rain/flooding, poor soil fertility, heat and cold stressors) factors are known to cause significant reductions in

grain yields [11]. Bean anthracnose [Colletotrichum lindemuthianum (Sacc. & Magnus) Briosi & Cavara] poses a major constraint on the production of dry bean in Ethiopia. A study by [10, 12] stated that yield loss up to 62.8% due to anthracnose was recorded in Ethiopia on susceptible cultivars of common bean like Mexican-142, Awash-1 and Awash Melka.

In Ethiopian, a number of improved varieties (high yielding, early maturity and disease resistant, varieties meeting the requirements for local consumption and export markets) and management practices have released and popularized since early 1960s to enhance the productivity of common bean and income. The actual smallholder farm yields (1700 kg per hectare) are by far below the potential yield (3500 kg per hectare) at research stations and 3000 kg per hectare for research managed farmers [9, 13].

The development of cultivars, which are Resistant/ Tolerant to major biotic and abiotic environmental stresses, and adapted to a wide range of diversified environments, is the ultimate aim of plant breeders in a crop improvement program. The adaptability of a variety over diverse environments is commonly evaluated by the degree of its interaction with different environments in which it is grown. 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.

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

Total of 16 Large-red Seed Common Bean genotypes including the standard check "Melka dima and Red kidney" 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, Milkesa (DAB-523) was selected and verified along with two standard checks.

3. Result and Discussions

3.1. Varietal Origin and Evaluation

Milkesa (DAB-523) along with 16 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, "Melka dima and Red kidney", across two locations (Goro and Ginner) from 2015-2017. Genotype "DAB-523" were selected as candidate variety based on a combined data analysis of variance and mean performances comparison of genotypes. The promising candidate variety and the standard check variety, "Melka dima and Red kidney", were eventually promoted to a variety verification trial. The candidate variety 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 (NVRC) during the 2020/21 cropping season. Finally, the national variety release committee decided "DAB-523" genotype for release.

3.2. Agronomic and Morphological Characteristics

Milkesa was adapted to mid-agro-ecologies of Bale and East Bale, southeast Ethiopia, in the range of altitude 1600 m.a.s.l. to 1950 m.a.s.l. It gives a high yield under the range of 550 mm to 650. In an attempt to develop Milkesa, higher yield, and resistance to major Haricot bean diseases were important traits of consideration. Milkesa was taken 49 days for heading and 93 days for maturing. Milkesa variety is relatively shorter in height than the standard varieties than Melka dima and red kidney. Milkesa has large seed size with

red grain color and it has good general acceptance for Haricot bean with high quality.

3.3. Yield Performance

Highly significant variations among large red common bean genotypes in seed yield in all study years and locations were observed. The average grain yield of Milkesa combined over locations and years were 1626kg ha^{-1}, which is higher than Melka dima (best standard check), 1477kg/ha^{-1}. The grain yield performance and stability parameters of Milkesa (DAB-523) and the checks are summarized in Table 5. Under research field, Milkesa gave grain yield ranging from 23-25 Qt ha^{-1} while on farmers' field it ranges from 12-18 Qt ha^{-1}. The combined mean grain yield over locations and years of the newly released variety 'Milkesa' exceeded the average yield of best standard checks 'Melka dima' by 10.03% seed yield advantage (Table 4).

3.4. Reaction to Disease

The major Common Bean diseases according to their importance in the growing areas are Alternaria Leaf Spot, Common Bacteria Blight and Rust**.** On the standard rating scale of 0-9, Milkesa variety is characterized by resistance/Tolerance types of reaction to these major diseases at all sites (Table 2). The resistance reaction of the variety could be integrated with other disease management methods such as crop rotation, managing infested debris, and fungicide seed treatments for better results.

3.5. Stability Performance

Milkesa variety showed stable yield performance across tested years over location (Table 4). It performs best if it is produced with recommended fertilizer, seed rate and other recommended fertilizer rate in the recommended ecologies.

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 Milkesa, Large red type Common Bean variety.*

Variety name:		**Milkesa (DAB-523)**
Adaptation area:		Goro, Ginner, Dellomena, Berbere and other similar agro-ecologies
Altitude (m.a.s.l.)		1600 – 1950
Rainfall (mm)		550 –650
Seed Rate (Kg/ha)		90-100
Planting date		End of September to Early October
Fertilizer Rate (NPS) kg/ha)		100
Days to Flower		49
Days to Maturity		93
Plant Height (cm)		58
Growth habit		Portrait
1000 Seed Weight (gm)		298.2
Seed Color		Red
Seed seize		Large
Cotyledon Color		Light white
Flower Color		Pink
Yield (Qt/ha)	Research Field	23-25
	On-farmer's Field	12-18
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 16 Large Red bean genotypes (Set-I) across locations and years.*

Entry	**Goro**			**Ginner**			**Mean**	**Yield Adv. over St. check**
	2015	**2016**	**2017**	**2015**	**2016**	**2017**		
DAB-525	1875	1767	918	1524	1070	1146	1383	
DAB-531	1886	1014	469	1316	762	626	1012	
DAB-538	2264	1737	840	1583	942	934	1384	
DAB-523	2507	2315	1136	1807	1037	952	1626	10.03%
DAB-498	1933	1555	1217	1699	903	1272	1430	
DAB-504	1472	1432	838	1685	866	1059	1225	
DAB-491	1736	1497	741	1485	704	870	1172	
DAB-537	1891	1268	712	1499	550	734	1109	
DAB-488	1761	1901	917	1626	914	974	1349	
DAB-518	2313	1605	626	1765	980	974	1377	
DAB-496	2112	1784	1104	1682	1041	1152	1479	
DAB-526	1829	1594	977	1241	864	766	1212	
DAB-507	1826	1463	507	896	560	485	956	
DAB-522	2034	1317	933	1586	890	840	1267	
Melka dima	1745	1726	1212	1480	1231	1470	1477	

Entry	Goro			Ginner			Mean	Yield Adv. over St. check
	2015	2016	2017	2015	2016	2017		
Red kidney	1389	1327	694	901	822	773	984	
Means	1911	1581	865	1486	884	939	1278	
C. V.	23.0	21.8	20.1		18.0	22.7	20.3	
LSD (<0.05)	616.2	717.1	314.8	481.9	230.6	365.1	219.5	

Table 4. *Mean seed yield and other agronomic traits of 16 Large Red bean genotypes tested regional variety trial (Set-I) 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
DAB-525	49	94	82	59	14	4.2	408.3	1383
DAB-531	50	94	78	58	14	4.2	338.0	1012
DAB-538	50	93	80	60	14	4.0	401.4	1384
DAB-523	49	93	83	58	12	4.5	298.2	1626
DAB-498	49	93	83	58	12	4.2	399.8	1430
DAB-504	50	95	80	58	13	4.3	408.4	1225
DAB-491	49	94	82	60	11	4.2	377.6	1172
DAB-537	49	94	82	60	14	4.1	368.6	1109
DAB-488	50	94	82	58	13	4.2	346.0	1349
DAB-518	50	94	82	59	12	4.1	394.4	1377
DAB-496	50	93	81	58	12	4.1	409.8	1479
DAB-526	50	94	84	59	16	4.0	368.8	1212
DAB-507	50	95	81	61	13	4.2	392.1	956
DAB-522	50	94	81	60	12	4.1	385.5	1267
Melka dima	50	94	81	60	13	4.1	405.2	1477
Red kidney	50	95	81	59	12	4.0	379.8	984
Mean	50	94	81	59	13	4.2	380.1	1278
LSD (<0.05)	1.0	2.2	3.7	6.2	4.2	0.4	27.7	219.5
CV%	3.4	4.2	8.0	18.4	21.6	16.6	12.8	20.3

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 'Milkesa' among two standard checks tested at two environments at varietal verification levels during 2015-2017 cropping seasons.*

Entry	Agronomic traits								Disease Reaction (1-9)		
	DF	DM	Stand %	PH (cm)	NPP	NSP	TSW (g)	GY (kg/ha)	ALS	CBB	Rust
DAB-523	49	93	83	58	12	4.5	298.2	1626	4	3	4
Melka dima	50	94	81	60	13	4.1	405.2	1477	5	3	4
Red kidney	50	95	81	59	12	4.0	379.8	984	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

Milkesa produced high yield, and it had a more stable performance in seed yield over locations and years than the standard check variety. The variety also showed a higher Tolerant to Alternaria Leaf Spot, Common Bacteria Blight and Rust. Therefore, it was released and recommended for cultivation in southeast Ethiopia, but could be adopted for production in similar agro ecologies in the country.

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