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Registration of "Bullaallaa" Newly Released Durum Wheat (*Triticum turgidum* L.) Variety for Bale Mid and Highland Areas

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Abstract: Durum wheat is the major staple cereal crop in Ethiopia. Including checks 20 durum wheat genotypes were evaluated in randomized complete block design (RCBD) with three replications. The study was took place for two consecutive years during 2012 and 2013 main cropping season at four locations, namely; Sinana, Agarfa, Ginir and Gololcha representing of the major durum wheat growing areas of South Easter of Ethiopia. The objective of the study was to evaluate the most stable, high yielding, disease resistant and quality durum wheat genotype for mid and highland areas of Bale. The analysis of variance (ANOVA) showed significant ($p \leq 0.01$) variation among varieties for all traits. After evaluation of genotypes across location and years Bullaallaa with a pedigree designation of "Durum ICARDA/Ethiopia PDYT-322" was selected and verified for one year at multilocation during 2016. Bullaallaa is a common name given for thisnewly released durum wheat variety. The study found that Bullaallaa (Durum ICARDA/Ethiopia PDYT-322) variety had above average yield performance in most tested environments, out yielded for Tate, Toltu and Ingilizechecks. The mean grain yield across locations and years of Bullaallaa was 56.4quintal per hectare. It was more yielder, stabile, disease resistant and uniform than checks. Finally, it was evaluated by National Variety Releasing Committee and recommended for release in 2017 for the studied area and similar agro- ecologies.

Key words: Durum Wheat Variety · Grain Yield · Grain Quality · Protein Content · Disease Reaction

INTRODUCTION

Wheat (*Triticum* sp.) is one of the most important cereals cultivated in the world. Ethiopia is the second largest wheat producer of wheat in Africa next to South Africa [1, 2]. In Ethiopia wheat stands fourth in area coverage. Eighty-one percent of the total land cultivated to grain crops is covered by cereals out of which wheat accounts for 13.14% of the area [3]. According to Dereje Hailu [4], wheat is one of the major cereal crops produced in the Ethiopia highlands, which ranges between 60 and 100N latitude and 350 and 420E longitude, at altitude range from 1500 to 2800m.a.s.l. At national level, during 2014/15 cropping season 1, 663, 837.58 hector of land was covered by bread and durum wheat and 42, 315, 887.16 quintals were harvested from these lands [5]. At present, wheat is produced solely under rainy conditions. The current total wheat production area, 75% is located in Arsi, Bale and Shewa regions. Small amount is produced in the rest of the north and south regions [6]. Durum wheat (*Triticum turgidum* L.) is the second most cultivated wheat in the world next to bread wheat [7]. Durum wheat is indigenous to Ethiopia and it has been under cultivation since ancient times. Ethiopia is considered to be the center of genetic diversity of this crop. It is traditionally grown on heavy black clay soils (Vertisols) of the central and northern highlands of Ethiopia between 1800-2800 meters above sea level. Accurate statistics on area and production of durum wheat in the country are difficult to obtain since they are lumped together with bread wheat [5].

Durum is the hardest of all wheat. Its density, combined with its high protein content and gluten strength make it the preferred choice for producing pasta products. Pasta made from durum wheat is firm with consistent cooking quality. The dough is less elastic than bread dough's, but this makes it easier to roll into pasta shapes. Semolina of durum wheat is the preferred raw material for the production of high quality pasta, due to unique color, flavor and cooking quality. Pasta is a

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popular wheat-based food worldwide, due to its convenience, cost, palatability and nutritional value [6]. In Ethiopia, durum wheat is consumed as leavened bread, common bread, macaroni, spaghetti, biscuits, pastries and in various indigenous food preparation. The straw is mainly used for cattle feed and for fuel at times of scarcity [7]. However, the productivity of durum wheat in the country is very low compared to world average. This is due to lack of improved variety, low cultural practices, moisture stresses and other biotic and abiotic factors. Rust is among the major problem limiting durum wheatproductivity in Ethiopia. Especially stem rust is one of the challenging and limit durum wheat productions. Diseases incur yield and quality losses in Ethiopia and research results on their identity, the extent of damage they cause and their managements have been reviewed previously [9]. Yellow rust alone and in combination with stem rust caused 11 to 71% yield losses in Bale area depending on the level of resistance in the wheat varieties used, season and locations where the trials were made [10, 11]. Generally, rusts break down the so far released varieties. This is sometimes, under severe conditions, there is a possibility for released varieties to suspend from entering to production due to sudden breakdown of their resistance to the prevailing rust races. Thus, it is the alert time for breeders' crosses and selects the right material for resistant genes.The objective of the present study is therefore, to evaluate disease resistant, high yielder, quality, stable and uniform, tolerant to pests and other abiotic factorsof durum wheat genotype for mid and highland areas of Bale.

MATERIALS AND METHODS

Including Sinana Agricultural Research Center the experiment was carried out at four locations namely: Sinana, Agarfa, Gololcha and Ginir. Sinana Agricultural Research Center is located to South Eastern of Ethiopia at 7°N latitude and 40°E longitudes; and is located at altitude of 2400 m.a.s.l. The other location 'Gololcha is about 120km to East, Ginir is 56km to East and Agarfa' is about 60km to North West from Sinana Agricultural Research Center.

The genotypes were selected from ICARDA materials and the trial evaluation was started from observation nursery till to verification stage. In the multi-location trial, 17 genotypes retained from the yield trial were further evaluated. The experiment was carried out for two consecutive years in the four environments during 2012 and 2013 main cropping seasons.Including three checks twenty (20) durum wheat genotypes were evaluated for their yield performance, disease resistance and other agronomic performance at multilocation representing the major durum wheat growing of Bale mid and highland areas. Planting was conducted in three replicates using randomized complete block design (RCBD) on plot size of 1.2m wide (6 rows with 20cm apart) by 2.5m length of which four central rows were harvested for grain yield estimate. Seed @ 150 kg/ha and fertilizer @ 110/ 41 N/ P O kg/ha was utilized. Urea fertilizer was applied in split form ($1/3^{rd}$at planting and $2/3^{rd}$at tillering stage). All agronomic managements and practices were adopted as per recommendation for each location. Data were collected on plant and plot basis for morpho-agronomic traits of wheat;days to heading, days to maturity, biomass weight, grain yield, thousand kernel weights, test weight, protein contents, disease data (leaf rust, yellow rust and stem rust) were assessed on plot basis. On the other hand plant height was assessed on single plant basis of three selected and random sample of plant form each plot and the mean data of the three plants were used for analysis.Yield data was taken per plot basis and converted to quintal ha^{-1} for carrying out subsequent statistical analysis.Lastly, Bullaallaa (Durum ICARDA/ Ethiopia PDYT-322) wasselected and verified at multi location with two checks; Dire and Ingilize year (2016). Finally at verification stage it was evaluated by National Variety Releasing Committee as per the guide line of the variety releasing and registration of the country.

RESULTS AND DISCUSSION

Morphological Characteristics: During study at multilocation, Bullaallaa performed very well in mid and highlandagro ecologies. It has medium plant height (82cm) (Table 1). Ithas high plant stand, good tillering capacity, lodging resistance, erect growth habit, largeear size and slightly black awn, amber seed color and deep green at vegetative stage. Moreover, other characteristics of the variety described in Appendix I.

Varietal Characteristics: Bullaallaavariety is good disease resistance/tolerance, it needs 71 days to heading and it takes 136 days to reach physiological maturity (Table 1). It is stable, uniform, has strong stalk, early matured, frost tolerant and lodging resistance variety. Bullaallaa has high biomass weight that preferred by farmers which indirectly used for animal feeds. Also it has high germination potential and has no shattering problem.

Table 1: Mean agronomic performance and disease reactions of 20 durum wheat genotypes tested in durum wheat regional variety trial (DWRVT) combined over locations and years (2012-13)

		Agronomic and disease data								
S.No.	Pedigree /Code of genotypes	Dh‡	Dm‡	Plh‡	Tkw‡	Tw	Gy‡	SR	YR	LR
1	DW ICARDA -01	71	136	85.6	43.1	83.6	4704.9	15s	5ms	5ms
2	DW ICARDA -02	70	136	85.0	40.0	83.1	4631.8	10ms	0	15s
3	DW ICARDA -03	69	134	87.7	43.5	83.7	5269.2	15ms	trmr	10ms
4	DW ICARDA -04	70	136	87.2	44.2	83.7	5131.6	15s	5mr	5ms
5	DW ICARDA -05	74	137	82.2	44.8	81.8	5330.8	5ms	0	5ms
6	DW ICARDA -06	73	136	81.7	43.8	82.5	4887.8	10ms	0	10ms
7	DurumICARDA/Ethiopia PDYT-322	68	136	86.6	44.4	82.8	5641.5	10ms	5mr	5ms
8	DW ICARDA -08	67	134	86.6	43.6	83.5	4613.0	5ms	0	5ms
9	DW ICARDA -09	68	135	78.8	46.2	81.5	4575.2	10ms	trmr	10ms
10	DW ICARDA -10	67	137	87.4	47.7	82.4	4624.1	5ms	5mr	5ms
11	Durum ICARDA/Ethiopia SR.R-6	68	133	81.4	40.8	83.1	5391.3	10mr	5mr	10ms
12	DW ICARDA -12	67	135	86.7	47.1	82.6	4651.3	5ms	trmr	5ms
13	DW ICARDA -13	66	134	86.8	50.9	81.9	4721.5	5ms	trmr	5ms
14	DW ICARDA -14	67	137	88.0	50.4	83.3	4660.5	10ms	0	10ms
15	DW ICARDA -15	68	135	82.8	47.9	83.0	4641.1	10ms	5mr	10ms
16	DW ICARDA -16	67	135	88.2	48.3	83.2	4384.5	5ms	5mr	10ms
17	DW ICARDA -17	67	134	86.6	44.1	82.9	4622.5	5ms	0	10ms
18	Tate	70	136	87.0	44.4	83.2	5278.7	15s	trmr	10ms
19	Toltu (standard check)	69	133	79.5	40.5	83.2	4995.6	10ms	5mr	5ms
20	Englize (Local check)	67	135	110.7	44.3	82.7	4609.7	10ms	trms	15s
Mean	69	135	86.3	45.0	82.9	4868.3				
CV (%)	1.9	1.6	5.3	5.3	3.0	12.9				
SE	0.26	0.43	0.94	0.48	0.51	127.72				
LSD (5%)	0.73	1.21	2.62	1.34	*ns*	355.39				

Note: Dh: days for heading, Dm: days to maturity, Plh: plant height (cm), TKW: thousand kernel weight (gm), TW: test weight (kg/hl), Gy: grain yield (kg/ha), Sr: stem rust (%), Yr: yellow rust (%), Lr: leaf rust (%), S: Susceptible, MS: moderately susceptible, Mr: Moderately resistant, Tr: Trace, Trms: Trace with moderately susceptible , Trmr: Trace with moderately resistant, R: CV(%): Coefficient of variations, SE: standard error of the mean, LSD: Least significant differences.

Table 2: Annex statistical analysis of yield data (year, location and year x location)

Year	Location	Error mean square (EMS)	Total yield Bullaallaa (DurumICARDA/Ethiopia PDYT-322)	Percent of check (Toltu) in the trial	Percent of local check in the trial
2012	Sinana	264823.1	4825.3	4.7	8.2
	Robe	439125.3	4540.0	20.0	49.4
	Ginnir	346045.6	4039.8	53.4	13.0
	Gololcha	368235.4	7327.5	-0.5	21.1
2013	Sinana	628794.0	5530.1	12.1	32.6
	Robe	122071.0	3952.2	20.2	20.9
	Ginnir	634873.0	7287.2	-1.2	6.6
	Gololcha	550258.0	7629.7	26.1	48.2

Yield Performance: Highly significant variations among durum wheat genotypes in grain yield across all study locations and years were observed. The mean grain yield ranged from 39.5 quintal per hector to 76.3 quintal per hectare. The highest overall grain mean recorded for Bullaallaa was 56.4 quintal per hectare and for standard checks Tate and Toltu were 52.7 and 49.9 quintal per hectare respectively, whereas the lowest grain yield was recorded for local checkIngilize 46.0 quintal per hectare among the tested entries (Table 1). Also this variety has high thousand kernel weight and test weight (Table 1). Also the yield advantage of Bullaallaa over checks was calculated (Table 2). Total yield of Bullaallaa variety over standard check Toltu was 16.9% and 25.0% over the local check Englize.

Quality Characteristics: Also the quality parameters of Bullaallaa were evaluated and compared with checks. Bullaallaa variety has high protein content (13.3%), 30.3% gluten and good past making quality that

Table 3: Mean agronomic performance, disease reactions and quality parameters of the candidate verified at multi-location (2016)

		Agronomic, disease and quality data											
Genotypes		Dh	DM	Plh	Gy	TKW	TW	SR	YR	LR	Gluten	Moisture	Protein
1	Bullaallaa(DurumICARDA/Ethiopia PDYT-322)	68.5	136	86	56.5	45.1	83.9	5ms	5mr	trms	30.3	10.4	13.3
2	Dire	66	134	76	49	33.3	83.8	10ms	10ms	trms	24.9	9.7	11.7
3	Durum ICARDA/Ethiopia SR.R-	68	133	82	52	47.8	83.7	10s	10s	10s	28.1	9.9	12.8
4	Ingilize	67.5	136	111	46	43.3	82.9	10s	5ms	15s	31.16	9.5	13.1

Note: Dh: days for heading, Dm: days to maturity, Plh: plant height (cm), TKW: thousand kernel weight (gm), TKW: test weight (kg/hl), Gy: grain yield (kg/ha), Sr: stem rust (%), Yr: yellow rust (%), Lr: leaf rust (%), S: Susceptible, MS: moderately susceptible, Mr: Moderately resistant, Tr, trace, Trms: Trace with moderately susceptible

fulfill industrial standards (Table 3). Also it has high thousand kernel weight (45.1g) and test weight (83.0 kg/L) (Table 3). Its seed color is good and preferred by consumers.

Disease Reaction: The major durum wheat disease according to their importance in the growing area is rust (YR, SR and LR). Disease data across location and years were scored and analyzed. Accordingly, Bullaallaa scored 10mr % for stem rust, 5mr % for yellow rust and 5ms % for leaf rust (Table 1). The variety reaction response showed moderately resistance for yellow rust and stem rust and moderately susceptible to leaf. Generally, Bullaallaa variety is tolerant against disease, insect pests and other abiotic factors.

Adaptation Range: Bullaallaa released for the mid and highland areas of Bale and similar agro-ecologies. It performs very well in areas having an altitude 1700-2500 m.a.s.l. and annual rainfall of 750-1500mm. Clay soils (vertisols) and mid altitude area is the most favorable for this variety. Planting date is mid-June to early September based on the agro-ecologies of the area. The seed rate recommendation for the variety is 150kg/ha and fertilizer rate is 41kg/ha of P_2O_5 and 110kg/ha of N. Based on agronomic recommendation Urea application in split form $1/3^{rd}$ at planting and $2/3^{rd}$at tillering stage. Generally, it can possible to extend to other areas having similar agro-ecologies.

Variety Maintenance: The variety is maintained under the responsibility of breeder and foundation of the seed by Sinana Agricultural Research center/Oromia Agricultural Research Institute.

CONCLUSIONS

The development of cultivars, which are adapted to a wide range of diversified environments, is ultimate aim of breeders in crop improvement program. Analysis of genotype by environment interaction is vital for breeders in order to design the dissemination strategies for new varieties. Precise recommendation of lines for general and specific adaptation requires clear understanding of the real pattern of genotype by environment interaction. 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. According to the evaluation of yield performance, disease reaction and agronomical parameters the newly released variety is very well adapted in the studied environments. In economical point of view this variety is very important (disease resistant, earlier, high yielder, higher TKW, good test weight, high protein content and higher biomass). The average grain yield of Bullaallaa is 56.5 quintal per hectare. Also, Bullaallaa variety had above average yield performance in most tested environments, out yielded for checks and other entries. It has 16.9% and 25% yield advantage over the standard check Toltu and local check Ingilize respectively. Generally it is high yielder, stabile, uniform, better disease and abiotic factor tolerant, wider adapted variety, highly preferred by consumer and that is why it is recommended to release.

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Appendix: Agronomic and Morphological Descriptors of Newly Released Durum Wheat Variety (Bullaallaa)

- Variety Name: Bullaallaa*(Durum ICARDA/Ethiopia PDYT-322)*
- Adaptation area: Mid and high lands of Bale
  2.1. Altitude (m.a.s.l): 2000-2500 m.a.s.l
  2.2. Rainfall: 750-1500mm

- Seed rate: 150kg/ha
- Planting date: Mid June to early September in Bale based on the agro-ecologies of the area
- Fertilizer rate (kg/ha):
  5.1. P_2O_5=69
  5.2. N=41

- Days to heading: 68
- Days to mature: 136
- Plant height: 86
- Growth habit: Erect
- Ear type: big size having of slightly black awn
- 1000 weight: 45.1
- Seed color: Amber
- Hectoliter weight (kg/L): 83.0
- Crop pest reaction: Resistance to disease and tolerance to major wheat pests

- Yield (qt/ha):
  15.1. Research field: 48.2-55.3kg/ha
  15.2. Farmers field: 39.5-76.3kg/ha

- Quality parameters:
  16.1. Protein =13.3
  16.2. Gluten=30.3
  16.3. Moisture=10.4

- Year of release: 2017
- Breeder/Maintainer: Sinana Agricultural Research Center/Oromia Agricultural Research Institute.

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