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Registration of "Haydaroo" Newly Released Emmer Wheat (*Triticum dicoccum L.*) Variety for Bale Highland Areas

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Abstract: Ethiopia has suitable environmental condition for emmer wheat production. However, the productivity of emmer wheat is very low as compared with world average due to lack of stable, improved seed and poor agronomic managements. Therefore, the objective of the study was to evaluate the promising genotypes and verify the most stable, uniform, high yielding and disease resistant emmer wheat for highland areas of Bale. The materials were crossed at Sinana Agricultural Research Center; i.e. emmer wheat crossed with durum to improve yield and thresh ability of emmer wheat. The experiment was carried out at two locations namely Sinana and Goba. Including checks 15 genotypes have been evaluated in three replicated of randomized complete block design (RCBD). The trial was studied for three consecutive years (2013, 2014 and 2015) main cropping seasons. After evaluation of genotypes across location and years, Haydaroo was selected and verified for one year (2016) at multilocation. Haydaroo is a common name given for the newly released emmer wheat variety that a pedigree designation of "Sinana_01 x DZ2212//Sinana_01". Haydaroo (Sinana_01x DZ2212//Sinana_01) had above average yield performance in most tested environments, out yielded for Sinana-01 and Local check varieties. The mean average grain yield of Haydaroo is 30.24 quintal per hector. It is stabile and uniform across locations. Finally, it was evaluated by National Variety Releasing Committee and recommended for release in 2017 for high lands of Bale and similar agro-ecologies.

Keywords: Emmer Wheat Variety, Grain Yield, Thresh Ability, Disease Reaction

1. Introduction

Emmer (*Triticum dicoccum*) is amember of the wheat family of annual grasses. Wild emmer wheat (*T. turgidum spp. dicoccoides* (Körn.) Thell.), an annual predominantly self-pollinated [1] tetraploid (genome constitution AABB) species [2], is considered to be the progenitor of cultivated durum and bread wheat's [3]. Wild emmer is fully compatible with the tetraploid (AABB) durum wheat, it can be crossed with the hexaploid (AABBDD) bread wheat [4], and it harbours wide genetic diversity relevant to the improvement of various economically important traits in cultivated wheat [5]. Cultivated emmer wheat, *T.dicoccum* [syn. T. turgidum L. subsp. Dicoccon (Schrank) Thell.], is a tetraploid species (BA-genomes) belonging to the *Triticum* L.genus [6]. It is predominantly awned with spikelet's consisting of two well developed kernels. Emmer glumes are long and narrow with sharp beaks. It possesses valuable traits of resistance to pests and diseases and tolerance to abiotic stresses and is increasingly used as a reservoir of useful genes in wheat breeding. The genomic constitution AA of emmer is thought to be derived from *T. monococcum*. Various sources of the BB genome have been suggested, *T. speltoides*, *T. searsii*, and *T. tripsacoides* [7, 8]. Due to the addition of the BB genome cultivated emmer could be grown in a wider range of environments including regions having high growing season temperatures. Emmer is an ancient wheat crop which 20 years ago was considered an underutilized or neglected crop and which it seemed was probably going to be completely abandoned because of its low productivity and threshing and other agro technical problems [9, 10]. Today the increase in interest in natural and organic products has led to a

"rediscovery" of this hulled wheat, which has health characteristics associated with high starch-resistant content [11, 12]. Breeding of emmer has rarely been given attention and its productivity does not usually achieve that of modern bread wheat cultivars [10]. Mean while, some literature presents a similar productivity level of emmer and bread wheat, if varieties are grown in arid conditions [12]. Genetic information like heritability and genetic advance for different yield contributing traits would be of great value enabling the breeder to use best genetic stock for improvement inbreeding programme [13]. Another advantage of emmer, published in the literature is a high quality of production [6]. Emmer wheat has been traditionally grown and used as a part of the human diet [12], and as requirements for the diversity and high quality of food products become more demanding, interest in this wheat variety is increasing [14]. The grains contain more crude protein than the grains of modern varieties [15]; whole meal flour is a valuable source of dietary fibre in its insoluble forms, cellulose and hemi cellulose, and it contains high quantities of P, Zn, Cu, K, Mg and Mn [12].

In Ethiopia emmer wheat, locally known as Hayisa (Aja), is used in various ways. Some is ground into flour and baked into special bread (Kita). Some is crushed and cooked with milk or water to make porridge (Genfo), and some is mixed with boiling water and butter to produce gruel. As some literature indicates, emmer's high protein content and smooth and easily digestible starch, infants and nursing mothers especially favor the gruel. In the country emmer wheat production is very low as compared to other crop. This is due to lack of improved variety; thresh ability problem, low cultural practices, and other biotic and abiotic factors. The objective of the current study therefore, to select disease resistance, high yielder, simple to thresh, quality, stable and uniform emmer wheat genotype for highlands of Bale and similar agro-ecologies.

2. Materials and Methods

Including Sinana Agricultural Research Center the experiment was carried out at two locations (districts) namely; Sinana and Goba. 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 center is 463km far from Addis Ababa to South East and 33km far from Robe capital city of Bale zone to East direction. The other location, Goba is about 48km far from Sinana Agricultural Research Center to West and 13km far from Robe to South direction.

The materials were crossed at Sinana Agricultural Research Center; i.e. emmer wheat with durum wheat then, F1 emmer wheat generation was again backcrossed with emmer wheat (sinana-01) two times. The objective of crossing was to improve yield, thresh ability and disease reaction of emmer wheat. After filial generation was evaluated at different breeding stages in different years, better lines were selected and evaluated at two environments namely; Sinana and Goba. In multi-location trial, thirteen (13) genotypes retained from the yield trial were further evaluated. The experiment was studied for three consecutive years at both environments during 2013, 2014 and 2015 main cropping seasons. Including two checks fifteen (15) emmer wheat genotypes were evaluated for their yield performance, disease resistance and other agronomic performance at multilocation. 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. The seed rate 100kg/ha and fertilizer rate $P_2O_5$46kg/ha and N18kg/ha was utilized. The experiment was conducted in the main season under rain fed condition. All the agronomical packages and practices were applied to raise healthy crop. Data were collected on plant and plot basis for morpho-agronomic traits of emmer wheat; days to heading, days to mature, biomass weight, grain yield, disease data (leaf, yellow and stem rusts) 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 for 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. Based on data analyzed and field performance, Haydaroo (*Sinana_01/ DZ2212// Sinana_01*) was selected and verified at multilocation. After verification of Haydaroo (*Sinana_01/ DZ2212// Sinana_01*) at multi-location the National Seed Releasing Committee has been evaluated and recommended to release as per the guide line of the variety releasing and registration of the country.

3. Results and Discussions

3.1. Morphological Characteristics

Haydaroo is suitable for highlands from the point of its morphological features. The average plant height is 108cm, it means of the length of stalk of modern varieties. The height of plant has its own merits and demerits. Higher varieties are more competitive to weeds, but they may cause some problems as lodging. So, the plant height of this newly released variety is medium (108cm) and it has strong stalk. It has high biomass and good plant stand 81% (Table1). It has erected growth habit, deep green at vegetative stage, has compact and slightly gay to black awn ear type (Figure 1). Also it has amber seed color.

Figure 1. *Morphological structure of Emmer Wheat Haydaroo variety at Milking Stage.*

Moreover, other characteristics of the variety were described in Appendix I.

3.2. Varietal Characteristics

A varietal character governed by Haydaroo includes better disease resistance/tolerance (Table 1). Also the thresh ability of the variety is improved to some extent as a result of genetic heritability of both crops. The variety has good tillering capacity and densely populated. It has medium days for heading (72) and it takes 127 days to reach physiological maturity (Table 1).

Table 1. *Mean agronomic performance and disease reactions of 15 emmer wheat genotypes tested in emmer wheat regional variety trial (EWRVT) combined over locations and years (2013-2015).*

SN	Genotypes	Agronomic, yield and disease data					
		DH	DM	PLH	St	Gyldha	Lr
1	(Sinana-01/Ude)//Sinana-01(1)	67	127	109	81	2894.1	30s
2	(Sinana-01/Ude)//Sinana-01(4)	68	126	106	78	2917.6	40s
3	(Sinana-01/Ude)//Sinana-01(22)	70	126	108	80	2933.6	30s
4	(Sinana-01/Cocorit71)//Sinana-01(4)	65	125	105	79	2753.9	40s
5	(Sinana-01/Cocorit71)//Sinana-01(12)	69	126	110	84	3175.5	40s
6	(Sinana-01/Gedilfa)//Sinana-01(1)	66	127	112	82	3229.6	30ms
7	(Sinana-01/Gedilfa)//Sinana-01(8)	64	128	114	84	2915.3	40s
8	(Sinana-01/Gedilfa)//Sinana-01(9)	68	128	109	80	2725.7	40s
9	(Sinana-01/Gedilfa)//Sinana-01(11)	70	126	107	83	2927.6	30s
10	(Sinana-01/Gedilfa)//Sinana-01(12)	70	126	106	82	2984.5	30s
11	(Sinana-01/DZ2212)//Sinana-01(3)	70	126	106	82	2935.2	25sms
12	(Sinana-01/DZ2212)//Sinana-01(10)	72	127	108	81	3023.8	30s
13	(Sinana-01xDZ2212)//Sinana-01(13)	69	127	108	84	2972.8	40s
14	Sinana-01	72	125	105	82	2637.1	40s
15	Local	70	125	106	80	2646.3	40s
Mean		68.6	126.5	126.5	81.4	2911.5	
CV(%)		4.8	7.7	6.8	9.0	24.6	
LSD(5%)		2.2	3.0	4.8	4.8	615.4	

Note: DH: days for heading, DM: days to maturity, PLH: plant height (cm), St: stand in percentage, Gylha: grain yield (kg/ha), Lr: leaf rust (%), S: Susceptible, MS: moderately susceptible, SMS: Susceptible to moderately susceptible, Mr: Moderately resistant, Tr: Trace, Trms: Trace with moderately susceptible, Trmr: Trace with moderately resistant, R: Resistant, CV(%): Coefficient of variations, LSD: Least significant differences, ns: non-significant differences based on the 0.05 probability level of LSD

3.3. Yield Performance

Highly significant variations among emmer wheat genotypes studied were observed. The mean grain yield of Haydaroo ranged from 17.8 to 45.7 quintal per hector. Also average grain yield ranges from 24.6 to 45.3 quintal per hector at research field where as, 17.8 to 45.7 quintal per hector at farmers' field. The mean grain yield of Haydaroo combined over locations and years contribute 30.24 quintal per hector which is higher than standard check Sinana-01 (26.3qt/ha) and Local check (26.4 qt/ha) (Table 1), whereas, the lowest grain yield were recorded for some tested entries (Table 1). Total yield advantage of Haydaroo over the standard check Sinana_01 was 14.7% and 14.3 % over the Local check (Table 2). Also, the trial was verified and evaluated at multilocation during 2016 and the yield performance of the candidate was superior over checks (Table 3).

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

Year	Location	Error mean square (EMS)	Total yield (kg/ha) of the candidate variety Sinana_01/DZ2212//Sinana_01 (Haydaroo)	PercentofcheckSinana_01inthetrial	Percent of Local check in the trial
2013	Sinana	206371.5	4421.3	19.0	10.8
	Goba	289334.5	2491.7	-8.2	-8.3
2014	Sinana	182505.8	2414.2	54.9	63.9
	Goba	86705.5	1782.5	19.7	22.7
2015	Sinana	262600.3	2465.8	10.1	46.3
	Goba	262051.3	4567.0	11.3	0.2

3.4. Quality Characteristics

Haydaroo thresh ability as well as its height improved. Emmer wheat provides the production of very good-quality grains. According to several authors, crude protein content in grain is very high; it may achieve 20% [12]. The seed color Haydaroo also preferred by consumer.

Table 3. *Mean agronomic performance and disease reactions data of the candidate verified at multi-location (2016).*

S NO.	Genotypes	Agronomic and disease data							
		DH	DM	Plh	Gy	ST	SR	YR	LR
1	Snana-01/Gedilfa//Sinana-01(1)	56	132	112	27.50	75	0	15ms	10ms
2	Local check	59	133	106	29.10	80	Trms	5ms	20ms
3	Sinana-01/DZ2212//Sinana-01(10)	55	134	108	41.50	95	0	5ms	5ms
4	Sinana-01(Standard check)	60	135	105	34.20	85	trms	10ms	15ms

Note: Dh: days for heading, Dm: days to maturity, Plh: plant height (cm), 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

3.5. Disease Reaction

The major emmer wheat disease according to their importance in the growing area is rust (Leaf rust, yellow rust and stem rust). Disease data across location and years were scored and analyzed. Haydroo reaction response showed moderately resistance for leaf rust (Table 1). Also Haydaroo is tolerant for yellow and stem rusts (Table 3). Generally, Haydaroo variety is tolerant for disease, pests and other abiotic factors.

3.6. Adaptation Range

Haydaroo released for highlands of Bale and similar-agro-ecologies. It performs very well in areas having an altitude 2400-2500 m.a.s.l. and annual rainfall of 750-1500mm. Also it is possible to extend the production of this variety to other areas having similar agro-ecologies. Planting date is mid June to early September based on the agro-ecologies of the area. The seed rate recommendation for the variety is 100kg/ha and to achieve better yield fertilizer rate is 46kg/ha of P_2O_5 and 18kg/ha of N.

3.7. Variety Maintenance

The variety maintained by foundation seed of the variety by Sinana Agricultural Research center / Oromia Agricultural Research Institute.

4. Conclusion

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. Based on yield performance, disease reaction and agronomical parameters evaluated the newly released variety (Haydaroo) is very suitable for the studied environments. It is the most economical advantage variety (high yielder, disease tolerant, good stand, simple to thresh and better biomass weight) as compared to checks. The variety had above average yield performance in most tested environments, out yielded for Sinana-01 and Local check. The average grain yield of Haydaroo is 30.5 quintal per hector. It has 14.7% and 14.3% yield advantage over the standard check Sinana-01 and Local check respectively. Generally; it is uniform, stable, disease and abiotic factor tolerant and can adapted to a wider environments.

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Appendix

Agronomic and Morphological Descriptors of Newly Released Emmer Wheat Variety (Haydaroo)

1. Variety Name: Haydaroo (Sinana-01/DZ2212//Sinana-01)
2. Adaptation area: Highlands of Bale and similar agro-ecology
   (i) Altitude (m.a.s.l):2300-2600m.a.s.l
   (ii) Rain fall:750-1500mm
3. Seed rate:100kg/ha
4. Planting date: Mid June to early September in Bale based on the agro-ecologies of the area
5. Fertilizer rate (kg/ha):
   (i) P_2O_5=46
   (ii) N=18
6. Days to heading:72
7. Days to mature:127
8. Plant height:108
9. Growth habit: Erect and deep green
10. Ear type: compact and grey to black awn
11. Seed color: Amber
12. Crop disease reaction: Resistance/tolerance to major emmer wheat disease and pests
13. Yield(qt/ha):
   (i) Research field:24.6-45.3
   (ii) Farmers field:17.8-45.7
14. Year of release=2017
15. Breeder/maintainer: Sinana Agricultural Research

Center/Oromia Agricultural Research Institute

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