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Research Article

The Release and Registration of "Hachalu" Bread wheat (*Triticum aestivum* L.) Variety for highland of Southeastern Ethiopia

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Abstract

Releasing of improved bread wheat varieties plays a significant role in increasing the production and productivity. Many Bread wheat varieties have been released so far in the Ethiopia by different National and Regional Research centers. But most of them are pushed out of production within few years of their release due to biotic factors (mainly rusts). The objective of this study was to evaluate and release high yielding and stable variety. Hachalu (RANA96/SIDS-1) is ICARDA crossing material formerly introduced to SARC as ICARDA screening nursery in 2014 cropping season. Based on its performance the genotype promoted from screening to observation and then transferred to variety yield trial 2017 under multi-location for two consecutive years (2017 and 2018) at Sinana, Agarfa and Goba. Hachalu had performed better than all genotypes and checks. The yield advantage of Hachalu was 8.9% over standard check Sanate. On research field, Hachalu gave grain yield ranging from 5.29-6.37ton ha-1 and 4.19-5.12 ton ha-1 on farmers field. Hachalu has erect juvenile plant growth, a semi-erected flag leaf with broad leaf width. The spike is owned, medium-dense spike type, and tapering. The kernel is amber color and relatively medium-tall variety with 103.7cm height with high tillering capacity. The genotypes with PCA1 scores close to zero expressed general adaptation accordingly, genotype G13 (Hachalu) with its relative IPC1 scores close to zero, has less response to the interaction and showed general adaptation to the test environments. The released variety Hachalu has moderately susceptible reaction to both stem rust and yellow rust with 10% and 5% severity, respectively. SARC will maintain breeder seed and small quantities of seed for research purposes may be obtained from the corresponding wheat breeders in Center. Small holder farmers, private investors and seed enterprises can benefit more from producing Hachalu variety following its full production package.

Keywords: *Released; Hachalu, Grain yield, Stable genotype.*

Introduction

Ethiopia is leading wheat producer in Sub Saharan Africa and total production of 4.64 million tons (CSA, 2018). Accordingly, Oromia National Regional State contributes a total production of 2.66 million tons in the country. Among the wheat producing zones of Oromia, Arsi, West Arsi and Bale are considered as the wheat belts of eastern Africa. Although the productivity of wheat has increased in the last few years in the country, it is still very low as compared to other wheat producing countries in other parts of the world. The national average of wheat productivity is estimated to be 2.74 t ha^{-1} (CSA, 2018), which is below the world average of 3.5 t ha^{-1} (USDA, 2019). Production and productivity of wheat is highly constrained by accessibility of improved seed and other biotic (diseases, insect pests and weeds) and abiotic (moisture stress, low soil fertility, recurrent drought and others) factors, which hampered our attempt to bridge the gap for huge demand in wheat.

Wheat is one of the major staple crops in the county in terms of both production and consumption. In terms of caloric intake, it is the second most important food in the country next to maize (FAO, 2014). Wheat produced in Ethiopia is used mainly for domestic food consumption, seed and raw material for agro-industries. It accounts for about 10-15% of all the calories consumed in the country (Berhane *et al.*, 2011; FAO, 2014). Moreover, estimated total wheat

consumption (for food, seed and industrial use) is rapidly increasing at the national level (CSA, 2017). According to GAIN (2014), wheat consumption growth is higher in urban areas than other area due to higher population growth, changes in life style, and the rising prices for *teff*.

Releasing of improved bread wheat varieties plays a significant role in increasing the production and productivity of wheat in Ethiopia particularly Oromia. Many Bread wheat varieties have been released so far in Ethiopia by different National and Regional Research centers. Even though, many bread wheat varieties are released for production in many parts of the country over years, most of them are pushed out of production within few years of their release due to biotic factors (mainly rusts) and threatened by newly evolving and existing virulent races of rusts. Besides, the recurrent climate change is becoming a challenge and there is a need to develop climate resilient crop varieties for wide adaptation area. Therefore, release of new bread wheat varieties should be a continuous endeavor by using locally adapted varieties and/or introduction of exotic materials to cope up with the current rust epidemic problem. The objective of this study was to evaluate and release high yielding and stable variety.

Variety Origin and Evaluation

Hachalu is ICARDA crossing material and its Pedigree: RANA96/SIDS-1. It was formerly introduced to Sinana Agricultural Research Center as ICARDA bread wheat screening nursery in 2014 cropping season. During screening this genotype had a good performance and then promoted to Bread wheat Observation nursery in 2015 cropping season at Sinana with 120 genotypes and then promoted to bread wheat Preliminary yield trial 2016 (BWPYT-16) with 49 genotypes at Sinana in 2016 cropping season. Based on performance in preliminary yield trial this genotype was transferred to bread wheat regional variety trial 2017. Under multi-location the experiment was tested for two consecutive years (2017 and 2018) at Sinana, Agarfa and Goba districts. Hachalu (RANA96/SIDS-1) had performed better than all genotypes and checks.

Yield Performance

The grain yield performance of the newly released bread wheat variety is described in Table 1. During multi location evaluation at three Sinana, Agarfa Goba for two years from 2017 to 2018, mean grain yield was consistently better than all genotypes. The yield advantage of Hachalu was 8.9% over standard check Sanate. On research field, Hachalu gave grain yield ranging from 5.29-6.37ton ha-1 and 4.19-5.12 ton ha-1 on farmers field during multi location test.

Morphological and Agronomical characters

Hachalu has erected juvenile plant growth, a semi-erected flag leaf with broad leaf width. The spike is owned, medium-dense spike type, and tapering. The kernel is amber color and oval in shape with angular cheeks and a narrow, mid deep crease. Hachalu is relatively medium-tall variety with 103.7cm height with erected type upright growth habit and high tillering capacity.

Table 1. Morphological and Agronomical descriptions of variety Hachalu

Variety Name	Hachalu
Pedigree	RANA96/SIDS-1
Adaptation area	Highlands of Southeastern Ethiopia and similar agro ecology
Altitude (m.a.s.l)	2000-2500
Rainfall (ml)	750-1500
Fertilizer (kg/ha)	
NPS	100
Urea	50
Seed rate (kg/ha)	150
Days to heading	71
Days to mature	143
1000 seed weight(g)	44
Hectoliter weight(kg/hl)	83.1
Plant height(cm):	103.7
Yield (qt/ha^{-1})	
Research field	52.9-63.7
Farmers' field	41.9-51.2
Seed color	Amber
Growth habit	Erect
Spike density	Medium density
Seed shape	Oval shape

Genotype Stability Performance

Figure 1 AMMI biplot where genotypes and environments are depicted as points on a plane. The abscissa showed the main effects and the ordinate showed the first multiplicative axis term (PCA1). The horizontal line showed the interaction score of zero and the vertical lines indicated the grand mean yield (tha^{-1}). Displacement along the vertical axis indicated interaction differences between genotypes and between environments, and displacement along the horizontal axis indicated difference in genotype and environment main effects. The genotypes with PCA1 scores close to zero expressed general adaptation whereas the larger scores depicted more specific adaptation to environments with PCA1 scores of the same sign (Ebdon and Gauch, 2002).

Accordingly, genotype G13 (Hachalu) with its relative IPC1 scores close to zero, has less response to the interaction and showed general adaptation to the test environments. The best genotype should hold high yield with stable performance across a range of environments. Based on this genotype, G13 (Hachalu) was combined the highest mean yield over test environments (Table 1) with demonstrated low IPC1 score is considered as the most stable cultivar with relatively less variable yield performance across environments (Figure 1).

AMMI 2 biplot was generated using genotypic and environmental scores of the first two AMMI multiplicative components to cross-validate the interaction pattern of the 20 bread wheat genotypes within six environments (Figure 1). Connecting vertex genotypes markers in all direction forms a polygon, such that all genotypes are contained within the polygon and a set of straight lines that radiate from the biplot origin to intersect each of the polygon sides at right angles form sectors of genotypes and environments (Hernandez and Crossa, 2000; Yan, 2011). Based on AMMI2, a biplot with six sections were observed depending upon signs of the genotypic and environmental IPC scores (Figure 1).

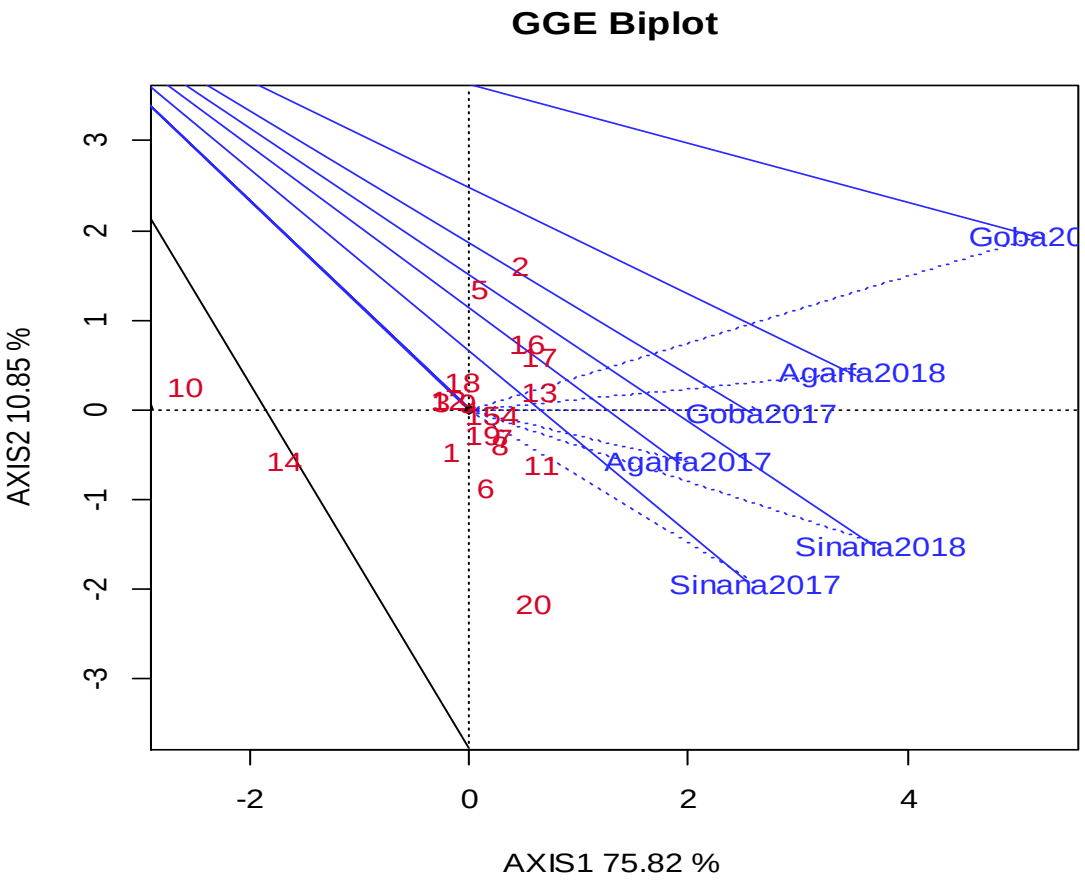

Figure 1: AMMI biplot analysis showing the mega-environments and their respective high yielding genotypes (G13= Hachalu).

Disease Reaction

Yellow and stem rust severity were assessed by estimating the approximate percentage of leaf/stem area damaged using modified Cobb's 0-100% scale (Peterson *et al*., 1948); where, 0% is considered immune while, 100% is completely susceptible to rust. The released variety Hachalu has moderately susceptible reaction to both stem rust and yellow rust with 10% and 5% severity, respectively (Table 2) where as the maximum score of stem rust overall location for the check

Sanate and Mada walabu were 15s and trms, respectively. Yellow rust was scored 10s and 50s for checks Sanate and Mada walabu, respectively.

Table 2. The maximum Disease Reaction of variety Hachalu and genotypes tested with released variety overall locations

SN	Genotypes	Yr	Sr
1	KINDE/4/CMH75A.66//H567.71/5*PVN/3/AERI	40s	trms
2	Sanate	10s	15s
3	CHYAK/RL6043/3*GEN C	40s	10s
4	C80.1/3/BATAVIA//2*WBLL1/3/C80.1/3*QT4522//	20s	15s
5	BLOUK#1/DANPHE#1BECARD	10s	5ms
6	PASTOR//HXL7573/2*BAU/3/WBLL1/4/1447/PASTOR	20s	5s
7	WBLL1*2/BRAMBLING/5/BABAX/LR42//BABAX*2/4/	10s	trms
8	WBLL1*2/BRAMBLING/5/BABAX/LR42//BABAX*2/4/	20s	trms
9	T.DICOCCON PI254157/AE.SQUARROSA(879)/4/	5ms	40s
10	MOUKA-4/RAYON	60s	10s
11	FLORKWA2/6/SAKER'S'/5/ANZA/3/KVZ/HYS//YMH/TOB/4/BOW'S'/7/DAJAJ-6	5mr	trms
12	KUAZ/PASTOR//FLAG-4	10ms	trs
13	RANA96/SIDS-1 (Hachalu)	10ms	5ms
14	Mada walabu	50s	trms
15	ETBW7670	15s	trms
16	ETBW6435	20s	5s
17	ETBW6861	30s	10s
18	ETBW8469	15s	5ms
19	ETBW8146	10s	5s
20	WAXWING//PFAU/WEAVER/3/FRNCLN	40s	20s

Availability/variety maintenance

Sinana Agricultural Research Center will be maintaining breeder seed of Hachalu. Basic and Pre basic seed will be multiplied by SARC and other private or public seed producing enterprises. Seed sample will be deposited in the Ethiopian Biodiversity conservation institute for genetic resources preservation. Small quantities of seed for research purposes may be obtained from the corresponding wheat breeders in SARC.

Conclusion and Recommendation

Hachalu is high yielding and stable variety across locations with desirable agronomic and morphological traits as compared to the rest of genotypes used in the study. Accordingly, it has been officially released for highlands of Southeastern Ethiopia and areas with similar agro ecologies in 2020. This variety has got its name 'Hachalu' to remind contribution our artist who lost his life in June 2020. This variety is currently under seed multiplication for further production in Bale highlands and similar agro-ecologies. Small holder farmers, private investors and seed enterprises can benefit more from producing Hachalu variety following its full production package.

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