

Title: Durum wheat (*Triticum durum* Desf) Variety “Tesfaye” Performance in Ethiopia

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Abstract

*Durum wheat (*Triticum durum* Desf.) is an industrial crop and recipe for traditional food in Ethiopia and the North African Countries. After subsequent evaluation in the national variety trial, this variety was selected and evaluated at Debre Zeit, Minjar, Enuary and Chefe Donsa one on -station and three on farms in 2014/15 and it was proved to have stable, high yield and excellent industrial qualities. A durum wheat variety: Tesfaye CDSS04Y01186T-OTOPB-12Y-0M-06Y-1M-1Y-0B) developed by CIMMYT and released for production in the mid to highlands of Ethiopia and similar agro-ecologies. It has also partial resistance to stem, yellow and leaf rusts. The multi-environment testing in the national variety trial for two years confirmed its productivity with above-average yield performance in all environments and a yield advantage of 8% and 13.3% over the current commercial durum wheat varieties Mangudo and Hitosa, respectively. The name “Tesfaye” given to commemorate the late Dr. Tesfaye who was a senior durum wheat researcher.*

Keywords: Durum wheat; Tesfaye; Yield; Quality

Abbreviations: CSA: Central Statistical Agency, CIMMYT = International Centre for Wheat and Maize Improvement, ICARDA = International Center for Agricultural Research in the Dry Areas.

Introduction

Tetraploid wheat ($2n = 4 \times 9 = 28$) has been cultivated in Ethiopia for thousands of years. Through the long-time evolution, this species has acquired a diverse set of characteristics (Tsegaye and Berg 2007). Ethiopia is a center of diversity for tetraploid wheat (Mengistu et al., 2016). Hence, the species exhibits tremendous variability for a number of traits, including resistance to *Septoria tritici* blotch (STB) (Kidane et al., 2017), novel sources of resistance to rust and drought tolerance traits (Cherinet et al., 2018)

There are six types of *Triticum* species of which *Triticum aestivum* and *Triticum turgidum* are the most dominantly grown species in Ethiopia. Durum wheat as an industrial crop demands modern varieties with acceptable level of quality parameters, (i.e., protein content and gluten quality). Modern breeding technologies can achieve this, but it depends on a steady supply of 'fresh' genetic diversity with interesting traits. Farmers grow many local varieties of durum wheat (*Triticum turgidum* ssp. durum) because of both a natural evolution and farmers' domestication.

In Ethiopia, durum wheat hybridization, which has been suspended for many years, was resumed in 2014. The national and regional agricultural research system has been striving to improve durum wheat production in Ethiopia since the late 1960s. As a result, 41 improved varieties of durum wheat have been released for commercial production from 1966 to 2018

The grain of durum wheat is used for the manufacturing of pasta products (macaroni, spaghetti, and noodles) and for the preparation of traditional Ethiopian recipes including injera, Dabo, dabo-kolo, genfo, kinche, nifro, and other food types and beverages. The straw is mainly, used as a source of animal feed.

The use of old cultivars and biotic and abiotic stress is partly attributed to the low yield of the durum wheat. Thus, the experiment was designed to develop high yielding and acceptable quality improved varieties of durum wheat suitable for diverse agro-ecologies and agricultural systems

Methodology

The experimental materials consist of twenty genotypes including “Tesfaye” sourced from Ethiopia, ICARDA and CIMMYT and a local check were evaluated during two cropping seasons (2014–2015) at eight research sites. The genotypes were grown in a randomized complete block design with four replications at each site.

Tesfaye (CDSS04Y01186T-OTOPB-12Y-0M-06Y-1M-1Y-0B): The top cross made at CIMMYT in 2004. Debrezeit agricultural research center received the genotype and included in variety trial. The combined data analysis across locations and over the years using SAS 9.1 software (SAS Institute (2002)). The seed was drilled by hand at seed rate of 125 kg/ha which is equivalent of 45gm/3m² and planting depth was ~5cm. Planting carried out at appropriate planting time for each location and fertilizer applied according to the specific recommendation (200 kg/ha of Urea and 100kg/ha of DAP) of each location. The purpose was to develop stable, high yielding; and farmers and consumers preferred durum wheat varieties for the high rainfall and optimum moisture (high potential) areas of the country. In other words, it was targeted at developing varieties with high yielding potential and better quality than the improved contemporary standard check variety Utuba was selected for its high yielding ability, farmer- and consumer-preferred high yielding amber seed color, and specific adaptability. Following successful germplasm advancement was made. As a result, Tesfaye was selected as a variety through successions of multi-environment yield tests in major durum wheat-growing regions of the country. The name “Tesfaye” given to commemorate the late Dr. Tesfaye who was a senior durum wheat researcher.

Results and Discussions

1. Yield performance

Multi-location trial testing was conducted within the national variety trial, which consisted 20 durum wheat genotypes including two standard checks (Mangudo and Hitosa) and one local check (Boohai). The experiment was carried out at eight sites for two consecutive years representing the durum wheat growing environments of Ethiopia. Yield performance of the multi-location testing for promising genotypes among the twenty genotypes is summarized in Table 3. Location x year mean yields of each of varieties Tesfaye (#8) was higher than all tested

genotypes mean yields. It was also higher than the mean yields of the two standard checks and a local check. Based on the grand mean yield, Tesfaye out yielded the standard check, Mangudo by 8% and Local check by 13%. In addition, Tesfaye was the top yielder at all environments followed by CD11-Y10 BIR SEL/97/off/2011 (#6) at all locations. In conclusion, the yield performance of the variety was above average in many environments.

2. Reaction to Stem, Yellow and Leaf Rusts

For rust diseases the modified Cobb's scale applied; i.e., disease severity (%) with reaction types (R, MR, MS and S for resistant, moderately resistant, moderately susceptible & susceptible reactions, respectively). This variety "Tefaye" showed good level of resistant for stem rust (15 MS) which is moderately susceptible at hot spot area and moderately resistant to yellow and leaf rusts. Reactions to stem, yellow and leaf rusts were recorded for all genotypes at all sites; therefore, the variety may be considered to have adequate resistance to all the three rust diseases(table 4). However, standard checks were found to be susceptible to either of the three rusts relative to the newly released varieties.

3. Physical and chemical quality analysis

The quality analysis of both physical grain analysis and chemical wheat flour analysis were presented in Tables 2 and 3, respectively. The result showed that Tesfaye has the best hectoliter weight, 1000 kernel weight and hardness index qualities from physical quality parameters and best wet gluten content, dry gluten content, starch, Zeleny and gluten index number from chemical quality parameters. These released variety is highly appreciated and accepted by farmers.

Table 2. Durum wheat cultivars yield and physical quality parameters as analyzed of the candidate verified at multi-location (2020)

Variety name	TKW	YLD	HLW	Moisture (%)	Impurity (%)	Hardness Index	Diameter
Tesfaye	50.74	6.52	82	9.4	4	92.4	2.98
Mangudo	42.4	5..12	76.4	9.8	4	69.95	2.9

Boohai (local check)	44	4.2	80	10.1	5	56.29	3.12
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Note: TKW: thousand kernel weight (gm), HLW: test weight (kg/hl), YLD: grain yield (t/ha)

Table 2. Durum wheat cultivars chemical quality parameters of the candidate verified at multi-location (2020)

Variety name	Grain Protein	Zeleny (ml)	Starch Content (%)	Wet Gluten Content (WGC) %	Dry gluten Content (DGC) %	Gluten Index (%)
Tesfaye	13.21	28	67.6	29.58	18.6	72
Mangudo	11.7	26.7	69.5	34.8	15.5	78
Boohai	8.2	20	71.7	34	14	70

4. Morphological and agronomical characteristics

During multi-location and variety verification trial, Tesfaye performed better in medium to highlands of Ethiopia. It has Medium short height, amber seed color, good tillering capacity, lodging tolerant, erect growth habit...etc. are described in Appendix I.

Table 3: Mean agronomic performance of Durum wheat genotypes evaluated in National Variety Trial across locations and over 2 years.

Genotype	TKW	HLW	protein	Wet Gluten	DTH	DTM	PH	Yield/kg
1. 34thIDONMD/89/off2011	50.25	81.33	13.47	29.75	75.54	130.02	67.45	5192.44
2. IDON-2009-off/222/2009	53.86	81.39	13.44	29.65	64.91	121.47	69.51	6151.67
3.DSP2009-off.F3.2H.291-meh.1H.158	52.37	79.68	13.46	29.53	64.86	120.45	64.05	5690.73
4. DSP2009-off.F4.2H.695-meh.2H.245	49.45	82.48	13.43	29.85	72.49	126.01	70.11	5233.41
5. CD11-Y10BEK SEL/25/off 2011	51.47	81.18	13.33	29.31	75.13	131.25	66.33	6248.81
6. CD11 -Y10 BIR SEL/97/off2011	48.67	79.44	13.32	29.08	75.07	132.38	69.8	6340.05
7. CD10-MCDZ- off/64/2010	57.14	80.53	13.01	29.19	66.56	122.48	68.68	4919.37
8. CDS10MS ELT -DZ meh 81/2010	50.74	82.28	13.21	29.58	68.2	125.42	70.35	6579.52
9. CD11-Y10 BEK SEL/115/off 2011	52.85	78.55	13.43	29.84	76.36	133.02	72.55	5837.86

10. DSP2009-off.F4.2H.976-meh.3H.291	52.84	78.81	13.35	29.05	65.03	120.23	66.08	5659.20
11. CD11-Y10 BIR SEL/197/off2011	48.5	76.68	13.29	28.54	68.61	117.4	65.79	5466.98
12. CD11-Y10 BIR SEL/95/off2011	56.59	79.69	13.48	30.25	71.14	127.46	75.99	4583.07
13. CD11-Y10 BEK SEL/98/off2011	50.56	79.21	13.54	30.02	75.43	129.92	66.74	5386.75
14. CDS10MS ELT -DZ meh61/2010	49.67	80.01	13.39	29.53	76.25	131.95	69.97	5645.06
15. 34thIDONMD/110/off2011	50.05	80.89	13.17	29.22	69.32	125.69	71.08	4864.32
16. DSP2009-off.F4.1H.429	53.98	81.68	13.72	30.4	69.49	122.7	66.08	5319.32
17. 34thIDONMD/111/off2011	51.03	81.05	13.14	28.91	63.92	119.65	63.92	5854.00
18. Mangudo	53.74	79.17	13.52	29.89	72.61	129.17	66.68	5721.94
19. Hitosa	53.92	81.45	13.23	29.29	73.31	128.74	69.7	4966.36
20. Local	51.85	81.53	12.98	28.3	69.49	125.74	72.04	5551.38
Heritability(broad)	0.62	0.67	0.36	0.72	0.84	0.8	0.67	0.80
Grand Mean	51.97	80.35	13.35	29.46	70.69	126.06	68.65	5560.66
LSD5%	3.02	1.34	0.69	1.36	1.5	1.32	4.99	900
CV5%	7.99	2.28	7.06	7.38	2.91	1.44	8.89	20.74

Note: DTH = days to heading, DTM=days to maturity, TGW= thousands grain weight (gm), PH=plant height (cm), HLW= hectoliter weight

In addition to having high yield, “Tesfaye” could be excellent progenitor of quality traits for future durum wheat national program because of having excellent yellow pigment content = 6%, protein content =13.21%, hectoliter mass = 82.28 kg/hl and wet gluten =29.58%; indicated in table 2.

Table 3: Stem rust, Leaf rust and yellow rust durum wheat genotypes disease reaction and response.

Genotype	Leaf rust	Stem rust	Yellow rust
1. 34thIDONMD/89/off2011	50s	50s	TR
2. IDON-2009-off/222/2009	5S	5RMR	TR
3. DSP2009-off.F3.2H.291-meh.1H.158	30MS	15MS	5R
4. DSP2009-off.F4.2H.695-meh.2H.245	30MS	20MRMS	TR
5. CD11-Y10BEK SEL/25/off 2011	50S	30MS	TR
6. CD11 -Y10 BIR SEL/97/off2011	20MR	30MRMS	TR
7. CD10-MCDZ- off/64/2010	5MS	15MS	0

8. CDS10MS ELT -DZ meh 81/2010	10MS	15MS	0
9. CD11-Y10 BEK SEL/115/off 2011	10MS	10MSS	5R
10.DSP2009-off.F4.2H.976-meh.3H.291	15MR	5R	0
11. CD11-Y10 BIR SEL/197/off2011	15MSS	20MR	0
12. CD11-Y10 BIR SEL/95/off2011	30S	40MS	0
13. CD11-Y10 BEK SEL/98/off2011	15MS	20MS	0
14. CDS10MS ELT -DZ meh61/2010	TR	40MS	0
15. 34thIDONMD/110/off2011	TS	40MS	TR
16. DSP2009-off.F4.1H.429	5MS	5MRMS	0
17. 34thIDONMD/111/off2011	0	5R	0
18. Mangudo	5MS	20MS	0
19. Hitosa	20MS	40MS	
20. Local	TR	TR	0

Note: MR=moderately resistant, MS= moderately susceptible, TR= tress resistant, R= resistant

Rust diseases records were taken three times using standard procedures. For rust diseases the modified Cobb's scale applied; i.e., disease severity (%) with reaction types (R, MR, MS and S for resistant, moderately resistant, moderately susceptible & susceptible reactions, respectively).

Conclusions

The development of commercial varieties, with high yielding, disease-resistant, desired quality, diverse agro-ecologies, is vital goal of breeders. According to the field evaluation of yield performance, disease reaction, and agronomical parameters, the newly released variety has been well adapted in the studied environments. In this regard, this variety has preferred characteristics; moderately disease resistant, high yielder, amber seed color, high protein content and quality, cold and lodging tolerant. Tesfaye out yielded the standard check, Mangudo by 8% and local check by 13.2%. Generally, it is high yielder, stable, highly preferred by farmers. Consequently, Tesfaye was recognized and released for large-scale production.

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Appendix I:

Agronomic and Morphological Descriptors of Newly Released Durum Wheat Variety

Variety Name: Tesfaye (CDSS04Y01186T-OTOPB-12Y-0M-06Y-1M-1Y-0B)

Adaptation area: Mid and high lands of Ethiopia

Altitude (m.a.s.l): 1800-2800 m.a.s.l

Rainfall: 750-1500mm

Seed rate: 125kg/ha

Planting date: First week of July to 4th week of July based on the agro-ecologies of the area

Fertilizer rate (kg/ha):

DAP =100

Urea=200

Days to heading: 68

Days to maturity: 120

Plant height: 70 cm

Ear type: big size having of long white awn

Growth habit: Erect

Seed color: Amber

1000 weight: 51.97

Hectoliter weight (kg/L): 80.35

Crop pest reaction: Resistance to disease and

Yield (t/ha):

Research field: 3.4 to 6.5 t ha⁻¹

Farmer's field: 2.5 to 4.5 t ha⁻¹

Quality parameters:

Protein =13.21

Gluten=29.58

Year of release: 2016

Breeder/Maintainer: Debre Zeit Agricultural Research Center

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