

Registration of a Newly Released Bread Wheat (*Triticum aestivum* L.) Variety 'Deka' for Low to Midland Areas of Ethiopia

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Abstract

The development of new varieties with high yield and acceptable levels of stability is an important breeding program. The performance of a given genotype depends on its genetic potential and the environment upon which it is grown. Deka is a commercial name given for a newly released bread wheat variety with the pedigree name ATTLA/3*BCN*2//BAV92/3/KIRITATI/WBLL1/4/DANPHE which originated from CIMMYT. It was developed and released by Kulumsa Agricultural Research Center for low to mid-altitude of wheat growing agro-ecology of Ethiopia. The variety showed higher grain yield performance than the check and it has good agronomic characteristics and early maturing type as compared to the current varieties. Deka consistently out-yielded other tested bread wheat genotype over two years. Combined years over locations analysis revealed that it had produced an average yield of 3150 kg/ha and has wide adaptability. The newly released bread wheat varieties moderately resistant to stem rust, and yellow rust and comparable for leaf rust disease and Septoria with the standard checks Kingbird and Ogolcho) and local check Hawi. It proved to be more resistant to stem yellow and leaf rust as compared to all currently produced varieties in the low land part of wheat growing agro-ecologies. Deka offers new hope for resource-poor farmers in stem rust-prone areas of Ethiopia. Deka has white grain color and it has good general acceptance for bread with high quality.

Keywords

Deka, Genotype, New Variety, Out-yielded, Rust

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1. Introduction

Wheat (*Triticum aestivum* L.) is the most widely adopted and cultivated cereal grain in the world and is an important cereal crop that receives the most attention from specialists in plant breeding and production worldwide in general and in

Ethiopia in particular. Wheat is a major source of starch and energy, wheat also provides substantial amounts of several components that are crucial for health, notably protein, vitamins (notably B vitamins), dietary fiber, and phytochemicals [1]. The unique properties of the gluten protein fraction allow the processing of wheat to produce bread, other baked goods, noodles and pasta, and a range of

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functional ingredients. Wheat is well as a strategic, industrial, political, and economic crop in Ethiopia. Wheat is becoming an important food crop in the world because of rapid population growth associated with increased urbanization and change in food preference for easy and fast food such as bread, biscuits, pasta, noodles, and porridge. It is a mandatory food crop and provides a staple food in different parts of the world [2]. Wheat annual production was more than 4.6 million tons of grain on 1.7 million hectares of land which accounted for 13.4% of total land allotted to cereals and contributing 15.17% of the total annual cereal production. Although the productivity of wheat has increased in the last few years in Ethiopia, the national average productivity is still 2.7 tons per hectare [3]. The yield of bread wheat should be increased in parallel with the increasing population [4].

Ethiopia is inimitably characterized by diverse agro-ecology and climatic conditions which are suit for the production of various cereal crops. Bread wheat is one of the major cereal crops are grown in the middle and high lands of Ethiopia [5]. So, having a different range of altitudes, soils, and climatic conditions provide ecological settings suitable for the cultivation of diverse species of wheat. Bread wheat grows in Ethiopia, in the altitude range of 1500 to 3000 m.a.s.l [6], however, the most suitable agro-ecological zones for wheat production fall between 1900 and 2700 m.a.s.l [7]. Environmental differences, i.e., in precipitation, soil productivity, abiotic and biotic stresses, and altitude within and across agro-climatic regions resulted in limited productivity and adaptability of currently available wheat varieties [8, 9]. It has covered the most cultivation area and its product is the most widely used product in the world and of primary importance for human nutrition [10, 11].

The development of varieties which can be adapted to a wide range of environments is the crucial goal of plant breeders in a crop improvement program [12]. Frequent biotic and abiotic stresses in the years and locations affect bread wheat kernel yield stability [13]. Multi-environment yield trials are crucial to identify adaptable high yielding cultivars and discover sites that best represent the target environment [14]. Poor response of genotypes to different environmental condition is the result of genotype and genotype by environment interaction; resulted in yield variations among genotypes across environments [15]. Thus, multi-environment trials (MET) are required to identify genotypes that have the specific and the general adaptability in tested environments.

Ethiopia is among the most important wheat-producing countries which are highly threatened by cereal rust particularly yellow and stem rusts. There exist frequent epidemics of these diseases as a result of the evolution of

new races. Regardless of the enormous attempts made to develop high yielding and disease-resistant varieties, therefore, the agronomic life span of most of the varieties is very short. Besides, the current global warming has a great impact on the production of wheat in Ethiopia. The process of variety development of wheat genotypes for disease resistance, wide adaptability, and high yield, which resulted in the release of many cultivars to end-user in the country, is continuing year after year through various research institutes and universities. This dictates continuous effort to develop and release new varieties with high yield potential, a good level of resistance to major wheat disease, and adaptability to different climatic conditions. However, most of these cultivars were out of production due to their susceptibility to rust disease. Developing high yielding, stable and rust resistance genotypes are important in wheat variety development strategy, and evaluation across locations would form a basis for breeding. Current commercial bread wheat varieties cultivated in the lowland are susceptible to stem rust and a long maturity period. Therefore, developing a new rust-resistant and early maturing variety is a paramount solution for the resource-poor farmers growing wheat in the low land. This paper presents the overall performances of the recently developed and released bread wheat variety Deka intending to play a significant role in full filling the variety out of the production in the country and to exploit its wheat production capacity for end-user.

2. Materials and Methods

Twenty-four bread wheat lines of ICARDA and CIMMYT origin were tested under national variety trials for two consecutive years Kulumsa, Asasa, Dhera, Melkesa, Alem-Tena, Negele-Arsi, Halaba and Haromaya University in 2015/16-2016/17. The field experiment was laid out in an alpha lattice design with three replications. The experimental field plot was 6 rows of 2.5 m long with a 0.2 m inter-row spacing. Each plot was planted at a seed rate of 150 kg /ha. Two bread wheat genotypes, ETBW7638 and ETBW9017 were selected due to significantly better mean grain yield and reaction to wheat rust (stem rust and yellow rust) across all test environments in 2017/18, the two candidate bread wheat genotypes and check varieties, Ogocho' and Kakaba, verified at six locations (at on-station and two on-farms at each location) in 2017/18 for official release. Farmers and NVRC evaluated all trials across on stations and on-farms and the committee decided the first genotypes coded as ETBW7638 and named "Deka", for official release.

3. Varietal Evaluations

Deka is a commercial name given for a newly released bread

wheat variety with the pedigree name ATTLA/3*BCN*2//BAV92/3/KIRITATI/WBLL1/4/DANPHE which originated from CIMMYT. It is targeted for moisture-stressed areas and optimum moisture areas and it has good agronomic characteristics and early maturing type as compared to the current varieties except for Kingbird. As Deka outshined many bread wheat lines obtained from ICARDA, CIMMYT, and local crossing in observation and preliminary yield trials, it was advanced to a national variety trial to be tested across wide locations over years to further test its overall performances. The bread wheat national variety trial consisting of 24 advanced bread wheat genotypes including the standard check Ogolcho, and Kingbird and local check Hawi was conducted at major bread wheat-growing regions in Ethiopia. Deka consistently out-yielded other tested bread wheat genotype over two years. Combined years over locations analysis revealed that it had produced an average yield of 3150 kg/ha (Table 1). Thus, Deka was verified at six locations (at on-station and two on-farms at each location) in 2017/18 for official release. Consequently, Deka showed superior overall agronomic performances over the standard check Ogolcho and the local check Kakaba under verification trial too. Likewise, it proved to be more resistant to stem yellow and leaf rust as compared to all currently produced varieties in the low land part of wheat growing agro-ecologies. Deka offers new hope for resource-poor farmers in stem rust-prone areas of Ethiopia. It is

expected to replace the varieties Hawi and Kakaba in lowland areas, and complement Ogolcho and a few other mid-altitude varieties.

4. Agronomic and Morphological Characteristics

Deka was adapted low to mid-agro-ecologies of Ethiopia, in the range of altitude 1550 m.a.s.l. to 2340 m.a.s.l. It gives a high yield under the range of 620 mm to 900 mm annual rainfall and in the range temperature 5.8 -28.6 degree centigrade. In an attempt to develop Deka, higher yield, and resistance to major bread wheat diseases were important traits of consideration. Deka was taken 57 days for heading and 75 days for maturing. The number of days to flowering was similar with the standard check Kingbird but earlier than Ogolcho and local check Hawi by two days. The Deka is relatively shorter in height than the standard varieties than Ogolcho and taller than Kingbird and local check Hawi. However, Deka has better thousand kernel weight and grain yield than standard check and local check and 69.47 hl/kg hectoliter weight. Deka has white grain color and it has good general acceptance for bread with high quality

Table 1. Mean performance of some important agronomic traits of 21 genotypes and 3 checks tested in 2015/16 and 2016/17 cropping season.

Entry	Genotypes	DH	DM	PHT	TKW	HLW	GYLD
1	Ogolcho	59.74	77.56	74.84	27.74	71.21	3085.54
2	ETBW 7610	57.82	75.84	68.71	31.12	70.65	2635.99
3	ETBW 7598	54.18	72.71	72.07	31.04	71.2	3174.49
4	ETBW 7609	56.71	74.96	72.06	33.95	70.81	2768.25
5	ETBW 7638	57.20	75.52	74.27	31.27	69.47	3150.75
6	ETBW 7399	54.16	72.31	71.75	31.09	71.16	3157.83
7	ETBW 7436	56.93	74.87	69.87	31.03	68.99	2847.75
8	ETBW 7496	58.92	76.57	72.41	34.05	72.35	3087.26
9	ETBW 8489	54.69	73.44	71.39	31.77	70.84	2985.15
10	ETBW 8492	56.21	74.57	71.26	28.23	70.57	3022.26
11	ETBW 7650	57.23	75.12	77.84	31.28	70.86	2745.49
12	Hawi	59.70	77.44	73.06	30.03	70.99	3000.42
13	ETBW 7652	59.78	77.26	72.29	28.25	70.18	2644.03
14	ETBW 7713	57.60	76.3	73.32	30.73	70.26	2979.45
15	ETBW 7718	57.73	75.54	71.77	26.04	72.33	2771.68
16	ETBW 7790	58.33	76.31	73.96	32.75	71.35	2562.41
17	ETBW 8048	59.41	77.31	71.29	34.15	69.93	2531.14
18	ETBW 9015	58.13	75.36	75.75	29.69	69.13	3277.57
19	ETBW 9016	58.34	75.94	72.78	30.19	70.98	2998.66
20	ETBW 9017	58.73	76.48	70.89	27.43	71.77	3043.92
21	ETBW 9018	57.57	75.59	74.8	28.68	69.62	3175.84
22	ETBW 9041	57.80	75.58	70.35	30.23	70.25	2732.35
23	ETBW 9051	62.87	80.48	74.8	29.33	66.77	2581.94
24	Kingbird	56.77	75.33	71.64	28.33	69.91	2873.46
GRAND MEAN		57.77	75.76	72.63	30.35	70.48	2909.734
CV (%)		3.35	2.32	6.68	10.17	5.03	16.26
LSD (5 %)		0.86	0.85	2.16	1.43	2.15	210.368
R-squared		0.97	0.99	0.94	0.91	0.76	0.947

Note: DH: Days to heading; DM: Days to maturity; PHT: Plant height; TKW: Thousand kernel weight; HLW: Hectoliter weight; GYLD: Grain Yield

5. Disease Resistance

Current commercial bread wheat varieties cultivated in the lowland are susceptible to stem rust and a long maturity period. There was intense stripe rust disease pressure, the newly released bread wheat variety which was designated with local name Deka exhibited a high level of yellow rust resistance with resistance and moderately resistance response respectively (Table 2). The standard check Kingbird which was released in 2015 and local check Hawi moderately

susceptible reaction response to stem rust and highly susceptible yellow rust and another standard check Ogolcho shows moderately susceptible to yellow rust and highly susceptible to stem rust when compared with a newly released variety called Deka. The newly released bread wheat varieties moderately resistant to stem rust, and yellow rust and comparable for leaf rust disease and Septoria with the standard checks Kingbird and Ogolcho) and local check Hawi (Table 2).

Table 2. Disease response of 21 genotypes and 3 checks tested in 2015/16 and 2016/17 cropping season.

Name	2015			2016			AA	DR	AN	GR	NR
	KUL	AA	MK	KUL	SR	SR					
	SR	SR	SR	YR	SR	SR					
Ogolcho	5MR	5MR	TMR	20SMS	5MR	30MS	5MR	30MR	25MS	5MS	80S
ETBW 7610	TMS	0	0	50S	TMS	50S	20SMS	50MS	0	10MS	10M
ETBW 7598	TMR	0	5MR	70S	TMR	100S	20MS	70S	10MR	20MS	50S
ETBW 7609	5MS	5MS	TMR	60S	TMS	50S	50S	25MR	20MR	25MS	15MS
ETBW 7638	5MR	5MR	0	20MR	TMS	20MR	15MS	10MR	20MS	TMR	20M
ETBW 7399	0	5MS	TMR	60S	10MS	80S	10MS	30MS	20MS	20S	20MSS
ETBW 7436	0	0	TMR	100S	0	90S	5MR	30MS	45MS	50S	30M
ETBW 7496	TMR	5MR	TMR	40MS	TS	60S	15MS	70S	15MR	30S	30M
ETBW 8489	0	TMR	TMR	70S	0	80S	5MR	70S	20MR	10MS	5MR
ETBW 8492	0	0	0	90S	0	90S	5MS	60S	0	30S	40M
ETBW 7650	0	5MS	TMR	80S	TMR	100S	15MS	60S	25MS	60S	40M
Hawi	5MR	5MR	0	70S	0	60S	TMR	40MS	25MS	5MS	-
ETBW 7652	5MR	10MS	5MR	100S	TR	100S	15MS	35MS	30MS	60S	30M
ETBW 7713	10MS	5MR	TMR	90S	TMR	100S	5MS	80MS	15MR	60S	20M
ETBW 7718	20MS	10MS	30MS	90S	5MR	100S	40SMS	60MS	10MR	50S	30M
ETBW 7790	TMR	5MS	10MS	TMS	5MS	60S	20SMS	25MS	30MS	TMS	10MS
ETBW 8048	0	TMR	TMS	90S	0	90S	5MR	10MR	20MS	30S	40M
ETBW 9015	TMR	5MS	10MS	5MR	TMR	70S	5MR	70MS	15MR	TMR	50MSS
ETBW 9016	5MR	5MS	TR	60S	5MS	60S	5MR	60MS	10MS	20S	MSS
ETBW 9017	5MR	5MR	5MR	10MR	0	20MR	5MR	25MS	15MS	10MS	20MR
ETBW 9018	TMR	0	TMS	20MR	TMS	30S	5MS	60MS	5MR	5MS	20MR
ETBW 9041	10MR	5MR	TMS	10MS	70S	30MS	50SMS	30MR	30MS	10MS	60MSS
ETBW 9051	5MR	5MS	40S	20MS	TMS	60S	40S	70MS	15MS	5MS	5M
Kingbird	TMR	TMR	TS	60S	TMR	60S	5MS	25MR	25MS	5MS	-

Where: MR: Moderately Resistance; MS: Moderately Resistance; S: Susceptible and TR: Trace resistance

6. Conclusion

Increasing the production of foodstuffs in developing countries against the background of rapid population growth, widespread food shortage, malnutrition and the destruction of the natural resource base still remains important for the future. Therefore, there is a need to intensify crop production through application of relevant innovations including better crop varieties adapted to varying agro ecological conditions and socioeconomic set-ups. The development of cultivars or varieties, which can be adapted to a wide range of diversified environments, is the ultimate goal of plant breeders in a crop improvement program. The adaptability of a variety over diverse environments is usually tested by the degree of its interaction with different environments under which it is planted. A variety or genotype is considered to be more

adaptive or stable one if it has a high mean yield but a low degree of fluctuation in yielding ability when grown over diverse environments.

A successful variety must produce a high yield in favorable environments and still should produce acceptable yield under less favorable ones. In general, both yield and stability of performance should be considered simultaneously to take advantage of the useful effect of GE interaction and to make a selection of the variety more precise and refined. Deka was the best yielding bread wheat variety. It is stable in grain yield performance over locations and years. It was resistant to major wheat rust diseases that prevailed in the growing areas. Farmers also preferred the variety for its superior performance over the existing local variety, which is manifested by better grain yield, and disease resistance. Likewise, the variety has white grain color and it has good general acceptance for bread with high quality. Hence, Deka

was verified and officially released for Low to midland wheat-growing areas of Ethiopia in 2018.

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