Development of Soil Acidity Tolerant Triticale (*X-Triticosecale*) Variety under Acid Soil Prone Areas of Ethiopia

Fekadu Mosissa[1], Gemechu Keneni[1], Geremew Taye[1], Sisay Aragaw[1], Cherinet Asefa[1], Matiyas Dejene[1], Tolesa Debele[5] and Temesgen Desalegn[1]

[1] Holetta Agricultural Research Centre, PoBox-2003, Addis Ababa, [2]Ethiopian Institute of Agricultural Research (EIAR); *Corresponding Author E-mail* fekadu.mosisa@yahoo.com

Abstract

*Triticale (***X-Triticosecale Wittmack***) is a result of chromosomal addition of wheat (Triticum spp.) as a female parent and rye (Secale cereal L.) as the male parent (pollen donor). Its genomic constitution (AABBDR or AABBRR) is an artificial cereal crop genus from these two cereal crops. Triticale has the best agronomic features of the parental species, most importantly it combines the vitality and robustness of the rye plant in terms of disease and drought tolerance, and adaptation to poor soil conditions with the superior grain quality characteristics of Triticale. Even though triticale is a hardy plant that can comparatively withstand soil fertility problems the study aimed to select acid tolerant high yielding and promising Triticale variety. One hundred fifty test genotypes were subjected to sever selection pressure and fourteen elite genotypes including the candidate variety (ETCL 161) were promoted to National Variety Trial (NVT), and laid in a randomized complete block design with three replicates. The result revealed that ETCL 161 is superior in grain yield performance in the multi-location trials across the testing environments of acid soil affected areas. It has better agronomic performance and a comparative yield advantage of 17.9% and 15.34% over the standard checks Dilfakew and Logaw respectively. Hence, it has been approved for release by the National Variety Release Committee. Therefore, cultivation of the new variety is recommended in highland acid prone areas of the country having similar climatic conditions with the testing sites.*

Introduction

Ethiopia is a country of diverse agro-ecologies and natural resource bases. The highlands which account 43% of the total land area, host 88% of the human and 86% of the livestock populations (Amsalu *et.al.* 2007). Ninety-five percent of the total cultivated land area also concentrates in the highlands of Ethiopia (Sonneveld and Keyzer, 2003). Soil erosion, loss of fertility and soil acidity are some of the critical challenges facing land productivity in the highlands of Ethiopia. In the central-western highland areas soil acidity and fertility loss are influencing agricultural productivity than ever. Particularly, areas receiving high rainfall and the soil type dominated by Nitisols are the immediate victim of the increasing level of soil acidity.

It is generally agreed that liming is the best approach to overcome soil acidity. Unless efficient soil fertility management practices and amelioration of soil acidity are designed and implemented, the productivity of acidic soils will remain poor. As liming alone is expensive, and in some situations subsoil acidity restricts the benefit of lime, genotypes with better tolerance to acidity are alternative integral approach in-terms of cost efficiency, convenience and sustainability. Triticale (X-*Triticosecale wittmack*) is a result of chromosomal addition of wheat (*Triticum spp*.) as a female parent and rye (Secale cereal L.) as the male parent (pollen donor). Its genomic constitution (AABBDR or AABBRR) is an artificial cereal crop genus from these two cereal crops. The resulting hybrid is sterile and thus has to be treated with the alkaloid chemical colchicines to make it fertile and thus able to reproduce itself (Ashenaf Gedamu – Gobena, 2008).

The overall objective of Triticale development has been to combine the best agronomic features of the parental species, most importantly to combine the vitality and robustness of the rye plant in terms of disease and drought tolerance, and adaptation to poor soil conditions with the superior grain quality characteristics of wheat. Kim *et al.* (2001) also reported that the advanced lines showed the highest degree of Aluminum (Al) tolerance in acid soils containing high level of Al in Brazil. The objective of this study is to obtain an acid tolerant high yielding and promising *Triticale (X-Triticosecale)* variety.

Materials and Method

Description of Soil Acidity level of the Study Areas

The national variety trial (NVT) and variety verification trial (VVT) experiments were carried out at seven soil-acidity prone locations (Holetta, Jeldu, Robgbeya, Gumer, Mulo and Telecho). These sites have a pH range 4.45 – 4.93/ very strongly acidic soils (Soil Survey Division Staff, 1993).

Experimental Procedures

One hundred fifty test genotypes were brought from the national program coordinating center (Kulumsa), placed in screening in 2013/14 and subjected to simple mass selection with and without lime at Holetta and Bedi. By posing a sever selection pressure fourteen elite genotypes including the candidate variety (ETCL 161) were promoted to National Variety Trial (NVT). The work was done by the collaboration of a senior crop breeder and the acid soil research team of the center at Holetta. The NVT was carried out at seven soil-acidity prone locations (Holetta, Jeldu, Gumer, Mulo, Rebugebeya and Telecho) in 2014/15 and 2015/16, in randomized complete block design with three replications having a plot size 3*4 m^2 consisting 20cm distance between rows. Fertilizers used were urea at the rate of 72 kg ha^{-1} and DAP at the rate of 150 kg ha^{-1}. Likewise, seeds were planted in rows at the rate of 150kg ha $^{-1}$. Data were collected on phonological traits (days to flowering and days to maturity) and important agronomic traits (plant height (cm), Spike length, Spikelet per spike and thousand seed weight (g) were recorded based on the standard procedure. All field handling and weed management practices were undertaken as per the standard recommendations. Moreover, all the yield and yield related parameters were taken from thirteen central rows of 11.4 m^2 areas.

Finally, the measured agro-morphological traits were subjected to analysis of variance using SAS software version 9.00(SAS, 2004). As a result, promising genotypes with better agronomic performance across all testing sites was identified. The identified genotype, ETCL - 161 was entered into the variety verification trial for release in 2016/17.

Results and Discussion

Agronomic and Morphological Characteristics

The candidate genotype ETCL 161 showed clear superiority ($P \leq 0.05$) over the other genotypes and standard checks in biomass (3108.87 kg ha^{-1}) and grain yield (7382.8 kg ha^{-1}), and also it has less maturity time /or early maturity period (134 days) when compared with other genotypes (Table 1). Mean grain yield performance rank order of the candidate genotype ETCL 161 in respective testing locations was very good (Table 1).

Table 1: Mean value of morpho-agronomic traits of triticale genotypes combined over location and over years (2014 -2016)

	Morpho - agronomic traits							
Genotype	**PLHT (cm)**	**SL (cm)**	**SPS**	**BM (kg/ha)**	**HLW**	**TSW**	**MD**	**GYLD (kg/ha)**
ETCL - 173	**102.79**	**9.19**	**66.05**	**3119.0**	**75.77**	**44.23**	**140**	**6560.6**
ETCL - 231	**104.69**	**9.26**	**68.23**	**3052.4**	**76.95**	**40.63**	**138**	**6510.5**
ETCL - 147	**105.38**	**9.67**	**78.42**	**3066.7**	**77.10**	**40.89**	**141**	**6597.0**
ETCL - 185	**116.26**	**9.65**	**68.97**	**3066.7**	**75.70**	**50.99**	**139**	**6457.5**
ETCL - 175	**104.92**	**9.87**	**73.01**	**2942.9**	**77.78**	**43.54**	**137**	**6608.4**
ETCL - 143	**105.12**	**9.64**	**72.47**	**3038.1**	**77.56**	**43.49**	**136**	**6508.2**
ETCL - 207	**103.71**	**9.84**	**72.72**	**3009.5**	**77.42**	**44.32**	**139**	**6389.9**
ETCL - 192	**102.03**	**9.19**	**66.75**	**3152.4**	**75.69**	**42.65**	**136**	**6401.8**
ETCL - 222	**106.21**	**9.13**	**59.63**	**3071.4**	**77.40**	**49.01**	**140**	**6187.9**
ETCL - 146	**107.55**	**9.55**	**65.14**	**2738.1**	**74.06**	**52.40**	**136**	**5882.2**
ETCL - 148	**118.33**	**9.97**	**61.96**	**3238.1**	**77.61**	**46.84**	**133**	**5869.3**
ETCL - 161	**118.66**	**9.90**	**75.86**	**3440.0**	**75.20**	**44.90**	**134**	**7382.8**
Dilfakew	**120.16**	**9.87**	**58.53**	**3304.8**	**77.01**	**48.21**	**139**	**6061.3**
Logaw	**119.60**	**13.95**	**65.25**	**3300.0**	**77.10**	**49.16**	**138**	**6250.2**
Mean	**109.67**	**9.91**	**68.07**	**3108.87**	**76.60**	**45.81**	**137.00**	**6401.50**
CV (%)	**4.07**	**17.19**	**11.52**	**13.22**	**1.42**	**6.46**	**1.35**	**14.94**
LSD	**2.72**	**2.85**	**4.78**	**250.77**	**0.66**	**1.81**	**3.13**	**583.43**

PLHT = Plant height, SL = Spike length, SPS = Spikelet per spike, BM = Biomass, HLW = Hecto litre weight, TSW = Thousand seed weight, MD = Maturity date, GYLD = Grain yield.

Table 2: Mean grain yield performance of triticale genotypes, candidate variety and standard checks, (2014 – 16)

	Seed yield (kg/ha) at different testing locations															
Genotype	**Holeta 2014/15**	**R**	**Rob-Gebya 2014/15**	**R**	**Holeta 2015/16**	**R**	**Jeldu 2014/15**	**R**	**Gumer 2014/15**	**R**	**Mulo 2015/16**	**R**	**Telecho 2015/16**	**R**	**comb. analysis**	R
ETCL - 173	7794.8	1	5821.2	10	7296.7	10	8670.0	9	5792.0	5	4726.3	2	5823.7	6	6560.6	4
ETCL - 231	6937.8	10	5839.3	9	7725.0	3	9007.0	7	6609.0	1	3953.7	9	5502.3	7	6510.5	5
ETCL - 147	7229.0	7	6177.8	8	8170.2	2	8385.0	13	6481.5	2	4254.7	5	5481.5	8	6597.0	3
ETCL - 185	7520.5	3	6326.2	7	7519.2	5	8577.0	10	4676.8	13	4601.0	3	5981.8	5	6457.5	7
ETCL - 175	7046.8	8	6604.5	2	7464.3	7	9712.0	4	5628.8	8	3375.7	13	6426.5	3	6608.4	2
ETCL - 143	6220.3	14	6599.8	3	7369.8	8	9894.0	1	5137.8	11	3557.7	11	6778.2	2	6508.2	6
ETCL - 207	7494.2	4	6328.2	6	7005.3	12	9089.0	6	4597.0	14	4176.5	6	6039.0	4	6389.9	9
ETCL - 192	7332.3	5	6596.0	4	7658.2	4	9848.0	3	6050.3	4	3643.2	10	3684.8	14	6401.8	8
ETCL - 222	6625.0	13	5744.2	12	7311.5	9	9683.0	5	5508.7	9	3420.3	12	5022.0	10	6187.9	11
ETCL - 146	6845.2	12	5257.0	13	6854.8	13	7979.0	14	4729.8	12	4340.5	4	5169.0	9	5882.2	13
ETCL - 148	7020.8	9	5105.2	14	6571.3	14	8387.0	12	5168.2	10	4141.2	7	4691.8	12	5869.3	14
ETCL - 161	7601.3	2	7536.0	1	8300.2	1	9883.0	2	6188.3	3	4976.3	1	6795.8	1	7382.8	1
Dilfakew	6846.5	11	6556.5	5	7480.0	6	8447.0	11	5640.2	7	3236.2	14	4223.0	13	6061.3	12
Logaw	7255.5	6	5761.8	11	7164.2	11	8814.0	8	5789.0	6	3971.2	8	4995.8	11	6250.2	10
Mean	**7126.44**		**6160.98**		**7420.76**		**9026.56**		**5556.19**		**4026.74**		**5472.52**		**6401.47**	
CV (%)	**10.61**		**13.17**		**7.46**		**13.95**		**19.31**		**24.55**		**19.69**		**14.94**	
LSD	**1269.40**		**1362.40**		**929.41**		**2112.80**		**1836.50**		**1659.00**		**1808.50**		**583.43**	

R= rank order of the genotypes in respective testing locations.

Reaction to major disease/insect pests: As compared to other genotypes and standard checks, the candidate variety ETCL 161 was tolerant to foliar diseases.

Conclusion

ETCL 161 (Chima) is superior in grain yield performance in the multi-location trials across the testing environments of acid soil affected areas. It has better agronomic performance with moderate tolerance to foliar diseases as compared to the standard checks. It has showed a comparative yield advantage of 17.9%, and 15.34% over the standard checks Dilfakew and Logaw, respectively. It was verified under field condition at each testing locations by National Variety Release Committee (NVRC). Hence, cultivation of the new variety is recommended in major Triticale growing highland acid prone areas of the country having similar climatic conditions with the testing sites.

Reference

Amsalu A, Stroosnijder L, and Graaff JD. 2007. Long-term dynamics in land resource use and the driving forces in the Beressa watershed, highlands of Ethiopia.*Journal of Environmental Management* 83 (2007): 448-459.

Ashenafi Gedamu Gobena. 2008. Triticale Production in Ethiopia-Its Impact on Food Security and Poverty Alleviation in the Amhara Region. A PhD thesis, http://www.uni-kassel.de/upress/online/frei/978-3-89958-411-0.voltext.frei.pdf

Kim AC, Baier DJ Sommer and Gustafson JP. 2001. Aluminum tolerance in triticale, wheat, and rye. Euyphitica 120: 329 – 337.

SAS Institute. 2004. SAS User's Guide, Statistics version 8.2 (ED.). SAS Inst, Cary, NC, USA.

Soil Survey Division Staff. 1993. Soil Survey Manual. USDA Handbook 18, U.S Government Printing Office, Washington, DC.

Sonneveld, B.G.J.S and M.A. Keyzer, 2003. Land under pressure: Soil conservation concerns and opportunities for Ethiopia. *Land degradation and development*. 14: 5-23.