Evaluation of Soil Acidity Tolerant Food Oat (*Avena sativa*) Variety under Acid Soil Prone Areas of Ethiopia

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Abstract

Oats remain an important crop in marginal ecologies, for grain as well as for feed. They are well adapted to a wide range of soil types and can perform better than other small-grain cereals on acid soils. Low soil pH and associated soil infertility problems are considered to be amongst the major challenges to acid sensitive crops production. The study comprises six different genotypes as treatments which were laid in a randomized complete block design with three replicates. The result revealed that grain type white seeded food oat variety 79 Ab 382 (Tx) 80 SA 94 is superior in grain yield performance on acidic soil in the multilocation trials across the testing environments. It has a short stand and less vegetative growth that favours less logging. It has better agronomic performance and has showed a comparative yield advantage of 5.53% over the mean. 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.

Keywords: Acidic soil, highlands, liming, nitisols, oats

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 (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.

In Ethiopian highlands, the most contributors to soil acidity development in Nitisols is associated mainly with continuous crop harvest in the absence of proper fertilization, removal of cations (Wang *et al.*, 2006) and use of acidifying nitrogenous fertilizers (Cook, 1982; Bolan *et al.*, 1991). 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 sub-soil acidity restricts the benefit of lime, genotypes with better tolerance to acidity are alternative integral approach in-terms of cost efficiency, convenience and sustainability.

Among the different forage crops recommended for various agro-ecological zones of Ethiopia, common oats (*Avena sativa*) is abundantly grown in the central highlands, especially in north and west Shewa. It is also grown to a considerable scale in other parts of the country like Arsi, Bale and Gojam (Lulseged GH, 1981). Although oats are chiefly used as livestock feed, oat as a food grain has rapidly gained increasing popularity in recent years, as a result of its serum cholesterol lowering properties thereby preventing heart related problems (Price et al., 1987; Anderson et al., 1990).

Oats remain an important crop in marginal ecologies, and can perform better than other small - grain cereals on acid soils. Because of its potential to grow under such degraded soil (especially acidified soil) farmers were forced to grow oat not only for feed but also for food. The oat type which was preferred and processed for human food in central highlands abundantly were the white colored grain types. Therefore, the objective of this study is to obtain an acid tolerant high yielding and promising white colored grain type food oat (*Avena Sativa*) 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, Robgbeya, Emdibir, Dufa and Telecho). These sites have a pH range 4.45 – 5.10/ very strongly acidic soils (Soil Survey Division Staff, 1993).

Experimental Procedures and Treatments

Initially, from numerous different colored oat genotypes of CIMMYT introductions obtained from Animal Feeds and Nutrition national program coordinating center (Holeta), the white colored grain type genotypes including the candidate (79 Ab 382 (Tx) (80 SA 94) were identified. Color identification was considered as criteria for primary selection. This is because our farmers in central highlands are preferring the white colored grain types for human food. The identified genotypes were few in number, hence not entered into screening nursery under limed and unlimed condition. The identified six genotypes were directly entered to National Variety Trial in 2014/15 and 2015/16 cropping season in randomized complete block design with three replications having a plot size 3*4

m^2 consisting 20cm distance between rows. The work was done by the collaboration of a senior crop breeder and the acid soil research team of the center at Holeta. Land preparation and all other agronomic practices were as recommended. Sowing date was from late June to early July. Fertilizer used was only DAP at the rate of 150 kg ha^{-1} at sowing period; Urea was not applied because of lodging. Likewise, seeds were planted in rows at the rate of 100kg ha^{-1}.

Treatments

1. SRCPX 80 Ab 2252
2. SRCPX 80 Ab 2291
3. SRCPX 80 Ab 2806
4. 79Ab 382 (Tx) 80 SA 94
5. 79Ab 3825 80 SA 95
6. 79 CP 84 80 SA 130

Data collection and analysis

Data were collected on phonological traits (days to flowering and days to maturity) and important agronomic traits (plant height (cm), panicle length (cm), 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 recommendation uniformly for all treatments. 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, *79 Ab 382 (Tx) (80 SA 94)* was entered into the variety verification trial (VVT) for release in 2016/17.

Result and Discussion

Agronomic and Morphological Characteristics

The candidate genotype 79 Ab 382 (Tx) (80 SA 94) showed clear superiority ($P \leq 0.05$) over the other genotypes and standard check in grain yield (3228.1 kg ha^{-1}), on the other hand it has the least bio mass yield (10655.2. kg ha^{-1}) with a short stature and less vegetative growth that favors less logging (Table 1). Mean grain yield performance rank order of the candidate genotype 79 Ab 382 (Tx) (80 SA 94) in respective testing locations was very good (Table 2). Seed yield variation across location might be due to soil fertility status difference, beside the soil acidity level (Table 2).

Table 1: Mean value of morpho-agronomic traits of oat varieties combined over location and over years (2014 -16)

Morpho - agronomic traits							
Variety	**PLHT (cm)**	**Pln (cm)**	**BM (kg/ha)**	**HLW**	**TSW**	**MD**	**GYLD (kg/ha)**
SRCPX 80 Ab 2252	121.82	25.17	11241.0	46df.19	35.24	151	2959.6
SRCPX80 Ab 2291	120.23	28.37	12111.4	50.11	32.46	147	3111.3
SRCPX80 Ab 2806	125.01	25.23	11409.5	49.72	34.62	148	2784.0
79Ab 382 80 SA 94	96.95	19.45	10655.2	48.63	27.87	143	3228.1
79Ab 3825 80 SA 95	128.51	25.07	12742.9	48.32	32.17	146	3065.6
79 CP 84 80 SA 130	129.18	26.25	12091.4	48.52	38.31	148	3214.9
Mean	120.28	24.92	11708.57	48.57	33.44	147	**3059.29**
CV (%)	5.22	7.51	21.09	3.71	8.98	1.6	**28.19**
LSD	3.85	1.15	1519.6	1.20	1.85	4.3	**535.44**

PLHT = Plant height, Pln = Panicle length, BM = Biomass, HLW = Hectolitre weight(kg/ha), TSW = Thousand seed weight(g), MD = Maturity date, GYLD = Grain yield.

Table 2: Mean grain yield performance of oat varieties, food oat candidate varieties and standard checks, (2014 – 2016)

	Grain yield (kg/ha) at different testing sites															
Variety	Holeta 2014/15	R	Rob - Gebya 2014/15	R	Holeta 2015/16	R	Emdibir 2015/16	R	Duffa 2015/16	R	Rob - Gebya 2015/16	R	Telecho 2015/16	R	Comb. analysis	R
SRCPX 80 Ab 2252	2957.0	5	3308.5	5	5259.4	2	745.9	5	2187.2	1	3241.1	3	3017.8	5	2959.6	5
SRCPX80 Ab 2291	4024.0	3	3469.8	4	4575.6	6	974.4	1	2004.6	2	3316.4	2	3414.9	2	3111.3	3
SRCPX80 Ab 2806	2794.0	6	4152.5	2	4784.2	4	168.4	6	1726.5	5	2983.2	4	2879.6	6	2784.0	6
79Ab 382 80 SA 94	5202.0	1	3021.9	6	5319.7	1	863.7	2	1861.4	3	2953.5	6	3375.3	4	3228.1	1
79Ab 3825 80 SA 95	3818.0	4	4181.8	1	4861.7	3	790.5	4	1702.6	6	2965.2	5	3390.4	3	3065.6	4
79 CP 84 80 SA 130	4732.0	2	4070.4	3	4649	5	793.7	3	1784.7	4	3380.7	1	3599.5	1	3214.9	2
Mean	**3876.5**		**3700.83**		**4908.27**		**722.78**		**1877.84**		**3140.03**		**3279.59**		**3059.3**	
CV(%)	**53.88**		**25.34**		**6.95**		**48.09**		**11.95**		**12.76**		**14.91**		**28.19**	
LSD	**NS**		**NS**		**620.5**		**632.34**		**408.29**		**729.25**		**889.5**		**535.44**	

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

Reaction to major disease/insect pests and other hazards: As compared to other genotypes and standard checks, the candidate variety 79 Ab 382 (Tx) (80 SA 94) was tolerant to foliar diseases.

Conclusion

79 Ab 382 (Tx) (80 SA 94) (Soratаf) 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 5.52% over the mean. Hence, cultivation of the new variety is recommended in highland acid prone areas of the country having similar climatic conditions with the testing sites.

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