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Demonstration and Popularization of Improved Oat Varieties/Accessions at the Highland of Guji Zone High Land, Ethiopia

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Abstract
This experiment was conducted with the objectives of to demonstrating and popularizing recommend improved Oat accessions/varieties to the area and to assess farmers preference for the improved Oat cultivars as a feed for livestock production in Guji Zone high land parts. The experiment was laid out in simple plot with size of 10 X10 m under four kebele's of eight farmers two each kebele's of Bore and Ana Sora districts. The materials used for this experiment was CI-8251, CI-8235, 79Ab384 (TX) 80SA95, Lampton, SRCPX80Ab2291and SRCPX80Ab2806 oat accessions. Data was recorded for plant height, maturity date, 50% flowering date, seed yield, diseases reaction, lodging, green fodder yield and farmers preferences. The varieties differed in yield and yield related parameters. Accession CI-8251 produced significantly higher green forage yield (73.13 ton/ha) followed by SRCPX80Ab2806 and 79Ab384 (TX) 80SA95 which was 64.05 and 61.65 ton/ha respectively, the variety lampton recorded lowest green forage yield (55.0 ton/ha) might be due to high lodging and diseases. The highest seed yield (31.34qt/ha) was obtained from SRCPX80Ab2806 accession followed by 79Ab384 (TX) 80SA95 and CI-8235 (31.15qt/ha and 30.65qt/ha) respectively while lampton variety gives only 22.94qt/ha was the lowest yield. The tallest plants (184.5 cm) recorded from Lampton followed by CI-8251 (175.5 cm) and 79Ab384 (TX) 80SA95 (161.25 cm) and minimum (147.75, 154.75cm) from SRCPX80Ab2806 and SRCPX80Ab2291 respectively. Based on their own evaluation criteria, farmers grouped SRCPX80Ab2806 and 79Ab384 (TX) 80SA95 in the first rank; CI-8251 in the second; SRCPX80Ab2291 in the third; CI-8235 and lampton ranked as last. Lampton variety was the most susceptible and have low resistance to disease and no diseases was recorded from accession CI-8251. Low diseases was recorded from 79Ab384 (TX) 80SA95 and SRCPX80Ab 22 91, but resistance to disease and give good yield and yield components. Hence accessions SRCPX80Ab2806, CI-8251 and 79Ab384 (TX) 80SA95 proved its superiority over all the other varieties included in the experiment and could popularized with the same agro-ecology of the zone and other parts of the country.
Keywords: diseases resistance, forage yield, oats, Seed yield
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1. Introduction

The highlands of Guji are characterized by crop-livestock mixed farming systems. Because of the steady conversion of grazing lands into crop fields shortage of feed in quantity and quality is becoming the major challenge to improve livestock production and productivity (Solomon Bogale, 2004). Considering this pressing need for livestock, it is very important for farmers to integrate cultivated forages such as fodder oats in to the farming system. Fodder oat (*Avena sativa* L.) is one of the potential annual fodder crop commonly cultivated in the highland agro-ecologies of Ethiopia. It is well adapted to wide range of soils and relatively tolerant to moisture stress, water logging and frost. Oats can be a good source of animal feed in the dry season if harvested at the right stage of growth, cured and stored as hay. So far, some oat varieties were recommended for fodder production in the Guji highlands (Usman *et al*., 2018). Fodder cultivars have to produce large amounts of digestible green fodder of good quality and resistant to potential plant diseases that can limit fodder yield in the production areas.

Oats are mostly grown in cool moist climates and they can be sensitive to hot, dry weather between head emergence and maturity. For these reasons, world oat production is generally concentrated between latitudes 35 and 65◦N.Traditionally oats have been cultivated in cropping areas not appropriate for wheat, barley or maize and the cultivated area maintained stable over the years. Due to its good adaptation to a wide range of soil types and because on marginal soils oats can perform better than other small-grain cereals, there is an increasing interest to expand oat cultivation to southern countries and even to sub tropical areas (Buerstmayr *et al*., 2007; Løes *et al.,* 2007; Ren *et al*., 2007).

Oat is amongst the major winter cereal forages cultivated throughout the country. It is a fast growing, palatable, succulent and nutritive fodder (Nawaz *et al.,* 2004; Alemayehu, 1997). Oat is mostly fed as green chop while spare is stored as a hay which is used during periods when green fodder is not available (Suttie and Reynolds, 2004). There is no any animal feed technology which is tested in the study area (Guji zone) and no information

on forage nutritional quality due to the remoteness of the area.(Usman *et al.,* 2018).

This experiment was initiated to demonstrated and popularize oat genotypes for yield and yield attributes of adapted Oats under farmers condition in selected high land of Guji zone with the objectives to demonstrating and popularizing recommend improved Oat accessions/varieties to the area and to assess farmers preference for the improved Oat cultivars as a feed for livestock production in Guji Zone high land parts so as to address farmers in quality and quantity of forages for sustainable livestock production and productivity of their by contributing to the food security through increasing livestock production.

2. MATERIALS AND METHODS

2.1. Description of the study area

Bore district is located at 385 km to the south from Addis Ababa and 220 from the Guji Zone capital city (Negele) (Basha *et al.,* 2017). The district is located with geographical location of 557'23" to 626'52"N latitudes and 3825'51" to 3856'21"E longitude to South-eastern Oromia. It is bordered on the south by Bore is bordered on the south by Ana Sora, on the west by the Uraga, and on the north and east by the South Nations, Nationalities, and Peoples. The largest town in Bore is Bore. The district has moist humid and sub humid moisture condition, with relatively longer growing season. The mean annual rain fall is about 1250mm /annual, temperature of 15-24^{o}C (Obsa and Yared, 2017), the altitude ranges from 1800 to 2900 (GOR, 2006). The major soil types are Nitosols (red basaltic soils) and Orthic Aerosols(Yazachew and Kasahun, 2011). The districts produces diverse crops such as bread wheat, food barley, horticultural crops (mostly potato, enset, garlic and head cabbage) and highland pulse crops (faba bean and field pea) are the main produced crops (Basha *et al*., 2017). In the districts there is high potential of honey production

Ana Sora district is located at 401km to the south from Addis Ababa and 200 km from the Guji Zone capital city (Negele) (Basha et al., 2017). The district is found with geographical location of 620'30" to 557'30"N latitudes and 338^{o}39'30" to 38^{o}57'30"E longitude. The annual rain fall is about 1400-1800mm and the annual temperatures of the district ranged from 17.5-28 ^{O}C(Obsa and Yared, 2017) and the altitude ranges from 1900 to 2850 m.a.s.l. The districts produces diverse crops such as bread wheat, food barley, horticultural crops (mostly potato, enset, garlic and head cabbage) and highland pulse crops (faba bean and field pea) are the main produced crops (Basha *et al*., 2017).

2.2. Experimental procedure

The experiment was conducted under field conditions during the main cropping season of 2013/14 to 2014/15 for two consecutive years in selected districts of Guji high land Zone, Bore and Ana Sora districts. The selection of Bore and Ana sora districts was purposive based on the agro ecology of the Zone (high land parts of the zone). From each district, two PA's, Songo bericha and Abayi Kuture from Bore and Bube Korsa and Irba Buliyo from Ana Sora (a total of four PA) were selected randomly and from each PA's ten (10) farmers (a total of forty farmers) selected purposively based on the experience they have evaluating good quality and quantity forage crops. After farmer selection had been conducted, the training was prepared for 20 experimental farmers from each districts and ten (10) other farmers from each districts (total of 60 farmers, one development agents (DA) from each PA's and one experts per woreda and respective woreda's livestock administrator to create awareness. After training has been given, the experimental farmers was divided in to eight FRG (Farmer Research Group), four at Bore district and four at Ana Sora district according to their closeness and voluntariness which each FRG contains five members. From each five members, one volunteer member provide experimental land (10m x30m) which was three 10 x 10m plots. Based on this, two FRG from each PA (total of eight FRG) of both districts was established. The land was ploughed three times from April to July and sown on forth. Row drilling techniques was used to simplify agronomic data and other managemental practices. Fertilizer application was in the rate of 50kg URUA and 50kg DAP per hectare. The space between plot and row was 1.5m and 0.3m respectively.

The experiment consisted of six treatments of oat varieties namely CI-8251, CI-8235, 79Ab384 (TX) 80SA95, Lampton, SRCPX80Ab2291and SRCPX80Ab2806 provided for FRG according to the following table.

table 1. Oat seed distributed to the farmers for both districts in respective PA and FRG

Bore District			Ana Sora District		
Name of PA	FRG's	Accession provided	Name of PA	FRG's	Accession provided
Songo Bericha	FRG1	CI-8251, CI-8235 and 79Ab384 (TX) 80SA95	Bube Korsa	FRG1	CI-8251, CI-8235 and SRCPX80Ab2291
	FRG2	SRCPX80Ab2806, SRCPX80Ab2291 and Lampton		FRG2	79Ab384 (TX) 80SA95, SRCPX80Ab2806 and Lampton
Abayi Kuture	FRG3	CI-8251, CI-8235 and SRCPX80Ab2806	Irba Buliyo	FRG3	CI-8251, CI-8235 and 79Ab384 (TX) 80SA95
	FRG4	79Ab384 (TX) 80SA95, Lampton and SRCPX80Ab2291		FRG4	SRCPX80Ab2291, SRCPX80Ab2806 and Lampton

FRG = Farmer Research group, FRG1 = Farmer Research group one, FRG2 = Farmer Research group two, FRG3 = Farmer Research group three and FRG4 = Farmer Research group four

2.3. Data collected

Date of emergency, date of 50% flowering, lodging, disease resistance, green forage yield, plant height, date of maturity, seed yield, experimental Farmers perception (FRG) and farmers perception data from mini field day were carefully collected for all accessions/varieties at consecutive years.

2.4. Statistical analysis

Data on agronomic parameters and yield components was analyzed by using SAS computer soft ware (SAS, 2002 version 9.1) and General Linear Model (GLM) was used at 5% significance level. Farmers perception data was analysized by simple descriptive methods.

3. RESULT AND DISCUSSION

3.1. Training and Field days

Training was given for 60 farmers on the productivity of improved varieties of this crop with its all packages for all farmers who got seeds and who not got seeds in order to share information on the technologies. Mini field day was arranged at Bore district of Abayi Kuture and Ana Sora of Irba Buliyo Kebele to share experiences among farmers and other kebele's farmers participating on the field day. During the occasion farmers, DAs and experts were satisfied by observing the performance of delivered technologies on farmers' land. On self-initiation, farmers, DAs and others encouraged to work together in similar activities. Around 80 farmers, 6 DAs, 9 experts, districts livestock administrators (from each district) and five researchers attended and observed the yield advantage of the improved varieties. This field visit created a pressure of a good linkage among farmers, DAs and other participants on future research activities.

3.2. Plant height and Lodge

Plant height is a major factor contributing towards forage yield of different crops. The data obtained from plant height revealed that cultivars have significant ($P<0.05$) differences. The tallest plants (184.5 cm) were produced by Lampton followed by CI-8251 (175.5 cm) and 79Ab384 (TX) 80SA95 (161.25 cm). Minimum plant heights (147.75, 154.75cm) were produced by SRCPX80Ab2806 and SRCPX80Ab2291 respectively (Table-2) which similar with Gebremedhn *et al*. (2015) Lampton produce tallest plant height (178 cm). Lodhi *et al.* (2009) observed that high yielding varieties of oats tended to gain more plant height than low yielding varieties which in contrast with our study as Lampton has maximum plant height but lowest fodder yield among varieties. This is might be due to lampton has high lodging percentage that reduce yield and yield components of forages. Chohan et al (2004) also reported significant differences among the oats varieties regarding plant height (Gebremedhn *et al.,* 2015). The variation in plant height could be due to genetic make-up of the varieties. Zaman *et al*. (2006) explained that plant height may differ in varieties due to environmental conditions which in turn cause variation in hormonal balance and cell division rate.

There was a significant ($P<0.001$) difference in lodging among Oat accessions as presented in Table 2. Lampton variety has the highest percentage of lodging followed by CI-8235 and the lodging was not recorded from accessions CI-8251 and SRCPX80Ab2806 which was produce relatively higher seed. Farmers, experts and researchers was gave lowest values for Lampton variety and CI-8235 accession during mini field day due to lodging. They agree that the most criteria reducing both forage quality and quantity is lodging.

3.3. Seed Yield, Maturity and Diseases reactions of Oat

Seed yield, D50%F, plant maturity and disease severity were presented in Table 2. There was significantly($P<0.05$) difference in seed yield among varieties. From the demonstrated Oat accessions or varieties, the highest yield (31.34qt/ha) was obtained from SRCPX80Ab2806 accession followed by 79Ab384 (TX) 80SA95 and CI-8235 (31.15qt/ha and 30.65qt/ha) respectively while lampton variety gives only 22.94qt/ha was the lowest yield. The seed yield obtained from the present finding was higher than yield reported by (Nawaz *et al.,* 2004) which was 8.10 to 24.03 qt/ha and (Sánchez *et. al.,* 2014) reported oat could be produced 21.40 qt/ha to 17.20 qt/ha that grain yield was strongly affected by agro-climatic conditions.

There was significantly($P<0.05$) difference in date of 50% flowering and date of maturity among the tested cultivars Table 2. Accessions/varieties Lampto, CI-8235 and CI-8251has longer both date of 50% flowering and maturity date. On the other hand, Accessions/varieties SRCPX80Ab28 06, SRCPX80Ab2291 and 79Ab384 (TX) 80SA95 has relatively shorter duration both date of 50% flowering and maturity date. The present findings of date to maturity was shorter than 210 days as reported by (Nawaz *et al.,* 2004). Significant differences in days taken to maturity among different varieties may be due the genetic make up or adaptability. The diseases severity was the most important criteria during the data collection. Lampton variety was the most susceptible and have low resistance to disease reaction(leaf and stem rust). On the other hand, diseases was recorded from accessions 79Ab384 (TX) 80SA95 and SRCPX80Ab 22 91. But this accessions were resistance to disease and give good yield and yield components after all.

Table 2. Seed yield, Fresh biomass yield, plant maturity and plant height of Oat accessions

Varietie (Accession)	DE	D50%F	MD	DS	Lo %	Ph (cm)	FBt/ha	Ylku
CI-8251	7	123.25^{abc}	188.0^{a}	0.0^{b}	0.0^{c}	175.5^{ab}	73.13^{a}	30.65^{a}
79Ab384 (TX) 80SA95	7	113.25^{c}	181.75^{ab}	11.25^{ab}	15.0^{bc}	161.25^{ab}	61.65^{ab}	31.15^{a}
SRCPX80Ab2291	7	117.25^{ab}	173.75^{b}	8.75^{ab}	2.5^{bc}	154.75^{ab}	61.25^{ab}	27.34^{b}
CI-8235	7	124.5^{ab}	188.25^{a}	0.0^{b}	27.5^{b}	156.0^{ab}	58.25^{ab}	27.33^{b}
Lampton	7	127.0^{a}	184.25^{a}	26.25^{a}	76.25^{a}	184.5^{a}	55.0^{b}	22.94^{c}
SRCPX80Ab2806	7	114.5bc	181.75^{ab}	5.0^{ab}	0.0^{c}	147.75^{b}	64.05^{ab}	31.34
Mean	7	119.96	182.96	8.54	20.21	163.29	64.35	28.47
CV	0	6.02	3.72	173.73	82.13	12.12	15.85	7.50
LSD	0	10.89	10.25	22.37	25.02	29.84	145.9	3.22
P- value	-	*	*	*	***	*	*	***

[a, b, c] Means in a column within the same category having different superscripts differ (from $P<0.05$ to $P<0.001$); * = significant, ** = very significant, =*** highly significant, DE = date of emergency, D50%F = date of 50% flower, MD = maturity date, DS, = disease severity, Lo = lodging, Ph(cm) = plant height in centi meter, FBt/ha = Fresh biomass tone per hectare, Ylku = seed yield quintal per hectare

3.4. Fodder yield

Green fodder yield was presented in Table 2. There was significantly ($P<0.05$) varied among oats varieties due to variety difference which ranged from 55.0 to 73.13 ton/ha used in the experiment. Maximum green fodder yield 73.13 ton/ha was obtained from accession (variety) CI-8251 followed by SRCPX80Ab2806 and 79Ab384 (TX) 80SA95 which was 64.05 and 61.65 ton/ha respectively. Hussain *et al*. (1993) reported the improved varieties of oat produce three-fold green fodder i.e. 60-80 t/ha. Minimum fodder yield 55.0 ton/hectare was observed from lampton. The present findings was in contrast with Gebremedhn *et al.* (2015) as reported that variety Lampton produced the highest green fodder yield of 67.2 t ha^{-1}. This is might be there was no lodging during the experiments. From current study, it showed that lower than the yield obtained during adaptation study (105.6 ton/ha) of CI-8251 and 91.0 ton/ha of 79Ab384 (TX) 80SA95 (Usman *et al.,* 2018). The Green fodder yields difference was might be due to management difference on station and under farmer condition. Shah *et. al.* (2015) reported that the highest yield of 80 t ha^{-1} and the lowest yield of 63.72 t ha^{-1} which was similar with current findings and Lodhi *et al.* (2009) reported that oat fodder yield 33.332 to 47.600 ton/ha which was less than the current findings. Irfan *et al.* (2016) also reported 45.8 and 53.9 t ha^{-1} at 50% heading stage. Hussain *et al*. (1993) also reported that fresh forage yield differed due to differences in leaves per tiller and plant height.

3.5. Farmers' Assessment

Farmers' assessment was made during flowering and at physiological maturity stages of the Accessions (varieties). Accession (Varieties) selection was conducted through experimental farmers (FRG) and other farmers during mini field day at 50% flowering. These farmers put their opinion based on the performance of the experimental Accession (varieties). They considered early establishment at field level, uniform appearance, reaction to diseases and occurrence of insects, leafiness, vigorous and lodging resistance as a criteria. Based on their own evaluation criteria, they grouped SRCPX80Ab2806 and 79Ab384 (TX) 80SA95 in the first rank; CI-8251 in the second; SRCPX80Ab2291 in the third; CI-8235 and lampton ranked as last due to high lodging for both varieties and

Lampton was highly affected leaf and stem rust.

4. Conclusions

The result of the current study showed that SRCPX80Ab2806 followed by 79Ab384 (TX) 80SA95 and CI-8251 varieties of oats had higher seed yield, low lodging, resistance to diseases, higher green fodder and ranked as a first by farmers, experts and other participants during mini field day and this information can help in the adoption of these varieties for increased forage production in low-input cropping systems high land Guji's and similar agro-ecologies of the country.

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