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Performance Evaluation of Improved Oat Varieties/Accessions at the Highland of Guji Zone, Bore, Ethiopia

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Abstract
This study was conducted with an objective of introducing, adapting, see the yield, quality and recommends improved Oat accessions/varieties to the area in a randomized complete block design (RCBD) with three blocks. Accessions/varieties was (CI-8251, CI-8235, CI-8237, Lampton, Jasari, SRCPX80Ab2291, SRCPX80Ab2806, 79Ab384 (TX) 80SA95, 79Ab384 (TX) 80SA94 and Grayalegris), Bonsa and Bonabas. The analysis of data revealed that CI-8251 proved to be the highest biomass yielder accession, and as regards the other characters, it was found to be the highest in plant height, seed yield, harvesting index (HI) and less susceptible to disease and have no lodging, which reflects its better characteristics. 79 Ab384 (TX) 80SA94 was significant in seed yield and HI and less significant in disease attack and has short date of flowering and maturity and no lodging, where as JASARI was significant in disease attack and has short date of maturity and less significant in seed yield.. SRCP x 80Ab2806 was highest in Crude Protein (CP) content than the rest accessions followed by Grayalegris and 79 Ab384 (TX) 80SA94. Bonsa and Bonabas varieties are also good both in yield and quality aspect specially NDF content. Generally from this it is concluded that, considering all the agronomic and yield parameters accessions, CI-8251 was superior followed by 79 Ab384 (TX) 80SA94 and from quality analysis aspect SRCP x 80Ab2806 and Bonsa and Bonabas varieties both yield and quality aspect was selected and recommended to the area so that farmers are using for their livestock feed and go for further demonstration.
Keywords: Acid-detergent fiber, Chemical composition, Harvest date, Seed yield

Introduction

Animal feeding systems in developing countries are mainly based on grazed native pastures, which are deteriorating in production and quality, which vary seasonally resulting in poor animal performance. Despite the importance of livestock, inadequate livestock nutrition is a common problem in the developing world, and a major factor affecting the development of viable livestock industries in poor countries (Sere *et al.,* 2008). Substantial efforts have been made so far to resolve the feed shortage problem in the Ethiopian highlands, aiming at improving feed availability and thereby improve livestock productivity. The available fodder supply is 1/3 less than the actual needs of animals (Younas and Yaqoob, 2005). So that more nutritious and high yielding fodder varieties are needed to run an efficient livestock industry.

Oat is one of the potential annual fodder crop commonly cultivated in the highland agro-ecologies of Ethiopia mainly under rain fed conditions. It is well adapted to wide range of soils and relatively tolerant to moisture stress, water logging and frost. Oats are used for livestock feeding in the form of green and conserved as hay or silage for dry season and are import as a source of carbohydrate as supplementation (IARI, 1980). Different varieties/accessions of oat have different yield and agronomic performance such as forage yield, maturity day and adaptation to specific situation. Earlier varieties/accessions performance declining due to problems including leaf and stem rust attack. Others are high yielding and disease resistant. On the other hands information on feed quality is one of the decision support tools required to provide rational basis to optimize utilization of feed resources, to improve animal production and productivity and ultimately to increase financial return to the producer. The feasibility of livestock enterprise is largely a function of the type, quality of feed and the strategy of feeding. Removing or reducing nutritional constraints leads to dramatic improvement in livestock production and productivity. Dynamic changes have been made in the areas of feed evaluation, nutrient requirement and feeding systems (Seyoum *et al*. n.d). Several environmental, genetic and genotype by environment interaction aspects are expected to influence chemical composition and nutritive value of the feeds. Compositional data information on digestibility and estimated metabolizable energy offers opportunity to formulation of least cost ration.

Selection of the promising oat varieties/accessions is one of the most important decisions of plant breeders. This decision has an impact on the potential yield (forage and grain), disease and insect management and maturity of the crop. 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 and Bore Agricultural Research was established recently. This experiment was initiated to introduce, evaluate oat genotypes for yield and yield attributes, see the adaptability to that specific agro ecology and see the nutritional quality of adapted Oats. Therefore, the experiment was conducted with the objective of introducing, adapting, see the yield, quality and recommend improved Oat accessions/varieties to the area so as to address farmers in quality and large quantity of forages for sustainable livestock production and productivity of their by contributing to the food security through increasing livestock production.

Materials and Methods

Description of the study area

The experiment was carried out at Bore Agricultural Research Center, which is one of recently established Research Centers in the Oromia Agricultural Research Institute (OARI) at Bore district, Guji Zone of Oromia. Bore district is located at 385 km to the south from Addis Ababa and 220 km from the Guji Zone capital city (Negele) with geographical location of 557'23" to 626'52" N latitudes and 3825'51" to 3856'21" E longitudes, South-eastern Oromia. It has moist humid and sub humid moisture condition, with relatively longer growing season. The annual rain fall is about 1400-1800mm and the annual temperatures of the district ranged from 10.1 to 20^{O}C. The major soil types are Nitosols (red basaltic soils) and Orthic Aerosols (Yazachew and Kasahun, 2011). Bore Agricultural Research station is located at 7km from Bore town which is geographically located at 624'37" N latitude and 3834'76" E longitudes. The research site represents highlands of Guji Zone with an altitude of 2736m.a.s.l. receiving high rainfall characterized by bimodal distribution. The first rainy season extends from April to October and the second season starts late November and ends at the beginning of March. The soil type of the site is mostly black soil.

Experimental procedure

The trial was arranged in randomized complete block design (RCBD). There were three blocks each containing 10 plots of Oat accessions (*CI-8251, CI-8235, CI-8237, Lampton, Jasari, SRCPX80Ab2291, SRCPX80Ab2806, 79Ab384 (TX) 80SA95, 79Ab384 (TX) 80SA94 and Grayalegris*) resulting to 30 plots in total and tested for two years, 2 plots of Oat varieties (Bonsa and Bonabas) resulting to 6 plots in total tested for one year with each plot measuring 3m x 4m. Distance between plots and replication were 1m and 1.5m respectively. Plots in each block were randomly assigned to each treatment. Broad casting methods and no fertilizer were applied at the planting time for the treatments of Oat accessions. Row method with 30cm spacing and no fertilizer were applied for the varieties of Bonsa and Bonabas. The nutrient analysis was conducted at Adami Tulu Agricultural Research Center and Holeta Agricultural Research Center Laboratory.

Composite samples from each Oats accessions and varieties were collected at 50% flowing stage in the respective years. Samples were dried at 65 ^{O}c in a forced draft oven for 72 hrs. All samples were ground using a willy mill and allowed to pass through 1mm screen, run in duplicates and Dry matter (DM), Ash, Crude protein (CP), Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), Acid Detergent Lignin (ADL) and *In vitro* dry matter Digestibility (DOMD) were determined by Near Infra Red Reflectance) NIRRS methods and Hemicellulose was calculated by subtracting the ADF from the NDF content while cellulose was determined by subtracting the ADL from the ADF content and results were carefully collected. Harvest index (HI) was calculated on a plot basis, as the ratio of dried grain weight adjusted to 12.5% moisture content to the dried total above ground biomass weight. Disease severity score was calculated as

= Sum of all disease rating X100
Total number of rating *Maximum disease grade

Data collected

Date of emergency, date of 50% flowering, lodging, disease resistance, pest resistant, green forage yield, plant height, date of maturity, seed yield and harvesting index (HI) and chemical composition data were carefully collected for all accessions/varieties at consecutive years.

Statistical analysis

Data on agronomic parameters, yield and chemical analysis was analyzed by using SAS computer soft ware (SAS, 2002 version 9.1) and General Linear Model (GLM) was used at 5% significance level.

Result

Yield and yield components

The result of analysis shows that there was a significant difference in date of flowering, date of maturity, lodging, disease resistance, plant height, green forage yield, seed yield and HI for oat accessions/varieties.

Table 1. Agronomic and yield parameters as influenced by Oat accessions

Accessions	Date of emergency	Disease severity score	Lodging %	Plant vigor	Green forage yield tone/ha	Date of 50% flowering	Plant height in cm	Date of maturity	Seed yield Qun/ha	HI
LAMPTON	7	26.67^{ab}	30.00^{ab}	95.00^{a}	76.80^{bcd}	120.00^{dc}	179.250^{ab}	193.00^{bc}	26.51^{bcd}	3.822^{b}
SRCPX80Ab2806	7	3.33^{c}	0.00^{d}	91.67^{ab}	65.60^{cd}	106.00^{ef}	147.667^{dc}	182.33^{dc}	49.59^{abc}	7.613^{a}
JASARI	7	40.00^{a}	0.00^{d}	91.67^{ab}	54.40^{d}	120.00^{dc}	133.167^{de}	177.00^{d}	23.55^{d}	4.323b
79Ab384 (TX)80SA95	7	13.33^{bc}	6.67^{dc}	90.00^{bc}	91.20^{ab}	109.33^{edf}	143.750^{dc}	182.33^{dc}	51.60^{a}	5.570^{ab}
CI-8251	7	3.33^{c}	0.00^{d}	93.33^{ab}	105.60^{a}	135.00^{b}	174.167^{ab}	200.33^{b}	56.93^{a}	5.247^{ab}
CI-8235	7	8.33^{c}	20.00^{bc}	92.33^{ab}	92.80^{ab}	116.33^{de}	174.417^{ab}	187.67^{dc}	38.72^{abcd}	4.190^{b}
79Ab 382(TX)80SA94	7	3.33^{c}	0.00^{d}	86.67^{c}	73.60^{bcd}	99.00^{f}	123.833^{e}	177.00^{d}	54.60^{a}	7.957^{a}
CI-8237	7	26.67^{ab}	43.33^{a}	91.67^{ab}	82.80^{abc}	130.00^{bc}	181.167^{a}	187.67^{dc}	23.46^{d}	3.127^{b}
GRAYALEGRIS	7	8.33^{c}	0.00^{d}	91.67^{ab}	60.80^{cd}	150.00^{a}	147.083^{dc}	215.00^{a}	23.94^{cd}	4.123^{b}
SRCP X 80Ab2291	7	18.33^{bc}	0.00^{d}	93.33^{ab}	76.80^{bcd}	109.00^{edf}	159.833^{bc}	177.00^{d}	41.23^{abcd}	5.247^{ab}
SEM	0	8.574294	9.408428	2.906570	14.57907	6.430253	10.39572	7.352500	14.98785	1.631325

$^{a, b}$ Means in a column within the same category having different superscripts differ (P<0.05); cm = Centimeter; ha = hectare; HI = Harvesting Index; Qun = Quintal and SEM = Standard Error of Means

The analysis of Oat varieties (Table 2) shows that, Bonsa was significant in seed yield, while Bonabas was significant in plant height when compared to each other at (P< 0.05).

Table 2. Agronomic and yield parameters as influenced by Oat variety

Variety	Date of emergency	Lodging%	Date of flowering	Plant Height in cm	Green forage yield in tone/ha	Seed yield in Qt/ha	HI
Bonabas	7.00	0	96.0	184.667^{a}	85.60	23.233^{b}	9.900
Bonsa	7.00	0	96.0	161.553^{b}	81.60	53.790^{a}	6.800
SEM	0	0	0	3.436704	16.76902	4.574852	8.628152

$^{a, b}$ Means in a column within the same category having different superscripts differ (P<0.05); cm = Centimeter; ha = hectare; HI = Harvesting Index; Qun = Quintal and SEM = Standard Error of Means

Chemical composition

There was a significant difference on dry matter (DM), Ash, organic matter (OM) Crude Protein (CP), Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), Acid Detergent Lignin (ADL) and *In vitro* dry matter Digestibility (DOMD) among the tested Oat accessions/varieties.

Table 3. Chemical composition and digestibility as influenced by Oat accessions

Accessions	DM%	Ash	OM	CP	NDF	ADF	ADL	DOMD	Cellulose	Hemi-cellulose
LAMPTON	93.89	10.61	83.28	3.270	65.97	44.66	5.000	59.49	39.66	21.31
SRCP x 80Ab2806	95.59	10.45	85.18	7.980	71.10	41.58	5.010	55.22	36.57	29.52
JASARI	90.85	10.41	80.44	5.410	67.08	41.37	4.460	57.91	36.91	25.71
79Ab384 (TX)80SA95	94.60	10.30	84.30	5.050	72.85	48.09	6.120	54.74	41.97	24.76
CI-8251	93.89	10.14	83.75	3.010	75.70	46.94	6.470	54.64	40.47	28.76
CI-8235	95.02	9.96	85.06	4.250	62.51	43.52	4.490	65.58	39.03	18.99
79Ab 382(TX)80SA94	95.83	9.71	86.12	5.970	74.02	48.51	5.930	54.24	42.58	25.51
CI-8237	90.11	9.44	80.67	4.650	64.74	38.88	4.670	61.75	34.21	25.86
GRAYALEGRIS	95.33	9.05	86.28	7.940	66.67	44.14	4.770	59.14	39.37	22.53
SRCP X 80Ab2291	96.49	8.38	88.11	3.680	78.88	55.18	7.780	51.49	47.4	23.7
Mean	94.16	9.845	84.319	5.121	69.952	45.287	5.47	57.42	39.817	24.665

ADF = Acid Detergent Fiber; ADL = Acid Detergent Lignin; CP = Crude Protein; CV=Coefficient of Variation; DOMD = *In vitro* dry matter Digestibility; NDF = Neutral Detergent Fiber and OM = Organic Matter

Table 4. Chemical composition and digestibility as influenced by Oat variety

Variety	DM%	Ash	OM	CP	NDF	ADF	ADL	DOMD	Cellulose	Hemi-cellulose
Bonabas	90.11	5.21	84.9	5.9	64.24	53.77	8.04	52.77	45.73	10.47
Bonsa	91.52	5.86	85.66	4.2	60.91	52.87	9.35	59.12	43.52	8.04
Mean	90.81	5.535	85.28	5.05	62.575	53.32	8.695	55.945	44.625	9.255

ADF=Acid Detergent Fiber; ADL=Acid Detergent Lignin; CP=Crude Protein; CV=Coefficient of Variation; DM=Dry matter; DOMD=*In vitro* dry matter Digestibility; LSD=Least Significant difference; NDF=Neutral Detergent Fiber and OM=Organic Matter

Discussion

Accession CI-8237 were produced maximum height (181.167 cm), but it did not statistically different with accession Lampton (179.250 cm), CI- 8235 (174.417 cm) and CI -8251(174.167 cm).This results high green forage yield. However its lodging percentage (43.3%) was significantly high. While the minimum plant height (123.833 cm) recorded by accession *79Ab 382(TX) 80SA94* (Table 1). The main cause of those differences in plant height is due to differences in genetic makeup of the accessions. The significant effect of variety on plant height in present study is in agreement with previous findings (Kibite *et al.,* 2002b). Chohan *et al* (2004) also reported significant differences among the oats accessions regarding plant height.

Data on green fodder yield ($t \cdot ha^{-1}$) showed that fodder yield varied significantly among the accessions (Table 1). The fodder yield is the most important trait and the ultimate product of a fodder accession. Accession CI-8251 produced the highest yield of (105.60 t ha^{-1}). While accession Jasari produced the lowest yield of (54.40 t ha^{-1}) (Table 1). The analysis of the data revealed that CI-8251 proved to be the highest yielder accession, and as regards the other characters, it was found to be the highest in plant height, seed yield Qun/ha, HI and less susceptible to disease and have no lodging, which reflects its better characteristics. The result obtained was in line with Gautam *et al* (2006) and Peltonen-Sainio *et al* (1995) reported positive correlations between tiller number, fodder and grain yield. Significant difference was observed between CI-8251 and *79Ab 382(TX) 80SA94, SRCPX80Ab2806, Grayalegris and Jasari* but CI-8251 was significantly at par with the rest of the other accessions. Nawaz *et al* (2004) also reported significant differences among the oat cultivars regarding green forage yield. These results are inconformity with Ayub *et al* (2011), Hussain *et al* (1993), Naeem *et al* (2006) and Lodhi *et al* (2009). Amanullah *et al* (2004) stated that higher yields of fodder in oat cultivars can be possibly attributed to their greater leaf area, responsible for more photosynthetic activities having high capacity to store assimilative products of photosynthesis.

Generally speaking among oat accessions tested, CI-8251 was significant in green forage yield and seed yield and was less in disease attack and no lodging, CI-8237 was significant in plant height and lodging and less significant in seed yield (Qun/ha), 79 Ab384 (TX) 80SA94 was significant in seed yield and HI and less significant in disease attack and has short date of flowering and maturity and no lodging, JASARI was significant in disease attack and has short date of maturity and less significant in seed yield; GRAYALEGRIS has long date of flowering and date of maturity and has no lodging and less in disease attack, SRCP X 80Ab2291 has no lodging and short date of maturity as compared to the other accessions at ($P< 0.05$). Considering all the agronomic and yield parameters CI-8251 was superior followed by 79 Ab384 (TX) 80SA94.

From the analyzed Oats accessions tested in 2011 summer, SRCP X 80Ab2291 was highest in OM, NDF, ADF and ADL and less in Ash and DOMD content as compared to other accessions, SRCP x 80Ab2806 was highest in CP content, LAMPTON was highest in Ash content, CI-8235 was highest in DOMD and less in NDF content, JASARI was low in OM and ADL content and CI-8251 was less in CP than the rest Accessions at ($P<0.05$) and from varieties tested in 2012 summer, Bonsa was highest in Ash, OM, ADL and DOMD content. However Bonabas was Significant in CP,NDF and ADF content as compared to each other at ($P<0.05$).

LAMPTON was highest in Ash content, where as *SRCP X 80Ab2291* was lowest at ($P<0.05$) and the reverse is true for organic matter (OM) content. SRCP x 80Ab2806 was highest in CP where as CI-8251 was the lowest at ($P<0.05$). The CP content of all the tested Oat accessions in 2011 summer (Table 3) and both varieties of Oats tested in 2012 summer (Table 4) which is less than the result of (Dawit and Mulusew., 2011) on the same variety which might be due to the soil factor and difference in chemical analysis method employed was less than the average CP content of any feed (10.6) and the CP content of young herbage to be as high as 14 to 16%. Van Soest (1982). This level of CP is below the recommended minimum level of CP in the diet of ruminants for optimum rumen function (Van Soest, 1994). Roughage diets with NDF content of 45-65 and below 45% were generally considered as medium and high quality feeds, respectively (Singh and Oosting, 1992). Therefore some improvement mechanisms should have to be employed.

The NDF content of *79Ab 382(TX)80SA94* and *CI-8235* Oat accessions and variety Bonabas and Bonsa were (64.74%, 62.51%,64.21% and 60.91%) respectively which is categorized under NDF content of 45-65%, medium quality feeds (Singh and Oosting, 1992). However, the rest accessions are above 65% percent which grouped them as poor and the NDF content of all Oat accessions recorded in this experiment ranged above the 66.2% average value reported for tropical grasses (Van Soest, 1994). Roughages with less than 40% ADF is categorized as high quality and those with greater than 40% as poor quality (Kellems and Church, 1998), and the ADF value of Oats accessions and varieties in the present study was greater than 40% except CI-8237 which was (38.88%). This indicates that there has to an enhancement of the feeding value of the grass. All accessions and varieties of Oats consisted ADL ADL (limits DM intake) value was below 10% which is in a good range (Reed *et al*., 1986). The Cellulose content of all the tested Oat accessions/varieties are above the recommended level of most tropical grasses, 31.9%. Whereas the hemicelluloses contents of the treatments were below the recommended level of most tropical grasses, 35.4% respectively as noted by Moore and Hatfield (1994).

CI-8235 was highest in DOMD where as *SRCP X 80Ab2291* in OM at ($P<0.05$).The DOMD value of all Oats accessions and varieties for the current study was in the range of the digestibility of tropical grasses which lies between 50 to 60% (Own and Jaysuria, 1989) which is considered to best. However CI-8235 was even more than this value which was (65.58%) due to its low NDF content. DOMD content of the entire tested Oat accessions were above the average content of is any feed which is 50.3%, but less than the DOMD content of energy supplement feeds which are 82.2%. The increase in digestibility also will lead to increased feed intake as digestibility and feed intake are positively correlated (Van Soest, 1982).

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Conclusion
Access to new and improved agricultural technologies especially that of forage is highly limited in Guji zone of Oromia, most probably due to the remoteness from the center and in accessibility of the area. That is why Bore Agricultural Research Center paved the way to adapt and recommend new accessions/varieties of forages to the area. Based on the results obtained from the adaptation and nutritional quality analysis improved Oat accessions/varieties, *CI-8251, SRCP80Ab2806* and *79Ab382 (TX) 80SA94, in 2011,* Bonsa and Bonabas in 2012 were selected and recommended to highland of the Guji zone. Therefore, those accessions have to be evaluated under farmers' conditions so as to prove their best performing ability.

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