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The Development and Registration of "Bate", Oat (Avena sative L.) Variety for Western Oromia, Ethiopia

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Abstract
Eight Oat (Avena sativa L.) genotypes including standard check were essentially evaluated for their herbage dry matter yields, grain yields and nutritional quality characters at two environments (Bako and Billo) Western Oromia during 2014, 2015 and 2016 main cropping season with the objective of selecting the top performing oat (Avena sativa L.) genotypes for variety development. The tested genotypes were ILRI 6710, ILRI 5453, ILRI 5518, ILRI 6207, ILRI 712, ILRI 8237, Jasari (local check) and Bonsa (standard check). The genotypes were arranged in randomized complete block design with three replications. Data on herbage DM yield, grain yield and other agronomic traits were collected and analyzed using GenStat software. The combined analysis for herbage dry matter yield indicated that a significant differences ($p \leq 0.01$) were observed among genotypes, which ranged from 7.36-9.03 ton ha^{-1}. Bate variety had produced mean herbage DM yield of 8.56 ton ha^{-1} with 12.93 % ton ha^{-1} yield advantage over the standard check (Bonsa) which produced 7.58 ton ha^{-1} Similarly, grain yields differed significantly ($p \leq 0.01$) among the genotypes, which ranged from 28.79 to 31.99 qt ha^{-1} with a mean of 30.49 qt ha^{-1}. Accession ILRI 5518 gave the highest mean grain yields (33.67 qt ha^{-1}) followed by Bate variety (31.99 qt ha^{-1}) while Jasari variety gave the lowest (28.79 qt ha^{-1}) over locations. Besides, significant results ($p \leq 0.01$) were observed in nutritive values for DM, IVOMD and OM among the tested genotypes while non-significant ($p > 0.05$) results were observed in crude protein and fiber quality parameters (NDF, ADF and lignin). Genotype and genotype by environment interaction biplot analysis (GGE) also confirmed that Bate variety showed better stability and thus ideal variety recommended for production in the tested environments and other areas with similar agro-ecologies.
Keywords: *Avena sativa* L., Bate, Genotype, Herbage yield, Quality parameters
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1. Introduction

The success and prosperity of livestock farming is determined by adequate and timely availability of feed. The green forages are major and the most economical source to fulfill the dietary needs of livestock. The insufficient fodder supply is characterized as major constrain of low animal performance for milk and meat production (Rana *et al*., 2014, Ahmad *et al*., 2014). On the other hand, the continuous and long term feeding with poor quality forage results in malnutrition in animals. Livestock feed resources in Ethiopia are mainly obtained from natural and improved pastures, crop residues, forage crops, agro-industrial by-products and non-conventional feeds (CSA 2012). The contribution of these feed resources, however, depends up on the agro-ecology, the type of crop produced, accessibility and production system (Ahmed *et al.,* 2010). Though, natural pasture is the major source of livestock feed in Ethiopia, its importance is gradually declining because of the expansion of crop production into grazing lands, redistribution of common lands to the landless and land degradation (Berhanu *et al.,* 2009). This and other feed resources related problems became initiating forces for the need of improved forage germplasm introduction and evaluation (like *Avana sativa*). Oat (*Avena sativa* L.) is a cereal forage crop which belongs to poaceae family. It is used mostly for animal feeding and to some extent as human food. The use of oat as animal feed has declined steadily owing to emerging use and interest in oats as human health food (Ahmad *et al*., 2010). It is favorite feed of animals and its straw is soft and superior to wheat and barley. The oat grain is valuable feed for almost all categories of animals (Zaman *et al.,* 2006). The oat is fast growing and produces a significant amount of fresh fodder within short period (60 to 70 days) with adequate nutritional facts. It contains large amount of digestible crude protein, total digestible nutrients (TDN), vitamin B1, minerals and fat. Thus far, one hundred three (103) *Avena sativa* genotypes were introduced and evaluated at Bako Agricultural Research Center resulting in release of one oat variety with high performance against standard check across tested environments. Therefore, the objective of the study was to select the top performing oat varieties for variety release.

2. Materials and Methods

Eight genotypes of oats (*Avena sativa* L.) including two standard checks (Bonsa and Jasari) and one adopted variety (Jasari) were tested across locations (Bako and Billo) for three cropping season (2014-2016 G.C). The

objective of the experiment was to evaluate the performance of *Avena sativa* genotypes for herbage DM yield and other agronomic parameters and their stability across environments. The tested accessions were ILRI 6710; ILRI 5453, ILRI 5518, ILRI 6207, ILRI 712, ILRI 8237, Jasari and Bonsa as standard check. The genotypes were arranged in randomized complete block design with three replications in which each plot comprises of six rows having 1.8 x 2.0 m length. Seeds were planted in rows spaced 30 cm apart. A 100 kg ha^{-1} DAP and 100 kg of urea fertilizer were applied in which split application urea was followed for urea. Recommended agronomic package of practices were followed to raise a healthy crop. Data from herbage yield, seed yield and other important agronomic parameters and forage quality parameters were measured as dependent variables. For forage sampling 200 g fresh biomass were taken and dried in an oven at 65^{o}c for 72 hours to a constant weight. Partially dried feed samples were ground to pass through a 1mm sieve screen using Wiley mill and stored in airtight plastic bags for chemical analysis. Data on herbage DM yield, grain yield and other agronomic traits were collected and analyzed using GenStat software.

3. Results and discussion

3.1. Varietal Origin/Pedigree and Evaluation

Bate is the name given by the breeder to a released Oat (*Avena sativa L.*) variety with the pedigree of *ILRI 5453*. *Bate* and the other Oat genotypes were originated from International Livestock research Institute (ILRI) and evaluated against the standard checks (Jasari and Bonsa) at two environments (Bako and Billo) in 2014, 2015 and 2016 main cropping seasons.

3.2. Herbage dry matter and Grain yield performances

Based on the analysis of results, two genotypes ILRI 6710 and Bate (*ILRI 5453*) were beat other accessions in both quantitative and qualitative traits were evaluated. Significant differences ($p \leq 0.01$) were observed among genotypes in the mean herbage DM yields and grain yields. *Bate* variety has produced mean herbage DM yields of 8.56 ton ha^{-1} with 12.93 % ton ha^{-1} yield advantage over the standard check (Bonsa) which was produced 7.58 ton ha^{-1}. On top of that, as can be seen from the result, *Bate (ILRI 5453)* shows high herbage yield (DM ton ha^{-1}) advantage over the standard check (Bonsa) by 12.93 %. Besides, grain yields differed significantly ($p \leq 0.01$), which ranged from 28.79 to 31.99 qt ha^{-1} with a mean of 30.49 qt ha^{-1}. The Bate variety gave the high mean grain yields (31.99 qt ha^{-1}) next to accession 5518 (33.67 qt ha^{-1}) while Jasari variety gave the lowest (28.79 qt ha^{-1}) Table 1.

Table 1**:** Pooled mean value of herbage yields (DM ton ha^{-1}) and other parameters of Oat (*Avena sativa L.*) genotypes across environments from the year 2014-2016 G.C.

Genotypes	PL	PH	GY	DMY	DMY Yield advantage %
ILRI 6710	27.38	131.17^{ab}	31.01^{ab}	9.03^{a}	19.13
Bate (ILRI 5453)	28.13	135.03^{a}	31.99^{ab}	8.56^{ab}	12.93
Bonsa (standard check)	26.12	126.33^{bc}	29.66^{bc}	7.58^{bc}	-
Jasari (local check)	28.13	130.78^{ab}	28.79^{c}	7.69^{bc}	1.45
ILRI 5518	27.39	132.97^{ab}	33.67^{a}	7.36^{c}	-2.90
ILRI 6207	27.16	131.47^{ab}	29.06^{bc}	7.74^{bc}	2.11
ILRI 712	28.20	129.58^{b}	30.07^{abc}	8.10^{abc}	6.86
ILRI 8237	26.97	132.50^{ab}	29.64^{bc}	8.21^{abc}	8.31
Mean	27.44	131.23	30.49	8.03	
CV %	9.9	6.1	18.8	20.6	
LSD (0.05)	1.81	5.37	3.77	1.1	
LS	NS	*	**	**	

Key: ns =none significant, **= highly significant, *=significant, PH=plant height, DMY=dry matter yield, PL=panicle length, GY=grain yield**,** CV=coefficient of variation, LS=Level of significance.

3.3. Nutritional Quality Analysis

The mean values of nutritional composition of oat (*Avena sativa*) genotypes tested were presented in table 2. **S**ignificant results ($p \leq 0.01$) were observed in nutritive values for DM, IVOMD and OM among the tested genotypes. The highest DM was recorded in genotype ILRI 6710 (61.22 %) which was closely followed by Bate variety (59.54 %) while ILRI 6207 showed lowest DM content (52.22 %).

Table 2: Nutritive value of different accessions of Oat (*Avena sativa*)

Genotypes	DM%	% DM						
		Ash	CP	NDF	ADF	ADL	IVOMD	OM
ILRI 6710	61.22	8.26	6.81	67.19	47.42	3.65	66.03	52.96
Bate (ILRI 5453)	59.54	7.80	6.43	70.03	52.78	3.37	65.00	51.74
Bonsa (standard check)	57.86	8.25	5.92	71.61	54.31	3.84	61.24	46.35
Jasari (local check)	52.89	9.19	5.41	72.32	59.16	5.12	60.39	43.70
ILRI 5518	53.87	9.13	5.93	70.47	61.92	5.91	61.32	44.74
ILRI 6207	52.22	8.49	3.87	71.62	62.32	4.32	60.46	43.73
ILRI 712	54.38	9.01	5.82	72.00	60.55	6.18	59.77	45.37
ILRI 8237	52.43	8.93	4.06	71.46	56.88	5.56	60.43	43.51
Mean	55.55	8.63	5.53	70.84	56.92	4.74	61.83	46.51
CV	3.0	5.4	23.8	2.9	7.6	28.8	2.0	3.4
LSD (0.05)	3.93	1.11	3.09	4.88	10.23	3.31	2.93	3.79
Significance level	**	NS	NS	NS	NS	NS	**	**

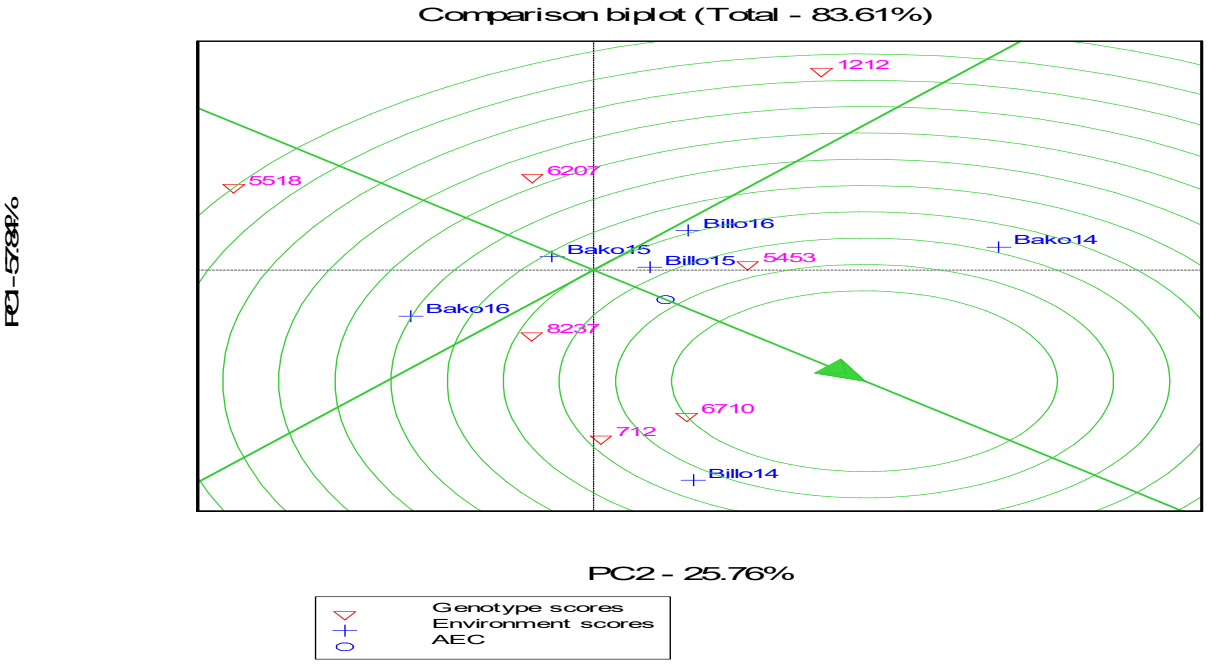
Note**:** NS, non-significant; **, significant at p<0.01; DM, dry matter; CP, crude protein; NDF, neutral detergent fiber; ADF, acid detergent fiber; IVOMD, *in vitro* organic matter digestibility; OM, organic matter; ADL= Acid detergent lignin CV, coefficient of variation.

Among the tested genotypes, the highest IVOMD was observed in genotype ILRI 6710 (66.03 %) followed by Bate variety (65.00 %). Similarly, Bate variety was showed highest OM content (51.74 %) next to genotype ILRI 6710 (52.96 %) while Jasari variety showed the lowest IVOMD and OM contents (60.39 and 43.70 %) respectively. Whereas, non-significant results (p>0.05) were observed among the treatments in Ash, CP, NDF, ADF and LDF.

3.4. Stability of Performance/Adaptation

Yield stability parameters for tested oat genotypes for three years at two locations were studied based on the methods of Eberhart and Russel (1966). Analysis using the GGE biplot confirmed that genotype ILRI 6710 and Bate variety are most stable and desired genotype as compared to the other genotypes since the regression coefficients approximating to unity and had one of the lowest deviations from regression and also have above average mean herbage DM yield. This is implying that it has good general adaptability compared to the remaining tested genotypes in the test environments and similar agro-ecologies (fig.1). Besides, the *Bate* variety (ILRI 5453) showed herbage yield advantage of about 12.93 over the corresponding check.

Figure1. Showed that stability and adaptability of pigeon pea genotypes across years and locations.



3.5. Reaction to Major Diseases

Leaf and steam rest are economically importance disease for cereal production (like fodder oat). In the present study some genotypes (ILRI 5518, Jasari, ILRI 8237 and ILRI 6710) were slightly infected by this disease at few sites. But the rest oat genotypes including Bate variety were free of the stated disease.

4. Conclusion and Recommendation

In the present study, though, the genotype ILRI 6710 was found to be top in both quantitative and qualitative traits, unlikely it was rejected to be released and officially registered due to oat rest infection were observed during field evaluation. The released variety, Bate *'ILRI 5453'* has better herbage dry matter yield performance, grain yield, good general adaptability and resistant to oat rest as compared to rest genotypes. The released variety also has better nutritional quality, especially dry matter, organic matter and invtro digestibility. Therefore, smallholder farmers and other stockholders who have engaged in animal production can utilize the Bate variety as energy supplements for low quality feed resources.

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Table 3. Agronomic and morphological characteristics of Bate and Jasari varieties.

Characteristics	***Bate***	**Jasari (standard check)**
Adaptation area:		
Altitude (masl)	1500 – 3000	1500–3000
Rainfall (mm)	800 – 1200	800–1200
Seeding rate (kg/ha):	70-80 kg	70-80 kg
Spacing b/n rows (cm)	25 and drilling	25 and drilling
Planting time:	Mid July	Mid July
Fertilizer rate: (kg/ha):	P_2O_5: 46; N: 18	P_2O_5: 46; N: 18
Days to 50% flowering:	89	82
Days to seed maturity:	120	115
Height at biomass harvest (cm):	135.03	130.78
Life span	Annual	Annual
Flowering color	White	white
Seed color:	White	White
Seed size:	Oval	Oval
Thousand seed weight (g):	213	188
Yield		
Grain yield(qt ha^{-1})	32.99	27.79
Biomass yield (DM/t ha^{-1}:	8.56	7.69
Crop pest reaction (1-9 scale)		
B blight	1	2
Yellow rest	1	3
DM (%):	59.54	52.89
CP (%):	6.43	5.41
OM (%):	51.74	43.70
IVOMD (%):	65.00	60.39
Ash (%):	7.80	9.19
NDF (%):	70.03	72.32
ADF (%):	52.78	59.16
ADL (%)	3.37	5.12
Special merits:	High biomass and yield gain	
Year of release:	2018	
Breeder/maintainer:	(OARI/ BARC)	

Note: DM = dry matter; CP= crude protein; NDF= neutral detergent fiber; ADF=acid detergent fiber; IVOMD=*in vitro* organic matter digestibility; OM=organic matter, ADL= Acid detergent lignin, OARI=Oromia agricultural research institute, BARC=Bako agricultural research center