Performance evaluation of Oat (*Avena sativa*) varieties in highland areas of North Shoa Zone, Oromia region, Ethiopia.

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Abstract

The experiment was conducted in six locations of North Shoa Zone of Oromia region. The objective of the study was to evaluate and identify the adaptable and high biomass yielding oat varieties. Eleven oat varieties (CI-8237, CI-8251, Lampton(1920), Sorataf (79Ab382(Tx) (80SA.94)), Bate (ILRI 5453), CI-8235, CV-SRCP X 80Ab 2291, Bonsa (IAR-P1-79AB384), Bona-bas (IAR-P1.1660), CV-SRCP X 80Ab 2806 and Local) were tested under rain fed condition during main season in the year 2020. The experiment was laid out in a randomized complete block design with three replications. A significant difference ($p<0.05$) was observed in the parameters of plant height, number of leaves per tiller, number of tillers per plant, number of leaves per plant, fodder and dry matter yield at 50% flowering stage but the other parameters did not show significant differences. Based on the result, it can be concluded that the oat variety Bona-bas(IAR-P1.1660), CI-8237, and CI-8235 varieties of Avena sativa showed high DM yield potential and stability across locations scoring 17.96 t ha^{-1}, 16.75 t ha^{-1} and 16.44 t ha^{-1} respectively. The highest mean fresh weight was produced by CI-8237 followed by Bona-bas(IAR-P1.1660) scoring (38.56 t ha^{-1}) and (38.01 t ha^{-1}) respectively while the lowest mean fresh weight was recorded by Sorataf(79Ab382(Tx)(80SA.94)) (25.5 t ha^{-1}). The recommended varieties were Bona-bas(IAR-P1.1660), CI-8237 and CI-8235 in range from first to third because they have outstanding dry matter yield potential and good general stability than other tested varieties. Therefore, Bona-bas is the best oat variety followed by CI-8237 that livestock producers of the study area and similar agro ecologies of North Shoa Zone can utilize as feed resources to enhance livestock production.

***Keywords**: Avena sativa, Varieties, Bona-bas, Dry Matter, Biomass*

1. Introduction

Oat (*Avena sativa* L.) is one of the most important well-adapted fodder crops grown in the highlands of Ethiopia mainly under rain fed conditions. It is produced by some peri-urban dairy cattle producers and by smallholder farmers who own crossbred dairy cows. It is early maturing, palatable, succulent and energy rich crop. Oat is mostly used as silage or hay during fodder deficit periods (Suttie and Reynolds, 2004) and liked by animals due to high palatability and softness. Its grain is also valuable feed for dairy cows, horses, young breeding animals and poultry. Lulseged (1981) reported that its grain also makes part of the staple diet of human beings in some parts of central highlands of the Ethiopia. Temperate and cool sub-tropical conditions are congenial for its growth. A well distributed rainfall of 400 mm and temperature range of 16-32 ^{0}C during the five months of its growing seasons is sufficient to meet its requirements as a fodder crop (Bhatti *et al.*, 1992).

The improved varieties of oats have potential to produce three-fold green fodder i.e. 60-80 t ha^{-1} and could feed double the number of animals per unit area as against the traditional fodder crops (Haqqani *et al*., 2003). With the introduction of new high yielding oat varieties, the farmers have recognized oat as important fodder crop for filling the fodder gap (Habib *et al*,. 2003). Although the initial aim of Oats introduction to the smallholders was for feed production, it has been realized that it is also being extensively grown as a food grain. However, it has been perceived that farmers have no awareness on the existence of different Oats varieties with different merits and consequently they grow the single variety they own for multipurpose uses (Getnet A, 1999). The extent of horizontal expansion and utilization trend (forage vs. grain), socio-economic factors governing production and utilization of Oats, available improvement opportunities and the overall prospect of Oats in the region have not been clearly understood. It is also essential to create awareness on the presence of alternative Oats varieties in order to enable farmers to make their best choice based on the intended purpose of growing Oats. The rural and agricultural development office of North Shoa Zone has launched an informal directive to limit the expansion of Oats especially as grain crop. The intention of the directive has been to replace the area covered by Oats with more productive food crops. Despite this, Oats has still been widely grown by the community both for feed and grain purposes.

To solve the feed shortage, some grass and legume forage species have been tested under rain fed condition without application of fertilizer at national level as most farmers of the country do not practice irrigation agriculture and application of fertilizer. Among the forage grasses, oat (*Avena sativa*) is the best adapted and productive forage with minimum input usage. *Avena sativa* varieties have high dry matter yields. It can be used for making hay and for grazing (Wheeler, 1981). Although, oat varieties should be tested for quality and productivity under the different climatic conditions, to date such studies did not carried out in the study area. Therefore, bearing all the above facts in mind, this activity was designed to evaluate and identify the adaptable and high yielding oat variety (s) in selected districts of North Shoa Zone, Oromia, Ethiopia.

2. Materials and Methods

2.1.Description of the Study area

The study was conducted in six locations of North Shoa Zone (i.e., Kuyyu, Warra Jarso, Degem (Ano Degem), Degem (Alidoro), Wachale and Gerar Jarso districts) of Oromia region in Ethiopia. The topography is ragged terrain with some mountains. The soil type of North Shoa zone is mostly vertisol and nitosol (Gutu Tesso *et al.*, 2012).

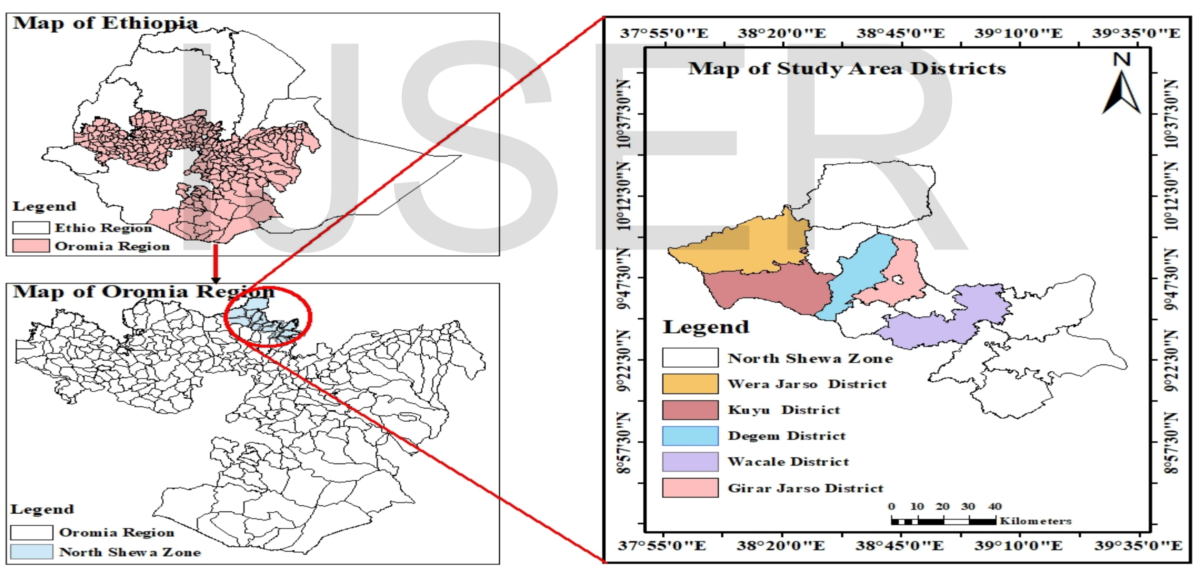

Fig. 1. Map of North Shoa Zone and the study districts

2.2.Experimental Design and Treatments

The experiment was arranged in randomized complete block design (RCBD) with three replications. Eleven oat varieties including local check; (CI-8237, Bate (ILRI 5453), Local check, CI-8251, CI-8235, SRCP X 80Ab 2291, Sorataf(79Ab382(Tx)(80SA.94)), CV-SRCP X 80Ab 2806, Bona-bas(IAR-P1.1660), Lampton (1920) and Bonsa(IAR-P1-79AB384) varieties and tested for one year in six locations. These oat varieties were sown in a plot (1.2

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m X 3 m) of 6 rows in lines of 20 cm apart using drilling method in main cropping seasons of 2020. The distance between plots and replication was 1 m each. Treatments were randomly assigned to plots. All recommended field management practices and packages such as land preparation, weeding and fertilizer applications (100 kg/ha NPS as basal and 75 kg/ha urea in split application) were applied in a similar manner for all the plots in each of the treatments.

2.3.Data Collected

Date of emergence, days to 50% flowering, maturity date, plant height, leaf height, no. of tillers, fresh biomass, leaf to stem ratio, dry datter yield and seed yield were recorded.

2.4.Statistical Analysis

The data recorded was statistically analyzed using the analysis of variance method and significant means separated by using least significance difference (LSD) at 5% probability level and Correlation analysis using SAS software package (SAS, 2002).

3. Results and Discussions

3.1.Sum of Squares of Oat Varieties As Influenced By Location and Year

Table 1 summarizes the results of sum of squares of varieties in days to maturity, plant height, total fresh weight, dry matter yield, leaf to stem ratio, number of tillers and number of leaf per plant.

Table1: Sum of squares of Oat Varieties evaluated at six locations of North Shoa Zone in 2020 main rain season

Source of Variation	**Agronomic parameters as influenced by Oat varieties**							
	DF	**PH (cm)**	**LH (cm)**	**TFW ($t\ ha^{-1}$)**	**DMY($t\ ha^{-1}$)**	**LTS**	**NTL**	**NLPP**
Loc	5	13123.94**	467.17**	6779.48**	493.38**	2.61**	283.28**	13.65**
Rep	2	405.17	33.53	365.04	117.49	0.02	56.96**	0.06
Trt	10	5616.49**	250.41**	262.41	71.86	0.32**	23.14**	2.37**
Loc*Trt	50	113.59	12.78	71.11	42.02	0.06	3.45	0.35
Rep*Trt	20	100.41	10.53	47.69	17.16	0.03	3.89	0.13

Note: ***= highly significant; *=significant; ns=non significant; DF= Degree of Freedom; PH= Plant Height; LH= Leaf Height; TFW=Total Fresh Weight; DMY= Dry Matter Yield; LTS= Leaf to Stem Ratio; NTL= No. of Tillers per Plant; NLPP=No. of Leaf per Plant; Cm= Centimeter;* ($t\ ha^{-1}$= *tone per hectare; Loc= Location; Rep=Replication; Trt=Treatment*

The result of analysis showed that there was high significance (P≤0.05) difference among varieties across location in terms of plant height, leaf length, total fresh weight, dry matter, leaf to stem ratio, number of tillers, and number of leaf per plant. There was no significant difference among replication except number of tillers. There was high significant difference among treatments in plant height, leaf length, leaf to stem ratio, number of tillers, and number of leaf per plant (Table 1).

3.2.Effect of varieties on Biomass Yield and other related parameters

Table 2: Combined mean for DM yield, grain yield and related traits of Oat varieties

	Agronomic parameters as influenced by Oat varieties							
	PH (cm)	**LH (cm)**	**TFW (t ha^{-1})**	**DMY (t ha^{-1})**	**LTS**	**NTL**	**NLPP**	**GnYd (kg/ha)**
CI-8237	130.92^{b}	26.17^{ab}	38.56^{a}	16.75^{ab}	1.39^{ab}	8.32^{bc}	5.37^{b}	2628^{ab}
Bate (ILRI 5453)	124.99^{bc}	21.45^{ef}	31.13^{cd}	14.47^{abcd}	1.17^{bc}	9.33^{b}	5.34^{b}	2520^{abc}
Local	146.49^{a}	24.81^{bcd}	31.62^{bcd}	13.65^{bcd}	1.14^{bc}	7.43^{cd}	5.83^{a}	2189^{abc}
CI-8251	148.44^{a}	27.01^{ab}	35.3^{abc}	16.04^{abc}	1.11^{c}	8.41^{bc}	5.54^{ab}	2760^{ab}
CI-8235	129.46^{b}	25.71^{abc}	36.5^{abc}	16.44^{abc}	1.14^{bc}	8.19^{bc}	5.53^{ab}	2878^{ab}
SRCP X 80Ab 2291	120.36^{c}	23.16^{de}	30.3^{cd}	12.96^{cd}	1.15^{bc}	8.31^{bc}	4.81^{cd}	2596^{ab}
Sorataf(79Ab382(Tx)(80SA.94))	93.80^{d}	22.38^{def}	25.5^{d}	12.96^{d}	1.39^{a}	8.39^{bc}	4.64^{d}	2941^{a}
CV-SRCP X 80Ab 2806	128.13^{bc}	23.47^{cde}	31.48^{bcd}	14.55^{abc}	1.05^{c}	7.86^{cd}	5.55^{ab}	2466^{abc}
Bona-bas(IAR-P1.1660)	154.26^{a}	14.64^{g}	38.01^{ab}	17.96^{a}	0.84^{d}	11.28^{a}	5.5^{b}	1660^{c}
Lampton(1920)	152.60^{a}	27.87^{a}	32.04^{abcd}	15.06^{abc}	1.11^{c}	6.87^{d}	5.6^{ab}	2036^{bc}
Bonsa(IAR-P1-79AB384)	124.63^{bc}	20.32^{f}	32.99^{abc}	13.38^{bcd}	1.17^{bc}	8.09^{cd}	5.03^{c}	2779^{ab}
LSD (5%)	8.03	2.50	6.73	3.57	0.13	1.24	0.31	1324.23
CV%	9.19	16.22	21.82	26.63	17.38	22.25	8.74	32
Mean	132.19	23.36	33.04	14.74	1.14	8.41	5.34	2495.73

Note:- *Means in the same column with the same letter are not significantly different.*

DF= Degree of Freedom; PH= Plant Height; LH= Leaf Height; TFW=Total Fresh Weight; DMY= Dry Matter Yield; LTS= Leaf to Stem Ratio; NTL= No. of Tillers Per Plant; NLPP=No. of Leaf Per Plant; Cm= Centimeter; t ha^{-1}= te per hectare; Loc= Location; Rep=Replication; Trt=Treatment

The result also showed that (Table 2 above) Bona-bas(IAR-P1.1660) was highly significant in plant height, total fresh weight, dry matter, number of tillers, and number of leaf per plant at

($P<0.05$). Bona-bas(IAR-P1.1660) variety has produced maximum height (154.26 cm), but it did not statistically different with varieties Lampton (152.60 cm), CI-8251(148.44 cm) and local (146.49).This results in high green forage yield. While the minimum plant height (93.80 cm) was recorded by variety Sorataf(79Ab382(Tx)(80SA.94)) (Table 2). The mean height of the oat varieties was 132.19 centimeter. This is higher than the result reported by Yehalem (2012) (1.065 m) in irrigation areas at Ribb River using fertilizer. There was high significant difference in the mean height among the oat varieties, Bona-bas(IAR-P1.1660) (154.26), Lampton(1920) (152.60), CI-8251(148.44), Local(146.49), CI-8237 (130.92), CI-823(129.46), CV-SRCP X 80Ab 2806 (128.13), Bate (ILRI 5453) (124.99), Bonsa(IAR-P1-79AB384)(124.63), 2291(120.36) and Sorataf(79Ab382(Tx)(80SA.94)) (93.80). The difference in plant height is due to differences in genetic makeup of the varieties. The significant effect of variety on plant height in this study is same with previous findings (Kibite *et al.*, 2002b). Chohan *et al.*, (2004) also reported significant differences among the oat varieties regarding plant height.

The results on fresh biomass yield ($t \cdot ha^{-1}$) showed that fresh biomass yield varied significantly among the varieties (Table 2). The fresh biomass yield is the most important trait and the ultimate product of a forage varieties. Variety CI-8237 produced the highest yield of (38.56 t ha^{-1}) followed by Bona-bas(IAR-P1.1660)(38.01 t ha^{-1}). The lowest total fresh weight was recorded by Sorataf(79Ab382(Tx)(80SA.94)) (25.5 t ha^{-1}) (Table 2). There was high significant difference in the mean total fresh biomass yield among the oat varieties, CI-8235 (36.5 t ha^{-1}), CI-8251(35.3 t ha^{-1}), Bonsa(IAR-P1-79AB384) (32.99 t ha^{-1}), Lampton (32.04 t ha^{-1}), Local (31.62 t ha^{-1}), SRCPX80Ab 2806(31.48 t ha^{-1}), Bate(31.13 t ha^{-1}), SRCP X 80Ab 2291(30.3 t ha^{-1}), and Sorataf(79Ab382(Tx)(80SA.94))(25.5 t ha^{-1}) (Table 2).

The result obtained was similar to Gautam *et al.*, (2006) who reported positive correlations between tiller number and fresh biomass yield. Significant difference was observed between CI-8237, Bona-bas (IAR-P1.1660), CI-8235, CI-8251, Bonsa (IAR-P1-79AB384), Lampton (1920), Local check, SRCPX80Ab2806, Bate, SRCP X 80Ab 2291 and Sorataf (79Ab382 (Tx) (80SA.94)). Among oat accessions tested, the highest dry matter yield (t ha-1) was recorded by Bona-bas(IAR-P1.1660)(17.96 t ha^{-1}) followed by CI-8237(16.75 t ha^{-1}), CI-8235(16.44 t ha^{-1}), CI-8251(16.04 t ha^{-1}). There was high significant difference among varieties in Dry matter yield, Bona-bas (IAR-P1.1660)(17.96 t ha^{-1}), CI-8237 (16.75t ha^{-1}), CI-8235 (16.44 t ha^{-1}), CI-

8251 (16.04 t ha^{-1}), Lampton (15.06 t ha^{-1}), SRCPX80Ab2806 (14.55 t ha^{-1}), Bate (14.47 t ha^{-1}), Local (13.65 t ha^{-1}), Bonsa (IAR-P1-79AB384) (13.38 t ha^{-1}), Sorataf (79Ab382 (Tx) (80SA.94)) (12.96 t ha^{-1}) and SRCP X 80Ab 2291 (12.96 t ha^{-1}).

Similarly, there was high significant difference among varieties in leaf to stem ratio. The highest leaf to stem ratio was recorded by Sorataf(79Ab382(Tx)(80SA.94)) (1.39), and CI-8237(1.39), followed by Bonsa (IAR-P1-79AB384) (1.17), and Bate(1.17). There was high significant difference among Oat varieties in leaf to stem ratio, Sorataf(79Ab382(Tx)(80SA.94)) (1.39), CI-8237(1.39), Bate(1.17), SRCP X 80Ab 2291(1.15), CI-8235(1.14), Local(1.14), Lampton(1.11), CI-8251(1.11), SRCPX80Ab2806(1.05), and Bona-bas(IAR-P1.1660)(0.84).

The result showed that there was high significant difference among varieties in the number of tillers. The highest number of tillers was recorded by Bona-bas(IAR-P1.1660) (1.39) followed by Bate (9.33). There was high significant difference among Oat varieties in number of tillers, Bona-bas(IAR-P1.1660)(11.28), Bate(9.33), CI-8251(8.41), Sorataf(79Ab382(Tx)(80SA.94)) (8.39), CI-8237(8.32), SRCP X 80Ab 2291(8.31), CI-8235(8.19), Bonsa(IAR-P1-79AB384)(8.09), SRCPX80Ab2806(7.86), Local(7.43), and Lampton(6.87).

The analysis result showed that there was high significant difference among varieties in number of leaf per plant. The highest number of leaf per plant was recorded by Local (5.83) followed by Lampton (5.6). There was high significant difference among Oat varieties in number of leaf per plant, Local (5.83), Lampton (5.6), SRCPX80Ab2806 (5.55), CI-8251 (5.54), CI-8235 (5.53), Bona-bas(IAR-P1.1660) (5.5), CI-8237 (5.37), Bate (5.34), Bonsa(IAR-P1-79AB384) (5.03), SRCP X 80Ab 2291 (4.81), and Sorataf(79Ab382(Tx)(80SA.94)) (4.64).

The highest grain yield was recorded by Sorataf(79Ab382 (Tx) (80SA.94)) followed by CI-8235 which recorded 2941 kg/ha and 2878 kg/ha respectively. According to Usman Seman *et al.*, 2018; Lampton, SRCPX80Ab2806, CI-8251, CI-8235, CI-8237, SRCP X 80Ab2291, Bonabas, Bonsa, and Sorataf (79Ab 382 80 SA 94) scored 2651, 4959, 5693, 3872, 2346, 4123, 2323.3, 5379 and 5460 kg/ha respectively which is by far higher than the scores described in this finding. Analysis of variance revealed that Sorataf (79Ab 382 80 SA 94) showed the highest mean seed as compared to other varieties (Table 2). As reported by Afework and Ewnetu, 2020 Sorataf variety scored 3228.1 kg/ha which is greater than the yield in this study. Considering all the agronomic parameters Bona-bas(IAR-P1.1660) was superior followed by CI-8251 while other varieties has no stability across locations.

Table 3: Across Location mean performance of DM yield (t ha-1) of oat varieties

Treatments	Locations/Woredas					
	Dagam (Alidoro)	Dagam (G/Shano)	G/Jarso	Kuyu	Wachale	W/Jarso
CI-8237	17.59	19.48[bcd]	15.81	7.46	19.74[ab]	20.41[ab]
Bate (ILRI 5453)	13.13	16.11[de]	14.31	8.74	8.947[cd]	25.59[a]
Local	12.43	23.83[b]	13.91	11.37	10.07[cd]	10.26[b]
CI-8251	10.19	23.21[bc]	19.72	9.76	15.39[abcd]	17.97[ab]
CI-8235	14.02	23.34[bc]	19.62	10.99	13.75[abcd]	16.95[ab]
SRCP X 80Ab 2291	15.97	14.64[de]	17.61	6.15	9.83[cd]	13.54[b]
Sorataf(79Ab382(Tx)(80SA.94))	9.95	11.95[e]	11.03	5.20	8.96[cd]	18.50[ab]
CV-SRCP X 80Ab 2806	13.81	17.23[bcde]	17.23	10.97	11.83[bcd]	16.23[ab]
Bona-bas(IAR-P1.1660)	12.00	33.21[a]	13.17	9.95	21.51[a]	17.92[ab]
Lamptonom (1920)	13.66	20.27[bcd]	20.08	9.34	17.20[abc]	9.79[b]
Bonsa(IAR-P1-79AB384)	11.96	16.82[cde]	18.99	7.02	8.42[d]	17.08[ab]
LSD (5%)	8.02	7.00	9.30	7.45	8.58	10.72
CV%	25.80	20.54	23.08	29.61	28.04	27.58

Note: *Means in the same column with the same letter are not significantly different.*

DF= Degree of Freedom; PH= Plant Height; LH= Leaf Height; TFW=Total Fresh Weight; DMY= Dry Matter Yield; LTS= Leaf to Stem Ratio; NTL= No. of Tillers Per Plant; NLPP=No. of Leaf Per Plant; Cm= Centimeter; t ha^{-1}= tone per hectare; Loc= Location; Rep=Replication; Trt=Treatment

3.3.Dry Matter Yield Potential and Stability

Dry matter yield stability parameters for tested oat varieties for one year at six locations were studied based on the methods of Eberhart and Russel (1966). Analysis using the GGE biplot confirmed that Bona-bas (IAR-P1.1660), CI-8237, CI-8235 and CI-8251 varieties were most stable and desired varieties as compared to the other varieties 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 varieties in the study locations and similar agro-ecologies of North Shoa Zone (fig.2 below).

Fig 2. GGE bi-plot comparison of Varieties for their DM yield potential and stability

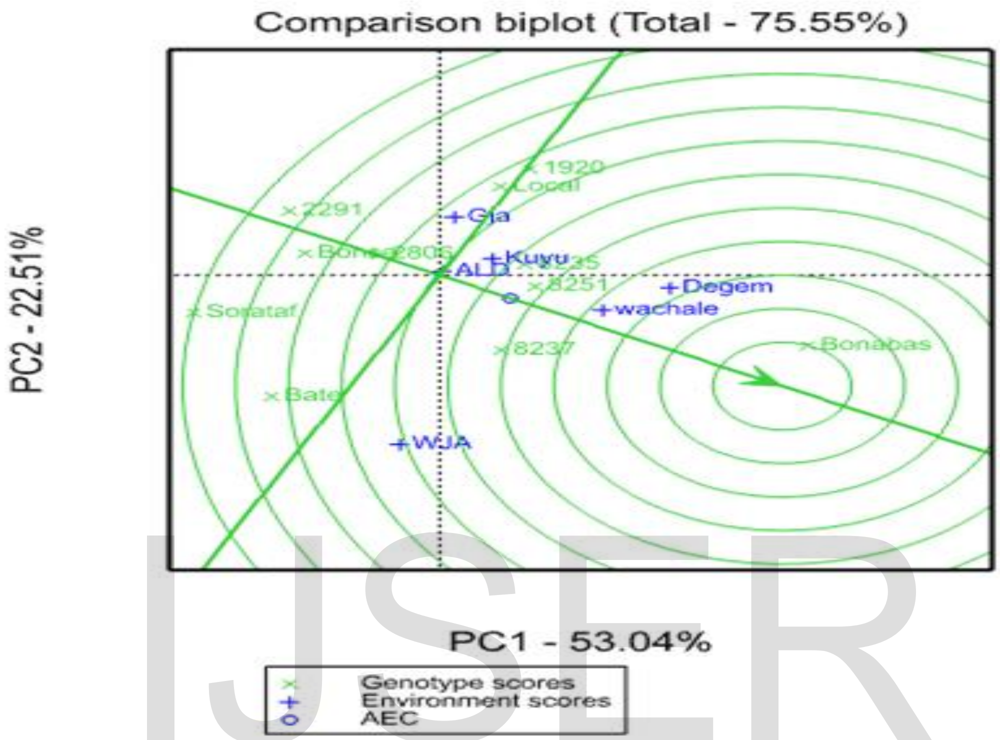
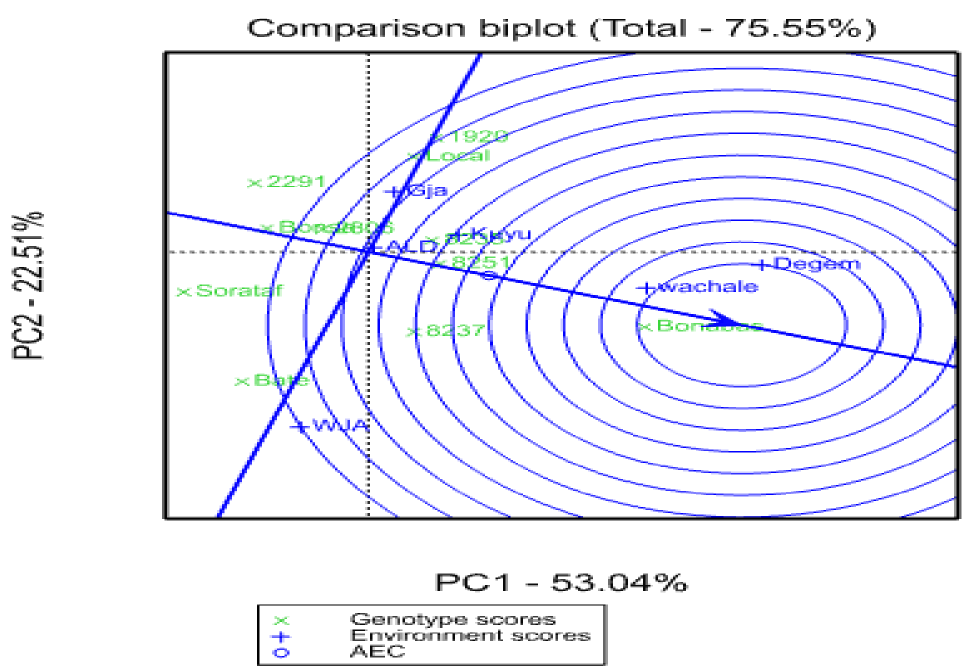


Fig 3. GGE bi-plot based on tested environments-focused comparison for their relationships



4. Conclusions and Recommendations

- Based on the result, it can be concluded that the oat variety Bona-bas(IAR-P1.1660), CI-8237, CI-8235 and CI-8251 varieties of *A.sativa* showed high DM yield potential and stability across locations 17.96 t ha-1, 16.75 t ha-1, 16.44 t ha-1 and 16.04 t ha-1 respectively.
- The recommended varieties were Bona-bas(IAR-P1.1660), CI-8237, CI-8235 and CI-8251 in range from first to fourth because they have better dry matter yield potential and good general stability than other tested varieties.
- Therefore, Bona-bas(IAR-P1.1660) is the best oat variety followed by CI-8237 that livestock producers of North Shoa Zone can utilize as feed resources.

5. References

Adugna T (2007) Feed resources and feeding management: A manual for feed operators and development workers. Ethiopia Sanitary and Phytosanitary Standards, Livestock and Meat marketing Program (SPS-LMM) Report, Addis Ababa, Ethiopia.

Akililu M, Alemayehu M (2007) Measurements in pasture and forage crop systems. Technical manual, EIAR, Addis Ababa, Ethiopia

Ayub, M., Shehzad, M., Nadeem, M. A., Pervez, M., Naeem. M., and Sarwar, N. (2011). Comparative Study on Forage Yield and Quality of Different Oat (Avena sativa L.) Varieties under Agro-Ecological Conditions of Faisalabad, Pakistan. African Journal Agriculture Research, 6, 3388-3391.

Bhatti, M.B., A. Hussain and D. Muhammad. 1992. Fodder production potential of different oat cultivars under two cut system. *Pakistan J. Agric. Res.*, 13: 184– 90

Chohan, M. S. M., Naeem, M., Khan, A. H., Kainth. R., and Sarwar, M. (2004). Forage Yield Performance of Different Varieties of Oat. International Journal of Agriculture and Biology, 6, 751-752.

CSA, 2007. Central Statistical Authority. Population census. Ministry of Agriculture and Rural development, Addis Ababa, Ethiopia.

Eberhart, S.A. and Russell, W.A. 1966. Stability parameters for comparing varieties. Crop Science 6: 36-40.

Gautam, S. K., Verma, A. K., and Vishwakarma, S. R. (2006). Genetic variability and association of morphophysiological characters in oat (Avena sativa L.). Journa of Farm Science l. 15(1): 82-83.

Gebremedhn B, Araya HA, Gebremedhn BH (2015) Evaluation of different oat varieties for fodder yield and yield related traits in Debre Berhan Area, Central Highlands of Ethiopia. Livestock Research for Rural Development 27(9).

Getnet Assefa. 1999. Feed resource assessment and evaluation of forage yield, quality and intake of oats and vetches grown in pure stands and in mixtures in the highlands of Ethiopia. M.Sc. Thesis. Department of Animal Nutrition and Management, Swedish University of Agricultural Sciences, Uppsala, Sweden.

Gutu Tesso, Bezabih Emana[1] and Mengistu Ketema[2] 2012. A Time Series Analysis of Climate Variability and its Impacts on Food Production in North Shoa Zone in Ethiopia. African

Crop Science Journal, Vol. 20, Issue Supplement s2, pp. 261 - 274 ISSN 1021-9730/2012 $4.00 Printed in Uganda.

Habib G T Ahmad I Saba and N Akhtar 2003 Gentoype variation in the yield and nutritive quality of oats fodder. *Sarhad J. Agric*. 19: 419-422.

Haqqani AMZ, Ali SS, Zahid, Bakhsh A (2003) A fodder of winter lean period. Agricultural Journal of Zari Tarqiati Bank Ltd. 06: 15-23.

Hogan, J.P. and West, R.H. 1969. The dry matter yields of Oats. *Aust. J. Agric. Res.*, **20**: 347-350.

Khan A, Anjum MU, Rehman M, Zaman Q, Ullah R (2014) Comparative Study on Quantitative and Qualitative Characters of Different Oat (Avena sativa L.) Genotypes under Agro-Climatic Conditions of Sargodha, Pakistan. American Journal of Plant Sciences 5(20): 3097- 3103. 19.

Kibite, S., Baron, V., McCartney, D., Fairey, N., & Clayt, G. (2002b). Murphy oat.Can. J. Plant Sci., 82, 555- 557. http://dx.doi.org/10.4141/P01-173oats cultivars. Sarhad J. Agric., 21, 209-213

Lulseged G/Hiwot. 1981. Summary of fodder oats research undertaken by IAR. Pasture and fodder forage bulletin no. 2, IAR, Addis Ababa.

Suttie, J.M., and S.G. Reynolds. 2004. Fodder oats: A world overview. Food and Agriculture Organization of the United Nations, Rome,Italy.

Wheeler, J.L. 1981. Grazing lands. In: FHW Morley (Eds). *Grazing Animals*. Elsevier, New York, p. 239.

Yehalem, D. 2012. Adaptation of different annual forage crops on irrigation at Ribb River. In: Proceedings of Amhara Agricultural Research Institution, 1-10 January 2012, Bahir dar, Ethiopia, pp. 22-25.

Younas M Yaqoob M 2005 Feed resources of livestock in the Punjab, Pakistan. Livestock Research for Rural Development. Vol. 17, Art.#18. http://www.lrrd.org/lrrd17/2/youn17018.htm