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Adaptation Trial of Oat Varieties for Fodder Production at Moisture Stress Area of Central Rift Valley of Oromia

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Abstract: The experiment was conducted at Adami Tulu Agricultural Research Center (ATARC), Dugda and Lume districts with the objective to evaluate adaptability, agronomic performance, yield and quality of six oat varieties (Bonsa, Bate, CI-8251, Bona-bas, Jasari and Cl-8237) under rain fed condition for two consecutive years from 2020-2021. In this experiment, oats varieties were planted in 18 experimental plots of each size with 3m*3m were arranged in six treatments with three replications by Factorial arrangement Randomized in Complete Block Design. Combined mean value of plant height, total forage biomass yield and seed yields were showed that there was significance ($P<0.001$) variation among varieties and sites. The highest mean value of plant height was recorded from Bate (122.34cm) and the lowest was from CI-8251 (90.96cm). The maximum plant height was obtained at ATARC (120.61cm) and the minimum was at Lume site (92.09cm). The highest mean value of total biomass yield was obtained from Bate (13.03 t/ha) and the lowest yield was from Bonabas (8.87 t/ha). The maximum total forage biomass yield was produced at ATARC (13.53 t/ha) followed by Dugda site (11.59 t/ha) and the minimum was at Lume (6.73 t/ha). The maximum seed yield (21.95 quant/ha) was produced by Bonsa and the second and third was from CI-8251 (20.8 quant/ha) and Bate (20.07 quant/ha). The lowest seed yield was recorded from CI-8237 (17.72 quant/ha). The maximum seed yield was produced at Lume (21.88 quant/ha) site. The lowest seed yield value was produced at ATARC site followed by Dugda, this value was due to the occurrence of lodge at both sites after attained 50% of flowering. Late and early maturity varieties at 50% flowering were CI-8237 (80 days) and Bonabas (69 days), respectively. The maximum days to attained 50% of flowering was observed at Dugda followed by ATARC site, whereas the minimum was recorded at Lume site. Ash, ADF and LDF were showed none significance ($P>0.05$) difference except CP contents. Bate and Bonsa varieties were well performed in total forage biomass yield, seed yield and nutritive quality. Bonabas was better in early maturity to attained 50% of flowering in moisture stress area. Therefore, Bate, Bonsa and Bonabas oats varieties were recommended for the end users of the study area and for similar agro ecology.

Keywords: Adaptation, Fodder, Moisture Stress and Oat Varieties

1. Introduction

Shortages of animal feed resources have been identified as one of the major factor limiting the production and productivity of livestock. In mid rift valley, livestock feed is based on natural pastures, fallow and stubble grazing and crop residues [3]. However, natural pasture and crop residues are poor in quantity and quality. Thus, the existing feed resources do not meet the nutrient requirements for growth and reproduction of animals [11]. One approach for alleviating the problem is identification and development of forage species suitable for the existing climatic condition. Hence, production of adaptable forage species with high herbage yield and quality are very important for tackling the problem of feed shortage.

Oats are important in feeding ruminant animals for their high dry matter production and low cost. Oats are very palatable (softness), good in protein when compared to the other grains and considered as an excellent feed for all livestock [2]. Oat are mainly cultivated in high land of Ethiopia than low land [8]; however other cereals crops are

cultivated in this moisture stress area. The adaptability of fodder oat was not evaluated in study area. The adaptability of wheat, barley and others were evaluated in this study area. Fodder oat is harvested earlier; because of it is harvested at 50% of flowering for livestock feeding and not delayed for maturity as other cereals crops. This indicated fodder oat is not take prolonged time for forage production as compared with other cereals crops. Other cereal crops are took a long time until maturing for seed providing, oat is harvested before maturity for quality feed production at recommended flowering stage. Regardless of the importance of this fodder, adaptable and high yielding varieties of oat have not been identified for forage production the study area. Hence, this study was designed to evaluate the adaptability of fodder oat varieties for biomass yield and nutritional quality under mid rift valley conditions.

Objective

To evaluate adaptability, yield performance and quality of improved oat varieties for forage production.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted at on -station site of Adami Tulu Agricultural Research Center (ATARC), Dugda and Lume Districts under rain fed condition for two consecutive years from 2020 to 2021. ATARC is located at 174 km from the capital city of Ethiopia, Addis Ababa. The altitude of ATARC ranges from 500 to 2000 meters above sea level and has semi-arid type of climate. The mid rift valley has erratic, unreliable and low rainfall, averaging between 500 and 900 mm per annum. The rain fall is bi-modal with the long rain June to September.

Dugda district is located at 135 km from the capital city of Ethiopia, Addis Ababa and 90 km from East Shewa zonal capital Adama. The district covers 5.2% of East Shewa Zone with area of 751 km^2. Dugda has 18 Kebele's among which one kebele was used for this study. The district has an average 636 mm annual rainfall and 26 c^o average temperature.

Lume district capital is located 88 km from Addis Ababa and 25km from zonal capital Adama town. The district covers 9.8% of East Shewa Zone with area of 870 km^2. Lume has 38 Kebeles among which one kebele was used for this study. The district's annual rainfall ranges from 500-1200 mm and temperature ranging from 18 to 28 c^o. The major crops produced include teff, wheat, chickpea and lentil.

2.2. Experimental Materials and Design

Six oat varieties (Bonsa, Bate, CI-8251, Bona-bas, Jasari and Cl-8237) were used for the study. Seed, fertilizer rate and other agronomic practice were applied as per recommendation. Germination test was done for varieties before sowing in order to determine the quality of seed for improving the lower seed germination conditions. The experiment was designed with factorial arrangement in randomized complete block design with three replications. Size of plot, distance between each block, plot and row spacing were 3m*3m, 1m, 50cm and 20cm, respectively.

2.3. Collected Data

Plant height (cm), Coverage (%), Numbers of tiller per plants (count), Leaf to Stem Ratio (gm), seed yield (quant/ha), Total forage biomass yield (t/ha) and Leaf length (cm).

2.4. Forage Sampling Procedures

Total forage biomass yield was determined by harvesting from the two middle rows of each plot at its 50% flowering stage, at a height of 5cm near the ground. After harvesting, the total fresh weight of the forage sample from each plot was measured immediately for total biomass yield determination by using a sensitive balance at field and 250g subsample per plot was brought to ATARC Animal feed laboratory and chopped in to pieces for further chemical analysis.

2.5. Total Forage Biomass Yields Determination

The representative subsample was dried in oven dry at 105°c for overnight for total dry matter determination. Accordingly, DM yield (t/ha) estimation was calculated by using recommended formula by the research [1]. The final total dry matter yields were reported in tons per hectare and calculated as 10 x TFW x (DWss /HA x FWss) Where, TFW = Total fresh weight, DWss = oven dried subsample, FWss = Fresh weight subsamples and HA = Harvesting area.

2.6. Chemical Analyses

The dried subsamples were ground to pass through a 1mm sieve for further chemical analyses. Ash was determined by igniting the samples in a muffle furnace at 550 C^o for 3 hours in ATARC. CP was calculated as N × 6.25 (Kjeldahl methods) in the Ziway soil Research Center and ADL and ADF determined according to the author [16] at ATARC Animal feed laboratory.

2.7. Data Analysis

The collected data on total dry matter yield, plant height, and leaf length, number of tiller per plant, coverage and nutritional quality parameters was analyzed by using the Generalized Linear Model of SAS 9.1 [13]. When there is a significance difference, mean separations were tested by using LSD at a significance level of 5%.

3. Results and Discussion

3.1. Agronomic Performances of Oat Varieties

The combined mean value of plant height showed that there was significance ($P<0.001$) variation among varieties and sites (table 1). The highest mean value of plant height was recorded from Bate (122.34cm) and the lowest was from CI-8251 (90.96cm). This variation was may be due to genetic

make of the varieties [14]. The overall mean of the current finding was 108.9cm, which was similar with the report [18] (106. 5cm). The overall average mean value of the current result was higher than the finding [15] and which records 60.7cm and lower than the report [10] which record 131.23cm. This difference might be due to soil factors, soil moisture and management practices. The maximum plant height was recorded from ATARC (120.61cm) and the minimum was from Lume site (92.09cm).

There were a significant ($p<0.001$) variation among the tested varieties for the experiment in leaf length. The highest mean value of leaf length was recorded from CI-8237 (43.89cm) followed by bate varieties (42.78cm) and the lowest mean value was from bonabas variety (22.93cm). The highest average mean value of leaf length was recorded at ATARC (41.88cm) followed by Dugda site (37.27cm) and the lowest value were produced at Lume experimental site (30.02cm).

Total dry matter yield was showed significance ($P<0.05$) difference between the tested varieties in the study area. The highest average mean value was obtained from bate (13.03 t/ha) by followed Bonsa variety (12.06 t/ha) and the lowest total forage biomass yield value was recorded from Bonabas variety (8.87 t/ha). The overall average mean of the present result is higher than the report [10] (8.03 t/ha). The maximum average mean value of total forage biomass yield was produced at ATARC (13.53 t/ha) followed by Dugda site (11.59 t/ha) and the minimum value was at Lume (6.73 t/ha).

There were significant ($P<0.001$) differences in the seed yield of oat between varieties and sites. From the recorded data the maximum seed yield (21.95 quant/ha) was produced by bonsa variety and the second and third mean value were from CI-8251 (20.8 quant/ha) and bate (20.07 quant/ha). The lowest seed yield was recorded from CI-8237 (17.72 quant/ha). The maximum quintal was produced at Lume (21.88 quant/ha) experimental site. This value was obtained due to the absence of lodge. The lowest average mean value of the seed yield was produced at ATARC sites followed by Dugda experimental trial, this lowest value was due to the occurrence of lodge at both sites after attained 50% of flowering. The overall average mean value of seed yield of the current work was found in range [14] who reported 15.6-28.85 quant/ha), but out of the range in the finding [6] who reported from 21.70 to 29.80 quant/ha. This difference was might be due to agro ecology of study area and, the former research was conducted at Bale high land and the current was at low land area, this indicates seed yield and other agronomic parameters are strongly affected by agro climatic condition.

The analyzed data indicated that there was significance ($P<0.001$) difference between the tested oat varieties to reach 50% of flowering. The highest and shortest date of 50% flowering was CI-8237 (80 days) and Bonabas (69 days). Day of maturity at 50% of flowering was higher than the mean figure reported [14] (64.94 days). This variation might be due to agro ecology of the study area. In the contrast of study sites, the maximum days to attained 50% of flowering was observed at Dugda site followed by ATARC site, whereas the shortest days of maturity was recorded at Lume site. This difference was might be due to soil moisture contents of the experimental site. Varieties and sites interaction effect shows significance variation for the collected parameters.

Table 1. *Combined mean values of six oat varieties for grain yield and other agronomic performance at 3 sites (2020-2021).*

Varieties	Parameters							
	PH (cm)	LL (cm)	TBMY (t/ha)	NTPP	SY (q/ha)	LSR	CO	50% F
Bate	122.34^{a}	42.78^{a}	13.03^{a}	21.56^{a}	20.07^{abc}	1.94^{c}	91.50^{a}	74.11c
Bonabas	121.7^{a}	22.93^{c}	8.87^{c}	21.17^{a}	13.25^{d}	2.067^{ab}	85.67^{c}	69.33^{d}
Jasar	118.92^{a}	41.93^{a}	9.64^{c}	17.07^{b}	18.18^{bc}	2.054^{ab}	88.56^{b}	75.17^{bc}
Bonsa	92.03^{c}	32.72^{b}	12.06^{ab}	17.10^{b}	21.95^{a}	2.30^{a}	89.00^{ab}	79.67^{a}
CI-8251	90.96^{c}	34.09^{b}	10.44^{bc}	20.82^{a}	20.80^{ab}	2.24^{ab}	88.50^{b}	76.39^{b}
CI-8237	107.92^{b}	43.89^{a}	9.67^{c}	17.13^{b}	17.72^{c}	2.12^{ab}	87.33^{bc}	79.89^{a}
Overall mean	108.97	36.39	10.62	18.60	18.30	2.12	88.43	75.76
CV	10.6	12.7	27.5	22.5	22.9	23.9	4.4	4.09
LSD (0.05)	***	***	**	*	***	**	**	***
sites								
ATARC	120.61^{a}	41.88^{a}	13.53^{a}	21.16^{a}	18.01^{b}	1.94^{b}	91.72^{a}	75.94^{b}
Dugda	114.2^{b}	37.27^{b}	11.59^{b}	17.09^{b}	16.10^{b}	2.30^{a}	87.61^{b}	78.00^{a}
Lume	92.09^{c}	30.02^{c}	6.73^{c}	19.17^{a}	21.88^{a}	2.11^{ab}	85.94^{b}	73.33^{c}
LSD (0.05)	**	***	***	**	**	*	**	***
Significance								
Varieties	<.0001	<.0001	0.0003	0.0263	0.0014	0.0413	0.0023	0.0067
sites	<.0001	<.0001	<.0001	0.0007	<.0001	0.0348	0.0327	<.0001
Variety*sites	0.0009	<.0001	0.0061	<.0001	<.0001	0.0002	0.0011	<.0001

$^{a, b, c, d}$ 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, PH- Plant height, LL- Leaf Length, TDMY- Total Dry Matter Yield, NTPP- Number of Tiller per plant, CO- Coverage, SY- seed Yield, Quantal/ha, LSR- Leaf Stem Ratio and 50%F- 50% of flowering.

3.2. Chemical Composition of Oat Varieties

Nutritive value of the evaluated oat varieties was presented in (table 2). Crude protein (CP) contents of the tested varieties showed the significance ($P<0.05$) difference. The highest average mean value of CP content was recorded from

Bate (10.41%) followed by Bonsa, CI-8251 and Jasar which produced 9.14, 8.21 and 8.19%, respectively. The current result was higher than the work [12, 7] reported in a range from 3.0-7.9 and 4.8 - 7.6%, respectively. This dissimilarity might be due varietal genetics variability of the tested materials, soil fertility and soil moisture content of the experimental site and stage of harvesting. The CP content of the current result was in the range of quality roughage [5].

As the analyzed data indicate ash content of oat varieties showed none significance (P>0.05) difference. The overall mean of the current result was higher than the finding [10] (8.63%). ADF and ADL contents of oat varieties showed none significance (P>0.05) difference. The fiber content of the current result is in the normal range that would not limit dry matter intake of ruminants as the finding [17] less than 40% is categorized as high quality and above 40% as low quality.

Table 2. *Nutritive value of Oats varieties at ATARC, Dugda and Lume, during 2020-2021.*

Varieties	Parameters			
	CP%	Ash%	ADF%	ADL%
Bate	10.41[a]	13.35	24.15	10.35
Bonabas	8.02[b]	12.90	22.35	9.47
Jasar	8.19[ab]	12.50	20.78	10.82
Bonsa	9.14[ab]	13.55	21.54	11.39
CI-8251	8.21ab	13.7	18.71	8.34
CI-8237	7.22b	12.45	20.65	13.20
Mean	8.53	13.08	21.36	10.59
CV (%)	10.43	5.61	11.85	26.82
LSD (0.05)	2.29	1.89	6.51	7.30
P- value	*	ns	ns	ns

[a, b] Means in a column within the same category having different superscripts differ (from P<0.05 to P<0.001), * = significant, ns= none significant. CP- Crude protein, ADF- Acid Detergent Fiber, ADL- Acid Detergent Lignin

4. Conclusions and Recommendations

The results of the current study showed that there were a significance variation in plant height, leave length, total forage biomass yield and seed yield between the tested oat varieties. The highest mean value of plant height was recorded from Bate and the lowest was from CI-8251. The maximum plant height was recorded from ATARC and the minimum was from Lume site. The highest forage biomass yield mean value was obtained from Bate by followed Bonsa variety and the lowest biomass yield value was recorded from Bonabas variety. The maximum average mean value of total biomass yield was produced at ATARC followed by Dugda site and the minimum value was at Lume.

From the recorded data; the maximum seed yield was obtained from Bonsa variety and the second and third mean value was from CI-8251 and Bate. The lowest seed yield was recorded from CI-8237. The maximum seed yield was produced at Lume experimental site. This value was obtained due to the absence of lodge. The lowest average mean value of the seed yield was produced at ATARC sites followed by Dugda experimental trial, this lowest value was due to the occurrence of lodge at both sites after attained 50% of flowering.

The highest and shortest maturity date for 50% flowering was recorded from CI-8237 and Bonabas, respectively. In the contrast of study sites, the maximum days to attained 50% of flowering was observed at Dugda site followed by ATARC site, whereas the shortest was recorded at Lume site. This difference was might be be due to soil moisture contents of the experimental site and moisture or rainfall availability. The highest average mean value of CP content was recorded from bate and the lowest mean value was from CI- 8237 variety.

Bate and Bonsa varieties were well performed among the tested oats varieties in total forage biomass yield, seed yield, nutritive quality and other agronomic parameters. Bonabas was better among the tested oats varieties in early maturity to attained 50% of flowering in moisture stress area. Therefore, Bate, Bonsa and Bonabas oats varieties were recommended for the end users of the study area and for similar agro ecology.

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