Effects of Fertilizer Types on The Agronomic, Forage Yield And Nutritional Value of Forage Oat Accessions in the Highlands of Ethiopia

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Abstract
The experiment was conducted to evaluate the effect of fertilizer type and oat accessions on agronomic performance, forage yield and chemical composition under acidic soil condition in Ethiopia. This study employed randomized complete block design (RCBD) using 3 by 3 factorial with three replications. The forage oat accessions used in the study were: CI8251, CI8237 and Jassari and the three fertilizer types used were inorganic (NPK), organic (compost) and without fertilizer. The data collected from the study includes: plant morphological parameters such as plant height (PH), leaf length (LL), number of leaves per plant (LNPP), number of tillers per plant (NTPP), forage dry matter (DM) yield and chemical composition of the forage. The collected data were analyzed with general linear model (GLM) of statistical analysis system (SAS) version 9.4. The result indicated most of the morphological parameters were not significantly affected by the effects of fertilizer type while oat accession had also effect on these factors. Regarding fertilizer application, there was significant different ($p<0.0001$) among fertilizer types in all morphological parameters. Among chemical composition parameters dry matter (DM), DM yield, organic matter (OM), crude protein (CP), CP yield, ASH, neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were significantly different ($p<0.0001$), for both fertilizer and oat accessions. The highest CP content was observed for the treatments received chemical fertilizer (NPK) which was 11%. It can be concluded, that the addition of inorganic and organic fertilizer with the grass species in the present study improved oat accession morphological characteristics which could be a reflection of biomass yield and also the nutritional value of oat grass in this experiment. Of the oat accessions assessed, CI825 was selected in terms of DM yield and CP contents followed by plant CI8237 and Jassari in the current study area.

Keywords: Morphological, chemical composition, Inorganic fertilizer, Compost, Oat accession, yield

1. Introduction

In Ethiopia, livestock production plays important role in providing export commodities, such as live animals, hides, and skins to earn foreign exchanges to the country [1]. On the other hand, draught animals provide power for land cultivation, crop threshing and many types transport to take holders and their families long-distances, to convey their agricultural products to the market places and bring back their domestic necessities. Livestock as well confer a certain degree of security in times of crop failure, as they are a "near-cash" capital stock. Furthermore, livestock provides farmyard manure that was commonly applied to improve soil fertility and also used as a source of energy. The highlands of Ethiopia comprise nearly half of the land area of the country and hold more than 85% of the total human population, and about two thirds of the livestock population [2]. These highland areas which are dominantly crop-livestock systems were recognized to be under stress because of shrinking

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cultivated areas per household, land degradation and reduced feed availability [3]. Because of this reason, productivity of livestock is generally low associated with many factors of those factors feed shortage in quantity and quality is the one. In the country, the major feed resource, natural pasture, is gradually declining because of the expansion of crop production into grazing lands. The second main feed resource is crop residue which is not consistent in its supply and inherently low in nutritional values. Hence, it is important to find solutions that can combat the existing livestock nutritional constraints. Among the possible strategies that can mitigate the problem is improved forage variety testing and use in the area. Of improved forages, forage oats are among the options for highland areas which are affected by acidic condition of soils. Although forage oat research is not new approach in the country, there is only limited study about the performance of oat grass under different fertilizer applications in the highland areas. Hence, the study aimed at assessing agronomic performance, biomass yield and chemical composition under different fertilizer type applications on three oat accessions in the highlands of Ethiopia.

2. Materials and methods

Description of the study area

The study area was conducted in Fagita Lekoma District, Awi administrative zone, Amhara National Regional State. The district which is located in (37°05E'-10°55'S) and 104-km far from the regional city Bahir Dar to south and 465-km north to Addis Ababa [4]. The mean annual rain fall is 2600 mm above with the main rainy season (June-November) of 2018-2020. The mean altitude range from 2876 mm above sea level and the mean temperature was 12°C to 24°C with mean value of 18°c. It is classified into one agro climatic zone, which is high land with wet and cool weather condition. In terms of topography, Fagita Lekoma District has, 65% of the total area gentle slope, mountainous slope lands account for 23% and others 12% respectively [4]. The study site characterized by highland (*Dega*)(55%) and midland (*Woina Dega*) (45%) in which the available grazing land is decline from time to time due to expansion of crop land.

In terms of land use pattern, an estimated of the area is cultivated, planted, settlements, grazing lands and others account for about 21.30, 15, 21 and 13%, respectively. The population of Fagita Lekoma was 145,887 in rural areas and 17189 in urban areas, a total of 79,059 males of which 83,537 were females. The major crops grown in the district are barley, potato, wheat, teff, maize, finger millet, onion, pea and bean. The types of livestock reared the number of district include cattle (181,862), chicken (123,000), sheep (52,132), goats (14,193), equines (23,966) and bee colonies (6,010)).

Land preparation and farming practice

The land was ploughed for four times before oat seed sowing until the soil become fine. The experimental land was measured for 3, 4, 5 triangle method of exactly site in the total area 0.0287 ha. The total area used in the current study was 287 m^2=width 14 m^2* length 20.5 m^2. Soil physical and chemical properties of the experimental site indicated that the soil type was sand soil with brown color and soil acidity checkup soil sample was taken before sowing from the whole experimental plots at soil depth of 20cm a sample weighing 1 kg was taken, mixed and air dried under the shade and preserved in an air tight plastic bag into the soil laboratory. This soil sample analysis of experimental ploughed land was characterized with acid soils and a soil buffer adjustment of lime stone 48 kg/0.0216 ha was applied. Oats varieties seed was planted on well prepared experimental plot. The spacing between each plot rows was 25 cm constant all plots and oats sown using broad method in June 2018.

Compost preparation procedure

The compost was prepared from farm residue in farmers' homestead. All the farm residue composting materials, such as dry, green materials, and animal manure were collected before the pit filling process. Long crop residues and green materials were chopped in to small pieces before putting into the pits. Such as Length 3 m*Width 1 m*Depth 1m total $3m^3$ then to happen the compost prepared material collection that is dry matter, green plant material, manure, dug, ashes, soil, water and bamboo stick. These are making the compost/organic fertilizer the 1st layer foundation of dry matter (20-25 cm) thick,

2second layer green plan material (20-25 cm) thick, 3rd layer of manure and soil (10-15 cm), 4th layer of ashes and 5th layer of covering of soil with each layer to add water, Farm residues are mainly straw, grass and stalk of field crops and left-over from animal trough. Green material such as grasses, weeds, leaves and tree branches were harvested from the surrounding. Animal manure was obtained mainly from cattle, goat/sheep, chicken droppings and equines. This processing control the bamboo stick in pit /hole/45^o stand that similar to use thermometer for brown color to smell well the form mixed to natural fertilizer.

Sampling Procedure

Morphological data was collected from the middle rows on 10 plants per row. The morphological characteristics collected were plant height (PH), number of leaves per plant (NLPP), number of stem tillers per plant (NTPP), leaf length per plant (NLPP), forage dry matter (DM) yield per hectare, chemical composition parameters, root length and toot number per plant.

Experimental Design and Treatment

A factorial arrangement of treatments was used with randomized complete block design having two factors (oats accessions and fertilizer type) with 3 replications. Oats accessions (CI-8251, CI-8237 and Jassari) were compared at 3 fertilizer applications (organic, inorganic and control). In all treatments inter plot spacing was 25 cm. The total experimental area was 14m*20.5 m (287 m^2) with individual plot size of 8m^2 and spacing between plots and blocks 0.25 m and 0.5 m, respectively. The land was prepared thoroughly by plowing at the start of the rainy season. All plots were kept free of weeds throughout the experimental period by hand weeding.

Experimental Input

After the exact screening and evaluation to do works, the accession of oats CI-8251, CI-8237, Jassari were recommended for the high lands of Ethiopia and they are far-reaching growth in the country [5]. The fertilizer combination was used inorganic source, Nitrogen, Phosphorus and Potassium (NPK) and organic fertilizer (compost). The grass was harvested 16 weeks after establishment to determine biomass production in the experiment. Generally, each plot treatment 2*4m=8m^2*27 replication total treatment putting area 287 m^2 without block spacing, plot spacing and border effects in all direction.

Application of fertilizer and seed rate

One block has 9 plots and the area of one plot was 2m*4m=8 m^2. The total area of the plots was 9*8=72 m^2 for the three block replications I would use the total area of 3*72m^2=216m^2. For 10,000 m^2 of land requires 100kg seed. For 216 m^2 Oat seeds 2.16 kg would be enough for my experiment total trial needed area 18mx12m=216m^2. Compost applied at rate of 10000 kg/ha for establishment and 2000 kg for maintenance and in organic fertilizer (DAP).Use about 100 kg/ha of fertilizer for establishment and 25 kg for maintenance. The control plots were without fertilizer.

Morphological parameters and forage dry matter yield

The morphological parameters such as plant height, leaf length, steam tiller, root tiller, leaf tiller, steam thickness, leaf width, and root height oat grasses were measured from ten plants that were randomly select from the border and middle each plot. Data on agronomic characteristics, of oat were recorded throughout the experimental period of growth time (4 month) and effect of fertilizer application with oats accessions and 120 day of harvest and high land agro-ecology would be recorded by taking samples after harvest, tillers development and growth of leaves would continuously be observed during the entire growing period. Plant height was measured on the primary shoot from the soil surface to the base of the top-most leaf using a meter rule [6]. The number of tillers for the plants were counted and recorded. Total tiller number per plant on each measurement occasion was defined as the sum of total tiller number per plant count. Leaf length was measured started from ligules (oricle) to the shoot of plant by meter ruler while the number of leaves per plant was counted from ten plants selected in each plot at the middle rows. The total herbage on each plot at the fixed days would be harvested leaving out border rows. Harvesting was done by hand using a sickle, leaving a stubble height of 50% the flowering stage. The harvested herbage was weighed on the field soon after mowing/cut down/ using a field balance. Sample taken from harvesting seasons would be oven dried at 60°C for 72 h and grounded to be followed by determination of DM percent. Finally the total

Digestible Dry Matter Yield (DDMY) would be calculated by multiplying the fresh yield by percent DM.

Chemical Analysis of forage samples

The forage samples harvested were measured using sensitive balance of grass (oats) were sorted from each plot and 200 g sample from each plot leaf and stem separated to pack together in paper pocket was dried in forced air draft oven at 70°C for 48h and dry weight was recorded. The chemical composition of the forage samples was analyzed to determine its nutrient content by drying representative samples to a constant weight at 70°C. Samples of forage (oats) were ground using a blender before passing through a 1 mm screen. Forage samples were analyzed for DM, OM and as using the procedure [7]. The crude protein (CP), crude fiber (neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) [8].

Statistical analyses

Data on agronomic parameters and quality of forage samples were subjected to ANOVA based on the General Linear Model (GLM) designed for a factorial design according to Gomez an Gomez (1984) [9].To compare significant differences in response variables, ANOVA was done using SAS package (version 9.4). Duncan's Multiple Range Test was carried out for subsequent comparison of means using significance level of 5% ($p<0.05$).

The statistical model for analysis of the data was:

$$Yijk=\mu+Fi+Aj+Fi*Aj+eijk, \text{ where:}$$

Yijk=all dependent variables (morphological data and chemical composition) collected

μ=over all mean

F_i=the effect of i^{th} fertilizer chemical and compost

Aj=the effect of j^{th} accession

Fi*Sj=the interaction of fertilizer application and plant/oat seed

Eijk=random

3. Results and discussion

Effect of fertilizer type and Oats accession on morphological characteristics of oats grass

*Plant height (Ph***)**

The effect of fertilizer type and oats accession on plant height of oats grass is shown in Table 1. As indicated in the table fertilizer type (NPK, compost and control) significant effected ($P<0.005$) plant height (PH) of oat grass in the study area. The highest mean plant height (PH) was observed for NPK fertilizer (140 cm) while the lowest value was recorded for control (without fertilizer) (120 cm).The effect of compost had shown intermediate value 131cm between NPK and without fertilizer. The mean PH for oat grass in the current study was according to Sajjad et al. [10], the highest values of plant height (118.3 cm) was produced by (100%) organic fertilizer while the least (103 cm) plant height was recorded for the control group. Many cultivars of oat have high feed value if cut at flowering stage i.e. the best time for the crop harvest is at 50 percent flowering stage for better yield and can solve the demand of rapidly growing livestock industry of Ethiopia. These plant height to suitable the environmental conditions that soil type and fertility, frost tolerant, temperature, altitude and the management practices applied on the plant.

The effect of oats accession had significant effect ($P<0.05$) on plant height and there was also significant difference in PH ($p<0.05$). The highest plant height was recording on fertilizer and compost application and oats accession plant. These study results on plant accession was in agreement with many other researchers for different forage crops [11, 12]. And other hand the integration of organic and inorganic sources of nutrients increases their efficiency and reduces environment hazards. According to Sajjad et al. [10], the highest values of plant height (140 cm) was produced by NPK fertilizer while the least (120 cm) plant with control/without fertilizer by CI-8251 oat accession in agronomic practice performance of high land area and other necessary water, sunlight, nutrient and rain supply there was management and control weed in plant.

The highest plant height (CI-8251) was observed in stem tillers lower while lower plant height (Jassari) was recorded in stem tillers higher or wider oat accession plant and the highest plant height (140 cm) with the variety CI-8251 was observed in root tillers number per plant lower (33cm) and other variety CI-8237 highest plant height was observed intermediate (69) but root tiller number per plant highest (85 count) and other variety Jassari lower plant was observed in root tiller per plant on intermediate. This result similar to Rayburn [6] in broad cast oat accession

of plant maximum height recorded in CI-8251 oat grass. At broadcast, plants reach maturity before the achievement of optimal leaf area. Thus, lower tillers count in stem and root but the shoot growth high height broad cast row may be due to high plant length long but stem and root tiller decreased competition for resources, namely sun- light, plant length and nutrients. The competition for sun-light causes abnormal growth and reduces the tailoring capacity.

Table 1. Mean Performance Morphological Characteristics Fertilizer type and Oat accession

Parameters	Factors	PH cm	LLPP cm	STNPP count	LTNPP count	RLPP cm	RTNPP count
Fertilizer type	NPK	140[a]	52[a]	7[a]	6[a]	12[a]	69[a]
	Compost	131[b]	51[b]	6[b]	6[a]	11[b]	61[b]
	Control	120[c]	42[c]	5[c]	5[b]	10[c]	58[c]
	Sign.	***	***	***	*	***	***
	Interaction	Ns	Ns	Ns	Ns	ns	ns
Oats accession	CI-8251	140[a]	46[c]	5[c]	6[a]	11[b]	33[c]
	CI-8237	134[b]	49[b]	6[b]	6[a]	12[a]	85[a]
	Jassari	117[c]	50[a]	7[a]	5[b]	10[c]	69[b]
	Sign.	***	***	***	*	***	***
	Interaction	Ns	Ns	Ns	Ns	ns	ns
	Mean	130.14	48.48	5.81	5.52	11.11	62.4
	SE	10	3	1	0.3	0.8	8

Means followed by different letter with the same column are statistically not significant at P>0.05 NPK=chemical fertilizer (nitrogen-phosphoric fertilizer containing POTASH); COMPOST=(organic) fertilizer; PH=plant height; LLPP=leaf length per plant; LTNPP=leaves tiller number of per plant; STNPP= Stem tillers number of per plant; R TNPP=root tiller number of per plant; RLPP=root length per plant; sig=significant, ns=not significant SE=standard error.

Leaf length per plant (LLPP)

Regarding fertilizer type the control treatment had shown significantly lower ($p<0.05$) than both fertilizer types, However, compost and NPK were not significant ($p>0.05$). Both fertilizer type and oat accession was significant ($p<0.05$) however, oat accession ($p<0.005$) were not significant on leafs length per plant, but their interactions fertilizer type and oat accession were statistically significant ($p<0.05$) (Table 1). The leaf length per plant was application of NPK was significantly higher ($p<0.0001$) than the intermediate and without fertilizer (control). The highest mean leaf length per plant (LLPP) was observed for NPK fertilizer (52 cm) while the lowest value was recorded unfertilized (control) (42 cm).The effect of Compost had significantly difference than non-fertilizer or control treatment shown mean (51cm) less than NPK but highly greater than without fertilized treatment mean. Oat accession for CI-8251, CI-8237 and Jassari variety the experimental with the fertilizer interaction of each plot different kind of leaf length per plant and the environmental condition comfortable sun-light, photosynthetic and chlorophyll as served while leaf flat. Accordingly, Butt et al. [13], the number of leaves increased with an increase in use of fertilizers and harvesting days, and fewer total leaves per plant were produced from short harvesting interval of grass due to cutting at the younger stage of growth, while leaf length per plant was highest at reduced harvesting intervals.

Stem numbers of tillers per plant (SNTPP)

As indicated in the table fertilizer type (NPK, Compost and control) significantly affected ($p<0.05$) number of tiller per plant (STNPP) of oat grass. The highest mean number tiller per plant was observed at application of NPK fertilizer 7 (STNPP) counts and the lower value count STNPP was recorded for control 5 counts. The application of compost (organic fertilizer) had significant effect ($p<0.05$) than the effect of NPK but significantly different (control) without fertilizer treatment. There was similar result obtained by Rady et al. [14], for other forage types. The mean number of tiller per plant for oat grass on the type of fertilizer significantly different

($p<0.0001$) this indicated that the number of tillers per plant increased with an increase in application of fertilizer. The stem /stalk that support the leaf flower and fruits .It also serves as the main route of transportation materials.

Numbers of tillers per plant

As indicated in the table fertilizer type (NPK, compost and control) significantly affected ($p<0.0001$) number of tiller per plant (LTNPP) of oat grass. The highest mean number tiller per plant was observed at application of NPK fertilizer (LTNPP) counts and the lower value count LTNPP was recorded for control 5counts. The application of compost (organic fertilizer) had significant effect ($P<0.05$) than the effect of NPK but significantly different (control) without fertilizer treatment. The mean number of tiller per plant for oat grasses on the type of fertilizer significantly different ($p<0.0001$) this indicated that the number of tillers per plant increased with an increase in application of fertilizer. It was leaf tiller most of photosynthetic organ for function. The current finding is supported by the reports of Tolera et al. [15], for other species performance.

Root length per plant

The effect of fertilizer type and oat accession on root length per plant of oat grass is shown in Table 1. The effect of fertilizer type (NPK, Compost and control) significantly affected ($p<0.05$) root length per plant (RLPP) of oat grass in the study area. The highest mean root length per plant (RLPP) was observed for NPK fertilizer (12cm) and compost (11cm), respectively while the lowest value was recorded for control (without fertilizer) 10cm. The effect of NPK and Compost were not significant ($p<0.0001$) difference on root length per plant of oat grass. It was grows below the ground and absorb water and mineral from the soil (Xylem tissues).

Root number per plant

The effect of fertilizer type and oat accession root tillers on number of per plant of oat grass is shown in Table 1. As indicated in the table fertilizer type (NPK, compost and control) significantly affected ($p<0.05$) number root per plant (RTNPP) of oat grass. The highest mean number of root per plant (RTNPP) was observed for NPK fertilizer (69 count) while the lowest value was recorded for control (without fertilizer) 58 count. The effect of compost (61 count) had shown intermediate value between NPK and control treatment. Root tillers main function oat accession plant attaches into soil and absorb water and minerals that were useful for the plant from the soil.

Effect of fertilizer type and oat accession on Dry Matter Yield and Chemical Composition of oat grass

The effect of type of fertilizer and oat accession on chemical composition, dry matter, dry matter yield, organic matter, ash, crude protein content and crude protein yield and fiber and lignin contents of oat grass is shown in table.

Dry matter content

The effect of fertilizer type and oat accession on chemical composition of oat grass is shown in Table 2. Dry matter content (DM %) of the oat grass influenced by application of fertilizer NPK, compost and unfertilized was significantly different ($p<0.05$).According to Gezahegn et al. [5], for the higher livestock population in Ethiopia higher supply of feed in terms of quality and quantity is needed with Oats being one of the major sources as green feed, hay, straw and grain. DM content of the oat grass in the current PNK, Compost, without fertilizer and Cl-8251, Cl-8237, Jassari each plot at interaction effect of dry matter respectively.

Dry matter yield (DMY)

The effect of fertilizer type and oat accession on the DM yield of the oat grass is shown in Table 2. As indicated in the table fertilizer type (NPK, Compost and Control) was highly significant affected ($p<0.001$) Dry matter yield (DMY) of oat grass. The highest mean dry matter yield was observed for NPK fertilizer application (30 t/ha) while the lowest value of dry matter yield of oat grass was recorded for control (without fertilizer) application (21 t/ha). The effect of Compost had shown intermediate value between NPK and without fertilizer treatment. The highest dry matter yield means was observed in chemical fertilizer (NPK) 30 tons per hectare, followed by organic fertilizer (compost) 23 tons per hectare and the lower mean result was observed in unfertilized (control) 21 tons per hectare respectively.

Table 2. Mean chemical composition and yield in the fertilizer type and oats accession of oat grass

	Factors	DM %	DMY (t/ha)	OM %	ASH%	CP %	CPY (t/ha)	NDF %	ADF %	ADL%
Fertilizer type	NPK	91a	30a	83a	8b	11a	3a	56b	37a	4.7c
	Compost	91a	23b	83a	9a	10b	2b	56b	37a	5.1b
	Control	90.95a	21c	82b	8b	9c	1c	57a	37a	5.3a
	Sign.	ns	***	*	*	***	***	*	ns	***
	Interaction	ns	ns	ns	ns	ns	ns	ns	ns	ns
Oats accessions	CI 8237	91a	26a	83a	8b	10a	2.5a	59a	37a	4.9a
	CI 8251	91a	27a	82.6a	9a	10a	2.7a	55b	37a	3.7b
	Jassarii	91a	20b	82.7a	8b	10a	2b	55b	37a	4.6a
	Mean	91	24.6	82.9	8	9.8	2.45	56	6	6
	SE	1	6.2	1.9	1.6	1.4	0.86	6.7	4.7	1
	Sign.	ns	*	ns	*	ns	*	*	ns	*
	Interaction									

Means followed by the different letter with the same column are statistically different at P<0.0001 SE=standard error; DM=dry matter; DMY=dry matter yield; OM=organic matter; Ash=ash content CP=crude protein; CPY=crude protein yield; NDF=neutral detergent fiber; ADF=Acid detergent fiber; ADL=Acid detergent lignin; sig=significant; ns=not significant; AC=Accession.

Crude protein content (CP %)

The effect of fertilizer type and oat accession on chemical compositions of oat grass is shown Table 2.The effect fertilizer type (NPK, compost and control) significantly affected ($p<0.005$) crude protein content (CP %) of oat grass. The highest mean crude protein (CP %) was observed for NPK (11%) while the lowest value CP% of oat grass was recorded for the control (without fertilizer) 9% experiment. The effect of Compost 10% CP had shown intermediate value between NPK and control treatment.

Crude protein yield (CPY)

The effect of fertilizer type and oat accession on crude protein yield of oat grass is shown in Table 2. Crude protein yield (CPY) is significantly affected by interaction. The highest mean crude protein yield was observed for NPK (3 t/ha) CP while the lowest value was recorded for control (without fertilizer) (1t/ha) CP. The effect of Compost had shown intermediate value (2 t/ha) between NPK and control treatment.

Total ash content

The effect of fertilizer type using and oat accession on total ash content of oat grass total ash content is shown in Table 2. Total ash content is significantly affected by interaction. The highest mean total ash content was obtained in compost fertilizer type (9%) while the lowest value was recorded in without fertilizer and NPK fertilizer used 8% and 8% respectively.

The present study indicated that total ash content was very low for PNK (inorganic fertilizer) and control treatment but as increased organic (compost) fertilizer also ash content increased of the oat grass.

Neutral detergent fiber content

The insoluble portion of the forage (neutral detergent fiber) contains the cellulose, hemicelluloses, lignin and silica. It is commonly referred to as the cell wall fraction. Neutral Detergent fiber has been shown to be negatively correlated with dry matter intake. In other words, as the NDF in forages increases, animals will be able to consume less forage. NDF increases with the advancing maturity of forages. A better prediction of forage intake can be made using NDF; therefore, better rations can be formulated. Neutral detergent fiber content was significantly affected by application of fertilizer type (NPK, Compost and without fertilizer) ($p<0.05$) in the study area. The highest mean of NDF content was observed for control (without fertilized) (57%) while the lowest value was recorded for NPK (56%).The effect of compost had shown intermediate result between control and NPK fertilizer type 56% treatment. The highest mean was recorded for the control (unfertilized), so it indicates that as the level of NPK fertilizer used the NDF content decreases. This may be elucidate that the type fertilizer NPK immediately and compost gradually improves the plant growth and raise new leaves and shoots.

Acid detergent fiber content

Acid detergent fiber is the portion of the forage that remains after treatment with a detergent under acid conditions. It includes the cellulose, lignin and silica. Acid detergent fiber is important because it has been shown to be negatively correlated with how digestible forage may be when fed. As the ADF increases, the forage becomes less digestible. Acid detergent fiber is sometimes misinterpreted as indicating the acid content of fermented forages. The term acid detergent fiber has nothing to do with the acid content of forage. The name is derived from the procedure used to determine the cellulose and lignin content. Acid detergent fiber content of oat grass was affected on the type of fertilizer (NPK, compost and control) the same as oat accession Cl-8251, Cl-8237 and Jassari ($p<0.05$) but their interaction was significant ($p<0.05$). The highest mean acid detergent fiber (ADF) content of oat grass was obtained compost fertilizer (37%) while the lowest mean value of oat grass was recorded for NPK (37%) of the treatment. The effect of control/without fertilizer/ had shown intermediate value of ADF content (37%) between compost and NPK treatment.

Acid detergent lignin content

Effect of fertilizer type (NPK, compost and control) and oat accession (Cl-8251, CI-8237 and Jassari) affected the ADL content of oat grass was significant difference ($p<0.05$) on ADL content, whereas their interaction had significant effect ($p<0.05$). The highest mean of ADL content was observed in the control 5.3% while the lowest value was obtained for NPK (4.7%). The effect of compost had middle value (5.1%) of between control and NPK fertilizer type treatment. The highest mean ADL contents were observed (5.3%) unfertilized treatment than compost and NPK fertilizer application but the lowest ADL content was recorded (4.7%) in NPK fertilizer. The current finding is in line with the reports of Freitas [16] in another type of forage crop.

Correlation among morphological characteristics and chemical composition of oats grass

The simple linear bivariate correlation analyses among morphological characteristics and chemical composition of oat grass are presented in Table 3.

Table. 3. Correlation coefficients among morphological parameters and chemical composition of oats grass

	LLPP	PH	STNPP	LTNPP	RLPP	RTNPP	DM	DMY	OM	ASH	CP	CPY	NDF	ADF	ADL
LLPP	1	0.71	0.99	0.24	0.45	0.37	0.52	0.92	0.74	0.95	0.29	0.66	-0.29	-0.38	-0.18
PH		1	0.08	0.86	0.74	0.798	0.68	0.74	0.3	0.004	0.39	0.98	0.56	0.2	0.24
STNPP			1	0.77	0.38	0.4	0.89	0.32	0.7	0.26	0.31	0.36	0.25	0.8	-0.05
LTNPP				1	0.87	0.04	0.46	0.35	0.4	-0.05	0.35	0.25	0.34	0.08	0.04*
RLPP					1	0.27	0.84	0.2	0.28	0.7	0.28	0.45	-0.13	0.35	-0.21
RTNPP						1	0.5	0.37	0.72	0.3	0.01	0.16	0.74*	0.07	-0.03
DM							1	0.25	0.64	0.18	0.16	0.26	0.04	0.07	-0.06
DMY								1	0.26	-0.09	0.44	0.9	0.14	0.16	0.14
OM									1	-0.8	0.6	0.3	-0.12	0.14	0.09
ASH										1	0.12	0.003	0.19	0.04	-0.21
CP											1	0.73	0.007	0.23	-0.36
CPY												1	0.22	0.09	0.02
NDF													1	0.36	0.29
ADF														1	0.71
ADL															1

Level of significance: **=P<0.001; *=P<0.001; DM=dry matter %; DMY=dry matter yield; OM=organic matter %; Ash=ash %;CP=crude protein %; CPY=crude protein yield; NDF=neutral detergent fiber %; ADF=acid detergent fiber %; ADL=acid detergent lignin %; PH=plant height; LLPP=leaf length per plant; LTNPP=leaves tiller number of per plant; STNPP=Stem tillers number of per plant; RTNPP=root tiller number per plant and RLPP=root length per plant.

Dry matter content (DM) and dry matter yield (DMY) are positively correlated with plant height (PH), leaf length per plant (LLPP), leaves number of tiller per plant (LTNPP), stem tiller, number of per plant (STNPP), root tiller number of per plant (RTNPP), root length per plant (RLPP) and with each other, but negatively correlated ($p<0.001$) with neutral detergent fiber (NDF), acid detergent

fiber (ADF) and acid detergent lignin (ADL). Crude protein content (CP) was positively correlated with crude protein yield (CPY) leaves length per plant (LLPP), stem tiller, number of per

plant (STNPP, number of root tiller number of per plant (RTNPP), root length per plant (RLPP) and dry matter (DM). Crude protein yield (CPY) was positively correlated with Dry matter yield (DMY), plant height (PH), leaf length per plant (LLPP), leaves tiller number of per plant (LTNPP), Stem tiller number of per plant (STNPP), Organic matter, and total Ash and crude protein (CP) but negatively correlated with neutral detergent fiber (NDF), acid detergent fiber (ADF)and acid detergent lignin (ADL). The NDF content was positively correlated ($p<0.001$) with ADF, ADL while it was negatively correlated ($p<0.001$) with total ash content (ash) and other morphological parameters. ADF was positively correlated ($p<0.001$) with NDF and ADL while it was negatively correlated with other morphological parameters of oat grass. Stem tillers number of per plant (STNPP) was positively correlated with leaves tiller number of per plant (LTNPP), leaves length per plant (LLPP), number of root tiller number of per plant (RTNPP), root length per plant.

4. Conclusions

Most of the morphological parameters were not significantly affected by the effects of fertilizer type while oat accession had also effect on these factors. Similarly, the chemical composition of oat grass was affected both by fertilizer type and oat accession. It is possible to generalize that maximum biomass yield and improved quality can be obtained using NPK fertilizer if it is accessible by smallholder farmers. However, if the NPK is not accessible, the use of compost could be an alternative to produce good quality oat fodder with optimum yield. The oat grass has potential to produce large amount of biomass per unit area and agronomic performance good amount and plant length oat accession very high shoot system but stem tiller and fibrous root system which was decreased, especially in the upper soil horizons, making it well adapted for efficient uptake of nutrients and water, this is suitable to different forage production strategies it should be done backyard, ploughing land and that use rain season and irrigation season different oat accession for sowing broad cast and other forage strategies. Further research on the integration of oat grass with legume species and food crops should be conducted to optimize nutrient balance and to minimize land ploughing land and back yard strategies in the study area.

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