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Dry Matter Yield, Chemical Composition and *In Vitro* Dry Matter Digestibility of Selected Alfalfa (*Medicago sativa* L.) Accessions in North Western, Ethiopia

Misganaw Walie[1], Tekeba Eshetie[2] Wondmeneh Mekonnen[1], Biyadglegne Hunegnaw[1] and Adebabay Kebede[1]
[1]*Andassa Livestock Research Center, P.O. Box, 27, Bahir Dar, Ethiopia*
[2]*Ethiopia Sanitary & Phytosanitary Standards and Livestock & Meat Marketing Program (SPS-LMM), Debrezeit, Ethiopia*
Corresponding author's email: misganaw2000@gmail.com

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ABSTRACT: The experiment was laid using five Alfalfa accessions with the objective of evaluating forage biomass yield, chemical composition and *in vitro* dry matter digestibility at Andassa Livestock Research Center, North Western Ethiopia. The experiment was done under irrigation after the plot properly and finely prepared using randomized complete block design with four replications. During planting 100 kg/ha diammonium phosphate (DAP) was applied. Between January 2013 and June 2013, two cuts were taken on average at an interval of 73 days between harvest. Moreover, in 2014 two cuts were also taken on average 60 days. Significantly higher ($P<0.05$) herbage dry matter yield was recorded for FG-9-09, FG10-09, Magna788 and Magna801-FG, while herbage yield was slightly lower for *Hairy Peruvian*. Plant height was higher ($p<0.05$) for FG-9-09, medium for FG-10-09, Magna788 and *Hairy Peruvian* and lower for Magna801-FG. Crude protein content was higher ($P<0.05$) for Magna801-FG, FG-10-09, Magna788 and *Hairy Peruvian* but lower for FG-9-09. *In vitro* dry matter digestibility ($P<0.05$) was significantly lower for FG-9-09, with the remaining four accessions exhibiting comparable values for both parameters. FG-9-09, FG-10-09, Magna 801-FG and Magna-788 gave better dry matter yield as compared to standard check (*Hairy peruvian*) indicating their potential for better biomass and nutritional value as protein source for livestock feed under Andassa condition and other areas with similar agro ecologies.

Key words: Alfalfa, Dry Matter Yield, Plant Height, Crude Protein, *In Vitro* Dry Matter Digestibility

INTRODUCTION

Feed scarcity in qualitative and quantitative dimensions is one of the major impediments to livestock production in Ethiopia. The quality and quantity of feed resources available to the animals in most parts of the country is mainly affected by seasonal fluctuation of rainfall. Zinash and Seyoum [1] reported that the crude protein (CP) and metabolizable energy (ME) content of natural pasture showed seasonal variations which correspond closely to the seasonal pattern of rainfall. According to the results reported by same authors Zinash and Seyoum [1], peak CP and ME content of 11.2% and 8.2 MJ/kg observed in July declined steadily to 3.3% and 7.1MJ/kg in March. In contrast, neutral detergent fiber (NDF) content increased from 61% in July to its peak of 80% in March. This shows that during the long dry season, animals are prone to nutritional deficiency and need to be supplemented.

Grazing systems typically increase productivity by increasing the number of heads and the land area used. However, currently expansion of cropping at the expense of grazing lands being triggered by increase in human population has led to further deterioration of grazing areas with the consequent erosion of biodiversity and disappearance of palatable pasture species [2]. Mixed farming also faces limitations as innovations in crop production are reducing crop residues and non-grain biomass available for feeding. Moreover, the contribution of agro-industrial by-products in animal production has been minimal due to high cost, unreliable supply and poor access [3].

There is an acute shortage of feed supply during the dry season and the available feeds during this period are of very poor quality (low in protein and high in fiber content), which results in low digestibility and low voluntary intake by animals [4]. Very recently, however, policy environment for dairy production gained due attention with growing demands for livestock products. Intensified dairying has become a key direction of Ethiopian government to deal with low productivity problem of indigenous cattle and to enable resource poor small-holder

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mixed crop livestock farmers to raise incomes. Therefore, in order to cope up with the up-coming problems there is a need to intensify feed and livestock production systems. To realize this, animal production should be supported with technological options that increase livestock productivity per unit of high energy feed and intensification of production need to be in place. Also, the existing backyard production system should be shifted to more intensive feedings via introduction and utilization among others of high yielding grasses and legumes.

Improved forage crops play an important role in sustaining the livelihoods of small and medium scale farmers, mainly as a result of their positive effects on livestock production and contribution to economic and environmental sustainability. On the other hand, indigenous forage species in Ethiopia have low productivity or low digestibility, which reduces their usefulness for livestock nutrition [2]. Thus use of improved forages like alfalfa (*Medicago sativa*) is an important step in supporting and improving livestock productivity especially in mixed crop-livestock production systems. Though, some promising cultivars of forage grasses, legumes and shrubs are identified for limited agro-ecologies of the country, information on their adaptation and productivity under wider ecological conditions seems low. However, these alfalfa cultivars are adaptable and productive under Debre Zeit, central part of Ethiopia [5]. With all the above mentioned advantages, alfalfa could be a potential legume forage crop in North Western Ethiopia specially integrated with improved dairy production. Moreover, there are no recommended/introduced accessions of alfalfa for the area. Thus, this alfalfa adaptation trial was conducted to evaluate selected accessions of *Medicago sativa* for yield and quality characteristics and identify potential materials for subsequent variety evaluation.

MATERIALS AND METHODS

Description of the study area

The study was conducted at Andassa Livestock Research Center (ALRC), located $11^{0}29'$ N latitude and $37^{0}29'$ E longitude at an altitude of 1730 m above sea level. The mean annual rainfall is 1434 mm and the mean maximum and minimum temperature ranged from 27.9 to 13.1^{o}c and humidity ranged from 95% throughout the rainy season to 35% during the dry season. The topography of the area varies from river valley plain to gentle slope grassland. In general, the area is characterized by dark clay soil, which is seasonally water logged [6].

Experimental design and Treatments

Five alfalfa accessions were brought from Debrezeit Agricultural Research Center (DARC) and evaluated at Andassa livestock research center (medebit trial site). The treatments used were FG-9-09, FG-10-09, Magna 801-FG, Magna 788 and *Hairy Peruvian*. The accessions were planted in rows of 20 cm between rows after the land was finely prepared. The plot size used was 3mx4m (12m^2). The design used was randomized complete block in four replications. 100kg/ha of DAP was applied during sowing. The seed was drilled in row carefully, slightly covered with soil and supply with water once per week. Weeding and all other management was done manually as required.

Figure 1. Alfalfa during onset of flowering

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Chemical analysis

For chemical composition and *in vitro* dry matter digestibility, dried sample was taken and chopped herbage of the four replications were pooled into one and properly homogenized and one representative subsample was taken for each accessions within each cutting cycle. CP, NDF, ADF, lignin and *in vitro* dry matter digestibility were analyzed in Holeta Nutrition laboratory using near infra-red reflectance spectroscopy.

Data collection and Statistical analysis

Plant comprising leaf and steam were taken from middle four rows during 50% flowering, dried in air until constant weight for dry matter determination for two years and two cutting per year. Five plants were taken randomly and measured for plant height parameter. The General linear model (GLM) procedure of SAS was used to analyze both yield and chemical composition parameters[7] and significant mean differences were separated using LSD (Least Significant Difference) test.

RESULT AND DISCUSSION

Herbage dry matter yield and plant height

Mean value for herbage dry matter yield (DMY) and average plant height (APH) of the five alfalfa accessions are presented in Table 1. The effect of accession was significant for DMY ($P<0.05$) and plant height ($P\leq0.01$). FG-9-09 showed significant difference as compared to *Hairy peruvian* but no significant difference was observed as compared to other three accessions in terms of DMY. Plant height was higher for FG-9-09, medium for FG-10-09 and lower for *Hairy Peruvian*, Magna-788 and Magna801-FG. Plant height also showed highly significance difference between FG-9-09 with Magna 801-FG and *Hairy peruvian* but no significant difference was observed between FG-10-09, Magna-788 and *Hairy peruvian*. Cutting cycle significantly affected herbage DMY and plant height ($P\leq0.05$).

Table 1. Herbage DMY (tha^{-1}) and plant height (cm) of the five alfalfa cultivars

Variables	APH	DMY
FG-10-09	72.0^{b}	4.63^{ab}
FG-9-09	79.87^{a}	4.87^{a}
Magna 801-FG	65.06^{c}	4.65^{ab}
Magna-788	69.38^{bc}	4.78^{ab}
Hairy peruvian	69.06^{bc}	4.02^{b}
Overall	71.07	4.53
SE	2.1408	0.2821
CV	12	14.9

APH= average plant height; DMY= dry matter yield; SE= standard error of mean; CV= coefficient of variation; *=significant at $P\leq0.05$; **= significant at $P\leq0.01$; means with the same superscript in columns are not significantly different.

The significant accession differences observed for herbage DMY in the present study agree with other reports [5, 8]. Quite the reverse, other researchers [9, 10] reported a respective herbage DM yield values ranging from 1.78 - 3.23 t/ha and 0.67 - 2.16 t/ha, figures that are lower than those recorded for the cultivars in the present work. The wide range of herbage DMY values observed in different reports could be attributed to varietal or environmental differences and/or their interactions.

The significant accession differences observed for plant height in the present study was also in agreement with other report [11]. Ullah et al. [6] also stated variations in plant height to be linked to genotypic differences and explained this trait to be influenced by differential genotypic response to prevailing site and crop management scenarios. Similarly, Dineshkumar [13] indicated that plant height in alfalfa can be influenced by crop management factors such as application of fertilizers.

Herbage yield across cutting cycles

Mean value for average plant height (APH) and DMY by cutting cycles are presented in table2. A total of four harvest were taken during two years of data collection. Both APH and DMY showed significance difference by cutting cycles. First harvest was lower in its APH and DMY as compared to other cutting cycles which could be due to the time of establishment.

A total of two harvests obtained per year and four harvest within two years in the present study was very low as compared to eight harvest per year under Debre Zeit, Ethiopia condition [5]. This might be associated with experimental site seasonally waterlogged which reduce the growth and time of harvest. Evidence shows that alfalfa could be harvested at shorter intervals, around 30 days, with higher number of cuts achieved during the dry months of the year under irrigated conditions, which indeed is lower than an interval of around 60 to 73 days recorded in the present study. The interval between harvests in the current study was longer during wetter months compared to dry months, and this could be explained by the fact that the trial site of Andassa Livestock Research Center mostly dominated by black soil and seasonally waterlogged during July to October.

Table 2. Effect of cutting cycles on herbage DMY (tha^{-1}) and plant height (cm) averaged over the five alfalfa accessions

Cutting cycle	APH	DMY tha^{-1}
Cycle1	63.29^{b}	3.96^{b}
Cycle2	67.82^{b}	4.79^{a}
Cycle3	85.38^{a}	4.59^{ab}
Cycle4	67.8^{b}	4.77^{a}
SE	2.14	0.28

APH= average plant height; DMY= dry matter yield; SE= standard error of mean; CV= coefficient of variation; *significant at P≤0.05; ** significant at P≤0.01; means with the same superscript in columns are not significantly different.

Chemical composition and *in vitro* dry matter digestibility

Table 3 shows least square means of the different herbage quality traits for the five alfalfa accessions. The DM content was significantly (P≤0.05) higher for FG9-09 as compared to four cultivars FG10-09, Magna801-FG, Magna788 and *Hairy Peruvian*. Similarly, the CP content was significantly (P≤0.05) lower for FG9-09 as compared Magna-788, FG-10-09, Magna801-FG and Hairy Peruvian but no significance difference was observed between four accessions. The NDF and lignin concentrations were superior for FG9-09 (P≤0.05), with the other accessions exhibiting comparable values for both fractions. The IVDMD (P≤0.05) significantly lower for FG-9-09, with the remaining ones having comparable values for these traits.

Table 3. Chemical composition and *in vitro* DM digestibility of five alfalfa accessions (Lsmean±SE)

Treatments	DM%	Chemical composition (%DM) and *in vitro* DMD				
		CP	NDF	ADF	Lignin	*In vitro* DMD
FG-10-09	91.02^{b}	$18.92^{a}\pm0.91$	$26.66^{b}\pm1.07$	$25.58^{b}\pm0.89$	$5.07^{ab}\pm0.19$	$62.37^{a}\pm0.52$
FG-9-09	91.3^{a}	$15.41^{b}\pm0.95$	$30.62^{a}\pm1.12$	$29.05^{a}\pm0.93$	$5.39^{a}\pm0.19$	$59.73^{b}\pm0.54$
Magna 801-FG	90.88^{b}	$19.6^{a}\pm0.95$	$26.46^{b}\pm1.12$	$25.61^{b}\pm0.93$	$4.73^{b}\pm0.19$	$61.67^{a}\pm0.54$
Magna-788	91.02^{b}	$18.62^{a}\pm1.01$	$27.43^{ab}\pm1.18$	$25.82^{b}\pm0.98$	$5.29^{ab}\pm0.21$	$62.12^{a}\pm0.57$
Hairy peruvian	91.04^{b}	$17.63^{ab}\pm0.95$	$28.23^{ab}\pm1.12$	$26.45^{ab}\pm0.93$	$5.09^{ab}\pm0.19$	$62.01^{a}\pm0.54$
Overall	91.05	18.06	27.86	26.5	5.11	61.58
CV	0.25	17.4	13.2	11.6	12.6	2.9

DM= dry matter; CP= crude protein; NDF= neutral detergent fiber; ADF= acid detergent fiber; CV= coefficient of variation; *significant at P≤0.05; ** significant at P≤0.01; means with the same superscript in columns are not significantly different.

High quality alfalfa was reported to contain >19 % CP, <31% ADF and <40 % NDF [14]. In this study, the cultivar Magna801 had CP content with in the indicated threshold value, while the other three cultivars had comparable CP values, ranging from 15.41% for FG9-09(F) to 18.92% for FG10-09(F), values lying slightly below the threshold of 19 %. Indeed, all the cultivars had CP contents of above 15%, a level suggested for a protein source feed to be considered optimal for use as supplement for lactation and growth in dairy cattle. Thus each one of the cultivars can be used as a potential source of plant protein supplement for dairy cattle [15]. The NDF content of FG9-09(F) was comparatively higher than the figure recorded for the other cultivars, but the result was below the threshold level of 40%. On the other hand, the ADF content of all the cultivars was observed to be below the 31% upper threshold level that good quality alfalfa hay was reported to contain.

The *in vitro* dry matter digestibility (IVDMD) values varied significantly among the accessions and this agrees with what has been reported extensively. For instance, Volenec and Cherney [16] reported significant differences in IVDMD among alfalfa cultivars and accessions and these differences were indicated to be associated with variation in digestibility of the stem fraction [17]. Similarly, significant differences in IVOMD were reported for 14 alfalfa varieties, with values ranging from 59.15 to 66.33% [18], which were much lower than values recorded for the cultivars in the present study. Selection for improved forage quality has also been successful for increasing IVDMD in alfalfa [8].

CONCLUSION AND RECOMMENDATION

The effect of cultivar was significant for DMY and plant height. FG-9-09 showed significant difference as compared to *Hairy peruvian* but no significant difference was observed as compared to other three cultivars in terms of DMY. Plant height was higher for FG-9-09, medium for FG10-09 and lower for *Hairy Peruvian*, Magna-788 and Magna801-FG. From the present study all cultivars had CP contents of above 15%, a level suggested for a protein source feed to be considered optimal for use as supplement for lactation and growth in dairy cattle. Thus all the tested alfalfa cultivars can be used as a potential source of plant protein supplement for dairy cattle. Except standard check (*Hairy peruvian*), the four tested alfalfa cultivars FG9-09, FG-10-09, Magna 801-FG and Magna-788 gave better dry matter yield. Therefore, FG-10-09, Magna 801-FG, Magna-788 and FG-9-09 can be promoted as source of protein feed for livestock production under Andassa condition and in areas having similar soil and climatic conditions.

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Competing interests
The authors declare that they have no competing interests.

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