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Evaluation of Alfalfa (Medicago Sativa) cultivars for their Agronomic Performances and Nutritive values in highland and midland of Guji zone of Oromia

Teshale Jabessa [1*], Ketema Bekele [2], Zinash Amare [3]

[1] School of Animal and Range Sciences, Haramaya University, Haramaya, Ethiopia

[2] Bore Agricultural Research Center, Bore, Ethiopia

[3] Fiche Agricultural Research Center, Fiche, Ethiopia

* Corresponding author, email: teshalejabessa@gmail.com

Abstract: The study was conducted to identify adaptable high biomass, leaf to steam ratio, and good quality yield of Alfalfa cultivars at Bore Agricultural research center. Eight Alfalfa cultivars; Hunter river, Magna-801-FG, Pioneer (1995) DZF-406, Segule1396 (408), Peruvian DZF (406), F-G-9-09, F-L-L-77-(406), and Hunter river (4010) were tested in RCBD with three replications. Plant height was significantly ($P < 0.05$) higher for Hairy (1995) DZF-406 cultivar (83 cm) while lower for Magna-801-FG. Disease resistance was significantly different ($P < 0.05$) among cultivars. Segue (1396)-408 cultivars were highly resistant to diseases compared to others. Leaf to stem ratio, biomass yield, and seed yield did not show significant ($P > 0.05$) differences among treatments. Regarding chemical compositions of NDF, ADL and CP were significantly ($P < 0.05$) different among treatments. The superior ADL was obtained from Segule (1396)-408 cultivar (32.5%) while, the low was obtained from F-L-L-77 (406) cultivar. The superior NDF was obtained from Poineer (1995) DZF-406 cultivar (70.7%) whereas; the low was from Peruvien- DZF- 406 cultivars (45.9%). The CP yield showed a significant ($P < 0.05$) difference among cultivars. Magna-801-FG cultivar had the superior (26.3%) CP while Segule (1396)-408 cultivar (11.3%) had the inferior CP content. Cultivar F-G-9-09 was produced superior in DM (91.8%) and less in

ADL (9.3%) while Segule 1396 (1396)-408 cultivar produce (91.3%) DM and lower in TASH (10.8%). superior OM has obtained from Segule 1396 (408) cultivar (80.4%) compared to others. Based on its yield, plant height, biomass yield, and chemical compositions, good DM and OM Peruvien- DZF- 406, F-L-L-77 (406,) Segule-1396 (408), and F-G-9-09 is recommended for further promotion in the highland and midland of Guji and similar agro-ecologies.

Keywords: Medicago Sativa, chemical composition, Adola, Cultivar.

Introduction

Alfalfa (Medicago sativa L.) is often recognized as one of the most important perennial forage legumes worldwide and is widely known as the "queen of the forages" due to its ability to consistently produce high forage yield and forage quality and adaptability to different climatic conditions (Kamalak et al., 2005; Turan et al., 2009). Alfalfa is a drought-tolerant forage crop because it has a deep root system that reaches down to 4 m and 7-9 m in well-drained soils. The plant survives long periods of water stress by impeding its vegetative growth (Annicchiarico et al., 2010) and accessing water from deep layers through its long root system (Volaire, 2008). The optimum growing air and soil temperatures for alfalfa are 27°C and 12°C respectively, but it is tolerant of air temperatures above and below 27°C (McKenzie et al., 1988).

This forage legume is also known as an effective source of biological nitrogen fixation, and energy-efficient crop to grow, and an important source of protein yield. The optimum soil pH range for alfalfa is 6.5 to 7.5 and tolerates relative salinity. Alfalfa grows best on well-drained, deep soils but it thrives on sandy soils with adequate moisture and fertility (Barnhart, 1997). Alfalfa does not grow well on soils where root growth is limited such as shallow hardpans, high water tables, bedrock, or acidic subsoils (Lacefield et al., 1987).

Poorly drained or waterlogged soils are strongly discouraged for alfalfa because root and crown diseases reduce stand longevity under these conditions. The crop needs very frequent irrigation during its early growth period at an interval of about one week but once the plants are established, subsequent irrigations are provided at an interval of 10-15 days

during the dry season. Alfalfa is one of the few cultivated forage crops that can produce a high level of biomass with minimum inputs. Low-quality crop residues need nitrogen supplementation, often provided by forage legumes to become productive diets (Anderson, 1985).

Climate, cultivation practices, feed technologies, and genetic variations are the main factors affecting the nutritional value of feed for livestock. Forage legumes contribute significantly to livestock production in crop-livestock systems. Legume forages generally lead to higher intakes and animal production than grass silages of comparable digestibility (Dewhurst et al., 2003). Alfalfa nutritive value is identified with protein content which depends on the share of leaves in dry matter yield which in turn is positively correlated with protein content. The proportion of leaves and stems in alfalfa hay can vary greatly, depending on maturity at harvest, cultivars, handling, and rain damage (Katic et al., 2006). Protein content in alfalfa dry matter varies from 18 to 25% depending on the growth stage, cultivar difference, and other factors. Alfalfa is one of the most important forage legumes of the world as a major source of protein for livestock and it is a basic component in rations for all classes of domestic animals (Barnes et al., 1988).

Where alfalfa can easily be grown, it is regarded as key forage for high-producing ruminants because of its richness in protein, palatability, high calcium, and vitamin content. In many cases, animals feeding on alfalfa do not require supplements. Alemayehu (2002) noted that because of its very high feed value, alfalfa should be used as a supplement for crop residues and natural hay in a mixture of 30 percent alfalfa and 70 percent other roughages. Alfalfa produces more protein per hectare than other legumes and grasses; therefore, it is widely used for hay production and as pasture for livestock, especially to ruminants (Monteros and Bouton, 2009).

Ruminants fed on alfalfa have higher nutrient intake and digestibility than when fed on other forage legumes and grasses (Frame, 2005). To improve the availability of livestock feed in terms of quantity and quality, it is better to cultivate alfalfa forage that has better biomass yield and nutritional quality. Therefore, the objective of the present study was to

evaluate the adaptability potential Good biomass yield, leaf to stem ratio, and nutritional quality of alfalfa cultivars grown at high land and mid-land parts of the Guji zone.

Materials and methods

Description of the study area

The experiment was carried out at Songo barista on station and Adola sub-site of Bore Agricultural Research Center. Bore district is located at 385 km to the south of Oromia from Finfinne and 220 km from the Guji Zone capital city (Negele) with a geographical location of 557'23" to 626'52" N latitudes and 3825'51" to 3856'21" E longitudes, South-eastern Oromia. The annual rainfall is about 1400-1800mm and the annual temperatures of the district ranged from 10.1 to 20 C. The major soil types of the site are mostly black soil. Bore Agricultural Research station is located 7 km from Bore district which is geographically located at 624'37" N latitude and 3834'76" E longitudes. The research station represents the highlands of Guji Zone with an altitude of 2736 m.a.s.l. receiving high rainfall characterized by bimodal distribution. The first rainy season extends from April to October and the second season starts in late November and ends at the beginning of March. Adola district is located at a distance of 470 km from Addis Ababa and 120 km from the Zonal capital city, Negele Borena. The areas are a mixed farming and semi-nomadic economic activity takes place, which is the major livelihood of the local peoples. The District is situated at 5o44'10" - 6o12'38 N and 38o45'10" - 39o12'37" E. The District is characterized by highland (11%), midland (29%), and lowland (60%). The major soil types of the district are tools (red basaltic soils) and orthic across (Yazachew E. and Kasahun D.2011).

Experimental treatments and design

The experiment was conducted using eight Alfalfa cultivars Hunter river, Magna-801-FG, Pioneer (1995) DZF-406, Segule1396 (408), Peruvian DZF (406), F-G-9-09, F-L-L-77-406, and Hunter river (4010). The experiment was conducted in a randomized complete block design (RCBD) with three replications. Seeds were sown in rows spaced 20 cm and 1 m, 1.5 m between plot and block respectively on a plot size of 2 m x 2 m (4 m2). Seed & fertilizer was applied and other agronomic crop protection practices were adopted uniformly as per recommendation for production.

Methods of data collections

All relevant data like plant height, Biomass yield, seed yield, leaf to stem ratio, and resistance to disease and insects were carefully recorded.

Chemical analysis

For forage quality analysis, chopped herbage of the three replications was pooled into one and properly homogenized and one representative subsample was taken for each cultivar. The DM and ash contents were determined by oven drying at 105°C overnight and by igniting in a muffle furnace at 500°C for 6 hours, respectively. Nitrogen (N) content was determined by Kjeldahl method and CP was calculated as N x 6.25 (AOAC, 1995). The neutral detergent fiber (NDF), acid detergent fiber (ADF), and acid detergent lignin (ADL) fractions were analyzed according to Van Soest and Robertson (1985).

Statistical analysis

All collected data were analyzed using the general linear model procedure SAS (SAS, 2002) version 9.1. Means were separated with the least significant difference (LSD) at a 5% significant level. The statistical model for the analysis data was:

$$Yijk= \mu + Aj + Bi + eijk$$

Where; Yijk= response of variable under examination, μ = overall

mean, Aj = the jth factor effect of treatment, Bi = the ith factor effect of block/ replication, eijk = the random error.

Results and Discussions

Yield and yield-related components

The experiment was conducted on eight improved Alfalfa cultivars to select the highest yield and best performing in all agronomic traits and good quality compositions. Combined mean values of agronomic characters, mean values of agronomic traits, and yield components of Alfalfa cultivars on different locations and combine mean values of chemical compositions are presented in Table 1, Table 2, and Table 3 respectively.

Plant height at forage harvesting stage

For plant height determination, the mean height of five randomly selected plants was recorded for each plot of the trial. Plant height was significantly different ($P < 0.05$) among cultivars at forage harvesting stages in Table 1. Plant height was significantly higher for

Hairy (1995) DZF-406 cultivar (83 cm) and medium for F-L-L-77 (406) cultivar (82.9 cm) whereas lower for Magna-801-FG cultivar (63.8 cm). The result of this study agreed with that of Diriba et al., (2014) where they reported significant variation for Alfalfa cultivars.

Disease Resistance

Disease resistance was significantly different ($P < 0.05$) among cultivars at different growth stages of the forages Table 1. From eight Alfalfa adapted at Bore Agricultural research center, four cultivars Hunter River (4010), Poineer (1995) DZF-406, Hunter River, and F-L-L-77 (406) were highly attacked by diseases while Magna- 801-FG, Peruvien- DZF-406, F-G-9-09, and Segule (1396)-408 cultivars were resistant to diseases compared to the other cultivars observed in the study areas over two consecutive years.

Mean fractions of the leaf to stem ratio

Leaf to stem ratio was determined by separately harvesting a central section of two adjacent middle rows with a sampling area of 0.25 m2 (0.5 m length x 0.5 m width) and by partitioning the harvested biomass into leaf and stem fractions. Leaf to stem ratio was not significantly different ($P > 0.05$) among alfalfa cultivars at the forage harvesting stage. Leaf to stem ratio was superior for Hunter river-4010 cultivar (0.71) followed by Peruvian- DZF-406 cultivar (0.69) and the lower was obtained from Poineer (1995) DZF-406 cultivar (0.54). This is agreed with the results of Solomon W. and Tesfay A. (2019); Mekuanint et al., 2015). The non-significant cultivars differences in the leaf to stem ratio at the forage harvesting stage observed in the present study is dis-agreement with other reports (Lamb et al., 2003; Hayek et al., 2008; Monirifar, 2011; Mekuanint et al., 2015), but happens at the same time with others research findings (Afsharamanesh, 2009; Diriba et al., 2014; Geshaw et al., 2015).

Mean biomass yield of cultivars

The fresh weight of the cut biomass was recorded just after mowing using field balance. Then, sub-samples of 300g were taken and dried in an air draft oven at 65°C for 72 hours to determine the herbage dry matter yield (DMY). The combined mean biomass yield did not show a significant ($P > 0.05$) difference among treatments. The highest mean value of biomass yield was obtained from Segule-1396-(408) cultivar (8.2 t/ha) followed by F-L-L-

77 (406) cultivar (8.07 t/ha). The lowest biomass yield was obtained from the Hunter river (4010) cultivar (7.13 t/ha).

Combined mean seed yield

Combined mean seed yield did not show significant (P > 0.05) differences among treatments. The superior seed yield was obtained from Segule-1396 (408) cultivar (0.083 qt/ha) and the lower seed yield was obtained from Hunter river (4010), Hunter River, F-L-L-77 (406), and Magna- 801-FG cultivars respectively.

Table1 Combined mean values of different agronomic traits and yield-related components of Alfalfa cultivars from two locations Adola sub-site and songo on the station.

Cultivars	PH (cm)	Ds	LSR	SY qt-1	BMYt-1
F-L-L-77 (406)	82.9a	1.42abc	0.63	0.08	8.07
Magna- 801-FG	63.8b	1abc	0.62	0.07	7.31
Peruvien- DZF- 406	83a	0.7abc	0.69	0.08	7.90
F-G-9-09	71ab	0.67bc	0.62	0.07	7.68
Poineer (1995) DZF-406	82.4a	1.75ab	0.54	0.08	8.05
Segule (1396)-408	79.8a	0c	0.66	0.083	8.2
Hanter River (4010)	79.6a	2.17a	0.7	0.07	7.13
Hanter River	73ab	1.42abc	0.56	0.07	7.32
Mean	77.1	1.15	0.62	0.076	7.71
CV	17.1	140	33.2	21.18	28.9
LSD (5%)	*	*	NS	NS	Ns

[a,b,c] Mean in a column within the same category having different superscripts differ significantly (p<0.05) PH (cm)=plant height in centimeter, Ds=Disease resistance, LSR=leaf to steam ratio, $SYqt^{-1}$=seed yield cuntal per hectare, $BMYt^{-1}$= biomass yield tone per hectare, CV=Coefficient of variation, LSD= Least significant difference,*= significantly different, NS= None significant different.

Yield and yield-related to Alfalfa cultivars from different locations.

The mean value of agronomic and yield parameters of alfalfa cultivars are shown in Table 2. The analyzed result shows that plant height and disease were significantly (P < 0.05) different among treatments. Alfalfa cultivars were more attacked by diseases at Songo

on station than at Adola sub-site. Highly attacked cultivar by diseases was Hunter river cultivar (2.5) at Songo on station whereas, Magna-801-FG cultivar (2) were highly diseased at Adola sub-site. Segule-1396 (408) cultivar was resistant to the disease at both locations and Magna-801-FG cultivar at Songo on the station. The rest cultivars were comparable with each other at both locations.

The long plant height was measured from F-L-L-77(406) cultivar (99.22 cm) at Adola sub-site whereas; Segule-1396 (408) cultivar (76.05 cm) was the long plant height at Songo on the station. On the other hand, the short plant height was obtained from Magna -801-FG (69.5 cm) cultivar at Adola sub-site and Hunter River (4010) cultivar (49 cm) at Songo on station compared to the other cultivars.

Leaf to stem ratio, Biomass yield, and seed yield did not show significant (P > 0.05) differences among treatments.

Table2 Mean value of agronomic traits and yield components of Alfalfa cultivars on different locations.

Cultivars	Locations									
	Adola sub-site					Songo station				
	PH cm	DS	LSR	SY qt-1	BMYt-1	PH cm	Ds	LSR	SY qt-1	BMYt-1
F-L-L-77 (406)	99.2a	0.8ab	0.63	0.06	8	63.12ab	2ab	0.62	0.105	8.0
Magna- 801-FG	69.5c	2a	0.61	0.05	7	63ab	0c	0.61	0.08	7.6
Peruvien- DZF- 406	97.6ab	1ab	0.72	0.07	8	66.75ab	0.5bc	0.66	0.09	7.8
F-G-9-09	82.8bc	0.5ab	0.58	0.06	7.25	61.ab	0.8abc	0.64	0.08	8.1
Poineer (1995) DZF-406	97.2ab	1.5ab	0.54	0.08	8	67.91ab	2ab	0.53	0.08	8.08
Segule (1396)-408	88.6ab	0b	0.69	0.08	8	76.05a	0c	0.61	0.08	8.1
Hanter River (4010)	93.8ab	2a	0.69	0.06	7.2	49b	2.3ab	0.72	0.08	7.05
Hanter River	88.6ab	0.3ab	0.56	0.05	7.2	66.66	2.5a	0.57	0.09	7.4
Mean	89.7	1.02	0.63	0.06	7.6	64.2	1.27	0.62	0.09	7.78
CV	8.6	156	31.1	26	22.5	15.9	128	27.6	17.8	20.5
LSD (5%)	*	*	NS	NS	NS	*	*	NS	NS	NS

[a,b,c] Mean in a column within the same category having different superscripts differ significantly ($p<0.05$) PH (cm)=plant height in centimeter, Ds=Disease resistance, LSR=leaf to steam ratio, $SYqt^{-1}$=seed yield cuntal per hectare, $BMYt^{-1}$= biomass yield tone per hectare, CV=Coefficient

of variation, LSD= Least significant difference,*= significantly different, NS= None significant different.

Chemical Composition

From tested alfalfa cultivars, all the traits showed non-significant (P > 0.05) differences except NDF, ADL, and CP Table 3. Alfalfa F-G-9-09 cultivar was produced superior in DM (91.8%) and less in ADL (9.3%) while Segule 1396 (1396) -408 cultivar produce (91.3%) DM and lower in TASH (10.8%). The higher result of the current study was (91.8%) dry matter percentage which was higher than the result reported. The highest OM was obtained from Segule 1396 (408) (80.4%) cultivar, flowed by F-G-9-09 (80.1%) cultivar. The superior ADL was obtained from Segule (1396)-408 cultivar (32.5%), followed by Hunter River Poineer (1995) DZF-406 cultivar (20.5%) whereas the last was obtained from F-L-L-77 (406) cultivar. The ADL content showed variability (P < 0.05) difference among the tested alfalfa cultivars, this is dis-agreed with the result reported by (Diriba et al., 2014; Mekuanint et al., 2015).

The superior NDF has obtained from Poineer (1995) DZF-406 cultivar (70.7%), followed by Hanter River cultivar (64.8%) whereas the least was from Peruvien- DZF- 406 cultivars (45.9%). This is in agreement with the result reported by Diriba et al., (2014) NDF contents of alfalfa cultivars but, dis-agreement to the result Mekuanint et al., (2015) reported non-significant differences for NDF contents of alfalfa cultivars. The current results revealed that the highest NDF contents recorded for Poineer (1995) DZF-406, indicating low-quality alfalfa cultivar when compared with other Diriba et al., (2014).

The CP yield showed a significant (P < 0.05) difference among the tested cultivars. The result revealed that Magna- 801-FG cultivar had the highest (26.3%) CP followed by Hanter River (4010) cultivar (24.6%) while Segule (1396)-408 cultivar (11.3%) had the lowest CP content. This result is des- agreed with the result reported by Diriba et al., (2014) for the same cultivar evaluated under supplementary irrigation.

Table3 Combined mean chemical composition of alfalfa cultivar from Adola sub-site and Songo on the station.

Cultivars	DM	TASH	OM	NDF	ADF	ADL	CP
F-L-L-77 (406)	89.4	13.7	75.7	46.3c	43.5	11.6b	22.9ab
Magna- 801-FG	90.8	12.5	78.3	57abc	43.75	21.6ab	26.3a
Peruvien- DZF- 406	88.17	13.3	74.79	45.9c	40.7	9.47b	17.4bc
F-G-9-09	91.8	11.6	80.1	55.1bc	37.6	9.3b	22.5ab
Poineer (1995) DZF-406	90.7	12.4	78.34	70.7a	40.9	20.3ab	22.2a
Segule (1396)-408	91.3	10.8	80.4	58abc	40.8	32.5a	11.3c
Hanter River (4010)	89.6	12.9	76.72	58.4abc	37.4	13.3b	24.6ab
Hanter River	90.3	12.3	78	64.8ab	44.7	15.8b	23.4ab
Mean	90.28	12.46	77.8	57	41.2	16.7	21.3
CV	2	14.79	3.8	9.5	13.1	31.3	15.6
LSD (5%)	NS	NS	NS	*	NS	*	*

[a,b,c] Mean in a column within the same category having different superscripts differ significantly ($p<0.05$) DM=dry matter, TASH=total ash, OM=organic matter, NDF=neutral detergent fiber, ADF=acid detergent fiber, ADL=acid detergent lignin, CP= crude protein, CV=Coefficient of variation, LSD= Least significant difference,*= significantly different, NS= None significant different.

Conclusions and recommendations

The result implies that Peruvien- DZF- 406, F-L-L-77 (406), Segule-1396 (408) and F-G-9-09 cultivars were well adapted and being productive regarding the plant height, biomass yield, and leaf to the steam ratio which, is hopeful to fill the gap of low quality and quantity ruminant feed supply of the community. The current study indicated that Segule-1396 (408) cultivar was resistant to disease in both study areas. Regarding the nutritional values (chemical composition) were promising particularly the dry matter (DM) and Organic Matter (OM) content in Peruvien- DZF- 406, F-L-L-77 (406), Segule-1396 (408), and F-G-9-09. Thus, it could be possible to conclude that Alfalfa cultivars especially Segule-1396 (408) and F-G-9-09 used as a protein supplement for highland and midland of Guji, which

were suffering from poor quality roughage and low protein and digestible crop residues which were the major livestock feed sources, particularly in Guji. Based on its adaptability, plant height, biomass yield, and chemical compositions, good DM and OM Peruvien- DZF-406, F-L-L-77 (406,) Segule-1396 (408), and F-G-9-09 is recommended for further promotion in the highland and midland of Guji and similar agro-ecologies.

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