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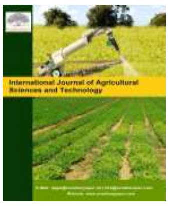

Research Paper
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Adaptation trial of Alfalfa (*Medicago sativa*) Cultivars in the Highland Areas of West Arsi Zone

Daniel Wana[1*], Dawit Abate[2], Meseret Tilahun[3] and Nebi Husen[4]

[1]Oromia Agricultural Research Institute, Adami Tulu Agricultural Research Center, P.O. Box 35, Batu, Ethiopia. E-mail: danielwana2015@gmail.com
[2]Oromia Agricultural Research Institute, Adami Tulu Agricultural Research Center, P.O. Box 35, Batu, Ethiopia. E-mail: dawit_40@yahoo.com
[3]Oromia Agricultural Research Institute, Adami Tulu Agricultural Research Center, P.O. Box 35, Batu, Ethiopia. E-mail: mesereta28@gmail.com
[4]Oromia Agricultural Research Institute, Adami Tulu Agricultural Research Center, P.O. Box 35, Batu, Ethiopia. E-mail: nabihusein2008@gmail.com

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Abstract

Alfalfa (*Medicago sativa*) is one of the potential perennial forage legume adapted to a wide range of agro-ecologies. Despite its importance as a high-quality animal feed resource, there is a lack of information on the best adaptable alfalfa cultivars in the highland areas of West Arsi Zone. Thus, the study was conducted to identify adaptable, high-yielding, and quality of alfalfa cultivars for the study areas. Seven alfalfa cultivars; FG-09-09, Magna-801, FB-96-T-206, FG-10-09, Magna-788, Alfalfa-Italy, and Hunter-river (Adapted Check) were evaluated using Randomized Complete Block Design (RCBD) with three replications. The result showed significant ($p<0.001$) differences between cultivars for plant height, leaf to stem ratio, number of tiller per plant, herbage DM yield, and seed yield. Plant height, leaf to stem ratio, and seed yield were affected by experimental years ($p<0.001$); similarly the number of tiller per plant and herbage DM yield ($p<0.01$). The mean DM yield recorded in the establishment year (2020/21) was lower as compared to the 2nd (2021/22) and 3rd (2022/23) years while the maximum DM yield was obtained in the third year (2022/23) (indicate the year) of production. As compared to other cultivars, FG-10-09 produced the highest DM yield (2.92-6.53 t/ha) followed by Magna-801 (2.43-6.37t/ha)across all the three years from the tested cultivars, Magna-801and Hunter river performed best in seed yield production (176.5-216qt/ha and 169.8-220.4qt/ha), respectively, in all test sites and years. The highest CP value was recorded from Magna788 (21.1%) followed by Magna-801 (20.5%) and FB-96-T-206 (20.3%). Generally, it was found that cultivars with higher biomass yield didn't show the best performance in seed yield and CP contents. Hence, it is important to select cultivars with optimum performance with other parameters were evaluated. Accordingly, among the tested cultivars, Magna- 801 and Hunter river produced optimum biomass, seed yield, and quality performances as compared to other cultivars. Therefore, these cultivars are recommended for demonstration to smallholder farmers and popularized for production in tested areas and similar agro-ecologies. Moreover, to improve seed yield of alfalfa, further study is required on season of establishment, time of planting, clipping time, and soil moisture management.

Keywords: *Adaptability, Alfalfa, Biomass yield, Cultivars, Seed yield*

1. Introduction

Shortage of animal feed resources is one of the major factor limiting the production and productivity of livestock in west Arsi zone of Oromia. One approach for alleviating the problem is development of improved and high-yield forage species adapted to the agro-ecology. Alfalfa *(Medicago sativa)* is a widely-adapted perennial forage legume. It is moderately

* *Corresponding author: Daniel Wana, Oromia Agricultural Research Institute, Adami Tulu Agricultural Research Center, P.O. Box 35, Batu, Ethiopia. E-mail: danielwana2015@gmail.com*

saline tolerant, and withstands long periods of water deficit by impeding its vegetative growth and accessing water from depth through its deeper root system (Volaire, 2008; Annicchiarico *et al*., 2010). Alfalfa is known for its high forage biomass and nutritive value (Adugna Tolera, 2008, Mielmann, 2013; Dawit *et al.*, 2017; Shi *et al.*, 2017) and positive effects on soil fertility (Julier *et al*., 2017). Where alfalfa can easily be grown, it is regarded as a key forage for high-producing ruminants because of its biomass and good nutritional quality (Annicchiarico, 2015, Jia *et al.*, 2018). Alemayehu Mengistu (2002) also 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.

Efforts have been made to introduce alfalfa forage at different areas including in the highland agro-ecologies of the country by governmental and non-governmental organizations. However, it was observed that the biomass and seed yield performance of these forage legumes varies mainly due to the differences in varieties/cultivars. The study also indicated that the variation in alfalfa cultivars has a significant effect on its agronomic performances, herbage biomass yield, and nutritive value (Diriba *et al.*, 2014). Climatic conditions, edaphic and biotic factors also affect the performance and yield of the forage (Elisa *et al.*, 2021, Alemayehu Mengistu, 2002). Despite the importance of alfalfa as livestock, information on its adaptability and yield performance at the highland agro-ecology of west Arsi zone is lacking. Hence, the study was conducted with objective to identify the best adaptable, high yielder, and nutritional quality of alfalfa cultivars for the study areas.

2. Materials and Methods

2.1. Study Site

The study was conducted at two highland agro-ecologies of Shashemene and Kofele districts of west Arsi zone for three consecutive years (2020/21 to 2022/23). The altitudes of the study sites were 2650 and 2690 m.a.s.l for Shashemene and Kofele sites, respectively. Shashemene site is located at 7°08’29.065’’N latitudes and 38°42’30.661" E longitudes while Kofele site is found at latitude and longitude of 07°04’39.558" N and 038°47’08.945’’E, respectively. The mean annual rainfall and temperature of the study sites during the study period are indicated in (Figure 1). The mean annual rainfall of Shashemene area was 700–950 mm while the average temperature ranged from 12–27°C (Robe and Kinfe, 2022). The

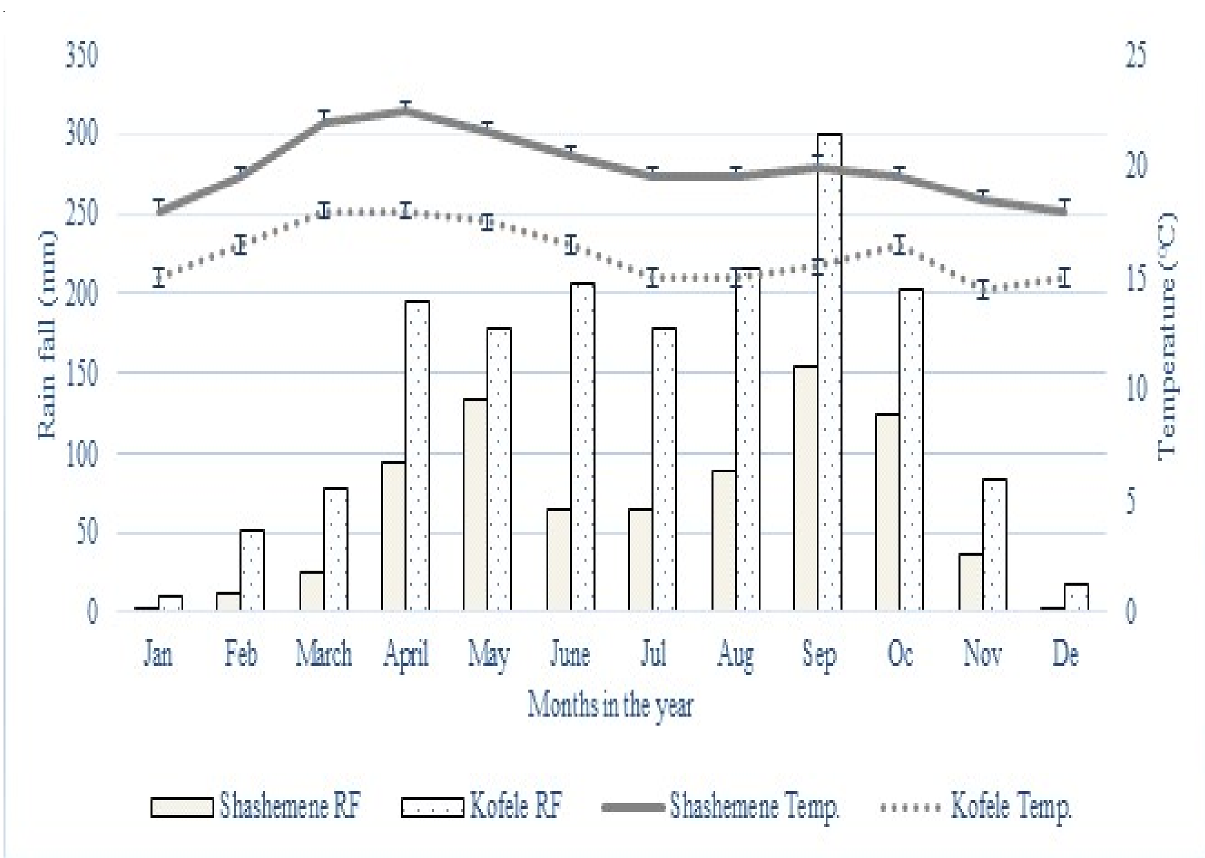

Figure 1: Mean Monthly Rainfall and Temperature Data of the Study Area

average rainfall at Kofele is 1800 mm per annum with a minimum of 2000 mm per annum and a maximum of 3050 mm per annum while the average temperatures were 19.5°C per year with a minimum of 17°C and a maximum of 22°C (DOANR, 2018).

2.2. Treatments and Experimental Design

The treatments were comprised of seven alfalfa cultivars (FG-09-09, Magna-801, FB-96-T-206, FG-10-09, Magna-788, Hunter-river (Adapted Check) and Alfalfa-Italy) and evaluated by using randomized block design with three replications. Seed rate of 10 kg ha^{-1} was used for all cultivars. The cultivars were planted in rows on a plot size of 3 m * 2 m at 25 cm spacing between rows. Spacing of 1 m and 1.5 m were used, respectively between plots and block. The trial was managed and closely examined from the establishment until all important data were collected.

2.3. Experimental Procedures and Field Management

A seed rate of 80 kg/ha was used for oat while fertilizer (NPS and UREA) at the rate of 100 kg/ha was used. The trial was managed and closely examined from the establishment until all important data collection was finalized. Forage biomass yield was estimated by harvesting the forage at 50% flowering stage at a height of 5 cm near the ground. Plants in the middle row of the plots were harvested and weighed immediately to obtain fresh yield.

2.4. Data Collected

All relevant agronomic and yield data including, plant height, date of 50% flowering, tiller per plant, leaf to stem ratio, biomass yield, and seed yield were collected. Three plants were randomly selected from each plot and plant height was measured from the base of the plant to the flag leaf. The mean plant height was then calculated. Number of tiller per plant was determined by direct counting of the tillers from three plants that were randomly selected and the average was taken. The harvested forage samples were manually chopped into small pieces using sickle and sub-samples of 300 gm fresh weight were taken and oven-dried for determination of herbage dry matter yield.

Forage DM yield (t/ha) was obtained by using James *et al.* (2008) formula which is DM yield (t/ha) = (10 x TFW x SSDW)/ (HA x SSFW). Where; 10 = constant for conversion of yields in kg/m2 to tone/ ha, TFW = total fresh weight from harvesting area (kg), SSDW = sub-sample dry weight (g), SSFW= sub-sample fresh weight (g). Laboratory chemical analyses for major parameters were done at Batu Soil Laboratory. The feed sample was taken from each treatment and dried in an oven at 60°C for 72 hours to a constant weight and ground in a Willey mill to pass through a 1mm sieve. The ground samples were kept in airtight plastic bags before analysis for chemical composition. The DM was determined by an oven drying at 105° overnight and ash content was determined by igniting the dry samples in a muffle furnace at 550°C for 6 hours to burn off all the organic material. The inorganic material which does not volatilized at that temperature is ash. The difference between sample DM and ash gives the organic matter (OM). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were analyzed according to Van Soest and Robertson (1985). CP was determined according to AOAC (2000) methods. The Kjeldhal method was used and CP content was estimated from the N content by use of a multiplier of 6.25.

3. Data Analysis

Collected data was organized, summarized, and analyzed by using SAS 9.0 software. Means were separated using least significant difference (LSD) at 5% significant level (Steel and Torrie, 1984).

4. Results and Discussion

4.1. Analysis of Variance

Analysis of variance revealed that variation in cultivars, sites, and years have significant effects on plant height, tillers per plant, leaf to stem ratio, DM yield, and seed while the effects of cultivars and sites did not significantly affect days to 50% flowering. Leaf to stem ratio was not significantly affected by site. The interaction of cultivars with years and site had a significant effect on tiller per plant. Dry matter ($p<0.05$) and seed yield ($p<0.01$) were also significantly affected by cultivar and year interaction. The interaction of cultivar, year, and site showed a significant ($p<0.0001$) effect on plant height, tiller per plant, and seed yield while the other parameters weren't influenced (Table 1). The obtained result indicated that the genetic background of the cultivars had strong influences on observed parameters except on days to 50% flowering. In line with this study, Diriba *et al.* (2014) also indicated that cultivars significantly affected herbage DMY while the interaction factors of cultivars and sites were not significant. The significant differences among the cultivars observed for seed yield in the present study were also in agreement with the reports of Karta (2006).

Table 1: Mean Squares of Anova for Agronomic and Yield Parameters of Alfalfa Cultivars Tested at Shashemene and Kofele Sites

Source of Variation	DF	pH	D50%F	Tiller per Plant	LSR	Dry Matter Yield	Seed Yield
Cultivars	6	604.9***	124.2NS	148.3***	0.93***	149.02***	379.2***
Year	2	5543.8***	1563.6*	19458.7**	19.8***	127.6**	9471.2***
Site	1	1291.1***	23.8NS	1318.6***	0.3NS	22.97*	1137.8***
Cultivars *Year	12	98.4NS	1.52NS	27.74***	0.05NS	10.41*	160.8**
Cultivars *Site	6	49.0NS	0.96NS	22.05*	0.06NS	1.35NS	89.75NS
Cultivars *Site* Year	14	108.5NS	0.93NS	85.82***	0.10NS	0.27NS	213.1***
Error	126	61.79	0.54	7.66	0.099	0.68	44.8

Note: Where, *, **, and *** show a significance at 0.05, 0.01, and 0.001%, respectively. DF: Degree of freedom.

4.2. Days to 50% Flowering, Plant Height, and Leaf to Stem Ratio

The combined analysis of the result for days to 50% flowering, plant height, and leaf to stem ratio was indicated in (Table 2). The result showed significant ($p<0.05$) differences between cultivars for plant height and leaf to stem ratio while a non-significant ($p>0.05$) effect was observed for days to 50% flowering. Numerically the longest (137.3) day to reach 50% of flowering was recorded from cultivar Magna-801 while the shortest day (136.0) was from Magna-788. The result of the current study is in agreement with the findings reported by Tesema *et al.* (2021) who indicated that days of 50% flowering were not significantly influenced due to cultivar differences. Conversely, Hidosa (2015) reported a significant difference ($p<0.05$) in days of 50% flowering. Plant height is an important yield component for alfalfa and it is often used as a criterion when choosing superior cultivars/genotypes in selection (Tucak *et al.,* 2008). The maximum plant height values were recorded for cultivar Magna-801 (96.48cm) followed by FG-10-09 with (95.62 cm) while the

Table 2: Combined Analysis for Days to 50% Flowering, Plant Height, and Leaf to Stem Ratio of Alfalfa Cultivars Tested from 2020/21-2022/23 Years at Shashemene and Kofele Sites

Cultivars	Days to 50% Flowering	Plant Height (cm)	Leaf to Stem Ratio
FG-09-09	136.8	85.44[c]	1.36[c]
Magna-801	137.3	96.48[a]	1.75[ab]
FB-96-T-206	137.0	84.70[c]	1.60[bc]
FG-10-09	137.0	95.62[a]	1.95[a]
Magna-788	136.0	86.77[bc]	1.56[bc]
Hunter river –check	136.8	93.15[ab]	1.64[abc]
Alfalfa-Italy	136.7	83.62[c]	1.42[c]
Mean	136.8	89.4	1.61
CV (%)	8.44	13.44	24.72
LSD (0.05)	NS	6.85	0.32

Note: [1] CV=Coefficient of variation, LSD=Least significant difference, NS=Non significant, [2] Figures having the same letters within column are not significantly differ, while values followed by a different letter (s) are significantly differ.

minimum plant height was recorded for Alfalfa-Italy (83.62 cm). The mean plant height value (89.4 cm) obtained in this study was higher as compared to the values (66.36 cm and 58.36 cm) recorded by Yerosan *et al.* (2022) and Tesema *et al.* (2021), in that order. The variation in plant height could be mainly due to the genotypic variability of alfalfa cultivars. The significant differences in cultivars for plant height agree with that reported by different authors (Hidosa, 2015; Gezahagn *et al.,* 2017). In addition to genetic variability, soil fertility, moisture, and other factors could also contribute to the difference in height over the sites. Mean values of leaf to stem ratio for the tested alfalfa cultivars indicated that significantly ($p<0.05$) higher value (1.95) was recorded for cultivars FG-10-09 followed by Magna-801 (1.75) while the lowest value (1.36) was recorded from FG-09-09. Leaf to stem ratio is an important trait in the selection of appropriate forage cultivars as it is strongly related to forage quality (Julier *et al.,* 2000; Sheaffer *et al.,* 2000). The significant cultivar differences in leaf to stem ratio observed in the present study is in agreement with other reports (Heidarian and Mostafavi, 2012; Monirifar, 2011; Hayek *et al.*, 2008).

4.3. Number of Tillers per Plant

Analysis of results for the number of tillers per plant is presented in Table 3. The result showed significant ($p<0.05$) differences in number of tiller per plant among the tested cultivars over the three years at Shashemene and Kofele sites. At Shashemene site, the first year data indicated that the maximum value of tiller per plant was recorded from FG-10-09 (4.67) followed by Magna-801 (4.43). In the second year, the highest value of number of tiller per plant was obtained from cultivar Magna-801 (19.5) followed by cultivar FG-10-09 (19.0) while in the last year of the experiment, Hunter river – check showed the highest value followed by cultivar FG-10-09 (52.0). At Kofele site, the cultivar Magna-801 was recorded the highest value in 2020/21, 2021/22, and 2022/23 with values of 5.43, 33.3, and 58.6 respectively. The lowest value 2.43 and 16.4 of the number of tiller per plant was recorded from cultivar Alfalfa-Italy respectively in 2020/21 and 2021/22 years at Shashemene site. While at Kofele, cultivars Magna-788, FB-96-T-206, and Alfalfa-Italy have shown the least number of tiller per plant with values of 3.6, 26.2, and 44.0 in the first, second, and third years, respectively. Contrary to this finding, other scholars indicated that the number of tillers per plant was not significantly influenced due to cultivar differences.

Table 3: Mean Number of Tiller Per Plant of Alfalfa Cultivars Tested From 2020/21-2022/23 Year at Shashemene and Kofele Sites

Cultivars	Number of Tiller per Plant					
	Shashemene			Kofele		
	2020/21	2021/22	2022/23	2020/21	2021/22	2022/23
FG-09-09	2.47[cd]	16.38[b]	40.3[b]	4.13[b]	26.3[b]	44.3[bc]
Magna-801	4.43[a]	19.5[a]	44.3[ab]	5.43[a]	33.3[a]	58.6[a]
FB-96-T-206	2.8[cd]	16.5[b]	41.2[b]	3.9[b]	26.2[b]	47.0[bc]
FG-10-09	4.67[a]	19.0[a]	52.0[a]	5.3[a]	33.2[a]	56.3[a]
Magna-788	3.3[bc]	16.7[b]	44.7[b]	3.6[b]	29.7[ab]	46.6[bc]
Hunter river –check	3.9[ab]	18.8[a]	52.1[a]	4.43[ab]	32.1[a]	47.6[b]
Alfalfa-Italy	2.43[d]	16.4[b]	41.0[b]	4.0[b]	26.5[b]	44.0[c]
Mean	3.43	17.6	44.5	4.4	29.65	49.2
CV (%)	13.9	6.3	12.1	15.4	12.0	3.96
LSD (0.05)	0.82	1.31	9.46	1.2	4.2	3.42

Note: [1] CV=Coefficient of variation, LSD=Least significant difference, NS=Non significant, [2] Figures having the same letters within column are not significantly differ, while values followed by a different letter (s) are significantly differ.

4.4. Dry Matter Yield

The mean dry matter yield of the alfalfa cultivars studied at Shashemene and Kofele locations over three years (2020/21–2022/23) are shown in Table 4. The result has shown that there were significant ($p<0.05$) differences in DM yield performances of the tested cultivars throughout the three-year experimental periods. The mean DM yield recorded in the establishment year was lower as compared to the 2nd and 3rd years while the maximum DM yield was obtained in the third year of production. The first, second, and third years' respective mean dry matter yields were 1.96 t/ha, 4.83 t/ha, and 5.87 t/ha. The higher DM yield obtained in the third year than in the first and the second years agrees with the results reported by Sabanci *et al.* (2013). Cavero *et al.* (2017) also reported that the maximum alfalfa forage yield in the first year was lower than in the two subsequent years. This result is expected considering that alfalfa is a perennial crop and the expression of agronomic properties. As compared to other cultivars, FG-10-09 produced the highest DM yield across all three years. In the first year, the highest dry matter yield was recorded from cultivar FG-10-09 followed by cultivar FB-96-T-206 with dry matter yields of 2.92 t/ha and 2.55 t/ha, respectively. Cultivar FG-10-09 also produced the maximum dry matter yield in 2021/22 (5.86 t/ha) and 2022/23 (6.53 t/ha) followed by cultivar Magna-801 with dry matter yield of 5.26 t/ha and 6.37 t/ha, respectively in the year of 2021/22 and 2022/23. On the other hands, cultivar FG-09-09 produced the least dry matter yield of 1.15 t/ha, 4.1 t/ha, and 4.87 t/ha in the years 2020/21, 2021/22, and 2022/23, respectively. The differences observed in DM yield among the cultivars agree with other studies (Monirifar, 2011, Walie *et al.,* 2016, Gashaw *et al.,* 2015, Gezahagn *et al.,* 2017). In contrast to this finding, Solomon and Tesfay (2019) found no significant difference in DM yield among cultivars. The dry matter yield recorded from cultivars in the present study is higher as compared to the report ofYerosan *et al.* (2022) (0.97 t/ha - 1.28 t/ha) while it is lower than the values recorded by Gezahagn *et al.* (2017) (5.5 t/ha - 8.72 t/ha). Moreover, alfalfa forage yield depends on plant numbers per unit area, stem numbers per plant, and single-stem yield (Smith and Hamel, 2005). Moreover, the yield difference recorded may be due to moisture conditions during the experimental periods. Other studies also confirmed that the differences in DM yield values recorded in different sites could be attributed to soil fertility, moisture conditions, temperature, and other management factors (Tucak *et al.,* 2023; Fahad *et al.*, 2017; Veronesi *et al.*, 2010). Alfalfa forage yield also depends to a great extent on various climatic factors, with precipitation and temperature the most important contributors (Thivierge *et al.,* 2016).

Table 4: Mean Dry Matter Yield (t/ha) of Alfalfa Cultivars Tested from 2020/21-2022/23 Years ft Shashemene and Kofele Sites

Cultivars	Years		
	2020/21	**2021/22**	**2022/23**
FG-09-09	1.15[c]	4.1[c]	4.87[c]
Magna-801	2.43[b]	5.26[ab]	6.37[ab]
FB-96-T-206	2.55[b]	4.8[bc]	5.8[abc]
FG-10-09	2.92[a]	5.86[a]	6.53[a]
Magna-788	1.12[c]	4.7[bc]	5.76[abc]
Hunter river	2.36[b]	4.96[abc]	6.26[ab]
Alfalfa-Italy	1.18[c]	4.24[c]	5.47[bc]
Mean	1.96	4.83	5.87
CV (%)	15.4	24.7	13.7
LSD (0.05)	0.35	0.97	0.94

Note: [1] CV=Coefficient of variation, LSD=Least significant difference, NS= Non significant, [2] Figure having the same letters within column are not significantly differ, while values followed by different letter (s) are significantly differ.

4.5. Seed Yield

The mean seed yield of the alfalfa cultivars studied in two locations over three years is shown in Table 5. The result indicated significant ($p<0.05$) differences among the tested cultivars in seed yield performances at all sites and years except at Kofele during the 1st year of the experimental period. The mean seed yield produced from the tested cultivars were 189.3 kg/ha, 204.1, and 208.2 kg/ha respectively in 2020/21, 2021/22, and 2022/23 at Shashemene site while at Kofele sites the mean seed yield recorded were 173.5 t/ha, 199.2 t/ha and 212.4 t/ha in 2020/21, 2021/22 and 2022/23, respectively. At Shashamene the highest seed yield was recorded from Magna-801 in 2020/21 (199.9 kg/ha) and 2021/22 (209.9 t/ha) while Hunter river (check) produced the maximum (220.4 kg/ha) in 2022/23. At Kofele, the maximum seed yield (202.4 kg/ha) was recorded from both Magna-788 and FG-09-09 cultivars followed by Magna-801 (201.5 kg/ha) in the year 2021/22 while Hunter river produced higher yield (219.7 kg/ha) followed by Magna-801(216.5 kg/ha) in 2022/23. Hence as compared to other cultivars, Magna-801and Hunter river (check) performed best in seed yield production within all three years. On the other hands, cultivars FG-09-09, FB-96-T-206 and FG-10-09 produced the least seed yield respectively in 2020/21, 2021/22, and 2022/23 years at Shashemene while cultivar FG-09-09 showed the least seed yield performance in 2020/21 whereas cultivar FG-10-09 produced the lower seed yield in 2021/22 and 2022/23.

Table 5: Seed Yield (kg/ha) Performance of Alfalfa Cultivars Tested From 2020/21-2022/23 at Shashemene and Kofele Sites

Cultivars	Shashemene			Kofele		
	2020/21	2021/22	2022/23	2020/21	2021/22	2022/23
FG-09-09	173.4^{b}	201.5^{bc}	208.4^{b}	166.7	202.4^{a}	208.1^{cd}
Magna-801	199.9^{a}	209.9^{a}	213.2^{ab}	176.5	201.5^{ab}	216.5^{ab}
FB-96-T-206	175.1^{b}	199.9^{c}	206.4^{b}	173.2	198.1^{ab}	209.7^{bcd}
FG-10-09	193.5^{a}	204.1^{abc}	191.0^{c}	171.8	194.0^{b}	206.4^{d}
Magna-788	199.8^{a}	203.7^{abc}	211.6^{b}	174.8	202.4^{a}	214.9^{abc}
Hunter river –check	191.7^{a}	208.2^{ab}	220.4^{a}	169.8	197.9^{ab}	219.7^{a}
Alfalfa-Italy	191.7^{a}	200.8^{bc}	206.5^{b}	181.6	197.9^{ab}	211.6^{bcd}
Mean	189.3	204.1	208.2	173.5	199.2	212.4
CV (%)	3.8	4.2	5.7	5.44	4.7	3.8
LSD (0.05)	11.1	8.1	8.4	NS	7.89	7.6

Note: [1] [1]CV=Coefficient of variation, LSD=Least significant difference, NS= Non significant, [2]Figure having the same letters with in column are not significantly differ, while values followed by different letter (s) are significantly differ

On the other hands, seed yield was not significantly ($p>0.05$) affected due to cultivars differences at Kofele site in the year 2020/21. The mean seed yield recorded in this study was lower than the report of Karta (2006) and Tucak *et al.* (2023) who obtained seed yield of 286.7 kg/ha and 253.98 kg/ha, respectively under rain-fed conditions. The lower seed yield recorded for this study could be mainly due to the long and high rainfall that occurred in the rainy seasons during the experimental periods. The long rainy season of the study area could also result in lower flower flowering, seed setting, and seed maturity. Moreover, the variations in alfalfa crop management and availability of pollinators around the experiment also contribute to the seed yield differences observed. Karta (2006) and Karagic *et al.* (2014) also indicated that excessive soil moisture increased vegetative growth, a low percentage of flowers tripped by pollinators and a high number of florets aborted which ultimately resulted in poor seed yields. Studies also indicated that climatic factors such as moisture, temperature, and relative humidity are extremely important for seed production of alfalfa (Tucak *et al.*, 2023; Karamanos *et al.*, 2009). In addition to the weather conditions, the availability of pollinators such as honeybees around the alfalfa field is crucial to alfalfa seed setting (Karagic *et al.*, 2014).

5. Chemical Composition

Table 6 shows the combined analysis result of different quality parameters for the tested alfalfa cultivars. The result indicated significant ($p<0.05$) differences in CP, ADF, and ADL% among the cultivars. The highest CP value was recorded from Magna-788 (22.7%) followed by FB-96-T-206 (22.6%), Magna-801 (22.5%), and FB-96-T-206 (20.3%). The lowest CP value (20.4%) was recorded from the FG-10-09 cultivar. In line with this study, Gezahegn *et al.* (2022) indicated significant differences in CP content among the tested alfalfa cultivars. On the other hands, Tesema *et al.* (2021) found that there were no statistically significant variations in CP contents among the genotypes that were investigated. The mean value (21.87%) of CP content reported in the present study was slightly higher when compared with the finding of Diriba *et al.* (2014), but lower as compared to Gezahagn *et al.* (2017). High-quality alfalfa was reported to contain >19 % CP (Kazemi *et al.*, 2012; Redfearn and Zhang, 2011), in this regard all cultivars showed CP contents more than the indicated threshold value. The mean value of ADF and ADL concentrations were superior for Alfalfa-Italy with the values of 19.2 and 11.74%, respectively. The lower ADF (17.7%) was recorded from Hunter river cultivar (check) while the lowest value of ADL (10.1%) was obtained from the FG-10-09 cultivar. Other cultivars exhibit comparable values for both ADF and ADL fractions. In line with this study, Tesema *et al.* (2021) indicated that ADF and ADL contents were varied ($p < 0.05$) among alfalfa genotypes. Variations in the ADF and ADL contents of alfalfa could be due to cultivar differences, climatic, agronomic management practices, and/or their interactions (Solomon and Tesfay, 2019). On the other hands, the cultivars evaluated did not significantly ($p>0.05$) differ in percentage of DM content, Ash, and NDF contents. The mean percentage of DM, Ash, and NDF content of alfalfa cultivars recorded in this study were respectively in the range of 88.5 to 89.0, 10.6 to11.7, and 38.6 to 41.3%. In contrary to this finding Diriba *et al.* (2014) reported that a significant difference among alfalfa cultivars in DM and ash contents.

Table 6: Chemical Composition of Alfalfa Cultivars Tested at Shashemene and Kofele Sites

Cultivars	DM	Ash	CP	NDF	ADF	ADL
FG-09-09	88.7	11.6	21.8^{abc}	38.8	18.3^{ab}	10.5^{ab}
Magna-801	88.5	10.6	22.5^{ab}	38.6	18.56^{ab}	10.4^{ab}
FB-96-T-206	89.0	11.7	22.6^{ab}	39.9	18.84^{ab}	10.4^{ab}
FG-10-09	88.9	10.9	20.4^{c}	40.0	18.3^{ab}	10.1^{b}
Magna-788	88.6	11.7	22.7^{a}	38.7	18.5^{ab}	11.0^{ab}
Hunter river -check	88.7	11.7	21.2^{c}	38.8	17.7^{b}	11.71^{a}
Alfalfa-Italy	88.8	10.9	21.9^{ab}	41.3	19.2^{a}	11.74^{a}
Mean	88.7	11.3	21.87	39.5	18.56	10.85
CV (%)	1.5	10.3	5.86	6.0	5.1	11.3
LSD (0.05)	NS	NS	1.5	NS	1.11	1.43

Note: [1] CV=Coefficient of variation, LSD=Least significant difference, NS= Non significant, [2] Figure having the same letters with in column are not significantly differ, while values followed by different letter (s) are significantly differ.

6. Conclusions and Recommendation

Alfalfa cultivars were evaluated for adaptability, yield, and nutritional composition in the highlands areas of west Arsi zone of Oromia. The result indicated that the tested alfalfa cultivars showed significant differences in most agronomic parameters, dry matter, seed yield, and CP contents. The maximum plant height values were recorded for cultivar Magna-801 followed by FG-10-09 while the higher value of leaf to stem ratio was obtained from cultivar FG-10-09 followed by Magna-801. Among the tested cultivars, FG-10-09, Magna-801, and Hunter River-(check) have shown good performances in number of tiller per plant across all locations and years. The three-year result also indicated that the highest DM yield was recorded from cultivar FG-10-09 followed by Magna-801 while the least value was obtained from cultivar FG-09-09. The result also showed that the maximum seed yield was recorded from cultivar Magna-801 followed by Hunter river while the lowest seed yield was recorded from FG-09-09, FB-96-T-206, and FG-10-09 across the study years. The highest

CP value was recorded from Magna788 followed by FB-96-T-206 and Magna-801. However, it was found that cultivars with higher biomass yield didn't show the best performance in seed yield and CP contents. Hence, it is important to select cultivars with optimum performance with most of the major evaluated parameters. Accordingly, among the tested cultivars, Magna- 801 followed by Hunter river were shows optimum biomass, seed yield, and quality performances as compared to other cultivars across all sites and years. Therefore, these cultivars are recommended for demonstration to smallholder farmers and popularize for production in tested areas and similar agro-ecologies. Moreover, to improve seed yield of alfalfa, further study is required on season of establishment, time of planting, clipping time, and soil moisture management.

References

Adugna Tolera. (2008). Feed Resources and Feeding Management: A Manual For Feedlot Operators and Development Workers. SPS-LMM Program Ethiopia Sanitary & Phytosanitary Standards and Livestock & Meat Marketing Program (SPS-LMM) Texas Agricultural Experiment Station (TAES)/Texas A & M University.

Alemayehu Mengistu. (2002). Forage Production in Ethiopia: A Case Study With Implications for Livestock Production. 1-111. *Ethiop. Soc. of Anim. Prod*, Addis Ababa, Ethiopia.

Annicchiarico, P.L., Pecetti, A., Abdelguerfi, Bouizgaren A., Carroni, A.M., Hayek, T., M'Hammadi, B.M. and Mezni, M, (2010). Adaptation of Landrace and Variety Germplasma and Selection Strategies for Lucerne in the Mediterranean Basin. *Field Crops Res.,* 120, 283-291.

Annicchiarico, P. (2015). Alfalfa Forage Yield and Leaf/Stem Ratio: Narrow-Sense Heritability, Genetic Correlation, and Parent Selection Procedures. *Euphytica,* 205, 409–420.

AOAC. (2000). *Official Methods of Analysis*. 17th Edition, Association of Official Analytical Chemists, Gaithersburg, MD, USA. Methods 925.10, 65.17, 974.24, 992.16.

Cavero, J., Faci, M., Medina, E.T. and Martínez-Cob, A. (2017). Alfalfa Forage Production Under Solid-Set Sprinkler Irrigation In A Semiarid Climate. *Agric. Water Manag*., 191, 184–192.

Dawit Abate., Usman Semman., Nabi Husen., Lalisa Diriba., Belete Shenkute., Fikadu Nemera., Meseret Tilahun. and Abule Ebro. (2017). Yield and Agronomic Performance of Different Forage Grasses and Legume Species for Forage Production in the Mid Rift Valley of Oromia. In: Proceedings of Review Workshop on Completed Research Activities of Livestock Research Directorate held at Adami Tulu Agricultural Research Center, Adami Tulu, Ethiopia 17-21 November 2015, Oromia Agricultural Research Institute (OARI), *Finfinne, Ethiopia*. 247 p.

Diriba, Geleti., Mekonnen, Hailemariam,, Ashenafi, Mengistu, and Adugna, Tolera, (2014). Biomass yield potential and nutritive value of selected Alfalfa (*Medicago sativa L.*) cultivars grown under tepid to cool sub-moist agro-ecology of Ethiopia Journal of Agricultural Research and Development Vol. 4(1). pp. 007-014, January, 2014 Available online http://www.e3journals.org

DOANR (District Office of Agriculture and Natural Resource). (2018). Reports of Kofale District Office of Agriculture and Natural Resource, Kofale, Ethiopia

Elisa Perotti., Olivier Huguenin-Elie., Marco Meisser., S´ebastien Dubois., Massimiliano Probo. and Pierre Mariotte. (2021). Climatic, Soil, and Vegetation Drivers of Forage Yield and Quality Differ Across the First Three Growth Cycles of Intensively Managed Permanent Grasslands. *European Journal of Agronomy*, 122(January), 126194.

Fahad, S., Bajwa, A., Nazir, U., Anjum, S., Farooq, A., Zohaib, A., Sadia, S., Nasim, W., Adkins, S., Saud, S., Ihsan, M. Z., Alharby, H., Wu, C., Wang, D. and Huang, J. (2017). Crop Production Under Drought and Heat Stress: Plant Responses and Management Options. *Frontiers in Plant Science*, 8(1147), 1147. doi: https://doi.org/10.3389/fpls.2017.01147

Gashaw, M., Mengistu, A. and Gelti, D., (2015). Biomass Yield Dynamics and Nutritional Quality of Alfalfa (*Medicago sativa*) cultivars at DebreZeit, Ethiopia. *Journal of Agricultural Research and Development,* 5, 120-127.

Gezahagn Kebede, Getnet Assefa, Fekede Feyissa, Alemayehu Mengistu, Tadese Tekletsadik, Muluneh Minta, Mamaru Tesfaye, (2017). Biomass Yield Potential and Herbage Quality of Alfalfa (*Medicago sativa* L.) Genotypes in the Central Highland of Ethiopia. *International Journal of Research Studies in Agricultural Sciences (IJRSAS),* 3(1), 14-26.

Hayek, T., Loumerem, M., Nagaz, K. and Thabet M (2008). Growth Development and Dry Matter Yield of 16 Lucerne Genotypes Cultivated in South Tunisia. In: Porqueddu C. and Tavares de Sousa M.M. (Eds.). *Sustainable*

Mediterranean Grasslands and Their Multifunctions. Zaragoza: CIHEAM/FAO/ENMP/SPPF, 2008. 299-302 (Options Mediterraneennes: Serie A. Seminaires Mediterraneens; n.79).

Heidarian, A.R. and Mostafavi, K. (2012). Investigating of Phosphorus, Potassium and Weed Management Effects on Dry Matter Production and Morphological Traits of Alfalfa Ecotypes (*Medicago sativa* L.). *Advances in Natural and Applied Sciences,* 6, 793-801.

Hidosa Denbela (2015). Adaptation and Evaluation of Alfalfa (*Medico sativa* L.) Accessions Grown on Station of Jinka Agricultural Research Center Under Rain Fed Condition. *Inter J Agri Biosci*., 4 (6), 240-243. www.ijagbio.com

Jia, C., Zhao, F., Wang, X., Han, J., Zhao, H., Liu, G. and Wang, Z. (2018). Genomic Prediction for 25 Agronomic and Quality Traits in Alfalfa (*Medicago sativa*). *Front. Plant Sci*., 9, 1220.

James, K., Daniel, M. and Mugendi, N. (2008). Combining Napier Grass with Leguminous Shrubs in Counter Hedgerows Controls Soil Erosion Without Competing With Crops.

Julier, B., Huyghe, C. and Ecalle, C. (2000). Within and Among-Cultivar Genetic Variation in Alfalfa. *Crop Science*, 40, 365-369.

Julier, B., Gastal, F., Louarn, G., Badenhausser, I., Annicchiarico, P., Crocq, G., le Chatelier, D., Guillemot, E. and Emile, J.C. (2017). Lucerne (alfalfa) in European Cropping Systems. In *Legume in Cropping Systems*; Murphy-Bokern, D., Stoddard, F.L., Watson, C.A., Eds.; CABI: Wallingford, UK, 168–192.

Karagic Đ., Katiæ, S., Miliæ, D., Vasiljeviæ, S. and Miloñeviæ, B. (2014). *Alfalfa Seed Production in Semi-Humid Climate of the Southeast Europe.* https://www.researchgate.net/publication/268005110

Karamanos, A.J., Papastylianou, P.T., Stavrou, J. and Avgoulas, C. (2009). Effects of Water Shortage and Air Temperature on Seed Yield and Seed Performance of Lucerne (*Medicago sativa* L.) in a Mediterranean Environment. *J. Agron. Crop Sci*., 195, 408–419.

Karta Kaske (2006). Seed Yield Performance of Alfalfa (Medicago sativa L.) Varieties Under Rain Fed Environment: A Vital Prospect for Domestic Production of Alfalfa Seed. https://www.researchgate.net/publication/275652833

Kazemi, M., Tahmasbi, A., Naserian, A. and Valizadeh, R. (2012). Potential Nutritive Value of Some Forage Species Used as Ruminants Feed in Iran. *African Journal of Biotechnology*, 11(57), 12110–12117. doi: https://doi.org/10. 5897/AJB12.286

Mielmann, A. (2013). The Utilisation of Lucerne: A Review. *British Food Journal*, 11(4), 590–600. doi: https://doi.org/10.1108/00070701311317865

Monirifar, H. (2011). Path Analysis of Yield and Quality Traits in Alfalfa. *Not Bot Horti Agrobo,* 39, 190-195.

Redfearn, D. and Zhang, H. (2011). Forage Quality Interpretations, Oklahoma Cooperative Extension Service, PSS 2117, Vailable Online at: httpazing %20 management % 20pdfs/F 2117 web. pdf. Relative feed value and quality index. pp.16-31 In: Proc. Florida Ruminant Nutrition Symposium, January 10-11, University of Florida, Gainesville.

Robe Edassa and Kinfe Kibebew. (2022). An Assessment of Determinant Factors of Forest Management Practices: The Case of Shashemene Woreda of West Arsi Zone, Oromia Regional State, Ethiopia. *International Journal of Energy and Environmental Science*. 7(3), 27-41.

Sabanci, C.O., Ertu, M.M. and Celeb, S.Z. (2013). Collection, Conservation and Evaluation for Forage Yield of Alfalfa Landraces Grown in east Anatolia. *Turkish Journal of Field Crops*, 18(1), 46-51

Sheaffer, C.C., Martin, N.P., Lamb, J.F.S., Cuomo, G.R., Jewett, J.G. and Quering, S.R. (2000). Leaf and Stem Properties of Alfalfa Entries. *Agronomy Journal*, 92, 733-739.

Shi, S., Nan, L. and Smith, K.F. (2017). The Current Status, Problems, and Prospects of Alfalfa (*Medicago Sativa* L.) Breeding in China. *Agronomy*, 7(1), 1–11. doi: https://doi.org/10.3390/agronomy7010001

Smith, D.L. and Hamel, C. (2005). Crops Yield, Physiology and Processes. (Trans.) Y. Imam and M.G. Seghatoleslami (Ed.). Shiraz University Press. Iran.

Solomon Wayu and Tesfay Atsbha. (2019). Evaluation of Dry Matter Yield, Yield Components and Nutritive Value of Selected Alfalfa (*Medicago sativa* L.) Cultivars Grown Under Lowland Raya Valley, Northern Ethiopia. *Africa Journal of Agricultural Research*, 14(15), 705-711.

Steel, R.G.D. and Torrie, J.H. (1984). *Principles and Procedures of Statistics: A Biometrical Approach*. 2nd McGraw Hill Book Co., Singapore.

Tesema Tesfaye Atumo, Richard Kauffman, Deribe Gemiyo Talore, Mergia Abera, Temesgen Tesfaye, Bereket Zeleke Tunkala, Muluken Zeleke and Getinet Kebede Kalsa. (2021). Adaptability, Forage Yield and Nutritional Quality of Alfalfa (Medicagosativa) Genotypes, *Sustainable Environment*, 7, 1, 1895475, DOI: 10.1080/27658511.2021.1895475

Thivierge, M., Jego, G., Belanger, G., Bertrand, A., Tremblay, G.F., Alan, R.C. and Qian, B. (2016). Predicted Yield and Nutritive Value of an Alfalfa-Timothy Mixture Under Climate Change and Elevated Atmospheric Carbon Dioxide. *Agronomy J*., 108, 585–603.

Tucak, M., Popoviæ, S., Grljušiæ, C., Èupiæ, T., Kozumplik, V. and Šimiæ B. (2008). Variability and Relationships of Important Alfalfa Germplasm Agronomic Traits. *Periodicum Biologorum*, 110 (4), 311-315.

Tucak, M., Horvat, D., Cupi´c, T., Krizmani´c, G. and Ravli´c, M. (2023). Assessment of Alfalfa Populations for Forage Productivity and Seed Yield Potential under a Multi-Year Field Trial.

Van Soest, P.J. and Robertson, J.B. (1985). *Analysis of Forages and Fibrous Foods a Laboratory Manual for Animal Science*. Cornell University, Ithaca, NY

Veronesi, F., Brummer, E. and Huyghe, C. (2010). Alfalfa. In B. Boller, U. Posselt, F. Veronesi, B. Boller, U. Posselt, and F. Veronesi (Eds.), Fodder Crops and Amenity Grasses. Series: *Handbook of Plant Breeding,* 5, 395–437. Springer.

Volaire, F, (2008). Plant Traits and Functional Types to Characterize Drought Survival of Pluri-Specific Perennial Herbaceous Swards in Mediterranean Areas. *Eur J Agron*, 29, 116-124.

Walie, M., Eshetie, T., Mekonnen, W., Hunegnaw, B. and Kebede, A. (2016). Dry Matter Yield, Chemical Composition and In Vitro Dry Matter Digestibility of Selected Alfalfa (*Medicago sativa* L.) Accessions in North Western, *Ethiopia. J. Life Sci. Biomed*., 6 (3), 60-65.

Yerosan, Wekgari, Negasu Gamachu. and Fikre Diriba. (2022). Adaptation Trial of Alfalfa (Medicago sativa L.) Varieties for Midland Agro-Ecology of Kellem Wollega Zone, Oromia, Ethiopia. *Computational Biology and Bioinformatics,* 10(1), 14-19.

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