

Research Article

Performance Evaluation of Alfalfa (*Medicago sativa*) Cultivars for Biomass and Chemical Composition Yields

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Abstract

One potential perennial forage legume that can be adapted to a variety of agro-ecologies is alfalfa (*Medicago sativa*). The best adaptive alfalfa cultivars in the highland regions of the West Arsi Zone are not well known, despite the fact that alfalfa is a valuable source of high-quality animal feed. In order to find high-yielding, adaptive, and high-quality alfalfa cultivars for the study locations, the study was carried out. Using a Randomized Complete Block Design (RCBD) with three replications, 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 assessed. In terms of plant height, leaf to stem ratio, number of tillers per plant, herbage DM yield, and seed yield, the results indicated substantial ($p < 0.001$) variations across cultivars. Experimental years had a significant impact on plant height, leaf to stem ratio, and seed yield ($p < 0.001$), as well as herbage DM yield and the number of tillers per plant ($p < 0.01$). The highest DM output was achieved in the third year (2022/23) (specify the year) of production, while the mean DM yield recorded in the establishment year (2020/21) was lower than that of the second (2021/22) and third (2022/23) years. Among the studied cultivars, Magna-801 and Hunter River had the best seed yields during the three years, whereas FG-10-09 had the highest DM output (2.92-6.53 t/ha) in comparison to the other cultivars. Therefore, it is advised that smallholder farmers be shown these cultivars, and that they be made popular for production in agro-ecologies that are similar to those that have been evaluated. Additionally, more research is needed on the best times to plant, clip, and regulate soil moisture in order to increase alfalfa seed yield.

Keywords

Agro-ecology, Alfalfa, Herbage Yield, Cultivars, Seed Yield

1. Introduction

One of the main factors restricting livestock productivity and production in the west Arsi zone of Oromia is the scarcity of animal feed resources. Creating better, high-yield forage species that are suited to the agro-ecology is one way to mitigate the issue. Alfalfa (*Medicago sativa*) is a perennial forage legume that is widely adapted. Due to its deeper root structure and ability to impede vegetative development, it can tolerate

extended periods of water deprivation and is moderately saline tolerant [1, 2]. Alfalfa is well-known for its beneficial impacts on soil fertility [7] as well as its high feed biomass and nutritional value [3-6]. Because of its large biomass and high nutritional value, alfalfa is considered a critical fodder for high-producing ruminants in areas where it is easy to cultivate [8, 9]. [10] Indicated that alfalfa should be utilized as

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a supplement to agricultural leftovers and natural hay in a ratio of 30% alfalfa and 70% other roughages due to its extremely high feed value.

Governmental and non-governmental organizations have worked to promote alfalfa fodder in many locations, including the nation's highland agro-ecologies. However, it was found that the main cause of the variations in these forage legumes' biomass and seed production performance is the variety/cultivar differences. Additionally, the study found that the agronomic performance, herbage biomass output, and nutritional value of alfalfa are significantly impacted by cultivar variation [11]. The performance and yield of the forage are also impacted by biotic, edaphic, and climatic variables [12, 10]. Although alfalfa is a valuable livestock crop, little is known about its adaptability and production performance in the highland agro-ecology of the west Arsi zone. Therefore, the goal of the study was to determine which alfalfa cultivars were the most adaptive, high-yielding, and nutritionally sound for the study locations.

2. Materials and Methods

2.1. Study Area

For three years in a row (2020-21 to 2022-23), the study was carried out at two highland agro-ecologies in the Shashemene and Kofele districts of the west Arsi zone. The study sites at Shashemene and Kofele were 2650 and 2690 meters above sea level, respectively. The Shashemene site is situated at latitude 7°08'29.065"N and longitude 38°42'30.661" E, while the Kofele site is located at latitude 07°04'39.558" N and longitude 038°47'08.945"E. Figure 1 shows the average yearly rainfall and temperature at the study locations over the course of the study. The average temperature in the Shashemene region was between 12 and 27 °C, while the average annual rainfall was between 700 and 950 mm [13]. Kofele experiences 1800 mm of rainfall on average annually, with a minimum of 2000 mm and a maximum of 3050 mm. The average annual temperature was 19.5 °C, with a minimum of 17 °C and a maximum of 22 °C [14].

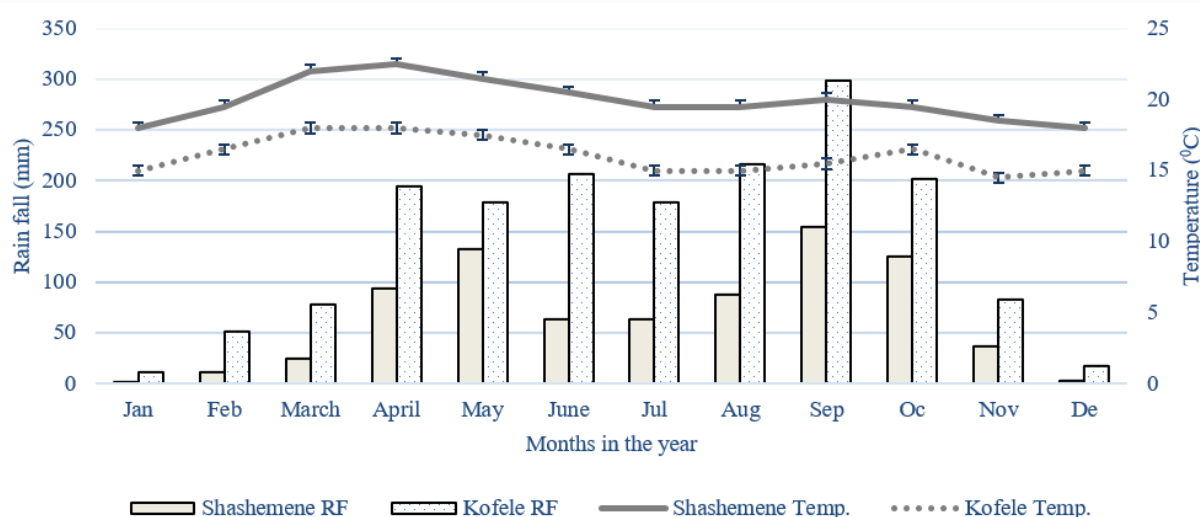


Figure 1. Mean monthly rainfall and temperature data of the study area.

2.2. Experimental Design

A randomized block design with three replications was used to assess the seven alfalfa cultivars that made up the treatments: FG-09-09, Magna-801, FB-96-T-206, FG-10-09, Magna-788, Hunter-river (Adapted Check), and Alfalfa-Italy. For all cultivars, a seed rate of 10 kg ha⁻¹ was employed. On a 3 m by 2 m area, the cultivars were planted in rows with a 25 cm gap between each row. Plots and blocks were separated by 1 m and 1.5 m, respectively. From the beginning, the experiment was overseen and constantly monitored until all pertinent data had been gathered.

2.3. Experimental Procedures and Field Management

Oats were seeded at a rate of 80 kg/ha, and fertilizer (NPS and UREA) was applied at a rate of 100 kg/ha. From the beginning of the experiment until the completion of all significant data gathering, it was overseen and rigorously monitored. Harvesting the forage at 50% flowering stage at a height of 5 cm close to the ground allowed for the estimation of the forage biomass output. To achieve fresh yield, the plants in the center row of the plots were plucked and weighed right away.

2.4. Data Collected

Plant height, 50% blooming date, tiller per plant, leaf to stem ratio, biomass output, and seed yield were among the pertinent agronomic and yield data that were gathered. From each plot, three plants were chosen at random, and the height of each plant was measured from the base to the flag leaf. Next, the average height of the plants was determined. Three randomly chosen plants had their tillers directly counted, and the average number of tillers per plant was calculated. To calculate the herbage dry matter yield, the gathered forage samples were manually cut into small pieces with a sickle, and 300 g fresh weight sub-samples were taken and oven-dried.

James et al. (2008) used the formula DM yield (t/ha) = $(10 \times \text{TFW} \times \text{SSDW}) / (\text{HA} \times \text{SSFW})$ to calculate the forage DM yield (t/ha), where TFW = total fresh weight from harvesting area (kg), SSDW = sub-sample dry weight (g), SSFW = sub-sample fresh weight (g), and 10 = constant for conversion of yields in kg/m² to tone/ha. The Batu Soil Laboratory performed laboratory chemistry tests for the primary parameters. Each treatment's feed sample was removed, dried for 72 hours at 60 °C in an oven to a consistent weight, and then ground in a Willey mill to fit through a 1mm filter.

Before being analyzed for chemical composition, the ground samples were stored in sealed plastic bags. The dry samples were ignited in a muffle furnace at 550 °C for six hours to burn out all the organic material, and the ash content was calculated by oven drying them at 105 ° for the entire night. Ash is the inorganic substance that does not volatilize at that temperature. The organic matter (OM) is determined by comparing the DM and ash samples. In accordance with [15], neutral detergent fiber (NDF) and acid detergent fiber (ADF) were examined. CP was calculated using the techniques described in [16]. The Kjeldhal method was applied, and a

multiplier of 6.25 was employed to estimate the CP content from the N content.

2.5. Data Analysis

SAS 9.0 software was used to organize, summarize, and analyze the collected data. At a 5% significance level, means were separated using the least significant difference (LSD) [17].

3. Results and Discussion

3.1. Analysis of Variance

Plant height, tillers per plant, leaf to stem ratio, DM production, and seed are all significantly impacted by cultivar, location, and year variation, according to analysis of variance. However, days to 50% flowering were not significantly impacted by cultivar or site variation. Site had no discernible impact on the ratio of leaves to stems. Tiller per plant was significantly impacted by the interplay of cultivars with place and years. Cultivar and year interaction also had a substantial impact on seed output ($p < 0.01$) and dry matter ($p < 0.05$). Plant height, tiller per plant, and seed output were significantly ($p < 0.0001$) impacted by the interaction of cultivar, year, and site, but the remaining characteristics were unaffected (Table 1). With the exception of days to 50% blooming, the results showed that the cultivars' genetic backgrounds had a significant impact on the characteristics that were observed. According to [11], cultivars had a considerable impact on herbage DMY, but there was no significant interaction between cultivars and sites. The notable variations in seed output between the cultivars found in this investigation also concurred with the findings of [18].

Table 1. ANOVA mean squares for yield and agronomic characteristics of alfalfa cultivars evaluated in the Shashemene and Kofele locations.

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

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

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

Table 2 showed the results of the combined examination of the leaf to stem ratio, plant height, and days to 50% flowering. The results indicated that cultivars differed significantly ($p < 0.05$) in plant height and leaf to stem ratio, but not significantly ($p > 0.05$) in days to 50% flowering. According to the numbers, Magna-801 took the longest (137.3) and Magna-788 the shortest (136.0) days to attain 50% flowering. The current study's outcome is consistent with the findings of [19], who found that cultivar differences had no discernible impact on the number of days of 50% flowering. On the other hand, a significant difference ($p < 0.05$) in the number of days of 50% flowering was found by [20]. Alfalfa yield is significantly influenced by plant height, which is frequently employed as a selection criterion to choose superior cultivars or genotypes [21].

Plant height measurements showed that Alfalfa-Italy had the lowest plant height (83.62 cm), while cultivar Magna-801

had the highest (96.48 cm), followed by FG-10-09 (95.62 cm). The average plant height measured in this study (89.4 cm) was greater than the values measured by [22, 19] (66.36 cm and 58.36 cm, respectively). The genotypic heterogeneity of alfalfa cultivars may be the primary cause of the variation in plant height. The notable variations in plant height between cultivars are consistent with what other writers have documented [20, 23]. The variation in height among the sites may also be caused by other factors, like as soil fertility and moisture, in addition to genetic diversity. The average leaf-to-stem ratio for the investigated alfalfa cultivars showed that FG-10-09 had the highest value (1.95), followed by Magna-801 (1.75), and FG-09-09 had the lowest value (1.36). These differences were statistically significant ($p < 0.05$). Given its high correlation with fodder quality, the leaf to stem ratio is a crucial characteristic in the selection of suitable forage cultivars [24, 25]. The present study's findings of notable cultivar variations in the leaf to stem ratio are consistent with previous findings [26-28].

Table 2. Combined analysis of alfalfa cultivars tested at the Shashemene and Kofele sites between 2020/21 and 2022/23 years for plant height, days to 50% flowering, and leaf to stem ratio.

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

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

3.3. Number of Tillers per Plant

Table 3 displays the results of the analysis for the number of tillers per plant. The number of tillers per plant varied significantly ($p < 0.05$) amongst the investigated cultivars over the course of three years at the Shashemene and Kofele sites. According to the first-year statistics at the Shashemene location, Magna-801 (4.43), followed by FG-10-09 (4.67), had the highest tiller per plant value. The cultivar Magna-801 (19.5) had the maximum number of tillers per plant in the second

year, followed by FG-10-09 (19.0); in the final year of the experiment, Hunter River-check had the highest number, followed by FG-10-09 (52.0). The cultivar Magna-801 at the Kofele location had the greatest values in 2020-21, 2021-22, and 2022-23.

At Kofele location, the cultivar Magna-801 was recorded the greatest 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 in Kofele, cultivars Magna-788, FB-96-T-206, and Alfalfa-Italy have showed 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. Con-

trary to this finding, other scholars indicated that the number of tillers per plant was not significantly influenced due to cultivar differences.

Table 3. The average number of tillers per plant for alfalfa cultivars studied at the Shashemene and Kofele sites during 2020-21 and 2022-23.

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

¹CV=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 different letter (s) are significantly differ

3.4. Dry Matter Yield

Table 4 displays the average dry matter yield of the alfalfa cultivars examined over a three-year period (2020-21-2022/23) at the Shashemene and Kofele locations. According to the results, the evaluated cultivars' DM yield performances varied significantly ($p < 0.05$) over the course of the three-year trial periods. The establishing year's mean DM yield was lower than that of the second and third years, whereas the third year of production produced the highest DM yield. The mean dry matter yields for the first, second, and third years were 1.96 t/ha, 4.83 t/ha, and 5.87 t/ha, respectively. The results reported by [29] are consistent with the greater DM yield that was obtained in the third year compared to the first and second years. Additionally, [30] noted that the first year's maximum alfalfa fodder yield was less than that of the two years that followed. Given that alfalfa is a perennial crop and exhibits agronomic traits, this outcome is to be expected. In all three years, FG-10-09 yielded the most DM when compared to other cultivars. Cultivars FG-10-09 and FB-96-T-206 produced the highest dry matter yields in the first year, with respective dry matter yields of 2.92 and 2.55

t/ha. In 2021/22 and 2022/23, cultivar FG-10-09 yielded the highest dry matter yields (5.86 t/ha and 6.53 t/ha, respectively). Magna-801 came in second with dry matter yields of 5.26 t/ha and 6.37 t/ha, respectively.

However, in 2020-21, 2021-22, and 2022-23, cultivar FG-09-09 yielded the lowest dry matter yields at 1.15 t/ha, 4.1 t/ha, and 4.87 t/ha, respectively. The cultivar-specific variations in DM yield are consistent with previous research [27, 31, 32, 23]. On the other hand, [33] did not discover any discernible variation in DM yield between cultivars. The dry matter yield of the cultivars used in this study is lower than the figures reported by [23] (5.5 t/ha - 8.72 t/ha) and greater than the report of [22] (0.97 t/ha - 1.28 t/ha). Furthermore, single-stem yield, stem numbers per plant, and plant numbers per unit area all affect alfalfa fodder output [34]. Furthermore, the observed yield discrepancy can be the result of the experimental periods' moisture conditions. Additional research also verified that soil fertility, moisture levels, temperature, and other management variables could be responsible for the variations in DM yield values seen in various locations [35-37]. Temperature and precipitation are the two main climatic elements that affect alfalfa fodder output, although other factors also play a significant role [38].

Table 4. Mean dry matter yield (t/ha) of alfalfa cultivars tested from 2020/21-2022/23 years at 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

¹CV=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

3.5. Seed Yield

Table 5 displays the average seed output of the alfalfa cultivars examined during a three-year period in two different locales. The results showed that the investigated cultivars' seed yield performances varied significantly ($p < 0.05$) across all sites and years, with the exception of Kofele in the first year of the trial. At the Shashemene site, the tested cultivars produced an average of 189.3 kg/ha, 204.1 kg/ha, and 208.2 kg/ha in 2020-21, 2021/22, and 2022-23. At the Kofele sites, the average seed yields were 173.5 t/ha, 199.2 t/ha, and 212.4 t/ha in 2020-21, 2021/22, and 2022-23, respectively. Magna-801 produced the most seeds in Shashemene in

2020-21 (199.9 kg/ha) and 2021-2022, (209.9 t/ha), whereas Hunter River (check) produced the most (220.4 kg/ha). The Magna-788 and FG-09-09 cultivars at Kofele provided the highest seed yield (202.4 kg/ha) in 2021-2022, followed by Magna-801 (201.5 kg/ha) in 2022-2022. In 2022-2023, the Hunter River generated the highest yield (219.7 kg/ha), followed by Magna-801 (21.6 kg/ha). Therefore, Magna-801 and Hunter River (check) outperformed other cultivars in terms of seed yield output throughout the course of the three years. However, at Shashemene, cultivars FG-09-09, FB-96-T-206, and FG-10-09 produced the lowest seed yields in 2020-21, 2021-22, and 2022-23 years, respectively. In 2020-21, cultivar FG-09-09 demonstrated the lowest seed yield performance, while in 2021-22 and 2022-23, cultivar FG-10-09 produced the lowest seed yield.

However, in 2020-2021, cultivar differences at the Kofele location did not significantly ($p > 0.05$) affect seed yield. The average seed yield found in this study was less than that reported by [18, 35], who found that rain-fed circumstances produced seed yields of 286.7 kg/ha and 253.98 kg/ha, respectively. The prolonged and heavy rainfall that took place throughout the rainy seasons during the experimental periods may have been the primary cause of the reduced seed production found in this study. Lower flower flowering, seed setting, and seed maturity could potentially be caused by the research area's protracted rainy season. Furthermore, the observed differences in seed output are also influenced by the management of alfalfa crops and the availability of pollinators in the vicinity of the experiment. [18, 39] also showed that high levels of soil moisture boosted vegetative development, a large number of florets aborted, and a low proportion of flowers tripped by pollinators, all of which led to low seed production. Research has also shown that climate variables like temperature, relative humidity, and moisture are crucial for alfalfa seed production [35, 40]. The presence of pollinators like honeybees in the vicinity of the alfalfa field is essential for alfalfa seed establishment, in addition to the weather [39].

Table 5. Performance of alfalfa cultivars studied during 2020-21-2022-23 at the Shashemene and Kofele sites in terms of seed yield (kg/ha).

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

Cultivars	Shashemene			Kofele		
	2020/21	2021/22	2022/23	2020/21	2021/22	2022/23
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

¹CV=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

3.6. Chemical Composition

The combined analysis results of several quality parameters for the evaluated alfalfa cultivars are displayed in Table 6. The results showed that the cultivars' CP, ADF, and ADL% varied significantly ($p < 0.05$). Magna-788 had the highest CP value (22.7%), followed by FB-96-T-206 (22.6%), Magna-801 (22.5%), and another FB-96-T-206 (20.3%). This cultivar, FG-10-09, had the lowest CP value (20.4%). According to this study, [41] showed that the examined alfalfa cultivars' CP contents varied significantly. However, [19] discovered that none of the genotypes under investigation had statistically significant differences in CP contents. The mean CP content value (21.87%) observed in this investigation was lower than that of [23] but somewhat greater than that of [11]. It has been noted that high-quality alfalfa contains more than 19% CP [42, 43].

In this respect, all cultivars exhibited CP concentrations

above the specified threshold value. With mean ADF and ADL concentrations of 19.2 and 11.74%, respectively, Alfalfa-Italy had superior results. The FG-10-09 cultivar had the lowest ADL value (10.1%), whereas the Hunter River cultivar (check) had the lowest ADF (17.7%). The ADF and ADL fraction results for other cultivars are similar. According to [19], alfalfa genotypes differed in ADF and ADL contents ($p < 0.05$), which is consistent with this findings. Agronomic management approaches, climate, cultivar variances, and/or their interactions may be the cause of variations in alfalfa's ADF and ADL contents [33]. However, there was no significant difference ($p > 0.05$) in the proportion of DM, Ash, and NDF contents among the assessed cultivars. The alfalfa cultivars included in this study had mean percentages of DM, Ash, and NDF content that ranged from 88.5 to 89.0, 10.6 to 11.7, and 38.6 to 41.3%, respectively. Contrary to this conclusion, [11] found that the DM and ash levels of alfalfa cultivars varied significantly.

Table 6. Alfalfa cultivars' chemical makeup as determined at the Shashemene and Kofele locations.

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

¹CV=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

4. Conclusions and Recommendation

The nutritional makeup, yield, and adaptability of alfalfa cultivars were assessed in the highlands of Oromia's west Arsi zone. According to the results, the evaluated alfalfa cultivars differed significantly in dry matter, seed yield, CP contents, and the majority of agronomic indices. The cultivar Magna-801 had the highest plant height values, followed by FG-10-09, whereas the cultivar FG-10-09 had the highest leaf to stem ratio, followed by Magna-801. Magna-801, Hunter River-(check), and FG-10-09 are the tested cultivars that have performed well in terms of the number of tillers per plant in all locations and years. The three-year results also showed that cultivar FG-10-09 had the highest DM production, followed by Magna-801; cultivar FG-09-09 produced the lowest value. Additionally, the results indicated that throughout the study years, FG-09-09, FB-96-T-206, and FG-10-09 had the lowest seed yields, whereas cultivar Magna-801 and Hunter River (check) had the highest seed yields. Magna788 has the greatest CP value, followed by Magna-801 and FB-96-T-206. It was discovered, meanwhile, that cultivars with greater biomass yields did not perform as well in terms of seed yield and CP contents. Therefore, it's critical to choose cultivars that perform optimally across the majority of the key assessed factors. Accordingly, Magna-801 and Hunter River were the evaluated cultivars that demonstrated the best biomass, seed production, and quality performances when compared to other cultivars across all sites and years. Therefore, it is advised that smallholder farmers be shown these cultivars, and that they be made popular for production in agro-ecologies that are similar to those that have been evaluated. Additionally, more research is needed on the best times to plant, clip, and regulate soil moisture in order to increase alfalfa seed yield.

Abbreviations

ADF	Acid Detergent Fiber
ANOVA	Analysis of Variance
DM	Dry Matter
CP	Crude Protein
CV	Coefficient Variation
LSD	Least Significant Difference
NDF	Neutral Detergent Fiber

Conflicts of Interest

The authors declare no conflicts of interest.

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