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Research Paper

Evaluation and Registration of the Newly Introduced Supersonic Alfalfa (*Medicago sativa L.*) Variety in Ethiopia

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Abstract

Alfalfa (*Medicago sativa L.*) is one of the most important perennial forage legume recommended for livestock feed due to its better yield and nutritional quality. So the introduced supersonic alfalfa variety was evaluated with the standard check variety (alfalfa-1086) at Holetta, Debre-Zeit, Kulumsa, Wondo-Genet, Werer, and Pawe locations aimed to assess forage biomass yield, chemical composition, and tolerance to major pests and diseases during the main cropping season of 2018 under supplementary irrigation. The result indicated that the introduced supersonic alfalfa variety gave a higher ($P<0.05$) plant height and dry matter yield than the standard check variety at each location and combined across locations. Moreover, the plant height and dry matter yield of alfalfa varieties varied significantly ($P<0.05$) across locations. The introduced supersonic alfalfa variety was consistently superior in dry matter yield than the standard check variety which implied better stability under diverse environmental conditions. However, the dry matter yield varied across locations due to the differential response of the varieties for the test locations. The introduced supersonic alfalfa variety had 12.9, 11.6, and 7.7% dry matter yield, digestible yield, and crude protein yield advantages over the standard check variety, respectively. The nutritive values of supersonic alfalfa were slightly lower in ash, crude protein, digestibility and relative feed value and higher in fiber contents than the standard check variety. Based on the overall performances, the introduced variety was verified with the same standard check variety during the main cropping season of 2020 under supplementary irrigation. Due to its better yield performance, and pest and disease reaction, the National Variety Releasing Committee approved supersonic alfalfa variety in 2021 to be cultivated in low to high altitude areas ranging from 750 to 2400 meters above sea level, which have an annual rainfall ranging from 800 to 1200 mm.

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1. Introduction

Despite the large livestock population in Ethiopia, the sector contributed below its potential due to various constraints (Gebremedhin et al., 2004). Feed shortage in terms of both quantity and quality is the leading problem affecting the livestock productivity in Ethiopia (Adugna, 2007; Fekede et al., 2015a; Fekede et al., 2015b). Livestock feed resources in Ethiopia are mainly natural pasture, crop residues, improved pastures, forage crops, and agro-industrial by-products (Alemayehu, 2004). The contribution of these feed resources, however, depends on the agro-ecology, the types of crop produced, accessibility, and production system. Traditional livestock production system mainly depends upon poor pasturelands and crop residues, which are usually inadequate to support reasonable livestock production (Tsige, 2000). During the latter part of the dry season, livestock feed is normally in short supply and is of poor quality. Residues from cereals are the main source of forage but these are low in protein and have poor digestibility (Getu, 2019). The production of adequate quantities of good quality dry season forages to supplement crop residues and pasture roughages is the only way to economically overcome the dry season feed constraints have been affecting livestock production. Thus, different forage crops were screened at both accessions and species level, and the promising genotypes were promoted for production (Getnet and Gezahagn, 2012). A wide range of annual and perennial forage species were evaluated in areas which have an altitude ranging from 600-3000 meters above sea level, and varieties of promising species had been selected and recommended for high, medium, and low altitudes in Ethiopia. These selected forage species are well adapted to the different agro-ecologies and gave high yield, and have better nutritional quality as compared to natural pasture (Getnet et al., 2012). However, the adoption of cultivated forage crops is very low due to various reasons (Agajie et al., 2016).

Among the different forage crops recommended for various agro-ecological zones of Ethiopia, alfalfa (*Medicago sativa* L.) is one of the most valuable forage species due to its high yield and nutritional value, and better adaptability under diverse environmental conditions. The species is also grown worldwide due to its better productivity and herbage quality (Turan et al., 2009). It is commonly known as the “Queen of forages” due to its ability to consistently produce better forage yield and quality (Kamalak et al., 2005). Moreover, it is used to improve vegetation cover, prevent grasslands degradation, and contribute to agriculture and livestock sustainability (Chen et al., 2012). When associated with other grass the grassland production increases, the nutritional value improves and feed costs decrease compared to balanced feed (Zaragoza et al., 2009). Variability for agronomic and morphological traits of alfalfa is frequently used in a breeding program for developing cultivars with high forage yields (Jullier et al., 2000; Radović et al., 2001; Radović et al., 2009). Depending on soil and environment conditions, alfalfa achieves fresh and dry matter yields which ranged from 50 to 100 t/ha and 12 to 19 t/ha, respectively (Katić, 2000; Nešić et al., 2005; Stanisavljević et al., 2006). Ruminants fed on alfalfa have higher nutrient intake and digestibility than when fed on other forage legumes (Frame, 2005). The alfalfa forages are characterized by a high content of crude protein (Dinić et al., 2005; Marković et al., 2007a), well balanced to an amino acid. It is enriched with important vitamins, and various microelements which are essential for the normal growth and development of animals (Marković et al., 2007b). To improve the quantity and quality of livestock feed, it is better to identify and cultivate the promising alfalfa variety that has better biomass yield and nutritional quality. Therefore, this study was aimed to evaluate the forage yield performance, nutritive value, agro-ecological adaptation, disease and pest reaction, and management recommendations of the recently registered supersonic alfalfa variety in Ethiopia.

2. Methodology

2.1. Study Areas

The national variety trial (NVT) was conducted at on-stations of Holetta, Debre-Zeit, Kulumsa, Wondo-Genet, Werer, and Pawe Agricultural Research Centers during the main cropping season of 2018 under supplementary irrigation. Moreover, the variety verification trial (VVT) was done at Holetta, Debre-Zeit, Melkassa, Kulumsa and Wondo-Genet Agricultural Research Centers during the main cropping season of 2020 under supplementary irrigation. The trial sites' geographical position and physicochemical properties of the soil are summarized in Table 1.

Table 1: Description of the test locations for geographical position and physicochemical properties of soils

Parameters	Holetta	Debre-Zeit	Kulumsa	Wondo-Genet	Werer	Pawe	Melkassa
Latitude	9°00'N	8°44'N	08°05’N	07°19’N	9°16’N	11°19’N	8°24’N
Longitude	38°30'E	38°38'E	39°10’E	38°38’E	40°9’E	36°24’E	39°19’E
Altitude (m.a.s.l.)	2400	1850	2200	1780	750	1120	1550
Distance from Addis Ababa (km)	29	48	167	270	280	572	117
Annual Rainfall (mm)	1044	850	820	1372	590	1588	763
Daily minimum temperature (˚C)	6.2	8.9	10.5	11.0	26.7	17.1	14.0
Daily maximum temperature (˚C)	21.2	28.3	22.8	26.0	40.8	32.7	28.4
Soil type	Nitosol	Alfisol	Luvisol	Luvisol	Vertisol	Nitosol	Andosol
Textural class	Clay	Loam	Clay loam	Clay loam	Clay loam	Clay	Loam
pH(1:1 H_2O)	5.24	7.26	6.0	6.4	7.5	4.72	7.6
Total organic matter (%)	1.80	2.83	5.50	1.8	1.9	3.34	12
Total nitrogen (%)	0.17	0.22	0.25	0.2	0.1	0.16	1.0
Available phosphorus (ppm)	4.55	10.84	7.5	9.0	26.3	5.39	20.29
References for soil properties	Gezahagn et al., 2020					Habtie et al., 2020	Gezahagn et al., 2020

m.a.s.l. = meters above sea level; pH = power of hydrogen; ppm = parts per million

2.2. Experimental Design and Treatments

The supersonic alfalfa variety was introduced from Australia and evaluated for yield and nutritional qualities under diverse environmental conditions. The experiment was laid out in randomized complete block design (RCBD) with three replications per variety. The introduced supersonic alfalfa variety was sown with the standard check variety (Alfalfa-1086) on well-prepared seedbeds in rows of 20 cm apart using a seed rate of 20 kg/ha (Gezahagn et al., 2021). Diammonium Phosphate (DAP) fertilizer at the rate of 100 kg/ha was uniformly applied for both varieties at sowing (Gezahagn et al., 2021). Based on its better adaptability, yield, and tolerance to pest and disease performances in NVT, the variety was selected for a variety verification trial (VVT). Accordingly, both varieties (Supersonic alfalfa and alfalfa-1086) were sown in rows of 20 cm apart on a plot size of 10 m by 10 m with a seeding rate of 20 kg/ha. The recommended rate of DAP fertilizer was also uniformly applied for both varieties in the VVT experiment at sowing. All recommended management practices (such as weeding, harvesting etc.,) were applied for both varieties during the growing season.

2.3. Data Collection and Measurements

Measurements on plant height were taken randomly from five plants in each plot using a height measuring meter from the ground level to the tip of the plant. For the determination of biomass yield, varieties were harvested at the 50% flowering stage (Gezahagn et al., 2021). The weight of the total fresh biomass yield was recorded from each plot in the field and the estimated 500 g of their representative samples were taken from each plot to the laboratory. The estimated 500 g sample taken from each plot was weighed to know the total sample fresh weight using sensitive table balance and then oven-dried for 72 hours at a temperature of 65oC to determine the dry matter yield. The crude protein yield was calculated by multiplying crude protein content with total dry matter yield and then dividing by 100% (Gezahagn et al., 2021). The digestible yield was determined by multiplying IVDMD with total dry matter yield and then dividing by 100% (Gezahagn et al., 2021).

2.4. Laboratory Analysis

The varieties were harvested at the 50% flowering stage and submitted for laboratory analysis. The oven-dried samples, at a temperature of 65°C for 72 hours, were used for laboratory analysis to determine the chemical composition and in-vitro dry matter digestibility of the varieties. The dried samples were then ground to pass a 1-mm sieve and used for laboratory analysis. The analysis was made for the different nutritional parameters. Total ash content was determined by oven drying the samples at 105°C overnight and by combusting the samples in a muffle furnace at 550°C for 6 hours (AOAC, 1990). Nitrogen (N) content was determined following the micro-Kjeldahl digestion, distillation, and titration procedures (AOAC, 1995), and the crude protein (CP) content was estimated by multiplying the N content by 6.25. The structural plant constituents like neutral detergent fiber (NDF), acid detergent fiber (ADF), and acid detergent lignin (ADL) were determined according to Van Soest and Robertson procedure (1985). The in-vitro dry matter digestibility (IVDMD) was determined according to the Tilley and Terry procedure (1963).

2.5. Relative Feed Value

Relative Feed Value (RFV) is an index used for legumes based on potential intake and fiber digestibility (Undersander and Moore, 2002). The index used to rank feeds relative to the typical nutritive value of full bloom alfalfa hay, containing 41% ADF and 53% NDF on a DM basis, and having an RFV of 100, which is considered to be a standard score. This index is widely used to compare the potential of two or more forages based on energy intake (Schroeder, 2013). Accordingly, forages with RFV greater than 100 are considered to have better quality than full bloom alfalfa hay and those with RFV lower than 100 are regarded as of lower quality than full bloom alfalfa. Such a single parameter is considered to be of useful practical significance in forage pricing and marketing (Uttam et al., 2010; Schroeder, 2013) and calculated as follow:

RFV = (DDM %DM) * (DMI % BW) / 1.29 (Uttam et al., 2010),

Where, DDM (digestible dry matter) and DMI (dry matter intake potential as % of body weight) were calculated from ADF and NDF, respectively as follow:

DDM (% DM) = 88.9 - (0.779 * % ADF)

DMI (% BW) = 120 / (% NDF).

2.6. Statistical Analysis

Differences among varieties were tested using analysis of variance procedures of the SAS general linear model to compare treatment means (SAS, 2002) and the following model was used:

$$Y_{ijk} = \mu + G_i + E_j + (GE)_{ij} + B_{k(j)} + e_{ijk};$$

where, Y_{ijk} = measured response of genotype i in block k of environment j; μ = grand mean; T_i = effect of genotype i; E_j = effect of environment j; $(GE)_{ij}$ = genotype and environment interaction; $B_{k(j)}$ = effect of block k in environment j; e_{ijk} = random error effect of genotype i in block k of environment j. The least significant difference (LSD) was used for the comparison of means at a 5% significance level.

3. Results and Discussion

3.1. Varietal Evaluation

The seed of supersonic alfalfa variety was introduced from Australia by Harvest General Trading private limited company under license from the ministry of agriculture. The variety was introduced to Ethiopia in 2018. The introduced supersonic alfalfa variety was sown with the standard check variety (alfalfa-1086) to conduct the national variety trial (NVT) at Holetta, Debre-Zeit, Kulumsa, Wondo-Genet, Werer, and Pawe Agricultural Research Centers during the main cropping season of 2018 under supplementary irrigation. The plots were uniformly irrigated at field capacity every 15 days during the dry season of the year. The experiment was laid out in RCBD design replicated three times. The introduced alfalfa variety and the standard check variety were sown on well-prepared seedbeds in rows of 20 cm apart using a seed rate of 20 kg per hectare. Diammonium phosphate (DAP) fertilizer was applied at the rate of 100 kg per hectare at planting at each location (Gezahagn et al., 2017). Plots were hand-weeded twice per year. Based on the overall performances, the introduced supersonic alfalfa variety was promoted to VVT with the same standard check variety (alfalfa-1086) at Holetta, Debre-Zeit, Melkassa, Kulumsa, and Wondo-Genet Agricultural Research Centers during the main cropping season of 2020. The varieties were planted in rows 20 cm apart on a plot size of 10 m by 10 m with a seeding rate of 20 kg/ha. At sowing, DAP fertilizer at the rate of 100 kg/ha was uniformly applied on the plots at each location. Other recommended management practices were also applied. The National Variety Releasing Committee (NVRC) evaluated the varieties at field conditions in October 2020 and based on their evaluation result, supersonic alfalfa variety was registered in April 2021 to be utilized by end-users.

The mean plant height of alfalfa varieties tested across locations varied significantly ($P<0.05$) as indicated in Table 2. The result showed that the introduced supersonic alfalfa variety gave significantly ($P<0.05$) a higher mean plant height than the standard check variety at each testing location and combined across locations indicating its better adaptability and stability under diverse environmental conditions. The supersonic alfalfa variety gave the highest plant height at Debre-Zeit followed by Holetta, Werer, Kulumsa, and Pawe while the lowest plant height was recorded at the Wondo-Genet site. Similarly, the mean plant height recorded from both varieties was the highest at Debre-Zeit followed by Werer, Holetta, Kulumsa, and Pawe while at Wondo-Genet the lowest plant height was recorded. The plant height of the supersonic alfalfa variety in the present study was higher than the value reported for the same variety in Pakistan (Nasratullah et al., 2018). Variations in plant height of alfalfa varieties were also reported (Gezahagn et al., 2017; Nasratullah et al., 2018; Denbela and Sintayehu, 2021; Tessema et al., 2021). In addition to genetic variability, soil fertility and environmental conditions could also contribute to the difference in plant height. Generally, genetic variation, the response of genotypes to environmental factors, and their interactions are the major reasons for plant height differences in alfalfa (Gezahagn et al., 2017).

3.2. Agro-Morphological Characteristics

The registered supersonic alfalfa variety is the perennial herbaceous forage legume characterized by its agro-morphological characteristics. The maximum plant height at the forage harvesting stage (50% flowering) is ranged from 45 to 95 cm. The registered supersonic alfalfa variety reaches for forage harvesting within 70 to 90 days after sowing. The leaf to stem ratio of the registered supersonic alfalfa variety is 1.10. The registered variety has better ash, crude protein, and in-vitro dry matter digestibility while relatively lower fiber (NDF, ADF, and ADL) contents. The dry matter yield of the registered variety per cut ranged from 2 to 5 t/ha at the forage harvesting stage. Moreover, the crude protein and digestible yields of the registered variety ranged from 0.4 to 1.0 t/ha and 1.2 to 3.0 t/ha, respectively. The variety adapted to a wide range of altitudes ranging from 750-2400 m.a.s.l., which have an annual rainfall ranging from 800-1200 mm. The registered variety has good performance under nitosol and clay loam soil types. The varieties should be planted with a seeding rate of 10-20 kg/ha at 20 cm row spacing in early June. At planting, DAP fertilizer at a rate of 100 kg/ha should be applied for better establishment (Gezahagn et al., 2017). A summary of agronomical and morphological characteristics of the registered supersonic alfalfa variety is presented in Table 3.

Table 2: Average plant height (cm) of alfalfa varieties tested across locations in 2018 cropping season

Location	Variety		Location Mean	LSD	P-value
	Supersonic	Alfalfa-1086 (SC)			
Holetta	90.2^{a}	79.9^{b}	85.0^{b}	3.8132	0.0074
Debre-Zeit	94.8^{a}	85.7^{b}	90.2^{a}	3.4033	0.0074
Kulumsa	85.5^{a}	74.2^{b}	79.8^{c}	4.2355	0.0074
Wondo-Genet	42.0^{a}	38.0^{b}	40.0^{e}	1.4905	0.0074
Werer	88.5^{a}	85.3^{b}	86.9^{ab}	1.1800	0.0074
Pawe	65.3^{a}	61.7^{b}	63.5^{d}	1.3539	0.0076
Variety mean	77.7^{a}	70.8^{b}	74.2	1.9487	<.0001

Means with different superscript letter/s within a row for variety at each location, within a row for variety mean, and within the column for location mean varied significantly at 0.05; SC = standard check; LSD = least significant difference.

Table 3: Agro-morphological and fodder quality description of the registered supersonic alfalfa variety

Characteristics	**Supersonic alfalfa**
Species	*Medicago sativa*
Variety	Supersonic
Adaptation	Wide range of environments
Altitude (m.a.s.l.)	750 – 2400
Rainfall (mm)	800 – 1200
Soil type	Nitosol and clay loam
Seeding rate (kg/ha)	10 – 20
Spacing inter-row (cm)	20
Planting date	Early June
Fertilizer rate (kg/ha)	
P_2O_5	46 kg/ha at planting
N	18 kg/ha at planting
Plant height at forage harvest (cm)	45 – 95
Days to forage harvesting (50% flowering)	70 – 90
Leaf to stem ratio	1.10
Yield per cut (t/ha)	
Forage Dry matter:	2 – 5
CP yield	0.4 – 1.0
Digestible yield	1.2 – 3.0
Fodder quality (%)	
Ash	14.28
CP	19.87
NDF	48.84
ADF	37.36
ADL	7.08
IVDMD	60.61
Year of release	2021
Breeder/maintainer	Harvest General Trading Private Limited Company /HARC/EIAR

DAP = diammonium phosphate; CP = crude protein; NDF = neutral detergent fiber; ADF = acid detergent fiber; ADL = acid detergent lignin; IVDMD = *in-vitro* dry matter digestibility; HARC = Holetta Agricultural Research center; EIAR = Ethiopian Institute of Agricultural Research.

3.3. Yield Performance

The mean dry matter yield of alfalfa varieties significantly (P<0.05) varied across the tested environments is indicated in Table 4. The result showed that supersonic alfalfa variety gave higher dry matter yield (P<0.05) than the alfalfa1086 variety used as a standard check at each location and combined over locations. The dry matter yield of supersonic alfalfa variety ranged from 2.7 to 4.9 t/ha with the mean of 3.5 t/ha per cut across the test locations. The highest mean dry matter yield was recorded at Werer followed by Kulumsa, and Debre-Zeit locations, while the lowest yield was obtained from Wondo-Genet location with the yield advantages of 96, 68, and 56%, respectively when compared to Wondo-Genet location. The dry matter yield of alfalfa varieties also varied (P<0.05) across the test locations. Accordingly, alfalfa varieties produced the highest dry matter yield at Werer followed by Debre-Zeit, Kulumsa, and Pawe while the lowest dry matter yield was obtained from Holetta and Wondo-genet locations. The difference in dry matter yield could be due to variations in soil fertility, weather conditions, and the genetic difference between the tested varieties.

The mean dry matter yield of the supersonic alfalfa variety in the present study was slightly lower than the value reported for the same variety in Pakistan (Nasratullah et al., 2018). This is might be due to differences in soil, weather, and management conditions. The stage of maturity, soil fertility, climatic conditions, and cultivar differences are the main factors affecting alfalfa yield and quality (Stancheva et al., 2008). The importance of alfalfa in world agriculture can be attributed to several variable morphological and physiological characteristics that contribute to its high and stable yield of nutritious herbage (Radović et al., 1996). Its economic significance is based on the high potential for production of biomass, over 80 t/ha of green and close to 20 t/ha of dry matter yield (Radović et al., 2004; Nešić et al., 2005). The rank of the varieties for dry matter yield didn't change across the test locations indicating the occurrence of non-cross-over interaction of the varieties for this trait due to their high stability performances under diverse environments (Figure 1). However, the dry matter yield fluctuates across locations due to the differential response of the varieties for the test environments.

The advantages of supersonic alfalfa variety over the standard check variety in terms of dry matter, crude protein, and digestible yields are indicated in Table 5. The result showed that the introduced supersonic alfalfa variety had advantages of dry matter yield, crude protein yield, and in-vitro dry matter digestibility yield over the standard check variety. The introduced supersonic alfalfa variety had about 12.9% dry matter yield, 7.7% crude protein yield, and 11.6% digestible yield advantages over the standard check variety. The introduced supersonic alfalfa variety had better dry matter yield, crude protein yield, and in-vitro dry matter digestibility yield than the standard check variety. The differences in CP and IVDMD yields were due to variation in dry matter yield between the two alfalfa varieties. The introduced supersonic alfalfa variety has better yield and quality and as a result, it can contribute a lot by fulfilling the nutrition shortfall thereby improving the livestock production and productivity in the country.

Table 4: Average dry matter yield (t/ha) of alfalfa varieties tested across locations in 2018 cropping season

Location	Variety		Location Mean	LSD	P-value
	Supersonic	Alfalfa-1086 (SC)			
Holetta	2.7^a	2.2^b	2.4^c	0.3603	0.0193
Debre-Zeit	3.9^a	3.8^b	3.9^b	0.0625	0.0192
Kulumsa	4.2^a	3.5^b	3.8^b	0.4471	0.0213
Wondo-Genet	2.5^a	2.3^b	2.4^c	0.0994	0.0202
Werer	4.9^a	4.3^b	4.6^a	0.3726	0.0196
Pawe	2.7^a	2.6^b	2.7^c	0.0872	0.0170
Variety mean	3.5^a	3.1^b	3.3	0.1560	0.0002

Means with different superscript letters within a row for variety at each location, within a row for variety mean, and within the column for location mean varied significantly at 0.05; SC = standard check; LSD = least significant difference.

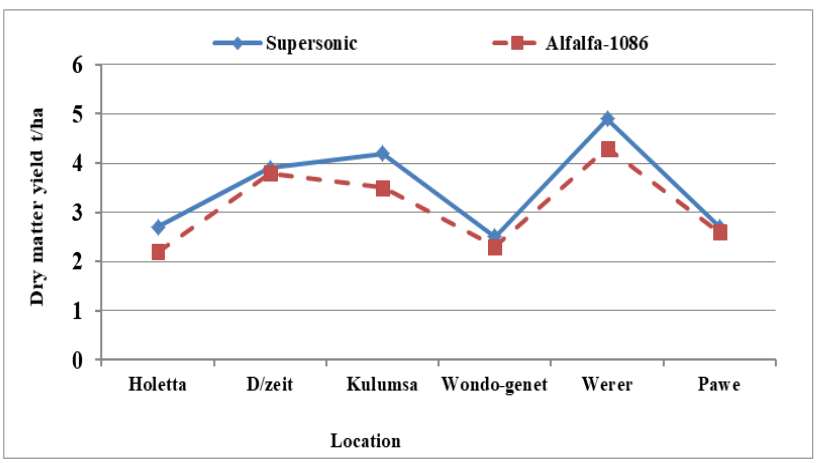

Figure 1: Genotype by location interaction for dry matter yield

Table 5: Dry matter, crude protein, and in-vitro dry matter digestibility yield advantage of supersonic alfalfa variety over the standard check variety

Parameters	Variety	
	Supersonic	**Alfalfa-1086 (SC)**
DMY	3.5	3.1
% increase in DMY	12.9	-
CP yield	0.70	0.65
% increase in CP yield	**7.7**	-
IVDMD yield	2.12	1.90
% increase in IVDMD yield	11.6	-

DMY = dry matter yield; CP = crude protein; IVDMD = in-vitro dry matter digestibility; SC = standard check.

3.4. Quality Attributes

The chemical composition and in-vitro dry matter digestibility of alfalfa varieties are presented in Table 6. The result indicated that the introduced supersonic alfalfa variety had slightly lower in ash, crude protein, in-vitro dry matter digestibility, and relative feed value while relatively higher fiber (NDF, ADF, and ADL) contents than the standard check variety. The ash content of the supersonic alfalfa variety in the current study was slightly higher than the value reported for the same variety in Pakistan while the reverse is true for CP content (Nasratullah et al., 2018). A nutritional quality difference between alfalfa cultivars was not also significant in different studies (Julier et al., 2000; Radović et al., 2004). The main effect on alfalfa forage quality belongs to the plant stage. The decline in feed quality is associated primarily with a decrease in crude protein content and an increase in fibrous constituents of the stem in the matured plant. The decline in alfalfa forage quality with advancing maturity was reported (Marković et al., 2008). The slightly lower in ash, CP, IVDMD and RFV and higher fiber (NDF, ADF, and ADL) contents in the introduced supersonic alfalfa variety than standard check variety might be due to differences in leaf to stem ratio. Because, leafy varieties have better ash, CP, and digestibility than varieties having high stem proportion. Leaf to stem ratio is an important trait in the selection of appropriate forage cultivar as it is strongly related to forage quality (Julier et al., 2000; Sheaffer et al., 2000). The proportion of leaves at the time of harvest is a major factor that determines the quality of the forage (Jung, 2005; Mihai et al., 2012).

The relative feed value (RFV) of alfalfa varieties is presented in Table 6. Feeds with an RFV index higher than 100 are considered to be of higher quality compared to full bloom alfalfa hay and those with a value lower than 100 are of lower value (Dunham, 1998). The RFV of the introduced supersonic alfalfa variety was slightly lower than the standard check variety. However, both the tested varieties had RFV index higher than 100 indicating the varieties had better nutritional quality. The RFV recorded in the present study was lower than the RFV reported by other researchers for different alfalfa varieties/genotypes (Diriba et al., 2014; Mekuanint et al., 2015; Gezahagn et al., 2017).

Table 6: Chemical compositions and in-vitro dry matter digestibility (g/kg DM) of alfalfa varieties

Parameters	Variety		Mean
	Supersonic	**Alfalfa-1086 (SC)**	
Ash	142.8	144.7	143.8
CP	198.7	209.0	203.9
NDF	488.4	484.9	486.7
ADF	373.6	371.2	372.4
ADL	70.8	68.0	69.4
IVDMD	606.1	612.5	609.3
RFV	115.9	116.1	116.0

CP = crude protein; NDF = neutral detergent fiber; ADF = acid detergent fiber; ADL = acid detergent lignin; IVDMD = *in-vitro* dry matter digestibility; RFV = relative feed value; SC = standard check.

Table 7: Response of alfalfa varieties for disease and pest incidence (%) during the study periods

Incidence (%)	Variety	
	Supersonic	**Alfalfa-1086 (standard check)**
Disease		
Downy mildew	8.5	9.5
Common leaf spot	10.5	12.0
Aphanomyces root rot	7.5	11.5
Bacterial wilt	11.5	12.5
Pest		
Aphids	11.5	13.5

3.5. Reaction to Diseases and Pests

The introduced supersonic alfalfa variety and the standard check variety were tested for their diseases and pests reaction starting from the initial stage of evaluation to verification stage and found to be resistant/moderately resistant to major diseases and pests which can affect the variety (Table 7). The diseases and pest effects on the performance of alfalfa varieties were recorded as 0-10% resistant, 11-30% moderately resistant, 31-60% moderately susceptible, and 61-100% susceptible. Accordingly, the registered supersonic alfalfa variety was found to be resistant to moderately resistant to the recorded major diseases (downy mildew, common leaf spot, aphanomyces root rot, and bacterial wilt) and pests (aphids) in the test locations during the experimental periods. The resistance reaction of the variety could be integrated with other diseases and pest management strategies for better results. Generally, the registered supersonic alfalfa variety is superior in tolerance to major diseases and pests than the standard check variety.

3.6. Adaptation

The registered supersonic alfalfa variety is adapted to a wide range of environments in Ethiopia. The variety performed very well in areas with an altitude of 750 to 2400 meters above sea level which has an annual rainfall of 800 to 1200 mm. It could also be possible to extend the production of the variety to other areas with similar agro-ecologies after conducting an adaptation trial. The registered supersonic alfalfa variety produces better dry matter yield, crude protein yield, and digestible yield when a recommended fertilizer rate and seeding rate are applied in nitosol and clay loam soils at sowing. For better performance, the variety should be planted in early June under rain-fed conditions and any time when irrigable water is available. In areas that receive high temperature and irrigable water, the variety can be harvested monthly and bimonthly for forage and seed yields, respectively.

4. Conclusion

After the national variety trial had been conducted over locations, the recently introduced supersonic alfalfa variety with the standard check (alfalfa-1086) was verified over locations and evaluated by the National Variety Releasing Committee as per the guidelines of the variety releasing and registration of the country during the 2020 cropping season. Based on their evaluation result, the supersonic alfalfa variety which had relatively better performance in terms of biomass production and diseases and pests reactions is registered in 2021 for production. The variety is well adapted in the low to high altitude areas and similar agro-ecologies of the country. The breeder and pre-basic seeds of the registered supersonic alfalfa variety are maintained by Harvest General Trading Pvt. Ltd. Co. and the feeds and nutrition research program of Holetta Agricultural Research Center.

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