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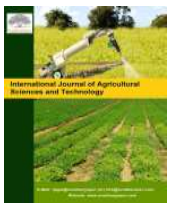

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Performance Evaluation of Different Vetch Species for Forage Biomass Yield and Nutritional Quality at East Hararghe Zone, Ethiopia

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Abstract

Scarcity of forage production is the major limiting factor for increasing livestock production in East Hararghe. Vetches are important and potential legume forage crops. Thus, the experiment was conducted to evaluate the forage potential as well as other agronomic characters of four varieties of vetch (ICARDA, Gebisa, Lalisa and Lana) belongs to three species Vicia dasycarpa (Lana), Vicia villosa (Lalisa) and Vicia sativa (Gebisa and ICARDA). The treatments were laid out in randomized Complete Block Design with four replications. The study showed that there was difference among the vetch species/varieties for days to flowering, dry matter and seed yields at both agro-ecologies. Accordingly, the highest dry matter was obtained by Lalisa and the lowest yield was recorded by ICARDA in midland while the highest DMY was obtained by Lana and the lowest yield was recorded by ICARDA in lowland. Lana and Lalisa varieties had recorded the highest seed yields than the other varieties and the longest plant height was recorded by Lana and Lalisa, respectively. The crude protein and NDF content were significantly different among vetch varieties. However, the neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL) in vitro dry matter digestibility (IVDMD) and dry organic matter digestibility (DOMD) were not significantly different among vetch varieties. The nutritional quality value of the whole vetch varieties evaluated was in the range of high quality feed in all parameters. The overall yield from the midland exceeded that of the lowland. The seed yield at lowland is particularly low. However, a promising forage yields has been found at both agro ecologies. The results of the current study identified that Lalisa and Lana had higher dry matter and nutritional quality yielder at midland and lowland of East Hararghe Zone respectively. Therefore, the selected variety should be demonstrated and multiplied for wider use.

Keywords: *Days to flowering, Plant height, Dry matter yield, Seed yields, Varieties, Vetch, Nutritional quality*

1. Introduction

Feed scarcity in terms of both quantity and quality is the leading problem affecting the livestock productivity in Ethiopia (Fekede *et al.*, 2015a; Fekede *et al.*, 2015b). Although the shortage of animal feed is known to be difficult as a country, the one in East Hararghe Zone (EHZ) of Oromia region is very serious problem. Hence, it is necessary to use all the

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existing opportunity to increase the animal feed resources of the areas. Among the existing opportunity integrating forage production into the soil and water conservation practice is the major one. The primary benefits of improved forages are to produce high amount of quality forage to be used as feed for livestock. On the other hand, forage crops could be grown as a component in integrated natural resource management to prevent soil erosion, increased biodiversity, increase carbon sequestration and to control weeds, and pests and diseases (Christiansen *et al.,* 2015). Legumes like vetch that grow in marginal cropping zones and are drought tolerant and resilient to changeable annual weather patterns, will be in high demand. Vetch can be used for forage, fodder, pasture, silage, or hay and the seed may safely be used as a protein-rich feed component. Vetch hay or silage can increase milk production per cow by more than 12% compared with grass or cereal hay (Hart Field, 2001).

Vetch is versatile in terms of its potential end use, producing hay/silage, grain, pasture or green manure (Francis *et al.,* 1997, Matic *et al.,* 2005). It is one of the most important forage crops and serving a source of feed for animals all around the world. Like other legumes, vetch forms a symbiosis with nitrogen-fixing bacteria (Rhizobia) that fix atmospheric nitrogen into nitrogenous compounds available to the plant, hence reducing the need for application of expensive nitrogen fertilizer and subsequent rotation crops. Often, common vetch is used as a green manure which, when incorporated into the soil, provides valuable carbon, and nitrogen for rotation crops such as wheat and barley. Additional soil carbon often increases water-holding capacity and ability to bind nutrients including nitrate (Reeves, 1997; Bünemann *et al.,* 2018).

In East Hararghe Zone, the rapid increase in human population densities, continuous cultivation, overgrazing and climate change has contributed to the depletion of soil fertility and plant biodiversity loss. A loss of valuable species and dominance by unpalatable invasive plant species is found to be the serious threats for EHZ. Reducing the impacts of climate change, land degradation, soil erosion and biodiversity loss is very important for the existing farming systems. It requires identifying and adopting new agricultural practices. Accordingly, soil and water conservation practices which are becoming an example not only at country level but also at Africa are being carried out on thousands of hectares in East Hararghe Zone of Oromia. One of the major objectives of these soil and water conservation practices is to increase the feed supply for their livestock. Thus, an integrated approach aimed to increase the animal feed resources and assists soil conservation and plant biodiversity is needed. This is very important for agricultural sustainability and climate change adaptation. Introducing forage legumes seems an acceptable approach and the most successful forage development strategies in these areas. One of the forage legumes used for this program is vetch. However, study regarding the adaptability and forage production potential of vetch varieties in Eastern Hararge is very limited. Therefore, the experiment was initiated to evaluate and select the high biomass yielder and high nutritional quality vetch variety/s for the study areas.

2. Materials and Methods

2.1. Description of the Study Area

The experiment was conducted at two locations for three consecutive years for each agro-ecology. Two districts namely Fedis (Boko research site) and Babile (Erer research sub-site) were selected for lowland and one district namely Kersa was selected from midland agro-ecology of East Hararghe zone. One location from each district were used for lowland while two sites were used for Kersa district at midland. The locations were Fedis district at Boko research station and Babile district at Erer sub-station for lowland, and Matakoma and Adele sites for midland. Boko research site is located at latitude of 9^0 07' north and longitude of $042^0$04' east and at an altitude of 1672 m.a.s.l. The experimental area receives average annual rainfall of 650-750 mm. The rainfall has a bimodal distribution pattern with heavy rain often received from April to June and long, and erratic rains from August to October. The mean maximum and minimum annual temperatures are 27 and 11 ^{0}c respectively. The Erer research sub-station is located at an altitude of 1350 m.a.s.l. The area receives an average annual rainfall of about 350-450 mm. Kersa district altitude ranges from 1,550 to 2,800 m.a.s.l. The experimental sites at midland ranges from 1750-2000 m.a.s.l.

2.2. Experimental Design and Treatments

The study was conducted using four (4) varieties of vetch belongs to three species namely *Vicia dasycarpa* (Lana), *Vicia villosa* (Lalisa) and *Vicia sativa* (Gebisa and ICARDA). The varieties were ICARDA, Gebisa, Lalisa and Lana. The varieties were obtained from Holeta and Sinana Agricultural Research Center. The treatments were laid out in randomized Complete Block Design with four replications. The space between plots and blocks was 1m with intra-rows spacing of 0.30 m. A seeding rate of 30 kg/ha and 100 kg/ha of NPS fertilizer were used. Weed and other management practice were applied when deemed necessary.

2.3. Data Collection and Nutritional Quality Analysis

Data collection was done at 50 % flowering stages for forage biomass yield and plant heights. The three middle rows were harvested and immediately the harvested fresh biomass was recorded using field balance. Then it was manually chopped into small pieces using sickle and a subsample of 300g was taken and dried in air draft oven 65^{0}C for 72 hours to determine herbage dry matter yield and nutritional quality. Plant height was determined by using mean height of ten randomly selected plants for each plot. The height of each plant was measured from the ground to the tip of the plants (Sadeghi *et al.,* 2009). Forage nutritional quality parameters the Ash, crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL), in vitro dry matter digestibility (IVDMD) and DOMD were analyzed at Holeta Agricultural Research Center, Animal Nutritional Laboratory.

3. Statistical Analysis

The collected data was analyzed using descriptive statistics.

4. Results and Discussion

4.1. Vetch Species Plant Height, Days to 50% Flowering, Dry Matter and Seed Yield

The current finding showed that there was a difference in plant height among the vetch species/varieties evaluated. Accordingly, maximum plant height was recorded by lalisa (128.1+11.11cm) and lana (122.5+9.44 cm) while the shortest plant height was obtained by ICARDA (74.9+18.93 cm) (Table 1). The obtained vetch plant height was in the range of 74.9+18.93-128.1+11.11 cm. Similar to the current study Rahmati *et al.* (2001) got the lowest value of plant height for *Vicia sativa* (ICARDA) and the highest value for *Vicia dasycarpa* (Lana). Our finding result is also align with the findings of Denekew and Asefa (2012) who reported 118 and 130 cm plant height for *Vicia villosa* (Lalisa). Similarly, Kassahun and Wasihun (2015) also reported 130 and 126 cm plant for Vicia dasycarpa and *Vicia villosa*, respectively.

The current study also showed that there was a difference among the vetch varieties for days to flowering, dry matter and seed yields (Table 1). Accordingly, the highest DMY was obtained by Lalisa (5.3+0.811 t/h) followed by Lana (4.83+0.52 t/h) and the lowest yield was recorded by ICARDA (2.34+1.02 t/h). The current study highest DMY (5.3+0.63 t/h) was lower than Shobeiri *et al.* (2010) who reported 6.14 t/h. However, greater than the findings of Anugroho and Kitou (2011) 4.47 t/ha. There was also a difference result in seed yields among the vetch species/varieties where Lana (4.62+0.44 t/h) and Lalisa (4.3+0.37 t/h) varieties had recorded the highest seed yields than the other varieties. The lowest seed yield was obtained by ICARDA (2.16+0.87 t/h). When we come to the days to 50 % flowering Gebisa had been flowered earlier than the other varieties.

Table 1: **Vetch Species/Varieties Mean Plant Height, Days to 50% Flowering, Dry Matter and Seed Yield at Midland**

Treatments	Plant Height	Days to 50% Flowering	Dry Matter Yield (t/h)	Seed Yields (t/h)
ICARDA	74.9±18.93	93.04±2.39	2.34±1.02	2.16±0.87
Gebisa	98±12.17	89.79±2.66	3.72±0.62	3.16±0.58
Lana	122.5±9.44	94.5±1.52	4.83±0.52	4.62±0.44
Lalisa	128.1±11.11	97.21±1.79	5.3±0.63	4.3±0.37

4.2. Vetch Species/Varieties Plant Height, Dry Matter Yield and Seed Yields at Lowland

The present finding revealed that there was a difference among the vetch species/varieties for plant height, dry matter and seed yields (Table 2). Hence, the longest plant height was recorded by Lana (108.89+29.623 cm) and Lalisa (101.6+29.724 cm) while the shortest variety was ICARDA. On the other hand the highest DMY was obtained by Lana (4.23+1.144 t/ha) and the lowest yield was recorded by ICARDA (1.61+1.062 t/ha). The current study highest DMY (4.23+1.144 t/h) was almost similar with the findings of Anugroho and Kitou (2011) who reported 4.47 t/ha. However lower than the reports of Shobeiri *et al.* (2010) 6.14 t/h who conducted at midland different agro ecology. There was also a difference result among the vetch varieties in seed yield where the average seed yield was high for Lana and Lalisa and low yield was obtained by ICARDA variety (Table 2). The seed yield obtained is low compared to other studies. This may have been due to the heavy rainfall occurred in the midland and the low rainfall appeared in the lowland areas during the study time. Precipitation is among the most important factor affecting seed yield. Since vetch is a midland and highland crop

the high rainfall occurred in midland/study area facilitates the vegetative growth and reduced the seed yield of the crop while the low rainfall in the lowland has reduced both the forage and seed yield. As a whole, the yields obtained at midland is higher than that in the lowland agro ecology.

Table 2: Vetch Varieties Mean Plant Height, Days to 50% Flowering, Dry Matter and Seed Yield at lowland

Treatments	Plant Height	Days to 50% Flowering	Dry Matter Yield (t/h)	Seed Yields (t/h)
Lana	108.89±22.95	80.29±1.28	4.23±0.99	2.39±0.47
Lalisa	101.6±21.34	82.71±1.41	3.72±0.77	2.1±0.39
Gebisa	80.27±18.41	78.75±1.02	2.88±0.66	1.6±0.32
ICARDA	42.88±20.26	81.08±0.19	1.61±0.75	1.02±0.38

4.3. Chemical Compositions

Samples for nutritional quality determination was cut at 50 % flowering stage. At this stage the balance of nutritional value is at its highest for vetch (Mihailovic *et al.,* 2005). The crude protein which is the limiting factor for animal productivity and NDF% content were differed among vetch varieties. Lalisa (23.36+1.681%) had higher CP % content followed by ICARDA (20.63+1.077%), Lana (20.37+0.12%) and Gebisa. The CP % content of the vetch varieties ranged from 18.06-23.36%. This result is almost similar with the findings of Rahmati *et al*. (2001) and Lanyasunya *et al.* (2007) who reported vetch CP content 21.46 and 21.5 % respectively. However, it is greater than the reports of Kassahun and Wasihun (2015) which is 9.1-18.9 % CP. The ash%, ADF%, ADL%, DOMD% and IVDMD% contents of the vetch species/varieties were almost similar. Even though they were not difference; the nutritional quality value of the whole vetch sepecie/varieties evaluated was in the range of high quality feed in all parameters. ADF content of vetch was in the range of high quality as Kazemi *et al*. (2009) reported legumes with less than 31% ADF value are rated as superior quality. The current study result of NDF% is in the range of 28.99+2.388 to 42.24+4.323 %. This is similar with the finding of Sanz-Sáez *et al.* (2012) that reported NDF for legumes less than 45% is considered as high quality.

Table 2: Vetch Varieties Mean Plant Height, Days to 50% Flowering, Dry Matter and Seed Yield at lowland

Treatments	Ash	ADF	ADL	CP	NDF	DOMD	IVDMD
Lalisa	5.995±0.264	22.49±0.906	5.049±0.254	23.36±1.681	42.24±4.323	65.81±0.709	73.71±0.664
ICARDA	5.611±0.150	24.1±0.516	5.573±0.226	20.63±1.077	33±2.089	66.12±0.752	74±0.705
Gebisa	5.28±0.123	25.32±0.551	5.613±0.244	18.06±1.150	28.99±2.388	67.58±0.852	75.37±0.799
Lana	5.279±0.131	24.29±0.12	5.049±0.226	20.37±0.12	33.54±0.455	65.52±0.37	73.44±0.345

5. Conclusions and Recommendations

As a whole, the current findings showed that the yields obtained at midland is higher than that in the lowland agro ecology. The seed yield at lowland is particularly very low. However, a promising forage yields has been found at both agro ecologies. The results of the current study identified that Lalisa and Lana had superior dry matter and nutritional quality yielder under midland and lowland conditions of East Hararghe Zone respectively. Farmers and other stallholders will benefit from these adaptable improved vetch varieties for better quality forage/hay production or use as a pasture/ green manure and increase soil fertility. Therefore, the selected variety should be demonstrated to under farmers' condition for wider use.

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Conflict of Interest

The authors declared that there is no conflict of interest.

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