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Performance Evaluation of Improved Vetch Varieties/Accessions at the Highland of Guji Zone, Bore, Ethiopia

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Abstract

This study was conducted with an objective of introducing, adapting, see the yield, quality and recommends improved vetch accessions/ varieties to the area in a randomized complete block design (RCBD) with three blocks. Accessions/varieties were (Vicia Villosa IRLI, Vicia Atropurporeum, Vicia Villosa Holota, Vicia Sativa ICARD 61509, Vicia Sativa ICARD 61744, Vicia Dyscarpa Lana, Vicia Dyscarpa Namoi, Vicia Narbonesis, Lelisa, Abdeta and Gebisa). The analysis of yield and yield components and quality of the tested vetch shows that Vicia Sativa ICARD 61744 was significant in seed yield which is not statistically different from Vicia Sativa ICARD 61509 and less in Acid Detergent Fiber (ADF) content than the rest accessions. Vicia Sativa ICARD 61509 was significant in Dry Matter Yield (DMy) and it is similar with other accessions except Vicia Dyscarpa Namoi. Vicia Vilossa Holeta was significant in green forage yield and highest in Organic matter (OM), Crude Protein (CP) and In vitro Organic matter digestibility (DOMD) and. Abdeta was significant in seed per pod, seed yield and Harvesting Index (HI) and highest in OM. Lelisa is significant in green forage yield and late in date of maturity than the rest varieties at ($P<0.05$).Therefore, based on the performance of most parameters, Vetch accessions/varieties, Vicia atropurputeum, Vicia villosa Holota, Vicia sativa ICARD61509 and Vicia sativa ICARD61744, in 2010 and Gebisa and Lelisa, in 2011 were selected and recommended to highland of the Guji zone. Therefore, those accessions have to be evaluated under farmers' conditions so as to prove their best performing ability. .

Keywords: Improved; Quality; Vetch; Yield

Abbrevations: ADF: Acid Detergent Fiber; OM: Organic Matter; CP: Crude Protein; DOMD: In vitro Organic Matter Digestibility; HI: Harvesting Index; OARI: Oromia Agricultural Research Institute; NDF: Neutral Detergent Fiber; ADL: Acid Detergent Lignin; GLM: General Linear Model

Introduction

Among a number of annual legumes introduced so far vetches are one the leguminous forages adapted to the highland of Ethiopian [1]. Vetches are being used for disease break, crops in the rotation, grain crops, for stock feed, hay production and green and dry grazing. As fodder crops, vetches mixed mainly with oats or other minor cereals such as barley and can be fed to animals while green or as hay or silage. Their matting types of growth not only protect the soil erosion but also can improve the physical and fertility states of the soil [1]. Vetches apart from being able to stay green in to the dry season are high in protein content and have a considerable potential for increasing forage quality. Information on feed quality is one of the decision support tools required to provide rational basis to optimize utilization of feed resources, to improve animal production and productivity and ultimately to increase financial return to the producer. The feasibility of livestock enterprise is largely a function of the type, quality of feed and the strategy of feeding.

Removing or reducing nutritional constraints leads to dramatic improvement in livestock production and productivity. Dynamic changes have been made in the areas of feed evaluation, nutrient requirement and feeding systems [2]. Several environmental, genetic and genotype by environment interaction aspects are expected to influence chemical composition and nutritive value. Compositional data information on digestibility and estimated metabolizable energy offers opportunity to formulation of least cost ration. Vetches apart from being able to stay green in to the dry season are high in protein content and have a considerable potential for increasing forage quality [1]. There is no any animal feed technology which is tested in the study area (Guji zone) and no information on forage nutritional quality due to the remoteness of the area and Bore Agricultural Research was established recently. This experiment was initiated to introduce, evaluate vetch genotypes for yield and yield attributes, see the adaptability to that specific agro-ecology and see the nutritional quality of adapted vetches. Therefore, this experiment was conducted with the objectives of introducing, adapting, see the yield, quality and recommend improved Vetch accessions/varieties to the area so as to address farmers in quality and large quantity of forages.

Materials and Methods

Description of the study area

The experiment was carried out at Bore Agricultural Research Center, which is one of the recently established Research Centers of the Oromia Agricultural Research Institute (OARI) in Bore district, Guji Zone of Oromia. Bore district is located at 385km to the south from Addis Ababa and 220km from the Guji Zone capital city (Negele) with geographical location of 557'23" to 626'52" N latitudes and 3825'51" to 3856'21" E longitudes, South-eastern Oromia. It has moist humid and sub humid moisture condition, with relatively longer growing season. The annual rain fall is about 1400-1800mm and the annual temperatures of the district ranged from 10.1 to 20 °C. The major soil types are Nitosols (red basaltic soils) and Orthic Aerosols [3]. Bore Agricultural Research station is located at 7km from Bore district which is geographically located at 624'37" N latitude and 3834'76" E longitudes. The research site represents highlands of Guji Zone with an altitude of 2736m.a.s.l. receiving high rainfall characterized by bimodal distribution. The first rainy season extends from April to October and the second season starts late November and ends at the beginning of March. The soil type of the site is mostly black soil.

Experimental procedures

The trial was arranged in randomized complete block design (RCBD). There were three blocks each containing 7 plots of vetch accessions (Vicia Villosa IRLI, Vicia Atropurporeum, Vicia Villosa Holota, Vicia Sativa ICARD 61509, Vicia Sativa ICARD 61744, Vicia Dyscarpa Lana and Vicia Dyscarpa Namoi) resulting to twenty-one plots in total in 2010 summer season and 4 plots of Vetch varieties/accessions (Vicia Narbonesis, Lelisa, Abdeta and Gebisa) resulting to twelve plots in total in 2011 summer season with each plot measuring 3m x 4m. Distance between plots and replication were 1m and 1.5m respectively. Plots in each block were randomly assigned to the seven treatments. Broad casting methods and no fertilizer were applied at the planting time for treatments of Vetch accessions in 2010. Row method and 35cm spacing between rows were applied for Vetch Varieties/accessions in 2011.

The nutrient analysis was conducted at Adami Tulu Agricultural Research Center and Holeta Agricultural Research Center Laboratory. Composite samples of Vetch accessions/varieties were collected at 50% flowering stage at each consecutive year. Samples were dried at 65 °C in a forced draft oven for 72hrs. All samples were ground using a willy mill and allowed to pass through 1mm screen, run in duplicates and Dry matter (DM), Ash, Crude protein (CP), Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), Acid Detergent Lignin (ADL) and *In vitro* dry matter Digestibility (DOMD) were determined by Near Infra-Red Reflectance) NIRRS methods and Hemicellulose was calculated by subtracting the ADF from the NDF content while cellulose was determined by subtracting the ADL from the ADF content and results were carefully collected. The weighed fresh subsample (FWss) was oven dried at 60 °C for 72 hours and reweighed (DWss) to give an estimate of dry matter production. The dry matter production (tone/ha) was calculated as $\left(10\times TotFW\times\left(DWss/HA\times FWss\right)\right)$ [4].

Where;

TotFW = total fresh weight from plot in kg; DWss = dry weight of the sample in grams; FWss = fresh weight of the sample in grams; HA = Harvest area meter square and 10 = is a constant for conversion of yields in kgm^2 to tone/ha. Harvest index (HI) was calculated on a plot basis, as the ratio of dried grain weight adjusted to 12.5% moisture content to the dried total above ground biomass weight.

$$\text{Disease severity score was calculated as} = \frac{\text{Sum of all disease rating}}{\text{Total number of rating } * \text{Maximum disease grade}}\times 100$$

Data collected

Date of emergency, date of 50% flowering, green forage yield, dry matter yield (DMy), plant cover, disease score, pest, pod per plant, seed per pod, date of maturity, seed yield, harvesting index (HI) and chemical composition data were carefully collected for all accessions/varieties at consecutive years.

Statistical analysis

Data on agronomic parameters, yield and chemical analysis was analyzed by using SAS computer software (SAS, 2002 version 9.1) and General Linear Model (GLM) was used at 5% significance level.

Results

Yield and yield components

Table 1: Agronomic and yield parameters as influenced by Vetch accessions.

Accessions	Date of Emergency	Plant Cover %	Date of 50% Flowering	Green Forage Yield in tone/ha	DM Yield tone/ha	Date of Maturity	Pod per Stem	Seed per Pod	Seed Yield in Qun/ha	HI
Vicia Vilosa ILRI	8	85.000^{abc}	159.00^{bc}	53.33^{ab}	3.773^{ab}	226.67^{ab}	12	4.6667^{ab}	3.973^{b}	0.548^{c}

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Vicia Vilossa Holeta	8	78.333^{bc}	149.00^{bc}	72.00^{a}	2.820^{ab}	248.00^{a}	14.667	5.0000^{a}	3.120^{b}	0.795 ^{c}
Vicia Atropurpureum	8	70.00^{c}	165.33^{ab}	53.33^{ab}	3.193^{ab}	226.67^{ab}	11	4.3333^{abc}	3.403^{b}	0.822 ^{c}
Vicia Dyscarpa Lana	8	95.0^{a}	159.00^{bc}	40.00^{b}	3.387^{ab}	216.00^{bc}	9.333	4.0000^{bc}	4.257^{b}	1.122^{c}
Vicia Dyscarpa Namoi	8	40.0^{d}	142.0^{c}	50.67^{ab}	0.170^{b}	216.0^{bc}	12.667	4.3333^{abc}	4.533^{b}	0.839 ^{c}
Vicia Sativa ICARD 61509	8	85.0^{abc}	182.0^{a}	53.33^{ab}	5.833^{a}	194.0^{c}	6.667	3.6667^{c}	19.243^{a}	3.659^{b}
Vicia Sativa ICARD 61744	8	86.667^{ab}	186.0^{a}	41.33^{b}	3.997^{ab}	218.0^{bc}	10.333	4.3333^{abc}	25.31^{a}	6.272^{a}
SEM	0	9.193683	12.54895	16.9481	2.194043	14.3361	4.92322	0.48795	4.190567	0.782337

^{a,b}Means in a column within the same category having different superscripts differ (P<0.05); DM = Dry Matter, ha = Hectare; Qun = Quintal and SEM = Standard Error of Means.

Table 2: Agronomic and yield parameters as influenced by Vetch varieties

Variety	Date of Emergency	Date of 50% Flowering	Green Forage Yield tone/ha	Seed per Pod	Pod per Stem	Yield Qun/ha	HI
Abdeta	10	96	16.267^{c}	6.3333^{a}	17.667^{b}	23.247^{a}	14.283^{a}
Gebisa	10	96	28.333^{b}	4.6667^{b}	24.667^{a}	17.853^{a}	6.457^{b}
Vicia Narbonesis	10	96	11.200^{c}	4.0000^{b}	24.000^{a}	6.380^{b}	5.770^{b}
Lelisa	10	96	41.200^{a}	-	-	-	-
SEM	0	0	3.844043	0.745356	3.036811	4.865353	1.767868

^{a,b}Means in a column within the same category having different superscripts differ (P<0.05); - = Absent; ha = Hectare; HI = Harvesting Index; Qun = Quintal and SEM = Standard Error of Means

The analysis of variance shows that there was a significant difference between accessions/varieties of vetch in date of flowering, green forage yield, dry matter yield, date of maturity, seed per pod, pod per stem, seed yield and plant vigor (Table 1 & 2).

Chemical composition (Table 3)

Table 3: Chemical composition and digestibility as influenced by Vetch accessions.

Accessions	Ash	OM	CP	NDF	ADF	ADL	DOMD	Cellulose	Hemi-cellulose
Vicia Vilosa ILRI	6.45	84.29	22.74	42.96	31.18	9.75	66.81	21.43	11.78
Vicia Vilossa Holeta	9.18	84.51	23.18	38.75	29.85	9.61	66.86	20.24	8.9
Vicia Atropurpureum	8.1	84.21	22.12	44.9	31.69	9.63	66.54	22.06	13.21
Vicia Dyscarpa Lana	8.51	84.36	22.18	43.43	31.19	9.48	66.45	21.71	12.24
Vicia Dyscarpa Namoi	8.13	84.51	22.01	44.96	31.67	9.56	66.46	22.11	13.29
Vicia Sativa ICARD 61509	8.56	84.34	22.36	42.9	31.06	9.53	66.54	21.53	11.84
Vicia Sativa ICARD 61744	8.59	84.36	22.4	42.82	31.03	9.54	66.57	21.49	11.79
Mean	8.22	84.37	22.43	42.96	31.01	9.59	66.6	21.42	11.95

ADF = Acid Detergent Fiber; ADL = Acid Detergent Lignin; CP = Crude Protein; CV=Coefficient of Variation; DOMD = In vitro dry matter Digestibility; NDF = Neutral Detergent Fiber and OM = Organic Matter.

Discussion

Yield and yield components

From accessions tested in 2010 summer season, Vicia Sativa ICARD 61744 was significant in date of 50% flowering and seed yield which is not statistically different from Vicia Sativa ICARD 61509 in both parameters and Vicia Atropurpureum in 50% date flowering. Whereas it is significant than the rest accessions at (P<0.05). Regarding maturity, Vicia Vilossa Holeta was late ma-

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tured accession as that of Vicia Vilosa ILRI and Vicia Atropurpureum than the other accessions. Vicia Sativa ICARD 61509 was significant in DMy and it is similar with other accessions except Vicia Dyscarpa Namoi which is less significantly. Vicia Sativa ICARD 61509 was less significant in seed per pod than the rest accessions, Vicia Vilossa Holeta was significant in green forage yield and Vicia Dyscarpa Lana was significant in plant cover than other accessions at (P<0.05).

From vetch varieties/accessions tested in 2011 summer season, Abdeta was significant in seed per pod, seed yield and HI and less significant in green forage yield than the rest varieties/accessions, Gebisa was significant in pod per stem and seed yield and less significant in HI, Vicia narbonesis was significant in date of maturity and pod per stem and less in green forage yield per hectare and HI and Lelisa is significant in green forage yield and late in date of maturity than the rest varieties at (P<0.05) and that is why it is unable to produce seed at that specific area due to long rainy season which causes it to become green throughout.

Chemical composition

From vetch accessions tested in 2011 summer season (Table 3), Vicia villosa Holeta was highest in Ash, OM, CP and DOMD and less in NDF content, Vicia Dyscarpa Namoi was highest in OM, NDF and less in CP content, Vicia Vilosa ILRI was significant in ADL and less in Ash content, Vicia Atropurpureum was significant in ADF and less in OM content, Vicia Dyscarpa Lana was less in DOMD and Vicia Sativa ICARD 61744 was less in ADF content than the rest accessions at (P<0.05). From tested varieties/accessions in 2011(Table 4), Vicia narbonesis was highest in Ash, CP, ADL and DOMD and less in NDF and ADF content, Gebisa was highest in NDF and ADF and less in Ash, CP, ADL and DOMD content, Abdeta was highest in OM and less in CP and is less in OM and ADL content at (P<0.05). The CP content of all accessions were above the average CP content of a feed which is 10.6, but less than the CP content of protein supplement feed which is 32.6. The result is in line with the suggestion of Van Soest [5], which noted the CP content of young herbage to be as high as 14 to 16%. This level of CP is above the recommended minimum level of CP in the diet of ruminants for optimum rumen function [6]. Decrease in NDF content has been associated with increasing digestibility and hence feed intake [5,7]. The NDF content of all accessions were less than the average NDF content of feed which is 56.2. Roughage diets with NDF content of 45-65 and below 45% were generally considered as medium and high-quality feeds, respectively [8]. The NDF percentage of Vetch recorded in this experiment ranged below the 45% value which can be categorized as high-quality feed category. The ADF content of Vetch accessions are in the medium range of quality [9] except Vicia villosa Holeta (29.85%) which is in a high range since legumes with less than 31% ADF value are rated as having superior quality whereas those with values greater than 55% are considered as inferior quality. All Vetch accessions consisted ADL (limits DM intake) value was below 10% which is in a good range [10]. The Cellulose and hemicelluloses contents of all the tested vetch accessions/varieties were below those of most tropical grasses, 31.9% and 35.4% respectively as noted by Moore and Hatfield [11] which categorized the feed under good quality. The DOMD content of all accessions were above the average DOMD content of a feed and protein supplement feeds which is 50.3 and 65.3 respectively. The increase in the DOMD of Vetch accessions is due to an increase in crude protein and decrease in ADF and ADL. The increase in digestibility also will lead to increased feed intake as digestibility and feed intake are positively correlated [5,12].

Table 4: Chemical composition and digestibility as influenced by Vetch varieties.

Variety	DM %	Ash	OM	CP	NDF	ADF	ADL	DOMD	Cellulose	Hemi-Cellulose
Abdeta	93.42	8.82	84.6	21.75	41.72	30.54	9.22	66.11	21.32	11.18
Gebisa	93.27	8.8	84.47	21.75	41.95	30.6	9.19	66.08	21.41	11.35
Vicia Narbonesis	93.5	8.91	84.59	22.1	41.35	30.51	9.33	66.29	21.18	10.84
Lelisa	93.16	8.85	84.31	21.95	41.71	30.53	9.19	66.14	21.34	11.18
Mean	93.28	8.845	84.4925	21.8875	41.6825	30.545	9.2325	66.155	21.3125	11.1375

ADF = Acid Detergent Fiber; ADL = Acid Detergent Lignin; CP = Crude Protein; CV=Coefficient of Variation; DOMD = In vitro dry matter Digestibility; NDF = Neutral Detergent Fiber and OM = Organic Matter

Conclusion

Access to new and improved agricultural technologies especially that of forage is highly limited in Guji zone of Oromia, most probably due to the remoteness from the center and in accessibility of the area. That is why Bore Agricultural Research Center paved the way to adapt and recommend new accessions/varieties of forages to the area. Based on the results obtained from the adaptation and nutritional quality analysis improved Vetch accessions/varieties, Vicia atropurputeum, Vicia villosa Holota, Vicia sativa ICARD61509 and Vicia sativa ICARD61744, in 2010 and Gebisa and Lelisa, in 2011 were selected and recommended to highland of the Guji zone. Therefore, those accessions have to be evaluated under farmers' conditions so as to prove their best performing ability.

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