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Collection and Evaluation of Native Forage Legumes for Feeds in Different Agro-Ecologies of East Shewa Zone of Oromia

Meseret Tilahun*, Nebi Husein, Dawit Abate, Daniel Wana, Genet Dadi

Oromia Agricultural Research Institute, Adami Tulu Agricultural Research Center, Batu, Ethiopia

Email address:

mesereta28@gmail.com (Meseret Tilahun)

*Corresponding author

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Abstract: The activity was undertaken in the East Shewa zone of the Oromia Regional state to collect and identify adaptable and high-yielding native forage legumes for forage production and grazing pasture improvement. The experiment was carried out at the on-station of Adami Tulu Agricultural Research Center. Four native forage legumes (Macroptilium atropurpureum, Neonotonia wightii, Melilotus indicus, and Glycine wightii) were evaluated in a randomized complete block design with three replications. Data from Morphological characteristics (growing habit, life cycle, and flower color), agronomic parameters, herbage dry matter yield, and nutritive values of native forage legumes were collected. The general linear model procedures of SAS and the least significant difference for data analysis and mean separation were employed respectively. The herbage dry matter yield ranged from 1.59-2.66 t/ha. From the evaluated Macroptilium atropurpureum and Neonotonia wightii were slightly higher dry matter yielders (2.66 and 2.31 t/ha), respectively than the others. Lower herbage DM yield (1.59 t/ha) was recorded from Glycine wightii followed by Melilotus indicus (1.68 t/ha). The Crude protein content of native forage legumes ranged from 17.24 to 21.85%. The highest CP concentration was recorded from Glycine wightii (21.86%) while the lowest CP value was obtained from Macroptilium atropurpureum (17.24%). From this study, it is concluded that Macroptilium atropurpureum and Neonotonia wightii were found to be more promising in terms of agronomic traits and herbage DM yield than others. On the other hand, Glycine wightii and Melilotus indicus produced better CP content than the rest. Therefore, it can be concluded that the tested native forage legumes can be popularized as an alternative feed resource under smallholder farmers in the study areas and other places with similar climatic conditions to enhance the production and productivity of animals and environmental aspects.

Keywords: Native Forage Legumes, Herbage, Dry Matter, Crude Protein, East Shewa

1. Introduction

Livestock production donates up to 80 percent of farmers' income in Ethiopia and about 20 percent of agricultural GDP. Ethiopia has the largest livestock population of any country in Africa [1]. Despite the large livestock population in Ethiopia, the production and productivity of livestock are very low due to primarily shortages of quality and quantity of animal feed [7]. Natural pasture is one of the feed resources for livestock. However, the productivity of these feed resources is declining from time to time. Currently, with the rapid increase of human population and increasing demand for food, grazing lands are steadily shrinking being converted to arable lands, and are restricted to areas that have little value or farming potential such as hilltops, swampy areas, roadsides, other marginal lands [10]. Hence, high grazing pressure and expansion of crop production reduced the size of grazing land and overall feed availability, which subsequently reduced productivity in the area. Although supplementation with nutrient-rich agro-industrial by-products cannot be practically achieved under most smallholder farmers' conditions, supplementation with

nitrogen-rich legumes will be the way forward. Thus, increasing livestock production and productivity through the optimization use of sown forages without affecting the environment is very crucial.

In the past, many efforts have been done to generate improved exotic varieties with high nitrogen content and nutritive values. Only a few species that can best suit different agroecology of rift valley were recommended. Evaluation of many legume species from exotic sources has shown little promise for many traits of production and productivity. Forage legumes are considered to be the main sources of fodder and natural pasture land improvement and have a potential for use as forage, soil improvement, and use as green manure and often with non-toxic herbage and successfully grown over widely varying environmental conditions making this a morphologically variable and highly diverse germ 4-plasm resource [9].

However, native forage legumes are declining due to different factors (climate change, overgrazing, fire, and farmland expansion) [6]. Thus, the quality and quantity of natural pasture declined with mismanagement and loss of species composition. In addition, conservation of the native plant diversity plays a great role to maintain the ecosystem in a sustainable way. This clearly indicates that native species of forages might be best explored under their original habitat. This is because they survived for centuries the climatic, edaphic, and grazing pressure of their original habitat. Many reports indicated that Ethiopia is endowed with varied agroecology that further provides habitat for different legume species. However, most of the pasture improvement research undertaken in Ethiopia neglected these native resources and failed to receive similar benefits by selecting appropriately improved cultivars in particular for stressful environments, where the emphasis should be most adaptive and productive species selection [8].

Legumes have a special place with several native crops and economically important species occurring along forest margins and openings, pastures, grasslands, and grazing lands. Several are dual-purpose species for food and feed. Forage legumes are usually of good to excellent nutritive value and can improve the seasonal distribution and nutritive value of grass forage systems. However, in most cases, forage germplasm for improving the grazing pasture is sought from other areas but such exotic seed is often expensive and may not be available. Specific ecotypes of such species are rarely suitable everywhere the species is endemic. At this moment there is scant information regarding native forage legume species on their production potential and nutritive quality under the mid-rift valley condition of Oromia. Hence, collecting species of native species from their habitats that are in a state of flux is important for locating potentially important and unique diversity well adapted to the areas of occurrence. The selection and conservation of legume varieties suited to conventional pasture production systems was considered as a major research strategy option [10]. Thus, the utilization of native forage legumes through collection, evaluation, and selection for sole cropping or in pasture improvement programs is very important. Therefore, this activity was undertaken with the objective to collect and identify native forage legume species with superior dry matter yield and quality for forage production and grazing pasture improvement.

2. Materials and Methods

2.1. Description of the Study Area

The experiment was conducted at Adami Tulu Agricultural Research Center; which is located in the middle rift valley of Ethiopia, 167 kilometers from the capital city of the country, in the Southeastern part of Oromia between 38°20’ and 38.5°5’ E and 7°35’and 8°05’ N. It lies at an altitudinal range from 1500 to 2000 masl [4]. The agro-ecology of Adami Tulu Jido Kombolcha district is semi-arid and sub-humid in which 90% of the area is lowland while the remaining 10% is intermediate with altitude ranges from 1500–2000 masl. The minimum and maximum temperatures are 22 to 28°C, respectively. It has an average annual rainfall of 760 mm. It has a bimodal rainfall from March to April (short rain season) and July to September (long rain season) with a dry period from May to June, which separates short rains from long rain [11].

2.2. Experimental and Activities Procedures

Seed collection of different native forage legumes was carried out from selected districts of east Shewa and west Arsi Zones in October-December of (2018). The collected native forage legumes seed were threshed, cleaned, identified, and stored at ATARC for seed multiplication.

2.3. Treatments and Experimental Design

Following the seed preparation four native forage legumes (*Macroptilium atropurpureum, Neonotonia wightii*, *Glycine wightii,* and *Melilotus indicus*) were laid out in Randomized Complete Block Design (RCBD) with three replications. The experiment was conducted from 2018-2022. The distance between plots and blocks was 1m for each. The gross plot size of the experiment was 2*3 m (6 m^2). All other required agronomic management was done as per the recommendation.

2.4. Data Collection

All-important agronomic, nutritive, and yield data (Plant height, Coverage, *leaflet number,* Leaf to Stem Ratio, and herbage dry matter yield) were collected from the experiment, and feed samples were ground and ready for further chemical analysis. From morphological data like growing habits, life cycle, and flower color were considered and characterized.

2.5. Herbage Dry Matter Determination

The fresh weight of the forage sample from each plot was measured immediately for total biomass yield determination by using a sensitive balance at the field and around 250 g subsample per plot was brought to the ATARC Animal Feed

Resources and Rangeland Management research team laboratory and interred into the oven. The representative subsample was dried in an oven dry at 105°C overnight for total dry matter, Ash, and crude protein determination.

2.6. Chemical Analysis

The dried subsamples were ground to pass through a 1 mm mesh sieve and ready for chemical analyses. Ash was determined by burning with carbolite oven at 550°C for 3 hr. Crude protein (CP) was calculated as N × 6.25 using the Kjeldahl method.

2.7. Statistical Analyses

Agronomic and yield data were analyzed using analysis of variance following the general linear model procedure of SAS, version 9.1. Means were separated using the Least Significant Difference (LSD) at a 5% significant level.

3. Results and Discussions

Morphological characteristics, agronomic and yield parameters, and nutritive values of native forage legumes are indicated in the following table 1, 2, and 3, respectively.

3.1. Morphological Characteristics of Native Forage Legumes

The collected native forage legumes were characterized by some morphological parameters like: Growing habits, life cycle, and flower color. Accordingly, *Macroptilium atropurpureum*, *Neonotonia wightii,* and *Glycine wightii* were characterized as a climber in growth habit and perennial in the life cycle, while *Melilotus indicus* was categorized as erected in growth habit and annual in the life cycle. Concerning the flower color all the tested native forage legumes were different as shown in Table 1.

Table 1. *Morphological attributes of native forage legumes.*

No	Scientific name	Growing habit	Life cycle	Flower color
1	*Macroptilium atropurpureum*	climber	perennial	brown
2	*Neonotonia wightii*	climber	perennial	pink
3	*Glycine wightii*	climber	perennial	white
4	*Melilotus indicus*	erected	Annual	yellow

Herbage dry matter yield and other Agronomic parameters

Table 2. *Mean performance of forage yield (t/ha) and yield-related components of native forage legumes ATARC in year.*

No	Scientific name	PH	Cover	Brach No/plant	LLNo	HDM t/ha	LSR
1	*Macroptilium atropurpureum*	123.89±23.30	94.67±2.60	12.45±2.39	6.78±1.47	2.66±0.05	9.85±0.46
2	*Neonotonia wightii*	93.89±24.92	98.00±9.07	15.67±3.10	9.78±2.51	2.31±0.13	9.39±0.23
3	*Glycine wightii*	94.44±7.91	89.00±4.58	31.78±19.15	6.78±1.28	1.59±0.13	3.19±1.26
4	*Melilotus indicus*	94.33±6.31	86.00±8.08	21.00±4.21	11.78±2.11	1.68±0.32	3.31±0.05

PH=plant height, LLNo=leaflet number, HDM=herbage dry matter, LSR=leaf steam ratio

The combined mean of plant height, *leaflet number, herbage dry matter, Leaf to steam ratio,* and plot coverage of native forage legumes was stated in Table 2. The plant height of native legumes collected ranges from 94-124cm. It is climbers morphologically. The highest mean value was recorded from *Macroptilium atropurpureum* (123.89 cm) followed by *Glycine wightii* (94.44 cm), while the lowest was achieved from *Neonotonia wightii* (93.89 cm). Similar trends have appeared on herbage dry matter yields of the tested native forage legumes in which the highest herbage dry matter yield was recorded from *Macroptilium atropurpureum* (2.66 t/ha) followed by *Glycine wightii (2.31 t/ha), whereas the* lowest was obtained from *Neonotonia wightii* (1.5 t/ha). The mean plot coverage of native forage legumes was more than 85 percent. This indicated that the collected native forage legumes were highly performing in the tested environment. Generally, from the collected native forage legumes *Macroptilium atropurpureum* and *Glycine wightii* were shown the best performances in plant height, plot cover, leaf-to-steam ratio, and herbage dry matter yield as compared to the other tested materials. This refers to naturalized legumes are usually very well adapted to the areas in which they grow, and may contribute significant quantities of nitrogen to pasture systems, enhancing overall pasture productivity and quality [10].

3.2. Chemical Composition

Table 3. *Chemical composition of native forage legumes tested at ATARC.*

No	Native collection	Ash	OM	CP
1	*Macroptilium atropurpureum*	11.83±0.61	74.77±0.81	17.24±1.69
2	*Neonotonia wightii*	12.83±2.65	73.70±0.95	18.90±1.07
3	*Melilotus indicus*	8.40±1.71	78.53±1.42	19.61±5.67
4	*Glycine wightii*	12.03±3.29	79.78±4.62	21.86±2.38

OM=Organic matter, CP=crude protein

The Nutritive value of the evaluated native forage legumes is presented on the above (Table 3). The Ash, OM, and CP results were characterized and have high crude protein content. The crude protein content of native forage legumes ranged from 17.24 to 21.85%. The highest CP content was recorded from *Glycine wightii* (21.86%) while the lowest CP value was obtained from *Macroptilium atropurpureum* (17.24%). The present finding is higher than some of the

herbs and lower than the mean CP value reported by (Gete and Gemedo) (2.71- 22.33%) for Some Native Forage Species in Tikur Incinni District [5]. This might be due to different agroecology and variability of the species. On the other hand, higher Ash concentration was recorded from *Neonotonia wightii* (12.83%) followed by *Glycine wightii* (12.03%). These native forage legumes have high dry matter and nutritive values. Therefore, conservation and introduction to grazing land are important to improve the composition of grazing land. There are a wide variety of pasture legumes that are naturalized in pasture systems, and that contribute to overall pasture and animal productivity [2]. Native plants are often promoted for gardening, biodiversity conservation and ecological restoration. Native plant gardening can contribute to environmental sustainability by conserving water and creating biologically diverse habitat [3].

4. Conclusions and Recommendations

The Collection of native forage legumes was conducted from different agroecologies of the East Shewa zone of Oroma. Out of the collected materials, four native forage legumes (*Macroptilium atropurpureum*, *Neonotonia wightii, Melilotus indicus, and Glycine wightii)* were evaluated at Adami Tulu Agricultural Research Center from 2018-2022. Based on the result, *Macroptilium atropurpureum* is the best native forage legume followed by *Neonotonia wightii* in dry matter yield and *Glycine wightii* is the best in crude protein content followed by *Melilotus indicus*. Hence, it can be concluded that the tested native forage legumes should be recommended to farmers of ATJK District and of similar climatic conditions in order to enhance the production and productivity of animals and environmental aspects.

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