

Phenological characteristics and nutritive value of Three forage legumes as being influenced by plant species and soil type under rainfed conditions

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SUMMARY

Three forage legumes, namely cowpea [*Vigna unguiculata* (L.) Walp], clitoria (*clitoria ternata*, L.) and pigeon pea [*Cajanus cajan* (L.) Millsp], were planted in three rows at two locations of different soil types, namely loamy and clay soils, under rainfed conditions. The objective was to study the effect of soil type on the morphological characteristics and nutritive value of these species. The experimental design used was 2×3 split plot with four replications.

Cowpea showed the lowest number of days to maturity followed by pigeon pea and clitoria. A similar trend was observed for fresh and dry matter yields per feddan (1 fed = 0.42 ha). Cowpea gave also the highest in vitro digestibility. Hundred seed weight differed between the three species. Generally, plants grown on loamy soil had better morphology and nutritional value as well as higher yields than those grown on clay soil.

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INTRODUCTION

Legume species grown in the semi-arid areas of the tropics are an important source of protein for animals during the dry season. Among these species are cowpea [(L.) Walp], clitoria (L.) and pigeon pea [(L.) Millsp]. In the Sudan, these legumes are grown along the river bank and in irrigated schemes for a dual purpose i.e. grains for human consumption and fodder for livestock.

Dry and fresh yields of legumes are usually lower than those of grasses, but higher yielding perennial legumes can give up to twelve or more tons of dry matter per year (in several cuts) under irrigated systems (Singh and Kush, 1980). The yield of forage depends on the species, variety and soil fertility. Pigeon pea has such plasticity that even in drought years it is capable of producing some yield (Pathak, 1970). Because of this plasticity pigeon pea fits into intercropping systems as fodder (Saxena and Yadav, 1975). Cowpea of short duration, can fit well in crop rotation and can grow throughout the year. It can be mixed with grasses and did best on loamy soils with rainfall of 300-500 mm per year (Rachie and Reperts, 1974).

Different species of legumes differ greatly in fresh and dry matter yields (Patel et al., 1977). Clitoria has the lowest yield among other legumes, however, it is a drought resistant perennial suitable for conditions of water scarcity. It has a very extensive and efficient root system and can withstand water logging (Gafar and Makki, 1989).

Extensive livestock production under traditional communal grazing system is widely practiced under semi-arid conditions of the Sudan. Introduction of legumes to native pasture increases

animal production (Preston and Leng, 1987), as was demonstrated in several experiments with sheep and goats (Mtenga and Niyaky, 1985). Therefore, the present study was carried out with the objective of assessing the nutritional value of some forage legumes that could be used as supplement for small ruminants during the dry season.

MATERIALS AND METHODS

Area of Study :

The area of study is located in Western Sudan, Kordofan region under rainfed conditions. Two locations were selected as to represent two types of soils. These were:

- Khor Abeid, Sheikan Province, north Kordofan. Here the type of soil is loamy, situated between Wadis (lowlands) and Khors (valleys) which usually receives seasonal streams that carry silt thus contributing to soil fertility. Thus the soil in location could be described as having batches of sandy clay and loams Rainfall received at this site during the course of the study was 425 mm, the highest being in September (147 mm) and the lowest in October (82 mm).
- Angarko (Dilling), located at south Kordofan. The type of soil in this area is characterized as being dark craking clays. Here total amount of rainfall received was 44 mm, the highest was in July (219 mm) while no rainfall occurred in October. At both locations, temperatures are generally high during most of the year (33 — 40 °C). Soil characteristics at both locations is shown in Table 1.

Three legume species (cowpea, clitoria and pigeon pea) were planted in the two soil types. The experimental design was 2×3 split plot design with four replications, the locations were the main plots and legume species occupied the subplots. In each location, sowing was done in three plots (5×5 m each) during July and August (1996). Sowing was done by hand and the seed rate was 2-3 seeds per hole at 50 cm inter- and intra-row spacing. Weeding was done twice, namely 23 and 30 days after planting. Harvesting was done manually in November carried out when all plants reached physiological maturity.

Data for each plant species at the two locations were recorded for the following parameters:-

- Days to germination.
- Days to 50% germination.
- Days to flowering.
- Days to 50% flowering.
- Days to pod formation.
- Days to 50% pod formation.
- Days to harvest.
- Plant height.
- Number of leaves per plant.
- Number of pods per plant.
- Number of seeds per plant.
- Number of seeds per pod.
- Hundred seed weight.
- Fresh and dry matter yield.

A quadrat 1 x 1 m was used to collect 20 random plant samples for measurement of the above parameters. Plant height was measured in centimetres at 15 days intervals after planting up to 75

days. Number of leaves per plant measurements were done at 15, 30, 45, 60 and 75 days after planting. Number of pods per plant was counted twice at 15 days intervals. At harvest ten plants were selected randomly from each plot and the seeds per pod were counted and an average for each location was calculated. Hundred seed weight was done by separating whole seeds from any damaged seeds and trash then subsamples of not less than 50g were dried in an oven at 102 °C. The samples were cooled and the dry weight of whole seeds were divided by their numbers and multiplied by hundred (A.A.M., 1981). Fresh yield was determined by weighing the harvested plants for each plot separately and the average yield per feddan was calculated. Dry matter yield was determined by drying plant samples in an oven at 105 °C over night until a constant weight was obtained. **Chemical analysis and in vitro digestibility :**

The plant collected at harvest from each plant at each location were air dried and mixed separately. From each sample, .500g were taken, dried at 80 °C to a constant weight and ground for chemical analysis and in vitro digestibility. Dry matter (DM), organic matter (OM), crude protein (CP), metabolizable energy (ME) and ash were determined as described by (AOAC, 1980). Acid detergent fiber (ADF) and neutral detergent fiber (NDF) were determined according to Van Soest (1982). In vitro dry matter digestibility (IVDMD) and in vitro organic matter digestibility (IVOMD) were carried out as described by Tilly and Terry (1963). Digestible crude protein (DCP) was estimated by the following equation:

$$\% \text{ CP} = (\% \text{ CP} \times 0.9115) - 3.67.$$

RESULTS

Germination, flowering and pod formation :

Table 2. presents the performance of the three forage legumes on the two soil types at the two locations. The effects of location and the differences among the three plant species were significant for all parameters except days to germination and days to harvest. Cowpea

required the least ($P < 0.05$) number of days to germination, days to flowering and days to pod formation on either loamy or soil. Pigeon pea, on the other hand, required the longest ($P < 0.01$) period to 50% pod formation and to ia both locations. The three species needed more time to harvest on to imy soil than on clay soil. Interaction of species and location was highly significant ($P < 0.01$) for all parameters except days to germination and days to harvest.

Number of leaves per plant :

The differences among the three species and between the two locations on number of leaves per plant is shown in Table 3. Clitoria had the highest ($P < 0.01$) number of leaves per plant at 15 days after planting (DAP) on either loamy or clay soil, whereas cowpea had the highest ($P < 0.01$) counts at 30 DAP, 45 DAP and 60 DAP on loamy soil. On the clay soil, clitoria showed the highest ($P < 0.01$) count at 45 DAP, 60 DAP and 75 DAP. Number of leaves were more ($P < 0.01$) in legumes grown on clay than those grown on loamy soil, However, cowpea showed less ($P < 0.01$) leaves count in clay soil at 45 DAP, 60 DAP and 75 DAP. Effect of either location or interaction of location and plant species were not significant at 30 DAP. only. **Plant height :**

Difference among the species and between the two locations were significant ($P < 0.01$) throughout the period of study (Table 4), except at 30 DAP for location and at 75 DAP for

interaction. Cowpea was the tallest ($P < 0.01$) on loamy soil except at 15 DAP and 30 DAP, while clitoria was the tallest ($P < 0.01$) on clay soil at 15 DAP and 30 DAP. Plants grown on loamy soil were generally taller ($P < 0.01$) than when grown on clay soil.

Number of pods, seeds and 100 seed weight :

Table 5 summaries the data on number of pods per plant, number of seeds per pods and hundred seed weight. Cowpea had the highest ($P < 0.01$) number of pods per plant on loamy soil, whereas on clay soil clitoria had the highest ($P < 0.01$) count. Cowpea had the highest ($P < 0.01$) number of seeds per pod and highest hundred seed weight on both loamy and clay soils. Loamy soil gave higher ($P < 0.01$) pod and seed counts as well as higher ($P < 0.01$) hundred seed weight than clay soil. Interaction of species and location was significant ($P < 0.01$) for all parameters except the second pod count.

Fresh and dry matter forage yields :

Table 6 depicts the yield of the three forage legumes in terms of fresh and dry weight in tons per feddan. Cowpea had the highest ($P < 0.01$) fresh yield on loamy and clay soils. Clitoria had the lowest ($P < 0.01$) fresh yield on loamy than the clay soil.

Chemical composition and in vitro digestibility :

The differences between the two locations among the three forage species in the chemical composition and in vitro digestibility for are shown in Table 7. OM was the highest ($P < 0.05$) in clitoria on clay soil, while cowpea had the highest ($P < 0.01$) ash content. Pigeon pea had the highest ($P < 0.05$) NDF and ADF on loamy soil, whereas on clay soil clitoria shown the highest ($P < 0.01$) NDF and ADF. Generally legumes grown on loamy soil had higher chemical composition than when grown on clay soil in term of crude protein and metabolizable energy. Clitoria showed the highest ($P < 0.01$) DCP on both loamy and clay soils and the highest ($P < 0.01$) DE and ME on clay soil. Cowpea showed the highest ($P < 0.01$) IVDMD on both loamy and clay soil and highest ($P < 0.01$) IVOMD on loamy soil alone. On clay soil, clitoria showed the highest ($P < 0.01$) IVOMD.

Interaction between species and location was significant ($P < 0.01$) for all the above parameters.

DISCUSSION

No significant differences were obtained among the three legume species in the number of days to the start of germination . However, clitoria required more days to germinate than the other two species. Similar observations were indicated by Gafar and Makki (1989). Cowpea showed the shortest duration to flowering and pod formation, while pigeon pea took the longest. This could be attributed to the quick growth rate of cowpea and its ability to complete with weeds. Similar findings were obtained by NG and Marechal (1985). Pigeon pea had a slow growth rate and was more susceptible to insects attack. Also, Bindra (1968) observed heavy damage of the foliage and flowers of pigeon pea due to insects infestation.

Cowpea gave the highest hundred seed weight followed by pigeon pea and clitoria. Similar results were obtained by El Hag (1993). Cowpea also gave the highest fresh and dry matter yields, while clitoria gave the lowest. Similar findings were obtained by Al Awad et al. (1994).

According to Van Soest (1982), NDF comprises the bulky components of the feeds and, hence, is negatively correlated with total dry matter and energy intakes. ADF contains the least digestible fragments of cell walls and, therefore, used to predict energy contents of forage. In this study, ME and DE were seemed to be negatively correlated with NDF and ADF.

Similar results were observed for *in vitro* digestibility. In this respect, one could say that cowpea had the best potential digestibility followed by pigeon pea and clitoria.

Generally, plants grown on loamy soils had better morphology; they were taller and had higher number of pods per plant, 100 seed weight and dry matter yield. Better still, they had less NDF and ADF

than those grown on clay soils. This could be attributed to soil quality and distribution of precipitation throughout rainy season.

It could be concluded that plant species and soil type as well as their interaction could greatly influence the phenology and nutritive value of forage legumes in rainfed areas.

Table 1. Some selected properties of the different soil types in the area of study.

Table 3. Main effects of soil type and forage legume species on number of leaves per plant.

Table 4. Main effects of soil type and forage species on plant height.

Table 5. Main effects of soil type and forage legume species on number of pods per plant, number of seeds per pod and hundred seed weight.

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