

Forage yield potentials of three legumes under irrigation in the Sudan.

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SUMMARY

An experiment was conducted for three seasons to compare the forage yields of lubia, *Lablab Purpureus* (L), clitoria, *Clitoria ternatae* (L) and phillipesara, *Vigna trilobata* (WAIP) using eight destructive harvests. The first harvest was at 42 days after emergence and the subsequent harvests were at 14-days interval. The mean yields of phillipesara in the individual harvests, across all harvests and in the maximum yield were higher than those of lubia and clitoria. The higher dry matter yield of phillipesara paralleled higher leaf area index (I AI). The earliness in attaining the maximum yield were in the order : phillipesara, clitoria and lubia.

INTRODUCTION

The increasing interest of integrating livestock in the irrigated schemes in the Sudan, necessitates growing of suitable forage crops within the crop rotations of those schemes. Under the intensive cropping systems practised in most of those schemes, forage legumes would be more appropriate as they will improve the soil fertility by nitrogen fixation.

Lubia, clitoria and phillipesara are the most successful forage legumes in the irrigated schemes in the Sudan. Previous studies pertaining to the agronomy of these crops included rotational advantages (Musa and Burhan, 1974), seed rate and nitrogen fertilization (Ishag and Khair, 1975, unpublished; Khair, 1987), harvesting heights (Osman and Abu Deik, 1982; Khair, 1990).

In this study, each of lubia, clitoria and phillipesara were grown in large subplots. Eight destructive harvests, were then randomly taken throughout the growth periods. The main objectives were to compare the dry forage yields of the three species in individual harvests, their maximum yields and the time taken to reach these maximum yields.

MATERIALS AND METHODS

The study was conducted in the Gezira Research Station farm, Wad Medani for three seasons from July to December of 1987, 88 and 89. The meteorological data pertaining to the growing periods are shown in Table 1.

The treatments comprised three legume species viz lubia, clitoria and phillipesara and eight harvesting dates. The three species were sown at their optimum seed rates sown on 60 cm apart ridges. those were 48 kg/ha for lubia (Khair, 1987) (two seeds per 15 cm apart holes), and 12 kg/ha for both clitoria and phillipesara (Ishag and Khair 1975, unpublished) drilled on the top of

the ridges. Irrigation was applied every 14 days. The experimental design was randomized complete block and replicated four times. The subplots size was 12 X 6 m.

Each subplot was divided into eight 3 m² harvest areas with guard areas around the whole subplot as well as between the harvest areas. Harvest 1 was taken 42 days after emergence (DAE) and subsequent harvests were at 14-day intervals. In each harvest, the phenological stage of each crop was recorded and all plants in the whole harvest area were destructively harvested from the ground level. At each harvest, fresh material was weighed in the field. Sub samples of known fresh weight were oven dried at 70-80 °C for 48 hours to constant weight for dry matter determination. Further sub samples were taken and separated into leaves, stem and reproductive organs for the determination of leaf/shoot and pod/shoot ratios. For the measurement of the leaf area, 50 leaves of the sub sample of each species in each harvest were punctured using a disc of known area. The 50 leaf disc were oven dried. The ratio of leaf area / leaf weight was then calculated using the dry matter and leaf area of the 50 leaf discs. The leaf area index LAI of each harvest area was finally calculated as: $LAI = DM \times \text{leaf/shoot} \times \text{leaf area} / \text{leaf weight} \times 1 / \text{harvest area}$

For both dry matter and leaf area indices, the whole data for each season were analyzed as split plot design. The species were considered as main plots and harvests as subplots. Further polynomial regressions were performed to determine the regression of each of the dry matter and the leaf area index on the harvest times.

RESULTS

Seasonal Conditions:

The mean monthly maximum temperatures, in most part of 1988/89 season were lower while the total rainfall in the same season was higher than the other two season (Table 1). With respect to rainfall distribution, the

amounts received in July and August of 1988/89 were higher than those received in the same months of the other two seasons.

Phenology:

Clitoria was exclusively the earliest in flowering and podding in the three seasons. However started 42 DAE and continued until the end of the growing season. Podding on the other hand started 28 days after the beginning of the flowering and by harvest 4 (98 DAE), the pods constituted 16% of the total dry matter.

In 1989/90, phillipesara started flowering as early as 42 DAE. In the other two seasons, flowering had started in 70 DAE. In the three seasons, however it continued to flower sporadically throughout the season till it reached flowering peak by late November. Podding started 48 DAE and progressed till it reached the peak of maturity by late December.

In a sharp contrast, Lubia in all seasons started flowering in November and podding started in early December.

Leaf Area Index (LAI):

The mean LAI of the three species increased progressively with time during early growth period then declined and increased again towards late growth periods (Table 2 and 5). The initial decline in clitoria and phillipesara was slightly earlier in 1988/89 (i.e. > 70 DAE) compared to other seasons. Exception to 1988/89 season, the initial decline in lubia occurred 84 DAE. I

Quadratic relationships were found when the LAI of each of phillipesara and clitoria were regressed on the time of harvest ($P < 0.05$) (Fig. 1). The change in LAI of phillipesara with time is described by equation $Y = -3.24 + 0.167 X + 0.0009 X^2$. That of clitoria is described by the equation $Y = 3.2905 + 0.1293 X - 0.000646 X^2$

where $Y = \text{LAI}$ and $X = \text{days after emergence}$. No specific trend was however, observed when the LAI of lubia was regressed on time. Phillipesara and lubia had invariably high mean seasonal LAI than clitoria over all harvests (Table 3). In relation to the specific harvests, phillipesara scored the highest LAI followed by Lubia and clitoria. The maximum values (mean over the three seasons) for phillipesara, Lubia and clitoria were 5.2, 4.5 and 4.2 respectively.

Dry Matter Yield:

The differences among the species in relation to the dry matter yields were manifested in several ways. Such differences were observed in the individual harvests (Table 4) and in the mean seasonal yield (average over the eight harvests) (Table 3).

Dry matter yield values in the three seasons, (means across three species) (Table 5) followed a similar trend to that of LAI except that the ranking order of the values noted during the early harvests remained unchanged throughout the growing season. In general, the seasonal mean yield of clitoria and lubia were invariably **lower** than that of phillipesara (Table 3).

Regression of mean dry matter yields on the DAE revealed a quadratic relation of dry matter with DAL for each of phillipesara and clitoria ($P < 0.05$) (Fig. 2). That of 'tibia was a linear relationship. The dry matter yield of phillipesara was best described by the equation of $Y = -6.0956 + 0.2165 x + 0.000942 x^2$. That of clitoria is described by $Y = -5.1943 + 0.15078 x + 0.000513 x^2$, and for lubia $Y = 0.413 + 0.0409 x$, where $Y = \text{dry matter t/ha}$ and $x = \text{DAE}$.

DISCUSSION

The maximum forage yields, of the three species in this study are quite comparable to that of Abu Sabeen, a popular forage sorghum long known in the Sudan (Kambal, 1972), and to some temperate forage legumes (Abd El moneim et al., 1990). In addition, the three species are also known for their high forage quality (Osman and Abu Deik, 1982).

The generally better performance of phillipesara in individual harvests, maximum yield or seasonal mean over clitoria and labia is in agreement with earlier findings (Musa and Burhan, 1974) and over clitoria alone (Ishag and Khair 1975, unpublished).

Phillipesara and clitoria attained maximum yields earlier than lubia in the last two seasons. Even in 1987, 92% and 97% of their maximum dry matter yields had been accumulated 98 and 112 DAE respectively. The earliness in both species has some advantages. First, they could be planted in July and harvested in late October or early November. Such growing period in the Gezira is characterized by a non limiting supply of irrigation water. Secondly, from the phenological point of view, the period between mid November through December coincides with maximum pod maturity. As the pods of the two species are highly shattering, harvesting them during late October to early November would minimize the hazards of pod shattering as a source of weeds in the succeeding crop.

The higher yields obtained in 1988/89 over the other two seasons could be attributed to the higher total rainfall accompanied with lower maximum temperatures during most of the growing period in that season.. Earlier reports indicated that the highest yields of lubia and clitoria were found when grown in areas with 750 and 1500 mm of rainfall respectively (Skerman et al; 1988).

The dry matter production whether as seasonal values or for species were highly associated with LAI similar to those found in temperate legumes (Abd-El moneim et al., 1990).

From the results of this study, it could be concluded that the yields obtained by these species compared closely with that of forage sorghum. The

yields of phillipesara were higher than those of lubia or clitoria. Growing of both phillipesara and clitoria in July and harvesting them by late October -early November, evade shortage of irrigation water and the hazard of pod shattering as a source of weeds.

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