SEASONAL CHANGES IN NITROGEN AND PHOSPHORUS CONCENTRATIONS AND *IN VITRO* DIGESTIBILITY OF *STYLOSANTHES* SPECIES AND *CENTROSEMA PUBESCENS*

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ABSTRACT

Changes in the N and P concentrations in the herbage of Stylosanthes guianensis, S. scabra *and* Centrosema pubescens *from fertilized swards cut at approximately four-weekly intervals were measured over a three year period.* C. pubescens *generally had the highest N concentrations (2.5–3.8%) and* S. scabra *the lowest (1.7–3.0%). Lowest N concentrations generally occurred in December-January. The concentration increased later in the growing season and then declined at the end of the season. Changes in P concentrations followed a similar trend but the differences between species were smaller.*

In another experiment changes in the N and P concentrations and in vitro *dry matter digestibility were measured in leaf and stem fractions of unmown* S. guianensis, S. scabra *and* S. viscosa *plants. N concentration and digestibility were less in stems than in leaves at the same age. The P concentration in stems was similar to or greater than that in leaves for young material, but it was always less with older material. All values decreased with age. In leaves, the mean N concentration fell from 3.3 to 2.3%, P concentration from 0.32 to 0.12% and digestibility from 71.6 to 60.3% between the first and last samplings. In stems the corresponding changes were 1.8 to 1.0%, 0.35 to 0.06%, and 51.9 to 36.7%.*

INTRODUCTION

The genus *Stylosanthes* contains a number of valuable legumes for tropical pastures. At present, there are commercial cultivars available in four species (*S. guianensis, S. hamata, S. humilis* and *S. scabra*) and a number of other species are showing promise in current evaluation studies. However, there is very little published information on the nutritive value of *Stylosanthes* species or changes in nutritive value throughout the year. This latter factor is extremely important in tropical areas where inadequate dry season nutrition frequently results in severe liveweight losses in grazing cattle. This paper reports seasonal changes in the nitrogen and phosphorus concentrations and *in vitro* digestibility of three *Stylosanthes* species. Data from another legume species, *Centrosema pubescens* has been included for comparison.

MATERIALS AND METHODS

The plant material analysed was obtained from two experiments conducted near Ingham (18.6° S, 148.7° E) in north Queensland.

Experiment 1

This experiment was conducted at Bambaroo approximately 30 km south of Ingham and the full details of the experiment have been published elsewhere (McIvor 1978). Briefly, legume accessions were grown with either *Brachiaria decumbens* or *Panicum maximum* and the plots mown to 10 cm every 4, 8, 12 or 16 weeks for three years. The soil was a solodic (Dy 3.41, Northcote 1971). An initial fertilizer dressing of 200 kg ha^{-1} superphosphate plus molybdenum, 100 kg ha^{-1} potassium sulphate,

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10 kg ha^{-1} copper sulphate and 10 kg ha^{-1} zinc sulphate was applied at sowing (January 23, 1973) with further annual applications of 200 kg ha^{-1} superphosphate. This annual application was made in March or April when the cutting treatments were all mown on the same date. Samples of four accessions were analyzed— *Stylosanthes guianensis* cv. Cook and C.P.I. 40294, *S. scabra* cv. Seca and *Centrosema pubescens*. The material consisted of complete plant tops cut 10 cm above ground level every four weeks.

Experiment 2

Four accessions were sampled—*S. guianensis* cv. Cook, and C.P.I. 40294, *S. scabra* cv. Seca and *S. viscosa* CPI 34904. The plant material was collected from pure undefoliated swards grown on a solodic soil (Dy 3.3, Northcote 1971) at Abergowrie (40 km west of Ingham). The experiment was sown on January 24, 1973 using 5 kg ha^{-1} of inoculated seed. A fertilizer dressing of 400 kg ha^{-1} superphosphate, 200 kg ha^{-1} potassium sulphate, 10 kg ha^{-1} copper sulphate, 10 kg ha^{-1} zinc sulphate and 200 g ha^{-1} sodium molybdate was applied at sowing. Whole plants were cut at ground level on seven occasions between sowing and the end of the dry season in September 1973 when rain stimulated new growth. The herbage was divided into leaf, stem and inflorescence then bulked over replicates for analysis.

Analyses

The whole plant samples from Experiment 1 and the plant components from Experiment 2 were analyzed for nitrogen and phosphorus concentration. In addition, the dry matter digestibility of the samples from Experiment 2 was estimated by the *in vitro* technique standardized with samples of known *in vivo* digestibility (Minson and McLeod 1972). Due to the bulking of replicates, no statistical analyses were made of the data from Experiment 2.

RESULTS

Experiment 1

Associate grass species had no significant effect on the nitrogen or phosphorus concentrations in the legumes, so mean values are presented in Figure 1. There were large differences in the concentrations of both elements between species and between sampling dates. On most occasions, nitrogen concentration was highest in *C. pubescens* and lowest in *S. scabra* but the differences were not always statistically significant. The pattern of change was generally similar from year to year with lowest concentrations occurring in December-January and highest concentrations later in the growing season, followed by a decline at the last harvests of the season. Phosphorus concentrations followed a similar trend (the correlation co-efficients between nitrogen and phosphorus concentrations ranged from 0.67 to 0.83) although the relative differences between species were generally smaller than those for nitrogen concentration.

Experiment 2

Weekly rainfall and changes in the percentage leaf, nitrogen and phosphorus concentrations, and digestibilities are shown in Figure 2. The proportion of leaf in the herbage declined from approximately 80% in young material to 25% in old material. Stems had lower digestibilities and nitrogen concentrations than leaves for all accessions at all sampling dates. However, stem phosphorus levels were similar to, or greater than, leaf phosphorus levels at the first sampling although they were lower at subsequent samplings. Inflorescence nitrogen and phosphorus levels (not shown) were greater than those of leaves for all species except for the nitrogen values of the two *S. guianensis* accessions which were intermediate between those of leaf and stem. The nitrogen and phosphorus concentrations in leaves and stems of all accessions decreased over the sampling period. The leaves of the *S. guianensis* accessions always

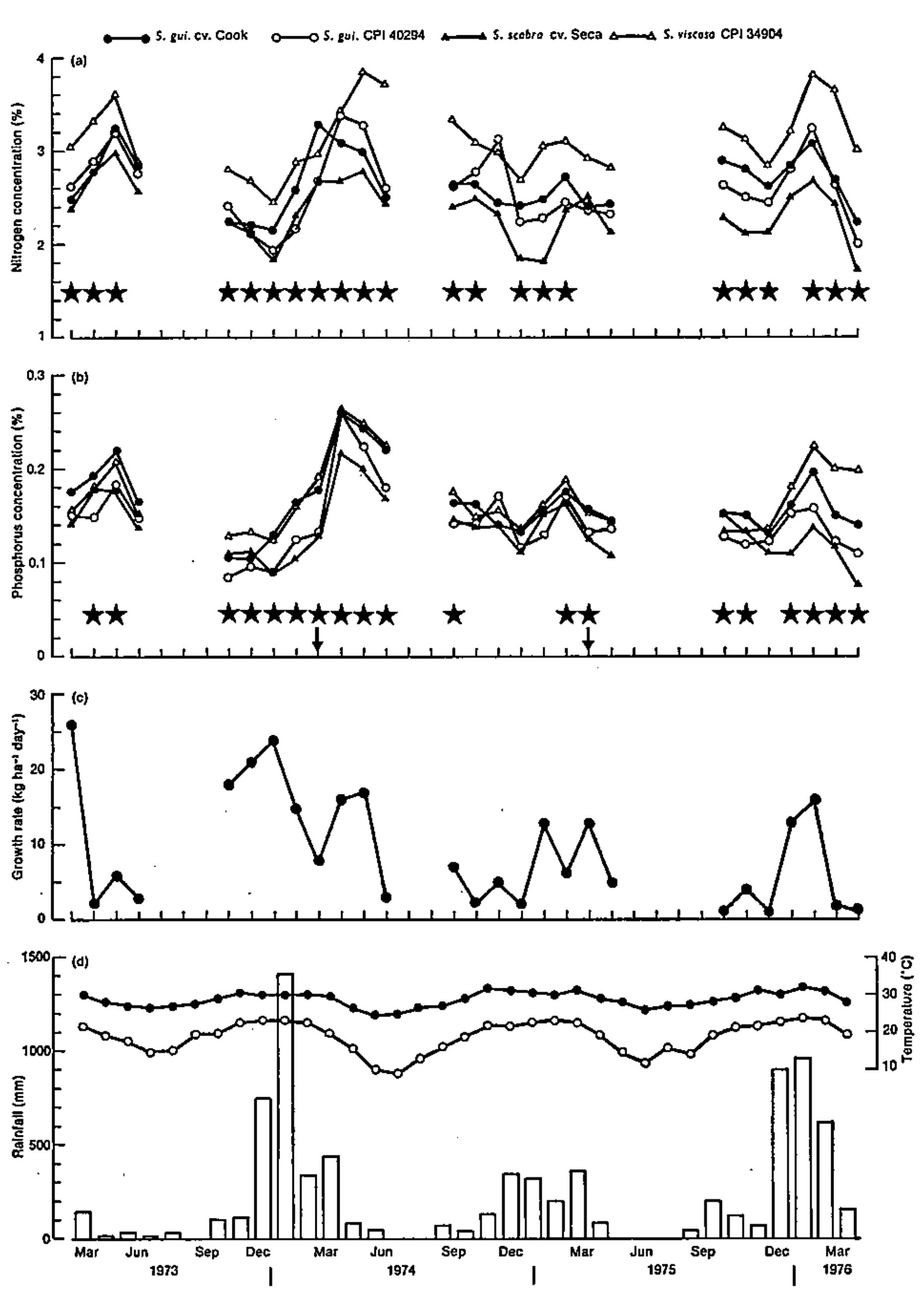

FIGURE 1

Seasonal changes in (a) nitrogen concentration, (b) phosphorus concentration, (c) mean legume growth rate and (d) monthly rainfall (columns) and maximum (●——●) and minimum (O——O) temperatures. Significant differences ($P < 0.05$) are shown by a star (★). The arrows in (b) indicate the date of application of superphosphate.

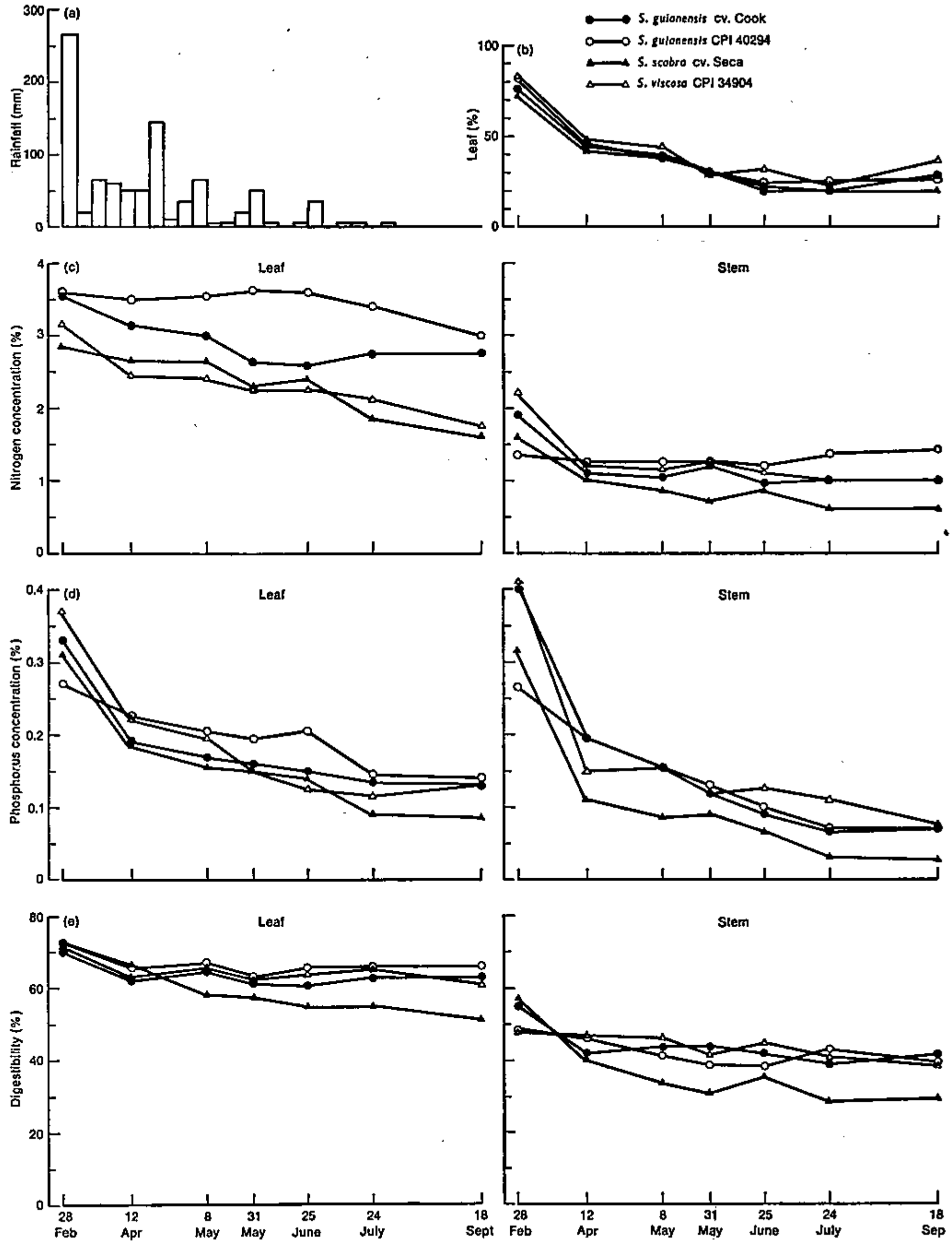

FIGURE 2

(a) Weekly rainfall, and changes in (b) percentage leaf, (c) nitrogen, and (d) phosphorus concentrations, and (e) digestibility of leaf and stem of four *Stylosanthes* species.

had higher nitrogen contents than those of *S. scabra* and *S. viscosa,* but apart from the lower nitrogen and phosphorus levels in *S. scabra* stems after the first sampling there were no other consistent differences between species. Although the digestibility of both components decreased during the season, the decrease in the leaf component was small except for *S. scabra*. Inflorescence digestibilities were similar to those of leaves in each species.

DISCUSSION

Although the value of these species can only be determined by measuring their effect on animal production under various conditions, these results suggest they may make a valuable contribution to the diet of animals. The herbage harvested from the regularly mown swards (Experiment 1) usually contained more than 2% nitrogen (12.5% crude protein) which is well above the level where nitrogen deficiencies may limit intake (6.0–8.5% crude protein, Minson 1971). In the undefoliated swards the leaves of all species were always above this critical range but the stems were within (or below for *S. scabra*) this range after the first sampling. If animals are grazing young herbage or sufficient mature herbage is available to allow them to select adequate amounts of leaf from stems and less nutritious species, these levels of nitrogen appear adequate to support growth of cattle.

It is difficult to determine whether the phosphorus concentrations are adequate since the critical phosphorus level for animal production will depend on the type of stock, the level of production, the physiological state of the animal, the herbage intake and the availability of the phosphorus to the animal. Based on the phosphorus requirements published by the Agricultural Research Council (1965) the phosphorus levels may be inadequate for cattle nutrition in some circumstances.

In legumes, the general pattern of change in digestibility with maturity is for a small decrease in the leaf component and a larger decrease in the stem component with the rate of change varying between species (Raymond 1969). The *in vitro* digestibility values reported here fit this pattern although the decrease for *S. scabra* leaves was relatively large and those for *S. guianensis* CPI 40294 and *S. viscosa* stems relatively small.

When the values for nitrogen and phosphorus concentrations and digestibility measured in these two experiments are considered together, the nutritive value of *S. scabra* was generally lower than that of *S. guianensis*. Since *S. guianensis* is more productive than *S. scabra* in this environment (McIvor 1978), *S. scabra* will generally be of less value in this locality. However *S. scabra* has the ability to produce high herbage yields over a wide climatic range in drier areas where it should be able to make a valuable contribution to animal nutrition.

Fisher (1969, 1970) included changes in nitrogen and phosphorus concentrations in a study of the growth of *S. humilis* in fertilized, unmown swards at Katherine. Except for an early, rapid decline in nitrogen concentration of leaves he found similar changes during the growing season to those in Experiment 2. The nitrogen concentrations in leaves and stems of *S. humilis* during the latter part of the growing season were within the range of values for the *Stylosanthes* species in my experiment but the phosphorus concentrations were lower.

Many authors have measured seasonal changes in chemical composition of legumes but they are usually less than the changes found in Experiment 1 (e.g. McNaught and Dorofaeff 1968, Jones 1973, Bruce 1974). Although there were no simple relationships between these changes and legume growth rate, fertilizer application, rainfall and temperature they may be the result of an interaction of superphosphate application and subsequent growing conditions. In 1974 approximately 550 mm of rain fell after superphosphate was applied which stimulated new growth and raised phosphorus and nitrogen concentrations. In contrast, in 1975 only 80 mm fell after superphosphate was applied so there was little change until December when heavy rain resulted in increased growth rates and nitrogen and phosphorus concentrations. The decline in nitrogen and phosphorus levels at the end of each growing season probably reflects the declining growth rates and maturation and senescence of plant material after flowering.

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