SEED PRODUCTION POTENTIAI
Stylosanthes gracilis

BY

LEKHA SREEKANTAN

THESIS

SUBMITTED IN PARTIAL FULFILMENT OF
THE REQUIREMENT FOR THE DEGREE
MASTER OF SCIENCE IN AGRICULTURE
FACULTY OF AGRICULTURE
KERALA AGRICULTURAL UNIVERSITY

DEPARTMENT OF AGRONOMY
COLLEGE OF AGRICULTURE
VELLAYANI, TRIVANDRUM

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DECLARATION

I hereby declare that this thesis entitled "Seed production potential of *Stylosanthes gracilis*" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title at any other University or Society.

Lekha Sreekantan

LEKHA SREEKANTAN

Vellayani,
9-9-1981.

C E R T I F I C A T E

Certified that this thesis, entitled "Seed Production Potential of Stylosanthes gracilis" is a record of research work done independently by Smt. LEKHA SREEKANTAN under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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INTRODUCTION

INTRODUCTION

There are 34 lakhs of adult cattle in Kerala. The per capita milk availability in the State is 86 grams. which is much below the recommended level. To make "White Revolution" a reality, improving the genetic make-up of our livestock population should be supported and supplemented by the production of adequate good quality fodder.

Leguminous fodder crops provide high protein diet to the livestock and help to reduce the cost of feeding by concentrates. In addition, the importance of symbiotic nitrogen fixation by legumes in improving soil fertility needs no emphasis. However, lucerne, berseem and such fodder legumes rich in protein cannot be cultivated in the plains of Kerala because of their specificity for climatic and soil requirements.

The importance of stylo or Brazilian lucerne, a perennial leguminous fodder crop, now gains importance because of its suitability for cultivation under open field conditions and in partially shaded coconut gardens in Kerala. Observational studies conducted by the Kerala Livestock Development and Milk Marketing Board, in almost all the districts, showed that this crop can be grown well in Kerala. Preliminary studies at Vellayani under the All India Coordinated Project for Research on forage crops have shown that it can yield as much as 34 t/ha of green fodder. Further studies by Marieppan (1978) threw some light on the nutritional requirements of this crop. Chandini (1980) also recorded high forage yields when stylosanthes was grown mixed with other popular fodder grasses and fertilized with varying doses of P_2O_5.

Recently, this fodder crop is getting popularity among the dairy farmers of the State on a very large scale as a pure crop as well as in grass legume mixtures. The present production of seed in our State is very meagre to meet the local requirements. Increasing the production of seed has become very important in view of low yields and high cost of seed. Research work on the various aspects of seed production of stylosanthes has not yet been attempted. The nutritional and management requirements for maximum seed production need to be investigated. However, production of seed cannot be made at the cost of green fodder yields when the acute shortage of the latter is to be kept in mind. Hence the optimum number of cuts of green fodder that could be taken before the crop is to be left for seed setting is to be worked out.

Phosphorus application upto 120 kg P_2O_5/ha was found to increase green matter yield of _Stylosanthes gracilis_ (Mariappan, 1978). Increasing levels of phosphorus application was found to increase seed yield in _Stylosanthes humilis_ (Shelton and Humphreys, 1971). Spray fertilisation of phosphorus was found to boost berseem seed yield and net profit (Singh and Pandey, 1969). The effect of levels and methods of phosphorus application on seed production of _Stylosanthes gracilis_ has not been assessed so far. Therefore an experiment was conducted at Vellayani, on _Stylosanthes gracilis_ c.v. Schofield with the following objectives.

(1) To find out the optimum stage of the crop or the number of cuts after which it is to be left for seed setting.

(2) To assess the level and method of phosphorus application for increased seed production.

(3) To study the effect of levels of phosphorus on yield and quality of fodder.

(4) To work out the economics of seed and fodder production.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

The effect of graded doses of phosphorus, methods of its application and the number of cuts of green fodder taken on the seed production of *Stylosanthes gracilis* was studied. The literature given below refer to the different aspects of the study. Wherever sufficient literature on *Stylosanthes gracilis* is not available similar works on other legumes are reviewed.

1. Effect of phosphorus on growth characters.

While studying the effect of phosphorus on the growth and mineral composition of four tropical pasture legumes viz. *Centrosema pubescens*, *Centrosema plumeris*, *Pueraria phaseoloides* and *Stylosanthes gracilis*, Falade (1973) found that all the species except *Pueraria phaseoloides* responded to phosphorus application and *Centrosema pubescens* required more phosphorus for optimum growth than *Centrosema plumeris* and *Stylosanthes gracilis*. The phosphorus content in the species *Stylosanthes gracilis* for maximum growth was found to be 0.27 percent.

Experiments under laboratory conditions revealed that with progressive improvement in the supply of phosphorus, large differences in growth developed between different groups of *Stylosanthes*. One group in which nodulation was partially or completely ineffective responded poorly in growth to additions of phosphorus. But the other groups were effectively nodulated and appeared to differ considerably in their inherent growth rates (Jones, 1974).

Steel and Humphreys (1974) observed positive quadratic responses to phosphorus addition on *Stylosanthes guyanensis*, over the range of 10 to 80 Kg phosphorus per hectare. But growth of the legume was independent of phosphorus application, presumably because of the high soil phosphorus availability at depths.

Studies at Kalyani, West Bengal, under the All India Coordinated Project for Research on Forage Crops revealed that height of legumes like cowpea and ricebean increased with increase in the dose of phosphorus upto 120 kg P_2O_5/ha (Anon, 1976, a).

At Rahuri, experiments under the AICPR on Forage Crops showed that height of lucerne increased with increase in the rate of phosphorus application from 0 to 120 kg P_2O_5/ ha (Anon, 1976,b).

Subramaniyan et al. (1977) observed in cowpea that application of different levels of phosphorus ranging from 12.5 to 37.5 Kg P_2O_5/ha in the soil and as soil plus foliar did not influence plant height.

Mariappan (1978) observed that phosphorus levels upto 120 Kg/ha increased the height of Stylosanthes gracilis. Effects of N, P and K fertilizers on growth and drymatter production of Vicia hirsuta and Vicia sativa were studied by Sharma and Lavania (1980) and found that application of phosphorus as calcium superphosphate at the rate of 62.03 g/m^2 twice, increased the shoot length and spread, significantly in both the species.

2. Effect of phosphorus on leaf:stem ratio.

Experiments in Tamil Nadu under the AICPR on Forage Crops showed that the leaf:stem ratio increased with increase in the dose of phosphorus in cowpea varieties EC-4216 and Local, while the variety Co-1 did not exhibit any difference in the leaf:stem ratio with changes in phosphorus application (Anon, 1974). Experiments at Rahuri also showed that phosphorus application increased the leaf:stem ratio in lucerne and the highest leaf:stem ratio was obtained by the application of 200 Kg P_2O_5/ha (Anon, 1976, b).

Mariappan (1978) recorded an increasing trend in the leaf:stem ratio of *Stylosanthes gracilis* with increase in the levels of phosphorus upto 120 kg P_2O_5/ha at which the highest leaf:stem ratio of 1.72 was obtained.

3. *Effect of phosphorus on nodulation and nitrogen fixation.*

Wendt (1970) reported that nitrogen fixation by *Stylosanthes gracilis* was stimulated by phosphorus application. Increase in the nodulation of *Desmodium intortum*, *Medicago sativa* and *Stylosanthes gracilis* by the application of phosphorus was obtained by Olsen and Moe (1971). While evaluating the effect of phosphorus on nodule and plant development in *Stylosanthes humilis*, Gates (1974) noted that phosphorus had a beneficial effect on the initiation of nodules. He further observed that nodule numbers, volume and dry weights were increased by phosphorus application. The weights of nodules increased with increasing rates of P_2O_5 application from 40 to 80 kg P_2O_5/ha, as reported by Singh (1975) who assessed the effect of various forms and levels of phosphorus on root development and nodulation of berseem.

The effect of phosphorus in increasing the root nodules of *Stylosanthes gracilis* was significant and maximum nodulation was noted at 120 kg P_2O_5/ha as reported by Mariappan (1978). The nodule weight showed an increasing trend with phosphorus application upto 120 kg/ ha.

On comparing the effect of phosphorus at the rate of 0 to 315 kg/ha on Phaseolus vulgaris cultivars inoculated with rhizobium and sown in soil low in available phosphorus, Graham and Rosas (1979) found that nodule weight increased significantly with increasing rates of phosphorus.

4. Effect of phosphorus on greenmatter yield.

Forage yield and fresh weight of lucerne per unit area increased with increase in the application of phosphorus from 0 to 50 kg P_2O_5/ha and the percentage increase was 19.5 per cent (Tomar, 1970). Garg et al. (1971) obtained significant increase in green fodder yield of cowpea upto 37 kg P_2O_5/ha while further additions did not accrue any significant advantage. Singh et al (1972) reported that green fodder yield of berseem at different cuts was higher under phosphate treated plots over untreated, with the maximum green fodder being obtained at the level of 120 kg P_2O_5/ha.

From two years' experiments conducted by Sinha (1972) it was found that application of 90 kg P_2O_5/ha gave significantly higher yield of berseem fodder over that due to 60 kg P_2O_5/ha. When the level of phosphorus was increased to 120 kg P_2O_5/ha the increase in the yield reached the significant level in the trial carried out 1970-71 but not in 1969-70.

Green matter production of cowpea and clusterbeans increased significantly due to application of phosphorus upto 70 kg P_2O_5/ha as observed by Sharma and Garg (1973), who found that further additions did not result in any significant advantage. Trials at Rahuri showed that phosphorus application improved the green forage production of lucerne significantly. Increasing phosphorus application from 0 to 200 kg P_2O_5/ ha progressively increased the green forage production in lucerne (Anon, 1976, b). Mir Mustafa Husain et al. (1976) noted that increase in the dose of P_2O_5 from 40 to 160 kg/ha correspondingly increased the yield of berseem and a dose of 116 kg was found optimum.

Kolling et al. (1976) reported increased fodder yields of Macroptilium atropurpureum and Desmodium intortum with the addition of 180 to 360 kg P_2O_5/ha.

increase in total yield of berseem in 4 cuts was obtained by Khokar and Singh (1977) by the application of phosphorus. By increasing the rates of P_2O_5 from 0 to 160 kg/ ha applied to three berseem cultivars, Dhar (1978) obtained increased fresh fodder yields.

In <u>Stylosanthes gracilis</u> Mariappan (1978) obtained maximum green fodder yield by applying phosphorus at 120 kg P_2O_5/ha.

Singh (1979) carried out an experiment to study berseem fodder and seed production as influenced by number of cuts, sowing dates, phosphate fertilisation and micronutrient application, which proved that phosphate application at 120 kg P_2O_5/ha gave significantly more fodder yield than 80 kg P_2O_5/ha.

Yadav et al. (1979) conducted a field experiment involving four crop rotations carrying lucerne and berseem, four levels of phosphorus (0, 60, 120 and 180kg P_2O_5/ha) and two forms of phosphate (singleand triple). In the case of green forage production during 1974-75, 120 and 180 kg P_2O_5/ha proved significantly superior to control while there was no significant difference between 60 and 120 kg P_2O_5/ha. However in 1975-76 the level 120 kg P_2O_5/ha recorded the maximum green forage yield which was significantly more when compared with application of 0,60 and 180 kg P_2O_5/ha.

5. Effect of phosphorus on drymatter yields.

Increased drymatter yields of *Stylosanthes humilis* was recorded by Shaw et al. (1966) by the application of superphosphate upto 4 cwt/ac. From a trial conducted on *Stylosanthes humilis*, Fisher (1970) revealed that increase in the application of phosphorus increased the drymatter yields and from the extrapolation of yield curves it was concluded that 75 percent, 90 percent and 100 percent of maximum yield would be attained with 250, 375 and 625 kg superphosphate/ha respectively. Increase in the drymatter production of *Desmodium intortum*, *Medicago sativa* and *Stylosanthes gracilis* by the application of phosphorus was recorded by Olsen and Moe (1971). Singh et al. (1972) reported significant increase in drymatter yield of berseem with the application of phosphorus upto 120 kg P_2O_5/ha.

On applying phosphorus upto 70 kg P_2O_5/ha, Sharma and Garg (1973), noted that drymatter production of cowpea and clusterbeans increased significantly and further additions did not result in any significant advantage. From three trials conducted in North Queensland by Bruce (1974) where Stylosanthes guyanensis pastures were top dressed with 0 to 625 kg superphosphate per hectare, it was observed that applied phosphorus increased drymatter yields; but yield response decreased with increase in phosphorus rates.

Trials at Kalyani, showed that drymatter yields of cowpea did not differ significantly due to different doses of phosphorus application (Anon, 1976, c).

Khokar and Singh (1977) found that increasing P_2O_5 rates from 0 to 320 kg/ha increased the total yields of berseem in 4 cuts from 1.46 to 2.33 tons of drymatter/ha.

Increasing the rates of P_2O_5 from 0 to 160 kg/ha applied to three berseem cultivars increased the drymatter yields as reported by Dhar (1978). Mariappan (1978) observed that phosphorus at the rate of 120 kg P_2O_5/ha gave maximum drymatter production in Stylosanthes gracilis.

Increase in the drymatter production of *Vicia hirsuta* and *Vicia sativa* with phosphorus application was observed by Sharma and Lavania (1980) who further noted that the effect of phosphorus in increasing the drymatter yield was more pronounced in *Vicia hirsuta*.

6. Effect of phosphorus on seed yield.

Mata and Sanchez (1970) observed the effect of 80, 100 or 120 kg P_2O_5/ha as rock phosphate, single or triple superphosphate, applied in a band below the seed, in a band on the surface or incorporated in the soil in cowpea. The results revealed that seed yields increased with increased rate of phosphorus for single and triple superphosphate upto 1.95 and 2.1 tons seed/ha, respectively from the application of 120 kg P_2O_5/ha. Shelton and Humphreys (1971) studied the effect of variation in density and phosphate supply on seed production of *Stylosanthes humilis* and observed that seed yield was increased from 46.2 g/m^2 to 55.6 g/m^2 when the rate of phosphorus applied was increased from 0 to 50 kg/ha.

From trials conducted in summer (April-June) and summer monsoon (July-September) Surinder Singh and Lamba (1971) arrived at the conclusion that cowpea given 0, 20 and 40 kg P_2O_5/ha gave linear increase in grain yields from 800 to 997 kg/ha in the summer season and 1.07 to 1.25 tons/ha in the monsoon season with increase in the rates of applied P_2O_5 . Similarly a trial on soybeans by Chatterjee et al. (1972) revealed that application of 40 to 80 kg P_2O_5/ha increased the seed yield.

Nihal Singh and Khatri (1972) observed that the seed yield of berseem was not influenced by the levels of phosphorus.

Trials during 3 years on *Phaseolus vulgaris* showed that phosphorus application of 60 and 120 kg P_2O_5/ha increased seed yields upto 1.7 and 2.6 times over the yield from control plots respectively (Braga et al.,1973)

Nicholls et al. (1973) worked out the phosphorus response of *Desmodium uncinatum* on seed production and stated that high rates of phosphorus increased seed yield, mainly because of increased inflorescence density.

Studies by Ovsyannikov (1973) brought out that seed yield of lucerne increased with increase in the rate of phosphorus applied with the maximum yield being obtained at the maximum level of phosphorus applied.

Quinlivan et al. (1973) found that seed production of subterranean clover was greatly influenced by the rate of applied phosphorus. Field trials conducted by Albinet (1976) to study the effect of irrigation, nitrogen, phosphorus, potassium and trace elements on seed production of lucerne showed that application of phosphorus, potassium, boron and molybdenum increased seed production.

Subramaniyan et al. (1977) carried out an experiment on cowpea in a clay loam soil with medium phosphorus status, which revealed that the application of 25 kg P_2O_5/ha recorded the maximum grain yield and was on par with 50 kg P_2O_5/ha.

Seed production of *Stylosanthes humilis* under experimental and field conditions, was measured by Wickham et al. (1977) and found that seed yield increased significantly by phosphorus application.

In a trial on cowpea conducted at Kalyani and Pantnagar, it was seen that phosphate application did not increase the seed yield of cowpea significantly (Anon,1978,b)

The response to four levels of phosphorus (0, 20, 40 and 60 kg P_2O_5) and two levels of nitrogen (0 and 20 kg N/ha) was studied on seed production of Stylosanthes humilis in red gravelly soil at Jhansi during 1977 and 1978. The results showed that application of phosphorus at the rate of 20,40 and 60 kg P_2O_5/ha significantly increased the seed production by 34.7, 39.3 and 44.8 percent respectively over control (Rai and Kanodia, 1980).

7. Effect of phosphorus on chemical composition of fodder.

a. Nitrogen and crude protein content

Singh and Verma (1953) reported that on application of 0, 66, 132, 198 and 264 lbs P_2O_5/ac. the crude protein contents in the drymatter of berseem were 20.19, 19.38, 18.94, 19.94 and 21 percent respectively.

In the presence of applied molybdenum, superphosphate upto 4 cwt/ac. increased the crude protein content of Stylosanthes humilis as reported by Shaw et al. (1966).

After studying the effect of variation in density and phosphate application on growth and composition of Stylosanthes humilis , Rickert and Humphreys (1970) drew the conclusion that phosphorus application did not affect the crude protein content.

From trials on red loam soil, Sasidhar and George (1972) reported that increasing rates of P_2O_5 application increased the nitrogen content in lablab.

Falade (1973) reported that phosphorus had no effect on the nitrogen content in Stylosanthes gracilis.

Keya and Kalangi (1973) observed that application of superphosphate increased the crude protein yields of Desmodium uncinatum and a dose of 500 kg per hectare was found optimum. On increasing the dose of P_2O_5 from 40 to 160 kg/ha Mir Mustafa Husain et al. (1976) found that crude protein content of berseem increased with increase in the dose of P_2O_5. Phosphate fertilization showed significant effect on improving the quality of the forage. No significant difference was observed in the crude protein content in perennial lucerne due to application of phosphorus in an experiment conducted at Anand under the All India Coordinated Project for Research on Forage Crops (Anon, 1978, a).

On increasing the rates of P_2O_5 from 0 to 160 kg/ha applied to berseem, Dhar (1978) observed that the crude protein content also increased.

A significant increase in protein content in *Stylosanthes gracilis* was recorded by Mariappan (1978) when phosphorus was applied at the rate of 120 kg/ ha.

From an experiment on blackgram, Annamma George (1980) found that protein yield of bhusa was increased by increasing the level of phosphorus from 30 to 45 kg P_2O_5/ha but a further increase declined it.

b. Phosphorus content

Singh and Jain (1968) from trials with cowpea reported that phosphorus content of plant parts increased markedly with increase in the rate of applied P_2O_5, upto 67 kg/ha and slightly with further increase to 100.5 kg/ha.

Increasing the rate of P_2O_5 applied upto 75 kg/ha increased the phosphorus content of lablab (Sasidhar and George, 1972). Dow et al. (1973) observed that concentration of phosphorus in irrigated bean plants increased with increase in phosphorus application.

Jones (1974) studied the effect of a wide range of phosphorus levels on the growth and uptake of phosphorus by 30 accessions of the genus Stylosanthes and found that with progressive improvement in the supply of phosphorus, large differences developed between the groups in phosphorus uptake.

Mir Mustafa Husain et al. (1976) observed that increasing the P_2O_5 rates from 40 to 160 kg P_2O_5/ha increased the phosphorus content in berseem. Santos and Cabral (1976) conducted pot trials with berseem, given various combinations of 0.25 g of nitrogen, 1,2 or 3 g of P_2O_5 and 1,2 or 3 g of K_2O per pot containing 5 kg soil with or without application of lime. They inferred that fodder phosphorus content increased with high rates of phosphorus application.

From trials conducted on lucerne in the years 1974-76 Botorac and Vasilj (1978) found that phosphorus treatments had inconsistent effects on the phosphorus content of the herbage which was 0.48 - 0.92% in the first year, 0.47 - 0.86% in the second year and 0.44 - 0.79% in the third year.

While increasing the rates of P_2O_5 from 0 to 160 kg/ha applied to three berseem cultivars, Dhar (1978) found that the phosphorus content of the herbage also increased with incremental doses of phosphorus.

Mariappan (1978) revealed that phosphorus at the rate of 120 kg/ha with lime influenced to give a maximum phosphorus percentage of 0.532 in Stylosanthes gracilis.

c. Potassium content

Falade (1973) noted that potassium concentration seemed to increase with the application of phosphorus in Centrosema pubescens, Centrosema plumeris and Pueraria phoaseoloides while in the case of Stylosanthes gracilis the potassium concentration appeared to be lowered by phosphorus application.

Santos and Cabral (1976) observed that potassium content of berseem fodder increased with high rates of phosphorus and potash application. From field trials on soybeans, Fogeria (1977) reported that increasing the rate of phosphorus from 0 to 125 kg/ ha increased plant potassium content. On increasing the phosphorus levels, significant increase in the potassium content of <u>Stylosanthes</u> <u>gracilis</u> was obtained by Mariappan (1978).

8. Effect of phosphorus on chemical composition of seed.

a. Crude protein content

Singh et al. (1969) carried out an experiment on pea varieties at New Delhi and reported that application of phosphoric acid at 0 to 90 kg/ha did not influence the protein content in grain.

George et al.(1971) reported that in peas protein content in grains increased due to phosphorus application at 20 and 40 kg P_2O_5/ha. Singh et al.(1971) noted that in soybeans the protein content of seed tended to increase with increase in levels of phosphorus ie. 0,40,80 and 160 kg P_2O_5 per hectare.

From a trial on cowpea, Malik et al. (1972) reported that application of phosphorus had no effect on seed protein content.

On studying the response of soybeans to graded doses of nitrogen and phosphorus, Kesavan and Morachan (1973) found that protein content increased with increase in the rate of phosphorus upto 150 kg P_2O_5/ha.

In trials with Phaseolus aureus Panwar and Singh (1975) reported that seed protein contents increased with increasing phosphorus rates from 0 to 20 and 40 kg P_2O_5/ha. Application of 80 kg P_2O_5/ha to Vigna radiata and soybeans and 120 kg P_2O_5/ha to Vigna mungo increased the seed protein contents (Ravankar and Badhe, 1975).

Annamma George (1980) observed that the effect of phosphorus in increasing the grain protein content in blackgram was not significant. However there was a slight increase in the protein contents with increase in the level of phosphorus.

Savithri (1980) reported that increasing the levels of phosphorus from 0 to 60 kg P_2O_5/ha increased the grain protein yield in greengram although there was no significant difference.

b. Phosphorus content

Bartz (1959) studied the effect of phosphorus nutrition on Alaska peas and observed that foliar application of phosphorus increased the phosphorus content of peas.

Mascarenhas et al. (1969) reported from a trial on *Phaseolus vulgaris* given 0, 50, 100 or 150 kg P_2O_5/ha that phosphorus application increased the content of phosphorus in the seeds. Omueti and Oyenuga (1970) observed that in groundnut and cowpea applied phosphorus increased the phosphorus content in grain.

Robinson and Jones (1972) noted that *Stylosanthes humilis* showed a very marked ability to translocate nutrients to the seed. The seeds of adequately fertilized plants contained 0.36 percent phosphorus.

c. Potassium content

From a trial on *Phaseolus vulgaris* Mascarenhas et al. (1969) reported that increase in phosphorus application from 0 to 150 kg P_2O_5/ha increased the potassium content in the seeds. Georgeiev (1977) in trials with groundnut reported that applied phosphorus promoted more intensive accumulation of potassium in pods.

9. Effect of foliar application of phosphorus on seed yield.

In the 1965-66 and 1966-67 experiments conducted at Jhansi, Singh and Pandey (1969) reported that spraying berseem with phosphate solution boosted the seed yield enabling a profit of Rs.1,038/- from an acre. In 1965-66 application of phosphate as spray increased the seed yield from 2.1 q to 5.1 q/ha when the crop was left for seed after the second cut. In the second year the treatment increased the seed yield from 6.1 q to 8.5 q/ha. When the effect of spray fertilization was studied under two sets of conditions namely (1) with a basal dressing of phosphate at sowing and (2) without any basal dressing, it was observed that increase in seed yield was more pronounced with the basal dressing of phosphate, because the soil application of phosphate provided more leaf area for the absorption and effective utilization of the sprayed nutrient at seed production. Gill et al. (1971) reported that phosphate application either to soil or foliar spray increased the seed yield of cowpea and 25 kg P_2O_5/ha given as foliar spray applied at flowering was statistically on par with 50 kg P_2O_5/ ha applied to soil at sowing. The highest seed yield was obtained with 50 kg P_2O_5/ha applied to soil at sowing followed by 25 kg P_2O_5/ ha foliar application at first flush of flowering, while from economic point of view, the best treatment combination was 25 kg P_2O_5/ha soil application followed by 25 kg P_2O_5/ha foliar application.

While studying the effect of foliar and soil application of phosphatic fertilizers (0, 20 or 40 lb. P_2O_5/ac.) on Phaseolus aureus, Gorde and Kibe (1973) found that in general the foliar application of 20 lb P_2O_5/ac in one dose on 25th day after sowing was found to be the best as indicated by highest grain yield when compared with soil and other foliar applications of phosphorus. The next best treatment was the level of 20 lbs P_2O_5/ac as foliar spray in three equal split doses on 25th, 35th and 40th day after sowing.

Subramaniyan et al. (1977) reported that application of 25 kg P_2O_5/ha in soil recorded the maximum grain yield in cowpea and it was on par with 50 kg P_2O_5/ha as well as 25 kg P_2O_5/ ha soil applied plus 12.5 kg P_2O_5/ha as foliar.

In trials conducted at Rahuri, significant differences in seed yield of lucerne was obtained due to application of phosphorus as foliar spray where 2 per cent of P_2O_5 spray increased the yield significantly over no spray and 2 percent and 4 percent P_2O_5 spray gave the same seed yield (Anon, 1978, c).

Foliar application of phosphorus did not show any significant effect on seed production of lucerne at Anand.

as seen from an experiment conducted under the All India Coordinated Project for Research on Forage Crops (Anon, 1978, d). Similar trials at Hissar and Hyderabad showed that seed yields of lucerne were not affected significantly by the spray treatments of phosphorus, but it showed improvement in the yield at Hissar as compared to control (Anon, 1979).

Singh (1979) reported that foliar feeding of phosphorus improved neither forage yield nor seed production in berseem.

10. Effect of number of cuts taken on seed yield.

The highest seed yield of lucerne was obtained by Batra and Gill (1967) from plots left uncut, followed by those cut for 1,2 and 3 times before leaving the crop for seed production.

Singh and Pandey (1969) conducted experiments to assess the efficacy of spray fertilisation of berseem in relation to the number of cuttings taken for green fodder, before leaving the crop for seed production and found that when the crop was left for seed after the third cutting, the seed yield decreased as compared to that after second cutting.

Overall highest seed yields of lucerne were obtained when lucerne was utilized for seed only without taking any cut for herbage (Konstantinova and Danilov, 1973).

Pačuta (1973) found out that seed yields of lucerne tended to be higher when the crop was allowed to set seed on primary growth rather then when it was cut at the bud stage or at early flowering for green fodder before a second cut was taken for seed. Seed yield of berseem declined when the number of cuts of green fodder taken was raised from one to two, as revealed by an experiment conducted Kalyani, West Bengal under the All India Coordinated Project for research on forage crops (Anon, 1976, c).

A single grazing followed by cutting at the early flowering stage increased seed yield from 221 kg/ha in the undefoliated control to 355 kg/ha, in the case of <u>Stylosanthes hamata</u> while intermittent grazing and mowing at later stages decreased seed yields (Wilaipon and Humphreys, 1976).

Experiment to study the effect of cutting management and phosphorus application on seed production of lucerne at Anand under the AICPR for research on forage crops showed that significantly more seed yield was obtained when the crop was left for seed production after three cuts were taken rather than after two cuts or four cuts (Anon,1978, d).

A trial was conducted at Hissar under AICPR on Forage Crops with the objective of studying the comparative performance of cowpea under different dates of planting, cutting and phosphate levels for grain. The data revealed that seed yield was higher when the crop was not cut for fodder before leaving for seed setting when compared to taking one cut before leaving the crop for seed production. However, statistically both the treatments were of the same order (Anon 1978, e).

Singh (1979) reported that seed yield of berseem did not differ significantly when the crop was left for seed production after 3 or 4 cuts of green fodder were taken. Thus differential time length available for seed production did not help in the reproductive activity of the plant.

11. <u>Effect of applied phosphorus on soil fertility status.</u>

From an experiment on lablab, Sasidhar (1969) reported that soil tested on 50th day after sowing indicated that incremental doses of phosphorus (0, 25, 50 and 75 kg P_2O_5/ha) showed highly significant progressive increase in available phosphorus content of the soil. However at the time of harvest when the soil was tested it was found that different levels of phosphorus effected significant increase in soil phosphorus content except 75 kg P_2O_5/ha which recorded a significant reduction in the available phosphorus content over 50 kg P_2O_5/ha. Available potassium content was reduced by application of phosphorus. Significant increase in the nitrogen content of soil was brought about by application of 25, 50 or 75 kg P_2O_5/ha over no phosphorus application to the crop of lablab eventhough the difference between the levels was not significant when soil was tested 50 days after sowing. At harvest when soil was tested it was found that phosphorus had no significant effect on soil nitrogen content.

Garg et al. (1970) observed that nitrogen and available phosphorus content of soil grown with cowpea were improved by the application of phosphorus at the rate of 37, 74 or 111 kg P_2O_5/ha. A trial conducted by Chatterjee et al. (1972) on soybean revealed that increasing the rate of phosphorus application from 40 to 80 kg P_2O_5/ha increased the soil nitrogen content.

Nihal Singh and Khatri (1972) carried out a field trial to study the effect of phosphate fertilization of legumes on soil fertility and they came to the conclusion that there was an increase in the nitrogen content of the soil with increase in the dose of phosphorus. There was also an increase in all the three forms viz. total, organic and available phosphorus along with the increase in the dose of applied superphosphate.

Inoculation and application of phosphate (22.4 kg/ha) was found to increase the soil nitrogen content by 58, 29 and 26 per cent over control in crops of cowpea, groundnut and greengram respectively as observed by Sahu and Behera (1972). It was reported by Lutz (1973) that the available phosphorus in the soil was significantly higher where phosphorus was applied in fields cultivated with lucerne. Sahu (1973) observed that application of 22.4 kg P_2O_5/ha increased the nitrogen content of soil from 20 to 38 per cent in the case of blackgram and from 7 to 19 per cent in the case of horsegram.

Bruce (1974) found that with the increase in successive dose of phosphorus upto 625 kg superphosphate per hectare, significant increases for the organic carbon, available nitrogen, available phosphorus and available potassium as well as cation exchange capacity of the soil occurred when Stylosanthes guyanensis was topdressed with superphosphate.

A study conducted in a typical upland soil of Ranchi, on Stylosanthes humilis treated with five levels of phosphorus viz. 0,40,80,120 and 160 kg P_2O_5/ha applied as superphosphate at the time of sowing, revealed that there was a trend towards increase in the physico-chemical properties of soil with the increase in successive doses of P_2O_5. Significant treatment differences were obtained for available nitrogen, phosphorus and potassium as well as cation exchange capacity of the soil. In the case of available nitrogen and cation exchange capacity of the soil, the differences upto 40 kg P_2O_5/ha were not significant. Application of phosphorus beyond 40 kg P_2O_5/ha appeared to have increased the silica sheet resulting in significant increase in the cation exchange capacity of the soil from 6.25 m.e. under control plot to 28.43 m.e. at 120 kg P_2O_5/ha (Singh and Singh 1975).

Mariappan (1978) observed that phosphorus application had no significant effect on the total nitrogen content in the soil cultivated with Stylosanthes gracilis but application of 120 kg P_2O_5/ha gave the highest available nitrogen content in the soil which was significantly superior to the other levels tried. He also reported that phosphorus at the rate of 120 kg/ha gave maximum available phosphorus in the soil.

Annamma George (1980) reported that in fields cultivated with blackgram the total nitrogen content of the soil was not influenced by the levels of phosphorus but available potassium contents in the soil tended to increase with increase in the level of applied phosphorus from 30 to 60 kg P_2O_5/ha though the effect was not significant.

From an experiment on greengram, Savithri (1980) found that the medium level of 45 kg P_2O_5/ha gave the maximum total nitrogen in the soil. She also reported that the available phosphorus content of the soil increased with increasing rates of P_2O_5 from 30 to 60 kg/ha while available potassium was not influenced by the levels of phosphorus.

MATERIALS AND METHODS

MATERIALS AND METHODS

The present study was undertaken with a view to find out the effect of different levels as well as methods of application of phosphorus and schedules of cutting of green fodder on the seed production potential of Stylosanthes gracilis, a perennial leguminous fodder.

Materials

I. Experimental site

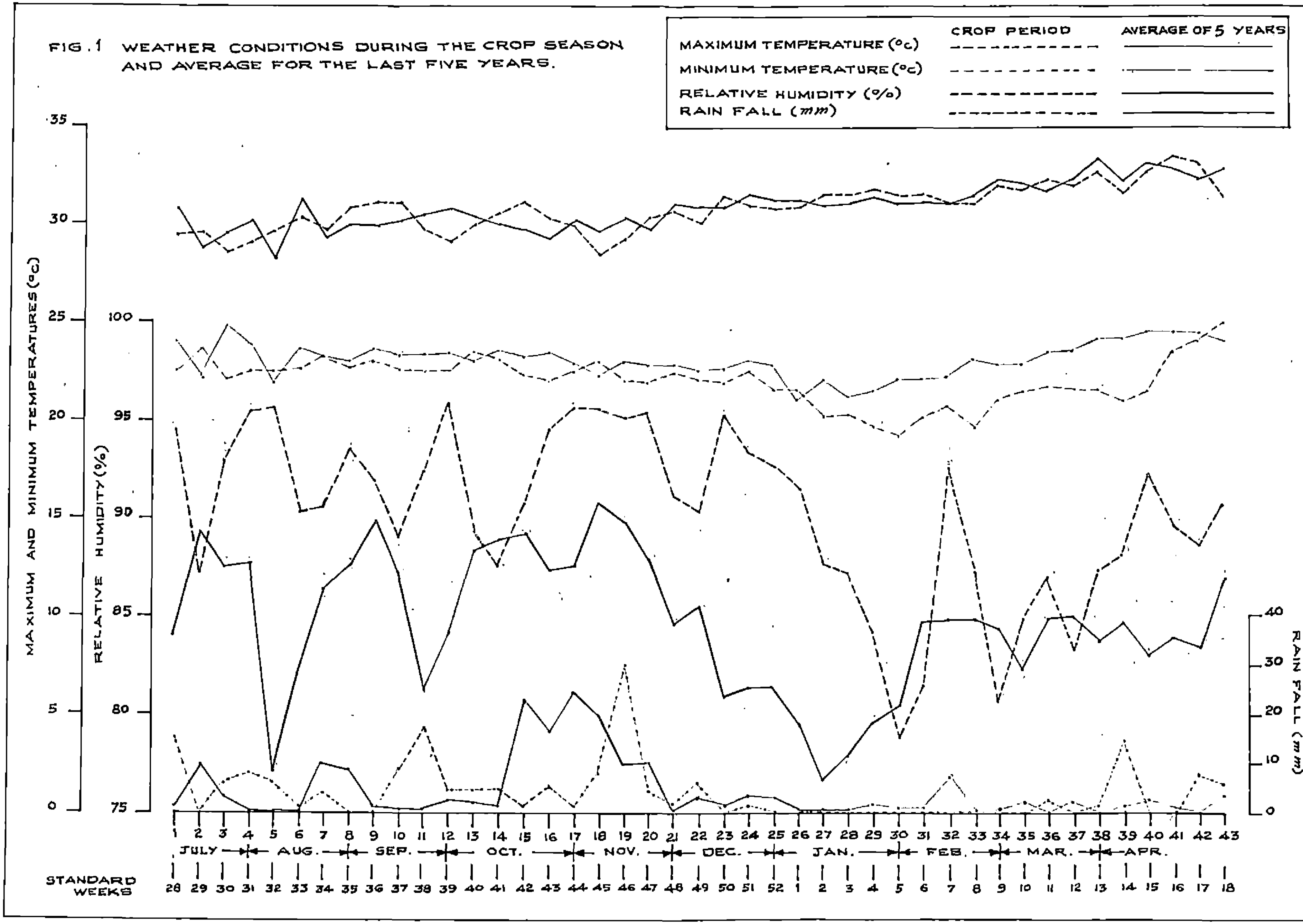
The trial was conducted in the Instructional Farm, College of Agriculture, Vellayani.

II. Soil

The soil of the experimental site was red loam with the following characteristics.

pH	- 5.4 (1:2 soil solution ratio using pH meter)
Total nitrogen	- 2280 Kg/ha (microkjeldahl method)
Available Phosphorus	- 46 Kg/ha (Bray's method)
Available potash	- 24 Kg/ha (ammonium acetate method)
Cation exchange capacity	- 3.42 m.e/ 100 gm. of soil.

FIG. 1 WEATHER CONDITIONS DURING THE CROP SEASON AND AVERAGE FOR THE LAST FIVE YEARS.



Methods

I. Treatments

Factorial combinations involving five levels and methods of application of phosphorus and three schedules of cutting were used.

A. Phosphorus levels and methods of application

P_1 - 40 Kg P_2O_5/ha (basal application- S)

P_2 - 80 Kg P_2O_5/ha (basal application- S)

P_3 -120 Kg P_2O_5/ha (basal application- S)

P_4 - 40 Kg P_2O_5/ha (S)+ 40 Kg P_2O_5/ha(foliar-F)

P_5 - 80 Kg P_2O_5/ha (S)+ 40 Kg P_2O_5/ha(foliar-F)

B. Cutting schedules

C_1 - Crop to be left for seed setting after taking 2 cuts of green fodder.

C_2 - Crop to be left for seed setting after taking 3 cuts of green fodder.

C_3 - Crop to be left for seed setting after taking 4 cuts of green fodder.

The first cut was taken 75 days after planting and subsequent ones at 30 days' interval.

C. Treatment combinations

P_1C_1 - 40 Kg P_2O_5/ha (S) and two cuts.

P_1C_2 - 40 Kg P_2O_5/ha (S) and three cuts.

P_1C_3 - 40 Kg P_2O_5/ha (S) and four cuts.

P_2C_1 - 80 Kg P_2O_5/ha (S) and two cuts.

P_2C_2 - 80 Kg P_2O_5/ha (S) and three cuts.

P_2C_3 - 80 Kg P_2O_5/ha (S) and four cuts.

P_3C_1 -120 KG P_2O_5/ha (S) and two cuts.

P_3C_2 -120 Kg P_2O_5/ha (S) and three cuts.

P_3C_3 -120 Kg P_2O_5/ha (S) and four cuts.

P_4C_1 - 40 Kg P_2O_5/ha (S)+ 40 Kg P_2O_5/ha (F) and two cuts.

P_4C_2 - 40 Kg P_2O_5/ha (S)+ 40 Kg P_2O_5/ha (F) and three cuts.

P_4C_3 - 40 Kg P_2O_5/ha (S)+ 40 Kg P_2O_5/ha (F) and four cuts.

P_5C_1 - 80 Kg P_2O_5/ha (S)+ 40 Kg P_2O_5/ha (F) and two cuts.

P_5C_2 - 80 Kg P_2O_5/ha (S)+ 40 Kg P_2O_5/ha (F) and three cuts.

P_5C_3 - 80 Kg P_2O_5/ha (S)+ 40 Kg P_2O_5/ha (F) and four cuts.

II. Layout and design

The experiment was laid out as a factorial experiment in Randomized Block Design with three replications. The layout plan is given in Fig. 2.

Replications	- 3
Treatment combinations	- 15
Total plots	- 45
Gross plot size	- 4.0 m x 3.0 m
Net plot size	- 3.4 m x 1.8 m
Net area of a plot	- 6.12 m^2
Spacing	- 30 cm x 10 cm.

FIG. 2. LAY OUT PLAN

FACTORIAL EXPERIMENT IN RANDOMISED BLOCK DESIGN.

P_4C_3	P_5C_2	P_1C_1
P_1C_3	P_2C_2	P_2C_1
P_2C_3	P_4C_2	P_1C_2
P_4C_1	P_3C_2	P_3C_3
P_5C_1	P_3C_1	P_5C_3

REPLICATION-I

P_5C_1	P_4C_3	P_5C_2
P_2C_3	P_5C_3	P_4C_2
P_1C_3	P_2C_1	P_3C_2
P_2C_2	P_1C_2	P_4C_1
P_3C_1	P_3C_3	P_1C_1

REPLICATION-II

P_3C_2	P_3C_1	P_2C_3
P_1C_1	P_5C_1	P_4C_3
P_1C_3	P_5C_3	P_1C_2
P_2C_1	P_4C_1	P_4C_2
P_5C_2	P_3C_3	P_2C_2

REPLICATION - III

LEVELS AND METHODS OF PHOSPHORUS APPLICATION

P_1 - 40 kg P_2O_5/ha SOIL APPLICATION
P_2 - 80 kg P_2O_5/ha SOIL APPLICATION
P_3 - 120 kg P_2O_5/ha SOIL APPLICATION
P_4 - 40 kg P_2O_5/ha SOIL + 40 kg P_2O_5/ha FOLIAR APPLICATION
P_5 - 80 kg P_2O_5/ha SOIL + 40 kg P_2O_5/ha FOLIAR APPLICATION

NUMBER OF CUTS

C_1 - 2 CUTS
C_2 - 3 CUTS
C_3 - 4 CUTS

GROSS PLOT SIZE - 4 X 3 M.

Two rows all around were left as border rows. One row was left as destructive row and the row adjacent to it also was left as border row uniformly in all plots.

V. Details of cultivation

With the onset of monsoon the experimental area was dug twice, stubbles removed, clods broken and the field laid out into blocks and plots. The plots were again thoroughly dug and levelled.

1. Fertilizer application

A uniform dose of 20 Kg N/ha as urea and 40 Kg K_2O/ ha as muriate of potash, was given to all plots. The basal application of phosphorus was given as per treatments ie. 40, 80, 120, 40 and 80 Kg P_2O_5/ha for P_1, P_2, P_3, P_4 and P_5 treatments respectively.

2. Seed treatment

Since the seeds of Stylosanthes have hard seedcoat and are difficult to germinate, they were scarified by treating with concentrated sulphuric acid. One hundred and fifty grams of the seeds were treated with sulphuric acid just sufficient enough to completely immerse the seeds. The seeds were kept in the acid for 1 minute. The time was standardized to one minute so as to provide maximum percentage of germination. The acid was decanted and the seeds were repeatedly washed with water till the water showed no acidity as tested with litmus paper. The scarified seeds were then treated with rhizobium culture.

3. Sowing

The seeds were dibbled in rows 30 cm apart and covered with a thin layer of soil. Sowing was done on 11-7-1979. The germination was uniform. Thinning and gapfilling were done 20 days after sowing and a uniform population was maintained by keeping a spacing of 10 cm between plants in the rows.

4. Intercultivation and weeding

Weeding was first carried out 35 days after sowing. A second weeding was given immediately after the first harvest of green fodder.

5. Plant protection

Plant protection measures were adopted as a prophylactic measure against mites.

6. Harvest of green fodder

The first cut was taken uniformly from all the plots on the 76th day of sowing and the second cut was taken 30 days after the first cut. The third and fourth cuts at 30 days interval were taken as per the schedule fixed in the programme. The details of the dates of cuts are furnished below:

Cutting treatments	Dates of cutting
C_1 - Plots left for seed - setting after two cuts	1st cut- September 25th 1979. 2nd cut- October 25th 1979.
C_2 - Plots left for seed - setting after three cuts	1st cut- September 25th 1979. 2nd cut- October 25th 1979. 3rd cut- November 24th 1979.
C_3 - Plots left for seed - setting after four cuts	1st cut- September 25th 1979. 2nd cut- October 25th 1979. 3rd cut- November 24th 1979. 4th cut- December 24th 1979.

7. Foliar application of phosphorus

A dose of 300 gm. of single superphosphate per plot at the rate of 250 Kg/ha was taken for making a solution for spraying. This quantity was soaked in equivalent quantity of water (300 ml) for five days. The material was stirred twice every day. On the sixth day more water was added and the supernatent solution was separated. The process was repeated by adding small quantities of water, stirring and decanting the solution. Finally the solution thus collected was made upto 2400 ml, with water to provide 2% concentration of P_2O_5 for spraying in each plot (Singh and Pandey, 1969). Foliar application of phosphorus, as per treatments P_4 and P_5 was given 20 days after the last cut in the respective cutting treatment plots.

8. Seed harvest

Since no specific method to fix the time of maturity for seed harvest has been evolved for the crop in Kerala it has been standardized with the observations taken from a previous crop and the procedure followed is detailed below. Ten plants at random were selected from which five branches were harvested and the seeds were collected from these branches and separated into mature and immature seeds based on the colour of the seedcoat. Black seeds were considered as mature and green as immature for this observation. The percentages of black seeds to the total were worked out. This observation was taken at twodays' interval. The first observation was taken on the 30th day after the first flower appeared and continued for a period of 20 days. A maximum of 40 percent maturity was noted on 45th day of flowering. So 40 percent maturity was kept as a standard for the harvest since there was a continuous shedding of seeds, if the harvest was delayed.

The harvest was done in the early morning by cutting the branches plotwise. These branches were dried, threshed and seeds were collected and cleaned. The top soil with the leaf mulch was carefully removed from plots and seeds were separated and dried.

Observations recorded.

A. Growth characters.

For assessing the periodical growth, 10 plants were randomly selected from each plot and the following growth characters were recorded.

(a) Height

The height of the plant was measured from the base to the growing tip of the tallest branch.

(b) Spread

The spread was measured as the maximum lateral diameter from the main stem of each plant.

(c) Number and weight of root nodules

The root nodules of five plants at flowering, selected randomly from the destructive row left for the purpose in each plot, were counted and the average number of nodules per plant and their weights worked out.

(d) Greenmatter yield

After each harvest of green fodder, the yield from each net plot was recorded and converted to per hectare yield.

(e) Drymatter yield

Sample plants cut into small pieces were dried in shade and then dried to constant weight in an air oven. Drymatter content for each treatment was computed and the drymatter yields calculated from the respective greenmatter yields.

(f) Leaf:stem ratio

Plant samples from each plot were separated into leaf and stem and from their dry weights, the leaf:stem ratios were computed at each harvest.

(g) Total seed yield per plot

The seeds separated from the harvested crop and the shedded seeds collected from soil surface were cleaned, mixed, dried and final weights recorded after adjusting the moisture content to 14 percent.

B. Quality characters.

The ovendried plant and seed samples were powdered in a Wiley grinder and used for chemical analysis. The plant and seed samples were separately analysed for total N, P and K.

(a) Nitrogen

Total nitrogen content of the samples were determined by modified microkjeldahl method (Jackson, 1967) and crude protein percentage worked out by multiplying the nitrogen content by the factor 6.25 (Simpson *et al.* 1965).

(b) Phosphorus

Phosphorus was determined by Vanado-molybdate phosphoric yellow colour method (Jackson, 1967).

(c) Potassium

Potassium was estimated by using a flame photometer.

C. Soil analysis.

The composite soil sample collected prior to the experiment and soil samples collected from individual plots after the experiment were analysed for total nitrogen, available phosphorus, available potash and cation exchange capacity.

Total nitrogen was determined by modified microkjeldahl method (Jackson, 1967). Available phosphorus was determined by Bray's method (Jackson, 1967). Available potash was determined by ammonium acetate method (Jackson, 1967). The cation exchange capacity of the soil was estimated by displacement technique using neutral normal ammonium acetate.

D. <u>Statistical analysis.</u>

Data relating to different observations were analysed by applying the technique of analysis of variance and significance was tested by 'F' test (Snedecor and Cochran, 1967). Important correlations were also worked out.

RESULTS

RESULTS

The observations recorded were statistically analysed and the mean values and correlation coefficients are presented in the text in Tables 1 to 22. The abstracts of the analysis of variance tables are presented in Appendix I to XXI.

1. Growth characters.

1.1 Height

The mean heights of the plants at the time of first cut, second cut, third cut and fourth cut are presented in Tables 1.1 to 1.4 and the mean heights at flowering in Table 1.5. The related abstracts of Analyses of variances are presented in Appendix I (a) to I (e).

The mean values of plant height as influenced by the phosphorus treatment indicated that increasing the rate of phosphorus application in the soil from 40 to 120 kg P_2O_5/ ha increased the height of Stylosanthes gracilis significantly at the time of all four cuts.

At flowering the mean height increased significantly on increasing the rate of phosphorus applied in the soil from 40 to 120 kg P_2O_5/ha. Combined application of

Table 1.1 Height of plants (cm) at the time of 1st cut

Rank	Levels of P_2O_5 applied in soil (kg/ha)	Mean values	C.D. (0.05)
1	120	61.01	2.160*
2	80	44.94	1.773**
3	40	33.50	

Table 1.2 Height of plants (Cm) at the time of 2nd cut

Rank	Levels of P_2O_5 applied in the soil (kg/ha)	Mean values	C.D. (0.05)
1	120	63.28	2.088*
2	80	45.89	1.705**
3	40	34.40	

Table 1.3 Height of plants (cm) at the time of 3rd cut

Rank	Levels of P_2O_5 applied in the soil (Kg/ha)	Mean values	C.D. (0.05)
1	120	65.85	1.399*
2	80	48.07	1.143**
3	40	34.95	

Table 1.4 Height of plants (cm) at the time of 4th cut

Rank	Levels of P_2O_5 applied in the soil (kg/ha)	Mean values	C.D. (0.05)
1	120	60.03	1.912*
2	80	44.03	1.479**
3	40	31.48	

* C.D. for comparisons involving 120 kg P_2O_5/ha.
** C.D. for comparisons between 80 & 40 kg P_2O_5/ha.

Table 1.5 Height of plants (cm) at the time of flowering

Levels and methods of phosphorus application	Number of cuts			Mean
	2 cuts	3 cuts	4 cuts	
40 kg P_2O_5/ha in soil	100.20	56.77	53.63	70.20
80 Kg P_2O_5/ha in soil	120.93	65.47	67.33	84.58
120 kg P_2O_5/ha in soil	148.07	82.23	84.77	105.02
40 kg P_2O_5/ha in soil + 40 kg P_2O_5/ha foliar	111.40	59.37	58.87	76.54
80 kg P_2O_5/ha in soil + 40 kg P_2O_5/ha foliar	127.23	71.00	73.23	95.49
Mean	121.57	67.57	66.97	

C.D.(0.05) for P = 2.866

C.D.(0.05) for C = 2.221

C.D.(0.05) for P x C= 4.965.

phosphorus in soil and by foliar (P_4 & P_5) was found to give significantly lower mean plant heights when compared to the same amount of phosphorus applied complete as basal soil application (P_2 & P_3). Application of 40 kg P_2O_5/ha in the soil gave the least mean plant heights.

As far as cutting treatments were concerned the minimum number of cuttings (2) recorded the maximum mean plant heights at flowering which was significantly superior to the other two cutting treatments (3 and 4) which were on par.

The interaction effect between phosphorus application and cutting treatment was also found significant. The maximum mean height of 148.07 cm was recorded by P_3C_1 (120 kg P_2O_5/ha soil application and two cuts combination) and the minimum mean height of 53.63 cm by P_1C_3 (40 kg P_2O_5/ha soil application and four cuts combination.)

1.2 Spread

The mean spread of the plants at the time of 1st, 2nd 3rd and 4th cuts are presented in Tables 2.1 to 2.4 and the mean spread at flowering in Table 2.5. The corresponding abstracts of the Analyses of Variance are given in Appendix II (a) to II (e).

Table 2.1 Spread of plants (cm) at the time of 1st cut

Rank	Levels of P_2O_5 applied in soil (kg/ ha)	Mean values	C.D.(0.05)
1	120	44.98	1.788*
2	80	32.20	2.189**
3	40	23.83	

Table 2.2 Spread of plants (cm) at the time of 2nd cut

Rank	Levels of P_2O_5 applied in the soil(kg/ha)	Mean values	C.D.(0.05)
1	120	46.62	1.931*
2	80	33.19	2.365**
3	40	24.66	

Table 2.3 Spread of plants (cm) at the time of 3rd cut

Rank	Levels of P_2O_5 applied in the soil(kg/ha)	Mean values	C.D. (0.05)
1	120	47.52	2.824*
2	80	34.08	
3	40	25.83	2.306**

Table 2.4 Spread of plants (cm) at the time of 4th cut.

Rank	Levels of P_2O_5 applied in the soil (kg/ha)	Mean values	C.D.(0.05)
1	120	42.93	2.352*
2	80	31.90	1.920**
3	40	21.47	

*C.D. for comparisons involving 120 kg P_2O_5/ha.

**C.D. for comparisons between 80 and 40 kg P_2O_5/ha.

Table 2.5 Spread of plants (cm) at the time of flowering

Levels and methods of phosphorus application	Number of cuts			Mean
	2 cuts	3 cuts	4 cuts	
40 kg P_2O_5/ha in soil	121.23	64.57	52.27	79.36
80 kg P_2O_5/ha in soil	152.60	83.47	69.60	101.89
120kg P_2O_5/ha in soil	182.93	95.57	68.50	115.67
40 kg P_2O_5/ha in soil + 40 kg P_2O_5/ha foliar	137.87	70.00	62.37	90.08
80 kg P_2O_5/ha in soil + 40 kg P_2O_5/ha foliar	168.20	86.73	78.23	111.06
Mean	152.57	80.07	66.19	

C.D. (0.05) for P = 2.649
C.D. (0.05) for C = 2.052
C.D. (0.05) for P x C = 4.587.

At the time of all 4 cuts the mean spread was maximum when 120 kg P_2O_5/ha was applied in the soil. This was significantly superior to the lower levels of P_2O_5 applied in the soil. The level 80 kg P_2O_5/ha applied in the soil gave significantly higher plant spreads than 40 kg P_2O_5/ha applied in the soil.

At flowering the mean plant spread recorded significant increase with the increase in soil phosphorus application from 40 to 80 and from 80 to 120 kg P_2O_5/ha. As in the case of plant height, combined soil and foliar application of phosphorus gave significantly lower mean plant spread as compared to the same amount of phosphorus applied in the soil.

A perusal of the marginal means of cutting treatments revealed that the minimum number of cuttings (2) resulted in the maximum mean spread of plants at flowering than the other two cutting treatments (3 and 4). The treatment, cutting 3 times recorded significantly higher mean plant spread than 4 cuts.

Interactional effects between P and C were also found significant and the maximum spread of 102.93 cm was recorded by combination 120 kg P_2O_5/ha soil application and two cuts and the minimum (51.27 cm) by 40 kg P_2O_5/ha soil application and four cuts.

1.3 Leaf:stem ratio

The mean leaf:stem ratios at the time of each cut are presented in Tables 3.1 to 3.4 and the relevant abstract of Analyses of Variance in Appendix III (a) to III (d).

Treatments were found to have significant influence on mean leaf:stem ratios at all four stages of observation. At the time of 1st, 2nd and 3rd cuts, application of 120 kg P_2O_5/ha in the soil gave significantly higher leaf:stem ratios than 80 kg P_2O_5/ha and 40 kg P_2O_5/ha while 80 kg P_2O_5/ha in turn gave significantly higher leaf:stem ratios than 40 kg P_2O_5/ha. In the 4th cut application of 120 kg P_2O_5/ha in the soil, gave the highest leaf:stem ratio significantly more than the other two levels which were statistically on par.

1.4 Number of root nodules

The mean number of root nodules are presented in Table 4 and the abstract of Analysis of Variance in Appendix IV.

From the table it is observed that phosphorus application had significant effect on the number of root nodules

Table 3.1 Leaf:stem ratio in the 1st cut

Rank	Levels of P_2O_5 applied in soil (kg/ha)	Mean values	C.D. (0.05)
1	120	1.63	
2	80	1.45	0.061*
3	40	1.20	0.049**

Table 3.2 Leaf: stem ratio in the 2nd cut

Rank	Levels of P_2O_5 applied in soil (kg/ha)	Mean values	C.D. (0.05)
1	120	1.66	
2	80	1.34	0.057*
3	40	1.16	0.045**

Table 3.3 Leaf: stem ratio in the 3rd cut

Rank	Levels of P_2O_5 applied in soil (kg/ha)	Mean Values	C.D. (0.05)
1	120	1.57	0.108*
2	80	1.25	0.087**
3	40	1.16	

Table 3.4 Leaf: stem ratio in the 4th cut

Rank	Levels of P_2O_5 applied in soil (kg/ha)	Mean Values	C.D. (0.05)
1	120	1.57	0.107*
2	80	1.20	
3	40	1.14	**NS

* C.D. for comparisons involving 120 kg P_2O_5/ha

** C.D. for comparisons between 80 and 40 kg P_2O_5/ha.

Table 4. Number of root nodules (per plant)

Number of cuts	Levels and methods of phosphorus application					Mean
	40 kg P_2O_5/ha in the soil.	80 kg P_2O_5/ha in the soil.	120 kg P_2O_5/ha in the soil	40kg P_2O_5/ha in soil + 40 kg P_2O_5/ha foliar	80 kg P_2O_5/ha in soil + 40 kg P_2O_5/ha foliar	
2 cuts	171.0	199.0	396.0	174.0	197.7	227.5
3 cuts	152.7	206.0	391.0	167.0	210.7	225.5
4 cuts	168.3	204.0	392.3	170.0	203.3	227.6
Mean	164.0	203.0	393.1	170.3	20.39	

C.D. (0.05) for P = 12.76

in Stylosanthes gracilis. Application of 120 kg P_2O_5/ha (P_3) as soil application, gave the maximum mean number of root nodules and was significantly superior to all other phosphorus treatments. P_2 and P_5 were on par and in turn gave significantly more number of root nodules than 40 kg P_2O_5/ha application in soil (P_1) and 40 kg P_2O_5/ha as soil plus 40 kg P_2O_5/ha foliar application(P_4). P_1 and P_4 were on par.

Cutting treatments as well as interactional effects between P and C were found to be not significant.

1.5 Weight of root nodules

Table 5 presents the mean values of the weight of root nodules and the corresponding abstract of the Analysis of Variance is given in Appendix V.

Among the treatments, phosphorus treatments alone were found to be significant. Phosphorus treatment P_3 (120 kg P_2O_5/ha in the soil) produced the maximum mean weight of root nodules and was significantly superior to all other treatments. P_5 (80 kg P_2O_5/ha in the soil + 40 kg P_2O_5/ha foliar) and P_2 (80 kg P_2O_5/ha in the soil) were on par and significantly superior to P_4(40 kg P_2O_5/ha in the soil + 40 kg P_2O_5/ha foliar) and P_1(40 kg P_2O_5/ha in the soil) which in turn were on par.

Table 5. Weight of root nodules (mg) per plant.

Number of cuts	Levels and methods of phosphorus application					Mean
	40 kg P_2O_5/ha in soil	80kg P_2O_5/ha in soil	120kg P_2O_5/ha in soil	40kg P_2O_5/ha in soil+ 40kg P_2O_5/ha foliar	80kg P_2O_5/ha in soil + 40kg P_2O_5/ha foliar	
2 cuts	180.0	209.0	404.3	185.3	205.7	236.9
3 cuts	166.3	220.3	400.7	178.3	221.3	237.4
4 cuts	181.0	213.0	400.0	181.3	217.7	238.6
Mean	175.8	214.1	401.7	181.7	214.9	

C.D.(0.05) for P = 12.69

Cutting treatments and interactions between P and C were found to be not significant.

2. Yield.

2.1 Greenmatter yield

The mean greenmatter yields at each cut are presented in Tables 6.1 to 6.4 and the mean total greenmatter yield from all the cuts in Table 6.5. The accompanying abstracts of the Analyses of Variance are incorporated in Appendices VI (a) to VI (e).

The effect of phosphorus application on mean green matter yield at each cut was significant. Application of 120 kg P_2O_5/ha in soil gave the highest greenmatter yield in all four cuts. It was superior to 80 kg P_2O_5/ha and 40 kg P_2O_5/ha soil applications in all cuts except 4th cut, where it was on par with 80 kg P_2O_5/ha soil application. In all cases 80 kg P_2O_5/ha applied in the soil was found to be significantly superior to 40 kg P_2O_5/ha soil application.

The result of the analysis of variance relating to the total greenmatter yield revealed that the treatments had significant influence on total greenmatter yield. Soil application of 120 kg P_2O_5/ha gave significantly

Table 6.1 Greenmatter yield in the 1st cut (kg/ha)

Rank	Levels of P_2O_5 applied in the soil(kg/ha)	Mean values	C.D.(005)
1	120	5319.58	137.063*
2	80	4075.92	111.912**
3	40	3395.09	

Table 6.2 Greenmatter yield in the 2nd cut (kg/ ha)

Rank	Levels of P_2O_5 applied in the soil (kg/ha)	Mean values	C.D.(0.05)
1	120	8115.54	189.528*
2	80	6545.09	154.740**
3	40	5455.75	

Table 6.3 Greenmatter yield in the 3rd cut (kg/ ha)

Rank	Levels of P_2O_5 applied in the soil (kg/ha)	Mean values	C.D.(0.05)
1	120	8142.76	439.243*
2	80	6454.30	358.641**
3	40	4316.49	

Table 6.4 Greenmatter yield in the 4th cut (kg/ ha)

Rank	Levels of P_2O_5 applied in the soil kg/ha	Mean values	C.D.(0.05)
1	120	6100.26	
2	80	5174.34	1184.634*
3	40	3349.70	967.263**

*C.D. for comparisons involving 120 kg P_2O_5/ha

** C.D. for comparisons between 80 and 40 kg P_2O_5/ha.

Table 6.5 Total greenmatter yield (kg/ ha)

Number of cuts	Levels of P_2O_5 applied in soil (kg/ha)			Mean
	40 (P_1)	80 (P_2)	120 (P_3)	
2 cuts	8905.3	10506.62	13398.80	10441.26
3 cuts	13104.68	17026.28	21699.52	16389.02
4 cuts	16503.40	22418.48	27614.60	21094.94
Mean	12843.24	16650.46	20898.86	

C.D.(0.05) for comparisons involving 120 kg P_2O_5/ha = 736.934
C.D.(0.05) for comparisons between 80 and 40 kg P_2O_5/ha = 604.580
C.D.(0.05) for cutting treatments .. .. = 658.502
C.D.(0.05) for comparisons between P_1C, P_2C combinations = 1040.858
C.D.(0.05) for comparisons between P_3C combinations = 1473.868
C.D.(0.05) for comparisons of P_1C, P_2C vs P_3C combinations = 1276.154

higher greenmatter yield over 80 kg P_2O_5/ha and 40 kg P_2O_5/ ha soil applications. Soil application of 80 kg P_2O_5/ha gave significantly higher yield over 40 kg P_2O_5/ha soil application.

As far as cutting treatments were concerned the maximum number of cuts (4) gave the maximum greenmatter yield which was statistically higher than that obtained from 3 cuts and 2 cuts. The treatment 3 cuts again gave significantly more greenmatter yield than 2 cuts.

Interactions between phosphorus and cutting treatments were also significant. The treatment combination 120 kg P_2O_5/ha soil application and four cuts recorded the highest greenmatter yield of 27614.60 kg/ha while the lowest value of 8905.30 kg/ha was obtained in the case of 40 kg P_2O_5/ha soil application and two cuts.

2.2 Drymatter yield

The mean values for drymatter yields in the four cuts are included in Table 7.1 to 7.4 and the mean total drymatter yields from all the four cuts is given in Table 7.5. The corresponding abstracts of Analyses of Variance are presented in Appendix VII (a) to VII (e).

Table 7.1 Drymatter yield in the 1st cut (kg/ha)

Rank	Levels of P_2O_5 applied in the soil (kg/ha)	Mean values	C.D. (0.05)
1	120	1022.72	29.412*
2	80	767.98	27.778**
3	40	637.42	

Table 7.2 Drymatter yield in the 2nd cut (kg/ha)

Rank	Levels of P_2O_5 applied in the soil (kg/ha)	Mean values	C.D. (0.05)
1	120	1519.62	
2	80	1274.52	112.746*
3	40	1045.76	91.504**

Table 7.3 Drymatter yield in the 3rd cut (kg/ha)

Rank	Levels of P_2O_5 applied in the soil (kg/ha)	Mean values	C.D. (0.05)
1	120	1565.86	78.432*
2	80	1238.74	
3	40	831.87	62.092**

Table 7.4 Drymatter yield in the 4th cut (kg/ha)

Rank	Levels of P_2O_5 applied in the soil (kg/ha)	Mean values	C.D. (0.05)
1	120	1247.23	208.000*
2	80	1037.26	170.000**
3	40	675.17	

*C.D. for comparisons involving 120 kg P_2O_5/ha

** C.D. for comparisons between 80 and 40 kg P_2O_5/ha.

Table 7.5

Total drymatter yield (kg/ha)

Number of cuts	Levels of P_2O_5 applied in soil (kg/ha)			
	40 (P_1)	80 (P_2)	120 (P_3)	Mean
2 cuts	1686.29	2015.53	2596.43	2000.02
3 cuts	2497.90	3241.53	4260.33	3137.90
4 cuts	3179.76	4360.82	5133.54	4043.00
Mean	2454.59	3206.07	3996.76	

C.D.(0.05) for comparisons involving 120 kg P_2O_5/ha = 176.472

C.D.(0.05) for comparisons between 80 and 40 kg P_2O_5/ha = 143.792

C.D.(0.05) for cutting treatments = 158.498

C.D.(0.05) for comparisons between P_1C and P_2C combinations = 248.368

C.D.(0.05) for comparisons between P_3C combinations = 351.31

C.D.(0.05) for comparisons of P_1C, P_2C Vs P_3C combinations = 303.924

In all four cuts, phosphorus treatment had significant effect on drymatter yields. The treatment 120 kg P_2O_5/ha as soil application produced significantly more drymatter yields than 80 kg P_2O_5/ha and 40 kg P_2O_5/ha as soil applications. The treatment 80 kg P_2O_5/ha applied in soil again gave significantly more drymatter yields than 40 kg P_2O_5/ha soil application.

Considering the total drymatter yields, it could be seen that 120 kg P_2O_5/ha soil application produced the maximum drymatter yield and it was significantly superior to 80 kg P_2O_5/ha soil application and 40 kg P_2O_5/ha soil application. 80 kg P_2O_5/ha soil application in turn gave significantly more drymatter yields than 40 kg P_2O_5/ha basal soil application.

The maximum number of cuts (4) resulted in the maximum drymatter yields which was significantly more than that obtained from 3 cuts and 2 cuts. Drymatter yield from 3 cuts was significantly more than that from 2 cuts. P x C interaction was also found significant. 120 kg P_2O_5/ha soil application and four cuts recorded the highest drymatter yield (5133.54 kg/ha) while 40 kg P_2O_5/ha soil application and two cuts tailed with the lowest (1686.29 kg/ha).

2.3 Seed yield

Table 8 gives the mean data on seed yields obtained and the abstract of the Analysis of Variance is shown in Appendix VIII.

It is seen that levels and methods of phosphorus application had significant effect on seed yield . The treatment P_5 (80 kg P_2O_5/ha in soil + 40 kg P_2O_5/ha as foliar) recorded the maximum seed yield and was superior over all other treatments. P_4 and P_3 were on par and superior over P_2 and P_1 while P_2 in turn was superior over P_1.

With regard to the number of cuts tried C_3 treatment (4 cuts) did not produce any seed. The treatment C_1 (2 cuts) was found to be significantly superior in seed production over C_2 (3 cuts).

Interactional effect was found to be not significant.

3. <u>Chemical analysis.</u>

3.1 Plant analysis

3.1.1 Protein content

The mean values of protein content of the plants in each cut are presented in Tables 9.1 to 9.4 and the abstracts of the Analyses of variance in Appendices IX (a) to IX (d).

Table 8. Seed yield (kg/ ha)

Number of cuts.	Levels and method of phosphorus application					Mean
	40 kg P_2O_5/ha in soil.	80 kg P_2O_5/ha in soil.	120kg P_2O_5/ha in soil.	40kg P_2O_5/ha in soil + 40kg P_2O_5/ha foliar.	80 kg P_2O_5/ha in soil + 40kg P_2O_5/ha foliar.	
2 cuts	38.67	46.84	77.34	83.33	107.30	70.70
3 cuts	19.61	41.4	44.66	50.65	55.56	42.37
Mean	29.14	44.12	61.00	66.99	81.43	

C.D. (0.05) for P = 12.42

C.D. (0.05) for C = 7.86

Table 9.1 Protein content (%) in drymatter in the 1st cut

Rank	Levels of P_2O_5 applied in the soil (Kg/ha)	Mean values	C.D. (0.05)
1	120	17.7708	0.74353*
2	80	14.6770	0.60709**
3	40	11.8645	

Table 9.2 Protein content (%) in drymatter in the 2nd cut

Rank	Levels of P_2O_5 applied in the soil (Kg/ha)	Mean values	C.D. (0.05)
1	120	18.5833	0.72380*
2	80	16.8402	0.57575**
3	40	13.3958	

Table 9.3 Protein content (%) in drymatter in the 3rd cut

Rank	Levels of P_2O_5 applied in the soil (kg/ha)	Mean values	C.D. (0.05)
1	120	18.0625	
2	80	15.4167	0.41042*
3	40	13.0833	0.33509**

Table 9.4 Protein content (%) in drymatter in the 4th cut

Rank	Levels of P_2O_5 applied in the soil (kg/ha)	Mean values	C.D. (0.05)
1	120	16.75	0.08725*
2	80	14.52	0.56114**
3	40	12.18	

*C.D. for comparisons involving 120 kg P_2O_5/ha

** C.D. for comparisons between 80 and 40 kg P_2O_5/ha

In all the four cuts, increase in the dose of phosphorus application increased the plant protein content significantly. The level 120 kg P_2O_5/ha applied in soil gave significantly more protein content in the plants than 80 kg P_2O_5/ha and 40 kg P_2O_5/ha soil applications. 80 kg P_2O_5/ ha was significantly superior to 40 kg P_2O_5/ha applied in the soil.

3.1.2 Total protein yield

Table 9.5 shows the mean values of total protein yield from all cuts and the corresponding abstract of the Analysis of variance is given in Appendix IX (e).

It could be seen that increasing the dose of phosphorus application from 40 to 80 kg P_2O_5/ha and from 80 kg to 120 kg P_2O_5/ha significantly increased the total protein yield in both cases.

Increasing the number of cuts from 2 to 3 and from 3 to 4 also significantly increased the total protein yield in both cases.

P X C interaction was significant and the combination of 120 kg P_2O_5/ha soil application and four cuts recorded the maximum total protein yield (909.97 kg/ha) while 40 kg P_2O_5/ha soil application and two cuts gave the minimum (211.19 kg/ha).

Table 9.5 Total protein yield from drymatter (kg/ha)

Number of cuts.	Levels of P_2O_5 applied in soil (kg/ ha)			
	40 (P_1)	80 (P_2)	120 (P_3)	Mean
2 cuts	211.19	321.54	485.08	310.11
3 cuts	325.98	497.49	758.67	481.13
4 cuts	405.89	678.20	909.97	615.64
Mean	314.35	499.09	717.91	

C.D. (0.05) for comparisons involving 120 kg P_2O_5/ha = 29.738

C.D. (0.05) for comparisons between 80 and 40 kg P_2O_5/ha = 24.296

C.D. (0.05) for cutting treatments .. = 26.610

C.D. (0.05) for comparisons between P_1C, P_2C combinations = 42.100

C.D. (0.05) for comparisons between P_3C combinations = 59.505

C.D. (0.05) for comparisons of P_1C, P_2C Vs P_3C combinations = 51.533

3.1.3 Phosphorus content

Tables 10.1 to 10.4 show the mean values of phosphorus content in the plant at each cutting while Appendices X (a) to X (d) give the corresponding abstracts of Analyses of Variance. Soil application of phosphorus at the rate of 120 kg P_2O_5/ha recorded the maximum phosphorus content in the plants and it was significantly more than that of 80 kg and 40 kg P_2O_5/ha applied in the soil. Phosphorus at the rate of 80 kg P_2O_5/ha in turn gave significantly higher phosphorus content values in the plants than that of 40 kg P_2O_5/ha as soil application. The results were the same in all four cuts.

3.1.4 Potash content

The mean values of potash content in plants at each cut are shown in Table 11.1 to 11.4 and the abstracts of the Analyses of Variance in Appendix XI (a) to XI (d).

It can be seen that phosphorus application had inconsistent effect on the potash content of plants at different stages of observation. Phosphorus treatment had no effect on the potash content in the plants in the first three cuts. However in the fourth cut application of 120 kg P_2O_5/ha was found to give significantly

Table 10.1 Phosphorus content in drymatter (mg/g)in the 1st cut.

Rank	Levels of P_2O_5 applied in the soil (kg/ha)	Mean values	C.D. (0.05)
1	120	3.64	0.252*
2	80	3.14	0.206**
3	40	2.68	

Table 10.2 Phosphorus content in drymatter (mg/g) in the 2nd cut

Rank	Levels of P_2O_5 applied in the soil (kg/ ha)	Mean values	C.D.(0.05)
1	120	4.44	0.180*
2	80	3.51	0.147**
3	40	3.02	

Table 10.3 Phosphorus content in drymatter (mg/g) in the 3rd cut

Rank	Levels of P_2O_5 applied in soil (kg/ ha)	Mean values	C.D. (0.05)
1	120	5.51	0.239*
2	80	4.81	0.171**
3	40	3.77	

Table 10.4 Phosphorus content in drymatter (mg/g) in the 4th cut

Rank	Levels of P_2O_5 applied in soil (kg/ ha)	Mean values	C.D. (0.05)
1	120	5.44	0.308*
2	80	4.28	0.254**
3	40	3.58	

* C.D. for comparisons involving 120 kg P_2O_5/ha.

** C.D. for comparisons between 80 and 40 kg P_2O_5/ha.

Table 11.1. Potash content in drymatter (%) in the 1st cut.

Rank	Levels of P_2O_5 applied in soil (kg/ha)	Mean values	C.D. (0.05)
1	80	2.08	*N.S
2	40	1.99	** N.S
3	120	1.89	

Table 11.2 Potash content in drymatter (%) in the 2nd cut.

Rank	Levels of P_2O_5 applied in the soil (kg/ha)	Mean values	C.D. (0.05)
1	120	2.38	*N.S
2	80	2.23	**N.S.
3	40	2.22	

Table 11.3 Potash content in drymatter (%) in the 3rd cut.

Rank	Levels of P_2O_5 applied in soil (kg/ha)	Mean values	C.D. (0.05)
1	40	2.48	*N.S.
2	120	2.37	**N.S.
3	80	2.29	

Table 11.4 Potash content in drymatter (%) in the 4th cut.

Rank	Levels of P_2O_5 applied in soil (kg/ ha)	Mean values	C.D. (0.05)
1	120	2.85	0.091*
2	80	2.53	0.074**
3	40	2.47	

* C.D. for comparisons involving 120 kg P_2O_5/ha.

** C.D. for comparisons between 80 and 40 kg P_2O_5/ha.

more potash content in *Stylosanthes gracilis* than 80 kg P_2O_5/ha or 40 kg P_2O_5/ha applied in soil which were in turn on par.

3.1.5 Nitrogen recovery from drymatter

Mean values of nitrogen recovery from cumulative drymatter are presented in Table 12 and the abstract of the Analysis of Variance in Appendix XII.

Application of phosphorus had significant effect on the nitrogen recovery from the drymatter yield. Increasing the dose of phosphorus application in soil from 40 to 80 kg P_2O_5/ha and from 80 to 120 kg P_2O_5/ha significantly increased the nitrogen recovery from the drymatter yield at both stages.

Increasing the number of cuts from 2 to 3 and from 3 to 4 also increased the nitrogen recovery in both cases.

Interactions between phosphorus and cutting treatments were found to be significant. While 120 kg P_2O_5/ha soil application and four cuts gave the maximum nitrogen recovery (145.60 kg/ha) 40 kg P_2O_5/ha soil application and two cuts gave the minimum (33.79 kg/ha).

Table 12. Nitrogen recovery from drymatter (kg/ ha)

Number of cuttings	Levels of P_2O_5 applied in soil (kg/ ha)			
	40 (P_1)	80 (P_2)	120 (P_3)	Mean
2 cuts	33.79	51.45	77.61	49.62
3 cuts	52.76	79.60	121.39	76.98
4 cuts	64.94	108.57	145.60	98.50
Mean	50.30	79.85	114.86	

C.D.(0.05) for comparisons involving 120 kg P_2O_5/ha = 4.758

C.D.(0.05) for comparisons between 80 and 40 kg P_2O_5/ha = 3.887

C.D.(0.05) for cutting treatments = 0.261

C.D.(0.05) for comparisons between P_1C, P_2C combinations = 6.736

C.D.(0.05) for comparisons between P_3C combinations = 9.520

C.D.(0.05) for comparisons for P_1C, P_2C Vs P_3C combinations = 8.245

3.1.6 Phosphorus recovery from drymatter

The mean values of phosphorus recovery from cumulative drymatter are presented in Table 13 and the abstract of Analysis of Variance in Appendix XIII.

Phosphorus treatment had significant effect on phosphorus recovery. Application of 120 kg P_2O_5/ha in soil, gave significantly more phosphorus recovery values than 80 kg and 40 kg P_2O_5/ha soil applications. Phosphorus at the rate of 80 kg P_2O_5/ha recorded significantly higher recovery values than 40 kg P_2O_5/ha applied in the soil.

Increasing the number of cuts from 2 to 3 and from 3 to 4 significantly increased the phosphorus recovery in each case.

Interactions between phosphorus treatments and cutting treatments were also significant, the maximum phosphorus recovery value (24.26 kg/ha) being given by the combination of 120 kg P_2O_5/ha soil application and four cuts and the minimum (4.90 kg/ha) by 40 kg P_2O_5/ha soil application and two cuts.

3.1.7 Potash recovery from drymatter

Table 14 gives the mean potash recovery values from cumulative drymatter yields while the abstract of the Analysis of Variance is shown in Appendix XIV.

Table 13. Phosphorus recovery fromdrymatter (kg/ ha)

Number of cuttings.	Levels of P_2O_5 applied in soil (kg/ ha)			
	40 (P_1)	80 (P_2)	120 (P_3)	Mean
2 cuts	4.90	6.89	10.72	6.86
3 cuts	7.80	12.52	20.38	12.20
4 cuts	10.64	16.68	24.26	15.78
Mean	7.78	12.03	18.46	

C.D. (0.05) for comparisons involving 120 kg P_2O_5/ha = 0.779

C.D. (0.05) for comparisons between 80 and 40 kg P_2O_5/ha = 0.616

C.D. (0.05) for cutting treatments .. = 0.675

C.D. (0.05) for comparisons between P_1C, P_2C combinations = 1.065

C.D (0.05) for comparisons between P_3C combinations = 1.508

C.D. (0.05) for comparisons of P_1C, P_2C Vs P_3C combinations = 1.320

Table 14. Potash recovery from drymatter (kg/ ha)

Number of cuts.	Levels of P_2O_5 applied in soil (kg/ ha)			
	40 (P_1)	80 (P_2)	120 (P_3)	Mean
2 cuts	35.10	42.85	57.37	42.65
3 cuts	58.96	74.39	92.08	71.76
4 cuts	78.66	98.60	123.34	95.57
Mean	57.57	71.95	90.93	

C.D.(0.05)for comparisons involving 120 kg P_2O_5/ha = 7.874

C.D.(0.05)for comprisons between 80 and 40 kg P_2O_5/ha = 6.429

C.D.(0.05)for cutting treatments = 7.097

C.D.(0.05)for comparisons between P_1C, P_2C combinations =11.135

C.D.(0.05)for comprisons between P_3C combinations =15.747

C.D.(0.05)for comparisons P_1C, P_2C VS P_3C combinations =13.562

Phosphorus application at the rate of 120 kg P_2O_5/ha in the soil, gave significantly higher potash recovery values than 80 kg P_2O_5/ha and 40 kg P_2O_5/ha applied in the soil. The level 80 kg P_2O_5/ha gave significantly more potash recovery values than 40 kg P_2O_5/ha.

Progressive increase in the number of cuttings from 2 to 3 and from 3 to 4 increased the potash recovery values significantly at each stage.

Phosphorus x cutting interaction was significant with 120 kg P_2O_5/ha soil application and four cuts giving the maximum potash recovery values (123.34 kg/ha) while 40 kg P_2O_5/ha soil application and two cuts ranked the lowest (35.10 kg/ha).

3.2 Seed analysis

3.2.1 Protein content

Mean values of protein content in seeds are given in Table 15 and the abstract of Analysis of Variance in Appendix XV.

It could be seen that treatments had significant effect on the protein content of the seeds. Phosphorus application significantly influenced the seed protein content recording the maximum protein content by soil

Table 15 Protein content (%) in the seed

Number of cuts	Levels and methods of Phosphorus application					
	40 Kg P_2O_5/ha in soil	80 kg P_2O_5/ ha in soil	120 kg P_2O_5/ha in soil	40kg P_2O_5/ha in soil + 40 kg P_2O_5/ha foliar	80 kg P_2O_5/ha in soil + 40kg P_2O_5/ha foliar	Mean
2 cuts	24.03	25.87	27.21	26.94	27.78	26.37
3 cuts	23.56	24.70	28.13	26.35	26.94	25.94
Mean	23.80	25.29	27.67	26.64	27.36	

C.D.(0.05) for P = 1.421

application of 120 kg P_2O_5/ha (P_3) which was on par with application of 80 kg P_2O_5/ha in soil + 40 kg P_2O_5/ha as foliar (P_5) and 40 kg P_2O_5/ha as soil application + 40 kg P_2O_5/ha as foliar (P_4). P_3 and P_5 were significantly superior to P_2 and P_1. P_4 gave higher protein contents but was on par with application of 80 kg P_2O_5/ha as soil application (P_2). These two treatments again recorded significantly higher values of seed protein content than P_1 (application of 40 kg P_2O_5/ha in the soil alone). The treatment, number of cuts had no significant effect on the seed protein content.

Phosphorus X cutting interaction was also not significant.

3.2.2 Phosphorus content

Table 16 gives the mean phosphorus content in the seeds of Stylosanthes gracilis while Appendix XVI gives the corresponding abstract of the Analysis of Variance.

From the mean table it could be seen, that phosphorus treatments significantly influenced the seed phosphorus contents to give significantly higher values at 80 kg P_2O_5/ha soil application + 40 kg P_2O_5/has as foliar (P_5), over 40 kg P_2O_5/ha as soil application + 40 kg P_2O_5/ha as foliar (P_4) and 80 kg P_2O_5/ha as soil application

Table 16. Phosphorus content (mg/ g) in the seed.

Number of cuts.	Levels and methods of phosphorus application					Mean
	40kg P_2O_5/ha in soil	80kg P_2O_5/ha in soil	120 kg P_2O_5/ha in soil	40 kg P_2O_5/ha in soil + 40kg P_2O_5/ha foliar	80 kg P_2O_5/ha in soil + 40 kg P_2O_5/ha foliar	
2 cuts	3.88	4.15	4.50	4.30	4.58	4.29
3 cuts	3.79	4.00	4.20	4.22	4.30	4.10
Mean	3.84	4.08	4.35	4.26	4.44	

C.D.(0.05) for P ... ... = 0.173

C.D.(0.05) for C ... ... = 0.067

C.D.(0.05) for P X C combinations ... = 0.149

(P_2) and 40 kg P_2O_5/ha as soil application (P_1). P_5 was on par with P_3 which in turn was on par with P_4. P_3 and P_4 were significantly superior to P_2 and P_1. The level 80 kg P_2O_5/ha (P_2) in the soil gave significantly higher values for phosphorus contents than application of 40 kg P_2O_5/ha in the soil (P_1).

Reducing the number of cuts from 3 to 2 significantly increased the phosphorus content in the seeds.

Interaction P x C was also significant with P_5C_1 recording the maximum seed phosphorus content and P_1C_2 the least.

3.2.3 Potash content

The mean potash contents in the seeds are given in Table 17 and the abstract of the Analysis of variance in Appendix XVII. Treatments had no significant effect on the potash content in the seeds. However an increasing trend could be observed in the potash content of seeds with the increasing levels of phosphorus applied soil. As for cutting treatment, although leaving the crop for seed setting after three cuts gave slightly more potash content in the seeds than when it was left for seed setting after two cuts, ~~But~~ the effect was not significant. Interactions were also not significant.

Table 17 Potash content (%) in the seed

Number of cuts	Levels and methods of phosphorus application					Mean
	40kg P_2O_5/ha in soil	80kg P_2O_5/ha in soil	120kg P_2O_5/ha in soil	40kg P_2O_5/ha in soil + 40kg P_2O_5/ha foliar	80kg P_2O_5/ha in soil + 40kg P_2O_5/ha foliar	
2 cuts	1.15	1.18	1.20	1.19	1.16	1.17
3 cuts	1.16	1.22	1.18	1.16	1.22	1.19
Mean	1.16	1.20	1.19	1.18	1.19	

4. Soil studies.

4.1 Total nitrogen

The mean values for total nitrogen content in the soil after the experiment are given in Table 18 and the abstracts of the Analyses of variance in Appendix XVIII.

Phosphorus at 120 kg P_2O_5/ha soil application gave the maximum total nitrogen content in the soil which was significantly superior to other phosphorus treatments. The level 80 kg P_2O_5/ha in soil + 40 kg P_2O_5/ha as foliar (P_5) and application of 80 kg P_2O_5/ha in the soil (P_2) were on par and gave significantly higher total nitrogen content in the soil than application of 40 kg P_2O_5/ha in the soil (P_1) and 40 kg P_2O_5/ha in the soil + 40 kg P_2O_5/ha as foliar (P_4). The latter two treatments were on par.

Cutting treatment had no significant effect on the total nitrogen content in the soil. However an increasing trend in the total nitrogen content in the soil could be observed with increase in the number of cuts.

Interaction P x C was significant and P_3C_3 gave the maximum value (2553.33 kg/ ha) for total nitrogen content in the soil while P_4C_3 gave the least (2366.67 kg/ha)

Table 18 Total nitrogen content in the soil (kg/ ha)

Number of cuts.	Levels and methods of phosphorus application					Mean
	40kg P_2O_5/ha in soil	80kg P_2O_5/ha in soil	120kg P_2O_5/ha in soil	40kg P_2O_5/ha in soil + 40kg P_2O_5/ha foliar	80kg P_2O_5/ha in soil + 40kg P_2O_5/ha foliar	
2 cuts	2386.7	2426.7	2506.7	2400.0	2445.7	2433.3
3 cuts	2380.0	2473.3	2520.0	2386.7	2453.3	2442.7
4 cuts	2393.0	2453.3	2553.3	2366.7	2466.7	2446.7
Mean	2386.7	2451.1	2526.7	2384.4	2455.6	

C.D(0.05) for P .. .. = 14.54

C.D.(0.05) for P X C combinations .. .. = 21.47

4.2. Available phosphorus

Table 19 gives the available phosphorus content in the soil after the experiment and Appendix XIX gives the abstract of the Analysis of variance.

Application of 120 kg P_2O_5/ha (P_3) in the soil, gave significantly higher phosphorus content in the soil than other phosphorus treatments. The level 80 kg P_2O_5/ha applied in the soil + 40 kg P_2O_5/ha as foliar (P_5) was found to be on par with 80 kg P_2O_5/ha applied in the soil alone (P_2). P_5 and P_2 were superior to application of 40 kg P_2O_5/ha in the soil + 40 kg P_2O_5/ha as foliar (P_4) and 40 kg P_2O_5/ha in the soil alone (P_1). P_4 and P_1 were on par.

Number of cuts taken had no significant effect on the available phosphorus content in the soil.

Interaction P x C was found significant and when P_3C_3 gave the maximum available phosphorus content in the soil (63.33 kg/ha) P_1C_2 gave the least (46.67 kg/ha).

4.3. Available potash content

The mean values for available K_2O content in the soil are given in Table 20 and the Analysis of variance abstract in Appendix XX.

Table 19 Available Phosphorus content in the soil (kg/ ha)

Number of cuts	Levels and methods of phosphorus application					Mean
	40kg P_2O_5/ha in soil	80kg P_2O_5/ha in soil	120kg P_2O_5/ha in soil	40kg P_2O_5/ha in soil + 40kg P_2O_5/ha foliar	80kg P_2O_5/ha in soil + 40kg P_2O_5/ha foliar	
2 cuts	51.33	60.67	61.33	47.33	58.66	55.86
3 cuts	46.67	56.00	63.31	48.67	55.33	54.01
4 cuts	50.00	53.33	63.33	52.67	59.67	55.00
Mean	49.33	56.67	62.68	49.56	57.22	

C.D. (0.05) for P ... ... = 1.854

C.D. (0.05) for P X C combinations ... = 3.198

Table 20 Available Potassium in the soil (kg/ ha)

Number of cuts	Levels and methods of Phosphorus application					Mean
	40kg P_2O_5/ha in soil	80 kg P_2O_5/ha in soil	120 kg P_2O_5/ha in soil	40kg P_2O_5/ha in soil + 40kg P_2O_5/ha foliar	80 kg P_2O_5/ha in soil + 40kg P_2O_5/ha foliar	
2 cuts	26.00	26.00	27.33	24.66	27.33	26.26
3 cuts	26.67	25.33	28.00	28.00	27.33	27.06
4 cuts	26.00	26.66	27.33	28.00	27.33	27.06
Mean	26.22	26.00	27.55	26.89	27.33	

Phosphorus treatments had no significant effect on the available potash content in the soil.

Number of cuts taken also had no significant effect on the available potash content of the soil and the same held good for the interaction P X C also.

4.4 Cation exchange capacity

The mean cation exchange capacities of the soil after the experiment are given in Table 21 and the abstract of the Analysis of variance in Appendix XXI.

Phosphorus treatments had significant effect on cation exchange capacity of the soil. Application of 120 kg P_2O_5/ha in the soil (P_3) gave significantly higher cation exchange capacity of soil than all other phosphorus treatments. Application of 80 kg P_2O_5/ha in the soil + 40 kg P_2O_5/ha as foliar (P_5) was on par with application of 80 kg P_2O_5/ha in the soil alone (P_2). P_5 and P_2 gave significantly higher cation exchange capacity values than application of 40 kg P_2O_5/ha in the soil (P_1) and 40 kg P_2O_5/ha in the soil + 40 kg P_2O_5/ha as foliar (P_4). P_1 and P_4 were on par.

Table 21. Cation exchange capacity of the soil (m.e./100 grams)

Number of cuts	Levels and methods of Phosphorus application					Mean
	40kg P_2O_5/ha in soil	80kg P_2O_5/ha in soil	120 kg P_2O_5/ha in soil	40kg P_2O_5/ha in soil + 40kg P_2O_5/ha foliar	80 kg P_2O_5/ha in soil + 40kg P_2O_5/ha foliar	
2 cuts	4.00	4.52	4.84	4.06	4.48	4.38
3 cuts	4.07	4.63	4.96	4.05	4.51	4.45
4 cuts	4.25	4.37	4.96	4.05	4.55	4.44
Mean	4.11	4.51	4.92	4.06	4.52	

C.D. (0.05) for P = 0.170.

Table 22 Values of simple correlation coefficients

1. Seed yield	x	Height of plants at flowering	= 0.66752**
2. Seed yield	x	Spread of plants at flowering	= 0.73016**
3. Seed yield	x	Protein content in the seed	= 0.71169**
4. Seed yield	x	Greenmatter yield	=-0.64870**
5. Total nitrogen content in the soil	x	Total protein yield from drymatter	= 0.64210**

** Significant at 1% level.

The number of cuts of green fodder taken before the crop was left for seed setting had no influence on the cation exchange capacity of the soil. Interactional effect was also not significant.

5. Correlation studies

The values of simple correlation coefficients are presented in Table 22. It was found that seed yield was significantly and positively correlated with height and spread of plants at flowering and protein content in the seed and the respective correlation coefficients were 0.66752, 0.73016 and 0.71169. Seed yield was significantly and negatively correlated with greenmatter yield, the correlation coefficient being -0.64870. Total nitrogen content in the soil was significantly and positively correlated with total protein yield from drymatter, the correlation coefficient being 0.64210.

DISCUSSION

DISCUSSION

An experiment was conducted in the Instructional farm attached to the College of Agriculture, Vellayani during the period from July 1979 to April 1980 to find out the effect of levels as well as the methods of application of phosphorus and number of cuts of green fodder on the seed production of *Stylosanthes gracilis*, under rainfed conditions. The effects of the treatments on growth, yield of greenmatter, quality and nutrients recovery from the crop were also studied. The results of the experiment are discussed below.

1 Growth characters

1.1 Height

(Tables 1.1 to 1.5, Fig.3 and Appendices I(a) to I(e).)

From the results, it was found that the height of *Stylosanthes gracilis* was increased by the higher levels of phosphorus applied in the soil, in all the four stages of cuts as well as at the time of flowering. This may be due to the influence of phosphorus on meristematic activity (Black, 1968) and also because, phosphorus was utilised for synthesis of higher molecular compounds for growth (Tamaki and Naka, 1971). Similar increase in plant height due to phosphorus application was observed by Jones (1974) on Stylosanthes species, (Anon (1976, b) on lucerne and Mariappan (1978) on Stylosanthesgracilis.

Combined application of phosphorus as soil + foliar was found to give lower mean values of plant heights at flowering when compared to the same amount of phosphorus applied completely as basal. Thus 40 kg P_2O_5/ha as soil + 40 kg P_2O_5/ha through foliar application and 80 kg P_2O_5/ha as soil + 40 kg P_2O_5/ha as foliar application gave lower heights than 80 kg P_2O_5/ha as soil application and 120 kg P_2O_5/ha as soil application respectively. It is obvious that this was another result to show that the plant heights increased with increase in the dose of phosphorus applied in the soil. Foliar application of phosphorus did not show any additional effect on plant heights probably because the treatment was given at a later stage and could not give any beneficial effect on nodulation and root growth.

It was found that increasé in the number of cuts significantly reduced the plant height at flowering.

This may be because as the number of cuts increased, the interval between the last cut and flowering was reduced which in turn resulted in less period of time for the plants to grow. Again as the number of cuts increased more number of secondary and tertiary buds developed and thus due to the activity of more number of meristematic tissue the height of the plants was reduced.

The interactional effect between phosphorus application and cutting treatments at flowering was found significant. Perhaps increased levels of phosphorus application might have increased the meristematic activity of the larger number of meristems functioning as a result of more number of cuts and thus reduced the effect of increasing number of cuts on height.

1.2 Spread

(Tables 2.1 to 2.5, Fig.4 and Appendices II(a) to II(e).)

Spread of plants at the time of all four cuts and at flowering, significantly increased with increase in the rate of phosphorus applied in the soil. As in the case of height this may be-cause of increased meristematic activity. At flowering the spread , resulting from

FIG. 3 HEIGHT OF PLANTS AS INFLUENCED BY LEVELS OF PHOSPHORUS APPLICATION IN SOIL.

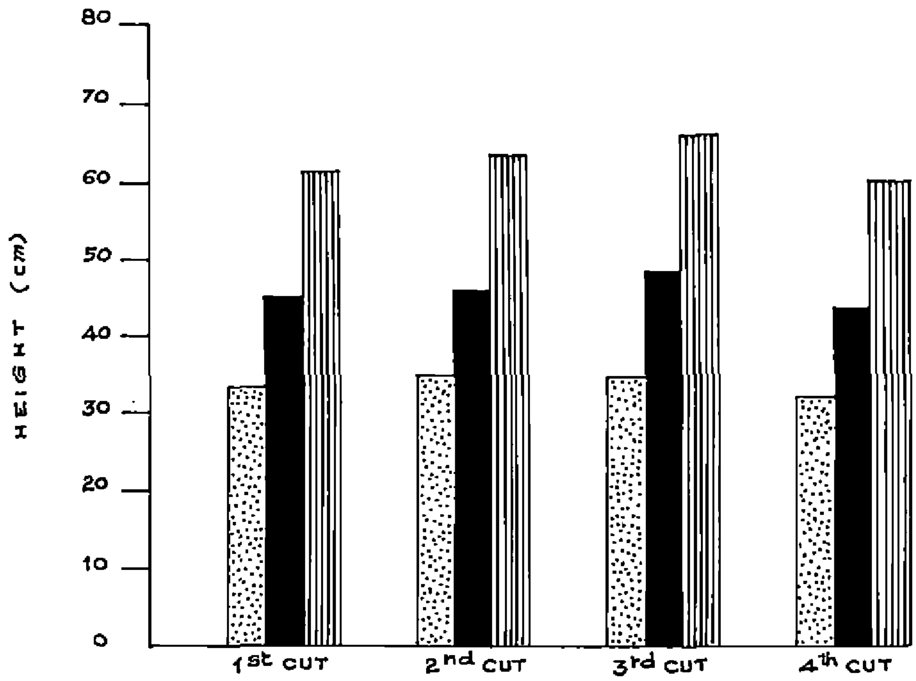
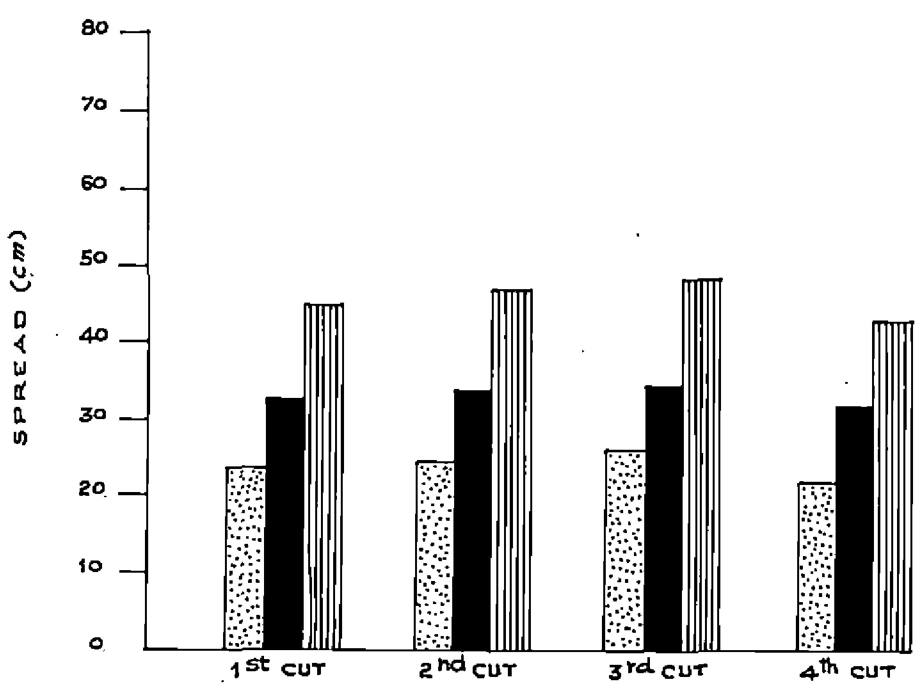


FIG. 4 SPREAD OF PLANTS AS INFLUENCED BY LEVELS OF PHOSPHORUS APPLICATION IN SOIL.



combined application of phosphorus as soil + foliar was significantly lower than that obtained when the same quantity was given completely as soil application. This again illustrates that increase in the dose of phosphorus applied in the soil significantly increased plant spread. Foliar application did not give any additional effect on plant spread since it was given at a later stage and could not influence nodulation and root growth. Increased plant spread due to application of phosphorus has been reported by Sharma and Lavania (1980) in _Vicia hirsuta_ and _Vicia sativa_.

As in the case of height, with increase in the number of cuts, plant spread reduced significantly, probably because of the less amount of time interval available for growth between the last cut and flowering and also because of more number of secondary and tertiary buds developing resulting in larger number of total functional meristems.

Interactional effect between phosphorus and cutting treatments was found to be significant. The increased meristematic activity brought about bythe application of phosphorus might have lessened the reduction in spread resulting from more number of cuts and more number of functional meristems.

1.3 Leaf : stem ratio

(Tables 3.1 to 3.4 and Appendices III (a) to III (d))

Increasing the dose of phosphorus applied in the soil significantly increased the leaf : stem ratio in <u>Stylosanthes gracilis</u>. In all four cuts application of 120 kg P_2O_5/ha gave significantly higher values of leaf : stem ratio than the other two levels. The level 80 kg P_2O_5/ha applied in the soil gave significantly higher values of leaf: stem ratio than 40 kg P_2O_5/ha as soil application in the first three cuts, but they were on par in the last cut. This may be because during the last stages of crop growth the difference might have diminished. Increase in the leaf:stem ratio due to phosphorus application has been reported in cowpea varieties E.C. 4216 and local (Anon 1974) and in lucerne (Anon 1976, b) where application of 200 kg P_2O_5/ha recovered the maximum leaf: stem ratio. Mariappan (1978) also obtained an increasing trend with increase in the levels of phosphorus application, upto 120 kg P_2O_5/ ha in <u>Stylosanthes gracilis</u>. Increased leaf:stem ratio resulting from phosphorus application might be due to increased nitrogen availability because of better nodule development (Tables 4 and 5).

1.4 Nodulation

(Tables 4 and 5 and Appendices IV and V)

Increasing the dose of phosphorus applied in the soil significantly increased nodule number and nodule weight in Stylosanthes gracilis. It is well known that phosphorus has tremendous influence on nodulation in legumes because of its role in increasing microbial activity by enhancing the availability of molybdehum. Increased nitrogen fixation due to phosphorus application has been reported by Wendt (1970) in Stylosanthes gracilis. Olsen and Moe (1971) in Desmodium intortum, Medicago sativa and Stylosanthes gracilis, Gates (1974) in Stylosanthes humilis, Singh (1975) in Trifolium alexandrinum, Mariappan (1978) in Stylosanthes gracilis, had all reported increased nodulation with increase in the dose of phosphorus applied. Foliar application of phosphorus had no effect on nodulation because it was given at a later stage when nodules had already been formed.

The cutting schedules were found to have no significant influence on the nodule number and weight and it maybe presumed that there was no direct relation between the top removal of the plants and the activity of the microorganisms. However an increasing trend was observed in the weight of root nodules with increase in the number of cuts.

2. Yield

2.1 Greenmatter yield

(Tables 6.1 to 6.5, Fig.5 and Appendices VI (a) to VI (e))

Greenmatter yields from each cut as well as the cumulative yield were significantly increased with increase in the level of phosphorus applied in the soil. Thus application of 120 kg P_2O_5/ha produced the maximum cumulative greenmatter yield which was 29 per cent more than that produced by applying 80 kg P_2O_5/ ha in the soil which again gave 25 per cent more yield than that obtained from application of 40 kg P_2O_5/ha in the soil.

Increase in greenmatter yield due to phosphorus application might be due to the increase in height and spread of plants with increase in the dose of phosphorus applied (Tables 1.1 to 1.5 and 2.1 to 2.5).

Increase in greenmatter yield of legumes with phosphorus application has been reported by Singh et al. (1972), Anon (1976,b) Dhar (1978), Mariappan (1978) and Singh (1979).

Cutting schedules had significant effect on total or cumulative greenmatter yield. Increasing the number of cuts significantly increased greenmatter yield. As the number of cuts was increased from 2 to 3 there was 56 per cent increase in greenmatter yield while there was 28.7 per cent increase when the number of cuts was increased from 3 to 4.

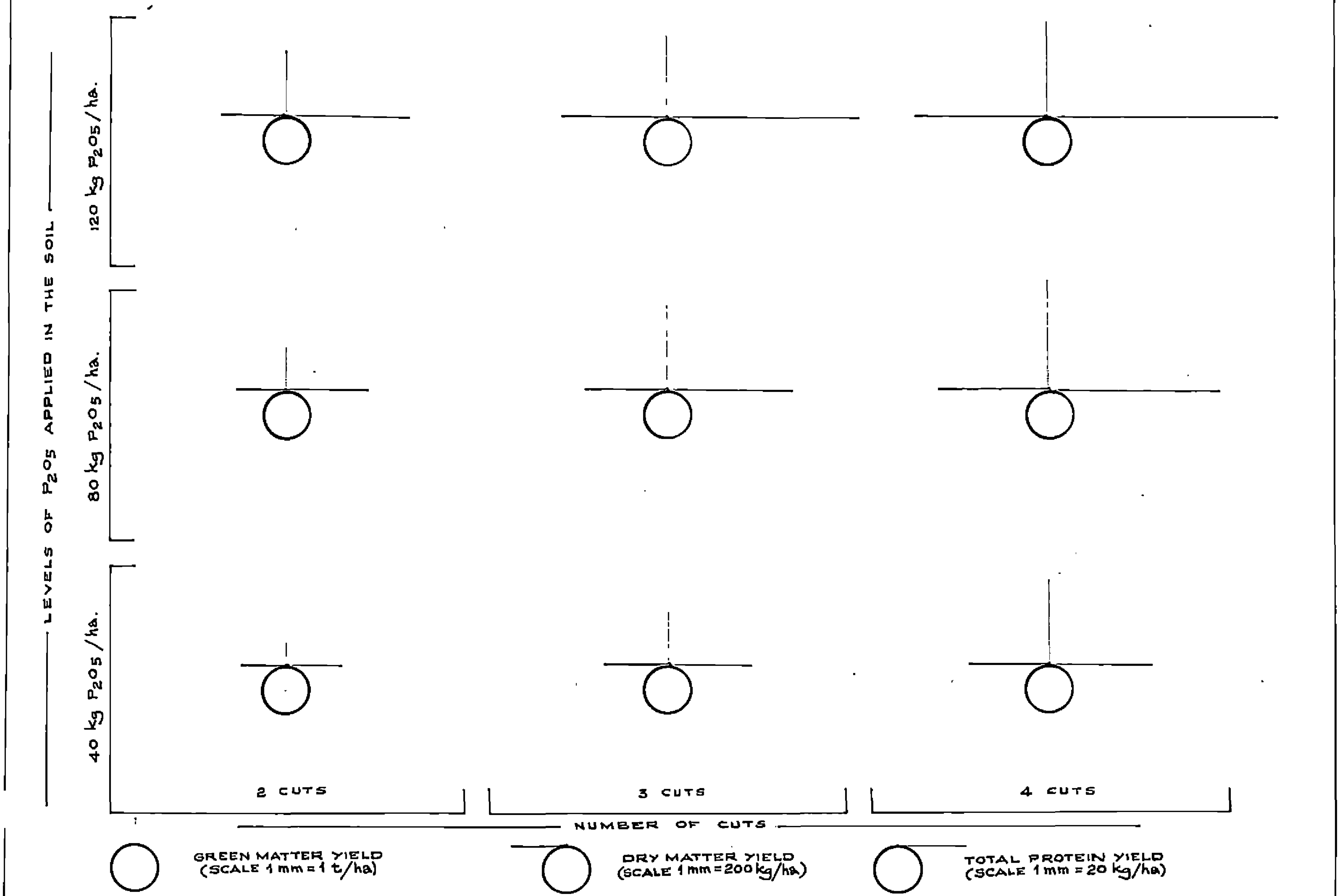
Interaction between phosphorus and cutting treatments was also significant. The additional quantity of greenmatter that could be harvested by increasing the number of cuts must have been enhanced by the increase in the dose of phosphorus application.

2.2 Drymatter yield

(Tables 7.1 to 7.5, Fig.5 and Appendices VII(a) to VII (e))

Drymatter yield showed the same trend as in the case of greenmatter yield. Significant increase was obtained with increase in the dose of phosphorus applied in the soil. Thus application of 120 kg P_2O_5/ha in the soil gave the maximum values for drymatter yield obtained in all the cuts as well as cumulative drymatter yield. Increase in the height and spread of plants on application of higher dose of phosphorus might have contributed to the increase in drymatter. Increased drymatter yields on

FIG. 5. GREEN MATTER YIELD, DRY MATTER YIELD AND PROTEIN YIELD AS INFLUENCED BY LEVELS OF PHOSPHORUS AND NUMBER OF CUTS.



application of phosphorus has been reported by Shaw et al. (1966) and Fisher (1970) in Stylosanthes humilis, Olsen and Moe (1971) in Desmodium intortum, Medicago sativa and Stylosanthes gracilis, and by Bruce (1974) and Mariappan (1978) in Stylosanthes gracilis.

Significant increase in the total drymatter yield was noted with increase in the number of cuts presumably because of the more amount of greenmatter harvested.

As in the case of total greenmatter yield, the interaction between phosphorus and cutting treatments was significant. The higher values of drymatter obtained due to the increased number of cuts might have been increased by the increase in the rate of phosphorus applied in the soil.

2.3 Seed yield

(Table 8, Fig.6 and Appendix VIII)

Phosphorus application which plays a major role in flowering and seed setting of plants gave significant increase in the seed yield of Stylosanthes gracilis. Combined application of 80 kg P_2O_5/ha in soil + 40 kg P_2O_5/ha as foliar gave the maximum yield which was followed by 40 kg P_2O_5/ha in soil + 40 kg P_2O_5/ha as foliar application. Thus it could be seen that as far as seed production was concerned foliar application of phosphorus gave the best results. This might be because the phosphorus sprayed at the later stages of crop growth was better utilised for flowering and seed production due to its quicker and better availability in the period of its necessity. This is very explicit in the fact that 120 kg P_2O_5/ha given in the soil was on par with 40 kg P_2O_5/ha soil application + 40 kg P_2O_5/ ha as foliar. Considering the difference in seed yield obtained from 80 kg P_2O_5/ ha soil application + 40 kg P_2O_5/ ha as foliar and 40 kg P_2O_5/ha soil application + 40 kg P_2O_5/ ha as foliar it can be presumed that increase in the basal dose of phosphorus given in the soil might have increased the total foliage (Tables 3.1 to 3.4) and thus facilitated better absorption of phosphorus applied as foliar. Increase in the dose of phosphorus applied in the soil alone has also been found to increase the seed yield.

Increased seed yield due to increase in phosphorus application in the soil has been reported in Stylosanthes humilis by Shelton and Humphreys (1971), Wickham et al. (1977) Rai and Kanodia (1980)

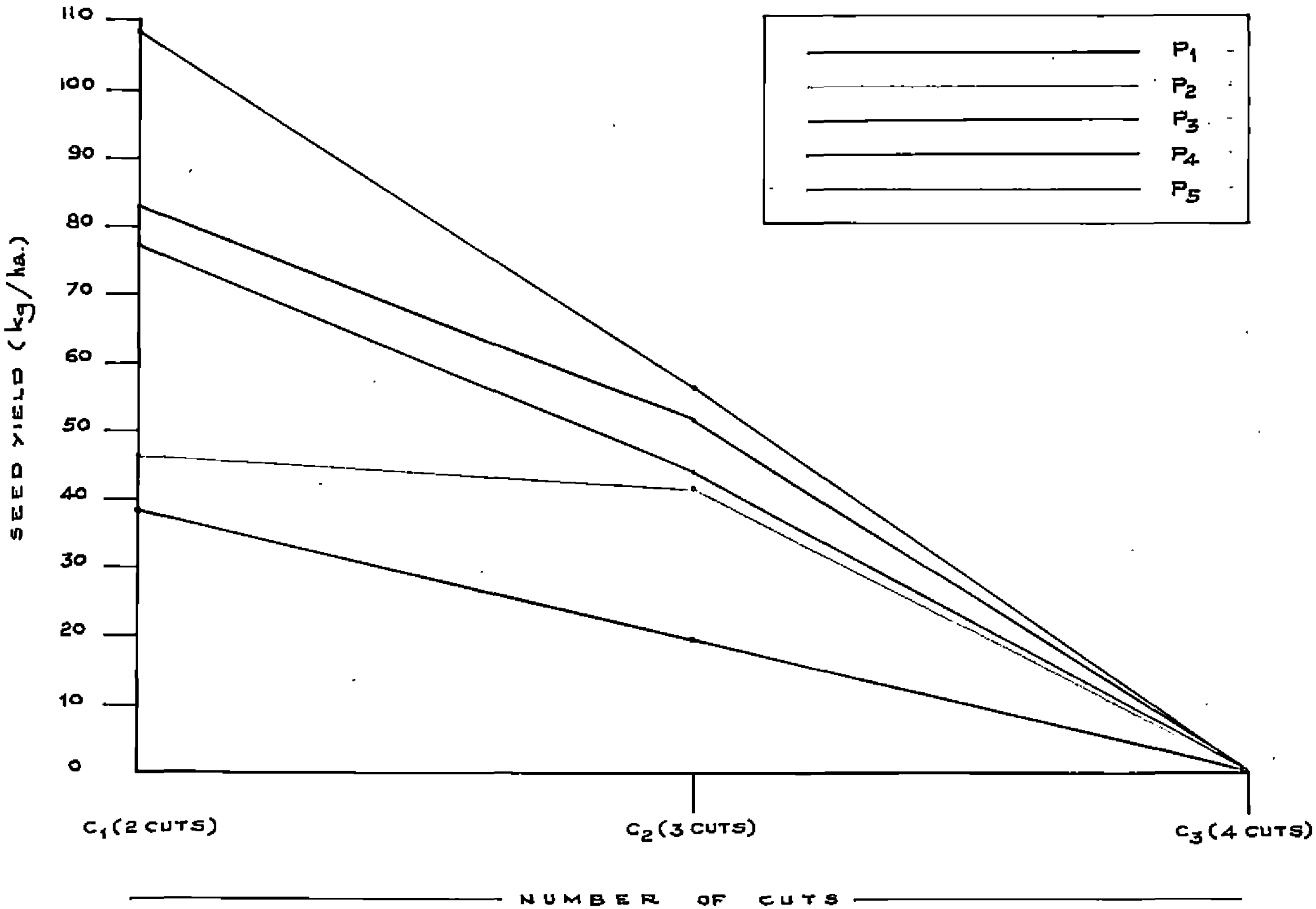
Similarly, increase in seed yield due to foliar application of phosphorus in berseem has been reported by

Singh and Pandey (1969) who observed that spray fertilization increased the seed yield when the crop was left for seedsetting after the second cut. Gill et al. (1971), Gorde and Kibe (1973), Anon (1978, c) all reported increased seed yield with foliar application of phosphorus

In the present study significant reduction in seed yield was noted with increase in the number of cuts. Two cuts gave the maximum mean seed yield followed by 3 cuts, while 4 cuts yielded no seed. Increasing the number of cuts to as much as four cuts had left the crop, little time to accumulate enough food material for producing enough flowers. The plants which were left for seedsetting after two cuts had enough time to putforth more fresh branches and set more flowers compared to the short time that was available to those plants which were allowed to set seed only after three cuts and four cuts. Batra and Gill (1967), Singh and Pandey (1969) Konstantinova and Danilov (1973), Pačuta (1973) Anon (1976, c), Anon (1978, c) all provided evidences to show that seed yield decreased with increase in the number of cuts.

Correlation studies showed that seed yield was significantly and positively correlated with height and spread of the plants at flowering. This can be attributed due to the better vegetative growth of the plants which might have

FIG. 6. SEED YIELD AS INFLUENCED BY LEVELS AND METHODS OF PHOSPHORUS APPLICATION AND NUMBER OF CUTS.



enabled them to produce more flowers and seeds. Seed yield was significantly and negatively correlated with greenmatter yield. Increasing the number of cuts increased the greenmatter yield, which in turn decreased the seed yield. This was because of the less amount of time available between the last cut and flowering due to the increase in number of cuts which resulted in less flower production and seedset.

3. Chemical composition of the drymatter.

3. 1. Crude protein in drymatter

(Tables 9.1 to 9.5, Fig.5 and Appendices IX (a) to IX(c))

The crude protein content of the dryfodder at each cut as well as the total protein yield from all the cuts were found to increase significantly with increase in the dose of phosphorus applied in the soil. Application of phosphorus might have increased the availability of nitrogen for assimilation by the plants which in turn might have enhanced the protein content. Phosphorus application might also have promoted the activity of nodule bacteria (Tables 4 and 5) resulting in higher nitrogen fixation. Increase in the protein content or nitrogen content of legume plants with increase in the dose of phosphorus applied has been reported by MirMustafa Husain et al (1978) and Dhar (1978) in berseem, Shaw et al (1966) in Stylosanthes humilis, Keya and Kalangi (1973) in Desmodium uncinatum and Mariappan (1978) in Stylosanthes gracilis.

Increasing the number of cuts, significantly increased the total protein yield. With increase in the number of cuts the drymatter yield also increased which led to higher total protein yield.

Interaction between phosphorus and cutting treatments also was significant in the case of total protein yield. Total protein recovery from drymatter was positively correlated with ~~total greenmatter yield and~~ total nitrogen content in the soil significantly.

3\. 2. Phosphorus in drymatter

(Tables 10.1 to 10.4 and Appendices X(a) to X (d)).

In all the four cuts the phosphorus content in the plants significantly increased with increase in the dose of phosphorus applied in the soil from 40 to 80 and from 80 to 120 kg P_2O_5/ha. Increasing the rate of phosphorus applied in the soil might have increased its availability and consequent assimilation by the plants which resulted in higher phosphorus values of the plant. Sasidhar and George (1972), Mir Mustafa Husain et al. (1976), Dhar (1978) and

Mariappan (1978) have all obtained similar results in the case of various legumes they tried.

3. 3. Potash in drymatter

(Tables 11.1 to 11.4 and Appendices XI (a) to XI(d))

Only in the fourth cut phosphorus application had significant effect on the potassh content of the plant. In the fourth cut application of 120 kg P_2O_5/ha in the soil was found to be significantly superior to the lower levels which were all on par although an increasing trend was found in the potash content with increase in the level of phosphorus applied in the soil from 40 kg to 80 kg P_2O_5/ha. In the early stages soil potassium was sufficiently available to the crop. But with time the potassium available in the soil might have diminished because of the continuous removal by the crop. The role of phosphorus in increasing the potash uptake by the plants might have now come into play and there was no much difference between 40 kg and 80 kg P_2O_5/ha applied in the soil but the highest level of 120 kg P_2O_5/ha applied in the soil could bring significant effect in potash content in the drymatter in the fourth cut. Increase in the potassium content of herbage with increase in the dose of phosphorus applied has been noted by Fogeria (1977) and Mariappan (1978).

4. Nutrient recovery from drymatter.

4. 1. Nitrogen

(Table 12 and Appendix XII)

The total nitrogen recovery from cumulative drymatter increased significantly with increase in the dose of phosphorus applied in the soil. Phosphorus application must have increased the nitrogen assimilation by the plants due to better nitrogen fixation resulting in higher nitrogen contents per unit drymatter. Increased nitrogen content in plants with increase in the dose of phosphorus applied has been reported by Mir Mustafa Husain et al. (1976) and Dhar (1978) in berseem, Shaw et al. (1966) in *Stylosanthes humilis* and Mariappan (1978) in *Stylosanthes gracilis*. Phosphorus also increased the drymatter yieldin all four cuts significantly with increase in its rate of application. Thus by both these ways it might have enhanced the total nitrogen recovery.

Number of cuttings also showed significant effect on total nitrogen recovery. With increase in the number of cuts the total drymatter yield increased and thus the total nitrogen recovery also increased.

Interaction of phosphorus and number of cuts was also significant; increase in the dose of phosphorus might have increased the amount of drymatter and total nitrogen that could be obtained by increased number of cuts.

4. 2 Total phosphorus

(Table 13 and Appendix XIII)

As in the case of nitrogen recovery, increase in the dose of phosphorus significantly increased the total phosphorus recovery. Again, phosphorus might have acted in two ways. The first role was to increase the phosphorus content per unit drymatter which was discussed earlier and the second role was to increase the drymatter yields in all four cuts. The net result was, increased phosphorus recovery with increase in the rate of phosphorus application.

Invariably, increasing the number of cuts significantly increased the total drymatter yield which in turn resulted in increased phosphorus recovery.

Interaction between phosphorus and cutting treatments was also found to be significant. The increased doses of phosphorus application resulted in increasing the amount of drymatter as well as phosphorus content of the plants resulting in higher phosphorus recovery.

4. 3 Total potash

(Table 14 and Appendix XIV)

Significant increase in potash recovery values was obtained with increase in the dose of phosphorus applied in the soil. In the first three cuts, increase in the dose of phosphorus application might have contributed to increase the potash recovery by merely increasing the drymatter yields. In the fourth cut increase in the level of phosphorus was found to increase the potash content in the plants besides increasing the drymatter yields. Thus in these two ways it might have increased the total potash recovery in the fourth cut.

Increasing the number of cuts increased the potash recovery values significantly because of the increase in total drymatter obtained as in the case of nitrogen and phosphorus recoveries.

Here again the significant interaction between phosphorus and cutting treatments might be accounted for by the increase in total drymatter due to increase in phosphorus application and the increase in number of cuts.

5. <u>Chemical composition of seed.</u>

5. 1 Crude protein

(Table 15 and Appendix XV)

The results show that application of 120 kg P_2O_5/ha in the soil was as good as applying 80 kg P_2O_5/ha in the soil + 40 kg P_2O_5/ha as foliar or 40 kg P_2O_5/ha in the soil +

40 kg P_2O_5/ha as foliar with regard to the crude protein content in the seed. This shows that foliar application of 40 kg P_2O_5/ha was found to be helpful in increasing the protein content irrespective of the quantity applied in the soil. May be phosphorus has been better absorbed through the foliage thereby resulting in increased crude protein content in the seeds. Phosphorus at the rate of 40 kg P_2O_5/ha applied in the soil + 40 kg P_2O_5/ha as foliar was on par with 80 kg P_2O_5/ha applied in the soil alone, because at the lower levels of phosphate application in the soil, nodulation was adversely affected. This resulted in reduced nitrogen assimilation and hence less protein content in the seed. Phosphorus at the rate of 80 kg /ha applied in the soil gave higher protein content than 40 kg P_2O_5/ha soil application because of better nodulation and nitrogen assimilation.

Increase in the protein content of legume seeds with increase in the dose of phosphorus application has been reported by Singh et al (1971), Kesavan and Morachan (1973) and Panwar and Singh (1975).

Cutting treatments had no significant effect on the protein content in the seed as number of cuts taken had no direct effect on the protein content of the seed.

Interaction between phosphorus and cutting treatments was also not significant.

Seed protein content was positively correlated with seed yield significantly. The high levels of phosphorus which brought about increased seed yield was also responsible for increased seed protein contents.

5. 2 Phosphorus

(Table 16 and Appendix XVI)

Increase in the dose of phosphorus applied, whether as combined application in the soil + foliar or as soil application alone, resulted in increase in the phosphorus content of the seeds. In the case of 80 kg P_2O_5/ ha soil application 40 kg P_2O_5/ha as foliar (P_5) and 120 kg P_2O_5/ha applied in the soil alone (P_3), the phosphorus content in the seed was almost the same in both the treatments may be because the total phosphorus applied was the same. Similarly phosphorus content of the seed was also enhanced by the application of 40 kg P_2O_5/ha in soil + 40 kg P_2O_5/ ha as foliar which was on par with 120 kg P_2O_5/ ha applied in the soil alone. This shows that the increase was due to the foliar application though the total quantity applied was less than when the phosphorus was completely applied in the soil. Comparison between the application of 80 kg P_2O_5/ha in soil + 40 kg P_2O_5/ha (P_5) as foliar and 40 kg P_2O_5/ ha soil + 40 kg P_2O_5/ha (P_4) as foliar showed that P_5 was significantly superior to P_4, may be due to the combined effect of the increase in total quantity and the foliar application. Increase in the phosphorus contentof the seed was noted by the increase in the dose of phosphorus applied in the soil.

Increase in the phosphorus content of seeds with increase in the dose of phosphorus applied has been observed by Mascarenhas et al.(1969). Robinson and Jones (1972) found that *Stylosanthes humilis* showed a very marked ability to translocate nutrients to the seed. Bartz (1959) has given evidence of foliar application of phosphorus giving increased phosphorus content in peas.

Reducing the number of cuts from 3 to 2 significantly increased the phosphorus content in tho seeds. The phosphorus content in the plants was found to be higher in the latter stages of crop growth than in the early stages. Thus large quantity of phosphorus absorbed was prevented from being translocated to the seeds by the third cut.

Interaction between phosphorus and cutting treatments was also significant. The positive effect of increased phosphorus application in increasing the phosphorus content of the seeds was reduced by the adverse effect brought about when the number of cuts was raised from two to three.

5. 3 Potash

(Table 17 and Appendix XVII)

Phosphorus treatments had no significant effect on the potash content of seeds. But an increasing trend in the potash content of seeds was observed with increase in the dose of basal soil application of phosphorus. Mascaronhas et al. (1969) and Georgeiev (1977) gave evidences of phosphorus application increasing the potassium content in seeds.

Number of cuts taken had no significant effect on the potash content of the seeds which indicated that number of cuts had no direct effect on the potash content in the seeds.

Interaction between phosphorus and cutting treatments was also not significant as both treatments together had no effect to exert on the potash content in the seeds.

6. Soil studies.

6. 1 Total nitrogen

(Table 18 and Appendix XVIII)

From the results it may be noted that as the level of phosphorus applied in the soil was increased from 40 to 120 kg P_2O_5/ha by any method (soil alone or soil + foliar applications) the total nitrogen content in the soil increased significantly. Thus foliar application of phosphorus had no additional effect on the total nitrogen content in the soil beyond that resulting from the soil applications. This may be because that the nodulation was effective only when phosphorus was given in the soil early. The significant increase in nitrogen content of the soil with increase in the dose of phosphorus applied in the soil might be due to higher rates of symbiotic nitrogen fixation and excretion of the fixed nitrogen into the soil by the leguminous crop. Increase in the nitrogen content of soil with increase in the dose of phosphorus applied, had been observed by Sasidhar (1969), Garg et al. (1970), Chatterjee et al. (1972), Nihal Singh and Khatri (1972), Sahu and Behera (1972), Sahu (1973), Singh and Singh (1975), Bruce (1974) and Mariappan (1978).

Cutting treatments had no significant effect on nitrogen content in the soil. However, an increasing trend in the nitrogen content of the soil was observed with increase in the number of cuts. This might be accounted for by the similar increasing trend observed in the weight of root nodules.

Interaction between phosphorus and cutting treatments was also significant. Increase in the dose of phosphorus applied in the soil resulting in increased symbiotic nitrogen fixation and the increasing trend in nodule weight set by the increase in number of cuts together might have increased the total nitrogen content in the soil.

6. 2 Available phosphorus

(Table 19 and Appendix XIX)

As in the case of total nitrogen content application of 120 kg P_2O_5/ha in the soil gave the maximum phosphorus content in the soil which was significantly superior to all other levels. P_5 and P_2 were on par and superior to P_4 and P_1 which again were on par. This shows that foliar application of phosphorus had no additional effect on the phosphorus content of the soil beyond that produced by the soil application. Thus only the increase in phosphorus levels applied to the soil, gave significant increase in available phosphorus content of the soil. Increase in available phosphorus content of the soil with increase in the dose of phosphorus applied has been obtained by Garg et al. (1970), Nihal Singh and Khatri (1972), Lutz (1973), Singh and Singh (1975), Bruce (1974) and Mariappan (1978).

Cutting treatments had no significant effect on the available phosphorus content of the soil.

Interaction between phosphorus and cutting treatments was significant may be due to the high doses of phosphorus application which might have influenced to give this effect.

6. 3 Available potash

(Table 20 and Appendix XX)

Neither the phosphorus levels nor cutting treatments had any significant effect on the available potash content in the soil. Since phosphorus and cutting treatments had little effect on the plant or seed content of potash, it could be understood why the potash content in the soil did not vary significantly. Savithri (1980) has given evidence of available potassium content of the soil as not influenced by the levels of phosphorus applied.

6. 4 Cation exchange capacity

(Table 21 and Appendix XXI)

Phosphorus treatments alone had significant effect on cation exchange capacity of the soil. Phosphorus at the rate of 120 kg P_2O_5/ha applied in the soil gave the highest C.E.C. values and it was significantly superior to all other phosphorus treatments. P_5 and P_2 were on par and superior to P_1 and P_4 which again were on par. Thus here again only the phosphorus applied in the soil influenced the cation exchange capacity of the soil and foliar application of phosphorus did not give any additional effect beyond that produced by the soil dressing. Increase in the cation exchange capacity values with increase in the dose of phosphorus applied in the soil was observed by Singh and Singh (1975) in *Stylosanthes humilis* and Bruce (1974) in *Stylosanthes guyanensis*.

Economics

The economics of levels and methods of phosphorus application and number of cuts in *Stylosanthes gracilis* presented in Table 23 revealed that the treatment combination of 80 kg P_2O_5/ha soil application + 40 kg P_2O_5/ha foliar application and two cuts gave the maximum net profit of Rs.5921.36 per hectare while 40 kg P_2O_5/ha soil application + 40 kg P_2O_5/ha foliar application and four cuts gave the lowest net profit of Rs.582.45 per hectare. Treatment combination of 120 kg P_2O_5/ha soil application + 40 kg P_2O_5/ha foliar application and two cuts gave the second highest net profit of Rs.4996.7 per hectare.

Table 23 Economics of levels and methods of phosphorus application and number of cuts in *Stylosanthes gracilis*.

Treatments	Cost of production excluding treatments Rs	Addl. cost of treatments Rs	Total cost of production Rs	Yield of seed kg/ha	Yield of green matter kg/ha	Value of seed Rs	Value of green matter Rs	Total revenue Rs	Net profit Rs
P_1C_1	1793.40	800	2593.40	38.67	8823.60	2320.20	2205.90	4526.10	1932.70
P_1C_2	1793.40	1100	2893.40	19.61	13121.02	1176.60	3280.26	4456.86	1563.46
P_1C_3	1793.40	1400	3193.40	0.00	16503.40	0.00	4125.85	4125.85	932.45
P_2C_1	1793.40	1000	2793.40	46.84	10506.62	2810.40	2626.66	5437.06	2643.66
P_2C_2	1793.40	1300	3093.40	41.40	16944.58	2484.00	4236.15	6720.15	3626.75
P_2C_3	1793.40	1600	3393.40	0.00	22500.18	0.00	5625.05	5625.05	2231.65
P_3C_1	1793.40	1200	2993.40	77.34	13398.80	4640.40	3349.70	7990.10	4996.70
P_3C_2	1793.40	1500	3293.40	44.66	21699.52	2679.60	5424.88	8104.48	4811.08
P_3C_3	1793.40	1800	3593.40	0.00	27614.60	0.00	6903.65	6903.65	3310.25
P_4C_1	1793.40	1150	2943.40	83.33	8987.00	4999.80	2246.75	7246.55	4303.15
P_4C_2	1793.40	1450	3243.40	50.65	13072.00	3039.00	3268.00	6307.00	3063.60
P_4C_3	1793.40	1750	3543.40	0.00	16503.40	0.00	4125.85	4125.85	582.45
P_5C_1	1793.40	1350	3143.40	107.30	10506.62	6438.00	2626.66	9064.66	5921.36
P_5C_2	1793.40	1650	3443.40	55.56	17107.98	3333.60	4277.00	7610.60	4167.20
P_5C_3	1793.40	1950	3743.40	0.00	22336.78	0.00	5584.00	5584.00	1840.60

Value of P_2O_5 = Rs.5/ kg. Value of greenmatter = Rs.250/ ton.

Value of seed = Rs.60/ kg.

SUMMARY

SUMMARY

An investigation was conducted to study the effect of different levels as well as methods of phosphorus application (40 kg, 80 kg and 120 kg P_2O_5/ha as soil applications, 40 kg P_2O_5/ha as soil + 40 kg P_2O_5/ha as foliar applications and 80 kg P_2O_5/ha as soil + 40 kg P_2O_5/ha as foliar application) and schedules of cutting of green fodder (crop to be left for seed setting after two cuts, three cuts and four cuts) on the seed production potential of *Stylosanthes gracilis*.

It was laid out as a factorial experiment in Randomised Block Design with three replications. The important results of the study are summarised below:-

1. Plant height and spread increased significantly with increase in the dose of phosphorus applied in the soil from 40 kg to 120 kg P_2O_5/ha at the time of all cuts as well as at flowering. Foliar application of phosphorus did not give any additional effect on plant height and spread at flowering.

Increasing the number of cuts significantly reduced plant height and spread at flowering.

2. Highest level of phosphorus (120 kg P_2O_5/ha) applied in the soil gave significantly higher leaf:stem ratio than lower doses applied in the soil in all the cuts while 80 kg P_2O_5/ha as soil application gave significantly higher leaf:stem ratio upto the third cut taken, than 40 kg P_2O_5/ha soil application but was on par with it in the last cut (fourth cut).

3. Number and weight of root nodules per plant increased significantly with increase in the level of phosphorus applied in the soil.

Cutting treatments had no significant effect on the number and weight of root nodules although an increasing trend was observed in nodule weight with increase in the number of cuts.

4. Increase in the level of phosphorus applied in the soil significantly increased the greenmatter and drymatter yields in each cut as well as the total greenmatter and drymatter yields from all the cuts.

Increasing the number of cuts from two to four significantly increased total greenmatter and total drymatter yields. Application of 120 kg P_2O_5/ha in the soil and taking four cuts before leaving the crop for seed setting gave a maximum total greenmatter yield of 27.6 t/ha which resulted in providing 5.1 t/ha of drymatter.

5. Application of 80 kg P_2O_5/ha in the soil supplemented by 40 kg P_2O_5/ha foliar application gave the highest seed yield significantly more than the other phosphorus treatments. This was followed by 40 kg P_2O_5/ha soil application + 40 kg P_2O_5/ha foliar application which was on par with 120 kg P_2O_5/ha applied in the soil and superior to other levels of phosphorus tried. Increasing the soil application of phosphorus from 40 to 80 kg P_2O_5/ha significantly increased the seed yield.

Cutting two times and then leaving the crop for seed setting gave the highest seed yield, significantly more than taking three cuts, while cutting four times yielded no seed. The maximum seed yield of 107.3 kg/ha was given by application of 80 kg P_2O_5/ha in the soil + 40 kg P_2O_5/ha as foliar application and taking two cuts of green fodder.

6. Increasing the dose of phosphorus applied in the soil significantly increased the crude protein content in the drymatter in all four cuts as well as the total

protein yield. Increasing the number of cuts significantly increased the total protein yield.

7. Nitrogen, phosphorus and potash recoveries from cumulative drymatter were significantly increased with increase in the dose of phosphorus applied in the soil and also with increase in the number of cuts.

8. Increase in the dose of phosphorus applied whether as combined application as soil + foliar or as soil application alone enhanced the crude protein content of the seeds while cutting treatments had no effect on the same.

9. As the level of phosphorus applied in the soil was increased from 40 to 120 kg P_2O_5/ha the total nitrogen content, available phosphorus content and cation exchange capacity increased significantly while there was no effect on available potash content in the soil.

Cutting treatments had no effect on the total nitrogen, available phosphorus, available potash and cation exchange capacity of the soil.

10. Significant and positive correlations were observed between seed yield and height and spread of plants at

flowering, seed yield and protein content in the seed, greenmatter yield and total protein yield from drymatter, and total nitrogen content in the soil and total protein yield from drymatter. A significant and negative correlation was observed between seed yield and greenmatter yield.

11. 80 kg P_2O_5/ha soil application + 40 kg P_2O_5/ha as foliar in combination with two cuts of green fodder gave the maximum net profit of Rs.5921.36 per hectare.

Future line of work

The optimum time to apply phosphorus through foliage to the crop, after the last cut, is to be investigated. Similarly the optimum time for cutting the crop to be left for seed setting to get higher seed production also needs further investigation.

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APPENDIX

Appendix IA

Weather data during the crop period and its variation from the past five years

Standard weeks	Temperature °C				Relative Humidity (%)		Rainfall (mm)	
	Maximum 1979-80	Variation	Minimum 1979-80	Variation	1979-80	Variation	1979-80	Variation
28	29.36	-1.71	22.53	-1.61	94.43	+10.23	15.29	+14.59
29	29.79	+0.36	23.47	+1.11	87.29	- 2.00	0.00	- 9.79
30	28.86	-0.93	23.04	-1.67	93.00	+ 5.14	5.43	+ 1.93
31	29.07	-1.14	22.34	-1.45	95.43	+ 7.64	7.71	+ 7.57
32	29.93	+1.22	22.50	+0.36	95.71	+ 8.64	5.43	+ 5.43
33	30.64	-0.57	22.73	-0.91	90.43	+ 8.43	0.86	+ 0.86
34	29.93	0.00	23.29	-0.07	90.71	+ 4.07	4.00	- 5.86
35	30.71	+0.64	22.70	-0.30	93.43	+ 6.22	0.00	- 9.64
36	31.43	+1.50	23.06	-0.49	92.00	+ 2.14	0.00	- 0.86
37	31.43	+1.07	22.87	-0.40	89.57	+ 2.28	9.57	+ 8.95
38	30.00	-0.79	22.59	-0.70	92.14	+10.90	17.71	+17.61
39	29.00	-1.93	22.53	-1.14	96.00	+11.71	5.00	+ 2.24
40	30.14	-0.43	23.49	+0.20	89.14	+ 0.71	0.00	- 2.24
41	30.64	+0.33	23.31	-0.20	87.43	- 1.52	0.00	- 1.81
42	31.36	+1.38	22.17	-1.11	90.86	+ 1.62	1.29	-21.61
43	30.57	+0.81	22.67	-1.08	94.86	+ 7.29	5.71	-10.91
44	30.00	-0.33	22.86	-0.37	95.71	+ 8.09	1.57	-23.43
45	28.71	-1.27	22.29	-0.47	95.71	+ 4.85	7.86	-11.95
46	29.50	-1.07	21.94	-1.16	95.29	+ 5.48	31.14	+21.01

contd...2..

Appendix A (contd.)

Standard weeks	Temperature °C				Relative Humidity (%)		Rainfall (mm)	
	Maximum 1979-80	Variation	Minimum 1979-80	Variation	1979-80	Variation	1979-80	Variation
47	30.36	0.00	22.40	-0.31	95.43	+ 7.33	4.86	- 5.52
48	30.93	-0.05	22.31	-0.63	91.29	+ 6.34	1.00	- 0.71
49	30.29	-0.78	22.20	-0.49	95.43	+ 9.99	5.57	+ 2.67
50	31.50	+0.17	22.40	-0.38	95.43	+14.33	0.00	- 0.90
51	31.21	-0.48	21.74	-1.43	93.86	+12.53	0.43	- 1.09
52	31.00	-1.48	21.26	-1.53	91.50	+10.21	0.00	- 1.54
1	31.07	-0.14	20.33	-0.96	87.86	+ 8.38	0.00	0.00
2	31.43	+0.07	20.26	-1.99	87.14	+10.57	0.00	0.00
3	31.50	+0.08	19.74	-1.86	83.86	+ 5.72	0.00	0.00
4	31.71	-0.11	19.43	-2.45	79.00	- 0.43	0.00	- 1.19
5	31.71	+0.49	20.23	-2.23	81.43	+ 0.86	0.00	- 0.48
6	31.79	+0.20	20.96	-1.51	92.71	+ 7.81	0.00	- 0.76
7	31.36	+0.16	19.76	-2.81	87.14	+ 2.09	0.00	- 7.24
8	31.29	-0.21	21.34	-2.01	80.71	- 4.39	0.00	0.00
9	32.19	+0.23	21.46	-1.38	85.00	+ 0.57	0.00	0.00
10	31.79	-0.25	21.90	-0.99	87.00	+ 4.38	0.00	- 2.10
11	32.36	+0.23	21.86	-1.54	83.57	- 1.29	2.43	+ 2.00

contd....3..

Appendix I A (contd..)

Standard weeks	Temperature °C				Relative Humidity (%)		Rainfall (mm)	
	Maximum 1979-80	Variation	Minimum 1979-80	Variation	1979-80	Variation	1979-80	Variation
12	32.07	-0.60	21.76	-2.34	87.86	+ 2.81	0.00	- 0.71
13	32.93	-0.15	21.04	-3.47	88.14	+ 4.33	0.86	+ 0.86
14	31.64	-1.08	21.69	-2.85	92.14	+ 7.43	14.86	+13.91
15	32.79	-0.56	23.97	-1.19	89.86	+ 6.86	0.00	- 1.67
16	33.71	+0.53	24.30	-0.45	88.71	+ 4.66	0.00	- 0.62
17	33.64	+1.04	24.84	+0.14	89.86	+ 6.34	7.86	+ 7.76
18	31.86	-1.00	23.76	-0.83	91.00	+ 4.05	5.86	+ 1.91

Appendix I

Abstracts of Analysis of variance Tables for mean plant heights

Appendix I (a) Height at the time of 1st cut

Sl.No.	Source of variation	df	Mean squares	F value
1	Block	2	1.878	0.2741
2	Treatments	2	2298.509	335.5035**
3	Error	40	6.851	
	Total	44		

Appendix I (b) Height at the time of 2nd cut

Sl.No.	Source of variation	df	Mean squares	F value
1	Block	2	3.728	0.5824
2	Treatments	2	2513.378	392.6170**
3	Error	40	6.402	
	Total	44		

Appendix I (c) Height at the time of 3rd cut

Sl.No.	Source of variation	df	Mean squares	F value
1	Block	29	8.654	3.2220
2	Treatments	2	1941.517	722.8283**
3	Error	2	2.686	
	Total	25		

Appendix I (d) Height at the time of 4th cut

Sl.No.	Source of variation	df	Mean squares	F value
1	Block	2	12.241	5.4972
2	Treatments	2	831.665	373.4964**
3	Error	10	2.227	
	Total	14		

** Significant at 1% level.

Appendix I (e) Height at the time of flowering (cm)

Sl.No.	Source of variation	df	Mean squares	F value
1	Block	2	24.460	2.7742
2	Treatments	14	2600.374	294.9240**
3	P	4	1622.385	184.0044**
4	C	2	14743.800	1672.1825**
5	P X C	8	53.513	6.0692**
6	Error	28	8.817	
	Total	44		

** Significant at 1% level.

Appendix II

Abstracts of Analysis of Variance Tables for mean plant Spreads (cm)

Appendix II (a) Spread at the time of 1st cut

Sl No.	Source of variation	df	Mean squares	F value
1	Block	2	3.460	0.4913
2	Treatments	2	1350.650	191.8019**
3	Error	40	7.042	
	Total	44		

Appendix II (b) Spread at the time of 2nd cut

Sl No.	Source of variation	df	Mean squares	F value
1	Block	2	13.507	1.6441
2	Treatments	2	1443.276	175.6783**
3	Error	40	8.215	
	Total	44		

Appendix II (c) Spread at the time of 3rd cut

Sl No.	Source of variation	df	Mean squares	F value
1	Block	2	0.064	0.0059
2	Treatments	2	957.449	87.5438**
3	Error	25	10.937	
	Total	29		

Appendix II (d) Spread at the time of 4th cut.

Sl No.	Source of variation	df	Mean squares	F value
1	Block	2	1.545	0.4585
2	Treatments	2	480.157	142.5180
3	Error	10	3.369	
	Total	14		

** Significant at 1% level.

Appendix II (e) Spread at the time of flowering (cm)

Sl No.	Sources of variation	df	Mean squares	F. Value
1	Block	2	10.74	0.98442
2	Treatments	14	5333. 11	488.82768**
3	P	4	2014.00	184.60128**
4	C	2	32272.68	2958.08249**
5	P X C	8	257.77	23.62695**
6	Error	28	10.91	
	Total	44		

** Significant at 1% level.

Appendix III

Abstracts of Analysis of Variance Tables showing the effect of phosphorus application on Leaf/Stem (L/S) ratio

Appendix III (a) Leaf: stem ratio at the time of 1st cut

Sl.No.	Source of variation	df	Mean squares	F value
1	Block	2	0.145	26.85000**
2	Treatments	2	0.620	114.81400**
3	Error	40	0.005	
	Total	44		

Appendix III (b) Leaf:stem ratio at the time of 2nd cut

Sl.No.	Source of variation	df	Mean squares	F value
1	Block	2	0.060	12.24490**
2	Treatments	2	0.750	153.06000**
3	Error	40	0.005	
	Total	44		

Appendix III (c) Leaf:stem ratio at the time of 3rd cut

Sl.No.	Sources of variation	df	Mean squares	F value
1	Block	2	0.00257	0.15953
2	Treatments	2	0.22354	13.87585**
3	Error	25	0.01611	
	Total	29		

Appendix III (d) Leaf:stem ratio at the time of 4th cut

Sl.No.	Source of variation	df	Mean squares	F value
1	Block	2	0.00159	0.22489
2	Treatments	2	0.17160	24.27157**
3	Error	10	0.00707	
	Total	14		

** Significant at 1% level.

Appendix IV

Abstract of Analysis of variance Table for number of root nodules

Sl.No.	Source of variation	df	Mean squares	F value
1	Block	2	845.07	3.34
2	Treatments	14	23141.66	91.37**
3	P	4	80736.86	318.77**
4	C	2	22.07	0.09
5	P X C	8	123.96	0.49
6	Error	28	253.28	
	Total	44		

** Significant at 1% level

Appendix V

Abstract of Analysis of Variance Table for weight of root nodules (mg)

Sl.No.	Source of variations	df	Mean square	F value
1	Block	2	893.75	3.57
2	Treatments	14	22538.14	89.93**
3	P	4	78605.81	313.67**
4	C	2	11.82	0.05
5	P X C	8	135.88	0.54
6	Error	28	250.61	
	Total	44		

** Significant at 1% level.

Appendix VI

Abstracts of the Analysis of Variance Tables for Greenmatter yield (g/plot)

Appendix VI (a) Greenmatter yield at the time of 1st cut

Sl.No.	Sources of variation	df	Mean squares	F value
1	Block	2	144666.67	13.99624**
2	Treatments	2	4164611.11	402.91861**
3	Error	40	10336.11	
	Total	44		

Appendix VI (b) Greenmatter yield at the time of 2nd cut

Sl.No.	Sources of variation	df	Mean Squares	F value
1	Block	2	17390888.88	880.05628**
2	Treatments	2	8032111.11	406.46052**
3	Error	40	19761.11	
	Total	44		

Appendix VI (c) Greenmatter yield at the time of 3rd cut

Sl.No.	Sources of variation	df	Mean squares	F value
1	Block	2	6932333.33	101.77646**
2	Treatments	2	11969583.33	175.73041**
3	Error	25	68113.33	
	Total	29		

Appendix VI (d) Greenmatter yield at the time of 4th cut

Sl.No.	Sources of variation	df	Mean squares	F value
1	Block	2	1308666.67	6.17976*
2	Treatments	2	3389166.67	16.00425**
3	Error	10	211766.67	
	Total	14		

* Significant at 5% level
** Significant at 1% level

Appendix VI (e)

Total Greenmatter yield (kg/plot)

Sl.No.	Sources of variation	df	Mean squares	F value
1	Block	2	51.80	120.47**
2	Treatments	8	61.33	142.63**
3	P	2	75.68	176.00**
4	C	2	159.80	371.63**
5	P X C	4	4.92	11.44**
6	Error	34	0.43	
	Total	44		

** Significant at 1% level.

Appendix VII

Abstracts of Analysis of Variance Tables for drymatter yields(kg/pl.

Appendix VII (a) Drymatter yield in the 1st cut

Sl.No.	Sources of variation	df	Mean squares	F Value
1	Block	2	0.0078	11.1429**
2	Treatments	2	0.1678	239.7143**
3	Error	40	0.0007	
	Total	44		

Appendix VII (b) Drymatter yield in the 2nd cut

Sl.No.	Sources of variation	df	Mean squares	F Value
1	Block	2	0.72	72**
2	Treatments	2	0.27	27**
3	Error	40	0.01	
	Total	44		

Appendix VII (c) Drymatter yield in the 3rd cut

Sl.No.	Sources of variation	df	Mean Squares	F Value
1	Block	2	0.2728	90.933**
2	Treatments	2	0.4391	146.367**
3	Error	25	0.0030	
	Total	29		

Appendix VII (d) Drymatter yield in the 4th cut

Sl.No.	Sources of variation	df	Mean Squares	F Value
1	Block	2	0.0685	6.9898*
2	Treatments	2	0.1424	14.5306**
3	Error	10	0.0098	
	Total	14		

* Significant at 5% level

** Significant at 1% level

Appendix VII (e) Total Drymatter yield (kg/plot)

Sl.No.	Sources of variation	df	Mean Squares	F Value
1	Block	2	2.1702	88.9426**
2	Treatments	8	2.2504	92.2295**
3	P	2	2.7861	114.1844**
4	C	2	5.8918	241.4672**
5	P X c	4	0.1618	6.6311**
6	Error	34	0.0244	
	Total	44		

** Significant at 1% level.

Appendix VIII

Abstract of Analysis of Variance Table for seed yield (kg/ha)

Sl.No.	Source of variation	df	Mean squares	F value
1	Block	2	2295.04	14.921**
2	Treatments	9	1970.21	12.809**
3	P	4	2480.44	16.126**
4	C	1	6016.87	39.118**
5	P X C	4	448.32	2.915
6	Error	18	153.81	
	Total	29		

** Significant at 1% level.

Appendix IX

Abstracts of Analysis of Variance Tables for Protein content in drymatter (%)

Appendix IX (a) Protein content in the 1st cut

Sl.No.	Sources of variation	df	Mean squares	F Value
1	Block	2	5.58	4.5517
2	Treatments	2	108.49	88.5099**
3	Error	40	1.23	
	Total	44		

Appendix IX (b) Protein content in the 2nd cut

Sl.No.	Sources of variation	df	Mean squares	F Value
1	Block	2	1.42	1.28
2	Treatments	2	96.62	87.05**
3	Error	40	1.11	
	Total	44		

Appendix IX (c) Protein content in the 3rd cut

Sl.No.	Sources of variation	df	Mean squares	F Value
1	Block	2	18.82	81.49**
2	Treatments	2	51.22	221.77**
3	Error	25	0.23	
	Total	29		

Appendix IX (d) Protein content in the 4th cut

Sl.No.	Sources of variation	df	Mean Squares	F Value
1	Block	2	1.59	4.58
2	Treatments	2	22.12	63.37**
3	Error	10	0.35	
	Total	14		

** Significant at 1% level.

Appendix IX (e) Abstract of Analysis of Variance Table for Total Protein yield (kg/plot)

Sl.No.	Sources of variation	df	Mean Squares	F Value
1	Block	2	330.7450	47.1496**
2	Treatments	8	832.9935	118.7480**
3	P	2	1880.8573	268.1270**
4	C	2	1317.2955	187.7880**
5	P X C	4	66.9107	9.5385
6	Error	34	7.0148	
	Total	44		

** Significant at 1% level

Appendix X

Abstracts of Analysis of Variance Tables for Phosphorus content in drymatter (mg/ g)

Appendix X (a) Phosphorus content in the 1st cut

Sl.No.	Sources of variation	df	Mean squares	F Value
1	Block	2	0.90600	9.67491**
2	Treatments	2	2.86146	30.55677**
3	Error	40	0.09364	
	Total	44		

Appendix X (b) Phosphorus content in the 2nd cut

Sl.No.	Sources of variation	df	Mean squares	F Value
1	Block	2	0.08935	1.87255
2	Treatments	2	6.04692	126.72809**
3	Error	40	0.04771	
	Total	44		

Appendix X (c) Phosphorus content in the 3rd cut

Sl.No.	Sources of variation	df	Mean squares	F Value
1	Block	2	0.28000	4.00000
2	Treatments	2	6.79000	97.00000**
3	Error	25	0.07000	
	Total	29		

Appendix X (d) Phosphorus content in the 4th cut

Sl.No.	Sources of variation	df	Mean Squares	F Value
1	Block	2	0.50500	8.61628**
2	Treatments	2	3.48260	59.41989**
3	Error	10	0.05861	
	Total	14		

** Significant at 1% level

Appendix XI

Abstracts of Analysis of Variance Tables for Potash content in drymatter (%)

Appendix XI (a) Potash content in the 1st cut

Sl.No.	Sources of variation	df	Mean squares	F Value
1	Block	2	0.05427	0.51121
2	Treatments	2	0.10993	1.03556
3	Error	40	0.10615	
	Total	44		

Appendix XI (b) Potash content in the 2nd cut

Sl.No.	Sources of variation	df	Mean Squares	F Value
1	Block	2	1.78137	12.09844**
2	Treatments	2	0.08699	0.59081
3	Error	40	0.14724	
	Total	44		

Appendix XI (c) Potash content in the 3rd cut

Sl.No.	Sources of variation	df	Mean squares	F Value
1	Block	2	0.53369	7.44149**
2	Treatments	2	0.10214	1.42431
3	Error	25	0.07172	
	Total	29		

Appendix XI (d) Potash content in the 4th cut

Sl.No.	Sources of variation	df	Mean Squares	F Value
1	Block	2	0.48474	95.95012**
2	Treatments	2	0.15333	30.35036**
3	Error	10	0.00505	
	Total	14		

** Significant at 1% level

APPENDIX XII

Abstract of Analysis of Variance Table for Nitrogen recovery (Kg/plot)

Sl No.	Sources of variations	df	Mean squares	F value
1	Block	2	330.745	47.1496**
2	Treatments	8	832.993	118.9480**
3	P	2	1880.857	268.1270**
4	C	2	1317.295	187.7880**
5	P X C	4	66.911	9.5385**
6	Error	44	7.015	
7	Total	44		

** Significant at 1% level.

Appendix XIII

Abstract of Analysis of Variance Table for Phosphorus recovery (Kg/plot)

Sl.No.	Sources of variation	df	Mean squares	F value
1	Block	2	0.1961	43.5778**
2	Treatments	8	0.6410	142.4440**
3	P	2	1.2909	286.8667**
4	C	2	1.1316	251.4667**
5	P X C	4	0.0708	15.7333**
6	Error	34	0.0045	
	Total	44		

** Significant at 1% level.

Appendix XIV

Abstract of Analysis of Variance Table for Potash recovery (kg/plot)

Sl No.	Source of variation	df	Mean squares	F. Value
1	Block	2	13.4283	27.3322**
2	Treatments	8	13.3015	27.0741**
3	P	2	12.7160	25.8824**
4	C	2	39.4606	80.3187**
5	P X C	4	0.5147	1.0476
6	Error	34	0.4913	
	Total	44		

** Significant at 1% level.

Appendix XV

Abstract of Analysis of Variance Table for Protein content in the seed (%)

Sl No.	Source of variation	df	Mean squares	F. value
1	Block	2	0.37	0.18
2	Treatments	9	7.46	3.71**
3	P	4	15.47	7.69**
4	C	1	1.40	0.69
5	P X C	4	0.95	0.47
6	Error	18	2.01	
	Total	29		

** Significant at 1% level.

Appendix XVI

Abstract of Analysis of Variance Table for Phosphorus content in the seed (mg/g)

Sl.No.	Sources of variation	df	Mean squares	F Value
1	Block	2	0.0403	2.2768
2	Treatments	9	0.1905	10.7627**
3	P	4	0.3486	19.6949**
4	C	1	0.2521	14.2429**
5	P X C	4	0.1690	9.5480**
6	Error	18	0.0177	
7	Total	29		

** Significant at 1% level

Appendix XVII

Abstract of Analysis of Variance Table for Potash content in the seed (%)

Sl.No.	Sources of variation	df	Mean squares	F Value
1	Block	2	0.00641	3.54144
2	Treatments	9	0.00185	1.02210
3	P	4	0.00189	1.04420
4	C	1	0.00056	0.30939
5	P X C	4	0.00215	1.18785
6	Error	18	0.00181	
7	Total	29		

Appendix XVIII

Abstract of Analysis of Variance Table for Total Nitrogen content of the soil (Kg/ha)

Sl.No.	Sources of variation	df	Mean squares	F Value
1	Block	2	595.56	1.81
2	Treatments	14	9540.32	29.01**
3	P	4	31057.78	94.43**
4	C	2	702.20	2.14
5	P X C	8	991.11	3.01**
6	Error	28	328.89	
	Total	44		

** Significant at 1% level.

Appendix XIX

Abstract of Analysis of Variance Table for Available Phosphorus content in the soil. (Kg/ha)

Sl.No.	Sources of variation	df	Mean squares	F value
1	Block	2	27.29	5.16*
2	Treatments	14	101.04	19.10**
3	P	4	299.87	56.69**
4	C	2	18.76	3.55
5	P X C	8	22.20	4.20**
6	Error	28	5.29	
	Total	44		

* Significant at 5% level.

** Significant at 1% level.

Appendix XX

Abstract of Analysis of Variance Table for available Potash content in the soil (kg/ha)

Sl.No.	Sources of variation	df	Mean squares	F Value
1	Block	2	1.86	0.33
2	Treatments	14	3.08	0.55
3	P	4	4.13	0.74
4	C	2	3.20	0.57
5	P X C	8	2.53	0.45
6	Error	28	5.58	
	Total	44		

Appendix XXI

Abstract of Analysis of Variance Table for C.E.C. of the soil (m.e/100g.)

Sl.No.	Sources of variation	df	Mean squares	F Value
1	Block	2	0.82	27.33**
2	Treatments	14	0.34	11.33**
3	P	4	1.12	37.33**
4	C	2	0.02	0.67
5	P X C	8	0.03	1.00
6	Error	28	0.03	
	Total	44		

** Significant at 1% level

SEED PRODUCTION POTENTIAL OF *Stylosanthes gracilis*

BY

LEKHA SREEKANTAN

ABSTRACT OF A THESIS
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ABSTRACT

factorial experiment in Randomised Block Design with three replications was conducted in the College of Agriculture, Vellayani to study the effect of levels and methods of phosphorus application and number of cuts of green fodder taken, on the seed production potential of Stylosanthes gracilis. The phosphorus treatments were 40, 80 and 120 kg P_2O_5/ha as soil applications, 40 kg P_2O_5/ha as soil application + 40 kg P_2O_5/ha as foliar and 80 kg P_2O_5/ha soil application + 40 kg P_2O_5/ha foliar. The cutting treatments were two, three or four cuts.

Increasing the level of soil applied phosphorus significantly increased height, spread, leaf:stem ratio, nodular weight and number, greenmatter and drymatter yields in each cut and the cumulative greenmatter and drymatter yields.

Increasing the number of cuts significantly increased cumulative greenmatter and drymatter yields while it reduced the plant height and spread at flowering.

Application of 80 kg P_2O_5/ha in the soil + 40 kg P_2O_5/ha as foliar gave significantly higher seed yields (107.3 kg/ha) than other phosphorus treatments.

Application of 40 kg P_2O_5/ha in the soil + 40 kg P_2O_5/ha as foliar was on par with 120 kg P_2O_5/ha soil application and superior to 80 kg and 40 kg P_2O_5/ha soil applications while 80 kg P_2O_5/ha soil application gave significantly higher seed yield than 40 kg P_2O_5/ha soil application.

Taking two cuts gave significantly higher seed yield than three cuts while four cuts yielded no seed.

Increasing the level of phosphorus applied in the soil and the number of cuts significantly increased nitrogen, phosphorus and potash recovery values and total protein yield.

Foliar application of 40 kg P_2O_5/ha gave higher seed protein content irrespective of the quantity applied in the soil while cutting treatments had no effect on the same.