RESPONSE OF PARA-CENTRO COMBINATION TO DIFFERENT FERTILIZER LEVELS UNDER COCONUT

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ABSTRACT

Paragrass [*Brachiaria mutica* (Forsk.) Stapf] and centrosema (*Centrosema pubescens* Benth.) were grown in combination under coconut and subjected to different fertilizer treatments. High dry matter yields were obtained during periods when soil moisture, nutrients, and solar radiation had been favorable for plant growth. Regrowth of both grass and legume was adversely affected by water stress coupled with high light intensity when pruning coincided with dry months. This condition depressed production and development of leaves and branches. Centrosema with a creeping growth habit was less affected by periodic pruning compared to paragrass which has an upright growth habit.

The mixed crops responded significantly to application of high amounts of N and K and less of P (400-75-150 and 400-75-300) as manifested by the vigorous and rapid growth of paragrass resulting in its dominance over the legume. At zero or low N level, centrosema dominated the grass. Whenever the former became predominant, the latter grew poorly and vice versa. The highest mean dry matter yield of 9.75 t/ha/year of the mixed crop was obtained in the 400-75-300 and 400-150-300 fertilizer treatments. No significant differences in the growth and dry matter yield of the 100-75-0 treatment and higher fertilizer levels were noted. The unfertilized control plot consistently produced the lowest dry matter yield during the 3-year period. The high dry matter yield obtained in the monocultured paragrass was attributed to the absence of competition with centrosema for light, nutrients, moisture, and space.

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KEY WORDS: Para-centro combination. Coconut. Pruning. Regrowth Fertilizer levels.

INTRODUCTION

The practice of utilizing areas under coconut for raising livestock is not new in the Philippines. In fact, 405,000 hectares out of the more than 2 million hectares planted to coconut are being utilized for cattle production. These plantations usually have fertile soils and are located in regions with necessary basic infrastructures such as roads and markets (De Guzman, 1974). This shows that about a million and a half hectares of the areas under coconut are still not fully and efficiently utilized.

Improved and better pastures, and livestock management techniques are necessary for the development of the livestock industry in the country. Sanchez (1976) reported that low livestock productivity in natural grasslands in the tropics is due to poor pasture productivity. The factors responsible for this are insufficient soil moisture and low soil fertility. It was suggested that to increase the stocking rate per hectare, improvement of the native grassland pastures be done by planting grass-legume mixtures using improved species. Javier (1974) said that one factor which should be considered in the successful integration of cattle and coconut production is the suitability of the pasture varieties to be planted under the palms. However, competition mainly for nutrients and moisture between introduced plant species and coconut as well as between improved species of grasses and legumes grown in combination should not be overlooked. Therefore, more attention must be given to the management techniques that would give maximum pasture utilization and eventually augment the income of the coconut farmers.

The compatibility of grass and legume species is related to their growth habits and adaptation to specific climatic, soil moisture, and soil fertility regimes. The proper grass-legume combination is therefore site-specific. Paragrass [*Brachiaria mutica* (Forsk.) Stapf] and centrosema (*Centrosema pubescens* Benth.) are two species which were found to be tolerant to poor drainage (Sanchez, 1976). This crop combination grows well together and the resultant pastures are nutritious and highly productive. When grown with pasture grasses, centrosema is not readily shaded out provided that nutrient conditions are satisfactory.

Grazing or cutting influences plant growth and development in a mixed sward. Too frequent or too seldom grazing will affect the quality of the crop and the dynamics of growth in a grass-legume combination. Javier (1974) reported that the grazing interval for pastures in the humid tropics ranges from 30-60 days which falls within the range of coconut harvest interval.

Application of fertilizer is essential for integrated cattle/coconut operations. Javier (1974) reported that high N rates tend to depress the growth of legumes while application of P encourages its growth. Although most Philippine soils contain fair amounts of K, its application becomes necessary due to combined demands for it by pasture grasses and coconut. In open pastures, yearly application of 200 kg N/ha tends to affect the legume component of a grass-legume combination.

Results of previous studies showed that the low protein content of grass species can be increased by applying N fertilizer or by planting it in association with a suitable legume species. If managed properly, the forage legume could significantly raise the protein content of the pasture grass. The protein content of *Brachiaria* species was nearly doubled when it was grown in association with centrosema (Javier, 1974).

Due to compatibility in their specific characteristics, paragrass and centrosema were grown in combination under coconut and subjected to different levels of fertilizer and specific cutting intervals. Their reactions to these factors in relation to their growth dynamics and yield were evaluated. This study was a part of a project that looked into the management of pastures under coconut.

MATERIALS AND METHODS

A slightly rolling area about 1,008 m² under coconut trees was used in this experiment. The coconut trees in the area were spaced 8 x 8 m apart, and were already 8-10 m tall. The treatments were laid out in a randomized complete block design with three replications. Each replication was laid out across the slope in between the rows of the coconut palms, 1.5 m away from each row. Soil samples were collected and composited for analysis before the application of fertilizer treatments. The fertilizer treatments in kg N, P_2O_5, and K_2O per hectare were as follows:

F_1 = 0-0-0 (para-centro combination)
F_2 = 0-75-0
F_3 = 100-75-0
F_4 = 100-75-100
F_5 = 200-75-100
F_6 = 400-75-150
F_7 = 200-150-150
F_8 = 400-150-150
F_9 = 200-75-300
F_{10} = 200-150-300
F_{11} = 400-75-300
F_{12} = 400-150-300

Stem cuttings of paragrass with 3-4 nodes were planted under coconut at a distance of 75 x 50 cm and at the rate of two 30-cm cuttings/hill. There were seven rows per plot and 16 plants per row. After planting paragrass, the area was overseeded with centrosema at the rate of 8 kg/ha. At the onset of the rainy season, one-half of the total amount of nitrogen and the whole amounts of P and K were applied. The other half of the nitrogen was applied at the end of the rainy season. Fertilizer application was done every year for 3 years.

To simulate grazing, herbage was harvested at an interval of 60 days. Cutting was done 20 cm above the ground surface. Plant samples of the paragrass-centrosema mixture were collected for dry matter yield and proximate analysis (fat, crude fiber, nitrogen, crude protein and ash). Botanical composition (% legume and % grass) was determined using a quadrat (50 cm x 50 cm) before each pruning operation and the data were averaged for each year.

An unfertilized control plot (0-0-0) where paragrass was grown as a monocrop was also maintained for comparison.

RESULTS AND DISCUSSION

Some Agronomic Characteristics of the Crops in Combination

Paragrass

Plant Height

Before the first harvest, plants treated with the highest amount of NPK (400-150-300) were the tallest (144.34 cm) followed by those treated with 200-150-300 whose height was 143.63 cm (Table 1). The rest had plant heights ranging from

Table 1. Plant height of paragrass in para-centro combination grown under coconut as influenced by different fertilizer rates (Year 1, 1979).

Fertilizer Rates (kg NPK/ha)	Plant Height (cm)[1]					
	Harvest Number					
	1st	2nd	3rd	4th	5th	6th
0-0-0 (pure paragrass)	44.31	136.60	156.64	127.24	142.16	156.30
0-0-0 (para-centro)	94.41	119.10	121.20	103.48	154.18	116.27
0-75-0	116.80	101.11	131.97	110.49	184.82	139.62
100-75-0	133.92	120.21	122.63	116.67	171.36	116.88
100-75-100	127.51	118.82	132.58	108.61	137.09	118.30
200-75-100	141.24	127.17	144.73	111.79	147.73	98.31
400-75-150	135.91	140.01	139.30	108.54	176.51	116.47
200-150-150	140.68	110.17	136.41	119.07	149.77	119.38
400-150-150	134.23	129.21	140.99	115.95	181.88	133.32
200-75-300	141.55	119.06	134.84	109.63	124.13	122.33
200-150-300	143.63	123.03	149.30	118.13	151.10	120.91
400-75-300	141.20	122.64	132.77	96.54	164.56	124.57
400-150-300	144.34	133.19	141.09	114.45	169.83	141.18
C.V. (%)	15.95	11.64	7.68	17.23	15.87	18.97

[1] Means of three replications/treatment. Taken at 2-month interval.

116 to 141 cm. Unfertilized paragrass grew 94.41 cm tall in mixed crop and 44.31 cm tall when monocultured.

Under varying NPK levels, no significant differences in the growth of the grass were observed during the first year. The effects of the different treatments were inconsistent. Application of high levels of N, P, and K either singly or in combination did not always result in rapid growth of paragrass. At the last harvest for the first year, plants applied with high rates of N and K grew taller than those applied with lower rates although no significant differences were noted.

For years 2 and 3, the same trend of results was noted. No marked differences were observed among the treated plants. Monocultured plants appeared to have similar growth rates as the treated mixed ones. The untreated crop combination performed poorly. For the treated mixed crops, applying 100-75-0 kg NPK/ha or high fertilizer rates gave comparable effects.

Tiller Number Per Hill

No significant effects of the various treatments on the number of tillers per hill were observed in all the harvests except for the last harvest of year 1 (Table 2). During the first harvest, very few tillers (only 9/hill) developed in the monocultured crop followed by the untreated crop combination with 16 tillers/hill. In the rest of the treatments, the number of tillers per hill ranged from 21-30. In the succeeding harvests for year 1, the number of tillers started to decline from the 2nd (42) to the 6th harvest (22).

The effects of the fertilizer treatments on the crop were still inconsistent for years 2 and 3. High amounts of fertilizer applied singly or in combination did not influence the formation and development of tillers per hill. The mortality of tillers and failure of stubbles to germinate during the 3rd to the 4th harvest (March and May) of each year during the 3-year period could partly be attributed to the low amount of soil moisture because low rainfall was noted (Table 3) during these months. As previously mentioned, paragrass is adapted to high-moisture conditions. The pruned plants were probably not able to recover and utilize the carbohydrate reserves in the stubble, hence some of them did not survive.

Centrosema

Length of Main Tendril

Results show significant effects of the treatments on this parameter. Shortest tendrils (64.53 cm) were observed in the unfertilized crop combination while the longest tendril (129.42 cm) developed at fertilizer rate of 200-75-100. The rest of the treatments produced main tendrils whose lengths ranged from 85 to 118 cm.

In the first year, the 100-75-0 fertilizer treatment gave com-

Table 2. Tiller number/hill of paragrass in para-centro combination grown under coconut as influenced by different fertilizer rates (Year 1, 1979).

Fertilizer Rates (kg NPK/ha)	Tiller Number/Hill[1] Harvest Number					
	1st	2nd	3rd	4th	5th	6th
0-0-0 (pure paragrass)	8.58	23.80	36.80	43.60	47.80	25.40b
0-0-0 (para-centro)	15.87	27.27	27.60	20.77	19.93	20.67b
0-75-0	23.93	42.23	29.80	19.47	15.66	19.54b
100-75-0	23.73	40.67	29.80	25.07	16.20	26.40ab
100-75-100	20.53	39.73	34.00	24.67	13.60	13.87c
200-75-100	25.87	41.07	38.80	25.40	16.93	21.54b
400-75-150	29.27	48.47	39.33	26.07	16.53	14.47c
200-150-150	28.93	48.47	40.00	29.33	18.86	19.14bc
400-150-150	28.73	47.27	48.67	33.20	24.06	20.27b
200-75-300	27.93	42.27	40.87	27.60	22.66	27.87a
200-150-300	22.40	43.20	39.93	30.00	23.66	21.94b
400-75-300	29.60	48.67	33.67	26.20	23.53	23.67b
400-150-300	28.27	48.33	41.20	30.47	20.86	37.67a
Mean	24.12	41.65	36.95	27.83	21.56	22.49
C.V. (%)	20.60	19.56	27.91	33.66	14.66	27.09

[1]Means of three replications/treatment. Taken at 2-month interval. Within a column, means followed by a common letter or without letters are not significantly different at 5% level, DMRT.

parable effect with that of high fertilizer levels. The legume manifested similar growth patterns under different fertility levels during the second and third year. However, the periodic cutting at 2-month intervals appeared to affect the growth rate of centrosema under dry condition as suggested by the declining tendril length from year 1 to 3.

Shoot Number/Plant

Except for the unfertilized control plot, the treated plants showed no significant differences in shoot number per plant. The observed effects of the treatments on this character of centrosema were also inconsistent just like the effects on other agronomic characters studied both in paragrass and centrosema. The 100-75-0 fertilizer treatment

Table 3. Monthly rainfall (mm) recorded in ViSCA, Baybay, Leyte for 1978-1981.

Month	Amount of Rainfall (mm)				
	1978	1979	1980	1981	Mean
January	339.9	151.1	356.9	431.8	319.9
February	139.3	57.9	266.6	87.6	137.8
March	158.3	42.7	57.7	41.9	75.2
April	130.3	190.1	149.4	70.1	135.0
May	146.6	138.8	24.9	88.2	99.6
June	142.0	304.1	357.9	363.0	291.8
July	214.7	237.7	271.2	293.8	254.4
August	424.2	81.6	457.9	123.7	271.8
September	462.0	209.4	298.4	382.7	338.1
October	278.4	384.2	191.7	273.8	282.0
November	181.5	269.6	506.9	297.0	313.8
December	472.7	258.9	230.9	266.3	307.2
Total	3089.9	2326.1	3170.4	2719.9	
Mean	257.5	193.8	264.2	226.7	

produced the same number of shoots per plant as the 400-150-150 treatment.

The same pattern of plant response to the different treatments was observed in years 2 and 3. There were cases when the shoot number of centrosema plants subjected to high NPK levels declined and was lower than those of the control and those which received lower fertilizer rates. It was also noted that as the length of tendril decreased from year 1 to 3, the number of shoots increased. Again, the 100-75-0 fertilizer treatment exerted the same or even better influence on shoot formation per plant than higher NPK levels.

Para-Centro Combination

Botanical Composition

Table 4 shows the botanical composition (percentage in the mixture) of the mixed crops which have been pruned periodically for 3 years to simulate grazing. In the control plot, paragrass consistently seemed to be slightly dominant over centrosema during the 3-year period. Probably, paragrass efficiently utilized the nitrogen fixed by the legume from the atmosphere for its growth. Addition of moderate amounts of nitrogen also gave the same results. Vicente-Chandler et al. (1974) reported that direct transfer of nitrogen fixed by the legumes

Table 4. Botanical composition of the mixed pasture crops for 3 years as affected by fertilizer rates and periodic pruning.[1]

Fertilizer Rates (kg NPK/ha)	Year 1 (1979) Percent		Year 2 (1980) Percent		Year 3 (1981) Percent		Mean Percent	
	Para	Centro	Para	Centro	Para	Centro	Para	Centro
0-0-0 (para-centro)	66ab	34cd	52d	48a	56de	44abc	58ab	42abc
0-75-0	64ab	36cd	56cd	44ab	57cde	43bcd	59ab	41abc
100-75-0	61abc	39bcd	68bc	32bc	69ab	31ef	66ab	34abc
100-75-100	57bcd	43abc	52d	48a	45f	55a	52b	48a
200-75-100	48cd	52ab	69bc	31bc	66abc	34def	61ab	39abc
400-75-150	59bc	41abc	88a	12d	70ab	30ef	72a	28bc
200-150-150	46d	54a	63cd	37ab	62bcd	38cde	57ab	43ab
400-150-150	62ab	38cd	64bcd	36ab	50ef	50ab	59ab	41abc
200-75-300	62ab	38cd	52d	48a	48ef	52ab	54b	46a
300-150-300	70ab	30cd	62cd	38ab	51ef	49ab	61ab	39abc
400-75-300	73a	27d	77ab	23cd	72a	28f	74a	26c
400-150-300	67ab	33cd	59cd	41ab	53def	47abc	60ab	40abc

[1] There were six harvests every year. Within a column, means followed by a common letter are not significantly different at 5% level, DMRT.

planted with grasses ranged from 0 to 53%. Direct transfer of N was attributed to fallen legume leaves as well as decomposition of roots and nodules. They also noted higher uptake value with longer cutting interval and longer cutting height after 3 years of establishment. These factors contributed to the increase in decomposition of roots and tops of the legume.

Application of high amounts of N and K and less of P (400-75-150 and 400-75-300) led to the most vigorous and rapid growth of paragrass making this grass species predominant (average of 72 and 74%, respectively) over the legume (average of 28 and 26%, respectively). In general, paragrass dominated centrosema during the 3-year period especially when high amounts of NPK were applied. As Heath et al. (1973) reported, attempts to supplement the legume with nitrogenous fertilizer did not work out well since the applied N replaced rather than supplemented the naturally occurring N that would normally be fixed. This is because paragrass was more responsive than centrosema to N application.

Dry Matter Yield

Table 5 shows the effects of periodic pruning and fertilizer application on the dry matter yield of the crop combination. During the first year, significant differences in the dry matter yield between the control and treated plants were observed but not among the treated plants. Higher yield of the latter could be due to the added nutrients in the soil. The same trend was noted during the second and third year.

Although the dry matter yield of pure paragrass was high during the first and second year, it declined drastically during the third year probably because the nutrients in the soil were already exhausted. For the first 2 years, its dry matter yield was comparable or even better than most of the treated ones. In the latter, competition between the mixed crops must have had a great effect resulting in suppression of their growth unlike in the pure paragrass where competition was nil.

In general, the mean dry matter yield for year 1 was lower than that for year 2 because of lower mean rainfall in the former. In the third year, dry matter yield declined since rainfall also decreased. Vicente-Chandler et al. (1974), and Whitney and Green (1969) reported that the response of grasses to nitrogen application is not uniform throughout the year. The highest dry matter production is attained during periods of high temperature and high rainfall. Sanchez (1976) suggested that one way of regulating dry matter production at different times of the year is by increasing or decreasing N rates aside from regulating the influence of temperature and rainfall.

Heath et al. (1973) claimed that even small amounts of N fertilizer tend to depress the growth of legumes in a grass-legume mixture if the forage is harvested as hay or silage. However with grazing wherein the grass is occasionally being

Table 5. Dry matter yield of para-centro combination grown under coconut for 3 years as influenced by fertilizer rates and periodic pruning.

Fertilizer Rates (kg NPK/ha)	Dry Matter Yield (t/ha/year)[1]			
	Year 1 (1979)	Year 2 (1980)	Year 3 (1981)	Mean
0-0-0 (pure paragrass)	9.51a	9.61 ab	6.15d	8.42ab
0-0-0 (para-centro)	4.89d	6.05c	4.16e	5.03d
0-75-0	6.25bcd	6.84c	6.33cd	6.47c
100-75-0	7.33abc	9.78ab	8.37abc	8.49ab
100-75-100	5.8cd	9.14abc	7.46a-d	7.48bc
200-75-100	7.24abc	9.20abc	7.06a-d	7.83b
400-75-150	7.57abc	8.95abc	8.08a-d	8.20b
200-150-150	8.06abc	9.10abc	6.90bcd	8.02b
400-150-150	8.53ab	9.32ab	7.57a-d	8.47ab
200-75-300	8.22abc	8.81abc	7.68a-d	8.24b
200-150-300	8.03abc	9.65ab	7.28a-d	8.32b
400-75-300	9.16a	11.52a	8.56ab	9.75a
400-150-300	9.14a	10.94a	9.13a	9.75a

[1] Within a column, means followed by a common letter are not significantly different at 5% level, DMRT.

defoliated, legumes are more successful in competing with grasses even at relatively high rates of N fertilization. Since centrosema has a creeping growth habit, it was less affected by periodic pruning than paragrass which has an upright growth habit.

As in botanical composition, the dry matter yields of the mixed crops in the different treatments did not show a distinct pattern every year. Generally, there was a linear correlation between nitrogen fertilizer application and dry matter yield. As the amount of N was increased, the dry matter of the mixed crops correspondingly increased. The highest mean dry matter yield of 9.75 t/ha/year was obtained in the 400-75-300 and 400-150-300 fertilizer treatments followed by 8.49 t/ha in the 100-75-0 treatment. The lowest dry matter yield was consistently obtained in the control during the 3-year period.

PCARR (1976) mentioned that grasses as well as mature coconut-bearing palms would require nitrogen, phosphorus and potassium. It was suggested that for the needs of a grass-legume pasture, phosphorus at 30 to 60 kg P_2O_5/ha/year is sufficient. In some cattle/coconut farms in Davao, they apply about 100 kg N/ha/year.

Proximate Analysis

Table 6 shows that the treatments did not significantly affect the proximate composition of the herbage in year 1. The values obtained were likewise not consistent and no definite trend or pattern in this analysis was noted in years 2 and 3. Nevertheless, the data imply that the fertilizer treatments influenced the amount of nitrogen, crude protein and ash in the herbage. Addition of 100-75-0 kg NPK/ha noticeably increased these parameters. In some cases, further increase in the amount of N with high level of P or K or reducing the amount of N but with high rates of P or K or vice versa increased proximate composition values of the para-centro combination. However, the highest values were consistently noted in the 400-75-300 treatment except for crude fiber and fat extract wherein the highest percentages were obtained in the 200-150-300 and 400-75-150 treatments, respectively. Vicente-Chandler et al. (1974) claimed that application of fertilizer

Table 6. Proximate analysis of para-centro combination for one year (Year 1, 1979).

Fertilizer Rates (kg NPK/ha)	Fat Extract	Crude Fiber	Nitrogen	Crude Protein	Ash
	(Percent)				
0-0-0 (para-centro)	1.23	33.03	1.93	12.06	12.38
0-75-0	1.23	34.79	1.61	10.08	12.64
100-75-0	1.15	33.57	1.81	11.29	12.91
100-75-100	1.78	35.28	1.57	9.81	12.42
200-75-100	1.37	33.14	1.62	10.16	12.90
400-75-150	1.92	34.76	1.69	10.58	11.94
200-150-150	1.51	34.44	1.87	11.68	12.32
400-150-150	1.40	33.70	1.51	9.44	13.26
200-75-300	1.36	34.57	1.70	10.64	12.52
200-150-300	1.38	35.31	1.79	11.18	12.47
400-75-300	1.84	32.31	1.97	12.30	13.89
400-150-300	1.66	34.69	1.81	11.32	12.76
Mean	1.49	34.13	1.74	10.88	12.70

affected the nutritive value of grass-legume mixtures. Heavy applications of nitrogen, phosphorus, potassium and lime considerably increased the digestible dry matter, crude protein, phosphorus and calcium contents of grasses. Soil organic matter and total nitrogen were also reported to increase significantly.

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