Grass/Legume Compatibility in the Derived Savanna Regions of Western State of Nigeria

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SUMMARY

THE grass/legume compatibility between six grasses and three legumes were studied at Fashola Stock Farm in the derived savanna region of Western State of Nigeria.

The highest herbage yields per hectare per annum were obtained from the mixed swards. The yields of legumes were smaller in the mixtures with the tall than in the short grasses.

It was concluded that in this area, *Stylosanthes gracillis* was compatible with the elephant and Guinea grasses. *Pueraria Phaseoloides* was compatible with the Northern Gambia and the molasses grasses, while the *Centrosema pubescence* combined well with the giant star grasses.

INTRODUCTION

THE place of legume in pasture association for the grazing livestock has long been established in several parts of the world. Grasses planted with legumes have been shown to yield higher than grasses planted in monoculture (Adegbola, 1964; Adegbola and Onayinka, 1966; Akinyemi, 1968; Cowling, 1961; Newman, 1968; Reid and Castle, 1965; Schofield, 1945 and Stobbs, 1966). The herbage from grass/legume pasture has been shown to contain higher crude protein than herbage from pure grass (Brockman and Wolton, 1963; Akinyemi, 1968; Brockman, 1966; Brockman and Wolton, 1963; Horrell and Newhouse, 1966). Furthermore, animals grazing a grass/legume pasture have been more productive (Stobbs, 1966) than animals grazing pure grass swards. They are also less likely to suffer from mineral deficiencies. It was not surprising therefore that Robert (1928) of Cornell University, had listed the maintenance of legumes in his pasture as the greatest factor responsible for its high yield over five years.

Also, Stapledon (1937) in accepting legume in pasture wrote that "No grassland is worthy of the name and indeed is worth bothering with unless a legume is at work. Find or breed the right legume for every corner of the world and you have tolerably good grassland in every corner of the world. Make conditions suitable for the legume and manage the sward to favour the legume as well as to feed the animals and everything else will be easy — the battle will be won".

However in recent years, the popular use of nitrogen fertilizer in crop production in developed countries has meant the use of these chemicals on pasture lands to the detriment of the legume. The legume fraction of pastures has been shown to disappear in the presence of nitrogen (Akinyemi 1968; Cowling 1961). On the other hand nitrogen gave linear increase to grass yield up to a point. It was obvious, therefore, that nitrogen fertiliser has come to challenge the legume in pasture production. Already in Holland and New Zealand the scale has tilted in favour of the fertiliser (Watkin, 1954). In many other countries decisions have been directed to meet specific need for intensification.

In Nigeria, the nature of the farmers' economy still limits his ability to use sufficient quantity of fertiliser even on his arable crops much less on his pasture. For feeding the grazing livestock he will have to rely for some time on the use of legumes in his pastures. The obvious problem will be the choice of compatible grass and legume.

The work discussed here investigates the question of grass/legume compatibility at Fashola in Oyo division of the Western State of Nigeria.

MATERIALS AND METHODS

The experiment was sited at Fashola in Oyo Division. This area lies within the derived Savanna zone of Nigeria which makes up about 33 % of the entire land area of Western State. This zone is rapidly gaining ground as rangeland due partly to high forage yield and reduced incidence of tse-tse flies attacks.

On the 18th March 1971 the seeds of three legumes were drilled in rows one metre apart. Two weeks later, the cuttings or rhizomes of six grass species were planted between the legumes at 1 metre by 0.6 metre between and within row spacing for the bunch grasses and at 0.3 metre each way for the sward formers.

The legumes planted were:-

1. *Stylosanthes gracilis* (stylo)
2. *Pueraria phaseoloides* (pueraria)
3. *Centrosema pubescence* (centro)

The grasses were:

1. *Pennisetum purpureum* (elephant grass)
2. *Panicum maximum* (Guinea grass)
3. *Andropogon gayanus* (Northern Gamba grass)
4. *Cynodon nlemfuensis* (giant star grass)
5. *Cynodon nlemfuensis* cv IB 8
6. *Melinis minutiflora* (molasses grass).

The first three grasses are tall tussock forming while the last three are stoloniferous sward grasses. All the grasses and legumes were planted in pure stands as well as and each grass in combination with each legume to give a total of 27 treatments. These were replicated two times and laid out in a randomised block design. The size of the experiment was a special constraint to the number of replications.

Weeding was done once in May 1971 and a uniformity cut was made in June 1971. The first recorded harvest was done on the 18th September and subsequent harvests followed at 12 weekly intervals. The experiment had to terminate on the 20th December 1972 after a serious fire outbreak in January 1973 wiped out the entire area.

At harvests, a quadrat 2 x 3m in area was harvested down to 30 cm in the tall grasses and to 10 cm in the short grasses. The herbage collected was taken into the laboratory for separation into grass and legume followed by dry matter determination. The picture of grass/legume compatibility obtained is presented in this paper.

RESULTS AND DISCUSSION

Effect of Grass/Legume Association on Pasture Yield

Table 1 shows that grasses, planted with the tropical legumes produced significantly higher yields of herbage per hectare than either the pure grass or the pure legume

TABLE 1

The mean cumulative yield of herbage from grass/legume mixtures [kg/ha/year] from December 1971 to December 1972.

Grasses Legumes	Elephant grass	Guinea grass (S112)	Northern Gamba grass	Giant Star grass	Cynodon IB8	Molasses grass	Mean of Mixture	Mean of Pure Legume
Stylo	3898.2	4773.8	2674.5	3277.2	3151.8	2046.6	3240.6	2543.7
	2964.6	3305.3	2205.3	2836.2	2477.7	2182.2	2561.9	1678.2
Centre	2568.3	2463.0	1357.2	777.6	668.7	2493.9	1738.2	371.7
Mean of Mixture	3143.7	3514.0	2079.0	2297.0	2099.4	2240.9	2547.0	1531.2
Mean of pure Grasses	2448.0	3448.0	2063.1	1121.7	2048.7	2139.0	2443.2	
Mean Le- gume contribution	569.4	99.5	15.9	1175.4	50.7	102.0	103.8	

swards. This is in conformity with many known work in this field (Cowling and Dewhurst, 1961; Cowling, 1961; Reid and Castle, 1965; Adegbola and Onayinka, 1966; Akinyemi, 1968). The Guinea grass/Stylo gave the highest herbage yield of 4773.8 kg/ha/year while the lowest yield was obtained from the IB8/*Centrosema* mixtures. In general the tall grasses were higher yielding than the short grasses.

The legume contribution to yield can be assessed as the difference between the mean yield of the mixtures and the corresponding yield of pure grass. Such an estimate is tabulated in Table 1. On average the legumes made their greatest contribution to yield in the Giant Star grass followed by the elephant grass. In the northern Gamba and the IB8., legume contribution to yield was very poor. The mixtures of the tall grasses with the legumes were generally higher yielding than the short grasses with legumes. The greatest output per hectare were obtained from grass/*Stylosanthes* mixture. Grass/*pueraria* mixture was medium yielding while poor yields were obtained from grass/*Centrosema* mixtures.

sward grasses both in competition and in pure stands. The average yields of the tall grasses were 2010.2 kg/ha/year and 2750. kg/ha/year in mixed and pure stands respectively. The comparable yields among short grasses were 737.8 and 1767.7 kg/ha/year respectively. The Guinea grass S112 was the most outstanding. This was in agreement with previous observation on this variety of guinea grass in this area by Onayinka in 1970 (Personal communication). The molasses grass was the highest yielding among the short grasses. This may be explained by the high drought resistance observed in this species which made it possible to obtain high yield from the molasses grass in the dry season when yields were low in the giant star grass varieties.

In all the pastures studied the pure grass swards outyielded the contribution from the grass fraction of the grass/legume systems (Table 2). The difference may be termed the effect of stress due to the association. The size of this effect was least in the elephant grass and greatest in the IB8. Similar competitive effects have been discussed by several workers both in the

TABLE 2

The mean cumulative effect of the association from December 1971 - December 1972 on the dry matter [DM] yield of the grass fraction of grass/legume mixture [kg/ha/year].

Legume Grasses	Stylo	Pueraria	Centro	Mean of Mixture	Pure Grass	Competitive stress
Elephant grass	2153.01	2022.48	2282.82	2152.77	2748.09	595.32
Guinea grass (S112)	2533.05	2603.37	2426.85	2521.09	3447.96	926.87
N. Gamba grass	1493.82	1478.73	1097.58	1356.70	2063.22	706.52
Giant star grass	555.48	359.43	358.95	424.62	1121.61	696.99
Cynodon IB 8	554.13	622.20	416.70	531.01	2048.55	1517.54
Molasses grass	706.17	1145.16	1921.95	1257.76	2138.91	881.14
Mean	1332.61	1371.90	1417.48			

Competition Effect of Grass/Legume Association

(a) Yield of Grass Fraction

The mean annual yields of the grass fraction of the different grass/legume associations are compared with the grass yields from pure swards in Table 2. Generally, the tall grasses yielded higher than the

temperate and tropical regions of the world. The validity of such a pattern of competition had been described by Ahlgren and Aamodt, (1939).

(b) Yield of Legume Fraction

The yields of pure legumes were also higher than the yields of the legume fraction of the grass/legume association (Table

TABLE 3

The Mean Cumulative Effect of the Association from December 1971 - December 1972 on the DM & Yield of the Legume fraction of Grass/legume Mixture kg/ha/year]

Grasses	Legumes	Stylo	Pueraria	Centro	Mean
Elephant grass		1745.19	1042.23	366.45	1051.29
Guinea grass(112)		2048.73	701.97	136.17	962.29
N. Gamba grass		1927.68	896.67	259.59	1027.98
Giant star grass		2730.57	2483.01	417.93	1877.17
Cynodon IB 8		2097.12	1954.02	287.94	1446.36
Molasses grass		1848.81	1037.01	778.71	1221.51
Mean of Mixture		2066.35	1352.49	374.47	
Pure legume		2543.58	1887.30	390.00	
Competitive Stress		477.23	525.81	15.53	

3). *Stylosanthes gracilis* was significantly the highest yielding legume both in pure culture and in competition. The *Pueraria phaseoloides* was next while *Centrosema pubescence* gave a poor performance. The Stylo planted with the tall grasses contributed an average of 1907.2 kg/ha/year to pasture dry matter yield and with the short grasses 2225.5 kg/ha/year. The pueraria contributed 880.3 and 1824.7 kg/ha/year in the tall and the short grasses respectively. The comparable productivity of Centro in the two types of grasses were 254.1 and 494.9 kg/ha/year.

This pattern of behaviour of the legumes when planted with the tall-type and short-type grasses seems to suggest a competition for light. The tall grasses, because of the disposition of their foliage, intercept most of the light which might have reached the legume's foliage surfaces, hence the lower yield of the legumes in the tall grasses. This pattern of interference has been described by many workers (Donald, 1956; Brougham, 1958; Stern and Donald, 1951; Reid, 1961; Brockman and Wolton, 1953) who have explained the disappearance of legumes from nitrogen fertilised mixed swards in similar terms. The poor performance of the centrosema under the condition of the experiment could be explained by the fact that the legume, which is a climber had little chance to climb the companion grasses to sufficient height for optimum light utilisation.

The results so far discussed does not deviate from the general pattern reported elsewhere. The operation of the forces of

competition was clearly demonstrated by the fact that the component of the grass/legume mixtures yielded lower in mixtures than in their pure stands. The result showed clearly the tendency of the more vigorous plants to displace the weaker ones from competition. Factors responsible for the disappearance of legumes from grass/legume mixtures have been discussed by many workers. Akinyemi (1968), working with ryegrass and white clover in Britain, showed that reduced light intensity affected the legumes more than the grass. This disappearance of the legumes in the face of vigorous competition from a grass species calls for the assessment of the degree of compatibility between the different grass and legume species. The degree of compatibility between a grass and legume is a resultant effect of a combination of vigour of each of the species and the level of management imposed. Left undisturbed, the grass/legume mixture should progress ecologically in accordance with the laws governing plant succession in a plant community. In this succession one species might disappear almost entirely. Good pasture management requires that this natural phenomenon be interrupted periodically in order to maintain the plant association in the most desirable state for livestock feeding. The intensity and frequency of this interruption will therefore depend on the compatibility between the species in the community. Compatibility could therefore be defined as a state of association existing between two or more plant species in which

the tendency of one to displace the other from the mixture is low. However because the plant association is usually a dynamic entity, there is a continuous need to help the state of compatibility by management. In other words, what can be considered is the relative compatibility pattern of species in association.

Table 4 which shows the percentage legume contribution in grass/legume associations is a picture of the relative compatibility between the grasses and the legumes. The

very high yields of herbage. *Pueraria* was most compatible with the Northern Gamba and the molasses grasses while *Centrosema* participated acceptably in mixture with giant star and IB8 grasses. In these areas it would not be advisable to plant stylo with a grass like the giant star or molasses since it might displace all these grasses within two years. In an identical way Guinea grass, especially the S112 variety, planted with *Centrosema* may be difficult to manage if the legume was to be saved.

TABLE 4

Grasses/Legumes	Elephant	Guinea (S112)	N. Gamba	Giant star	IB 8	Molasses
Stylo	45	43	72	83	67	90
<i>Pueraria</i>	35	21	41	88	79	48
<i>Centro</i>	14	6	19	54	43	31

picture shows that in about 18 months which the trial lasted, Stylo almost displaced the molasses, giant star and the northern gamba grasses from competition. The *pueraria* nearly eliminated the giant star and IB8 from the mixture. On the other hand, the Guinea and elephant grasses proved too vigorous for *Centrosema pubescence* and *Pueraria phaseoloides*. At the end of the experimental period, the stylo had contributed 45% and 43% of yield in the elephant and guinea grasses respectively. The *pueraria* was responsible for 41% and 48% of the yield of herbage from its mixture with the Northern Gamba and the molasses grasses respectively, while the *centrosema* contributed 54% and 43% of yield in the elephant and guinea grasses respectively.

It might be suggested therefore, that in the derived savanna regions of Western Nigeria typified by Oyo areas, *Stylosanthes gracilis* would be compatible with the elephant and Guinea grasses to produce

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