

Short Communication

Effect of Rice Bean (*Vigna umbellata*) Inter-cropping on the Yield of Perennial Grass, *Panicum maximum* CV. Gatton under Rain-fed Conditions

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ABSTRACT

A field study was conducted to assess the effect of grass and legume intercropping on the biomass yield, quality and soil fertility during monsoon, 2004. A maximum biomass production (487.61 g m⁻²) was recorded for grass-legume mixture with the ratio of 40:60, respectively followed by grass alone (419.05 g m⁻²). Lowest biomass yield (387.87 g m⁻²) was given by the legume alone. A 40:60 ratio mixture of grass and legume attained the greatest plant height (108.88 cm) followed by the 60:40 ratio mixture (100.11 cm). Maximum crude protein percentage (15.46%) was recorded in 40:60 ratio mixtures of grass and legume, while the minimum one in grass alone. Maximum soil nitrogen (0.051%) was determined in legume alone followed by (0.045%) in 40:60 ratio of grass-legume mixture, while it was the minimum in grass alone at 0 - 15 cm and 15 - 30 cm soil.

Key Words: Biomass production; Plant height; Crude protein, Soil nitrogen

INTRODUCTION

Pothwar Plateau consists mainly of Rawalpindi, Chakwal, Attock and Jehlum districts of Punjab covering an area of more than one million hectare. Being rain-fed tract, it contributes significantly to agricultural and livestock production of Pakistan (Supple *et al.*, 1985). Rainfall is erratic and varies greatly from 1000 mm in north-east to 250 mm in south-west part of the region. The tract lies at 33°.38/latitude (N) and 73°.00/longitude (E). Pothwar is classified as sub-tropical and sub-humid. More than 70% of annual precipitation falls in the summer monsoon period and there is a general shortage of forage for livestock during spring and winter seasons (Qamar & Arshad, 2002). The soils of the Pothwar plateau are, in general, low in fertility and in particular, deficient in organic matter. Maize, sorghum and millet are cultivated in summer and wheat is planted in winter and this continuous crop sequence has depleted the soil nitrogen, as use of inorganic nitrogenous fertilizers is very limited. Almost no fertilizer, either organic or inorganic is used for forage crops. Therefore introduction and management of forage legumes in the present farming system is crucial for sustainable crop-livestock production in the area (Parveen *et al.*, 2001).

When livestock feeds on grasses, protein contents are often below critical threshold. Thus, increasing amounts of forage legumes in animal diet not only improves protein content but also increases voluntary intake of entire diet (Osman & Osman, 1982). Intercropping forage legumes with grasses also increases forage yield and quality in terms

of crude protein content, voluntary intake and digestibility (Tukel & Yilmaz, 1987). Grown in mixtures, erect grass plants provide support to twining legume stems potentially facilitating the mechanical harvest of the whole crop (Osman & Osman, 1982). Grasses and cereals belong to family Poaceae and both cereals and grasses provide forage for livestock, protect the soil from erosion, improve soil structure and hence in water retention (Ahmad *et al.*, 2001).

Legumes are capable of fixing atmospheric nitrogen with the help of Rhizobia living symbiotically in the root nodules. Therefore legumes can be grown in soils with low fertility without applying chemical fertilizers (Schulz *et al.*, 1999). Leguminous forages are not only rich in protein but also in minerals and Vitamin B. Forage legumes increase fertility, control soil erosion and are also used as cover crops (Parveen *et al.*, 2001).

The grass species used in the study was guinea grass (*Panicum maximum* cv. Gatton), which is a medium-height variety a tufted, summer-growing perennial similar to green panic and palatable. It has similar cultural and soil requirements as green panic, but it does not exhibit the same shade and frost tolerance and although it is reputed to have a better drought resistance, but it needs a higher annual rainfall than green panic (a minimum of 750 mm) to persist. Gatton panic has longer, broader, hairless green leaves as distinct from green panic's light green foliage with hairy lower leaf blades and leaf sheaths (Partridge, 1996).

The legume species used rice bean (*Vigna umbellata*) is native to South and Southeast Asia. It is known for its diverse distribution and range of adaptation from the humid

sub-tropical to warm and cool temperate climate. Rice bean is known as one of the important fodder crops during the lean periods. It is a palatable, highly nutritious and rich in protein, calcium and phosphorous than many other summer legumes. The crop is adapted to high temperature, humidity as well as heavy soils. Rice bean is a dual purpose crop. It has high yield potential and under sound management practices, it can produce 3.0 t ha⁻¹ seeds and 3.30 t ha⁻¹ dry herbage to meet scarcity of green forage, while seeds contain high protein, amino acids and vitamins (Ahmad & Rabbani, 1992). In view of its importance, a field study was conducted to compare number of growth characteristic (height) of grass and legume in combination or alone, to compare of total biomass production and crude protein content of grass and legume with or without mixture and to determine total nitrogen in the soil before and after the experiment.

MATERIALS AND METHODS

An experiment was conducted in the experimental area of Rangeland Research Program at the National Agricultural Research Centre, Islamabad, situated in the sub-tropical, sub-humid Pothwar plateau during the year 2004. Average annual rainfall recorded in the last 80 years was 944 mm, mostly received in the monsoon season (Jilani *et al.*, 2001). Summers are very hot and the temperature may rise above 40°C in June and winters are cold with occasional frost in January. The soil was deep, loam and slightly alkaline. No fertilizer was applied at the time of sowing/tuft planting. The experiment was laid out in randomized complete block design (RCBD) with four treatments and three replications. The treatments were grass alone, legume alone, 60:40 ratio of grass:legume and 40:60 ratio of grass:legume. Line sowing was done with manual drill for rice bean, while for gaton, tuft planting was carried out during the last week of June 2004 at the onset of monsoon season. Row to row distance was 50 cm and 10 lines were maintained in each treatment. 60:40 ratio of grass:legume mixtures had six lines of grass and four of legumes, while combination of 40:60% grass:legumes had four lines of grass and six of legumes.

At the end of experiment, total biomass production of *P. maximum* var. Gaton as well as rice bean was determined in different treatments. Forage production was measured by destructive clipping of plant material at ground surface using 1 m² quadrats. Two quadrats were taken in each plot and the material was placed in paper bags and oven dried at 70°C. At the end of experiment, height of grass tillers in each treatment was taken. Ten grass plants were randomly selected to measure height of tiller (cm) in each treatment. Crude protein content was analyzed from total N measured using Micro-Kjeldahl method (AOAC, 1994). The data so collected were analyzed statistically by Fisher's analysis of variance (Steel & Torrie, 1980). Least significant difference at 5% level of probability was applied for comparing the treatment means.

RESULTS AND DISCUSSION

Plant height and aboveground biomass production.

Maximum height (108.88 cm) of the grass tiller was noted in 40:60 grass: legume ratio followed by the mixture of 60:40 grass: legume ratio (Table I). The lowest tiller height (92 cm) was noted in case of grass alone. The mixture of grass with legume significantly increased the height of grass, because of increased supply of soil nitrogen in the root zone. Maximum height of the legume (114.77 cm) was recorded in legume alone (Table I) followed by 40% grass and 60% legume (94.98 cm). The lowest height (74.66 cm) was attributed in mixture of 60% grass and 40% legume. The height of legume plants decreased with increasing level of mixture with grass species possibly, because of competitive effect of legumes with grass for space. Gaton grass is more vigorous in growth and the tillers spread horizontally, while gaining height with the passage of time (Partridge, 1996).

Maximum above ground biomass (487.61 g m⁻²) was recorded in 40:60 grass: legume combination followed by grass alone (419.05 g m⁻²), while it was lowest (387.87 g m⁻²) in legume alone (Table I). The mixture of grass with the legume significantly increased the height of grass, because of increased supply of soil nitrogen in the root zone, leading to the increased biomass of grass when grown in combination with legume. Greater the contribution of legume in grass mixture greater was the growth of grass in terms of tiller height thereby contributing towards more biomass yield per unit area. These results are similar to those of Odhiambo and Bomke (2001), Mohapatra *et al.* (2001) and Parveen *et al.* (2001).

Crude protein content. The maximum crude protein percentage of grass (15.46%) was recorded in 40:60 grass: legume mixture followed by (14.20%) in mixture of 60% grass and 40% legume (Table I). The lowest crude protein was displayed by the grass alone (11.84 %), which was similar to the results of Sleugh *et al.* (2000). The legumes, on the other hand, indicated highest crude protein (19.78%) followed by mixture 40:60 grass: legume ratio (Table I). The results are similar to the results of Parveen *et al.* (2001).

Total nitrogen (N) of soil. The soil nitrogen at 0 - 15 cm depth in all experimental plots was statistically similar (Table II), which changed at the end of experiment and produced significant difference among the treatments. Maximum soil N was 0.051% in legume alone followed by the mixture of 40:60 grass: legume mixture (0.045%). Minimum soil N (0.029) was recorded in grass alone (Table I). The results were similar to those of Giacomini *et al.* (2003) and Sleugh *et al.* (2000). Rice bean, being a legume added nitrogen in the soil through biological nitrogen fixation by the formation of nodules in the root zone. The maximum amount of N added in case of legume stand, while grass competed for nitrogen in mixture and exhausted some of the nitrogen fixed by the legume.

The soil nitrogen at 15 - 30 cm depth was statistically

Table I. Above ground biomass, average height and mean crude protein different grass-legume mixtures

Grass-legume mixtures	Biomass (g m ⁻²)	Biomass (kg ha ⁻¹)	Grass height (cm)	Legum height (cm)	crude grass (%)	protein (%)	crude protein legume (%)
Grass alone	419.05 b*	4190.50b	92.00c	-	11.84c	-	-
Legume alone	387.87 d	3878.70 d	-	114.77 a	-	19.78 a	-
60% grass+40% legume	405.63 c	4056.30 c	100.11 b	74.66 c	14.20 b	15.44 c	-
40% grass+60% legume	487.61 a	4876.10 a	108.88 a	94.88 b	15.46 a	18.00 b	-

Means followed by same letter (s) are statistically similar at 5% level of significance

Table II. Total soil nitrogen percentage in various grass-legume mixtures

Treatments	0.15 cm depth		15-30 cm depth	
	% N (before experiment)	%N (after experiment)	% N (before experiment)	% N(after experiment)
Grass alone	0.032	0.029 d*	0.023d*	0.021 d*
Legume alone	0.034	0.051 a	0.024	0.045 a
60% grass+40% legume	0.031	0.039 c	0.022	0.032 c
40% grass+60% legume	0.032	0.045 b	0.022	0.038 b

Means followed by same letter (s) are statistically similar at 5% level of significance

at par ($P > 0.05$) in all treatments (Table II). Towards the end of experiment, the status of soil N changed and significant difference was recorded in all the treatments. The maximum soil nitrogen (0.045%) was obtained in the legume alone followed by the combination of 40:60 grass: legume mixture (0.038%). The lowest soil nitrogen (0.021 g/100 g) was recorded in grass alone. The soil nitrogen recorded at 15 - 30 cm depth was lower in all the treatments as compared to that of 0 - 15 cm depth, because more nitrogen was fixed in the root zone at the upper layer of soil. The trend of total soil nitrogen in different treatments at 15 - 30 cm depth was same as of the values for 0 - 15 cm depth. These results are similar to the results of Sleugh *et al.* (2000) and Giacomini *et al.* (2003).

In conclusion, grass-legume combination proved useful in enhancing the growth of legumes and improving the fertility status of soils in the areas where there is scarcity of water.

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