



Glyricidia (*Glyricidia sepium*) as green manure in improving soil fertility and productivity of coconut under coastal littoral sandy soil

P. Subramanian, R. Dhanapal, P. Sanil, C. Palaniswami, C.V. Sairam and H.P. Maheswarappa

Central Plantation Crops Research Institute, Kasaragod - 671124, Kerala

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Abstract

A field experiment was conducted on substitution of nitrogenous fertilizer with glyricidia green manure to study the effect of this green manure on soil fertility, yield and economic returns from coconut under coastal littoral sandy soil at Central Plantation Crops Research Institute, Kasaragod. The treatments included substitution of 25, 50, 75 and 100 per cent of the recommended dose of nitrogen through glyricidia while the balance N and full dose of P and K was supplied through chemical fertilizers. In the control treatment, the recommended dose of NPK was applied through chemical fertilizers alone. The experimental results revealed that incorporation of glyricidia as green manure had higher levels of available soil nitrogen as compared to application of inorganic fertilizers alone. However, the different treatments did not show any significant effect on available soil phosphorus and potassium. Glyricidia application also improved the soil moisture availability. The treatment, where 50 per cent N was substituted by glyricidia + 50 per cent of N and 100 per cent of P and K through chemical fertilizers recorded higher yield of 52 nuts per palm per year (44 percentage increase over control). The cost benefit ratio was also most favourable in the same treatment (1: 1.82).

Key words: Coconut, coastal sandy soil, glyricidia green manure, N substitution, available nutrients, productivity, cost benefit ratio

Introduction

Coconut is grown in littoral sandy soil, which occurs all along the coastal sandy tract, with fairly high water table (1 to 2.5 m), of the West and East coasts of the Peninsular India lying mostly in Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Orissa and Maharashtra. The weather parameters prevailing along the coastal area are conducive for growing coconut economically. However, coconut productivity is very low in the coastal sandy soil. Srinivasa Reddy and Upadhyay (2002) also reported that coconut grown under coastal sandy soil without manuring resulted in lower yield of 12 - 18 nuts per tree per year. The reasons for low productivity are mainly poor physico-chemical characters viz., high bulk density, poor aggregate stability, poor water holding capacity, high soil temperature and poor soil fertility status. Earlier studies revealed that despite regular application of chemical fertilizers, no appreciable build up in soil nutrient status was noticed in littoral sandy soil. This was mainly attributed to low nutrient retention

capacity of the soil (Srinivasa Reddy *et al.*, 1999). To overcome the poor soil fertility status and to improve the water holding capacity, soil organic matter should be improved by addition of green leaves, compost or farmyard manure. Addition of organic sources like forest leaves and cattle manure, markedly enhanced the growth and vigour of coconut palm as compared to palms treated with NPK fertilizers alone under coastal sandy soils (Nambiar *et al.*, 1983). Srinivasa Reddy and Upadhyay (2002) reported that application of recommended dose of chemical fertilizers with 20 kg of organics resulted in 60 percentage increased nut yield over control. Keeping in view the poor physico-chemical character of sandy soil and the proven effect of growing glyricidia as alley crop in between the coconut palms in coastal areas (Subramanian *et al.*, 2000), an experiment was undertaken at CPCRI, Kasaragod to study the effect of substitution of nitrogenous fertilizer with glyricidia in improving soil fertility and productivity of coconut under littoral sandy soil.

Materials and Methods

The experiment was initiated in a 30 year old WCT coconut plantation during 1996 in the littoral sandy soil of the Beach Block at Central Plantation Crops Research Institute, Kasaragod. The experiment site is situated at 12°30' N latitude and 75°00' E longitude at an elevation of 10.7 m above mean sea level. This location receives an average annual rainfall of 3500 mm, of which 86 per cent is received during the four monsoon months (June–September). The twenty-year average maximum temperature ranges between 28.8° to 33.1°C and minimum temperature between 19.4° and 24.4° C. The relative humidity ranges between 81 to 94 per cent and the open pan evaporation ranges between 4.3 mm to 5.5 mm per day. The soil of the experimental field was classified as littoral sand (Quartzipsamments) with a mechanical composition of 95.8 per cent coarse sand, 3.3 per cent fine sand, 0.12 per cent silt and 0.7 per cent clay. The field capacity of the soil was 4.2 per cent and wilting point was 0.44 per cent.

The experiment was laid out in randomized block design with four replications and five treatments viz., T_1 = Control i.e. recommended dose (500 g N: 320 g P_2O_5 : 1200 g K_2O) of chemical fertilizers, T_2 = 25 per cent of N substituted by glyricidia (12.5 kg of glyricidia loppings) + 75 per cent of N and full PK by chemical fertilizers, T_3 = 50 per cent of N substituted by glyricidia (25 kg of glyricidia loppings) + 50 per cent of N and full PK by chemical fertilizers, T_4 = 75 per cent of N substituted by glyricidia (37.5 kg of glyricidia loppings) + 25 per cent of N and full PK by chemical fertilizers and T_5 = 100 per cent of N substituted by glyricidia (50 kg of glyricidia loppings) + full dose of PK by chemical fertilizers. The NPK content of glyricidia green manure on dry weight basis is 3.40, 0.25 and 1.16 per cent, respectively. The plot size of each treatment was five palms (281.25 m²) which followed square system of planting at a spacing of 7.5 m x 7.5 m. The nitrogen, phosphorus and potassium were applied in the form of urea, mussorie rock phosphate and muriate of potash, respectively, in two splits viz., one third in May-June (beginning of the monsoon) and two thirds in September-October (receding monsoon) for the control treatment. For glyricidia treatments, 1.8 m radius basin was opened at a depth of 20 cm around the bole and the green manure was applied in the basin and the required inorganic fertilizers were applied and covered with the excavated soil during first fortnight of September. Basin irrigation was provided for the experimental palms wherein 200 litres of water was supplied once in four days through hose in the basin area of 1.8 m radius from November to May, as reported by Dhanapal *et al.* (2000).

During the year 2003, soil samples were collected one, two, three and four days after irrigation from two depths 0-25 and 25-50 cm (four cycles) using tube augur from the coconut basin area at a distance of 1m away from the bole and soil moisture was estimated by gravimetric method. Soil samples were also collected for nutrient (NPK) analysis and organic carbon. The soil samples were air dried in the shade, ground to pass through a 2 mm sieve and analysed for available nitrogen, phosphorus and potassium status. Available nitrogen in the soil was determined by alkaline permanganate method (Subbiah and Asija, 1956). The available phosphorus was estimated (Bray 1) following the procedure outlined by Bray and Kurtz (1945) and Jackson (1973). The available potassium was estimated in the 1 N NH_4OAC flame photometrically (Stanford and English, 1949). The organic carbon content was estimated following the method outlined by Walkley and Black (1934). The nut yield from each palm was recorded separately during each harvest. The harvest was done at intervals of 45 days. The data recorded on various characters were subjected to Fisher's method of analysis of variance and interpretation of data was done as per the procedure given by Gomez and Gomez (1984).

Results and Discussion

Soil organic carbon

A clear trend of increased organic carbon content due to glyricidia application was recorded in the 0-25 and 25-50 cm depths of observation. All the treatments where glyricidia was substituted for nitrogen, resulted in higher organic carbon content as compared to the control (Table 1). However, only in the 0-25 cm depth, significant treatment effect on soil organic carbon content was observed. The treatment T_5 recorded the highest organic carbon (0.56 per cent) which was on par with the other three treatments viz. T_2 (0.45 per cent), T_3 (0.43 per cent) and T_4 (0.44 per cent) and significantly differed from the control treatment T_1 (0.25 per cent), where only inorganic fertilizers were applied. Liyanage (1994) also observed that the incorporation of glyricidia loppings in the coconut basin at 20 cm depth resulted in increased organic carbon content. The organic carbon content in the 0-25 cm depth was more when compared to that in 25-50 cm depth. It may be due to the application of glyricidia in that depth. Nambiar *et al.* (1983) also reported that soil organic matter status of the top soil was more than that in sub-soil. The effect of various treatments for the organic carbon percent was non significant for the 25-50 cm depth. However, higher level of organic carbon content was observed in those treatments which received glyricidia. In the treatment,

where only inorganic fertilizers were applied, it was found that the soil had low organic carbon (0.24 per cent). This is because the soil is sandy and basically poor in organic carbon and there was no external addition of organic matter.

Available soil nutrients

The available nitrogen status of the soil was significantly influenced by the treatments which received glyricidia green manure in combination with inorganic fertilizer. However, significant differences were observed only in the 0-25 cm depth and the treatment effects were found to be non significant in 25-50 cm depth. The treatment T₅ (100 per cent N by glyricidia + full PK by chemical fertilizers) recorded significantly higher level of nitrogen which was on par with the treatments T₄ and T₃ and significantly differed from the treatments T₂ and T₁ in the 0-25 cm depth. (Table 1). Studies carried out intercropping of *Casuarina equisetifolia* and the two legumes *Acacia mangium* and *Acacia auriculiformis* in coconut in coastal sandy soil and cutting of all the parts other than wood of intercrops being returned to soil resulted in enriching the soil and maintaining the soil fertility (Taffin *et al.* 1991).

No significant difference due to combined application of glyricidia and chemical fertilizer was noticed in available phosphorus status of the soil in both the depths (0-25 and 25-50 cm). The same trend was observed in available potassium also.

Soil moisture

The analysis of the soil moisture content at the two different depths revealed that higher moisture content was recorded in the 0-25 cm depth (Fig. 1) and lower moisture content in the 25-50 cm depth (Fig.2). In general, more soil moisture content was observed in the treatments which received glyricidia as green manure.

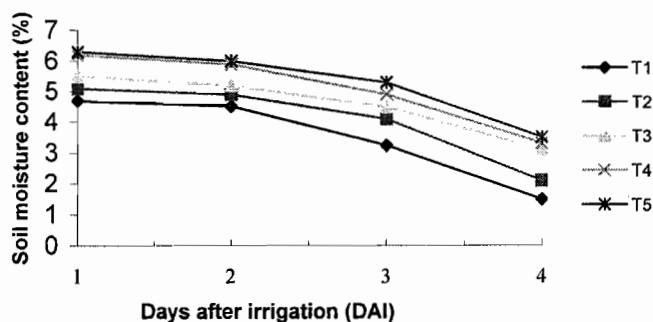


Fig. 1. Effect of different treatments on soil moisture content (%) (0-25 cm)

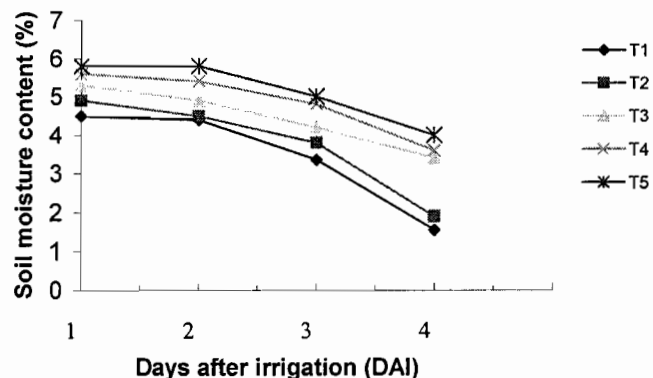


Fig. 2. Effect of different treatments on soil moisture content (%) (25-50cm)

Further, higher moisture content (6.3 per cent) was noticed in the treatment T₅ on the first day after irrigation (DAI) to the fourth day after irrigation (3.5 per cent), whereas lower moisture was noticed in the treatment T₁, where chemical fertilizers alone were applied (4.7 per cent on first day after irrigation and 1.5 per cent on fourth day after irrigation) at 0-25 cm. The same trend was observed in the 25-50 cm depth also. Higher soil moisture content in the glyricidia treatments might be due to improvement in water holding capacity of the soil. Application of organic material enhances the utilization of fertilizer nutrients by plants and water retention ability

Table 1. Organic carbon content and available soil nutrient status at different depths in coconut basin

Treatment	Available nutrients (ppm)							
	Organic carbon (per cent)		N (ppm)		P (ppm)		K (ppm)	
	0-25 cm	25-50 cm	0-25 cm	25-50 cm	0-25 cm	25-50 cm	0-25 cm	25-50 cm
T1: Control (chemical fertilizer alone)	0.25	0.24	38.4	31.2	89.82	65.21	35.77	23.08
T2: 25 per cent N by glyricidia + 75 per cent N and full PK by chemical fertilizers	0.45	0.25	44.5	33.4	107.96	46.5	42.69	27.69
T3: 50 per cent N by glyricidia + 50 per cent N and full PK by chemical fertilizers	0.43	0.26	46.3	36.4	107.88	28.62	41.54	25.38
T4: 75 per cent N by glyricidia + 25 per cent N and full PK by chemical fertilizers	0.44	0.33	47.0	37.9	104.24	40.09	43.84	35.77
T5: 100 per cent N by glyricidia + Full PK by chemical fertilizers	0.56	0.31	49.0	38.2	93.88	33.62	43.84	30.00
SE _d	0.08	0.06	1.56	7.68	23.006	19.813	4.682	5.312
CD (P=0.05)	0.17	NS	3.40	NS	NS	NS	NS	NS

of soil (Gaur, 1994). Nambiar *et al.* (1983) also observed that there was improvement in water holding capacity in the plots treated with coconut shedding, forest leaves, cattle manure and coir dust. In general, the soil moisture increased with increased quantity of green manure application.

Yield

The yield of palms as influenced by different treatments is presented in Table 2. The treatments which received combined application of glyricidia and chemical fertilizers had significant influence on nut yield. The treatment T₃ (50 per cent N by glyricidia green manure and 50 per cent N and full dose of PK by chemical fertilizers) recorded significantly higher yield when compared to the treatments T₁, T₂ and T₅ and it was at par with the treatment T₄. The treatment T₁ (recommended dose through chemical fertilizers) recorded the lowest yield. Venkitasamy and Khan (2002) also reported that application of 50 per cent of N on composted coir pith basis with 50 per cent of recommended dose of chemical fertilizers recorded higher nut yield. Hence, it can be presumed that substitution of glyricidia green manure with chemical fertilizers is beneficial coconut productivity. It is possible that the enhanced buffering capacity of these littoral sands through the influence of glyricidia in the slow and steady supply of nutrients and moisture and indirect effects of organic matter might have contributed to the increase in coconut yield over control.

Table 2. Effect of different treatments on the yield of coconut (Nuts/palm/year)

Treatment	Nuts/palm/year (average of 5 years)
T ₁ : Control (Inorganic fertilizer alone)	36
T ₂ : 25 per cent N by glyricidia + 75 per cent N and full PK by chemical fertilizers	41
T ₃ : 50 per cent N by glyricidia + 50 per cent N and full PK by chemical fertilizers	52
T ₄ : 75 per cent N by glyricidia + 25 per cent N and full PK by chemical fertilizers	45
T ₅ : 100 per cent N by glyricidia + Full PK by chemical fertilizers	41
SE _d	4.11
CD (P=0.05)	8.9

Economics

The details of the effect of treatments on the economics of incorporating glyricidia for the substitution of inorganic nitrogen under coastal sandy soil are presented in Table 3. The gross cost incurred varied from Rs. 19,500/ha in the control to Rs. 20100/ha in the case of T₅. When compared to control, the increase in the gross cost was maximum in T₅ (3.08 per cent), followed by T₄

(2.05 per cent). However, the same in the case of T₃ was only 0.77 per cent. The gross return varied from Rs. 23,100/ha in the case of control to Rs. 35,700/ha in the case of T₃. The comparative increase over control was maximum in T₃ (54.55 per cent) followed by T₄ (39.39 per cent). The same in the case of T₂ and T₅ was 27.27 per cent. The net return among the treatments varied from Rs. 10000/ha for T₂ to Rs. 16050/ha for T₃. The percentage increase over the control was maximum in T₃ (345.83 per cent) followed by T₄ (241.67 per cent) and T₅ (158.33 per cent). The realized BCR was maximum for T₃ (1.82) and the lowest for control (1.18). Similar results of higher cost benefit ratio under organic manure treatment were obtained by Nallathambi *et al.* (1988).

Table 3. Effect of different treatments on economics (Rs./ha) (Average of five years data)

Treatment	Gross cost	Gross return	Net return	B:C ratio	Increase over control
T ₁ : Control (Inorganic fertilizer alone)	19500	23100	3600	1.18	-
T ₂ : 25 per cent N by glyricidia + 75 per cent N and full PK by chemical fertilizers	19400	29400	10000	1.51	6400
T ₃ : 50 per cent N by glyricidia + 50 per cent N and full PK by chemical fertilizers	19650	35700	16050	1.82	13550
T ₄ : 75 per cent N by glyricidia + 25 per cent N and full PK by chemical fertilizers	19900	32200	12300	1.61	9700
T ₅ : 100 per cent N by glyricidia + full PK by chemical fertilizers	20100	29400	9300	1.46	6300

These results prove that adoption of T₃ (50 per cent of recommended nitrogen through glyricidia + 50 per cent N and full recommended dose of P and K through inorganic fertilizers would yield additional net return over the adoption of other treatments or control. This result further validates the significance of applying organic manure for coastal sandy soil to improve the productivity and profitability of coconut gardens. The economics indicated that the treatment with 50 per cent of the recommended nitrogen through glyricidia green manure and 50 per cent through chemical fertilizer (T₃) was economically beneficial in terms of total net income (Rs. 16,050/ha), benefit:cost ratio (1.82) and additional net income (Rs 13,550) over chemical fertilizer application alone (Table-3). This fact further validates the importance of application of organic manure in the coastal sandy soil to improve the profitability of coconut cultivation. From this experiment, it is concluded that combination of organics and inorganics by substituting 50 per cent of

nitrogen through organics and 50 per cent N and full P and K through chemical fertilizers improves the coconut productivity under littoral sandy soils.

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