

PRELIMINARY STUDIES ON THE MAJOR CHARACTERISTIC, AGRONOMIC FEATURE AND NUTRIENT VALUE OF *GLIRICIDIA SEPIMUM* IN COCONUT PLANTATIONS OF PAKISTAN

ABDUL HAMEED SOLANGI¹, BHUGRO MAL¹, A.R. KAZMI¹ AND M. ZAFAR IQBAL²

¹*Coastal Agricultural Research Station, SARC, PARC, Karachi,*

²*Department of Botany, University of Karachi, Karachi-75270, Pakistan.*

Abstract

The leguminous *Gliricidia sepium* (Jacq.) Stud., was for the first time tested on sandy loam soil in *Coco nucifera* L., plantations at Coastal Agricultural Research Station, PARC, Karachi, Pakistan. The aspect of morphological characteristic, floral biology and management of *G. sepium* were studied from February 2006 to November 2008. Twenty plants were marked and observed after every 4th day for morphological and phonological studies. The morphometric characteristic were small to medium sized tree, upto 06-11 meter in height. Branched frequently from the base reaching 40-60cm. Bark was smooth and whitish grey to light red brown. The leaves were odd pinnate and usually alternate with an average of 22.68cm long and 3.92cm width having 11.4 leaflets; midrib and rachis occasionally striped red. Leaf shading started in November and remained up to February. For floral biology, flowers and inflorescences were marked and observed until fruit set. Inflorescences appeared as clustered racemes on distal parts of new and old wood. The flowers were bloom with pink or reddish to lavender color during January and February. The fruit was green, tinged reddish purple when immature, light yellow-brown when mature narrow an average of 13.8 cm long, 2cm wide, 5-9 numbers of seeds/pods yellow-brown nearly round. Plants planted through seeds and cuttings had better biomass production of cuttings as compared to seeds. The nutrients concentration percentage showed minimum and maximum, potassium and chloride respectively. Aphids were observed during flowering season, especially in January and February. It produces fruit after cross-pollination. Aphid, honey bees and the main pollinators of this species were also noted.

Introduction

Gliricidia sepium (Jacq.) Stud., of the family Fabaceae is an evergreen deciduous and fast growing medium-sized leguminous tree. Domestication of *Gliricidia* has been in progress for several millennia and the multitude of indigenous common names from Mayan and Quiche peoples.

Pertchik & Pertchik, (1951) reveals the importance of this species to early occupants of the region. Spanish colonists adapted the local vernacular in naming the species 'madre de cacao (mother of cocoa) to describe its use as a cocoa shade tree. *G. sepium* originated in Mexico and Central America. Despite the widespread present occurrence of *G. sepium* in cultivation throughout Central American countries and Mexico, it is likely to be native only in the seasonally dry forest (Hughes, 1987). It was first introduced to Asia in the early in 1600 century; Spaniards took the species to Philippines second in 18th century transfer and it from Trinidad to Sri Lanka for use as shade tree in tea plantation. From Sri Lanka it spread out to India, Indonesia, Malaysia, Thailand and Pakistan.

Gliricidia leaves used as a green manure for coconut means that the addition of inorganic fertilizer for nitrogen can be avoided, with 50kg of leaves and tenders shoot

being the equivalent of 800g of urea. One ton of foliage is equivalent to 16kg of urea, so 1ha of *Gliricidia* can provide 128kg of urea equivalent fertility (Anon., 2005). It grows rapidly to produce manure. The leaves decompose relatively fast, providing nitrogen and potassium. *G. sepium* application also improved the soil moisture availability (Subramanian *et al.*, 2005). After coppicing, re-growth of *Gliricidia* is rapid enabling quick recycling of minerals. *Gliricidia* can be propagated through cuttings and seeds and it grows well in low fertile soils and is drought tolerant (Pertchik & Pertchik 1951).

According to Magat (1999) the tree has wide variety of uses in the farm such as ornamental, shade tree or trellis for black pepper, a hedge in ally cropping or green manure crop in intercropping system, under average conditions yield 3 to 4kg dry matter per tree, may be achieved. After cropping re-growth of *Gliricidia* is rapid enabling quick recycling of minerals. In the field experiment application of *Gliricidia* was shown to increase the soil nitrogen levels in the top soil than in the sub-soil. However, *Gliricidia* planted with in the plots and applied to coconut palms has shown that the nitrogen levels have increased in the top soil as well as in the sub-soil (Anon., 1993). Nutrient content we of goat manure and fresh foliage of *Gliricidia* had a higher content of N than the other material (Tennakoon & Bandara, 2003).

Allen & Allen (1981) reported that fallen leaves emit the new-mown- hay order, because of the occurrence of coumarin compounds. The toxic properties of the seeds and bark of *G. sepium* give rise to the generic epithet of this species (*Gliricidia* = mouse killer) as well as a number of common names (e.g. mata-raton). In Philippines it is widely used in traditional pest control. Nematicidal property of *G. sepium* leaves extract was observed in different concentration against *Meloidogyne incognita* nematode showing 60% mortality (Rahila *et al.*, 2008).

Gliricidia is reasonably fire resistant and recovers quickly after having been burnt. It is used for firewood, shade trees, ornamentals, fodder, fences, wind break and trunks are used as fence posts. Now days it is recommended in agro forestry and alley cropping system as green manure component soil stabilization (Rico-Gray *et al.*, 1991).

The research study included germination of seeds under shade and field conditions, sowing method through seed or cuttings, morphological and phenology study on total biomass to provide a complete package of technology to the future *G. sepium* on their sandy loamy soil of coastal area lands as a model multipurpose crop.

Materials and Methods

Study site: Pakistan is situated mainly in the semiarid to arid zone climate and coastal area is ecologically a virgin area. The area under study comprises the southern part of Pakistan. It is bordered by north east Arabian Sea situated between meridians 62 degree and 68 degree east longitudes and parallels 24 degree and 26 degree north latitudes. The study was carried out at Coastal Agricultural Research Station (CARS), Pakistan Agricultural Research Council (PARC), Karachi, during the 2006-2008. The average precipitation varies from 92.2-465.6mm annually, the relative humidity ranged from 48.8-73.0% and temperature maximum and minimum 32°C and 21.6°C respectively. The experimental soil was sandy loam in texture, with pH8.0, EC 1.6sm-I, O.M 0.32, N 0.016, available phosphorus 9.0ppm and available K 230ppm. The water of the well at CARS had pH7.6, EC 1.5ds m-I, SAR 4.95. The *G. sepium* seed and cuttings used in this study were collected from the *Gliricidia* plants being grown in experimental field of CARS.

Plant to plant and row to row distance was 10 x 10m in the square system. The plants was pruned twice annually at required stage. Normal cultural practices like manuring, hoeing, spraying etc. were followed through out the year and no any dose of the inorganic fertilizer was used on plantation.

Three year's data was recorded on plant height, stem width, number of branches, blooming period, fruit, ripening time, pods weight, pods size and number of seeds/pod. Fruit (pods), size and stem width was measured by taking diameter with the help of Vernier caliper.

Plant sample (100g) was dried in an oven maintained at 100°C, moisture contents were determined according to Anon., (1980). The dried sample was ground to fine powder. Finally ground plant material (0.5g) was digested with two volumes (20ml) of concentrated nitric acid and one volume (10ml) of perchloric acid (Gorsuch, 1986). The solution was aspirated on to Philips automatic-absorption Spectrophotometer model PU91000 to determine the macro and micro-elements.

Seed germination: Seed propagation is the most convenient and reliable means of establishment seedling. Pods containing seeds were collected in February to March just before maturity. Seeds were sown directly without pre treatment in the nursery bed or in plastic bags. The seedlings were ready for planting within 4-6 weeks. The seedlings were planted after monsoon. Seedlings were planted 15 cm deep.

Cuttings: The propagating materials for cuttings were collected from the healthy and moderately vigorous stock plant. The matured cuttings in length from 50 to 60 cm (cuttings size of 1.5m length and 2.5 - 3.0 cm diameter) were collected from two year old plant (Hudson & Kester, 1975). The data thus collected were subjected to statistical analysis according to the method developed by Gomez (1984).

Results and Discussion

The result regarding mean germination (85%) was recorded in fresh seed. It was noted that the seeds germinated directly after dropping on normal soil. The performance of the cutting was noted better as compared to seedling planted in the field. The organic matter percentage was harvested more as compared to seedling of three years old plants.

The morph - metric characteristic small to medium sized tree were up to 06 to 11 meter high (Table 1). Branch frequently reach 40-60cm from base. Bark was smooth, whitish grey to light red brown. The leaves were odd pinnate, usually alternate, on an average 22.68cm long, 3.92cm wide with 11.4 leaflets; midrib and rachis was occasionally striped red. Leaves shading started in November and remained up to February. Inflorescences appeared as clustered racemes of distal parts of new and old wood. The flowers were bloom with pink and reddish to lavender color during January and February. The imatured fruit was green, tinged reddish purple, was light yellow-brown in color when matured narrow an average 13.8 cm long, 2cm wide, 5-9 numbers of seeds/pods was yellow-brown nearly round (Table 1). The biomass production of cuttings was better as compared to seeds after three years old plants.

The fruit green was tinged reddish, purple when unripe and it was light yellow-brown when mature. Its size was 19-18 cm long, 2cm wide, seeds 5-8 yellow - brown nearly round. The biomass production of cuttings was better as compared to seeds of three years old plants.

Table1. Agronomic characteristics of *Gliricidia sepium* propagates through seeds at CARS, Karachi, Pakistan.

Characters	Mean	± SE*
Plant height (cm)	361.0	± 28.20
Stem. Dia (cm)	39.44	± 5.46
Leaf length (cm)	22.68	± 2.69
Leaflet no.	11.4	± 0.74
Leaflets length (cm)	8.3	± 0.72
Leaflets width (cm)	3.92	± 0.46
Pods length (cm)	13.8	± 0.93
Pods width (cm)	2	± 0.04
No. of seeds/pods	6.6	± 0.31
Seed length (cm)	1.3	± 0.06
Seed width (cm)	1.08	± 0.05
1000-seeds wt. (g)	1253	± 16.89

*=Mean are with ± standard error of the 5 replicates

The results for weight of seed *G. sepium* are given in Table 1 and 2. The average 1253g and 1167.6g of the 1000 seeds weight was recorded as management through seedling and cutting respectively. Average 7000 to 8000 seeds were recorded per kilogram. It was also noted that cuttings had produced higher weight of seed. These results are also supported by Allen & Allen (1981), who reported that vegetative cuttings produced the tallest plant with more pods.

Green manuring is of special value in poor soils that needs rejuvenation to produce profitable crops (Pocha, 1952). *Gliricidia* leaves could be used as a green manure. About 30kg of leaves will provide sufficient nitrogen, potash and phosphate for coconut. It was planted between rows of coconut and found to be an excellent organic fertilizer. Leaves were left on the surface as mulch. The nutrient concentration percentage showed minimum chloride and maximum potassium respectively (Table 3).

Among the nutrient concentration percentage the maximum concentration of potassium (2.33mg/g), while nitrogen (0.862mg/g), phosphorous (Traces), calcium (0.467mg/g), magnesium (0.212) and sulphur (0.396) were also found in leaves, flower and twinges of *G. sepium*. These findings are in agreement with those of Anon, (2001), Julie *et al.* (1988) and Magat (1999), who have also reported that *G. sepium* has less % of phosphorus. In many cases, *Gliricidia* has much yield and biomass than *L. leucocephala* (Stewart *et al.* 1992). Mafongoya & Nair (1997) and Singh *et al.* (2001) reported 96% of the applied *Gliricidia* foliage decomposed within the cropping season. Incorporating N rich materials, such as *Gliricidia* foliage into cropping systems is known to increase topsoil inorganic N and yields of associated crops. After *Leucaena leucocephala*, *G. sepium* is believed to be the most widely cultivated multipurpose tree (Rico-Gray *et al.*, 1999).

The easy coppicing nature of *Gliricidia* contributed to its acceptability as a source of fuel wood. Wood of *Gliricidia* burn slowly thus producing wood embers and gives of little smoke or sparks explaining its general acceptability. It has a good heating value with an average specific gravity of 0.5-0.6. The cuttings develop a shallow, lateral root system. Although establishment by cuttings is convenient, it is suitable mainly for localities where other trees are difficult to establish. The present results are further confirmed by the findings of Magat 1999, CRI, 1993 and Duke, 1983.

Table 2. Agronomic characteristics of *Gliricidia sepium* propagated through cuttings at CARS, Karachi, Pakistan.

Characters	Mean	± SE*
Plant height (cm)	393.2	± 8.75
Stem. Dia (cm)	48.68	± 3.72
Leaf length (cm)	20.44	± 1.01
Leaflet no.	12.0	± 0.48
Leaflets length (cm)	8.46	± 0.60
Leaflets width (cm)	4.88	± 0.21
Pods length (cm)	14.98	± 0.77
Pods width (cm)	2.08	± 0.07
No. of seeds/pods	8.0	± 0.44
Seed length (cm)	1.32	± 0.06
Seed width (cm)	1.14	± 0.04
1000-seeds wt. (g)	1176.6	± 29.62

* Mean are with ± standard error of the 5 replicates

Table 3. Nutrient concentration (%) of *Gliricidia sepium* nitrogen fixing tree at CARS, PARC, Karachi.

Nutrients	Quantity (%)
Nitrogen	0.862
Potassium	2.33
Phosphorus	Traces
Calcium	0.467
Magnesium	0.212
Sulphur	0.396
Chloride	0.147

The important basic characteristics are summarized in Table 4. The flowers had amagenta-coloured corolla and the central region of the flange cream colored, which functions as a nectar guide. It produced fruit after cross-pollination. Aphid and Honey bees were considered the main pollinators of this species. In Puerto Reco, the foliage is often attacked by aphids that secrete sweet honeydew which attracts ants, causing the leaves to fall. Same attack has been noted at the CARS farm mostly during the flowering season in January and February. Their findings concluded that green manure can increase economic fresh root weight of the coconut; however, the effects were more pronounced when used combined along with other major nutrients. *G. sepium* leaves could be used as a green manure for coconut as addition of inorganic fertilizers can be avoided, with 50kg of leaves and tender shoots being the equivalent of 500gm of urea (Shehal, 2008).

On the basis of quantitative and qualitative evaluation, it is concluded that the *G. sepium* performed well and showed a good potential for successful green manuring production for coconut and other cereal crops in this area. *Gliricidia* has wide variety of uses such as ornamental, shade tree, trellis for betel leaf, and green manure crop intercropping systems. It could be used for medicinal and pesticide purpose (Table 5). According to NAS (Anon., 1980a) that in the shed of *G. sepium*, the grass finally dies, leaving nothing that can sustain a grass fire. Same results were noted at the CARS the mostly weeds/grasses were not seen under the *G. sepium* plants. Increasing attention is needed for cultivating *Gliricidia*, specifically for fodder production. The wood could be used for specific and more important uses such as fire wood, charcoal, posts, farm implements, furniture, for construction purposes and railway sleeper and in barriers for erosion control.

Table 4. Characteristics of *Gliricidia sepium*.

<i>Gliricidia sepium</i>	Called <i>Gliricidia</i> . (medium size tree)
Family	Fabaceae
Origin	Mexico / Central America
Age / Height	8 to 20 years / 10 to 12 meter
Leave	Composite, 5-9 cm long
Leaflets	9-13 leaflets. Ovate, 5-9cm longs 2-5cm wide
Leaf color	Green
Flowers	Pink or reddish clustered from 5-15cm long
Fruit	Reddish in color, when unripe light brown when mature
Pods	Green / Yellow
Size of Pod	11-16cm long, 2cm wide
Seed pre pod	5-9 seeds. Yellow brown to brown nearly round
Seed weight 1Kg	7000-8000 Seeds
Propagation	Cutting / Seeds
Nursery period	4 to 6 weeks
Soil	Sandy, Loam soil, Semi arid to Arid climate
Nitrogen %	0.862, 0.863 % (leaves)
Special characteristics	Fruit resistant, drought tolerant and weed killer

Table 5. Uses of plant parts of *Giliricidia sepium*.

Plant parts	Uses
Flower	Vegetable, forage for bees and green manure.
Pods	Fodder, fire and rat poison
Seed	Fodder, sowing and fatty oil (Yield 85.54%).
Leaves	Green manures, young shoots as vegetable, medicinal, insecticide, rodenticide, fodder, human disease.
Wood	Firewood, charcoal, pots, farm implements, furniture construction purposes and railway sleeper. Highly resistance to termites and decay.
Bark	Human skin disease, insect and pest control.
Root	Cutting for vegetable growth and medicinal purposes.

Aphids were observed during flowering season, especially in January and February. At CARS Station the attack of Aphids on leaves and flowers of few plants was recorded during January to February 2007. As a result of the infestation all leaves shaded and flower could not developed in pod. Insecticide monocrotophos and Dithain-M45 were used to control it. It was also noted during the study that the favorable season for Aphids was the flowering season in months of December to fist week of February.

Conclusion

It is concluded from present studies that the *Gliricidia sepium* is extremely versatile plant, which can fulfill a number of roles in agricultural production system. The plant can be grown successfully in the irrigated areas as well as at arid zone of coastal area of Sindh and Balochistan to minimize the problems of the fuel, forage, wood, green manuring and also to control the soil erosion. Natural pesticides could be produced from the extract of *Gliricidia sepium*. It would be very useful and appropriate for small scale farmers to get more benefit from this plant. There is therefore need to undertake further studies to establish the state of knowledge on the responses of *G. sepium* to environment friendly activities in new areas.

References

Allen, O.N. and E.K. Allen. 1981. *The leguminosae*. The University of Wisconsin press, 812pp.

Anoka, U.A., I.O. Akobundu and S.N.C. Okonkwo. 1991. Effect of *Gliricidia sepium* and *Leucaena leucocephala* on growth and development of *Imperata cylindrica*. *Agroforestry Systems*, 16: 1-12.

Anonymous. 1993. Effect of green manuring practices on the improvement of organic matter content and water holding capacity of soil at dambadeniya. Report of the Coconut research institute of Sri Lanka, 23pp.

Anonymous. 1980. *Official methods of analysis of the association of official analytical chemists*. 14th edition, Washington DC.

Anonymous. 2005. *Sustainable use of Biomass Resources for energy*. Colombo, Sri Lanka.

Anonymous. 1980a. Fire wood crops, shrub and trees species for energy production. National Academy of Science, Washington D.C.

Ben Salem, B. and Palmberg. 1985. Place and role of trees and shrubs in dry areas. *Plant for arid lands*, 93-103pp: *Proceedings of the Kew international conference on economic plants for arid lands*, Jodrell laboratory. Rayal Botanic, Garden, Kew, England, 23-27 July 1984, George Allen and Unwin, London.

Chintu, R., P.L. Mafongoya, T.S. Chirwa, E. Kuntashula., D. Phiri and J. Matibini. 2004. Propagation and Management of *Gliricidia sepium* planted fallows in sub-humid eastern Zambia. *Experimental Agriculture*, 40: 37-51.

Combellas, J. S. Leyla Rios, P. Colombo, R. Alvarez and L. Gabaldon. 1996. Influnce of *Gliricidia sepium* restricted grazing on live weight gain of growing cattle in star grass pastures. *Live stock research for rural development*, 8(4):

Deguma, B. 1988. Establishment of stakes of *Gliricidia sepium* and *Leucaena leucocephala*. *Nitrogen Fixing Tree Research Reports*, 6: 6-9.

Duke and Wain. 1981. *Medicinal plants of the world*. Computer index with more then 85000 entries.30 volumes.

Ella, A., C. Jacobsen, W.W. Stur and G. Blair. 1989. Effect of plant density and cutting frequency on the productivity of four tree legumes. *Tropical Grasslands*, 23: 28-34.

Gutteridge, D.G. and S. Mac Arthur. 1988. Productivity of *Gliricidia sepium* in a subtropical environment. *Tropical Agriculture*, 65: 275-276.

Gorsuch, T.T. 1986. Accuracy in Trace analysis, sampling, sample handling and analysis, National Bureau of standards Pub. No.479, Washington DC, 481pp.

Hughes, C.E. 1987. Biological considerations in designing a seed collection strategy for *G. sepium*. *Common wealth in Forestry Review*, 66: 31-48.

Hughes, C.E. and B.T. Style .1984. Exploration and seed collection of multiple-purpose dry zone trees in central America. *The International Tree Crops Journal*, 3: 1-31.

Hudson T. Hartman and Dale E. Kester. 1975. *Plant Propagation principles and practices*. Prentice-Hall, Inc., Englewood Cliffs, and New Jersey.

http://www.hort.purdue.edu/newcrop/duke_energy/Gliricidia_sepium.html

Kang, B.T. and K. Mulongoy. 1987 *Gliricidia sepium* as a source of green manure in an alley cropping system. In: *Gliricidia sepium* (Jacq.) Walp.: *Management and Improvement of workshop Proceedings*. (Eds.): D. Withington, N. Glover and J.L. Brekbaker. Kandy, Sri Lanka, 37-44.

Liyanage, L.V.K. and A.M.U. Wijeratne. 1987. Uses and management of *Gliricidia sepium* in coconut plantations of Sri Lanka. In: *Gliricidia sepium* (Jacq.) Walp.: *Management and Improvement, proceedings of a workshop at CATIE, Turrialba, Costa Rica. NFTA Special Publication*. (Eds.): D. Withington, N. Glover and J.L. Brewbaker. 87-01: 95-101.

Magat, S.S. 1999. Coconut-based farming systems: Technology notes for practitioners. Dilmian, Quezon City, Metro Manila, Philippines, 34pp.

Magat, S.S.1999. *Handbook of fertilizer recommendations for coconut and selected intercrops*. Asian and Pacific coconut community. Jakarta , Indonesia, 106pp.

Mafongoya, P.L. and P.K.R. Nair. 1997. Multipurpose tree pruning as a source of nitrogen ton maize (*Zea mays* L) under semiarid conditions in Zimbabwe. 1. Nitrogen recovery rates in relation to pruning quality and method of application. *Agroforestry System*, 35: 621-626.

Nochebuena, G. and P.B. O'Donovan. 1986. The nutritional value of high-protein forage from *Gliricidia sepium*. *World Animal Review*, 57: 48-49.

Pertchik, B. and H. Pertchik. 1951. *Flowering Trees of the Caribbean*. Rhinehart and Co., New York, 125pp.

Stewart, J.L., A.J. Dunsdon, J.J. Hellin and C.E. Hughes. 1992. *Wood Biomass Estimation of Central American dry zone species*. Tropical Forestry paper 26, Oxford Forestry Institute, 83pp.

Stewart, J.L., G.E. Allison and A.J. Simons. 1996. *Gliricidia sepium: Genetic resources for farmers*. Oxford forestry institute, University of Oxford, UK.

Simons, A.J. and A.J. Dunsdon. 1992. *Evaluation of the potential for genetic improvement of Gliricidia sepium*. Report to ODA on Forestry Research project R.4525. Oxford Forestry Institute, 176pp.

Subramanian, P., R. Dhanapal, P.Sanil, C. Palaniswami, C.V. Sairam, H.P. Maheswarappa. 2005. *Glyricidia sepium* as green manure in improving soil fertility and productivity of coconut under coastal littrol sandy soil. *Journal of Plantation Crops*, 33(3): 179-183.

Pocha, Postonjee P. and Sons. 1952. *Pochas garden guide*. Pochas Horticultural Press, Poona, India.

Panjaitan, M. 1988. *Regional evaluation of tree legume species in Indonesia*. M.Sc. Thesis (Rural Science), University of New England, Armidale, Australia, 138pp.

Rahila Nazli, Mussarat Akhter, Shugfta Ambreen, Abdul Hameed Solangi and Nighat Sultana. 2008. Insecticidal, Nematicidal and Antibacterial activities of *Gliricidia Sepium*. *Pak. J. Bot.*, 40(6): 2625-2629.

Reco-Gray, V., A. Chemas and S .Mandujano. 1991. Uses of tropical deciduous forest species by the Yucatan Maya. *Agroforestry systems*, 14: 149-161.

Stewart, J.L., G.E. Allison and A.J. Simons. 1996. *Gliricidia Sepium: Genetic resources for farmers*. Oxford Forestry Institute, University of Oxford, UK.

Torquebian, E.F. and F. Kwesiga. 1996. Root development in Sesbania sesban fallow -maize system in eastern Zambia. *Agroforestry System*, 34: 193-211.

Tennakoon, N.A. and S.D.H. Bandara. 2003. Nutrient content of some locally available organic materials and their potential as alternative sources of nutrients for coconut. *COCOS*, 15: 23-30.

Wiersum, F. and S. Dirdjosoemarto. 1987. Past and current research with *gliricidia* in Asia. In: (Eds.): D. Withington, N. Glover and J.L. Brewbaker. *Gliricidia sepium* (Jacq.).

(Received for Publication 01 April 2009)