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Adaptability and nutritive value of Maku lotus (*Lotus pedunculatus*) in Nilgiri hills of India

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Abstract
A study was carried out to evaluate the adaptability, yield and nutritional value of Maku lotus (*Lotus pedunculatus*) under the typical mountain environment of Nilgiri hill region. The plant was established well in the acidic soils of swamp. The mean number of days to form new shoots was 32 days and ranged from 28 to 37 days. The established Maku lotus spread throughout the swamps in 60 to 80 days. The plants were susceptible to frost, however, rejuvenated during the ensuing rains after winter. The mean yield of fodder recorded in eight cuttings was 2.54 t/ha/annum on dry matter basis. The crude protein level of the legume was 15.72 per cent. The ability of the plant to establish well in acidic, water logged soils could enable its use for fodder production in the natural swamps. Thus, Maku lotus could be considered for inclusion in the cropping programme for fodder production in the Nilgiris.

Keywords: Fodder, Legume, Maku lotus, Proximate composition

Leguminous fodder is important as a source of protein and mineral for livestock and helps in better production, reproduction and immunity against diseases. Maku lotus (Greater lotus or Big trefoil), is a water loving legume, native to Europe, eastern Russia and northern Africa. Maku lotus is known to grow well in moist hill-country soils of low fertility and low pH (Lowther, 1980). Maku lotus is used as a pasture species in New Zealand, the United States and Uruguay. In addition, about 100,000 ha are sown in coastal New South Wales and Queensland (Moore *et al*., 2006).

The Nilgiris district in Tamil Nadu is a hilly tract with the highest peak measuring 2892 m above mean sea level. This plateau is the meeting place of the Western and Eastern ghats of the Indian peninsula. The typical shola grassland ecosystem with huge areas of undulating grasslands intervened by swamps at the valleys are characteristic features of the region. The annual rainfall in the region averages 1155.90 mm and rainfall pattern shows maximum rainfall between May and November. The geomorphology of the Nilgiris imparts a temperate like climate to the region with four distinct seasons *viz*., summer (March to May), south-west monsoon (June to August), north-east monsoon (September to November) and winter (December to February). After November, the temperature comes down even to sub zero levels and frost damages most of the grasses causing acute fodder shortage upto the month of April. The soil in the region was acidic with fairly better organic carbon, high iron and manganese content and low phosphorus levels. The texture of soil was loamy to clayey loamy. The values of soil organic carbon, phosphorus, potassium, iron, electric conductivity and pH of soil in the region were recorded as 2.89%, 43.67 kg/acre, 116.83 kg/acre, 43.98 ppm, 0.09 dS/m and 4.90, respectively. Similar observations of high iron content, fair quantities of organic matter and low availability of phosphorus in soil from the Nilgiris were made earlier also. Keeping this in view, Robertson (1995) under the Cattle Breeding and Fodder Development Scheme, Animal Husbandry Department, Government of Tamil Nadu, recommended Maku lotus as a pasture legume for the Nilgiri hills. The Maku lotus legume was introduced for the first time in India. The present study was conducted to evaluate the adaptability, yield, and nutritional value of Maku lotus under the typical mountain environment of the Nilgiri hills.

Initially, Maku lotus seeds imported from Australia were sown at District Livestock Farm, Ooty and further propagations were made by planting of rooted slips. Maku lotus plants produce a tap-root and spread by rhizomes (John and Lancashire, 1980). The study was conducted in natural swamps of Sheep Breeding Research Station, Sandynallah, The Nilgiris and adjoining Toda tribal hamlets, in the year 2011. Adaptability and establishment

of Maku lotus was studied in 12 natural swamps. Yield studies were conducted in six replicates of one cent area, marked in swamps located within the research station. Maku lotus slips were planted with a spacing of 30 x 30 cm during south-west monsoon (June to August). These slips were planted without any field preparation, amidst the water plants present in the natural swamps. The establishment of Maku lotus plants was recorded as number of days to produce new leaf shoots. Established plants of Maku lotus were observed throughout the year in all seasons. The fodder yields in the marked area (n = 6) were recorded at onset of inflorescence on dry matter basis. Eight harvests were available from each plot during the study period of one year. Representative samples (n = 5) of Maku lotus weighing 500 g each were analysed for proximate composition as per AOAC (2005).

Maku lotus slips established well in all the 12 swamps studied. The mean days to form new shoots were 32.23 days and ranged from 28 to 37 days (Fig. 1). The established Maku lotus spread throughout the swamps in 72 days with a range of 60 to 80 days (Fig. 2) and within a short period of time they were able to compete and remove the other dominant grasses and from swamps. According to Moore *et al.* (2006), Maku lotus is typically grown on acid soils that are waterlogged for extended periods. The relative water logging tolerance of different species were; greater lotus > narrow-leaf trefoil > birds foot trefoil > lucerne. The stems of the lotus plant are hollow, which assists oxygen transfer under water logged conditions. The plants were susceptible to frost and they rejuvenated during the ensuing rains after winter. Frost burns were noticed in the established Maku lotus, but they were able to withstand frost better than other grasses in the grasslands surrounding the swamps. It took longer for the frost to damage Maku lotus as the swamps could retain moisture longer than the slopes. Thus, Maku lotus once established becomes a perennial legume, capable of self rejuvenation during ensuing rains after the frost during winter. The winter legume berseem (*Trifolium alexandrium*) suitable for the Nilgiris gets destroyed permanently during frost. Shiller and Ayres studied the effect of winter on nutritive value of Maku lotus and *Trifolium repens*. The loss in nutritive value in terms of nitrogen was higher in Maku lotus than in white clover as defoliation was more due to frost burn in the former. However, white clover is not suitable for water logged or less fertile soils, whereas, Maku lotus perform better under these conditions. As described earlier, Maku lotus is well suited for soils with low fertility. The soil in the Nilgiris is low in phosphorus and Maku lotus is able to extract phosphorus efficiently through the lateral root system (John and Lancashire, 1980).

Fig 1. Appearance of Maku lotus shoots amidst other water plants in swamp

Fig 2. Maku lotus plant covering the entire swamp

The mean yield of fodder was 2.54 t/ha/annum on dry matter basis. This was recorded in eight cuttings. Junior *et al*. (2012) reported a pre-grazing dry matter yield of 3.34, 3.46 and 3.79 t/ha from three pasture-based systems comprising of elephant grass, ryegrass, forage peanut and red clover. Higher biomass yields were reported in grass/cereal fodder-legume pastures (Sanderson *et al.,* 2013; Ram, 2015; Ram and Trivedi, 2016). Even though the mean yield of Maku lotus in the present study was less, its ability to establish in acidic and less fertile soil is beneficial. Especially in the Nilgiris, large areas of swamp exist as waste lands due to water logging. Maku lotus could be efficiently used for leguminous fodder production from these wastelands. Moreover, animals like the Toda buffalo and Nilagiri sheep native to the region are exclusively maintained on grazing in the natural grasslands. Maku lotus in the swamps could form nutritive source of fodder for these animals.

Table 1. Proximate composition of Maku lotus fodder

Attributes	Value
Crude protein (%)	15.72
Crude fiber (%)	22.44
Ether extract (%)	2.63
Total ash (%)	8.40
Nitrogen free extract (%)	50.82
Gross energy (kcal/kg)	4067

Crude protein level (15.72 per cent) of Maku lotus in the present study was just below that of berseem (*Trifolium alexandrium*), another winter legume and higher than other grasses like phalaris, rye and kikuyu grown in the region (Table 1). Higher values of crude protein for the legume have been reported earlier (Ulyatt *et al.,* 1976). However, the crude protein level is highly dependent on the leaf to stem ratio, which will vary according to the stage and season of harvest (Schiller and Ayres, 1993). In the present study, the nutritional composition was done on samples collected during early winter and lesser CP could be due to decrease in the leaf to stem ratio. Studies show that Maku lotus is only next to white clover in terms of feeding value (John and Lancashire, 1980). The *in vitro* digestibility of herbage judged to be consumed during grazing was 85% for white clover and lucerne, 83% for Maku lotus and the red clover cultivars, and 79% for sainfoin. The lower lignin content of leaf than stem suggests that the efficient utilization of lotus swards would involve a grazing management which maximized the intake of leaf rather than stem material. Maku lotus legume, with more than 15 per cent crude protein can form part of sheep ration (up to 100 g dry matter /day), which can replace substantial quantity of concentrate feed, which forms the main component of feed cost. Another important attribute of Maku lotus is that the condensed tannins present in it provide protection against bloating in ruminants. In spite of high nutritive value, bloating is an important factor that limits use of other legumes like white clover, lucerne and berseem in feeding of ruminants. The use of non-bloating legumes of high feeding value, such as the *Lotus* species, may be one way of overcoming this problem. It has been proposed that the formation of these tannin-protein complexes would improve protein utilization during digestion by reducing protein degradation to ammonia in the rumen and subsequently increasing amino acid absorption in the small intestines (Ulyatt *et al.,* 1976). However, condensed tannins beyond certain levels can themselves be harmful to livestock and this can be overcome through feeding other grasses low in condensed tannins (John and Lancashire, 1980). Their study also showed that weight gain responses in sheep with Maku lotus were higher than either lucerne or red clover and inferior only to white clover.

Earlier studies (Lancashire *et al.,* 1980; John and Lancashire, 1980) show that Maku lotus has considerable potential as a major legume constituent in a number of environments. Maku lotus established well to the conditions prevailing in the Nilgiri hills. The ability to grow on acidic soils with low fertility, withstand water-logged conditions, non-bloating nature and comparable feeding values are important attributes of the fodder legume. Maku lotus legume can be considered for inclusion in the cropping programme for fodder production in the Nilgiris.

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