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TEPHROSIA PURPUREA (*PILA*) FOR THE CONTROL OF *EUPATORIUM* AND AS A GREEN MANURE ON COCONUT ESTATES

M. L. M. SALGADO[1]

The weed *Eupatorium odoratum* has established itself on coconut estates in most districts and its control and eradication has become both expensive and interfering with the effective utilisation of labour on estates. The methods of control such as slashing, mowing and mamotty weeding which were the usual practices are discussed. Methods are recommended based on the biology and ecology of the plant and its method of propagation.

A biological method of using an indigenous legume usually present on coconut estates *Tephrosia purpurea* (Sin-*Pila*—Tamil-*Kolinchi*), which has been successfully developed on a Coconut Estate as advised by the writer is described. The method is inexpensive compared to other methods some of which are prohibitively costly and yet ineffective.

Methods of utilising *T. purpurea* as a Green Manure are also discussed.

Further problems associated with the growth, and development of *Pila* both as a method of controlling and eradicating *Eupatorium* (and perhaps other weeds such as Illuk) are discussed.

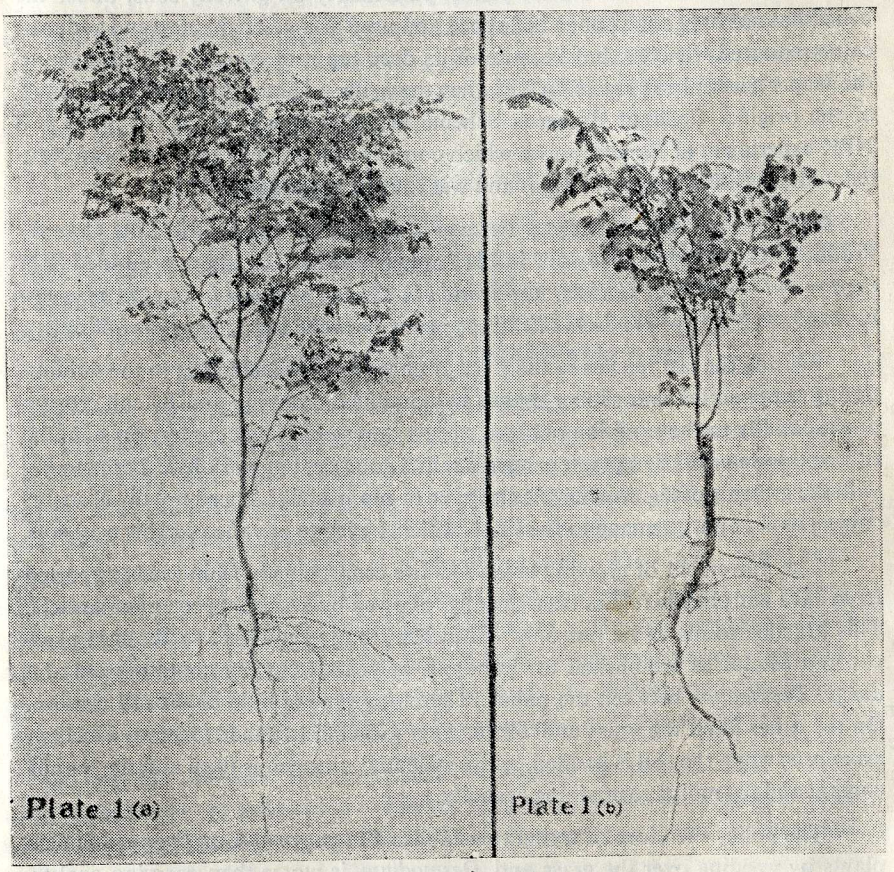
Tephrosia purpurea (Sinhalese '*Pila*' : Tamil '*Kolinchi*') is an indigenous leguminous shrub, which grows on coconut estates on a variety of soil types—particularly on gravelly soils, and on sandy soils such as Cinnamon Sands and coastal marine sands. It has a deep tap root which grows to a depth of almost a foot and several lateral roots which proliferate horizontally from the tap root mainly within 7″ to 9″ from the surface. On gravelly soils too *Tephrosia purpurea* has the ability to penetrate into the sub-soil.

There are two forms (cultivars) of this legume, the common type being erect, with a distinct branching habit to form a bush with branches emerging from the stem and reaching a height of about a foot or 1½ feet. The other type, more common on the coastal littoral sands is a recumbent type where the branches radiate from a central shoot, and growing radially on all directions, and extending even up to a radius of 1 to 2 feet. The creeping or recumbent variety of *T. purpurea* is an excellent indigenous leguminous plant protecting the coarse marine sands, such as Pala-

[1] Agricultural Consultant, 49, Lady Catherine Housing Estate, Borupana Road, Ratmalana, Ceylon.

cholai in the Puttalam district against wind erosion and the scorching action of solar insolation, and at the same time, as leaves mature and drop build up the organic matter regime of such soils. Being a legume which nodulates freely this plant fixes atmospheric nitrogen and thereby helps to build up the fertility of these poor soils.

Both varieties are similar and belong to the sub-order of *Pappilionacae* of the order *Leguminosae*, are characterised by purple flowers flowering in all months of the year, but particularly at the end of the dry season with the first rains. The pods which carry 5 to 6 seeds are flat and mature in the dry season. The pods burst during dry weather and the seeds are self shown by a mechanism by which the pod cases curl and expose the seeds which drop and are spread by wind, and also perhaps by bird. The seed coat is hard and thick and shed seeds remain viable in the soil for a long time and germinate particularly after heavy showers when the ground gets soaked.



Tephrosia purpurea. Plate 1 (a) Note deep tap root and lateral root and canopy of leaves. Plate 1 (b) Note new shoot growing from cut stem.

T. purpurea is a hardy legume, which rarely dies-back even during prolonged droughts, as the deep root system assists in tapping reserves of soil moisture from below, even during periods of moisture stress. On gravelly soils it is particularly useful, in that the deep tap roots open up the hard subsoils and facilate percolation of rain water, aerate the soil and contributes to build up a desirable soil structure by the decay of its proliferating lateral root system and the leaves which drop on maturity.

As a green manure it has been valued, particularly in the Jaffna Peninsula, where the writer about two decades ago, observed cart loads of *Tephrosia* being transported all the way from Elephant Pass to be added to the Paddy and Tobacco fields of the Peninsula as a green manure.

Almost 4 decades ago, in the 1930's during the economic depression, when coconuts were in the doldrums and copra prices had reached rockbottom, the writer recollects that *T. candida* (*boga*) belonging to the same Genus or family was planted in rows between coconut palms, particularly on gravelly soils, under the belief that not only could Boga be lopped and used as a green manure and added to cattle manured trenches, but because of its deep tap root, would help to open up the deeper hard subsoil layers. In fact when the writer assumed duties as Soil Chemist of the original Coconut Research Scheme in 1933, Block VI of the $3 \times 3 \times 3$ NPK experiment at Bandirippuwa which consists of a gravelly soil, had been planted with rows of *T. candida* (*Boga*) and was known as the '*Boga Block*'.

In May 1932, Sir H. Marcus Fernando, then Chairman of the Low Country Products Association in Ceylon, in his Annual Presidential address entitled "*On the Present position of Coconut Cultivation in Ceylon and how it may be advanced by the growing of Bye-Products side by side with the main crop*", stated as follows:—

"During the last ten years, there has been a great awakening as to the diminution of crops in tea and rubber estates by continued cropping and by soil erosion due especially to the tradition of clean weeding on steep hilly country. To stem the tide of this deterioration planters have put in a good deal of work by experimenting with the growing of leguminous plants in ten or more estates. I need not dwell on this subject as it is not germane to the thesis which I wish to advance on this occasion.

"The movement of growing green manure crops, chiefly from seeds imported from Java and elsewhere, has been steadily followed by even some coconut planters. This practice seems to be not only unnecessary but redundant. In the first place coconut estates as established for hundreds of years generally contain grass and creepy *Desmodium* between the palms. Therefore there is little or no soil erosion. On the other hand the grass and *Desmodium* growing together form an excellent *symbiosis*, while the soil is aerated, active potential nitrogen is fixed and the humus content and the moisture retaining capacity.

"The policy therefore of trying to establish *Calapagonium* or *Boga* or similar plants by weeding over the grass and *Desmodium*, is worse than carrying coal to New Castle".

The above observation of an eminent Scientist and Agriculturist of that time can be relevant to the present thesis put forward in this paper, the basis of which is that we have not exploited locally indigenous green manures and other legumes such as *Pila*, *T. purpurea*, both as a green manure and particularly as a method of biologically controlling the pernicious weed *Eupatorium odoratum*.

EUPATORIUM AND ITS CONTROL
USE OF *TEPHROSIA PURPUREA (Pila)*

In an article on weeds on coconut estates published by the writer in the *Ceylon Coconut Planters Review* in 1961: (i) the morphology and biology of *Eupatorium odoratum* was described. At that time this weed which had been introduced during the time of 2nd World War, had spread right through the island from the Tangalla District in the South where it was the main bugbear in vitiating the success of the Citronella Replanting Coconut Subsidy Scheme, right through the Western Province and to an alarming extent on coconut lands in the North Western Province, there was not one district which had not been spared by the ravages of this dominant pernicious weed, which had established itself particularly on Coconut and other small holdings that it was locally christened (*Podisingho Marang*—පොඩි සිඤ්ඝෝ මරං) the killer of Podi Singho.

BOTANY OF *EUPATORIUM*

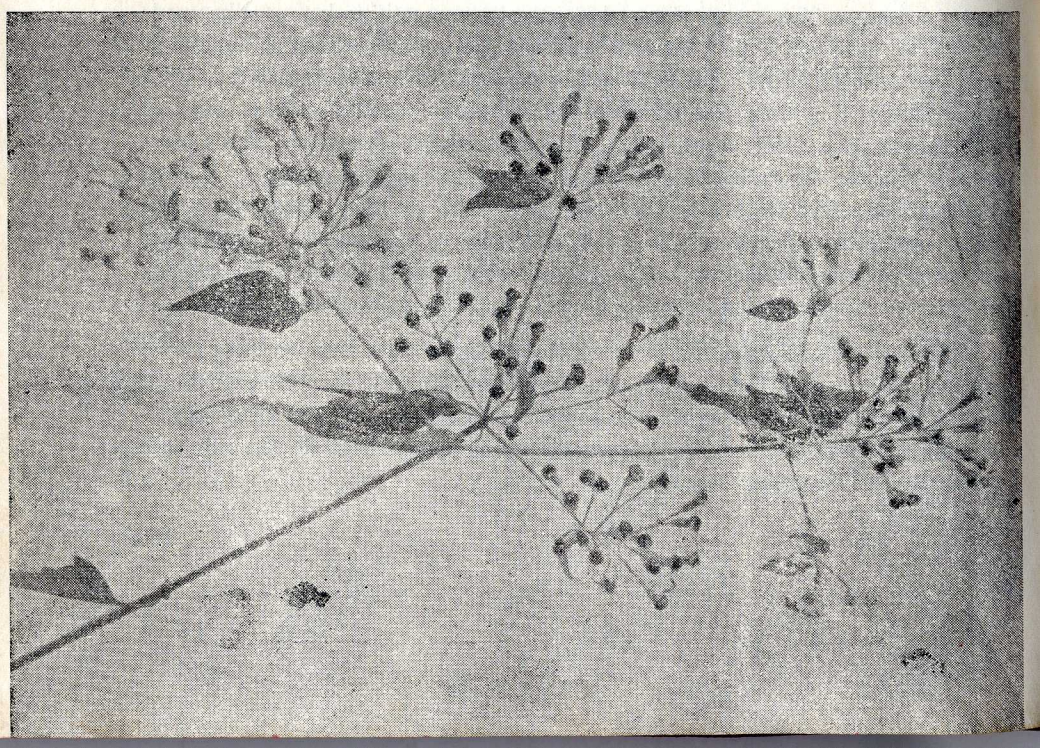
In order to control any weed, pernicious or otherwise, it is necessary to study its botany, and ecology (the adaptation to the environment), which is controlled by edaphic (soil), climatic (rainfall, temperature and sunlight) factors, its method of propagation (vegetatively by suckers, rhizomes as in *illuk* and by seeds, as well as their methods of disposal (by wind, birds, animals or man).

In nature there is a complex competition between a main cultivated crop—be it coconut, rubber, tea or rice and weeds, also competition between the weeds themselves, as to which plant survives in the struggle to outbid the other and dominate the weed flora (the dominant weed or climax). When a weed or other plant under natural conditions and/or under cultivation, smothers all other weeds and establishes as one variety of plant, e.g. *Cyperus rotundus—Kalanduru*, *Illuk* (*Imperata arundancia* var *cylindrica*), or *Cenchrus echinatus* (*kuveni* grass), or *Mimosa pudica* (*Nidikumba* නිදිකුම්බ), *Euphorbia geniculata*, common pernicious weeds on coconut estates, particularly in the case of exotic weeds (introduced from other countries), the Botanist/Agronomists have to study the biology and the ecology of the weed in determining successful (and economical) methods of control.

Eupatorium odoratum, is a plant which belongs to the natural order *Compositae*, characterised by inflorescences (clusters of flowers), which carry in each flower head a very large number of small seeds. These flowers are adapted for cross pollination and/or self pollination. This plant is also unique in that it flowers only once a year between December/January.

Plate 2.
Eupatorium odoratum.

Plate 3. *Eupatorium odoratum* (Flower Heads.)



The seeds are adapted for wind dispersal and the seeds on maturing are provided with a mechanism attached to the seeds by which the seeds float like balloons and are wafted by the air currents and drop on any other land by rain or otherwise, germinate and thereby *colonise* new land.

It is remarkable how within barely an year in the 1950's and 1960's from Middeniya in the Tangalla District, right through estates in the Colombo District, road sides and footpaths, and coconut estates in the NWP extending from Chilaw, Madampe, Kuliyapitiya, Puttalam the entire panorama of coconut and chena lands, was covered in no time with a mantle of this pernicious weed.

Once the seeds germinate, growth is very rapid and with the rains, the young plants may attain a height of a foot within barely a fortnight. Having attained this condition, unless dug out without delay, within six months, or even in a shorter space of time, the coconut plantation or small holding can be covered by a scrub jungle of this weed, which may have reached a height of 4 to 5 feet at this stage, the stems become woody, the root system develops into a massive system of a deep tap root, with proliferating laterals to such an extent that even the picking and collection of nuts become difficult, dangerous and expensive.

SOME COMMON METHODS OF CONTROL

The traditional methods of control and eradication adopted by most estates, some of which have been futile, being based on methods which are scientifically-inadmissable, are summarised below:—

(*a*) *Harrowing*. On estates where heavy tractors and discharrows have been available the method of least resistance was to discharrow. This was futile and fatal. It is difficult for the discs to cut the woody growth.

From the portions of the cut stems fresh growth occurs and so the cycle of pruning by discing, followed by fresh flush of shoots takes place. The thick root system, no doubt, has a store of food reserves (like the Tea bush) and by this method not only is control and/or eradication ineffective but also expensive.

(*b*) *Mowing with the Land Master Grass Cutter*. A method which has been *uncritically* adopted without a consideration of the physiology of the plant, for eradicating *Eupatorium* has been to adapt the horizontally moving grass cutter (Mower) which can be attached to the Land Master or similar 2 wheel tractors to cut this weed. The cutter rotates very fast at a speed of about 3,00 revolutions per minute, and at this speed the blades cut the stems 4 to 6 inches above ground level.

This method of cutting is a sort of pruning, with the result that the fresh flush of young shoots which develop is more luxuriant than before, and makes the situation even worse than before. The root system of *Eupatorium*, even after 6 to 8 months growth, after it has been established on new land, is so thickly developed, that it would have reserves of carbohydrates and other food reserves (as in the tea bush before pruning) so that with the first flush of new growth, the new leaves build up further stocks of sugars and carbohydrates by photosynthesis and other

reserves, and in a period of 3 to 4 months, particularly if even a few showers of rain fall, grow so fast that the weed reaches a height of even 3 to 5 feet in no time. This was particularly evident, where this method of pruning and/or similar slashing of the top growth (without digging out the roots and underground system had been adopted) during the recent period of 8 months following continuous rain from October 1969 to May 1970. In the case of some estates, in the Kuliyapitiya/Naram-mala areas, where *Eupatorium* was assumed to be reasonably controlled, the fresh growth following mowing and/or slashing *above* ground, grew so fast that by June 1970 the land had reverted to a veritable scrub jungle, making picking the crop and collecting nuts a very difficult problem. At the same time when the drought set in from mid-July 1970 and continued in its intensity for over 7 weeks, with no rain at all in August 1970, till the first showers fell during the first week of September, the competition for moisture between this weed *versus* coconut palms would have been so severe, that the palms were affected, as evidenced by the poor setting of female flowers of the spathes which opened in June/July and the abnormal heavy button nut fall evident in September 1970.

In this connection I may mention that the workers of the Guthrie Research Station in Malaysia, who attended the Rubber Conference in Colombo in September 1970, in the course of discussions, brought to the writer's notice that in oil palm plantations in Malaysia, *Eupatorium* HAS been observed to depress the growth, development and yields of oil palms.

Plate 4. *Eupatorium odoratum*. Thick Growth of *Eupatorium* after continuous rains during 6 months making picking and collection difficult.

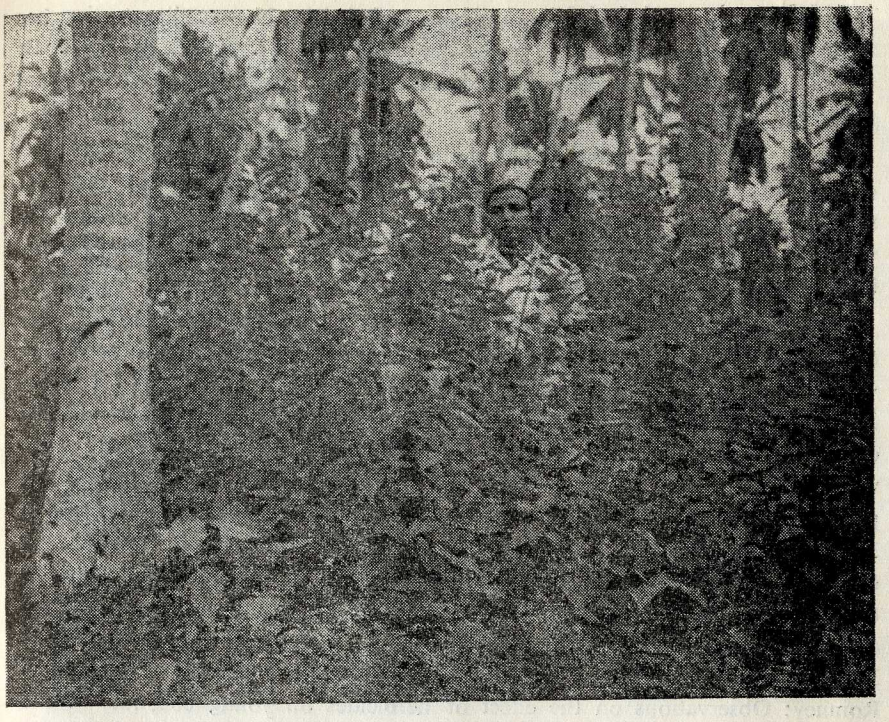


Plate 5. *Eupatorium*. Two months Growth after rains.

(*c*) *Weedicides*. The refuge of the coconut planter today, when misguided and unscientific systems of agronomy have failed to eliminate weeds, is recourse to weedicides. My own confirmed opinion is that under our conditions in Ceylon, the use of weedicides for controlling *Eupatorium* (and for that matter any other pernicious weeds) on Coconut Estates should be discouraged *in toto*, both as an expensive refuge of the inefficient planter, the cost being prohibitive, compared even to manual weeding, but also for reasons of national economy. The import of weedicides cause an extravagent and unnecessary drain on our limited resources of foreign exchange. Instead our reserves of available manpower, untapped and unchannelled in an integrated national coconut economy forms our capital, which should be, on a planned economy, diverted and directed to weed the *Eupatorium* scrub jungle, depressing yields of coconut estates (well over perhaps 30% or more of the coconut estates of Kuliyapitiya/Narammala/Kurunegala districts), and make an honest endeavour on a national scale, to pull out the entire subterranean root system, of this pernicious weed, and completely eradicate this pest.

In any case to repeat: *Do not cut or prune Eupatorium, with the mower, slasher, the pruning knife or the visiketta* (විසිකැත්ත).

This warning which should have been included in the preceding section has been purposely inserted here, to furthering my confirmed view that the wholesale adoption of weedicides to eradicate weeds on coconut estates is as much of a national tragedy as the use of mechanised mowers.

A further danger, if weedicides of the usual formulations in use on coconut estates where there are young supplies is the risk of spray residue being drifted on to the foliage of young palms, with resultant depressing effects on their growth, with even fatal results; such cases have come to my notice on more than one estate in the Badalgama area.

I cannot do better than quote from recent work published in Jamaica— "Phytotoxic effects of eight herbicides on young coconuts were assessed by recording visual symptoms of injury and growth following treatment. The growth regulators 2, 4-D, 2, 4, 5-T and MCPB were lethal at the normal doses used for annual weed control. Dalapon at 5.5 lbs/acre applied in 1 100 gallons/acre of water caused yellowing and necrosis of the foliage, reduced growth, and sometimes killed the whole plant, while doses down to 2.2 lbs/acre caused some fusion of pinnae. Mouron at 3.2 and 6.4 lbs/acre resulted in serious frond damage and reduced growth, and some frond injury occurred at 1.6 lbs/acre. Diquat at 0.25 to 1 lb and Paraquat at 1.0 to 1.5 lbs/acre, caused extensive necrosis of existing fronds but there was no appreciable reduction of new growth. Amitrole produced considerable chlorosis both at 3.1 and 6.3 lbs/acre, but only the higher dose caused a reduced growth". D. H. Romney: Observations on the effect of herbicides on young coconuts—Weed Research (1964) Vol. 4; p. 24-30.

Effective and Economical Methods of Control

The writer has finally developed the following effective methods which are both economical and effective not only in controlling, but also in completely eradicating *Eupatorium*, once it has got established on a coconut estate.

(*a*) *Removing with Tine Cultivator and subsequent hand digging*

On an estate where some fields were so thickly covered by *Eupatorium* in the Kuliyapitiya District that even a picker could not operate and manouvre their picking poles, and labour could not collect nuts, and hand weeding and cutting would have involved a prohibitive cost of at least -/75 cents to a Rupee per square or more, the entire thick growth, about 4 to 5 feet high, was dug out with the use of a *TINE CULTIVATOR* operated by a tractor. The work can best be done after a fairly heavy shower of at least 0.5 inches, when the ground gets soaked and moist up to at least 6 inches below ground. The tines are worked to a depth of 6″ to 9″ and the tractor worked at a slow speed. The entire plant with the root system was pulled out and dragged and collected into heaps by the tines, which could be lifted mechanically through the hydraulic system of the tractor. When there was very thick growth, the tines were twice run through the same ground and where no drains cause obstruction cultivation with the tine was carried out to complete the weeding effectively.

Plate 6. (a) *Tephrosia* spreading over *Eupatorium*.
Plate 6. (b) *Tephrosia* growing vigorously amidst *Eupatorium*.

The growth of weed close to the base of the palms, if any, were pulled out by digging with mamotties or mamotty forks, and put to the heap of weeds, which were later allowed to dry and burnt in small heaps.

The advantage of the use of the cultivator was that a large area could be covered, about 5 to 6 acres per 8 hour working day depending on the height and thickness of growth and the presence or otherwise of interfering drains or outcrops or concretions. On the average the overall cost did not exceed 15 cents per square, allowing for the wages of the Tractor Driver, fuel and depreciation.

Fresh growth soon occurs in wet weather from portions of the roots, even laterals left under ground, and these could be subsequently dug out with mamotties and/or mamotty forks or treated by methods (b) and (c) described below:—

(*b*) *Cover Crop*

Where regeneration from roots left below ground can occur where the original *Eupatorium* was thick, an effective method is to broadcast seeds of *Pueraria Javanica* a quick growing cover crop soon after the cultivator has been worked before other weed seeds usually *Hyptis suavolens* germinate and colonise the land.

Pueraria quickly germinates and completely smothers the fresh growth and covers the land completely in 3 to 4 months. It has however its disadvantages such as thick growth round young palms which have to be cleared of the cover up to a distance of 6 feet, even once every 2 to 3 months, or else the creepers even climb up the young palms; the difficulty of collecting nuts where growth of *Pueraria* is thick, and the inevitable breeding of reptiles under the cover. However the advantages overweigh these disadvantages of the thick growth of *Eupatorium* on a land under coconuts.

Further particulars on seed rates will be found in CRI Leaflet No. 17—"Cover Crops under Coconuts".

(*c*) *Establishing Tephrosia purpurea* (සෙ Pila: Tamil—'Kolinchi').

The establishment of *Tephrosia pupurea*, popularly known as *Pila* in Sinhala and *Kolinchi* in Tamil has been recently found to be the cheapest and most effective method not only for the control of *Eupatorium*, BUT EVEN for its complete eradication.

In fact this forms the main topic of this paper, where other methods of control have also been elaborated.

The Botany of this leguminous plant has already been described at the commencement of this paper. Plate I shows the root and shoots system of a moderate sized plant growing on a coconut estate.

Plate II shows a Field on a Coconut estate in a Field of bearing palms where the *Eupatorium* forms almost a scrub jungle.

On an estate in the Chilaw District on the boundary of the Kurunegala district on a gravelly soil, situated about 7 miles interior from the sea board the land was completely covered with *Eupatorium odoratum*. In 1968 the practice had been to

Plate 7. Tine cultivator working on an *Eupatorium* infested Field.

mow with the Landmaster operated mower, and no less than Rs. 5000/- was spent per annum, and in subsequent years even more for digging out this pernicious weed. When weeding rounds began in one field, where digging out the roots was not properly done, regeneration had occurred and grown a foot or so high before the weeding of the last Field was commenced. However in more than half the estate, except for stray plants, *Eupatorium* was completely eradicated by 1969 June.

Instructions had been given that under no circumstances *Pila* (*T. Purpurea*) and *Crotalaria* varieties (*C. striata* and C. *verrucosa*), which were growing on the land were to be removed. As a routine, all dried pods of Pila were occasionally collected, crushed between the palms of the hand to separate seeds and thrown between the rows. In every field where *Eupatorium* had been almost completely removed there were quite a few plants of *Pila* growing at random. From October 1969 till May 1970 there was heavy and continuous rain and when the estate was visited in March 1970 the writer was amazed to see these fields almost completely covered by a thick growth of *Pila* and not a sign of *Eupatorium* was evident where *Pila* thrived. The *Pila* had then grown about a foot to 18 inches high.

THE ECOLOGY OF *TEPHROSIA PURPUREA* IN CONTROLLING *EUPATORIUM*

It would be useful to find a scientific explanation for the fact that *Pila* once established to form a CLIMAX, completely smothers not only *Eupatorium* but also other weeds (*except Mimosa pudica* vide belo w).

About 25 years ago the writer came across a reference in a Technical Communication issued by the (then) Imperial (now Commonwealth) Bureau of Soil Science on Illuk, entitled "*Imperata Cylindrica* var *Arundanacea*", to the observation that trials with *Tephrosia candida* (*boga*) a variety of the same *Genus* as *Pila*, when established on a Field infested infested with *Illuk*, the pernicious graminaceous weed, completely smothers first retarding growth and finally eradicating *illuk*. The writer carried out a small trial plot at Ratmalagara Estate sub-station in an area densely infested with *Illuk*, in what is now a portion of the 3 × 3 × 3 NPK Experiment on young palms. Trials were also carried out by planting *Gliricidia maculata*, close planted (10 feet apart or even closer). While the *Gliricidia* was only partially successful in controlling *illuk*, *Boga* (*T. candida*) almost completely killed the *Illuk* in due course.

The Field was ploughed, disc harrowed and *Boga* seeds planted in rows. The *Boga* plants came up to a height of 3 feet or more within 3 months and were then lopped about a foot above ground level and the loppings left as a mulch. Two or three fresh loppings were cut. The *Illuk* completely disappeared in time. Unfortunately this trial was not followed up.

I would commend to the CRI the necessity to carry out a similar trial with *Boga* (*T. candida*) to control and eradicate *Eupatorium odoratum* using varying seed rates and planting distances.

How and why *Boga* killed the *Illuk*, inspite of its rhizomes and other underground organs with reserves of plant food, it would be interesting to speculate. I would hazard the view that *Tephrosia candida* secretes some chemical from the roots into the soil which may be some sort of growth, regulating chemical which acts as a Weedicide, at higher concentrations accumulate in the soil. That certain plants secrete into the soil various chemicals synthesised by the plant itself has been accepted and demonstrated and there is an extensive literature on the subject relative to the Soil/Plant Root Interactions of Plants.

It is known that *Tephrosia vogelii*, a plant of the same genes as *Boga* (*T. candida*) and *Pila* (*T. purpurea*, contains a fish poison, the use of which has even been commercialised. It may therefore be reasonable to speculate that there may be a similar chemical synthesised by *Pila* (*T. purpurea*) which is discharged into the soil and acts as the weedicide controlling and eradicating *Eupatorium odoratum*.

I would suggest that the CRI Agronomists who deal with weeds and weed control carry out simple *pot experiments* to study the fundamental factors of weed control by *Pila* (and by *Boga*) by growing a mixed flora of weeds such as *Eupatorium*,

Hyptis and *Epala* (එපල) and *Mimosa pudica* survives under the canopy of *pila*. This is a troublesome weed, due to the spines which are dreaded by labourers who work bare-footed and particularly by pickers.

While this lesser evil (compared to *Eupatorium*) can be obviated by providing Labourers with Tennis Shoes, and the pickers even with Rubber Boots, a method of eradicating or preventing the growth of *Mimosa* below the canopy of *Pila*, should be possible. The CRI should direct investigations to the solution of this problem by controlled experiments.

Pila is not eaten by cattle, or even by goats. Goats however relish *Mimosa*, but as to whether the canopy of *Pila* would interfere with the grazing by costs also should form the subject of a simple field trial.

PILA AS GREEN MANURE

At present on the estate where the control of *Eupatorium* by *Pila* was a success, no trials have yet been carried out to utilise excess growth of *Pila* as a green manure. So far where it grows in foot paths in the fields which have to be kept clean weeded to facilitate expeditious movements by watchers and supervisory officers, the *Pila* is slashed and spread as a surface mulch round both young and bearing palms or added to cattle manure trenches before covering with soil. This mulch also smothers weeds and conserves soil moisture.

BIOLOGICAL CONTROL OF *EUPATORIUM* BY INSECTS

The Director Commonwealth Bureau of Biological Control has suggested trials with an insect which is claimed to have successfully controlled and/or eradidicated *Eupatorium* (not *E. odoratum*) in Malaya in a manner similar to the control by the insect *Cactoblastus* which was used to eradicate with success cactus which was a serious plant pest in Australia.

FURTHER PROBLEMS

There are further problems in the optimum utilisation of *T. purpurea* (*pila*) as a biological method of weed control to some of which reference has already been made. Similarly its uses as a leguminous green manure which nodulates and fixed atmospheric nitrogen adding fertility to the soil needs further study. Another problem to investigate is regarding the viability of *pila* seeds and methods of accelerating the time for the seeds to germinate, by scarifying the seeds and/or soaking in water, as also the effects of phosphate applications to stimulate growth and nodulation.

Further the effect of lopping the top growth on regeneration if the loppings are to be used for mulching and/or as a green manure added to coconut manured trenches, need study.

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RESEARCH

The view is sometimes expressed that some research is so far ahead of any possible application that it is not worth doing. But wherever progress is taking place or is imminent, research is vital—there can be no enduring progress without it. Research must cover not only the basic biological sciences which lead to the production of new inputs such as improved seeds, fertilizers and pesticides; it must also evaluate systems of farming and agricultural production, and aim at a better understanding of the economic and social factors upon which progressive development may depend.

It is important to build up indigenous capacity and resources for research, but regional and international research effort also has an important role to play. Effective ways of building research programmes must be developed so that new knowledge that can be applied to the practical needs of development is generated. Evaluation techniques must, of course, be used to ensure that unproductive research is eliminated. Here again, it is imperative to encourage professional men and women and technicians to spend their lives in research organizations by giving them sufficient career prospects and status.

A. R. Melville: *Span* 1971. Vol. 14 No. 1 p. 6.