

CHANGING PATTERN OF WEED FLORA IN TEA FIELDS IN  
SOUTH INDIA

V. S. SHARMA, N. SATYANARAYANA

AND

K. RAMACHANDRAN

UPASI Tea Research Station, Cinchona

## INTRODUCTION

Cultural practices in tea plantations in South India have undergone remarkable changes over the decades, which inevitably have had an impact on the weed flora. For instance, the fertilizer, ammonium sulphate, when broadcast, scorches the annual weeds like *Drymaria diandra* Blume, and *Oxalis corniculata* L. and this fertilizer is applied once, or twice, in a year. Though these two weed species are still surviving the chemical, its continuous use may lead, or might have already led to the diminishing importance of certain other annual species. Fryer and Chancellor (1970) attributed the decline in importance of *Chrysanthemum segetum* L. and *Spergula arvensis* L. to the application of lime. In the light of this, it has to be watched whether the regular and extensive practice of liming tea fields in South India will have any impact on the status of certain weeds.

Before the advent of herbicides in tea plantations some fifteen years ago, various implements like fork, hoe and spade were used for weeding. Use of these implements turned up soil and brought out the buried seeds on to the surface, thus promoting the growth of a broad spectrum of weeds, with the annuals as an important component. With the current emphasis on "no tillage" many

annual weeds diminished in importance and their place is generally taken over by perennial dicotyledonous weeds and grasses such as, *Achyranthes aspera* L., *Axonopus compressus* (Sw.) Beauv., *Centella asiatica* (L.) Urban, *Commelina* spp., *Cyanotis* spp., *Cynodon dactylon* (L.) Pers., *Digitaria ciliaris* (Retz.) Koel., *Paspalum conjugatum* Berg., *Pennisetum clandestinum* Hochst. ex Choiv., *Polygonum chinense* L., *Sida acuta* Burm. f. and *S. rhombifolia* L.

The profound effect on the occurrence frequency and status of different species, by the advent of herbicides a decade and a half ago, should be judged against the background of continually changing cultural practices, which in themselves have had an impact on the weed flora. Currently, the following six herbicides are in wide use in tea plantations in South India : 2, 2-dichloropropionic acid (dalapon), 2, 4-dichlorophenoxy acetic acid (2, 4-D), monosodium acid methylarsonate (MSMA), 1, 1-dimethyl-4, 4-bipyridilium dichloride (paraquat), 3-(3, 4-dichlorophenyl)-1, 1-dimethylurea (diuron) and 2-chloro-4, 6-bis (ethylamino)-s-triazine (simazine). Of these, paraquat has been in extensive and prolonged use, followed by dalapon and 2, 4-D. Prolonged and continual use of these chemicals has had its effect and weed species tolerant to these herbicides are increasing in their importance

in several tea plantations in which these chemicals have been in use.

The scope of this paper is restricted to the Anamallais (Coimbatore District, Tamil Nadu) for reasons of space and, is based on several surveys carried out in six fields of four tea plantations, including two experiments running over a period of two years (1976 and 1977). Weeds occurring in an area left fallow for over a year after felling the forest in 1977 which is adjoining a tea clearing planted with tea in 1978, are enumerated to form a basis for comparison. This study, will give a comprehensive idea of the changing trends of weed flora in South Indian tea plantations in general and at mid-elevations in particular.

**a) Weed flora in a felled forest area left fallow for over a year :**

*Ageratum conyzoides* L., *Conyza ambigua* DC., *Crassocephalum crepidioides* (Benth.) S. Moore, *Digitaria ciliaris* (Retz.) Koel., *Eupatorium adenophorum* Spr., *E. odoratum* L., *Hydrocotyle javanica* Thunb., *Lantana camara* L., *Oplismenus* sp., *Paspalum conjugatum* Berg., *Polygonum chinense* L., *Pteridium aquilinum* (L.) Kuhn., *Rubus racemosus* Roxb., *Sida acuta* Burm. f., *Solanum torvum* Sw. and *Urena lobata* L.

In this fallow field, *Pteridium aquilinum* (L.) Kuhn. is the dominant species with *Crassocephalum crepidioides* (Benth.) S. Moore as the codominant. *Ageratum conyzoides* L., *Eupatorium adenophorum* Spr. and *E. odoratum* L., are of frequent density, while all others are rare to occasional.

**b) Weed flora in a clearing felled in 1977 and planted with tea in 1978 :**

*Ageratum conyzoides* L., *Crassocephalum crepidioides* (Benth.) S. Moore, *Cyperus* sp., *Dichrocephala integrifolia* (L. f.) O. Ktze., *Digitaria ciliaris* (Retz.) Koel., *Emilia sonchifolia*

DC., *Eupatorium adenophorum* Spr., *E. odoratum* L., *Lantana camara* L., *Oplismenus* sp., *Oxalis corniculata* L., *Paspalum conjugatum* Berg., *Polygonum chinense* L., *Solanum torvum* Sw. and *Urena lobata* L.

This field which was planted with tea during June/July, 1978, has been under hand-weeding since then. *Pteridium aquilinum* (L.) Kuhn., which occupied the dominant position in the fallow, disappeared from this field. *Ageratum conyzoides* L., which is frequent in the fallow fields, emerged as the dominant species in this field and, *Crassocephalum crepidioides* (Benth.) S. Moore, which is codominant in the fallow, dropped to the rank of being frequent. All others are represented as rare species. There is a decline in the total number of species also : from 16 species in the fallow, the number of species declined to 15 in the planted area. Five species, *Conyza ambigua* DC., *Hydrocotyle javanica* Thunb., *Pteridium aquilinum* (L.) Kuhn., *Rubus racemosus* Roxb. and *Sida acuta* Burm. f., which are present in the fallow, do not occur in the adjoining area planted with tea in 1978. On the other hand, four new weeds, *Cyperus* sp., *Dichrocephala integrifolia* (L. f.) O. Ktze., *Emilia sonchifolia* DC. and *Oxalis corniculata* L., made their appearance in the newly planted tea field.

**c) Weed flora in 1976—tea clearing, contiguous with 1978—tea clearing :**

*Ageratum conyzoides* L., *Axonopus compressus* (Sw.) Beauv., *Bidens biternata* (Lour.) Merr. & Sherf., *Borreria ocymoides* DC., *Conyza ambigua* DC., *Crassocephalum crepidioides* (Benth.) S. Moore, *Cyperus* sp., *Dichrocephala integrifolia* (L. f.) O. Ktze., *Digitaria ciliaris* (Retz.) Koel., *D. longiflora* (Retz.) Pers., *Drymaria diandra* Blume, *Emilia sonchifolia* DC., *Gnaphalium polycaulon* Pers., *Indigofera spicata* Forsk., *Lantana camara* L., *Mitracarpus verticillatus* (Schum. & Thonn.) Vatke, *Oplismenus* sp., *Oxalis latifolia* H. B. K., *Paspalum*

*conjugatum* Berg., *Polygonum chinense* L., *Richardia scabra* L., *Sida acuta* Burm. f., *Solanum torvum* Sw., *Torenia courtallensis* Gamble and *Urena lobata* L.

This clearing, which was planted during the year 1976, was exclusively under hand-weeding for one year and there after brought under regular application of paraquat. Two species, *Eupatorium adenophorum* Spr. and *E. odoratum* L., which occur in the 1978—clearing have been eliminated from the 1976—clearing, but, thirteen new species of which eight are annuals, have now made their appearance in the latter field; among the remaining five species, two are perennial grasses. Though there are a large number of species in the field, the density of weed infestation is below the tolerance level of 25 per cent, of which, *Borreria ocymoides* DC. is dominant comprising over 50 per cent of the weed population; the remaining species are represented with only a marginal density, ranging from rare to occasional.

#### d) Weed flora in 1969—clearing :

Tea was planted in this field in 1969 and the field was under continuous manual weeding up to 1976. Composition of the weed flora of this field in 1976 was as follows : *Achyranthes aspera* L., *Ageratum conyzoides* L., *Amaranthus viridis* L., *Axonopus compressus* (Sw.) Beauv., *Bidens biternata* (Lour.) Merr. & Sherf., *Commelina* sp., *C. benghalensis* L., *Conyza ambigua* DC., *Crassocephalum crepidioides* (Benth.) S. Moore, *Cyanotis* sp., *Cynodon dactylon* (L.) Pers., *Cyperus* sp., *C. rotundus* L., *Digitaria ciliaris* (Retz.) Koel., *D. longiflora* (Retz.) Pers., *Drymaria diandra* Blume, *Eleusine indica* Gaertn., *Eragrostis nigra* Nees ex Steud., *Galinsoga parviflora* Cav., *Gnaphalium polycaulon* Pers., *Ipomoea* sp., *Mitracarpus verticillatus* (Schum. & Thonn.) Vatke, *Neanotis quadrilocularis* (Thw.) Lewis, *Oxalis corniculata* L., *O. latifolia* H. B. K.,

*Panicum repens* L., *Paspalum conjugatum* Berg., *P. distichum* L., *Polygonum chinense* L., *P. nepalense* Meissn., *Sida acuta* Burm. f., *S. rhombifolia* L. and *Spilanthes paniculata* Wall. ex DC.

As is evident from the foregoing list, continuous manual weeding led to the invasion of the field with a wider spectrum of weed species of which, nine are grasses. However, only *Cynodon dactylon* (L.) Pers., was dominant in the field with *Panicum repens* L. and *Paspalum distichum* L., being codominant. All the other species were either rare or occasional in the status of their density.

In 1976, this field was brought under chemical weed control by the use of a new, broad-spectrum herbicide, N-phosphonomethyl glycine (glyphosate), and, weeds occurring in the field at the end of two years under this regime were recorded and enumerated here : *Ageratum conyzoides* L., *Bidens biternata* (Lour.) Merr. & Sherf., *Borreria ocymoides* DC., *Centella asiatica* (L.) Urban, *Conyza ambigua* DC., *Crassocephalum crepidioides* (Benth.) S. Moore, *Drymaria diandra* Blume, *Gnaphalium polycaulon* Pers., *Mitracarpus verticillatus* (Schum. & Thonn.) Vatke, *Neanotis quadrilocularis* (Thw.) Lewis, *Oxalis corniculata* L., *O. latifolia* H. B. K., *Polygonum chinense* L., *P. nepalense* Meissn. and *Richardia scabra* L. Continuous use of the herbicide over a period of two years reduced the diversity of the species and, of the thirty three species occurring, before the use of the herbicide, only twelve species survived the two-year period of chemical weed control. All the nine species of grasses were eliminated from the field. But, three new dicotyledonous weeds, *Borreria ocymoides* DC., *Centella asiatica* (L.) Urban and *Richardia scabra* L., made their appearance in the field. There has been a remarkable change in the status of individual species also : the dominant and codominant species, *Cynodon dactylon* (L.) Pers., *Panicum repens* L. and

*Paspalum distichum* L., having been completely eliminated from the field, *Polygonum nepalense* Meissn., which was previously rare has come to occupy the dominant position, with *Drymaria diandra* Blume and *Oxalis latifolia* H. B. K., both of which were previously frequent, having become codominant. The other species are rare to occasional. The general weed infestation of the field has also declined to far below the tolerance level of 25 per cent.

e) **Weed flora in a mature tea clearing under prolonged application of paraquat :**

This is an old tea field which was under the regular application of paraquat for over eight years. The weed composition in 1976 was : *Ageratum conyzoides* L., *Amaranthus viridis* L., *Axonopus compressus* (Sw.) Beauv., *Bidena biternata* (Lour.) Merr. & Sherf., *Borreria ocymoides* DC., *Centella asiatica* (L.) Urban, *Commelina benghalensis* L., *Conyza ambigua* DC., *Crassocephalum crepidioides* (Benth.) S. Moore, *Dichrocephala integrifolia* (L. f.) O. Ktze., *Digitaria ciliaris* (Retz.) Koel., *D. longiflora* (Retz.) Pers., *Drymaria diandra* Blume, *Eleusine indica* Gaertn., *Emilia sonchifolia* DC., *Eupatorium odoratum* L., *Galinsoga parviflora* Cav., *Lindernia crustacea* (L.) Muell., *Oxalis corniculata* L., *O. latifolia* H. B. K., *Panicum repens* L., *Paspalum conjugatum* Berg., *Peperomia pellucida* H. B. K., *Portulaca oleracea* L. and *Sida rhombifolia* L. Many of these species are tolerant to paraquat at the dosage used. Of the twenty five species, six were grasses, with *Paspalum conjugatum* Berg., occupying the dominant position; all other grasses were of frequent density, except *Panicum repens* L., which was rare. The dicotyledonous weed species were represented with marginal density of rareness.

In the year 1976, this field was brought under the regular application of glyphosate and, the weed composition at the end of the two

year regime was : *Ageratum conyzoides* L., *Bidens biternata* (Lour.) Merr. & Sherf., *Borreria ocymoides* DC., *Centella asiatica* (L.) Urban, *Conyza ambigua* DC., *Crassocephalum crepidioides* (Benth.) S. Moore, *Drymaria diandra* Blume, *Emilia sonchifolia* DC., *Gnaphalium polycaulon* Pers., *Neanotis quadrilocularis* (Thw.) Lewis, *Oxalis corniculata* L., *O. latifolia* H. B. K. and *Polygonum nepalense* Meissn. Here again, the continuous use of glyphosate for two years eliminated the grass species from the field and reduced the species diversity from twenty five to thirteen. Of the thirteen species occurring in the field, three species, namely, *Gnaphalium polycaulon* Pers., *Neanotis quadrilocularis* (Thw.) Lewis and *Polygonum nepalense* Meissn., are new to the field. There is also a change in the status of individual species, namely : *Drymaria diandra* Blume which was previously frequent has now become dominant, with *Polygonum nepalense* Meissn., which was not there before, becoming codominant. *Bidens biternata* (Lour.) Merr. & Sherf., *Borreria ocymoides* DC., *Oxalis corniculata* L. and *O. latifolia* H. B. K. are frequent.

f) **Herbicide tolerant species :**

The prolonged and continual use of the same herbicides in tea fields reduced weed density and also, the species diversity, but, resulted in a change in the composition of weed flora and, the populations of herbicide-tolerant species started becoming predominant (Sharma, 1977). Additionally, there is a change in the status of individual species. Sharma (1975) enumerated paraquat-resistant weed species that are now increasing in numbers in tea fields that have been under paraquat for a prolonged period. In tea fields where *Cynodon dactylon* (L.) Pers., *Paspalum conjugatum* Berg. and other common grass species were eradicated by the continual use of dalapon and paraquat, *Panicum repens* L., which is resistant to both the above herbicides,

is becoming a dominant weed. In the past three to four years, there has been virtual explosion in the populations of *Crassocephalum crepidioides* (Benth.) S. Moore in all those fields which have been under repeated application of 2, 4-D and/or paraquat. Thus, it is evident that while the species that are sensitive to herbicides decline, the populations of those species which are tolerant to the chemicals, increase.

Different degrees of tolerance to paraquat was noticed in the populations of *Borreria ocymoides* DC. and, such herbicide-tolerant strains within weed populations were reported earlier also (Evans and Pfeiffer, 1967; Rochecouste, 1962). Development of resistance in *Erechthites* Sp. to 2, 4-D was cited by Fryer and Chancellor (1970). But these incidences are unlikely to become a serious problem in tea fields because of the availability of a wide range of herbicides.

### CONCLUSIONS

The data discussed in this paper, though limited, point at a positive trend of change in weed flora in tea plantations due to the impact of herbicides, in addition to various cultural practices. The emphasis on "no tillage" led to the risk of invasion of the fields by grasses and perennial dicotyledonous weeds. The important contribution of herbicides has been reduction both in weed populations and species diversity, but, not complete elimination of weeds from the fields. This is sufficiently proved by the data presented from different surveys. There is also a change in the frequency of individual species due to the usage of herbicides.

In the final analysis, the authors agree with the conclusions drawn by Fryer and Chancellor (1970, p. 116) that "..... whilst

the trend for the more herbicide sensitive species to decline will continue, it is very probable that populations of more resistant or better adapted species will continue to be maintained or even to increase in the face of continuing herbicide usage"

Whatever be the pattern, recording of such changes in weed flora is essential not just because they form a very important component of a flora, but also because the weed species are chiefly responsible to keep the flora of a region ever-changing. Survey and identification of such changes will lead to the compilation of a comprehensive and complete flora of a region, besides forming a basis for planning an effective strategy for their control. With this aim in view, periodic surveys of weed flora in tea plantations in South India are being made. Also, six long term experimental blocks are being maintained in the UPASI Tea Research Station, Cinchona, under different weed control practices to monitor weed succession under their influence.

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Values: dominant = 5; codominant = 4; frequent = 3; occasional = 2; rare = 1.