Proc. Indian natn. Sci. Acad. B47 No. 6 pp 907–911 (1981)

Ecological Strategies of the Weed *Pluchea lanceolata* (DC) C B Clarke (Asteraceae)

K M M DAKSHINI and C A SABINA
Department of Botany, University of Delhi, Delhi 110007

(Received 15 October, 1981)

Pluchea lanceolata, commonly found in fields in semi-arid tracts of north western India, is a problem weed. It has a tremendous potential for modulating its life-cycle strategies in response to diverse ecological stresses by acting as a 'competitor', a 'reactor' or a 'resistor'. It is on account of its versatility, the control of this weed through the conventional methods is nearly impossible. The adaptive strategies of the weed have been discussed in this paper.

Key Words: *Pluchea lanceolata*; **Weed; Ecological strategies**

Introduction

Pluchea lanceolata (DC) C B Clarke, a hoary pubescent undershrub, is a common weed of sandy and saline tracts of the dry plains of north-western part of India (Wealth of India 1976). It occurs in similar situations in North Africa, Afghanistan and Pakistan (Oliver 1885, Nasir & Ali 1972). In India it thrives in cultivated fields as well as in uncultivated areas. Considerable losses have been attributed to it in the Kharif and Rabi crops. Attempts to control this weed through herbicidal compounds have been unsuccessful and the weed is becoming progressively more aggressive. The infestation of the fields is often so heavy that it poses a constant threat to the farmer. The present investigation was undertaken to understand the mechanism of its successful survival. In this paper, however, only field data pertaining to the plant and habitat characteristics have been covered.

Material and Methods

A reconnaissance survey of a tract, 150×50 km, south-west of Delhi showed that this weed inhabits, in various densities, the irrigated, unirrigated and abandoned fields as well as the surrounding uncultivated areas. Also, the populations vary with respect to morphological features such as height, size of leaves and number of branches. As the plant cover is a good indicator of the ecological conditions available to the plants, populations in the above-mentioned tract were analysed for some soil and morphological characteristics with a view to assessing the relationships, if any, between the above-mentioned variations and the success of the weed. For this purpose 50 populations were sampled through the area. From each population a minimum of 35 plants were randomly collected and details of branching pattern, height, leaf length and width, leaf margin, and reproductive capacity (total number of capitula per plant) were noted for every plant. Five samples of soil (from the root zone) were collected from the locality of each population and analysed, following the standard procedures (Jackson 1958, Piper 1942) for *p*H, conductivity exchangeable sodium and potassium, organic carbon, sulphates, total carbonates, soluble carbonates, bicarbonates, chlorides and moisture content. Populations were selected from both cultivated and uncultivated areas, but the cultivated habitats varied on account of duration of cultivation and irrigation. Based on these factors the populations sampled were classified according to the following habitat types:

Habitat Type	*Characteristics*
(i) Uncultivated (UC)	Areas with no record of cultivation or irrigation; no biotic disturbance to the weed
(ii) Cultivated:	
(a) Irrigated (I)	Cultivated during both the seasons (Kharif and Rabi); irrigated; frequent ploughing before sowing the fields damage the weed plants and its propagules
(b) Unirrigated (UI)	Cultivated during only one (Kharif) season, and the field left fallow after crop harvesting; the damage to weed plants restricted to only one sowing season
(c) Abandoned (A)	Fields with no cultivation in the immediate past; usually abandoned due to poor soil conditions; the weed flourishes without biotic disturbance

The types *I*, *UI* and *A*, thus represented three successive stages in terms of irrigation (or availability of moisture), cultivation and weed damage or disturbance. The fourth type (*UC*) was entirely different with no ecological stress or disturbance caused by agricultural practices.

Results

The data on soil characteristics which vary from habitat to habitat are summarised in table 1. As expected the moisture content of the soil was maximum in *I* habitats (17.87%). *UC* habitats had higher moisture content (8.3%) than either *UI* (5.0%) or *A* (4.0%). The other parameters varied as follows:

Habitat Type	*Characteristics*
I and UI	Higher conductivity, higher concentrations of sodium, chloride, sulphates, carbonate, and lower organic carbon
A and UC	Lower conductivity, lower concentrations of sodium, chloride, sulphates, carbonate, and higher organic carbon

However in UC, the values of most of the parameters analysed (except *p*H, organic carbon, and bicarbonates) were low. Further, in *A*, the range of variations in almost all (except exchangeable sodium, chlorides and moisture content of soil) soil characteristics, was highest as compared to other habitats. It is due to these variations that the soil characteristics of *A* were more or less intermediate to *UI* and *UC*.

Table 2 gives data pertaining to various morphological characters of plants in different habitat types. The overall range of variation of these characteristics of the weed plants sampled from different populations were: Height 33.0–68.0 cm; Leaf length 2.67–7.70 cm; Leaf width 0.65–2.60 cm; Number of capitula per plant 14.5–235.6. However, plants occupying various habitats show

Table 1 *Habitat types and their soil characteristics*

Soil Characteristics		Habitat Types			
		Irrigated (*I*)	Unirrigated (*UI*)	Abandoned (*A*)	Uncultivated (*UC*)
Soil colour	Dry	Dark yellowish brown	Light yellowish brown	Light yellowish brown	Pale brown
	Wet	Dark yellowish brown	Brown	Yellowish brown	Brown
Range and mean moisture content (%)		17.8 (9.1–34.0)	5.0 (2.8–8.0)	4.0 (2.0–6.1)	8.3 (6.6–10.0)
*p*H		8.14±0.16	8.38±0.21	8.10±0.49	8.17±0.14
Conductivity (μmhos/cm)		888.0±60.4	1060.0±55.1	351.5±143.0	119.5±12.0
Exchangeable Na (me%)		1.03±0.57	1.43±0.86	0.59±0.39	0.48±0.38
Exchangeable K (me%)		0.19±0.13	0.17±0.04	0.18±0.16	0.16±0.014
$CaCO_3$ (%)		2.50±1.98	2.52±2.12	2.50±2.36	2.00±0.7
Organic carbon(%)		0.32±11	0.61±0.14	0.89±0.42	0.87±0.27
Carbonates (me%)		0.05±0.004	0.014±0.002	0.01±0.014	0.00±0.00
Bicarbonates (me%)		0.30±0.23	0.46±0.13	0.435±0.31	0.54±0.1
Chlorides (me%)		1.03±0.58	0.33±0.25	0.087±0.07	0.025±0.002
Sulphates (me%)		0.23±0.11	0.70±0.15	0.19±0.47	0.10±0.03

Table 2 *Morphological characteristics of populations of P. lanceolata occupying different habitat types*

Morphological characteristics	Habitat types			
	Irrigated (*I*)	Unirrigated (*UI*)	Abandoned (*A*)	Uncultivated (*UC*)
Height (cm)	47.8±2.48	52.49±7.44	29.9±16.92	40.5±5.37
Leaf length (cm)	4.79±0.98	5.38±1.23	3.8±1.37	4.35±0.01
Leaf width (cm)	1.47±0.34	1.60±0.29	1.29±0.57	0.70±0.07
Number of capitula per plant	82.60±66.18	63.42±44.5	146.70±107.8	80.60±0.11
Range of frequency (%) of condensed type of branching	70–100	50–75	20–50	0–20

Table 3 *Nature of disturbance, stress and the strategies developed by plants of various populations of* P. lanceolata

Degree of disturbance and stress	Habitat type	Strategic response
High disturbance, no stress	*I*	Increased height; Greater number of branches; Large leaves; High frequency of condensed type of branching; Low reproductive capacity
Low disturbance, high stress	*UI*	Increased height; Number of branches less than in *I* but more than *A* or *UC*; Medium frequency (than *I*) of condensed type of branching; Large leaves; Very low reproductive capacity
No disturbance, high stress	*A*	Dwarfing; Reduced leaf area; Low frequency of condensed type of branching; Very high reproductive capacity
No disturbance, low stress	*UC*	Reduced plant height; Smaller leaves; Condensed type of branching rare; Low reproductive capacity

I = Irrigated; *UI* = Unirrigated; *A* = Abondoned; *UC* = Uncultivated

different features. It was found that the plants from cultivated areas especially *I* and *UI* were taller (45–62 cm) and had broad leaves (1.12–1.90 cm) than those in *UC* habitats. The reproductive capacity of the plants was least in *UI* and highest in *A*. Interestingly, however, populations occupying *A* habitats were more heterogeneous for these characters as compared to populations from other habitats. Thus, populations from *A* habitats which had characteristics nearing to *I* or *UI* were taller, with large leaf size, and lower reproductive capacity (*ca.* 72 capitula per plant). However, plants of populations inhabiting the other type of *A* (nearing *UC*) habitat were shorter with smaller leaf size and with higher reproductive capacities (*ca.* 235 capitula per plant) and thus were more like those of *UC* type. Also, plants inhabiting *A* habitats showed a maximum range of variations and those from *UC* the minimum. A correlative assessment of data on disturbances in the habitat (ploughing and other biotic action), stress (edaphic conditions) and, weed plant responses (morphological characteristics), brings out clearly the dynamic relationships in terms of development of different life-cycle strategies by the weed. These relationships are summarised in table 3.

Discussion and Conclusion

Natural selection brings about evolution of form, structure and function. However, since the purpose of evolution is to bestow maximum fitness to an organism in a specific environment, the successful survival of the organism will depend on its internal or external adjustments. The variation in diverse features of an organism should thus be a mode to optimize the partitioning of limited resources, in space or time, for achieving the maximum success under the available ecological conditions. The data on *P. lanceolata* presented here substantiates the existence of such a phenomenon. The observations on development of strategies, 1–4, outlined above (table 3) should provide maximum fitness under different stresses available to the weed. For example, as conditions for growth are favourable in *I* habitats, the weed creates more stress for the crop and competes with it through vigorous growth and higher densities. Interestingly, in comparison, such a growth allocation for flower production is maintained at lower levels. On the contrary in *UC* habitats, the stress experienced is of an entirely different nature as the overall undisturbed and wild habitat set up may not be congenial for growth of the weed. Since under these circumstances, survival becomes important, the weed responds through its low density, reduced stature and insubstantial reproductive capacity. These strategies result in conservative utilization of water and mineral nutrients and allow for survival over longer periods. In fact, this is the best adjustment to the conditions available under this habitat type. That the weed is capable of regulating growth and spread in response to available ecological conditions is amply borne out by the data on the populations from *A* or *UI*. Any variations in the stress (due to soil characteristics) within these habitats, are reflected through changed reactions (in terms of growth, etc.) of the plant characteristics. It may also be noted (table 2) that the range of variation of most of the characteristics is maximum in plants belonging to these habitat types and this may be indicative of the existence of different degrees of stresses to the plant. A difference in stresses (due to soil characteristics) within this type brings about striking variations between plant characteristics (tables 1 & 2). The varying reproductive capacities as noted in *P. lanceolata* (present work) may also be due to strategic allocation of resources towards reproduction under stresses as has been suggested by Sagar and Khan (1969), and Gadgil and Solbrig (1972). Darwin (1859) also viewed the variation in reproductive capacities as a reflection of the hazards faced by the organism.

The present investigation illustrates that *P. lanceolata* is capable of developing life cycle strategies with response to any eventuality it may have to face and can act as a 'competitor' (through strategy 1), a 'reactor' (through strategies 2 & 3) or a 'resistor' (through strategy 4). It is very likely that such adaptive features of the life cycle make it a problem weed. Detailed investigations on the evolution of these strategic forms are in progress.

Acknowledgements

We are grateful to Mrs Manju Gupta, Mr S K Gupta and Mr J K Soni for their help during the field work and useful discussions. One of us (CAS) thanks the National Council for Educational Research and Training, New Delhi, for providing a scholarship.

References

Darwin C 1959 *The origin of species* (New York: The Modern Library)

Gadgil M and Solbrig O T 1972 The concept of r-and k-selection: evidence from wild flowers and some theoretical considerations; *Amer. Natur.* **106**, 14–31

Jackson M L 1968 *Soil Chemical Analysis* (N J, USA: Prentice-Hall, Inc., Englewood Cliffs.)

Nasir E and Ali S I 1972 *Flora of West Pakistan—An annotated catalogue of the vascular plants of West Pakistan and Kashmir* (Karachi: Fakhri Printing Press)

Oliver D 1885 *Flora of Tropical Africa* (London: L. Reeve & Co.)

Piper C S 1942 *Soil and Plant Analysis* (Adelaide: The University of Adelaide)

Sagar G R and Khan A 1969 Alteration of pattern of distribution of photosynthetic products in tomato by manipulation of plant; *Ann. Bot.* **33** 753–769

Wealth of India 1976 *Raw Materials*, Vol. **10** (New Delhi: The Council of Scientific & Industrial Research)