

control. Various organisms have been shown to be form-specific in their relation to the host (Wapshere - pers. comm.). It may be that the forms differ in their response to herbicides, but this has not been tested. We have evidence that one of the forms, at present more restricted geographically, has a greater capacity to form new rosettes from cut root pieces than the already widespread form. Recognition of the morphological differentiation reported for the species is considered basic to effective control of the species where all three forms occur in central New South Wales.

For many investigations on the biology of weed species the species level may not be the most suitable taxonomic unit. Ecotypes and subspecies must always be expected to occur and the recognition of taxonomic units below that of species may have a direct or indirect bearing on control of weeds.

ECOLOGY OF *TRIBULUS TERRESTRIS* IN SOUTHERN AUSTRALIA

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Tribulus terrestris (Zygophyllaceae), an almost cosmopolitan plant, is a summer-growing annual weed which is widespread in Australia. Australian population of *T. terrestris* are believed to arise from two sources, an introduced form which is common in southern Australia and a native form common in central and northern Australia.

DISTRIBUTION

The distribution of herbarium material placed under *T. terrestris* is quite extensive ranging from the tropical areas to the southern sea-shores, from the desert of central Australia to the coastal dunes of South Australia. It has been recorded in localities with annual rainfalls from below 5 inches to more than 65 inches. *T. terrestris* appears to be adapted to a wide range

of climates but optimally to semi-arid and Mediterranean types. The limits of distribution of the introduced form have been defined by Squires (1969a). The localities at which the weed is considered a major problem are all within the zone with a normal daily maximum in January above 29°C. Relatively high temperatures are required for germination and growth.

VARIABILITY

T. terrestris is exceedingly variable in both vegetative and reproductive characters. Squires (1969b) has examined fruits of material collected within Australia and from overseas. The number of spines on each mericarp and the degree of hairiness of mature fruits differed considerably. Forms from more arid regions were extremely hirsute while those from humid regions are glabrous. The number of spines varied from two to four with spineless forms grading into 'normal' forms, spined and spineless mericarps being found on the one schizocarp.

GERMINATION AND ESTABLISHMENT

Germination will take place, under laboratory conditions, over a range of temperatures (25-40°C) with the optimum about 32°C. At the optimum temperature, germination begins within 6-8 hours and is light-insensitive (Squires, 1968). Seedlings will emerge successfully from surface seed or from seed buried to a depth of 5 cm in sandy soil but not from soils of heavier texture. Summer rains are spasmodic and unreliable in most of southern Australia. As a warm-season annual, the moisture and temperature conditions favourable to *T. terrestris* are likely to be restricted both spatially and temporally. In some seasons seedling mortality, due to drought, can be a major factor limiting the density of *T. terrestris*.

GROWTH CYCLE

At Deniliquin, New South Wales, *T. terrestris* in late spring and early summer (November-December). Germination will continue, if conditions are favourable, until late summer. Floral initiation is rapid; the first flowers appear within 3 weeks of emergence. Flowering may continue for several months if the plants are not killed by drought. Normally the plants mature very rapidly, and freshly produced fruits may be found throughout the summer-autumn period.

CHEMICAL CONTROL

No treatment, short of complete control, is likely to significantly reduce seed set. Being a reseeding annual, any

control measure that destroys the plant before the seed matures would be effective. However, the plant germinates irregularly throughout the season and produces seed at an early stage of growth; therefore, control measures would often need to be repeated. Even partial or temporary control by herbicides is expensive and may be uneconomic in many areas where the value of land is relatively low.

CONTROL BY COMPETITION

T. terrestris grows on a range of soil types but is more common on lighter-textured soils. It is these sandy soils which support the most abundant winter annuals. Winter annuals are usually prominent in the moister sites. In the less favourable areas, perennial grasses remain dominant, with few or no annuals. During summer, *T. terrestris* becomes abundant in those areas formerly dominated by winter annuals, while it is rare or absent where the native perennial grasses are dominant. Much of the area receives too little rainfall for establishment of sown pastures but, in those areas where it is possible, suitable perennials (lucerne, phalaris), should be sown.