

STUDIES ON POPULATION REGULATION OF TWO
ANNUAL WEEDS, *GALINSOGA CILIATA* (RAF.)
BLAKE AND *G. PARVIFLORA* CAV.

By

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I certify that the thesis entitled "Studies on population regulation of two annual weeds, Galinsoga ciliata (Raf.) Blake and G. parviflora Cav." submitted by Mr. Jai Prakash Narain Rai, M.Sc., for the Degree of Doctor of Philosophy of the North-Eastern Hill University, Shillong, embodies the record of original investigation carried out by him under my supervision. He has been duly registered and the thesis presented is worthy of being considered for the award of the Ph.D. Degree. This work has not been submitted for any Degree of any other University.

Date : 13 December, 1982.

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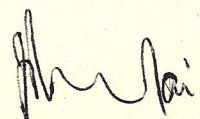
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GENERAL INTRODUCTION

How succeeding generations of a plant species persist in natural populations in almost same number in spite of its enormous offspring production, pricked to Darwin as far back as 1859, who questioned, "Look at a plant in the midst of its range, why does it not double or quadruple its number?" In fact a species population has innate potential to increase in size geometrically as a result of 'the passion between the sexes' (Malthus, 1798). But this potential is never realized in nature, and often the population of a species tends to remain constant showing fluctuations around mean value. This indicates that certain limitations are imposed by the environment, which either reduce the birth rate or enhance the death rate. The environmental factors that usually control the population growth and structure irrespective of density are the available resources, climatic conditions, population interaction, disease etc. Besides, the density-induced regulation of population size also occurs. Although attempts have been made to understand and quantify the effect of density-dependent and density-independent factors on the population growth of plant species (Sukatchev, 1928; Tadaki & Shedei, 1959; Yoda et al., 1963; White & Harper, 1970; Myerscough & Marshall, 1973; Tripathi & Gupta, 1980; Clay & Shaw, 1981; Tripathi & Yadav, 1982), the exact mechanism of population regulation is yet to be fully understood. In fact, under Indian conditions not much work has been done on the ecology of populations as a whole. In view of

this Tripathi & Dwivedi (1978) have stressed the need for studying the population ecology of plants of different growth habits under varied environmental conditions.

Studies on the dynamics and regulation of populations in nature inevitably involve demographic analysis at regular time intervals. The demographic analysis of many plant species has been done by Professor J.L. Harper and his coworkers (Harper & White, 1971; Sarukhan & Harper, 1973; Hawthorn & Cavers, 1976; Mack, 1976; Watkinson & Harper, 1978) while the behaviour of plant populations in pure and mixed stands has been studied by De Wit and his group and many other workers (e.g. De Wit, 1961; De Wit et al., 1966; Tripathi & Harper, 1973; Bazzaz & Harper, 1976; Mack & Harper, 1977; Berendse, 1979, 1981). The survivorship and dynamics of several perennial grass and herb populations from different geographic regions have been studied by a number of workers (e.g. Williams, 1970; Antonovics, 1972; Sarukhan & Harper, 1973; Hawthorn & Cavers, 1976; Johnson & Thomas, 1978; Bishop et al., 1978; Kushwaha et al., 1981; Law, 1981; Yadav & Tripathi, 1981; Silvertown & Dickie, 1981; Schellner et al., 1982) and of biennials by Holt (1972) and Klemow & Raynal (1981). Although the annuals pose relatively lesser practical problems (Harper & White, 1974), the population studies of annual plant species have engaged the attention of very few workers. Mack (1976) studied the survivorship of Cerastium atrovirens and Sharitz & Mc Cormick (1973) studied the population dynamics of two

competing non-weedy annuals and proposed the hypothesis that the population regulation in these species is mainly through interspecific competition for soil moisture. The seed population dynamics of winter annual grass Vulpia fasciculata has been studied by Watkinson (1978) and natural regulation of populations of the same has been described by Watkinson & Harper (1978), who emphasized the role of density in regulation of populations. Recently Weiss (1981) studied the population dynamics of Emex australis and reported heavy mortality during seedling stage especially in dense populations. The density increase may also reduce the reproductive potential of the species populations as reported by several workers (Palmbiad, 1968a; Tripathi, 1968; Myerscough & Marshall, 1973; Williams & Ingber, 1977; Tripathi & Gupta, 1980; Clay & Shaw, 1981; Trivedi & Tripathi, 1982a; Rai & Tripathi, 1982a).

Besides self crowding, the growth of associated vegetation also regulates the population size either through resource competition (Harper & Gajic, 1961; Sagar, 1970; Putwain & Harper, 1970; Mack & Harper, 1977; Dwivedi & Tripathi, 1980; Yadav & Tripathi, 1981) or through production of some toxic substances which inhibit the seed germination and growth of neighbouring plant species (Muller, 1969; Rice, 1974; 1979; Friedman et al., 1977; Hussain & Godoon, 1981; Rai & Tripathi, 1982b). The allelochemicals produced from plants have also been reported to regulate the rhizospheric microbial population (Singh, 1977; Tripathi et al., 1981).

Kulman (1971) laid emphasis on the role of herbivory in population regulation and reported that predation results into increased mortality and reduced seed and biomass production. Werner (1977) studied the effect of predation by Lepidopteron larvae on regulation of teasel population whereas Bentley & Whittaker (1979) emphasized the role of grazing by Chrysomelid beetle in the distribution of Rumex spp. in nature.

In the present investigation two annual weeds Galinsoga ciliata (Raf.) Blake and G. parviflora Cav. were selected for studying their detailed demographic analysis with a view to identify the factors involved and their relative importance in the regulation of the population of these weeds. The two species of Galinsoga grow abundantly in croplands and wastelands of Meghalaya. They are closely related sympatric pair of species with synchronous life cycle. These characters make these species ecologically interesting. Moreover, population ecology of these weeds has not been studied at all.

The studies on population regulation of these two weeds have been made to cover the following aspects:

- i) The demographic analysis of seedling cohorts of the weed populations with respect to recruitment, mortality and reproduction at cropland and wasteland habitats.
- ii) The effect of associated plant species and established mature plants of the two weeds on regulation of their seedling populations.

iii) Allelopathic effect of Eupatorium riparium Regel on population regulation of these two weeds.

iv) The effect of factors such as seed sowing density, sowing pattern, population density, soil texture and soil moisture and nitrogen level on the population regulation of weeds.

v) The effect of herbivore predation on competitive ability and growth of the two species.

vi) The effect of light intensity and 2,4-D on the weed populations.

The experimental data on various aspects mentioned above have been presented in chapters III to VIII which follow 'General Introduction', 'Review of Literature' (Chapter I) and 'Description of Study Site and Selected Species' (Chapter II). The 'General Introduction' outlines the objectives of the thesis while the 'Review of Literature' covers the published literature to show the present status of the subject. Chapter II deals with the soil, vegetation and climate of study site. It also includes the distribution and description of the two species. Though each chapter is provided with a separate discussion of results, the major findings of the whole thesis have been discussed under 'General Discussion' in an integrated manner. To avoid repetition, some important references that have been included in 'General Introduction' have been omitted from the 'Review of Literature'.

The studies on dynamics and regulation of population may prove quite useful in devising effective weed control

measures, as these studies may reveal the ecological conditions that may influence the natality, mortality, survivorship and ultimately population growth of these weeds. On the basis of data collected on various population parameters, working population model can be synthesized through which the reaction of a particular environmental factor on the population behaviour of the weed can be predicted. Thus, although the present study is largely of fundamental nature, it has applied value too.