

YIELD FOR ANNUAL PLANTS AS AN ADAPTIVE RESPONSE

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ABSTRACT. Because of the adaptive nature of biological systems, it follows that a given system may undergo a significant adaptive response when controlled by an imposed management program. In such cases, models used for management purposes should include the adaptive effect. An investigation of this effect is made here. Analysis is confined to a model for the growth of asexual annual plants under a limited nutrient resource and the adaptive response of this model to constant harvesting and mixed cropping.

Adaptive parameters are identified in the model. The value of these parameters is determined from one situation to the next by employing the hypothesis that an individual plant adapts by maximizing individual fitness. It is found that under constant harvesting the adaptation process will tend to make a species a less efficient user of resources. This means that for a given limited nutrient level the species has less potential yield under harvesting stress than without it.

Mixed cropping is of interest as a means to alleviate pest damage. A change in yield due to an adaptive response due to competition between plants for nutrients under mixed cropping is examined for some simple situations and it was found that again adaptation tends to reduce yield of all species in the mixed crop over what would be obtainable if adaptation were not to take place. In a competitive situation the resultant reduced yields represent a direct consequence of maximizing a species' individual fitness. This effect, if found to be predictable, could be significant for the proper management of untended ecosystems such as rangelands.

1. An Annual Plant Model. The following model is obtained from the more detailed development presented by Trenbath and Vincent (1979). It will be assumed here that each species of plant is asexual. Specifically, it is assumed that the characteristics of an individual plant of species i is the same as for all plants of species i during a given growing season on a given identified plot of land. It is further assumed that these characteristics may change from season to season in response to environmental changes by the process of genetic concentration as described by Pimentel (1968).

Let there be growing in a given plot of land i species of plant. A given identified characteristic, common within a species, but varying from species to species will be identified for a given species by the sub-

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