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The effect of phosphorus nutrition, shrub control and fire on the dynamics of Mediterranean batha vegetation in Galilee, Israel

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Summary: The low rate of available soil phosphorus is the main limiting factor for herbaceous plant growth on terra rossa and brown rendzina soils of the hilly Galilee, Israel. These areas are dominated by "batha", a shrubland of spiny shrubs and dwarf shrubs (mainly *Sarcopoterium spinosum* [L.] Spach). Transition of "batha" open woodland to (rich) herbaceous vegetation would improve pasture value, reduce fire hazard and increase the suitability of these areas for tourism and recreation. The influence of phosphorus application and shrub control by spraying herbicide on the relationship between herbaceous vegetation and shrubs was studied, on a site burnt by a wildfire. The herbicide eliminated almost all the bushes, and their regeneration was slow. A single P application increased the herbaceous yield initially by 100%-400%. The effect decreased in subsequent years but was still detectable in the sixth year. Application of P, in addition to herbicide, led to even slower regeneration of the bush component. As a result, the herbaceous vegetation competed more effectively with shrub seedlings, and a new dynamic balance between the two components was maintained. Application of phosphorus may be useful for converting low bush formations in open woodlands to rich grasslands.

Key-words: Mediterranean shrubland, pasture value, biomass, soil phosphorus, shrub control.

INTRODUCTION

About 22,000 hectares of Mediterranean scrubland in the Galilee are currently being used as pastureland to raise beef cattle. These areas, mostly on terra rossa and brown rendzina soils, are dominated by Mediterranean sclerophyllous scrub forest, or spiny shrubland covered by a low bushy vegetation complex (mainly *Calicotome villosa* (Poiret) Link and *Sarcopoterium spinosum* (L.) Spach), characterized as "garigue" and "batha" (Zohary, 1962). The dominance of the different vegetation types in these areas is influenced by the growing conditions in each habitat (Rabinovich-Vin, 1979), and the intensive demographic process which has been a major factor during the last 10,000 years (Mooney, 1977).

The quality of the pasture in these areas is poor and limited, due to the low nutritive value of the woody vegetation and the very low primary production of herbaceous vegetation. Conversion of scrubland formation, the "garrigue" and "batha", to open forest with rich herbaceous vegetation, would greatly contribute to improving the pasture value of these areas. It would also lessen the fire hazard and increase the suitability of these areas for tourist and recreational activities in the future.

The specific aims of this research were : To evaluate the effects of applying phosphate and controlling shrubs by herbicides and fire on natural herbaceous vegetation and to evaluate the effect of these treatments on the relationship between the low bushes and the herbaceous vegetation of a hilly soil, deficient in phosphorus.

MATERIALS AND METHODS

Study site

This study was performed in 1988 on a pilot farm located in the hilly Western Galilee, Israel. The landscape included abandoned terraces covered with scattered or dense low bushes of *Sarcopoterium spinosum*. The average yearly precipitation in this area is 780 mm.

Treatment protocol

The effects of herbicides and phosphate application were analyzed (all treatment groups included burning).

Variables monitored

Measurements were made of herbaceous yield and height, botanical composition, nutrient concentration, P and N uptake, and relative cover and renewal of the bushes. Concentration of soil available P was also measured.

Statistical analysis

The statistical significance of differences between treatments in each year of the study was tested using the GLM and Contrast procedures and the Duncan multiple range test at $p=0.05$ with the SAS package (SAS Institute, 1985).

RESULTS AND DISCUSSION

1. A single application of P significantly increased the herbaceous yield by a factor of 2 - 4 during the first five years (fig.1).
2. P application caused significant changes in the botanical composition of the herbaceous vegetation over the six year period of the research (fig.2).
3. P application enhanced the growth of herbaceous vegetation and as a result the regeneration of low bushes after fire was slower (fig.3).

This study demonstrated the activation of the first stages of the secondary succession process. The succession process started after the burning of the low bush vegetation and was characterized by the incursion of the herbaceous species. A gradual change from a dominant herbaceous vegetation complex to a "batha" formation, dominated by *Sarcopoterium spinosum* occurred. Mature low bushes and young sprouts that survived the dry summer regenerated. The rate of low bush renewal after the various treatments was greatly dependent on two principal factors :

A. The rate of primary disturbance (fire and spraying herbicide).

B. The intensity of competition between herbaceous vegetation and the low bushes.

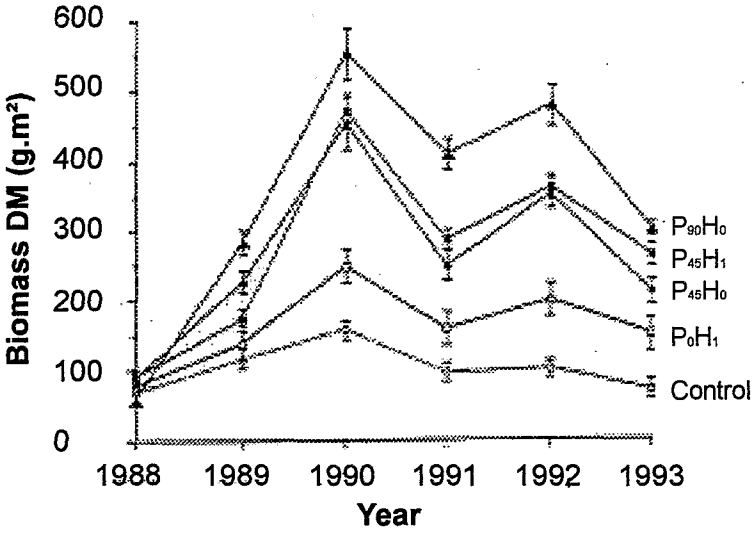

Figure 1: Effect of P fertilizer applied in 1988 on peak sward biomas in subsequent years (vertical bars show S.E.)

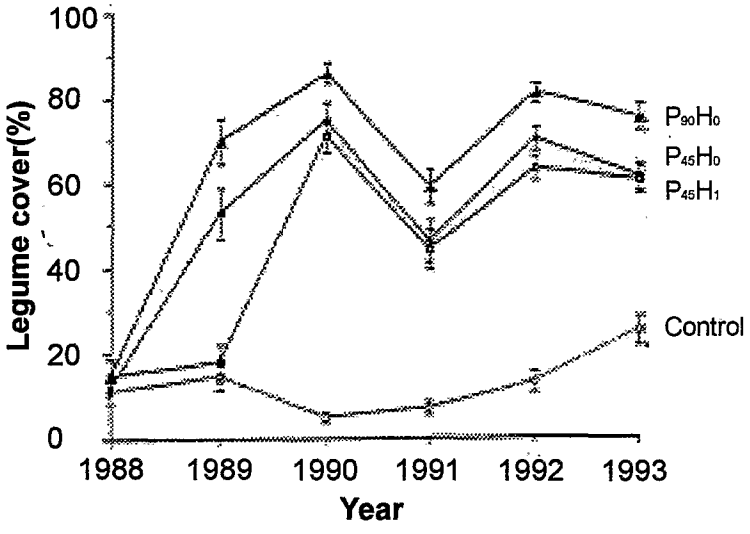

Figure 2. Effect of P fertilizer application and herbicide application in 1988 on cover of annual legumes in subsequent years

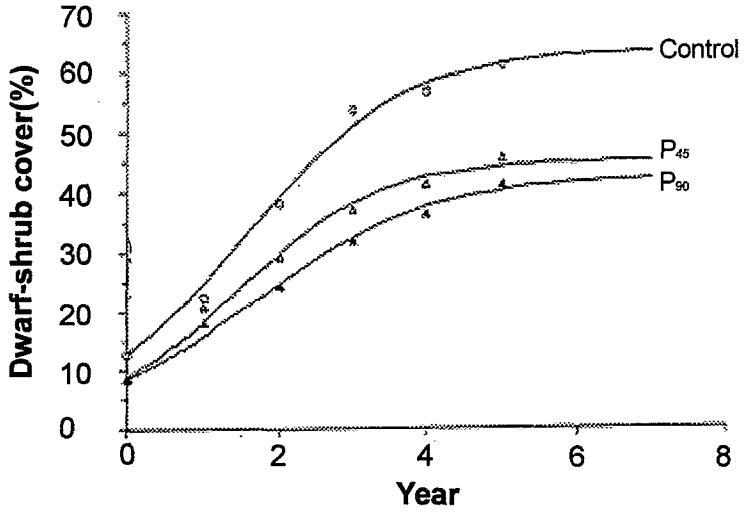

Figure 3. Effect of P fertilization on renewal of dwarf-shrubs after a fire event

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