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RAMULARIA RUBELLA AND *UROMYCES RUMICIS* INFECTING *RUMEX OBTUSIFOLIUS* IN THE AZORES

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ABSTRACT

Rumex spp. (Polygonaceae), namely *Rumex obtusifolius* L., are considered as weeds in permanent pastures in São Miguel island (Azores), demanding manual and chemical control. However, *R. obtusifolius* plants are found to be heavily infected by *Ramularia rubella* (Bon.) Nannf. or by *Uromyces rumicis* (Schum.) Wint. This is the first record of *R. rubella* for the Azores. This hyphomycete infects all the phenophases of *R. obtusifolius* and is found widely distributed on São Miguel island. Infected leaves of *R. obtusifolius* may present more than one hundred red spots each, as well as conidiophores and conidia. *U. rumicis*, already recorded for the Azores on *Rumex pulcher* L., was now found infecting all the phenophases of *R. obtusifolius* in São Miguel island. Leaves infected by the rust become chlorotic and covered by uredosori and uredospores. In late summer teleosori and teleospores were also found. Both fungi are potential biological control agents of *Rumex* spp. in the Azores.

RESUMO

O género *Rumex* (Polygonaceae) inclui várias espécies consideradas como infestantes nas pastagens permanentes da ilha de São Miguel, nomeadamente *Rumex obtusifolius* L., que exigem medidas de luta química e manual. No entanto, algumas dessas espécies encontram-se infectadas por *Ramularia rubella* (Bon.) Nannf. ou por *Uromyces rumicis* (Schum.) Wint. Este é o primeiro registo de *R. rubella* para os Açores. Este hifomicete, muito comum em São Miguel, infecta todas as fenofases de *R. obtusifolius*. As folhas infectadas podem apresentar mais de uma centena de pequenas manchas circulares vermelhas, e as manchas podem conter tufos de conidióforos com conídios. *U. rumicis*, já registado para os Açores em *Rumex pulcher* L., foi agora encontrado em todas as fenofases de *R. obtusifolius* em São Miguel. As folhas infectadas por esta ferrugem apresentam-se cloróticas e cobertas por uredossoros e uredosporos, acabando por morrer. No fim do Verão encontraram-se teleossoros e teleosporos. Ambos os fungos são potenciais antagonistas de *R. obtusifolius* nos Açores.

INTRODUCTION

Pasture for cattle raising is the most important economic activity in the Azores Archipelago, comprising nearly 50% of the surface of the islands and about 62% of the agricultural surface. In the Azores the climate is temperate and rainy with small variations in temperature, and high levels of rain fall and relative humidity. Mean annual temperature varies from 17 to 11 °C, and rain fall from 1000 to 2500

mm/year, at 70 and 800 m respectively. A slightly acidic soil was formed from volcanic piroclastic material.

After 1950 cattle breeding became more important with the increase of pasture areas and number of live cattle, and the development of dairy industry (Oliveira, 1989). In the Azores 40% of the income is originated by agriculture, involving 50% of the working population and originating 80% of the exportations (Anonymous, 1995). Traditionally the production is accomplished by permanent pastures of gramineae and *Tripholium repens* L. The pasture is used intermittently, but many pastures are submitted to 12 grazing periods per year. Cattle is left in the field year round and milk is collected in the pastures (Oliveira, 1989).

Rumex obtusifolius L. (Polygonaceae) is not appreciated by cattle (Cavers & Harper, 1964) and is considered as a major weed in Central Europe. Together with *Rumex crispus* L. and *Rumex pulcher* L. it is known world-wide as a weed. Chemical control is expensive and not permanent, and seed stock in the soil is enormous (Huber-Meinicke, 1989). *R. pulcher* is also a major weed in Mediterranean like climatic regions of south-western Australia which has proved difficult to control by chemical and cultural means (Scott, 1984). Niggli *et al.* (1993) concluded that established dock plants cannot be controlled to any extent by strong competition of grasses, by variation in the cutting frequency or by nitrogen fertilisation. Natural enemies for the biological control of *R. pulcher* were surveyed, namely insects (Scott, 1984; Scott & Way, 1989; Scott & Sagliocco, 1989, 1991a, b) and fungi (Schubiger, 1985; Meinicke, 1987).

In the Azores, Oliveira (1989) found *R. obtusifolius*, *Rumex conglumeratus* Murray, *Rumex angiocarpus* Murb., *R. crispus* and *R. pulcher* in the pastures, where they are considered as important weeds, demanding manual and chemical control. However, *Rumex* spp. plants in the Azores were found to be heavily infected by *Ramularia rubella* (Bon.) Nannf. (Hyphomycetes) or by *Uromyces rumicis* (Schum.) Wint (Uredinales).

This is the first record of *R. rubella* for the Azores, where it infects all the phenophases of *R. obtusifolius* and is found widely distributed in São Miguel Island. *Uromyces rumicis*, already recorded for the Azores on *R. pulcher* (Dennis *et al.*, 1977) was now found infecting all the phenophases of *R. obtusifolius* in São Miguel. Both fungi are potential biological control agents of *Rumex* spp. in the Azores. In this work, abundance of *Rumex* spp. in São Miguel Island (Azores) was estimated, and the natural enemies surveyed in 1995/1996.

METHODS

Spatial distribution of *Rumex* spp. in the pastures was evaluated by counting the number of plants in 100

m^2 using a 1 m^2 sampling unit, in four pastures with different levels of infestation. Distributions were fitted to the Poisson, the Negative Binomial model or to the Normal distribution (Scherrer, 1984).

Abundance of *Rumex* spp. in São Miguel island was evaluated by surveying 30 pastures, using Braun-Blanquet sociability and cover coefficients.

Natural enemies were searched for in the leaves and flowers of *Rumex* spp. plants.

RESULTS

R. obtusifolius was found in São Miguel island from 100 to 750 m of altitude. Percentage of each sociability coefficient (1 to 4) was 70, 20, 7, and 3% respectively. Percentage of pastures with different cover coefficients (+ to 3) were 47, 23, 13 and 17 % respectively. The distribution of *R. obtusifolius* in a pasture is considerably irregular, higher cover and sociability is found near field hedges, at the field entrance, near water tanks, at the bottom of field slopes, in drainage lines, and where cattle movement is frequent (at milk collection points).

Distribution of *R. obtusifolius* in the Azorean pastures varied from a negative binomial distribution to a normal distribution (Figs. 1 and 2).

Ramularia rubella and *Uromyces rumicis* are widespread in the island, from 100 to 700 m of altitude, and are both present in 75% of the pastures. Generally, *R. rubella* is more frequent, and *U. rumicis* is predominantly found in old leaves, at the base of the plant, although in laboratory, 5 to 6 leafed plants are readily infected by exposure to infected plants. Groups of uredosori with brown uredospores were found, each formed by a central sorus encircled by several sori, causing chlorosis and dead of basal leaves. *R. obtusifolius* leaves infected with *R. rubella* may present more than one hundred red spots each. In mature spots a central hole may appear as a consequence of leaf tissue necrosis. In many spots conidiophores and conidia are present.

Other *Rumex* spp. natural enemies found in São Miguel included *Spodoptera littoralis* (Lepidoptera, Noctuidae) and *Aphis fabae* Scopoli (Homoptera, Aphididae), the first causing heavy defoliation on *R. obtusifolius*.

DISCUSSION

R. obtusifolius was found in all the range of permanent pastures in São Miguel island, what agrees with previous work (Oliveira, 1989).

The spatial distribution of the weed in the pasture will determine how the herbicide should be applied (Christensen *et al.*, 1996). In lightly infested pastures, where the weed may be present in aggregates, localised application of Assulame will be recommended, in order to save herbicide, while at heavily infested pastures, where the distribution of the weed may be more regular,

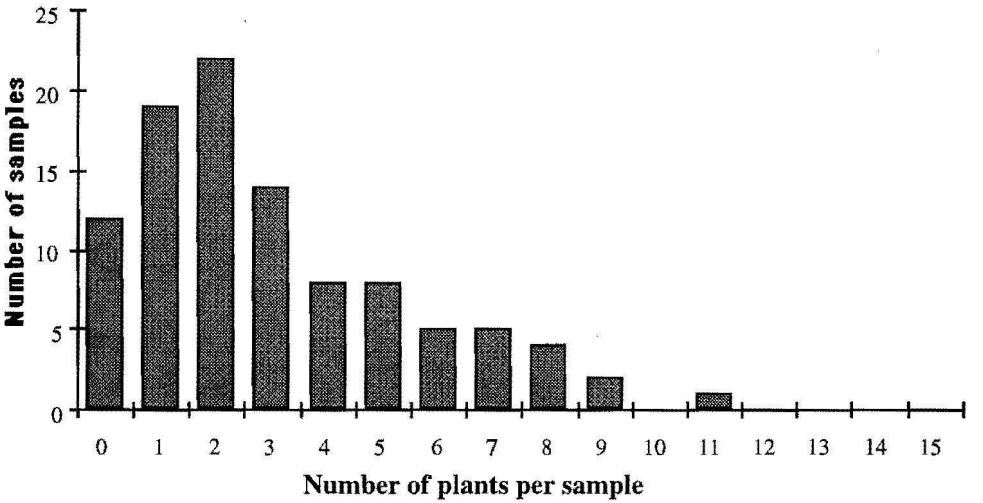

FIG. 1. Frequency distribution of 100 1 m^2 samples of *Rumex obtusifolius* in a lightly infested pasture at São Miguel island. This distribution fitted a Negative Binomial distribution with k=2,81 (χ^2 test, p=0,91). Average ± standard error = 3,03±2,48.

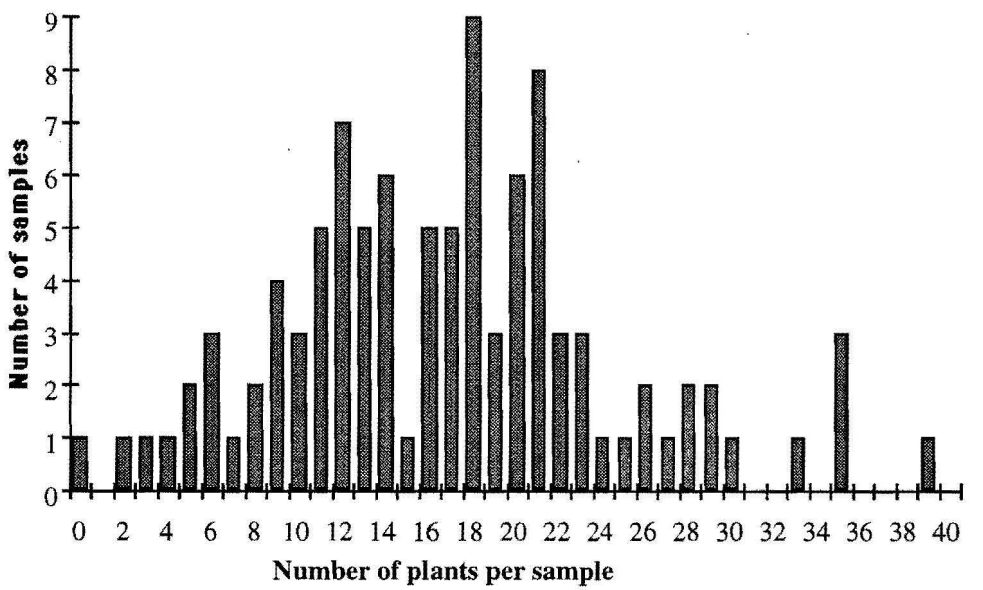

FIG. 2. Frequency distribution of 100 1 m^2 samples of *Rumex obtusifolius* in a heavily infested pasture at São Miguel island. This distribution fitted a Normal distribution (χ^2 test, p=0,08). Average ± standard error = 16,85±0,77.

a general spray would be recommended. In all cases the dense dock stands that generally occur at field hedges, field entrance, near water tanks, the bottom of field slopes, in drainage lines and at milk collection points should be eliminated, since they will probably contribute to increase the infestation.

The host range of *R. rubella* is very restricted, since only species of the subgenus *Rumex* have been infected (Strässle *et al.*, 1986). According to Meinicke (1987) this fungus might possibly control a stand of docks if combined with a parasite of the roots or a chemical herbicide. Propagation of mycelium in submersed culture seems to be the only method for mass production of inoculum of *R. rubella* (Meinicke, 1987).

U. rumicis was considered a biocontrol agent due to its effects on *R. crispus* and *R. obtusifolius* (Inman, 1971; Schubiger, 1985) and to the specialisation of the rust both in dicariotic and haplontic phases. Rusted *R. crispus* and *R. obtusifolius* plants always have a reduced number of leaves and a significant loss of dry weight of roots and leaves (Schubiger, 1985). In the Azores, interactions between *U. rumicis* and other natural enemies, like *Spodoptera littoralis* are possible, since similar processes were found by Hatcher *et al.* (1994). *Ranunculus ficaria*, the haplontic phase host, is not present in the Azores, and the fungus over winters on the primary host probably as uredia or vegetative mycelia (Schubiger *et al.*, 1985). Actually, uredospores are found year round in the Azores, while teleospores were found only by the end of summer.

In the Azores, both fungi should be thoroughly surveyed and they should be considered in a integrated control programme for pasture pests and weeds. Introduction of a complementary natural enemy, like a specific root borer should be carefully considered, in order to preserve *Rumex azoricus* Rech., an endemic species.

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