INTRODUCTION

The Asian soybean rust (ASR), caused by Phakopsora pachyrhizi Syd. & P Syd., occurs in tropical and subtropical zones, occurs in all soybean producing regions in the world. The survival of biotic pathogens depends on the continuous production of urediospores (Prophal and Yang; 2004, Agrón; 1997). In temperate regions, temperature is probably the environmental factor of major significance in the survival of P. pachyrhizi. In Brazil, it has been reported that at 7°C there is no sporulation. However, in ER Province during the growing seasons 2004-05 and 2005-06 active uredinia have been observed in volunteer soybean plants surviving to successive agroclimatic frosts (Fornentos et al. 2005; Fornentos y de Souza, 2006) out of the growing season. This could constitute an epidemiological risk situation for Argentina. The aim of the present study was to analyze the effect of low temperatures on the viability of urediospores under controlled conditions.

MATERIALS AND METHODS

An analysis of low extreme temperatures at 5 cm above ground was carried out (period 1966-2005, Meteorological Station at INTA EEA Paraná). 4 years (25%) and -4°C in 15 years (38%) (Table 1). The lowest record was 10°C and it occurred only once in 39 years. These records were used in the trial design to simulate conditions of low temperatures recorded in the region.

Urediospores present variable levels of initial germination: 22 to 36% (mean: 29) after 6 h and 48 to 73% (mean: 60.5) after 22 h of observation. For the statistical analysis of the data the SAS statistical package (SAS, 1999) was used.

RESULTS AND DISCUSSION

During the period 1966-2005 every year 11°C at 5 cm from the ground was recorded at least once; 0°C was observed in 23 years (29%) and -4°C in 15 years (38%) (Table 1). The lowest record was 10°C and it occurred only once in 39 years. These records were used in the trial design to simulate conditions of low temperatures recorded in the region.

Urediospores presented variable levels of initial germination: 22 to 36% (mean: 29) after 6 h and 48 to 73% (mean: 60.5) after 22 h of evaluation.

Exposure to temperatures between 11 and -10°C indicates that frosts and winter temperatures in Paraná may affect germination of the inoculum that remains locally on volunteer plants (Fig. 1). Survival of urediospores, evaluated through the percentage of normalized germination, and the relative rate (Fig. 2 and 3) diminished significantly with decrease of the temperature and prolonged exposure to constant temperatures between 6 and -10°C (Fig. 2).

Germination of urediospores decreased significantly at less than -4°C, even for brief periods. At -10°C very low values were obtained, almost zero germination.

After 22 h of incubation under optimum conditions (25°C), after exposure to coldness, germination was increased approximately 50% with respect to the evaluation after 6 h, independently of the treatment applied (Fig. 1).

Brief periods of exposure to temperatures of less than 0°C negatively affected the survival of urediospores. However at higher temperatures a significant reduction of germination was not observed, especially for the spores kept in the phylloplane (Fig. 1, B).

The phylloplane of volunteer plants could provide some protection to the urediospores. Even with periods of up to 24 hours, germination remained above the values determined for the free urediospores, especially at temperatures below 6°C (Fig. 1 and 2).

Urediospores of P. pachyrhizi may remain viable after being exposed to environmental conditions of cold stress (frost), however, this viability might be affected by other factors not considered in this study.

For the winter conditions of Paraná (ER), low temperatures would not constitute a limiting factor for the survival of P. pachyrhizi and urediospores could remain active on volunteer plants until the sowing of new soybean crops.