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EFFECT OF BROWN RUST ON SUGAR CONTENT OF WHEAT

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Changes in the amount of reducing sugars and total carbohydrates were studied in wheat plants infected by the brown rust fungus, *Puccinia recondita.* Initially, the amount of both reducing sugars and total carbohydrates increased in leaves due to infection, but decreased at the time of the appearance of ears. The maximum difference in sugar content between healthy and infected leaves was approximately of the order of 45%. In the stem of healthy plants the amount of reducing sugars and total carbohydrates were initially higher but at maturity their concentration increased in the infected plants. Accumulation of sugars is discussed in relation to the growth and development of the pathogens in this paper.

INTRODUCTION

Changes in the amount of reducing sugars and total carbohydrates after infection by various pathogens have been frequently studied in different plants. These studies have demonstrated that the alterations in carbohydrate metabolism to some extent are dependent upon the nature of the host and the pathogen. Munteanu-Deliv *et al.*, [6] and Jensen [3] observed an increase in the carbohydrate content after infection, whereas a decrease in sugar content was reported for other plants [4, 9]. Mirocha [5] reported an initial decrease of starch in rusted bean tissues followed by an increase during sporulation. Some of the discrepancies may be attributed to the differences in time after infection when samples were analysed as well as to the disease intensity and the nature of the host and parasite.

So far studies on the physiology of host – parasite system have attracted little attention in Pakistan. Experiments were therefore designed to determine changes in the amount of reducing sugars and total carbohydrates in the *Puccinia-Triticum* host-parasite system. It is rather important in that analyses of host-parasite relations have been made up to maturity whereas the previous studies available have been mostly restricted to the seedling stage only.

MATERIALS AND METHODS

Healthy seeds of wheat *(Triticum aestivum* L.) cv. Pak-70 were grown under field condition at a temperature ranging between 11–24° and average humidity of 37%. A month and a half old seedlings were inoculated with a suspension of the uredospores of *Puccinia recondita* (250 spores/drop) by hypodermic and foliar inoculations. Control plants were grown at a distance from the inoculated plants to minimize the dissemination of the spores. Leaves from healthy and infected plants were analysed at 7-day intervals for total carbohydrates and reducing sugars by the method used by Nelson [7] and Yemm and Willis [10] respectively.

RESULTS

It appears that the amount of reducing sugars and

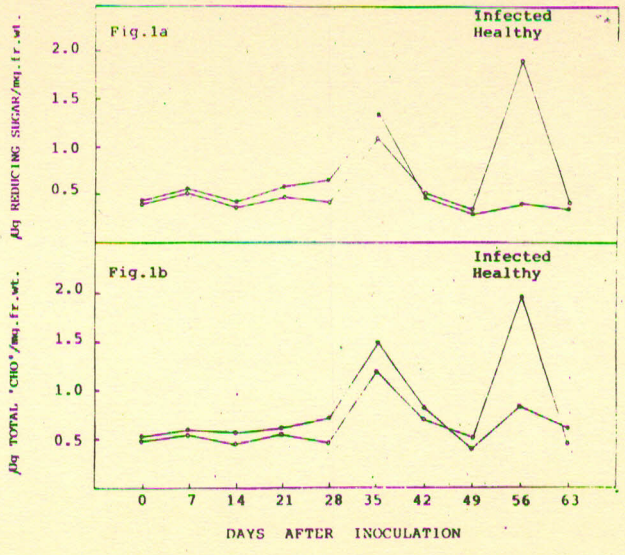

Fig. 1a and 1b Amount of reducing sugar and total carbhydrates in leaves at different intervals of inoculation with leaf rust.

total carbohydrates are related to the age of the host and the intensity of the pathogen. Rust infected leaves of wheat showed a definite increase both in reducing sugars and total carbohydrates. The increase in reducing sugars continued gradually till the appearance of ears and approximately 15% increase was observed during this period (Fig. 1a). Maximum increase was observed 28 days after inoculation (DAI) when it was approximately 45% higher over healthy plants. A similar pattern of the carbohydrate content was observed in infected leaves (Fig. 1b).

In the stems of the diseased wheat, the effect of rust infection was observed to be negligible with regard to the sugar content (Fig. 2a & 2b). Both these compounds were

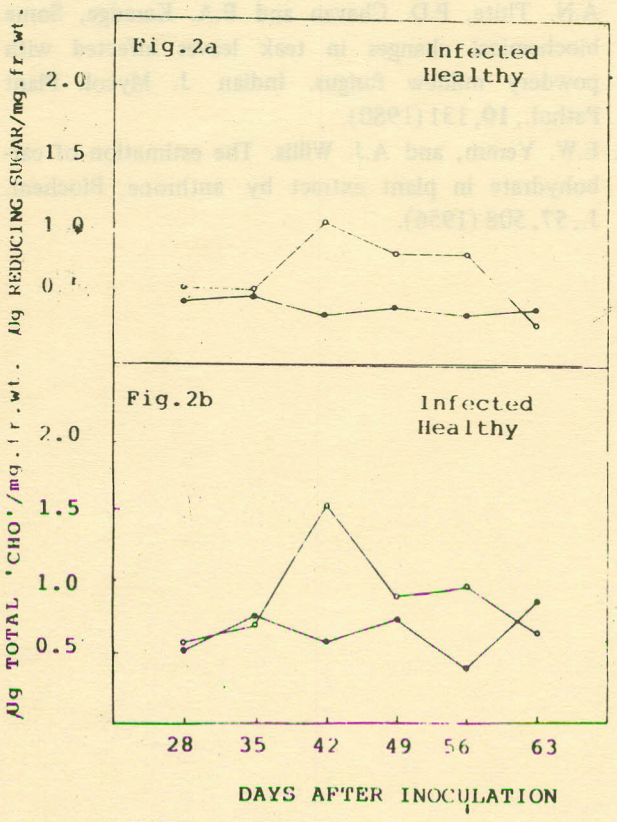

Fig. 2a and 2b Amount of reducing sugar and total carbohydrates in stem at different intervals of inoculation with leaf rust.

found to be higher in healthy tissues. On 35 DAI a slight increase in the total carbohydrate level was observed in the infected tissue which decreased substantially after a week. On 68 DAI a slight increase in the level of both reducing sugars and total carbohydrates was observed in the infected stem samples.

DISCUSSION

It has been observed that the entrance of fungal pathogen in the host plants results in the development of intercellular mycelium and haustoria. The initial germination of the spores requires an adequate supply of a carbohydrate source along with other soluble metabolites. Uredospores of *Puccinia* sp. initially utilize lipids and on their consumption they start utilizing carbohydrates [2]. This supply of carbohydrate source may be obtained through the hydrolysis of starch present in the host cells, but this degradation process takes place only around the infection centres. Accumulation of soluble carbohydrates around the rust pustules has been observed in many cases where the carbohydrate from healthy tissues get diverted to the site of infection and are either metabolized after being taken by the fungus or utilised in the synthesis and accumulation of starch.

Not only do the host plants exhibit an increase concentration of reducing sugars and total carbohydrates, but the fungal uredospores also have their own reserve carbohydrates. This has been obseved in wheats where the uredospores of stem rust contain a non-reducing disaccharide, trehalose [8]. The hydrolysis of one mole of trehalose yields two moles of glucose. The presence of this compound suggests the possibility of another source of carbohydrate available for fungal nutrition.

Either of the above discussed route for carbohydrate accumulation may account for the increased carbohydrate content in rust infected leaves. Increase in carbohydrate content also has a correlation with the increased rate of respiration, probably due to substrate accumulation, and decreased photosynthetic rate. Our unpublished data on the respiratory rate under pathogenesis demonstrates a similar pattern of relationship. However, from 35 DAI the rate of respiration and sugar content started decreasing. Similar results have been observed in the case of wheat infected with powdery mildew [1] and in barley leaves infected with barley yellow dwarf virus [3]. The increased respiration rate with the accumulation of carbohydrate and decrease in photosynthetic rate eventually leads to the depletion of the hosts carbohydrate reserves.

Both reducing sugars and total carbohydrates tend to decrease in leaves after the appearance of ears. This decline may be due to translocation, respiration or conversion to other compounds. After the vegetative growth of the mycelium has reached its maximum, the fungus itself does not require a high carbohydrate content and it may be translocated to other parts of the plant.

In the stem an increase in sugar level in the later

stages may be accounted for the delayed translocation of the sugars from the leaves. After the completion of vegetative growth the carbohydrates are mostly translocated to the stem, showing an increased amount in the stem followed by a proportional decrease in the leaves.

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