SCREENING AND SELECTING FOR THE SLOW RUSTING CHARACTERISTIC IN SUNFLOWERS

By

J.K. Kochman, Plant Pathologist
Department of Primary Industries
Toowoomba, 4350, Queensland, Australia
and
D.L. George, Plant Breeder
Department of Primary Industries
via Warwock, 4370, Queensland, Australia

Summary

Following early plantings (November, 1975 and October, 1976), approximately 2000 sunflower plants of an open-pollinated type were uniformly inoculated with *Puccinia helianthi* on each occasion and examined daily until pustules appeared. Rust generation time of 9 to 17 days (1975) and 8 to 14 days (1976) were recorded in field trials. In 1976 another 200 plants from the same seed consignment were grown in the glasshouse and inoculated, rust generation time varied from 7 to 10 days. Smaller pustules were also observed on some plants.

Plants on which the rust generation time was longest and which had small pustules were bagged and randomly cross-pollinated. Studies on the heritability of these characters are in progress but have not been completed. It is hoped to introduce these characters into a high oil type cultivars.

A long rust generation time would result in a reduction in the number of rust generations within a growing season and the smaller pustules would produce fewer uredospores within each generation. Hence, rust epidemics would develop more slowly on cultivars with the long rust generation time characteristic than on cultivars with a shorter generation time characteristic. It is hoped that the "slow rusting" type of resistance will provide effective rust control and will be longer lasting than the immune or hypersensitive type of resistance.

Introduction

In Australia, severe epidemics of rust (*Puccinia helianthi* schw.) in sunflowers (*Helianthus annuus* L.) can cause yield reductions of approximately 70% (Middleton and Obst, 1972; Brown et al, 1974). Although this pathogen can be controlled by fungicides, this would not be economically feasible in a general farm situation at present. Hence the breeding of rust resistant cultivars appears to be the most promising approach to sunflower rust control.

Putt and Sackston (1963) identified two genes, R1 and R2, dominant for rust resistance in wild annual sunflowers. These genes have been incorporated into some of the commercial hybrid cultivars presently grown in Australia and have provided good rust control. However, if the situation in other crops is any guide, the type of resistance is now usually limited to about four or five years (Browning and Frey, 1968). Hence there has been an increasing amount of work directed towards detecting and utilizing other mechanisms of resistance.

There have been several reports that the development of some pathogens is retarded on some crops, although the plants exhibit susceptible reaction to infection (Clifford and Schafer, 1968; Shaner, 1973, Kochman, 1974, Parlevliet, 1975). In some cases cultivars, on which the rate of rust development is slow have been called "slow rusters" while Parlevliet (1975) termed this "partial resistance".

Cultivars on which the rate of development of a pathogen is slow are likely to apply smaller selection pressures on a pathogenic population than cultivars with an immune or hypersensitive type of resistance. Therefore new pathogenic races should not arise as quickly on cultivars with the slow disease development characteristic as on cultivars with an immune or hypersensitive type of resistance. Hence the useful life of the former cultivars should be longer than that of the latter cultivars. The fact that potato cultivars, which exhibited slow development of late blight some 30 years ago, are still effective in controlling this disease supports this contention (Robinson, 1973).

Hence we decided to investigate the possibility of using the slow rusting characteristic to control sunflower rust. This paper deals with some preliminary work on screening and selection for this characteristic.

Materials and Methods

A large cyclone spore collector (Cherry and Peet, 1966), was used to collect rust uredospores from infected crops in various parts of Queensland. These were mixed and stored under refrigeration until required.

Seed of open pollinated sunflower of Argentinian origin was planted in the field in November, 1975 and again in October, 1976. Because of low infection rates in 1975, the 1976 trial was provided with overhead irrigation. At least 2000 plants at the budding stage were inoculated with rust uredospores each year. During 1976, a further 200 plants were grown in the glasshouse at Toowoomba and inoculated in the same manner as the field plants.

Rust inoculation was performed as follows: Small discs of germination paper (18.5 mm diameter, 1.5 mm thick) were dusted uniformly, in a spore settling tower, with dry rust uredospores. The number of uredospores on the discs ranged from 1,600-2,000 uredospores per cm^2 (mean 1,850 uredospores per cm^2). These were attached, dusted surface in contact with the leaf, to the adaxial surface of leaves by giant paper clips. The leaves which were inoculated had previously been tagged and were of the same physiological age. The paper discs were then moistened with water during the late afternoon. Each disc therefore acted as a small humidity chamber for the uredospores. After 16 hours, discs were removed from the leaves by cutting the paper clips. Plants were examined daily for pustule formation. Rust generation time (time between inoculation and pustule formation) was the main factor determined.

Results

In the 1975 trial there was no reaction to inoculation in 70% of the plants. However, a range of rust generation time from 9-17 days was observed in the remainder where pustules were formed.

In the 1976 trial, where overhead irrigation was provided, pustules appeared on 72% of the inoculated plants and there was a range of generation time from 8 to 14 days (Table 1). Approximately 8% of plants exhibited a hypersenstitive type of reaction to rust inoculation while 20% showed no reaction to inoculation.

TABLE 1. The Number of Sunflower Plants Grown in the Field with Pustules Appearing on the 8th to the 14th day after inoculation with Rust.

Days after Inoculation	Number of Plants with Pustules
8	584
9	412
10	338
11	60
12	44
13	50
14	25
Total	1,513

In the glasshouse, generation time varied from 7 to 10 days on 83.5% of plants (Table 2), while 12% exhibited a hypersensitive type of reaction and 4.5% showed no reaction to inoculation.

TABLE 2. Number of Plants Grown in the Glasshouse with Pustules Appearing on the 7th to 10th days after Inoculation with Rust.

Days after Inoculation	Number of Plants with Pustules
7	108
8	32
9	15
10	12
Total	167

Although no quantitative data was collected for pustule size, smaller pustules were observed on some of the plants on which rust generation time was long.

Plants on which the rust generation time was longest and which had small pustules were bagged and cross-pollinated. Studies on the heritability of the long rust generation character and small pustule size are in progress but have not been completed.

Discussion

The data indicate that this method of screening will enable material to be selected for:

a. the hypersensitive or immune reaction to rust infection; and
b. a range of rust generation time where the plants are susceptible to rust infection.

However, the data obtained were greatly influenced by conditions of the experiments. With glasshouse facilities, conditions suitable for rust infection can be controlled to a greater extent than in the field and therefore, data obtained in the glasshouse are probably the most reliable. However, space is often limited in glasshouses and field trials may need to be used for the screening of large plant populations. Experience with the 1975 and 1976 trial indicate that overhead irrigation is an advantage in this type of screening.

The long rust generation time in a cultivar would result in a reduction in the number of rust generations developing in a crop within a growing season. For example, take two cultivers (a) with a rust generation time of 7 days and (b) with a rust generation time of 10 days. The number of rust generations which would develop in a two month period of the growing season would be five on (b) and eight on (a). Because of the exponential rate of disease development during the latter portion of epidemics, it is likely that the level of rust on (b) would be very much lower than on (a) at the end of the two months. Hence long rust generation time would be a very important component of the "slow rusting" characteristic. In fact, Parlevliet and Kuiper (1977) considered that rust generation time, (latent period) was the most important component determining slow rusting (partial resistance) in barley.

Other factors in a cultivar such as the formation of small pustules producing fewer uredospores in each generation, fewer pustules being produced by a given quantity of inoculum, together with the long generation characteristic, would further retard the rate of development of the epidemic.

Although this work is preliminary, it would appear that screening and selecting for the slow rusting characteristic in sunflowers is possible. Whether this characteristic can be transferred into agronomically suitable cultivars, or whether it will provide effective rust control in a commercial situation, remains to be determined. Obviously much more research is required to answer these questions.

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