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FINAL REPORT

PROJECT No. I-269-81

Genetical and Biological Control of Septoria Diseases of Wheat

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630.72
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1986

14337

Wheat - Diseases and pests

Septoria

Fungi - Biological control

630.72
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Standard BARD Cover Page for Scientific Reports

Date - 15th February 1986

BARD
P. O. Box 6
Bet Dagan, ISRAEL.

BARD Project No. 1-269/81

Title of Research Project :

Genetical and Biological Control of Septoria Diseases of Wheat

Names of Investigators :

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Name and Address of Affiliated Institutions :

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Co-operating Institution(s) : 1. USDA-ARS, Montana State University,
Bozeman, Montana 59715, U. S. A.; 2. USDA-ARS, Oklahoma State
University, Stillwater, Oklahoma 74078; 3. The Volcani
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Project's starting date : September 1982.Type of Report : 1st Annual _____ 2nd Annual _____ Final x

Signatures :

Principal Investigator :

Institution's Authorizing Official :

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ABSTRACT

1. A combined effort was directed toward the development of methodology, germplasm and concepts which enable the elevation of the level of protection of wheat against the adverse effect of septoria diseases on wheat productivity.

Methods were evaluated by which the chemical desiccant, magnesium chlorate, could be used as a simulator of postanthesis stress exerted by septoria tritici blotch. Wheat cultivars were identified which express endurance in kernel weight to both biotic (septoria tritici blotch) and abiotic (chemical desiccation) stresses. The effect of these stresses on processes involved in kernel growth and mobilization of assimilates from the affected source to the sink was evaluated. It is possible that tolerant cultivars have a capacity to mobilize assimilates from reservoirs and non-affected tissue and maintain the rate and duration necessary to endure the effect of those stresses.

Wheat cultivars differ in the rate by which the photosynthesizing tissue is being depleted in septoria-affected plants. Infrared thermometry is capable of sensing plant canopies and assessing the relative resistance of wheat cultivars to Mycosphaerella graminicola. Wheat cultivars differ in their capacity to retain residual green leaf tissue under septoria-stress. Cultivars which maintain a high green leaf area, despite severe septoria coverage are capable of continuing to produce and mobilize assimilates for kernel growth.

Investigations on the protection of crop yield through low disease coverage (resistance), endurance of yield components (tolerance) and biological control were pursued in this project.

Effective resistance to septoria tritici blotch was revealed in winter and spring bread wheats and in durum wheats. The inheritance of

resistance in bread and durum wheats was assessed to virulences in the co-operating Institutions. Biological antagonists were isolated which were able to significantly reduce the development of M. graminicola symptoms.

A method was developed to assess virulence patterns in the sexual state of M. graminicola and relate the findings to the effect of the sexual state on the virulence spectrum of the asexual state.

GENETICAL AND BIOLOGICAL CONTROL OF SEPTORIA DISEASES OF WHEAT

2. Introduction

Septoria tritici blotch of wheat incited by the fungus Mycosphaerella graminicola (Fuckel) Schroeter (anamorph, Septoria tritici Rob. ex Desm.) and septoria nodorum blotch of wheat caused by Leptosphaeria nodorum E. Muller (anamorph, Septoria nodorum (Berk.) Ber.) have been studied considerably in recent years because of the damage they cause to wheat in several parts of the world (1, 3). Vulnerability of wheat to the diseases has been enhanced by the wide-spread adoption of susceptible cultivars and by changes in cultural practices (1).

Breeding for disease resistance is the most economical control measure, yet little is known about its utilization and the mode of protection and its durability. The effectiveness of the limited resistance sources is being threatened by the diversity of virulence in both pathogens (2, 4).

The utilization of lasting protection has been hampered by deficiency in methodology for its incorporation and understanding of its mode of action (1). Alternative protection measures (biological control) have been suggested to reeduce the increasing use of fungicide in the wheat management systems (3). Biocontrol agents of the pathogens of the phylloplane would offer a distinct advantage in reducing losses and pollution of the environment, if operative.

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Proc. Septoria Workshop, MSU, Bozeman, MT. USDA-ARS publ. # 12,
116 p.
4. Scharen, A. L. and J. M. Krupinsky, 1978. Detection and manipulation
of resistance to Septoria nodorum in wheat. Phytopathology 68 :
245-148.

3.

RESULTS AND DISCUSSIONS

Chemical desiccation of Wheat Plants as a Simulator of Postanthesis

Speckled Leaf Blotch Stress by M. Zilberstein, A. Blum and Z. Eyal

(enclosed)

The Effect of Septoria tritici Blotch and Chemical Desiccation on Grain

Filling of Spring Bread Wheat by Z. Eyal (enclosed)

The Effect of Septoria tritici Blotch on Wheat Productivity by Z. Eyal

(enclosed)

Infrared Thermal Sensing of Plant Canopies as a Technique to Assess the

Relative Resistance of Wheat Cultivars to Mycosphaerella graminicola

by A. Blum and Z. Eyal (enclosed)

The Development of Agronomic Breeding Lines which Possess Combined

Resistance and Tolerance to Septoria tritici Blotch of Wheat by Z. Eyal.

(enclosed)

Resistance to Septoria tritici Blotch in Winter Wheat and Biological

Control by F. J. Gough (enclosed)

Inheritance of resistance to S. tritici in durum wheat by A. L. Scharen

(enclosed)

Virulence Patterns in Ascospore-Derived Cultures of Mycoisphaerella

graminicola by F. R. Sasnderson and A. L. Scharen (enclosed)

4.

DESCRIPTION OF CO-OPERATION

Germplasm screened and evaluated for septoria tritici blotch in the U. S. and Israel was incorporated in both countries breeding for resistance programs. Segregating populations and lines were shuttled to both countries for further evaluation and screening. The most promising lines were made available to breeders both in Israel and the U. S.

Resistant germplasm both of bread and durum wheats, was screened to a wide spectrum of virulences of Mycosphaerella graminicola at Montana State University, utilizing techniques developed by the co-operating investigators. Exchange of material and information was performed during visits in the co-operating Institutions by the co-operating scientists.

Evaluation of yield components under septoria tritic blotch and chemical desiccation (magnesium chlorate) was conducted by the Israeli team. In addition, infrared thermometry sensing was evaluated in yield trials conducted by the Israeli investigators.

Resistant germplasm and lines possessing combined frontal resistance and tolerance were made available to the Volcani breeding program and are being evaluated for yield and quality in the ARU breeding program.

Assessment of virulence patterns of the sexual state was carried out by the Montana team with the aid of Dr. Sanderson, who is noted for his scientific contribution to the subject.

5.

BENEFIT TO AGRICULTURE

Germplasm resistant to a wide spectrum of virulences of *Mycosphaerella graminicola* was identified and incorporated into national breeding programs in the two countries.

Methods were developed to identify and assess wheat cultivars capable of enduring both biotic and abiotic stresses. The understanding of the ability of wheat cultivars to tolerate stresses will enable its better utilization.

A breeding scheme for the incorporation of resistance and tolerance in high yielding wheats was proposed and experimentally evaluated. This novel approach will enable wheat breeders to continue to select for frontal resistance and assess its incorporated endurance for septoria tritici blotch and abiotic stress, using septoria epidemics and chemical desiccation as stress agents.

The understanding of the parameters involved in the endurance of tolerant cultivars under disease and abiotic stresses contributed to its potential use in breeding programs and in wheat production in the future.

Infrared thermometry sensing may offer a rapid technique to assess the relative resistance of wheat cultivars under septoria tritici blotch epidemics. Residual green leaf area of resistant and susceptible cultivars may explain their ability to maintain high yields under disease stress. Selection of wheat cultivars which do not exhibit rapid depletion in green leaf area offer an advantage in protecting yield.

The isolation of biocontrol agents antagonistic to *Mycosphaerella graminicola* and capable of reducing the level of symptoms offers an opportunity of future use of biological control of this pathogen and possibly of other foliar pathogens.

The understanding of the virulence spectrum of the pathogen and the contribution of the sexual state to the virulence recombination of M. graminicola as pursued for the first time in this project. The implications on breeding for resistance to septoria tritici blotch are far reaching.

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