Journal of the Minnesota Academy of Science

Volume 28 | Number 1 Article 4

1960

The Role of Agropyron repens in the Seedling Blight Epidemiology of Alfalfa and Cereals

Thor Kommedahl
University of Minnesota

J. H. Ohman
University of Minnesota

THE ROLE OF *AGROPYRON REPENS* IN THE SEEDLING BLIGHT EPIDEMIOLOGY OF ALFALFA AND CEREALS[1]

THOR KOMMEDAHL AND J. H. OHMAN
University of Minnesota, St. Paul

There are many ways in which plants can affect each other ecologically. One way is by the production of one or more toxic substances by one plant that affects growth and survival of another. This topic has been reviewed by Bonner (1950).

Kommedahl *et al.* (1959) have shown that *Agropyron repens* (L.) Beauv, (quackgrass) produces a toxic substance, or substances, which stunt the growth of *Medicago sativa* L. (alfalfa) and small grains. The addition to soil of either water extracts of quackgrass rhizomes, or the dried, ground rhizomes, inhibited germination or growth of seedlings. Moreover, sowing seeds of alfalfa, flax, barley, oats, and wheat in the field in plots previously infested with quackgrass plants resulted in poorer growth of the crop plants than sowing seeds in soil not previously infested, but of the same soil type.

It was reported briefly by Kommedahl and Ohman (1958) that quackgrass may predispose alfalfa seedlings to infection by seedling blight organisms. Also, quackgrass was found to harbor fungi which could incite root rot in cereal crops (Kommedahl and Kotheimer, 1957).

This is a report of additional work to show that rhizomes of quackgrass harbor fungi pathogenic to crop plants and that rhizomes produce a substance that predisposes alfalfa seedlings to infection by root rot pathogens.

Materials and Methods: Rhizomes of quackgrass were collected from the field, cut into sections about 1 cm in length, surface disinfected with 1 per cent solution of sodium hypochlorite for one minute and placed on the surface of a potato-dextrose agar (PDA) medium and allowed to incubate at room temperature for about one week. At this time the fungi were isolated and identified and used in subsequent tests of their pathogenicity. Only sound, apparently healthy portions of rhizomes were selected for plating. The obviously discolored portions of the rhizomes were discarded because they

[1] Paper No. 4355, Scientific Journal Series, Minnesota Agricultural Experiment Station. Contribution from Department of Plant Pathology and Botany, Institute of Agriculture. Supported in part by a grant from The Rockefeller Foundation.

usually contain so many saprophytes that pathogens might not be recoverable.

The tests for pathogenicity were done in a greenhouse at a temperature of about 75°F. Flats of steamed soil were used and four rows (totaling 100 plants) were sown for each crop and two crops were sown per flat, making eight rows of plants per flat. Soil and flats were steamed in an autoclave for two hours to kill pathogenic organisms. Inoculum was grown in Erlenmeyer flasks on sterile potato-dextrose broth, comminuted in a Waring blender, diluted with water, and mixed with soil in flats. Notes were taken when seedlings were about two weeks old.

To obtain water extracts of quackgrass rhizomes the following procedure was used: Rhizomes of quackgrass were dried, ground to a number 40-mesh size in a Wiley mill, and 200 gm of ground material were mixed with 1 L of distilled water. This mixture was autoclaved for 20 minutes, allowed to steep for 24 hours, and filtered. This first filtrate was not used in this study. The residue from the first filtration was resuspended in distilled water, filtered again, and water sufficient to make 10 L was added to the resulting filtrate. This dilute (second) filtrate was then autoclaved and used to water plants daily at the rate of 50 ml. per 4-inch pot. The controls were watered daily with 50 ml. of tap water per pot. Alfalfa plants were harvested after one month by cutting shoots off at the ground line. These shoots were dried to constant weight in an oven at 107° C.

Experimental Results: Rhizomes as carriers of pathogenic fungi. Quackgrass produces an extensive network of rhizomes in soil which weighs from two to eight tons per acre, fresh weight. A given segment of rhizome lives two summers and an intervening winter. Following this, the rhizome segment dies and is subsequently decayed by many soil organisms. Or the pathogens in soil may rot rhizomes and thus permit colonization of dead rhizomes by saprophytes. Growing rhizomes proved to be infected with fungi also. As shown in Table 1, *Fusarium spp.* were the most frequently isolated, comprising at least half of the isolates found in quackgrass rhizomes. Another important pathogen isolated was *Helminthosporium sativum* P.K.B. which made up from 1 to 9% of the isolates.

Alternaria, Aspergillus, Penicillium, and *Trichoderma* species were common saprophytes and their prevalence had no observable effect on the prevalence of pathogens.

Isolations were made in both May (Table 1) and October, at Rosemount. *Fusarium spp.* comprised 58 per cent of the isolates in May and 57% in October while *Helminthosporium sativum* comprised 3% in both months. *Rhizoctonia solani* Kühn, a root rot pathogen, was not isolated at all in May but comprised 5% of the isolates in October.

The prevalence of saprophytes varied also. For example, *Alternaria* comprised 20% of the isolates in May but only 9% in October, while *Chaetomium* was not isolated at all in May but comprised 19% of the isolates in October.

TABLE 1. Fungi isolated from rhizomes of quackgrass from 4 locations in Minnesota expressed as percentage of total isolates obtained [a]

Genera of fungi	Atwater	Cokato	St. Paul	Rosemount
Fusarium	50	56	58	58
Alternaria	1	6	11	20
Trichoderma	10	29	8	3
Penicillium	13	0	3	5
Aspergillus	7	0	5	2
Helminthosporium	7	9	1	3
Colletotrichum	0	0	1	1
Curvularia	0	0	3	0
Miscellaneous [b]	10	0	10	9
Total rhizomes infected, in per cent	92	82	90	80

[a] Data based on isolations from 40 rhizomes from Atwater and Cokato and 100 rhizomes from St. Paul and Rosemount. Rhizomes were collected in May from Rosemount and in July for the other 3 locations. PDA was used as the isolation medium.

[b] Miscellaneous fungi include *Chaetomium*, *Mucor*, *Phoma*, *Rhizopus*, *Zygorrhynchus* and a few unidentified fungi plus some bacterial colonies.

When quackgrass is growing with crops the amount of infection in the crop plant may be influenced by the crop with which quackgrass is growing. For example, it was found that 80% of the quackgrass growing with wheat was infected with fungi while only 40% of quackgrass with soybeans was infected, based on thirty rhizomes in each crop. 74% of the quackgrass rhizomes in wheat were infected with *Fusarium* spp. while only 35% of quackgrass rhizomes in soybeans were infected. Also, 13% of rhizomes in wheat and none in soybeans were infected with *Colletotrichum*.

Four of the fungi on quackgrass rhizomes were tested for their pathogenicity on four crops: barley (*Hordeum vulgare* L.), oats (*Avena sativa* L.), wheat (*Triticum aestivum* L.) and corn (*Zea mays* L.). The results are in Table 2. All fungi were pathogenic to at least one host. Some isolates were more pathogenic than others. Thus it is apparent that quackgrass not only harbors many fungi but that

TABLE 2. The effect of four fungi isolated from quackgrass rhizomes on stand of four crops grown in the greenhouse [a]

Fungus	Isolate No.	Seedling stand as per cent of control			
		Barbless barley	Vicland oats	Mindum wheat	Min. 607 corn
Curvularia sp.	1	100	73	54	89
Fusarium sp.	1	96	88	54	88
	2	90	87	93	85
	3	75	91	39	84
	4	61	74	39	89
Helminthosporium sativum	1	98	70	63	100
	2	43	78	10	81
	3	40	46	0	28
	4	15	25	10	50
Nigrospora oryzae	1	100	74	53	88
	2	95	90	92	96

[a] Soil was infested with each of these pathogens isolated from rhizomes and tested at 75°F. Data were based on 100 plants per isolate and were taken when seedlings were 2 weeks old.

some of these fungi can cause seedling blight in some of our common cereal crops.

The effect of rhizome extracts on seedling blight. — It has already been demonstrated by Kommedahl *et al.* (1959) that an extract of quackgrass rhizomes stunts the growth of alfalfa. This was shown again when water extract of quackgrass rhizomes was added daily to alfalfa plants growing in either steamed (autoclaved) or in non-steamed soil in the greenhouse. The stand of alfalfa in the steamed soil was 72% when watered with the extract from quackgrass rhizomes. In non-steamed soil, the stand of alfalfa was 36% when plants were watered with tap water and 30% when watered with the rhizome extract.

There was also a reduction in dry weight per plant when a water extract was applied to steamed soil; the average dry weight per alfalfa plant was 3.2 mg when plants were watered with tap water and 2.4 mg when plants were watered with the rhizome extract. In non-steamed soil, the average dry weight of alfalfa plants was 2.3 mg when watered with tap water and 1.5 mg when watered with the rhizome extract. The non-steamed soil probably was naturally-infested with fungi capable of causing seedling blight of alfalfa and these pathogenic organisms accounted for the loss of about half the stand and about one-third the dry weight per plant, see Figure 1.

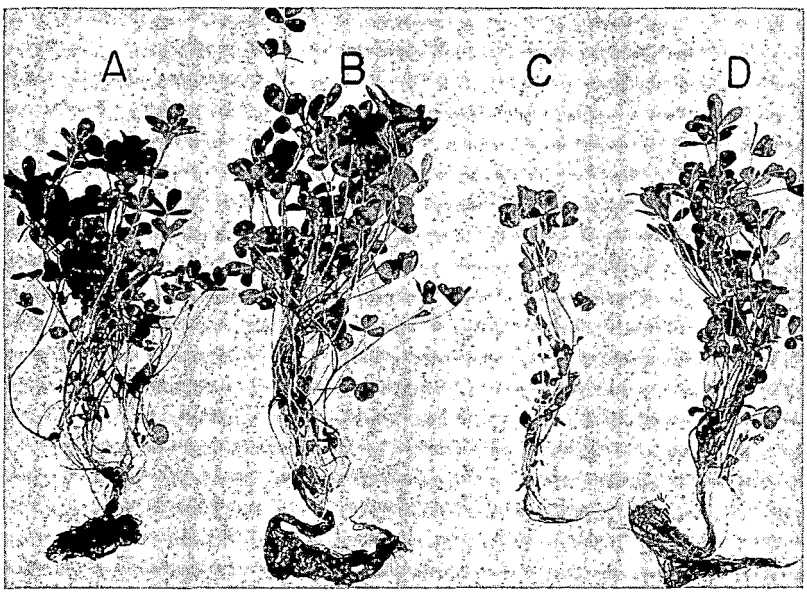

Fig. 1. The effect of extracts from quackgrass rhizomes on growth of Ranger alfalfa in steamed (A and B) and non-steamed (C and D) soil in the greenhouse. Plants in groups A and C were watered daily with the extract and plants in groups B and D were watered daily with tap water. Each group was taken from a pot in which 25 seeds were sown. Note that the fewest and smallest plants are found where the extract was applied to non-sterile soil (C).

However the combination of quackgrass extract and infested soil resulted in the lowest stand and the lowest dry weight per plant. The addition of ground rhizomes also results in a substantial reduction in growth of alfalfa as shown in Figure 2.

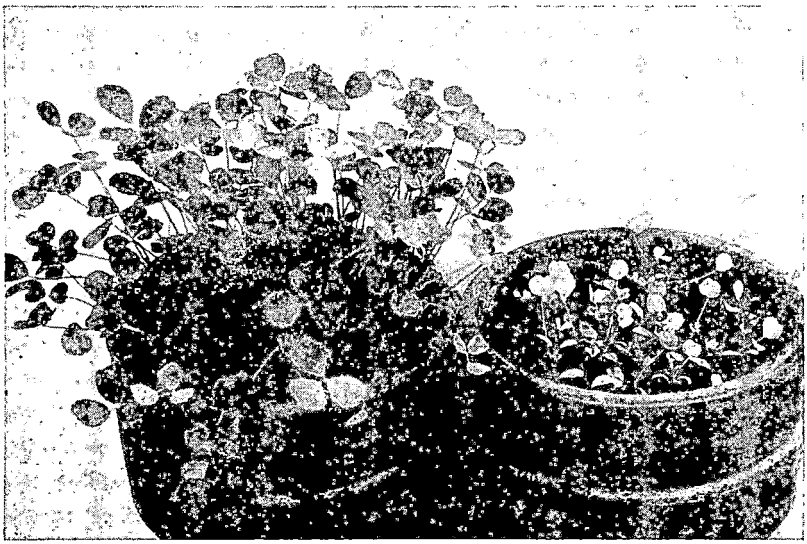

Fig. 2. The effect of adding ground rhizomes of quackgrass on growth of alfalfa. The pot on the left contains only steamed soil while the pot on the right has 15 gm of sterile ground rhizomes per pot of steamed soil (about 3 per cent of soil on dry weight basis). The stand was the same in both pots.

Quackgrass extracts were applied to alfalfa roots under aseptic conditions to ascertain the effect of the extract on alfalfa in the absence of microorganisms. To do this, sterile alfalfa seedlings were transferred aseptically to test tubes containing sterile quartz sand and nutrient solution. Sterile quackgrass extract was added to one set of tubes. The alfalfa seedlings growing in the medium with the quackgrass extract produced roots that were discolored, principally in the cortical tissue. Moreover there was very little branching, and the lateral roots were short and gnarled, when alfalfa grew on the medium containing the extract. The alfalfa growing without the extract produced normal white roots with abundant secondary and some tertiary branching.

Discussion and Summary: The effect of quackgrass on other plants may be due to several factors operating singly or together. Extracts from quackgrass rhizomes may kill cortical tissue on alfalfa roots in the absence of microorganisms. When alfalfa was grown in nonsterile soil watered daily with dilute extracts of quackgrass rhizomes, seedling blight and stunting increased. In steamed soil, in which pathogenic microorganisms were eliminated, at least initially, there was a reduction in dry matter per plant with the application of the

quackgrass extract. The addition of ground quackgrass rhizomes to soil also severely reduced growth of alfalfa. Some of this effect could be attributed to the increased carbon to nitrogen ratio when ground rhizomes are added to soil; however a toxin also was produced as demonstrated previously (Kommedahl *et al.* 1959).

Quackgrass rhizomes harbor both pathogenic and saprophytic fungi. *Curvularia spp.*, *Fusarium spp.*, *Helminthosporium sativum*, and *Nigrospora oryzae* (Berk. and Br.) Petch were isolated from quackgrass rhizomes and were found to be pathogenic to barley, oats, wheat, and corn when tested in the greenhouse. Pathogenic fungi were isolated from quackgrass rhizomes from four farm localities in the state: Atwater, Cokato, St. Paul, and Rosemount. It was found also that isolations made from rhizomes in May yielded about the same organisms and in about the same proportions as did isolations made in October.

Thus quackgrass is a pest not only because it competes with other plants for light, water, and nutrients but because quackgrass produces a toxin that is harmful to other plants and because quackgrass harbors plant pathogenic fungi in its rhizomes.

LITERATURE CITED

BONNER, J. 1950. The role of toxic substances in the interactions of higher plants. *Bot. Rev.* 16:51-65.

KOMMEDAHL, T., and J. B. KOTHEIMER. 1957. The role of quackgrass in root rots of cereals. (Abst.) *Phytopathology* 47:21.

KOMMEDAHL, T., J. B. KOTHEIMER, and J. V. BERNARDINI. 1959. The effects of quackgrass on germination and seedling development of certain crop plants. *Weeds* 7:1-12.

KOMMEDAHL, T., and J. H. OHMAN. 1958. Effect of water extracts of quackgrass rhizomes on damping off and dry weights of alfalfa seedlings. (Abst.) *Res. Rpt., No. Cent. Weed Control Conf.* 15:128.