BULLETIN 365
DECEMBER 1962

LIFE HISTORY STUDIES AS RELATED TO WEED CONTROL IN THE NORTHEAST

4 -- Quackgrass

Northeast Regional Publication

Agricultural Experiment Station
University of Rhode Island
Kingston, Rhode Island

The research reported in this bulletin was conducted as part of the investigations of the regional weed research technical committee under Northeast Regional Project NE-42 "Weed Life Cycles, Soil Micro-organisms and Light as Factors in the Control of Weeds in the Northeast".

AUTHORS

Pennsylvania ..... S. M. RALEIGH
Vermont ……T. R. FLANAGAN
West Virginia ……. COLLINS VEATCH

Cooperating Agencies and Personnel

Northeastern Agricultural Experiment Stations:

Connecticut (Storrs)	R. A. Peters, N. C. Yocum
Delaware	E. M. Rahn, 0. M. Bundy, W. F. Donnalley
Maryland	P. W. Santelmann, J. A. Meade, N. C. Glaze
Massachusetts	W. H. Lachman, J. W. Durfee, W. C. Lincoln, Jr.
New Hampshire	S. Dunn, G. Williams
New Jersey	W. S. Meggitt, R. 0. Inicki,, T. F. Tisdell
New York, Cornell, Agronomy	S. N. Fertig, M. Alexander, A. D. Rovira P. Hirsch, K. Burger, I. C. MacRae
New York, Cornell, Vegetable Crops	R. D. Sweet
Pennsylvania	S. M. Raleigh, C. W. LeFevre, C. O. Clagett
Rhode Island	R. S. Bell, T. E. Odland, E. Larssen
Vermont	T. R. Flanagan, T. Ming, A. R. Langille
West Virginia	C. Veatch, C. H. Bear, M. D. Welch, W. P. Pennell
Administrative Advisors	R. M. Kottrnan, H. R. Fortmann

United States Department of Agriculture:
Cooperative State Experiment Station Service, A. J. Loustalot
Crops Research Division, A. R. S., W. V. Welker, W. C. Shaw

CONTENTS

LIFE HISTORY STUDIES AS RELATED TO WEED CONTROL IN THE NORTHEAST

4 - **Quackgrass**

INTRODUCTION

Quackgrass *(Agropyron repens* (L) Beauv) is an aggressive perennial weed that spreads by seeds and rhizomes. It is a native of Europe (17) and was introduced into the Northeast before 1751, probably in mixed grass seeds. This serious plant pest is widely distributed throughout the northern half of the United States and southern Canada. Quackgrass competes severely with forage crops because of its ability to grow in cool fall and spring weather. Its growth characteristics are not fully known because of variability in clones, but findings reported herein appear fairly well established.

Quackgrass was originally called *Triticurn repens* by Linnaeus (12). The inflorescence arrangement is similar to that of wheat. From 2 to 8 florets per spikelet are arranged alternately on a rachis. *Agropyron repens* has been crossed with wheat (4).

Much work has been done on quackgrass control (1) (5) (8) (13) (18) by cultivation. Efforts of this kind have been much more successful in the less humid sections of the United States where the rhizomes will dry out quickly when exposed on the surface of the soil. Frequent cultivation reduces nutrient reserves which also will kill the plants. Studies on root reserves have been reported by Arny (2), Pinckney (16) and Le Baron and Fertig (10). Quackgrass rhizomes can be killed by exposing them to freezing temperatures.

Variation in Quackgrass

When reproduced from seed quackgrass, being cross pollinated, is subject to great genetic variation. This adds to the difficulties in controlling this pest. Reproduction by rhizomes produces quackgrass plants similar in all characteristics.

Some quackgrass plants are light green color, while others are dark green when grown under similar nutrient and soil conditions. Some lines are pubescent and others glabrous. The lower nodes of the rachis are occasionally short, but may be hairy or smooth. The outer glumes and lemmas may be blunt or have awns with varying lengths. In a few lines (clones) the rachises end in terminal spikelets. The plants vary greatly in height and length of the spikelet when grown under similar conditions. In some clones, the spikelets remain together when harvested and others the spikelets break up into individual florets.

Quackgrass produces a growth inhibitor which affects associated plants

and may effect the quackgrass itself. Much variation is evident among clones in quantity of inhibitor produced.

Much variation also appears in the production of seed; some lines produce little while others have heavy seed production.

Some clones are easily killed by herbicides while others appear to be little injured by such applications.

Seed Production and Germination

The majority of quackgrass culms produce spikes, which are generally between 3 to 6 inches long. The number of caryopses per spike varies with individual clones. Some clones produce no caryopses, while others have up to 60 per cent of their florets filled. Each spikelet always ends with a sterile floret. In some clones the spikelets break off as units, while in others each individual floret separates easily. This seemingly trifling adaptation makes quackgrass hard to clean out of many field crop seeds.

In a drill box survey in Centre County, Pennsylvania, Campbell and AlcKee (3) collected 268 samples of spring oats. Sixty samples contained quackgrass seed of which 22 germinated, thus giving an average germination of 4.3 per cent. In these oat samples many of the quackgrass florets contained ergot bodies. In 3 samples of winter wheat seed, the quackgrass germinated 6 per cent. By means of careful air separation the sterile florets were removed so that the lots from the wheat germinated 49 per cent.

Quackgrass in 20-seed lots was planted in the greenhouse by Ming (14) at ½ inch depth intervals to a maximum depth of 8 inches deep. The soil, a sandy loam, was autoclaved before use. The container holding the soil was a concrete tank. Twelve seeds germinated and emerged from ½ inch of soil, 8 from 1 inch, 3 from 1½ inches, 6 from 2 inches, 2 each from 2½ and 3 inches, and 1 each from 3½ and 4 inches. Similar autoclaved soil was used in the same manner in the field except a larger concrete tank and 100 seeds were planted at each depth. Seventy-three germinated and emerged from ½ inch of soil, 11 from 1 inch and 4 from 1½ inch. Some seeds buried at greater depths in the soil germinated but died before emerging.

Quack grass seeds which had been placed in soil between plastic and aluminum screens and buried in Hagerstown soil 6 inches deep in July were dug December 1 at University Park, Pa. The majority of the seeds had germinated; roots on the seeds were about ¾ of an inch long. One seed appeared alive but the growing point and roots were dead so it made no growth when put in the seed germinator. One seed out of 200 germinated in the germinator.

Quackgrass was included in a buried seed experiment reported by Toole and Brown (20). The seeds were buried in clay pots in 1902. Twenty-one per cent of those buried 8 inches deep had germinated in 1903, or 11 months after

the experiment started. No quackgrass seed was found germinated at this depth in later investigations. Of those seeds buried 22 inches, 73 per cent had germinated in 1903 and 1 per cent more in 1905. Of those buried 42 inches, 67 per cent had germinated in 1903, 19 per cent more in 1905, 1 per cent more in 1908, and 2 per cent more in 1912. No seeds germinated in 1918 or later years.

Emergence of Quackgrass Rhizomes

The depth from which new quackgrass plants will become established from rhizomes depends upon the type of soil and the length of the rhizomes.

In old quackgrass sods the rhizomes generally are at the 2-to-3 inch depth and frequently the internodes are about ½ to 1 inch long.

All lengths of rhizomes became established in the field equally well in Pennsylvania experiments when planted 1½ to 2 inches deep. Short rhizomes (¾ to l½ inch) grew poorly when covered 3 to 4 inches. Only long rhizomes (6 inches) established plants from the 6 inch depth. Under greenhouse conditions all lengths of rhizomes became established at 1-to-2-inch greater soil depths than in the field. (Figure 1)

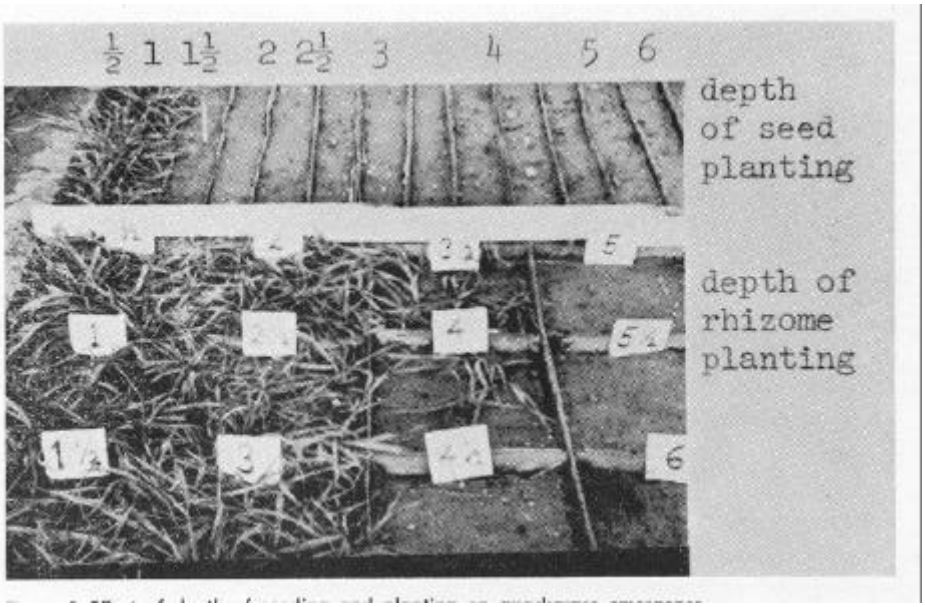
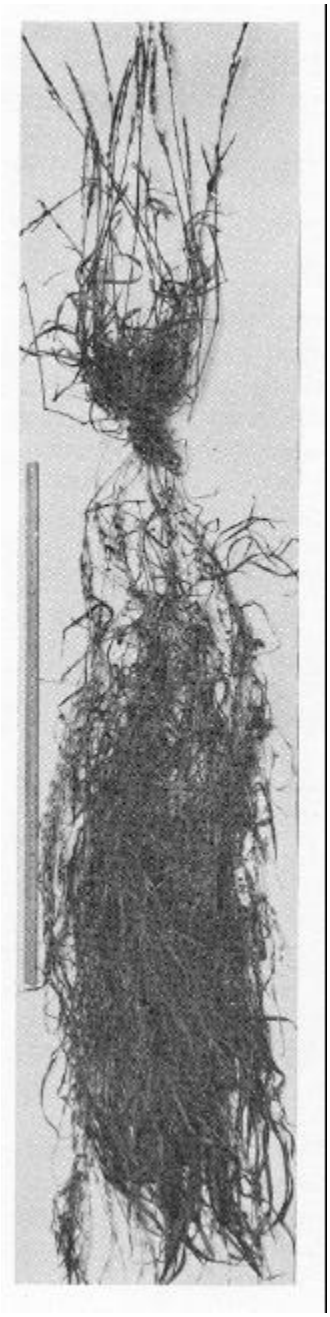


Figure 1 Effect of depth of seeding and planting on quackgrass emergence.

Rhizome Growth

Individual nodes of quackgrass were planted at University Park, Pennsylvania late in the fall of 1958 in soil which had been well manured in the spring.

On May 27, 1959, the soil was removed to plow depth to within 3 inches of the original quackgrass node of 7 plants. At this time 3 plants had 2 rhizomes; 3 plants, 3 rhizomes; and 1 plant, 5 rhizomes. The average length was 9.7 inches. The end of each rhizome was marked with a wire then measured from this wire on June 5. Growth of rhizomes averaged 10.3 inches during the 9-day period. Growth from June 5 to 12 was 7.9 inches. From June 12 to 20 the average growth was 5.1 inches. By this date one of the rhizomes had turned up to produce a new plant. From June 20 to 27 the average growth was 3.3 inches, the majority of the rhizomes had turned up to produce new plants, and the first bud at a node behind each shoot was sending out a new rhizome. (Figure 2)



On September 9, 1959, one of these plants was dug. The diameter of spread of its rhizomes was 10 feet and 10 inches; 14 rhizomes had originated from the parent plant. The total length of rhizomes was 458 feet and 3 inches. Two hundred and six shoots had arisen from the rhizomes and two hundred and thirty two additional growing points were found in the soil, making a total of 440 branches arising from the parent plant.

Fifteen spikes of quackgrass were evident at this time on the parent plant. The tallest culm was 29 inches. The dry weight of the rhizomes 164.5 grams or 62.1 per cent of the total plant. The parent plant weighed 34.5 grams or 13.0 per cent of the total weight of the new growth. Plant from rhizomes weighed 66.0 grams or 24.9 per cent of the total. The longest inter-node length was 3.5 inches. Many of the rhizomes were at the bottom of the furrow slice.

Figure 2 One year's growth of a quackgrass plant from a single node. There are 14 rhizomes arising from the parent plant with a total length of 458 feet yardstick on the left).

Seasonal Change in Quackgrass Rhizomes

Effects of PBA, dalapon and amitrole applications on the osmotic pressure, electrical conductivity and pH of quackgrass rhizome sap, and the total nitrogen and hygroscopic capacity of, dried rhizomes, from May 17 through October 15, are reported by Welch and Veatch (21). Characteristic seasonal curves were developed for all five specific factors studied. The herbicide treatments accentuated the variation in some of these factors but did not appreciably modify the seasonal curves.

Water Loss from Rhizomes

In a series of experiments by Ming (14) rhizome sections were placed under controlled humidity conditions. Two temperature levels in combination with 3 vapor pressure deficits offered a series of relative humidities ranging from 0 to 100 per cent. Initial water loss was at a rapid constant rate, apparently conforming to Thornthwaite's (19) concept of vapor pressure deficit, that evaporation is dependent on the relation between the amount present and the amount that can exist in the atmosphere under the prevailing conditions. Following this initial moisture loss, the rate of loss from the sections decreased at what appears to have been a constant rate until point of death, at which the moisture content of the rhizomes remained constant at a level probably again in equilibrium with the vapor pressure deficits.

Survival rates decreased with water content, but were not correlated with amounts or rates of water loss. Evidently other factors, such as temperature, age of cutting, status of bud dormancy, etc., also affect survival. Possibly death by desiccation occurs sooner at higher temperatures under the same humidity deficit levels, and death occurs sooner under drier conditions at the same temperature levels.

Plant Growth

Rhizomes from 15 fields, 5 each from Vermont, West Virginia and Pennsylvania were planted in 1958 at one location in each state. The tallest clone averaged about 42 inches and the shortest clone about 16 inches.

Fertilizer applications were applied each spring to a quackgrass sod laid out in a 3x2x3 design with 4 replications in West Virginia. Nitrogen was an important factor influencing quackgrass hay yield. Plots receiving no nitrogen, phosphate, or potash yielded 4.17 tons in 1958, 1.99 tons in 1959, 1.40 tons in 1960, and 2.87 tons in 1961. Nitrogen additions to quackgrass sods produced significantly higher yields each year. Nitrogen fertilization increased the nitrogen content of the grass and the protein production per acre.

Growth Inhibitor in Quackgrass

The presence of a substance in quackgrass that is toxic to plant growth has been reported by Osvald (15), Helgeson (7), Hamilton and Buchholtz (6), Kommedahl, Kotheimer and Bernardini (9). An attempt to identify the inhibitors by LeFevre (11) is summarized as follows:

Aqueous extracts of quackgrass rhizomes inhibited the root growth of several crop species. The inhibitor was soluble in polar solvents, partly soluble in semipolar solvents, and insoluble in nonpolar solvents. It was dialyzable and nonvolatile. It was not removed from solution by Norite or a cation exchange resin (Dowex 50), but was absorbed to anion exchange resins (Dowex 1, Duolyte A-4). Separation by paper chromatography revealed two components, one of which was further separated on celluose and silica gel columns. Infrared and ultraviolet spectra revealed that it was a non-aromatic compound, contained hydroxyl and carboxyl groups of low molecular weight. A second substance was separated with ion exchange, paper chromatography and Norite. Its infrared spectrum was similar to that of the first compound. Complete identification of the causative factors will require further work.

SUMMARY

Life history studies of quackgrass in a cooperative undertaking by the experiment stations of Vermont, West Virginia and Pennsylvania demonstrated much variation in plant growth and seed production. Some quackgrass seeds planted 1½ inches deep in the field germinated and emerged, while many of those planted deeper, germinated but did not emerge from the soil. The length of rhizome sections will influence the depth from which quackgrass establishes new growth. An individual quackgrass plant produced more than 458 feet of rhizomes in one season. The presence of two toxic compounds in quackgrass rhizomes was demonstrated.

LITERATURE CITED

1. Arny, A. C. 1915. Quackgrass eradication. Minn. Agr. Expt. Sta. Bull. 151.
2. Arny, A. C. 1932. Variation in the organic reserves in underground parts of perennials weeds from late April to November. Minn. Agr. Expt. Sta. Tech. Bull. 84.
3. Campbell, H. and G. McKee. Drill box survey in Centre County, Pennsylvania. (unpublished data).
4. Cicin, N. V. 1937. The problem of perennial wheat Herb. Abstr. 7:14-15.
5. Dunham, R. S., K. P. Buchholtz, L. A. Derscheid, A. H. Grisby, E. A. Heigerson, and D. W. Staniforth. 1956. Quackgrass control. Minn. Agr. Expt. Sta. Bull. 434.
6. Hamilton, K. C. and K. P. Buchholtz. 1935. Effect of rhizomes of quackgrass (*Agropyron repens)* and shading on the seedling development of weedy species. Ecology 36:304-308.
7. Helgeson, E. A. 1956. Quackgrass root extract has puzzling effect on seeds of crop plants. N. D. Agr. Expt. Sta., Bimonth Bull. 18:191-192.
8. Kephart, L. W. 1931. Quackgrass. U. S. Dept. Agr. Farmers' Bull. 1307.
9. Kommedahl, T., J. B. Kotheimer and J. V. Bernardini. 1959. The effect of quackgrass on germinating and seedling development on certain crop plants. Weeds 7:1-12.
10. LeBaron, H. M. and S. N. Fertig. 1962. The effects of chemical and cultural treatments on the survival of rhizomes and on the yield of underground reserves of quackgrass.
    Proceedings Northeastern Weed Control Conference 16:290-298.
11. LeFevre, C. W. 1961. Concentration of a growth inhibitor from *Agropyron repena,,* (quackgrass). PhD. Thesis, Pennsylvania State University.
12. Linnaeus, Carl. 1753. Species plantarum. p. 86.
13. Lowe, H. J. and K. P. Buchholtz. 1952. Cultural methods for control of quackgrass. Weeds. 1:346-351.
14. Ming, T. 1960. Some physiological studies on quackgrass, *Agropyron repens L.* M.S. Thesis, University of Vermont.
15. Osvald, H. 1947. Equipment of plants in the struggle for space. Vaxtodling 2:288-303 (in Swedish, English summary).
16. Pinckney, A. J. 1945. Composition and vitality of quackgrass roots. North Dakota Agr. Exp. Sta. Bull. 334.
17. Piper, C. V. 1924. Forage plants and their culture. The Macmillan Company.
18. Etoa, T. E., V. Sturlaugson, and H. F. McColly, 1930. Control of quackgrass by tillage. N. D. Agr. Expt. Sta. Bull. 244.
19. Thornthwaite, C. W. 1940. Atmosphere moisture in relation to ecological problems. Ecology 21:17-28.
20. Toole, E. H. and E. Brown. 1946. Final results of the Duvel buried seed experiment. Jour. Agr. Res. 72:201-210.
21. Welch, M. D. and C. Veatch. 1962. Some effects of herbicides and season on the rhizomes of quackgrass. Weeds 10:15-17.