spiders. Toads eating such organisms do sometimes show that they are uncomfortable, but they may fail to discriminate between stinging and nonstinging species. Phytophagous millepeds, some of which are known to secrete hydrocyanic acid, also are eaten by toads.

Do More Good than Harm

Without attempting to minimize any objectionable food habits that toads may have, it may be stated that the good they accomplish by feeding on termites, beetle larvæ with injurious or potentially injurious habits, plant-sucking bugs, voracious caterpillars, and other noxious insects more than compensates for the harm done by preying upon those that are beneficial. Although indiscriminate destruction of all sorts of terrestrial organisms characterizes their food habits, nevertheless toads consume large numbers of economically injurious insects, especially during periods when these pests are abnormally abundant, and in these activities they undoubtedly have an important place in nature. Under certain conditions in greenhouses, gardens, fields of small grain or forage crops, and on golf courses toads perform visibly effective service. In any of these situations noxious insects and other invertebrates are sure to predominate; hence the bulk of the toad's food consists of injurious forms.

FIG. 234.—Northwestern toad (*Bufo boreas*), the common toad of the Pacific Coast States and the Rocky Mountain region

Toads are not attractive and have always been the basis of curious beliefs and superstitions. In spite of all the absurd prejudices associated with them, they have managed to survive thus far. As the country has become more densely settled, however, toads have had to face new dangers from man's inventions, such as the automobile and the mower and binder and other farm machinery. Great numbers of toads migrating across highways are destroyed each year by automobiles, and the sewer systems of large cities have long taken an annual toll. An active interest in the conservation of toads must be taken if these useful animals are to escape extermination by the draining of their breeding places, by the burning over of fields and woods, and by other perils of their present-day environment.

REMINGTON KELLOGG.

TOBACCO Breeding for Root-Rot Resistance Paying Good Returns

The breeding of crop plants for resistance to disease has become one of the most promising fields of endeavor for the control of a number of important plant diseases. Differences in resistance to disease occur within species and varieties of plants in nature, and this resistant character

must be discovered, selected, and generally transferred to other varieties by crossing in order to develop commercial strains of disease-resistant plants. It is, of course, required that disease-resistant strains possess as well all the other characteristics of a desirable commercial variety adapted to the section where grown, and this feature of the work is often most difficult.

Tobacco is subject to about 20 different maladies, but the resistant character is thus far known to exist in the case of only 3 or 4 of these diseases. The most striking examples are those of resistance in tobacco to the black root-rot disease due to the fungus *Thielavia basicola* and resistance to the "black-shank" disease due to the fungus *Phytopthora nicotianae*. The black root-rot disease will serve for present purposes as an illustration of what may be accomplished in this respect. Black root rot, which occurs commonly in all tobacco districts, is usually most serious on land repeatedly grown to tobacco, a practice which is in certain other respects preferable to rotation. The disease is characterized by a decay and depletion of the root system with consequent stunted plant growth.

FIG. 235.—Comparative growth of a row of ordinary White Burley tobacco (center) and Standup Resistant white Burley (right) on field infested with root-rot

Growth Much Affected

When the principal types or varieties of commercial tobacco are grown side by side in a soil heavily infested with root rot, remarkable differences in rate and extent of growth appear. Some varieties may make little or no growth, whereas others may make a rapid and normal growth. Between these extremes will be found varieties showing various intermediate stages of growth. These differences in growth are due to relative differences in resistance to the black root-rot disease. Each type of tobacco has a distinct purpose and value of its own, and the varieties naturally more resistant may not be suited to replace the susceptible ones for commercial purposes in the districts where they are grown. Resistant strains, approximately otherwise identical with each susceptible commercial type or variety, must be developed in order to be of any value. As a rule this

can be done only by crossing a resistant variety with the susceptible variety, followed by careful and continued selection and comparison over a period of several years with all desirable characters in mind. It can be safely stated that the requirements of the tobacco trade and grower are probably more exacting than those of any other plant industry. This is chiefly due to the importance of the complicated factor of quality in tobacco. If judgment, patience, and luck have all been favorably combined, the effort of the plant breeder may be rewarded after several years by a desirable disease-resistant commercial strain.

Resistance Could Be Increased

Practically all of the commerical types of tobacco grown in the United States could profitably be improved in their resistance to root rot. Up to this time this has been seriously attempted in the

FIG. 236.—Comparative growth of ordinary Havana Seed tobacco (left) and Havana 142 (right) on soil heavily infested with root rot

case of only a few types. In two of these a considerable degree of success has resulted as a consequence of the cooperative efforts of the Bureau of Plant Industry and the Wisconsin Agricultural Experiment Station.

In Wisconsin a Havana Seed type of tobacco is grown, primarily intended for cigar binder purposes. This type, while having an intermediate degree of natural resistance to black root rot, is nevertheless seriously affected by the disease during seasons favorable to its occurrence. The resulting losses may consequently be heavy. Some other varieties of tobacco are grown to a limited extent in Wisconsin, and from one of these a root-rot resistant strain was selected, but its growth habit was not desirable. This strain was, however, crossed with Havana Seed, out of which was finally obtained a strain which was called Havana No. 142. The new type proved to be very resistant to root rot, having considerably more resistance than its most resistant parent. In addition it is a good yielder, has a desirable habit of growth, and so far as has been determined a

desirable quality. It is usually regarded, however, as being a somewhat later maturing strain than Havana Seed. On soil which is infested with root rot the yield and quality is usually strikingly better than that of Havana Seed. The Wisconsin growers have consequently adopted the new strain at a rapid rate, and several thousand acres of this strain are now being grown in the State. A few hundred acres are also being grown in the Connecticut Valley.

White Burley Susceptible

The ordinary White Burley strains of tobacco as grown in Kentucky are extremely susceptible to root rot. Continuous culture of tobacco on the same land is not attempted with these strains. Root-rot resistant strains of White Burley were first secured through field selection, although they had apparently arisen through accidental crosses with resistant varieties. Since these resistant Burley strains did not have the most desirable habit of growth, they were crossed with a good strain of Standup White Burley. From this cross a resistant strain was finally selected which so far as could be observed was desirable as a commercial type. This resistant Standup White Burley strain will ordinarily produce a good crop on land so heavily infested with root rot that ordinary strains may prove a complete failure. While a root-rot resistant type has not been generally adopted in the Burley district of Kentucky, for reasons which can not be discussed in a short paper, it is extensively grown in the Burley district of Ontario, Canada, where root rot is very prevalent.

Although the commercial returns from the root-rot resistant strains already in use have been large, the greatest value of these breeding trials has been in the demonstration of the future possibilities in this direction.

JAMES JOHNSON.

TOBACCO Fertilizer Should Have Ample Supply of Potash

It is said that the Indians, who were growing tobacco in this country long before the arrival of Europeans, followed the practice in some localities of felling a tree and burning it in order to obtain ashes for fertilizing their patches of tobacco. Probably they could have done nothing better to insure a healthy, vigorous growth of their tobacco plants in the field and also good smoking qualities in the cured leaf. In a prize essay written by a successful tobacco grower in Maryland in 1848, before the days of modern commercial fertilizers, we read: "Ashes are decidedly superior to any other fertilizer for tobacco. Theory and practice unite in sustaining this assertion." The virtue of ashes as fertilizer, of course, depends primarily on their content of potash. Recent experiments and observations show conclusively the value of a generous supply of potash in the fertilizer for tobacco.

It is true that tobacco plants may attain good size when supplied with only comparatively small quantities of potash, but the leaf produced is likely to be of poor quality and perhaps light in weight. The plant must develop a large leaf area within a short period of time, and potash is an efficient aid in maintaining the health and vigor of the leaf. Without sufficient potash the leaf begins to lose

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