WHAT'S HAPPENING IN ALFALFA CROWNS: A TIME TO LOOK AT ALFALFA CROWNS FROM THE INSIDE TO THE OUTSIDE

David G. Gilchrist and Ann N. Martensen
Plant Pathology Department
University of California, Davis

The ability of alfalfa growers to improve (in some cases just to maintain) current per acre output of high quality forage during the life of a stand rests, in large part, on the control of those diseases which currently cause annual economic loss estimated conservatively at about 20-25% of the forage potential (1). In fact, in the absence of long-term complete disease control the accumulation of these losses over any theoretical potential life of a disease-free alfalfa stand is incalculable but obviously the stated loss represents a minimal estimate.

Alfalfa diseases, like those of other crops, fall somewhere between the dramatic and severe to the subtle and virtually unnoticed with simple recognition of presence often playing a critical part in developing any control program (4). Similarly, the economic impact of various diseases are exhibited in a variety of different ways including: reduced yield, forage quality, and persistence; direct defoliation; increased damage from environmental stresses, and insect interactions; diminished competitiveness with weeds; and decreased efficiency of water and nutrient utilization.

Equally as varied are the causes of disease which include fungi, bacteria, viruses, mycoplasmas, nematodes, and phanaerogamic parasitic (such as dodder). In addition, a number of abiotic (non-living) causal agents such as air pollutants, nutrient deficiencies and excesses, and physiogenic factors as root aeration (scald) take their toll as well. However, since our current research efforts are concerned with biotic (living) causes of disease we will concentrate on these for the moment with particular emphasis on the crown and root decay problems.

For purposes of discussion we will place alfalfa diseases, regardless of cause, two general categories, those attacking principally the foliar tissue and those found primarily in crown and root tissue.

The foliar diseases have a direct effect on yield through leaf loss and an indirect effect on quality factors such as protein and carotene content as well as general digestibility. Similar statements apply to the effects produced by many insect pests. Crown and root diseases, on the other hand, exhibit their effect through reduction in number, size, and vigor of individual plants which, in addition to reduction in yield and quality, contribute to the most serious long term production problem in alfalfa; that of plant population persistence. Root and crown decay bacteria and fungi are widely distributed with specific fungi varying in frequency under different environmental conditions. The net result however is that the decay organisms are considered to incite progressive deterioration until maintenance of stands becomes uneconomical often within 3-4 years. No practical control measures other than adapted resistant varieties and crop rotation are known.

It is no accident, therefore, that crown and root diseases have historically occupied center stage in alfalfa disease control programs, particularly breeding programs, with noteable success being achieved in the cases of bacterial wilt (caused by Corynebacterium insidiosum) and Phytophthora root rot (caused by Phytophthora megasperma) through a combination of improvements in cultural practices and development of genetic resistance (3). While still requiring constant attention the relative significance of these two organisms in current crown and root decay problems is less than was the case in 1954 when Phytophthora root rot was first revealed by Irwin (2). As is often the case, control of a blatant pest reveals others more subtle but just as insidious. For reasons to be described such a situation may now exist for current crown and root decay problems.

Irwin, in 1954, reported on the crown rot diseases of alfalfa and indicated at that time they could be found in almost any irrigated field in California (2). In addition to Phytophthora megasperma which attacked primarily the roots, he considered three other crown and root diseases the most important of which was described as dark crown necrosis

for which a single causal agent could not be found, although he did rule out Fusarium spp as being involved. The second causal agent was Stagonospora meliloti which although potentially lethal was not considered as important as dark crown necrosis or Rhizoctonia solani the third crown rot fungus discussed by Irwin.

Recently, however, stagonospora root rot had been observed to be increasing in significance although no actual data were available (D. H. Hall, personal communication). It was therefore with this background that we began in June 1976, to look specifically at the current crown decay problems and, to the extent possible, determine the frequency of the various causal agents involved. Destructively sampled plants in 2 and 3-year-old variety trials in Butte and Merced counties were examined for crown and root disease. The only apparent problem associated with the crowns and roots of the sampled plants exhibited symptoms typical of S. meliloti infection. The symptoms are readily recognized in exposed crown and root tissue by the speckled red discoloration often spreading across an entire longitudinal section of the upper portion of a root. The presence of S. meliloti infection is not easily recognizable by any aboveground symptoms other than general unthriftyness or gradual thinning of the stand, with confirmation possible only by destructive sampling of the entire plant. The results further indicated that S. meliloti was not only present in all varieties, areas, and ages of stand but also with frequencies ranging from 30-90% infection.

Based upon this preliminary field sampling and the absence of any recent (10-15 years) information on type, frequency, and location of diseases present in alfalfa crowns and roots we began a systematic survey of the major alfalfa growing areas of the state. The basic procedure has been to destructively sample four replicate 0.5 M^2 areas each in 1, 2, 3 and 4-year-old alfalfa stands in selected counties, remove the plants from the field and evaluate in the laboratory each plant for crown or root disease symptoms. Isolations from diseased tissue are made for confirmation of specific pathogens where required as well as to build collections of the pathogens for future pathological studies.

Although the survey is not completed we have examined in excess of 10,000 crowns from various age plantings in Kern, Kings, Tulare, Merced, Yolo, and Monterey counties with several more still to be sampled. Early in the process of examing these plants and attempting to assess the frequency of various possible diseases it became clear that Stagonospora was by far the most common recognizable pathogen present in the samples examined. It was also clear that some form of a rating scale for severity was needed.

A relative 5 point scale has been established which in its present form is based solely upon severity of apparent colonization of the alfalfa crown and root as evidenced by the amount of root tissue showing the red flecking symptom. How this relative criteria relates to the actual physiological impact of the fungus on the host (particularly the projected life span) will have to be determined by further studies in progress but no doubt a number of modifying factors will have to be considered. For the present, however, class 0 is considered to be stagonospora symptomless; Class 1 less than 10% of the crown showing symptoms with no extension into the root area below the crown; classes 2 through 4 range in a relative fashion from 10 to 95% of the root area showing the red flecking symptoms plus significant invasion of the root system below the crown area.

For survey purposes classes 2 through 4 are considered to be confirmed positive for Stagonospora root rot.

The preliminary results from the collections analyzed so far are illustrated with an example of the year-by-year trends in Merced County shown in Table 2. Data from other counties will be presented during the symposium. The survey nature of these observations makes absolute conclusions regarding the actual role of Stagonospora in affecting productivity and stand persistence unrealistic but the results do force us to consider the significance of the frequency and widespread occurrence of a pathogen previously considered to be of minor importance. A number of very crucial pathological questions are being asked regarding the role, survival capabilities, means of spread, pathological variability and economic impact of the fungus on alfalfa as well as developing the means for exploiting potential genetic tolerance in alfalfa to the organism.

TABLE 1 Stagonospora meliloti and crown decay frequency determined in various age alfalfa plantings in Merced County, California, June 24, 1976.

Stand age	Number plants[1] per 0.5 M^2	Stagonospora[2] Class 2, 3, 4	Crown decay
		%	
1	169	5	88
2	105	72	85
3	53	44	91
4	33	42	87
5	20	46	95
6	23	37	100

[1]Average number of plants per 4-0.5 meter^2 samples.

[2]Stagonospora infection ranging from 10-95% with moderate to extensive invasion of root tissue.

In addition to the presence of Stagonospora we have also observed an even higher frequency of crown decay which has heretofore not been reported as due to any specific causal agent but is likely the same problem referred to by Irwin (2) as "dark crown necrosis" the symptoms of which he could not reproduce by any of the fungi associated with the malady.

In the plants we examined few were free of this latter form of crown decay which, in most all cases was associated with a gradual but continual wasting away of the crown and crown buds. We have been able to consistently recover from the infected bud and crown areas one specific fungus similar to Stagonospora but, as yet, inconclusively identified. The pathological significance of these isolations will not be known for several months, but we feel there is an important point to be made at this time.

Research on stand persistence has been on-going and varied in approach for some time with notable conclusions being drawn regarding the role of such factors as wheel traffic damage, weed competition, insect pressures, and various management practices as well as some diseases. We would simply point out that now seems an appropriate time to consider an analysis of the pathological state of the declining plants as they leave the field populations under different imposed stress or competition studies. In other words, a serious integrated look at alfalfa crowns and roots from the inside-out as well as the outside-in when assessing the role of physical and biological factors affecting stand persistence in alfalfa.

Acknowledgments

Assistance from the following individuals is gratefully recognized they know our debt if not our gratitude.

County Farm Advisors Jerry Smith, Butte; James Farley, Merced; Harry Agamalian, Monterey; David Woodruff, Kern; William McClellan, Tulare; O. D. McCutcheon, Kings; and Extension Plant Pathologist Dennis Hall.

Literature Cited

1. Hanson, C. H. (ed). 1972. Alfalfa Science and Technology. American Society of Agronomy Inc. Madison, Wisc. 812 p.
2. Irwin, D. C. 1953. Relation of stagonospora, rhizoctonia, and associated fungi to crown rot of alfalfa. Phytopathology 44:137-144.
3. Marble, Vern. 1975. Limiting factors in alfalfa production and adaptation north of the Tehachapi mountains. Proc. 1975 Calif. Alfalfa Symp. pp 7-19.
4. Summers, C. G., and W. D. McClellen. 1975. Interaction between Egyptian alfalfa weevil feeding and foliar disease: impact on yield and quality in alfalfa. J. Econ. Entomol. 68:487-490.