Screening of alfalfa cultivars for yield, winter hardiness and resistance to crown and root rot, common leaf spot and yellow leaf blotch in northeastern Alberta

S.F. Hwang[1] and G. Flores[2]

A field trial was conducted to evaluate alfalfa cultivars for dry matter yields, winter survival, and resistance to crown and root rot, common leaf spot and yellow leaf blotch. Significant differences were found among cultivars for dry matter yields and percent winterkill. All cultivars were affected by crown and root rot. Anik and Algonquin were the least affected, Trumpetor and Anchor the most. Anchor was the most susceptible cultivar to common leaf spot and yellow leaf blotch, whereas Trumpetor and Anik cultivars were the most resistant to common leaf spot and yellow leaf blotch, respectively.

Can. Plant Dis. Surv. 69:** 1,2 **1-23, 1989.

Un essai en plein champ a servi à évaluer des cultivars de luzerne pour les rendements de matière seche (MS), la survie a l'hiver, et la resistance à la pourriture du collet et des racines, à la tache commune et à la tache jaune. Les cultivars different significativement pour ce qui est des rendements de MS et du pourcentage de mortalité hivernale. La pourriture du collet et des racines infecte tous les cultivars. Anik et Algonquin sont les moins touches, tandis que Trumpetor et Anchor sont les plus atteints. Anchor est le cultivar le plus sensible à la tache commune et à la tache jaune, alors que Trumpetor et Anik sont les plus resistants a ces deux maladies, respectivement.

Introduction

Crown and root rot is a complex disease that has become a major limiting factor in the production of alfalfa (*Medicago sativa* L.) in Alberta for a number of years. The disease can predispose alfalfa to low-temperature kill and reduce a stand as a result of inadequate food reserves in the rotted crown area (7, 12). The development of resistant cultivars offers the best possibility for controlling this disease (12, 15).

Foliar diseases of forage crops are generally considered to be of minor importance (1, 2). They can, however, affect forage quality because of the reduced total nonstructural carbohydrate and crude protein in diseased leaf tissue and they can also lower yield due to premature defoliation and subsequent weakening of the plant (5, 6, 8, 13, 14, 15, 18). The severity of foliar diseases such as common leaf spot (*Pseudopeziza trifoliif.* sp. *medicaginis-sativae* Schuepp) and yellow leaf blotch (*Leptotrochila medicaginis* Schuepp) varies from year to year in Alberta. The purposes of this study were to compare the forage yield and winter survival of different alfalfa cultivars and to evaluate their resistance to crown and root rot, common leaf spot, and yellow leaf blotch.

Materials and methods

Experimental alfalfa plots were established in the spring of 1983 at the Alberta Environmental Centre, Vegreville. Eptam EC was incorporated in the soil at a rate of 4.5 L/ha as a pre-emergence herbicide along with 90 kg/ha of monoammonium phosphate (11-51-01, 20 kg/ha of potash (0-0-60) and 19 kg/ha of elemental sulphur (0-0-0-90). Fourteen cultivars of alfalfa were seeded in a randomized complete block design with six replications. Each plot consisted of four 6-m rows spaced 30 cm apart. There was 1 m between treatments and 2.5 m between replicates. The seeding rate was 8 kg/ha, and peat-based inoculant was used as a source of root nodule bacteria. Due to extremely dry conditions during the summer of 1983, very poor stand establishment was achieved; consequently, gaps in the rows had to be reseeded in the fall of 1983.

The middle two rows of each plot were harvested twice in the year at about 10% bloom stage and fresh-weight yields recorded. One-kg samples of fresh alfalfa were dried in an oven to determine dry-matter yields. During the spring of 1987, prior to first harvest, the degree of winterkill was determined by counting the number of plants with no green shoot development in the middle two rows of each plot. In the fall of 1987 prior to the second harvest, the severity of common leaf spot and yellow leaf blotch was rated. After the second harvest, 20 randomly selected plants from each plot were dug up and the roots bisected longitudinally to visually assess the severity of crown and root rot. Disease severity ratings were determined using the scale: 0, no disease; 1, slight; 2, moderate; 3, severe; 4, dead.

ANOVA and Duncan's Multiple Range tests were used to statistically analyze the data on dry matter yield, percent winter survival and disease severities of crown and root rot, common leaf spot and yellow leaf blotch.

Results

There were no significant differences in dry matter weights among the different cultivars of alfalfa with the exception of Anik in the first year after seeding (1984) (Table 1). Statistically significant differences for dry matter weights were observed

[1] *Alberta Environmental Centre, Vegreville, Alberta, Canada TOB4L0.*

[2] *Pesticides Directorate, Agriculture Canada, Ottawa, Ontario, CanadaK1A OC6.*

Accepted for publication November 15, 1988.

Table 1. Comparative forage yield and winter survival of fourteen alfalfa cultivars.

Cultivar	Dry Weight (kg)				Winter Survival
	1984	1985	1986	1987	%
Algonquin	4.6 a[x]	2.2 abcd	2.0 cd	2.3 a	74 abc
Anchor	3.5 a	2.1 abcd	2.1 bcd	1.2 bc	21 f
Vernal	3.8 a	2.1 abcd	1.9 cd	1.4 bc	55 d
Anik	1.9 b	2.0 bcd	2.4 abc	2.3 a	86 a
Beaver	3.6 a	2.4 abcd	2.0 cd	1.8 ab	73 bc
Drylander	3.6 a	2.8 abc	2.6 abc	2.3 a	78ab
Peace	3.5 a	2.8 abc	2.9 a	2.1 a	82ab
Rambler	4.0 a	3.0 a	3.0 a	2.5 a	80ab
Rangelander	3.7 a	2.6 abc	2.7 ab	2.5 a	77 ab
Roamer	3.8 a	2.9 abc	3.0 a	2.4 a	75 abc
Spredor II	3.7 a	2.6 abc	2.9 a	2.5 a	73bc
Thor	3.9 a	1.9 cd	1.6 d	1.0 bc	33 e
Trek	4.0 a	2.0 bcd	1.9 cd	1.5 b	63 cd
Trumpetor	4.0 a	1.5 d	0.8 e	0.3 d	7 g

'Values in a column followed by the same letter are not significantly different using Duncan's Multiple Range test (P = 0.05).

among cultivars in each of the subsequent 3 years. Except for Thor and Trumpetor, which consistently gave the lowest yields, the ranking of the cultivars varied from year to year.

Anik, Peace, Rambler, Drylander and Rangelander had the greatest winter survival, followed by Roamer, Algonquin, Beaver and Spredor II; Trek, Vernal, Thor, Anchor and Trumpetor had the lowest survival (Table 1).

All cultivars suffered, to varying degrees, from crown and root rot (Table 2). Anik and Algonquin had the least disease with severity ratings of 1.56 and 2.06, respectively, whereas Trumpetor and Anchor had the most at 3.40 and 3.37, respectively. Overall, most cultivars evaluated had disease severity ratings between 2.59 and 3.13.

Common leaf spot and yellow leaf blotch caused progressively greater defoliation in all cultivars during September and October of 1987. Foliar disease severity ratings differed significantly among the cultivars (Table 2). Anchor had the greatest amount of diseased foliage (disease severity ratings of 2.16 and 1.60 for common leaf spot and yellow leaf blotch, respectively), while Trumpetor and Anik had the least ratings of 1.25 for common leaf spot and 0.79 for yellow leaf blotch, respectively.

Table 2. Disease severity ratings of fourteen alfalfa cultivars to crown and root rot, common leaf spot and yellow leaf blotch'.

Cultivar	Crown and Root Rot	Common Leaf Spot	Yellow Leaf Blotch
Algonquin	2.06 de[Y]	1.56 abc	1.04 bc
Anchor	3.37 ab	2.16 a	1.60 a
Vernal	3.13 abc	1.67 abc	1.10 b
Anik	1.56 e	1.38 bc	0.79 c
Beaver	3.04 abc	1.50 bc	1.13 b
Drylander	2.85 abc	1.75 abc	.17 b
Peace	2.89 abc	1.92 ab	.21 b
Rambler	2.75 abc	1.67 abc	.13 b
Rangelander	2.59 cd	1.33 bc	.04 bc
Roamer	2.92 abc	1.38 bc	1.00 bc
Spredor II	2.64 bcd	1.67 abc	1.08 b
Thor	2.92 abc	1.46 bc	1.29 b
Trek	3.10 abc	1.75 abc	1.22 b
Trumpetor	3.40 a	1.25 c	1.00 bc

'Disease severity was based on a scale of 0–4 where 0 = clean; 1 = slight; 2 = moderate; 3 = Severe and 4 = dead.

'Values in column followed by the same letter are not significantly different using Duncan's Multiple Range Test (P=0.05).

Discussion

The results of this study clearly demonstrate that the severity of crown and root rot disease varies in the alfalfa cultivars evaluated. Although crown and root rot is not the only factor responsible for stand decline and yield reduction, there is increasing evidence that this disease predisposes alfalfa to winterkill (7). The impact of this disease on alfalfa plants increases with plant age and is generally irreversible (11). The damage alone may be lethal to plants in some years, but a combination of crown and root rot and winter stress factors is believed to be the more common cause for dead alfalfa in Alberta. During winter, alfalfa plants are subjected to such stress factors as freezing, ice cover, and long-lasting snow cover; hence, winter survival is a critical stage in the successful cultivation of alfalfa in Alberta (9). In our study Anik had the highest percentage of winter survival and the least crown and root rot damage 4 years after seeding. This substantiates the hypothesis that crown and root rot tolerant cultivars are more winterhardy because of less predispositon to winterkill. Since the use of winter-hardy and crown and root rot-resistant alfalfa cultivars offers the best possibiltiy for significantly reducing winterkill and losses due to this disease, greater effort is

needed to develop not only winter-hardy but also crown and root rot-resistant alfalfa cultivars suitable for cultivation in northern Alberta.

Foliar diseases are seldom important in northeastern Alberta, simply because hot and dry weather during July limits the rate of production and dissemination of secondary inocula (1, 2, 4). However, below normal temperature and above normal rainfall were recorded in July and August 1987. These abnormally cool and wet conditions not only favored infection and development of floliar diseases, but also provided an abundance of overwintering inocula since both pathogens, ***Pseudopeziza trifolii*** f. sp. ***medicaginis-sativae*** and ***Leptotrochila medicaginis,*** survive winter on diseased stems and leaves (10). In our study Anchor had disease severity ratings of 2.16 and 1.60 for common leaf spot and yellow leaf blotch, respectively. There is no doubt that foliar pathogens can build up quickly and spread quickly when environmental factors are favorable for their development (3, 12, 16, 17); consequently, serious outbreaks and significant crop losses may result. When foliar disease losses are added to crown and root rot losses, the loss of potential forage yield due to disease is substantial. Thereforq, research efforts are also needed to breed new alfalfa cultivars with more resistance to foliar diseases.

Acknowledgements

We gratefully acknowledge Mr. H.G. Philip, Dr. L.J. Piening and Miss D. Orr for comments on the manuscript and Mr. S. Allen for technical assistance.

Literature cited

1. Berkenkamp, B. 1974. Losses from foliage diseases of forage crops in central and northern Alberta, 1973. Can. Plant Dis. Surv. 54:111-115.
2. Berkenkamp, B. 1971. Losses from foliage diseases of forage crops in central and northern Alberta in 1970. Can. Plant Dis. Surv. 51:96-100.
3. Roberts, D.A. 1957. Observations on the influence of weather conditions upon severity of some diseases of alfalfa and red clover. Phytopathology 47:626-628.
4. Jones, F.R. 1919. The leaf-spot diseases of alfalfa and red clover caused by the fungi ***Pseudopeziza mediceginis*** and ***Pseudopeziza trifolii,*** respectively. U.S. Dept. Agr. Bull. 759.
5. Summers, C.G. and W.D. McClellan. 1975. Effect of common leaf spot on yield and quality of alfalfa in San Joaquin Valley of California. Plant Dis. Reptr. 59:504-506.
6. Henderson, R.G. and T.J. Smith. 1948. Relative susceptibility of alfalfa varieties to certain foliage diseases. Phytopathology 38:570.
7. Hwang, S.F. and G. Flores. 1987. Effects of ***Cylindrocladium gracile, Fusarium roseum*** and ***Plenodomus meliloti*** on crown and root rot, forage yield, and winterkill of alfalfa in northeastern Alberta. Can. Plant Dis. Surv. 67:31-33.
8. Mainer, A. and K.T. Leath. 1978. Foliar diseases alter carbohydrate and protein levels in leaves of alfalfa and orchardgrass. Phytopathology 68: 1252-1255.
9. McKenzie, J.S. and G.E. McLean. 1984. A field test for assessing the winter hardiness of alfalfa in northwestern Canada. Can. J. Plant Sci. 64:917-924.
10. Meyer, S.L.F. and E.S. Luttrell. 1987. Host-parasite relationships between ***Pseudopeziza trifoliif. sp. medicaginis-sativae*** and alfalfa. Phytopathology 77:309-319.
11. Michaud, R. and C. Richard. 1985. Evaluation of alfalfa cultivars for reaction to crown and root rot. Can. J. Plant Sci. 65:95-98.
12. Leath, K.T., F.L. Lukezic, H.W. Crittenden, E.S. Elliott, P.M. Halisky, F.L. Howard and S.A. Ostazeski. 1971. The Fusarium root rot complex of selected forage legumes in the Northeast. Pa. Agric. Exp. Sta. Bull. 777.
13. Leath, K.T., J.S. Shenk and R.F. Barnes. 1974. Relation of foliar disease to quality of alfalfa forage. Agron. J. 66:675-677.
14. Willis, W.G., D.L. Stuteville and E.L. Sorensen. 1969. Effects of leaf and stem diseases on yield and quality of alfalfa forage. Crop Sci. 9:637-640.
15. Semeniuk G. and M.D. Rumbaugh. 1976. Reaction of some perennial and annual ***Medicago*** species and cultivars to the yellow leaf blotch disease caused by ***Leptotrochila medicaginis.*** Plant Dis. Rep. 60:596-599.
16. Perisic M. and D. Stojanovic. 1966. A study of the biology of ***Pseudopeziza jonesii*** Nannf (***Pyrenopeziza medicaginis*** Fuck) the cause of yellow blotches on leaves of alfalfa. Zastita Bilja 17:183-190.
17. Semeniuk, G. 1982. Time required For alfalfa infection by ***Leptotrochila medicaginis.*** Proc. S.D. Acad. Sci. 61:107-113.
18. Davies, H. and A.E. Williams. 1970. The effect of mildew and leaf blotch on yield and quality of cv. Lior Italian ryegrass. Plant Path. 19:135-138.