5. BLACKTHORN DIEBACK DISEASE DEVELOPMENT IN THE NORTHERN REGIONS OF SOUTH WEST AFRICA

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ABSTRACT

The rate of decline in individual bushes over a period of 2 years (February 1986-April 1988), and the ability to recover after pruning, was determined at a site at Neudamm Experimental Farm. The disease index for 1988 was significantly higher than for 1986, and a significant negative correlation was established between disease and the regrowth index. Regrowth on pruned bushes was negatively correlated with disease severity and no coppice shoots formed on bushes which had a disease index higher than 5 and were cut back heavily. A comparison of rainfall during the preceding 30 years with dieback in specific areas revealed no distinct period of drought stress that might have acted as a trigger for dieback.

INTRODUCTION

Blackthorn [*Acacia mellifera* (Vahl) Benth. subsp. *detinens* (Burch.) Brenan] is of considerable importance in the northern regions of South West Africa because it has invaded more than 10 million hectares of veld and rangeland, and has forced some farmers to abandon their properties. In some areas chemical control has been tried, but is uneconomical (Bester, 1984).

During the early 1970's a disease of unknown etiology was observed on the farm Otjikuoko and other parts of the territory (F.V. Bester and H.H.P. Böhm, *personal communication*). Since 1984, the disease has reached epidemic proportions killing millions of bushes and trees (Part 1). Dieback is therefore of much concern to farmers as it has opened up large areas infested by blackthorn and thereby enhanced the economic value of farms.

Previous work (Parts 1, 2, 3, 4) has shown that the disease is characterized by an internal discolouration and decay of wood at the base of the trunk and upper taproot, that four fungi (*Phoma glomerata* (Cda) Wollenw. & Hochapf., *P. eupyrena* Sacc., *P. cava* Schulz. and *Cytospora chrysosperma* Pers. ex Fr.) are consistently associated with affected plant parts, and that these organisms are pathogenic on blackthorn. However, it also indicates that blackthorn dieback is a disease of complex abiotic/biotic origin, possibly enhanced by drought stress (Part 4).

Houston (1973, 1982, 1984) proposed the concept that dieback/decline diseases are diseases initiated by the predisposing effects of abiotic/biotic environmental stresses, which culminate in attacks, often lethal, by organisms of secondary action. In many of these diseases two phases, dieback and decline, occur. The dieback phase, manifested by a progressive dying back of buds, twigs, branches, and rootlets, often results from the effects of the stresses(s) alone. Dieback can be viewed as a survival mechanism, and trees often recover when stress is reduced. The decline phase, wherein the vitality of the entire tree is reduced, usually results from attack by secondary-action organisms and often culminates in death. Recovery from this phase is less likely to occur after removal of the stress factor.

To obtain a better understanding of blackthorn dieback, it is necessary to estimate the influence of rainfall on the disease and to determine the rate of symptom development in individual trees and within given areas. In this study the rate of dieback in individual bushes over a period of 2 years, and the ability to recover after pruning was determined. Determinations were done during February-March when symptoms are usually more prevalent (Part 1). Rainfall during a 30-year period preceding the 1987/88 season was correlated with dieback in specific areas to determine its effect on disease development.

MATERIALS AND METHODS

Disease ratings and indices

Experiments were conducted at the Neudamm Experimental Farm, South West Africa. The site chosen had no history of dieback prior to 1985, when disease symptoms were noted for the first time. Bushes chosen were of various sizes (See Table 1, 2) and in various stages of decline. Individual plants were selected so that soil type, elevation and stand density were as similar as possible.

In one experiment 30 bushes were selected on 20 February 1986 and rated for disease severity. On 23 April 1987 and 13 April 1988 these bushes were again rated for disease severity and for regrowth.

In another experiment 34 bushes were selected on 19 February 1986, rated for disease severity and pruned. The first 12 bushes were cut back heavily. All shoots and branches which had died back, as well as healthy shoots and branches, were removed and only the main frame left (heavy pruning). The next 12 bushes were cut back less severely although all shoots and branches that had died back were removed (moderate pruning). Only dead and dying shoots were removed from the other 12 bushes (light pruning). On 23 April 1987 the trees were rated for regrowth and the presence of leaves.

Disease severity was rated on a scale of 0-10 where 0 = no twig or branch dieback and defoliation evident and 10 = 91-100% of the branches dead and defoliated. Regrowth was rated on a scale of 0-10 where 0 = no new growth present and 10 = 91-100% of the bush covered with new growth. Foliage was rated on a scale of 0-10 where 0 = no leaves formed and 10 = 91-100% of the bush covered with leaves. Ratings were made by four referees and indices based on mean values.

Rainfall data and dieback

The following farms with a known history of dieback were selected: Thorn Trees, Teufelsbach, Otjikuoko, Goodehope, Neudamm Experimental Farm, Sonnleiten, Uitkomst Experimental Farm and Jagboom (Fig. 1). Precipitation at each site during a 30-year period preceding the 1987/1988 season was compared with rainfall norms for each region calculated by Katsiambirtas (1987, 1988). The norms are based on decile values determined

Fig. 1. Location of farms in South West africa for which cumulative drought stress values, calculated for a 30-year period, were compared with blackthorn dieback intensity.

for a 30-year period (1956-1985) for each rainfall station. To estimate the possible influence of prolonged dry periods on disease development, stress periods for each site were calculated on a scale of 1 = a period of precipitation below average; 2 = a period of precipitation much below; 3 = a period of precipitation very much below average. Cumulative values for two or more consecutive periods with precipitation below normal were then determined for each site.

RESULTS

Disease development in the observation plots is summarized in Table 2.

During 1986 only nine bushes had a disease index above 5. In the next 2 years the disease index gradually increased to the extent that 12 and 20 bushes had an index higher than 5 during, respectively, 1987 and 1988. Furthermore, statistical analysis of the data confirmed that the disease index for 1988 was significantly higher than that for 1986 (LSD = 1.35, P = 0.05). No recovery of bushes was evident during any of the ratings. Regression analysis showed a significant negative correlation (r = 0.63, P = 0.001) between the disease indices of 1987 and regrowth indices of the same year. Therefore, as the disease severity increased, the ability for regrowth decreased. No correlation was found between the disease and regrowth indices for 1988.

For pruned bushes the foliar and regrowth indices for 1987 were correlated significantly with the disease indices for 1986. Therefore, the ability for regrowth decreased as the disease index increased.

Precipitation at the experimental site during the period 1984/85 - 1987/88 is given in Fig. 2. Rainfall below the seasonal average was recorded only during 1986/87.

Rainfall data and dieback

The disease intensity of blackthorn bushes at the different sites and the cumulative stress values for each region during the preceding 30-year period is given in Table 3. Seasonal stress values for Thorn Trees, Teufelsbach, Otjikuoko, Goodehope and Neudamm Experimental Farm were essentially the same, whereas on Uitkomst and Jagboom, the two farms with, respectively, the lowest and highest seasonal stress values, disease intensity was low, with virtually no dead bushes prevalent.

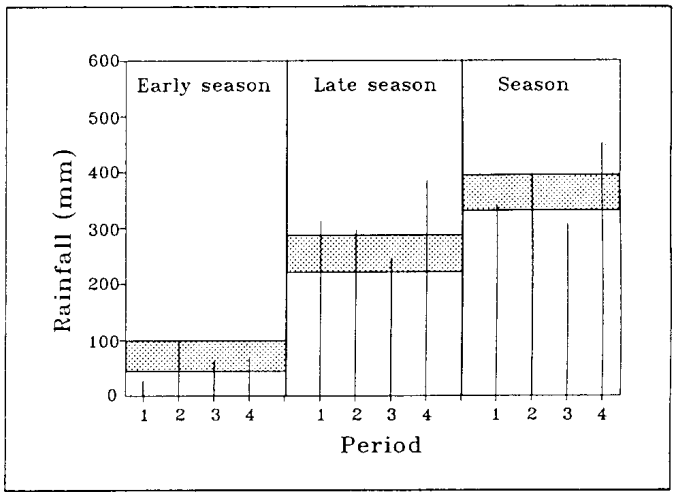

Fig. 2. Rainfall data during the period 1984/85-1987/88 for Neudamm Experimental Farm. Averages (▨) are based on the 4th to 7th decile number values calculated for a standard period of 30 years (1956-1985) by Katsiambirtas (1987, 1988).

DISCUSSION

This study has shown that, although normal precipitation was recorded during the period 1984/85-1987/88, disease severity of blackthorn bushes at the test site increased significantly during the past 2 years. None of the bushes showed any recovery. The study has also shown that dieback/decline under normal conditions increases rapidly after the onset of symptoms. Up to 1985 blackthorn dieback was not seen in the area (F.V. Bester, *personal communication*). Closer inspection during April 1986 revealed typical symptoms of dieback (Part 2), but of a low intensity. After 1986 there was a rapid increase in symptoms and during April 1988 the four referees classified the disease intensity of blackthorn at the site as moderate to high.

Like most acacias, blackthorn produces coppice shoots from the stems whenever the top growth is damaged (Donaldson, 1969; F.V. Bester, *personal communication*). In this study, the capacity for regrowth of pruned bushes was negatively correlated with the disease index, and virtually no coppice shoots formed on bushes which had a disease index higher than 5 and which had been cut back heavily. Coppices forming on these bushes died back during 1988. This confirmed that dieback is caused by an

infectious disease, and is not due to drought stress alone. It affirmed previous work which suggested that infection at the base of the trunk or upper taproot caused a gradual cut-off of water and nutrient supply to the crown (Part 1, 2, 3, 4). A similar relationship has been reported on *P. glomerata*-infected grapevines (Granata & Refatti, 1981).

In decline diseases, triggering stress factors frequently occur many months or even years before plants die (Houston, 1987). In this study, no distinct period of drought stress that might have acted as a trigger could be identified for any area. The cumulative stress values calculated for the 30-year period preceding the 1987/1988 season for Thorn Trees and Neudamm Experimental Farm were essentially the same, but the onset of disease symptoms and the incidence of dieback on the two farms differed markedly. The farms Thorn Trees, Teufelsbach, Otjikuoko, Goodehope and Neudamm Experimental Farm, which were classified in three different disease intensity categories, also showed nearly similar stress values. Furthermore, the farms Uitkomst and Jagboom with, respectively, the lowest and highest stress values, had almost similar dieback intensities.

According to Houston (1987), partitioning of the two developmental stages of dieback (stress factor).decline diseases (pathogen action) put into separate phases emphasises the dynamic nature of stress-host-organism relationships and provides a framework for diagnoses and study of these problems. However, the possible influence, if any, of prolonged dry periods on blackthorn dieback remains obscure.

Table 1 — Disease and regrowth indices for blackthorn bushes at an experimental site at the Neudamm Experimental Farm during the period 1986-1988:

Bush No.	Bush size[c]	Disease index[a]			Regrowth index[b]	
		Period			Period	
		19/2/86	23/4/87	13/4/88	23/4/87	13/4/88
35	3	8.50	9.50	9.75	1.0	0.00
36	1	1.50	3.75	4.00	4.5	0.50
37	2	1.25	1.00	2.75	9.0	2.25
38	3	4.50	5.50	4.75	3.5	0.00
39	3	3.00	3.75	6.25	2.0	0.00
40	1	3.75	4.00	3.00	5.5	0.00
41	1	1.00	1.00	1.00	9.5	0.00
42	3	9.00	8.50	10.00	1.5	0.00
43	3	9.00	7.75	8.75	1.0	0.00
44	3	4.50	4.75	10.00	2.0	0.00
45	2	3.75	3.25	9-00	3.5	0.00
46	2	10.00	10.00	10.00	0	0.00
47	2	2.25	2.50	4.50	1.0	0.00
48	1	3.25	4.50	3.75	5.0	0.75
49	1	4.75	5.25	6.50	3.75	1.25
50	2	8.50	8.50	9.00	1.0	0.25
51	2	3.00	2.25	6.25	1.0	0.75
52	3	6.50	6.75	6.50	1.0	0.00
53	3	3.00	3.00	5.00	1.25	0.00
54	2	3.00	3.75	9.75	3.0	0.25
55	3	5.50	5.75	8.00	2.0	0.00
56	3	10.00	10.00	10.00	1.0	0.00
57	2	3.75	3.50	7.00	2.75	0.00
58	2	2.00	3.75	3.75	3.25	0.00
59	1	2.50	2.50	1.75	8.25	1.25
60	1	3.25	4.50	5.00	4.0	0.00
61	1	2.00	3.75	3.50	3.0	0.00
62	1	4.25	4.50	5.25	3.0	0.25
63	2	8.25	8.75	8.00	1.0	0.00
64	3	7.25	7.50	8.75	1.0	0.00
64	3	7.25	7.50	8.75	1.0	0.00
65	3	5.25	6.00	8.50	1.25	0.25

[a]Disease index on a 0-10 scale with 0 = no twig or branch dieback or defoliation evident and 10 = 91-100% of branches dead and defoliated.

[b]Regrowth index on a 0-10 scale with 0 = no new growth present and 10 = 91-100% of bush covered with new growth.

[c]Bush size: 1 = smaller than 1m; 2 = 1-2m high; 3 = higher than 2m.

Table 2 — Disease index of blackthorn bushes at an experimental site at the Neudamm Experimental Farm prior to pruning, and of foliar and regrowth indices one year after pruning:

	Bush no.	Bush size[a]	Disease index[b]	Foliage index[c]	Regrowth index[d]
Heavy pruning	1	3	5.0	1.00	1.00
	2	2	3.0	1.00	1.00
	3	1	6.0	0.00	0.00
	4	3	8.0	0.00	0.00
	5	2	1.0	6.00	9.25
	6	3	5.0	3.25	7.25
	7	2	6.0	1.00	1.00
	8	3	2.0	5.00	8.00
	9	2	1.0	9.00	9.00
	10	1	8.0	0.00	0.00
	11	1	1.0	0.00	0.00
	12	1	4.0	5.75	7.75
Correlation, r, between disease index and other indices				0.631*	0.593*
Moderate pruning	13	3	3.0	8.00	7.50
	14	3	5.0	7.00	5.75
	15	3	2.0	8.00	8.25
	16	3	1.0	8.50	9.75
	17	2	1.0	9.50	9.25
	18	2	1.0	9.25	9.75
	19	2	2.0	8.00	8.75
	20	2	6.0	6.00	6.00
	21	1	2.0	9.50	9.75
	22	1	1.0	8.50	9.00
	23	1	6.0	4.50	5.50
	24	1	1.0	9.50	9.25
Correlation, r, between disease index and other indices				0.908***	0.956***
Light pruning	25	3	1.0	8.25	8.25
	26	3	5.0	6.25	7.75
	27	2	2.0	8.00	8.75
	28	2	4.0	7.25	6.75
	29	2	1.0	8.25	8.75
	30	2	2.0	8.25	8.50
	31	1	4.0	7.25	7.00
	32	1	4.0	7.50	7.00
	33	1	2.0	8.25	8.50
	34	3	4.0	7.25	7.00
Correlation, r, between disease index and other indices				0.930***	0.814**

[a,b,d]See Table 1.

[c]Foliage index on a 0-10 scale with 0 = no leaves formed and 10 = 91-100% of bush covered with leaves.

***Significant at P = 0.001; **Significant at P = 0.01; *Significant at P = 0.05.

Table 3 — *Disease intensity* of blackthorn bushes at different sites in South West Africa and the cumulative drought stress index for each site calculated for a 30-year period (1957/58-1986/87):

Disease intensity	History	Site	Cumulative stress value		
			Early season[b]	Late season[c]	Season
Very high	Large areas seriously affected by 1985; large areas of bush destroyed by 1988	Thorn Trees	22	15	18
		Teufelsbach	11	5	15
		Otjikuoko	23	9	16
High	Large areas of bush moderately affected by 1985; hectares of bush dead by 1988	Goodehope	9	18	19
Moderate	Symptoms noticed by 1986; individual bushes dead by 1988	Neudamm[d]	17	15	19
		Sonnleiten	14	22	25
Low	Symptoms noticed by 1987	Uitkomst	8	18	4
		Jagboom	22	25	28

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