YARROW: RHIZOME CONTROL BY CULTIVATION

G.W. BOURDOT

Agricultural Research Division, MAF, P.O. Box 24, Lincoln

SUMMARY

Yarrow (*Achillea millefolium*) rhizomes growing in field plots were fragmented into 4 cm lengths or left intact. The fragmented rhizomes were subsequently exhumed and reburied repeatedly either at shoot emergence or rhizome initiation after removing the primary regrowth shoots. The intact populations were exhumed and reburied intact at the same stages of regrowth. Numbers of regrowth shoots declined to zero in 81 days when 4 cm sections were disrupted on three occasions at shoot emergence. Other treatments either did not achieve complete exhaustion or did so after a much greater time or number of repeat disruptions.

INTRODUCTION

Yarrow on cultivated soils regenerates from both seeds and buds on rhizome fragments (Bourdôt 1980). Although the relative importance of each method of reproduction is likely to vary depending upon such factors as seeding history and time and depth of cultivation, field observations in Canterbury indicate that plants formed from rhizome fragments are almost always of major significance. Since selective control of rhizome-bearing plants is not possible with currently available herbicides and yield reduction of crops from yarrow can be high (Bourdôt and Butler 1981), it is prudent to eliminate the rhizomes before sowing.

Bourdôt *et al* (1979) found that the rhizome buds formed regrowth shoots when isolated on single-node rhizome fragments throughout the year and suggested that cultivations to cause shoot formation and destruction could form the basis of a cultural control programme. Since an increasing proportion of buds sprout as the length of rhizome fragment is reduced, Bourdôt *et al* (1982) speculated that severe fragmentation would be most effective for reducing the numbers of buds and hence regrowth potential.

This paper reports on an experiment to test the hypothesis that severe initial fragmentation, followed by subsequent disruptions and burial, will deplete rhizome buds more rapidly than repeated burial of intact rhizomes.

METHOD

On 18.11.80, 15 freshly cut 16 cm long rhizome fragments were planted 15 cm deep in each of thirty-two 20 x 60 cm trenches. Sixteen of these were located at Templeton Research Station on an Eyre fine sandy loam and 16 at the Lincoln College Research Farm on a Wakanui silt loam. There were two replicates of eight trenches at each site. The rhizomes were left to regenerate until February 1981 by which time there was sufficient new rhizome growth to begin the experimental treatments.

On 17.2.81 the subterranean parts of the plants in four of the trenches of each replicate were exhumed after removing the top growth. The rhizomes and regrowth shoots from two trenches were cut into 4 cm fragments while those from the other two were kept intact. The plant material from each trench was reburied 5 cm deep in the trench from which it originated.

Plants of both initial treatments were subsequently exhumed and reburied at 5 cm either at shoot emergence or rhizome initiation (five to six leaf stage). The regrowth shoots were severed from the rhizome fragments (Fig. 1) and reburied along with the rhizome fragments. Plants from intact rhizomes were reburied without shoot disruption

Proc. 35th N.Z. Weed and Pest Control Conf.

by laying them flat on the bottom of the 5 cm-deep trenches and covering with soil. On these occasions leaves were not removed since their bulk was insufficient to impede burial.

Fig. 1: Regenerative development of a rhizome fragment and an intact rhizome.

The fresh weight of rhizomes plus attached roots and regrowth shoots, and the number of primary regrowth shoots were recorded for each plot at each occasion of exhumation. Treatments were repeated until shoot production ceased. The rhizomes were then deemed to be exhausted and incapable of further shoot production. The experiment was terminated on 8.1.82 when most treatments had exhausted the rhizomes.

One of the remaining four trenches in each replicate was exhumed at one of four times over the experimental period and the fresh weight of rhizomes plus attached roots determined. These acted as controls against which the treatments could be compared.

RESULTS

The primary regrowth shoots occurring after fragmentation were formed from axillary buds on the rhizome fragments as well as from axillary buds on regrowth shoots severed at subsequent disruptions. In contrast, the shoots arising after burial of the intact rhizome system were formed almost entirely by the upturning and emergence of rhizome apices; most axillary buds remained inactive (Fig. 1). After a shoot had been removed from a rhizome fragment, further growth rarely occurred from that node.

The numbers of primary regrowth shoots and the fresh weights of rhizomes plus primary regrowth shoots and roots at each treatment time are given in Fig. 2. The times from the start of treatment until regrowth shoots no longer emerged are given in Table 1.

Fig. 2: The decline in numbers of regrowth shoots and total fresh weight of subterranean parts of plants arising from intact rhizomes and 4 cm fragments reburied at two stages of regrowth. (The points on the graphs represent the numbers of shoots/fresh weights recorded at that time. For treatments resulting in zero shoots, shoots did not occur after the penultimate point).

TABLE 1: Time (days) from 17.2.81 (start of treatments) after which shoots ceased to form.

Treatment (Initial treatment/stage of subsequent treatments)	Templeton		Lincoln	
	Rep. 1	Rep. 2	Rep. 1	Rep. 2
Intact/shoot emergence	260	260	260	81
Intact/5-leaf	>325	>325	>325	>325
4 cm/shoot emergence	81	81	81	48
4 cm/5-leaf	260	224	>325	260

Templeton

At Templeton, all four treatments brought about a progressive decline in the numbers of regrowth shoots appearing. However fragmentation resulted in many more shoots growing initially and a more rapid decline than did leaving the rhizome system intact (Fig. 2A). Fragmentation with repeated shoot breakage and reburial at shoot emergence resulted in the cessation of shoot emergence after 9.5.81, 81 days after the start of treatment (Table 1). When disruption and reburial was delayed until new rhizomes began to form, shoots did not cease to emerge until after 4.11.81 (260 days after start of treatment) and 29.9.81 (224 days) in replicates one and two respectively (Table 1). Both of these treatments had been repeated three times before regrowth no longer occurred (Fig. 2A).

When plants were buried intact, the decline in shoot numbers was again more rapid when reburial was done at shoot emergence than at rhizome initiation (Fig. 2A). In trenches exhumed and reburied at shoot emergence, shoots ceased to occur after 4.11.81 (260 days). This treatment was repeated six times before shoots stopped forming (Fig. 2A). Shoots still occurred on 8.1.82 on plots reburied at rhizome initiation (325 days) (Table 1).

The fresh weights of subterranean parts at Templeton declined with time with all treatments (Fig. 2B). In contrast the fresh weight of subterranean parts increased ten-fold during the autumn and winter in undisturbed trenches.

Lincoln

The effect of the four treatments on shoot numbers and fresh weights was very similar at the Lincoln site (Figs. 2C and 2D). The maximum time taken and hence number of repeat disruptions to reach the stage where no regrowth occurred was the same as at Templeton for all treatments except when initially fragmented and disrupted and reburied at rhizome initiation. In this case some shoots were present on 8.1.82 (325 days) (Table 1).

DISCUSSION

In order to prevent the regeneration of established yarrow it is necessary to kill, or render ineffective, the large numbers of axillary rhizome buds that occur (Bourdôt *et al* 1982). These remain inactive on intact rhizomes due to apical dominance. No herbicide gives complete bud kill in the arable situation although 3,6-dichloropicolinic acid applied at rates of 0.6 - 2.2 kg/ha gave 90-100% control of rosettes in pasture (Robocker 1977). Glyphosate appeared promising but in the author's experience did not give a complete kill of buds. Herbicides suitable for waste places may be effective however (Matthews 1975). Desiccation is also difficult since although the buds and rhizomes die quickly when exposed at the soil surface (Bourdôt unpublished), it is difficult to bring an entire yarrow rhizome system to the surface because it fragments very easily.

An alternative is to exhaust the buds and/or food reserves of the rhizomes so that they are eventually unable to produce new shoots. This could result from elimination of viable buds even though food reserves may remain, or depletion of food reserves when otherwise viable buds still remain. This is not a new concept in weed control since the attrition of buds and reserves is the principle behind the multiple cultivation technique advocated by Fail (1956) for the eradication of couch (*Agropyron repens*) and other rhizomatous weeds. Central to Fail's technique is severe initial breakage of rhizomes using a rotary hoe. This ensures that a high proportion of the axillary buds will sprout (Hakansson 1971). The resultant shoots are then destroyed by a further hoeing, repeated until regrowth ceases.

Attrition of food reserves, with little depletion of buds, is the principle behind techniques which either deeply bury intact rhizomes, or rebury intact rhizomes repeatedly. With these techniques, the food reserves of couch are exhausted mainly by the growth of apical buds while the majority of axillary buds are prevented from growing by a strong apical dominance (Johnson and Buchholtz 1962). A technique based on fragmentation and bud attrition is likely to reduce the regenerative potential of an apically dominant rhizome system, such as that of couch and yarrow (Bourdôt *et al* 1982), more rapidly than one based only on attrition of food reserves by a small number of growing points.

The results of the current experiment supports this hypothesis since at both Templeton and Lincoln, shoots stopped forming 81 days from treatment initiation when the rhizomes had been reduced to 4 cm lengths and the shoots thereafter broken off at emergence (Table 1, Fig. 2). In contrast 260 days or more were required when the rhizomes were kept intact and reburied at intervals.

The developmental stage at which rhizomes were buried influenced the time (but not the number of operations) taken to prevent regrowth. It took longer when disruptions subsequent to the initial one were delayed until the five to six leaf stage. This

was probably due in part to the increased amount of time needed to reach this more advanced stage and/or to the replenishment of food reserves which apparently occurs when five to six leaves have formed (Bourdote 1980).

These results suggest that yarrow regrowth could be prevented by four cultivations during a period of about 80 days. Such fallow would fit well into a cropping rotation between harvesting of a summer crop, e.g. white clover seed in February/March and sowing winter wheat in May/June. However success would depend upon three major factors: suitable weather conditions for cultivation; the soil being suitable for rotary hoeing to fragment the rhizomes and the effectiveness of subsequent operations to sever the regrowth shoots from the rhizome fragments.

ACKNOWLEDGEMENTS

I wish to thank Lincoln College for providing one of the sites for this work and Mr D.J. Saville, Agricultural Research Division, Ministry of Agriculture and Fisheries, Lincoln, for statistical advice.

REFERENCES

- Bourdote, G.W., 1980. A study of the growth and development of yarrow (*Achillea millefolium* L.). Ph.D. thesis, Lincoln College, New Zealand.
- Bourdote, G.W. and Butler, J.H.B., 1981. A relationship between seed yield of white clover and density of yarrow. *Proc. 34th N.Z. Weed and Pest Control Conf.*: 37-38
- Bourdote, G.W., Field, R.J. and White, J.G.H., 1982. Yarrow: numbers of buds in the soil and their activity on rhizome fragments of varying length. *N.Z. J. Exp. Agr.* 10: 63-67.
- Bourdote, G.W., White, J.G.H. and Field, R.J., 1979. Seasonality of growth and development in yarrow. *Proc. 32nd N.Z. Weed and Pest Control Conf.*: 49-54.
- Fail, H., 1956. The effect of rotary cultivation on the rhizomatous weeds. *J. Agr. Eng. Res.* 1: 68-80.
- Hakansson, S., 1971. Experiments with *Agropyron repens* (L.) Beauv. X. Individual and combined effects of division and burial of rhizomes and competition from a crop. *Swedish J. Agr. Res.* 1: 239-246.
- Johnson, B.G. and Buchholtz, K.P., 1962. The natural dormancy of vegetative buds on the rhizomes of quackgrass. *Weeds* 10: 53-57.
- Matthews, L.J., 1975. Weed control by chemical methods. N.Z., MAF., Bulletin No. 329: 7-8.
- Robocker, W.C., 1977. Germination of seeds of common yarrow, *Achillea millefolium* and its herbicidal control. *Weed Sci.* 25: 456-459.