WILD OATS

F. C. ALLEN

*The Canterbury (N.Z.) Seed Co. Ltd.,
Christchurch*

Summary

In Part I the agronomic characteristics of wild oats (*Avena fatua*) are reviewed. The distribution and control of the weed are commented on. In Part II small plot trials are described. Barban is sufficiently selective at 5 oz active ingredient per acre to control wild oats in Research and Kenia barley and Arawa wheat and at 10 oz in Victory Freezer and Partridge (Maple) peas. Any check to cereals at the 5 oz rate is expressed as delay in maturity. Seeding of wild oats was drastically reduced but not eliminated.

PART I: AGRONOMIC CHARACTERISTICS

INTRODUCTION

THE SPECIES of wild oat, *Avena fatua*, present in New Zealand, was first recorded by J. F. Armstrong from Canterbury in 1872 (Allan, 1940). It can now be found on medium to heavy land in all districts where cereals are grown, though the pattern of distribution is discontinuous, certain fields, farms or small groups of farms being heavily infested while others have only a trace or are clean. Reference to the weed in New Zealand literature is limited to a brief correspondence in the *N.Z. Journal of Agriculture* for 1920, a paragraph in an article by J. L. Symons in the *Journal* in 1954, and a page in Hilgendorf (1952) all recommending combinations of fallow and greenfeed crops for control. Overseas, considerable work has been done on the biology and control of wild oats, while in the past five years a number of control measures using chemicals have been developed.

IDENTIFICATION

The plant is similar to cultivated oats in the vegetative stage though more variable. The collar region (point of junction of leaf blade and sheath) differs from cereals other than oats in the absence of stem clasping ears (auricles). The first leaves of the seedling are usually narrow and less robust than those of cultivated cereals and have an anticlockwise spiral twist whereas wheat and barley twist clockwise. However, the most positive means of identification at this stage is to dig up seedlings and look for the seed hull at the junction of the root and shoot system. Once in seed *A. fatua* is distinguished from cultivated oats by the long bent and spirally twisted awns, the forward-pointing stiff hairs scattered over the hull and aggregated in a ring at its base, and the horseshoe-shaped abscission scar.

AGRONOMIC CHARACTERS

Like other weeds, wild oats compete with the crop with varying success for moisture, soil nutrients and light. Pavlychenko (1940) reported from Canada that over three years' trials wild oats reduced the yield of barley 15.3%, wheat 28.1%, and flax (linseed) 85.1% indicating both the possible magnitude of losses and the variation in competitive ability of different crops. More recently, as reported at the Fifth British Weed Control Conference, chemical control using barban has given a further measure of the importance of this weed. Winter wheat plots containing 70 and 31 wild oats per

sq. yd at time of treatment gave increases of 26% and 19%, respectively (Evans, 1960), spring barley 30% increase when "heavily infested" (Pfeiffer and Phillips, 1960), and garden peas containing 68 wild oats per sq. yd 112% increase over untreated plots (Armsby and Reynolds, 1960).

Wild oats are early maturing and the spikelets shatter readily, thus viable seed is shed within the span of most autumn- and spring-sown crops. Counts in barley at Lakeside averaged 1,920 seeds per sq. yd from 68 plants. Individual panicles with more than 100 seeds are common. Seed is viable from the time the husks begin to colour. Once on the ground the seeds are capable of burying themselves in crevices through the coiling and uncoiling of the hygroscopic awn and the barb action of the forward-pointing hairs.

When fully ripe, the seed enters a period of dormancy which may last four months (Brenchley and Thurston, 1948). This primary dormancy has been attributed by Naylor and Simpson (1961) to a gibberellin-sensitive inhibiting mechanism in the embryo which involves restriction of the accumulation and utilization of sugars. After this period seed stored in cool dry conditions will then germinate completely (Hay and Cumming, 1959). However, in the soil a secondary dormancy is induced by a variety of factors (Hay and Cumming, 1959; Chepil, 1946) including keeping the seed water soaked, lack of oxygen, high temperatures, white light, repeated wetting and drying. Dormancy is associated with the permeability of the hull and seed coat (testa) since dormant seeds will germinate if the hull is removed and the testa pricked. Freezing and thawing together with attrition of the hull and seed coat by abrasion and microbial action probably account for the breakdown of secondary dormancy under field conditions.

Seed stored under favourable conditions retains its viability for at least ten years. Viability in the soil is influenced by the subsequent treatment of the field. No further seeds germinated after five years of continuous fallowing (Thurston, 1961a) whereas after 6½ years under pasture Thurston (1961b) estimated that a field still contained over 2 million viable seeds per acre (413/sq. yd). From these figures and field experience it is unlikely that a period of less than 12 years under pasture will eliminate wild oats once a high level of infestation has been built up in the soil.

Seeds will germinate and reach the surface from depths down to 9 in. (Brenchley and Thurston, 1948). Pavlychenko defines optimum depth as that from which seeds produce the highest percentage germination in the shortest time. He gives 2.5 in. as the optimum depth for wild oats and wheat and 2 in. for barley. Wild oats took ten days to emerge and after 15 days 43.5% had emerged. Wheat and barley took 5 and 4 days to come up and after 15 days the strike was 86% and 89%, respectively.

Chepil (1946) and Thurston (1961a) have shown that the greatest numbers of wild oats germinated in the early spring but that some germination can be expected at any time other than mid-winter.

The wild oat when first up has a smaller assimilating surface and fewer primary seed roots than wheat or barley, but it establishes its secondary root system sooner and catches up with the cereals in growth rate if allowed to. However, plants emerging after the crop root system has established and the foliage has started to shade the ground seldom get above the crop and produce very few spikelets. Thurston reports that many autumn germinating seedlings do not survive the winter.

CONTROL OF WILD OATS

Primary dormancy ensures that some of the factors inducing secondary dormancy will have time to operate before any newly shed seed is ready to germinate. This means that, once seeding

has occurred, four to five years of cleaning crops will be needed to eliminate viable seeds. The importance of sowing clean seed and of roguing and burning stray plants in otherwise clean fields can be appreciated. Under frequent cropping dormant seed numbers build up in the soil and some form of extensive control becomes necessary.

CULTURAL METHODS OF CONTROL

These should be designed to obtain maximum germination and eliminate further seeding. General principles arising from the review are as follows.

Shallow cultivate to bury seeds lightly as soon after harvest as possible. Burning of stubble can be of benefit though results are variable, due possibly to the ability of the seed to bury itself in cracked soil, especially if burning is delayed.

If possible, avoid deep cultivation until a spring strike has been obtained since deep burying favours induction of secondary dormancy.

Winter fallow or sow greenfeed such as short-rotation ryegrass or oats.

Cultivate during August to October to strike and destroy as many seedlings as possible.

Sow to summer greenfeed, such as rape. Summer fallowing is not warranted because of the low level of germination over this period and because it has been shown that viability falls off at the same rate under crop as in fallow. The crops must be utilized before any wild oats come into ear.

Spring-sown barley sown as late as district experience will allow, is, because of its competitive efficiency, the best crop to re-introduce cash cropping to the rotation. For crops in general, heavier seed rate combined with conditions conducive to rapid establishment of the crop assist competitive ability.

Sow down to grass when the wild oat seed numbers in the soil are at a low level. Where possible make summer greenfeed the first crop when ploughing up old pasture believed to harbour wild oats, ploughing in time to get a spring strike.

CHEMICAL CONTROL

Research has been directed along the three lines: breaking of dormancy, preventing production of viable seed, and selective control in crops.

No great progress has been made in the first two. In Canada, ammonium nitrate increased germination of wild oats without reducing the yield of the crop. Maleic hydrazide sprayed at the milk stage has reduced viability to 5%. Timing is difficult, however, and while yield is not affected the viability of the crop seed can be impaired.

The selective chemicals fall into two groups, those applied pre-planting and incorporated in the soil (TCA, proflam and diallate) and the other applied post-emergence to the growing crop (barban).

PRESENT NEW ZEALAND POSITION

It is estimated, on the basis of a roadside survey, that not more than 10% of crops other than fodder crops in the South Island contain wild oats and that under 10% of these are heavily infested to the point where the farmer is concerned for his cereal yields or finds pea or linseed growing hazardous.

In view of the biological efficiency of *A. fatua* and the length of time it has been in the country, the low incidence of infestation is surprising. Seed certification and the high standards of seed dressing must have played a part in reducing rate of spread between farms, and the emphasis on fat lamb production with the need for summer

and autumn greenfeed has slowed or prevented the build-up once introduced. In this respect Wood (1953) states that wild oats are essentially unknown in Ohio owing to regular rotation including corn and fodder crops.

Those properties or fields which are heavily infested usually derive a large proportion of their income from cash crops, often stock are not carried all year round, or reliance is placed on lucerne hay for supplementary feed, and frequently stubble is not burned either to conserve organic matter or because cereals are undersown for future grass or clover seed production. Some alteration in management would be necessary for the successful adoption of cultural methods of control on these properties. For this reason chemicals are likely to find favour and, because strikes of wild oats are erratic and farmers ever hopeful, post-emergent chemicals are to be preferred. At present not more than 2,000 acres in one season would be likely to benefit from spraying in terms of net return.

The current increase in wheat growing could lead to an increase in wild oats on the lightly infested properties. Where possible the inclusion of greenfeed cleaning crops in the rotation would be desirable.

PART II: CONTROL

INTRODUCTION

SINCE Hoffman, Hopkins and Pullen first published in 1959 the discovery of a chemical with the rather improbable property of controlling wild oats post-emergence in wheat and barley, intense research has led to the wide-scale use of barban commercially in North America, England and Europe. Factors involved in its successful use are dealt with in detail by several authors in Vol. 2, *Proceedings of the Fifth British Weed Control Conference*.

In the past two years small plot trials have been laid down to learn something of the performance of the chemical under Canterbury conditions in wheat, barley and peas.

WHEAT TRIALS

In 1960 three rates of barban were applied to May-sown Arawa wheat at the three-leaf and at the 4½-leaf stage when the wild oats were ½- to 2¼- and 1- to 4-leaf. The weather was mild and sunny on the day of application and day after at both times of application. Because the crop suffered from mildew and barley yellow dwarf virus the plots were not harvested.

When the flush of growth began in September it was evident that all rates other than 4 oz at the first time had checked the wheat (quantities throughout this paper are in terms of active ingredient per acre). The differences were most obvious at ear emergence but by harvest the early treatments and 4 oz late treatment had caught up with control in general appearance except for slight differences in length of straw, amount of leaf and delay in maturity. The high-late treatment showed a reduction in straw length and marked retardation in maturity.

Wild oat control was best in the plots which were least checked. Recovery of wild oats in the high-late plots was marked, these plots being worse than the unsprayed. Table 1 summarizes these observations.

BARLEY AND PEA TRIALS

In 1961, two trials in barley were laid down together with observation plots in garden and partridge peas. The Department of Agriculture small plot sprayer was used to apply 10 gal per acre at 30 lb/sq. in. Plot size was 6 ft × 33 ft. On November 9, 1961, the weather was overcast with light NW. wind, low humidity, and

TABLE 1: ASSESSMENT OF BARBAN TRIAL IN ARAWA WHEAT

	<i>Date sprayed</i>	<i>Barban rates per acre</i>		
		<i>4 oz</i>	<i>10 oz</i>	<i>14 oz</i>
Vigour of wheat (Control = 10)	July 29, 1960	10	8.5	8.5
	August 28, 1960	8.5	6	3
Days delay in maturity (Compared with control)	July 29, 1960	0	2	5
	August 28, 1960	1.5	3.5	10
Percentage control of wild oats (Compared with control)	July 29, 1960	75	80	20
	August 28, 1960	65	35	-20

temperature of 80°F. On November 16, 1961, it was overcast, light to moderate SW. wind, high humidity, and temperature 59° to 57°F.

The crops were suffering from lack of moisture and the barley did not give good ground cover until approaching shot blade stage. Rainfall at Tai Tapu over the period October 1 to January 27 was 314 points on 17 days.

Duplicate plots at 10 oz and 20 oz barban were sprayed on the peas on November 9, 1961. Because leaf scorch showed, additional strips were sprayed in the garden peas on November 16, to determine whether a temperature effect was involved.

1961-62 RESULTS

The leaf scorch noted in the peas was more severe on the partridge than the garden variety. The 20 oz treatment caused some stem-break damage to the former but only more accentuated leaf spotting in the latter. At the 10 oz rate a temporary check in growth occurred in the partridge but not in the garden peas. The whitish leaf spotting of garden peas was similar whether sprayed at 80°F or 57°F. The effect thus seems to be a spray droplet concentration reaction.

The garden peas were harvested green and at that stage wild oat control was better than 90%. Vine height, size and maturity of the peas were similar to control but the virtual absence of wild oats made a vast difference to the vining proposition.

The partridge peas were a very poor crop owing to early season drought. Both treatments recovered and the 10 oz were similar in appearance to control, but pods set on the regrowth from plants damaged by the 20 oz treatment were very small. Wild oat control was barely detectable as might be expected from their advanced stage at spraying and lack of crop competition.

In both barley trials all plots were harvested the same day. At Tai Tapu this was considered undesirable but was necessary because the farmer wished to windrow his crop. At harvest the 10 oz plots were estimated to be two days later than control at Lakeside and seven days later at Tai Tapu.

Details of wild oat counts and of barley trial yields are set out in Tables 2 and 3.

DISCUSSION OF BARLEY TRIALS

At Lakeside the 10 oz early treatment gave the best wild oat control and a highly significant yield increase over control, the tendency for all treatments being to increase yield. At Tai Tapu the 10 oz treatment significantly reduced yield. The figures for percentage seconds and 100-seed weight indicate that delay in maturity

TABLE 2: STAGE OF CROP AND WILD OATS AT SPRAYING

Location and Crop	Date of spraying	Crop Growth Stage	Percentage Wild Oats with No. of Leaves								Wild Oats (sq. yd)
			1	1½	2	2½	3	3½	4	5	
Lakeside:											
Research barley	Nov. 9, 1961	2- to 2½-leaf	18	30	7	—	—	—	—	102	
Research barley	Nov. 16, 1961	3- to 4-leaf	8	7	29	22	23	8	3	—	
Tai Tapu:											
Kenia barley	Nov. 16, 1961	2½- to 3-leaf	12	20	50	10	6	1	1	25	
Greenpark:											
Victory											
Freezer peas	Nov. 9, 1961	5-node	2	5	13	30	34	14	2	—	
Lakeside:											
Partridge peas	Nov. 9, 1961	8½-node	—	—	46	—	38	—	31	11	

TABLE 3: YIELD DATA ON SPRING-SOWN BARLEY TRIALS WITH BARBAN

Barban (oz)	Total (bushel per acre)	Clean barley (% of control)	Firsts (% of control)	Seconds (% of Total)	Total 100 Seed weight (g)	Wild Oats (% controlled)
A: LAKESIDE; var. Research						
10	71.6	111.7 A	106.6 a	14.6 b	5.45	88
10 Late	68.3	106.6 A B	95.1 b	19.9 a	5.2	71
5	67.9	105.9 A B	104.9 a	11.8 b c	5.58	66
5 Late	67.7	105.7 A B	102.6 a	13.2 b c	5.43	43
Control	64.1	100 B	100 a b	10.0 c	5.68	0
C.V.	3.8%					
B: TAI TAPU; var. Kenia						
10	44.4	75.3 b	B	61.8 a	3.83	90
5	59.6	101 a	A	36.1 b	4.38	85
Control	59.0	100 a	A	30.4 c	4.63	0
C.V.	6.8%					

was greater than estimated at harvest and affected all treatments, being greater with increased rate or later application. At Tai Tapu this was accentuated by the fact that the controls were also harvested prematurely. From the figures and the appearance of the plots at harvest it seems fair to believe that adjusted harvest dates would have led to improvement in yield of all treatments relative to control except possibly the Lakeside 5 oz early.

A check in growth of barley and wheat has been reported from English trials (Pfeiffer and Phillips, 1960) and has been ascribed to a seasonal effect ("March effect") in the case of wheat since trials gave no conclusive evidence of varietal differences in reaction. In the case of barley, marked varietal differences occur enabling barley varieties to be divided into low, medium and high tolerance groups (Pfeiffer, *et al.*, 1960). Spraying is not recommended for low tolerance varieties of which Proctor is an example. Kenia is listed as medium and Carlsberg II resistant.

On the basis of this trial, Research must be considered at least medium resistant.

Holly (1960) has shown with pot experiments that wild oats show maximum susceptibility to barban at the 2- to 2½-leaf stage while barley susceptibility is less at this stage than later at the 3- to 4-leaf stage. Table 2 indicates that the Lakeside crop had entered the more susceptible stage at the second spraying while the Tai Tapu crop was passing into it. This, no doubt, largely accounts for the observed difference in maturity between times of application at Lakeside. However, the wild oat counts indicate that, in spring barley, optimum time for spraying both crop and wild oats could be expected to coincide. In Research the indication is that this delay affects only harvest date, not yield, and, while wild oat control is less effective with later application, crop yield responses from reduced competition can be expected from a spray period extended slightly beyond the optimum.

Holly (1960) also presents data showing greater spray retention by barley than oats for any given volume of application, with an optimum rate at 10.9 gal/ac. Differential retention may be accentuated in the field by wind drift since the barley is taller than the oats at this stage and may in part account for the increased barley response on November 16, 1961, as a light to moderate southerly was blowing at the time.

The effect of the barban on the wild oats is slow in appearing. Growth continues for a time in already formed leaves which become bluish green and stunted. Growth is at a standstill after two to three weeks and plants may slowly die or after a month begin to send out fresh lateral shoots. These show up yellow-green in marked contrast to the spray-affected leaves. Subsequent development of these lateral shoots depends on environmental factors. In the open they may develop full-sized panicles while in competition with the crop they may produce a few seeds within or at the level of the crop, or remain sterile. At Tai Tapu at harvest there was less than one live plant per square yard in the 10 oz plots and less than two per square yard in the 5 oz plots. No panicles in sprayed plots had more than 20 spikelets and the majority less than 10. In the control plots panicles stood 12 to 18 in. above the barley; most panicles had 30 to 50 spikelets and few less than 10. A count of a representative square yard of control yielded 540 spikelets estimated as 1,080 seeds, whereas the sprayed would be in the vicinity of 20 per square yard.

CONCLUSIONS

Wild oats can be controlled in wheat, barley and peas with advantage to the crop. Seeding can be very considerably reduced but not eliminated.

Research barley is at least of medium resistance to barban.
 Some delay in harvest date is likely in spring-sown barley or May sown wheat sprayed at the 4- to 5-leaf stage (late August).
 Optimum time for spraying May-sown wheat is likely to be mid-to end of July.
 Optimum time for spring barley is when the first germinated wild oats have reached the 2½-leaf stage and the crop is 2 to 2½-leaf. Crop stage may be more critical in the case of Kenia than Research.
 Garden pea variety Victory Freezer and partridge peas tolerate rates of barban adequate for wild oat control.

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