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Survey of the presence and methods of control of wild oat, black grass and couch grass in cereal crops in the United Kingdom during 1977

By J. G. ELLIOTT,* B. M. CHURCH,† J. J. HARVEY,‡ J. HOLROYD,* R. H. HULLS§
AND H. A. WATERSON||

* *Agricultural Research Council Weed Research Organization, Begbroke Hill,
Yarnton, Oxford OX5 1PF*

† *Rothamsted Experimental Station, Harpenden, Herts AL5 2JQ*

‡ *ADAS, ARC Weed Research Organization, Begbroke Hill, Yarnton, Oxford OX5 1PF*

§ *ADAS Extension Development Unit, Block A, Government Buildings,
Coley Park, Reading RG1 6DT*

|| *Advisory and Development Service, The West of Scotland Agricultural College,
Auchincruive, Ayr KA6 5HW*

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SUMMARY

In summer 1977 a random survey was made of 2250 fields on 1153 farms selected throughout the United Kingdom. Wild oat, *Avena* spp., was surveyed in all countries; black grass, *Alopecurus myosuroides*, was surveyed in England and Wales; and couch grass, including *Agropyron repens* and other perennial grasses, in Scotland and N. Ireland.

Wild oat was reported by farmers on 95% of farms in England, 34% in Wales, 65% in Scotland and 30% in N. Ireland; the areas of infestation in the different countries were 67, 13, 37 and 16% respectively. The majority of wild oat was *A. fatua*. Only 6% of the cereal area of U.K., including sprayed and unsprayed fields, contained more than one wild oat seed head/m² (10000/ha), the majority had less than one/20 m². Black grass was reported on 50% of farms in England (22% of cereal area) mainly in East and South, and on 2% of farms in Wales. Couch grass occurred on 92% of farms in Scotland and 68% in N. Ireland: areas of infestation were 88 and 67% respectively. Most of the infestations of all three weeds had been present for longer than 5 years.

Most farmers intended to eliminate or reduce wild oat and few proposed to hold the weed at its present level or do nothing. Herbicides were used against wild oat on approximately half of the infested area in England and Wales, with proportionately more use in Wales and much less in Scotland and N. Ireland. A third of the black grass infested area of England was treated with a herbicide. There was little spraying against couch grass in Scotland and N. Ireland. Details of dose, time of application and mixing of chemicals were obtained. Wild oat was subsequently found on most of the area treated against this weed, similar observations were made of black grass and couch grass. Most farmers considered herbicide performance good or excellent and those in East and South England believed wild oat to be decreasing as a problem; farmers elsewhere thought the problem to be increasing.

Hand pulling of wild oat (roguing) had occurred on only one tenth of the infested area but a greater area was intended to be rogued after the survey visit. Much of the land that had been rogued was found subsequently to contain few wild oats.

The survey provided information on associations between weed presence, soil type and cropping system, the types of herbicide used and farmers' impressions of their performance. Comparisons are made with previous surveys in 1972, and information on the disposal of the 1976 crop of straw and on types of cultivation used in different regions is provided. The implications of the results are discussed.

INTRODUCTION

Three species of *Avena* occur as weeds in British arable agriculture: *A. fatua* L. the wild oat, *A. ludoviciana* Dur. the winter wild oat and *A. strigosa* Schreb. the bristle oat. The commonest species is *A. fatua* which has been widespread in Britain for centuries; often referred to as the spring wild oat it has appreciable seed dormancy and can germinate at any time of the year. *A. ludoviciana* was first recorded at Falmouth, England, in 1914 and was probably imported in wheat from France (Thurston, 1954): the seed is less dormant than *A. fatua*. Its main period of germination is during the autumn and winter after being shed. *A. strigosa*, formerly a crop, is much less common, being reported only occasionally in Scotland and N. Ireland: its seeds have little dormancy. The origins, distribution and many other facets of the species commonly referred to as wild oats have been reviewed in detail recently (Price Jones, 1976).

Alopecurus myosuroides Huds., black grass, is a small seeded annual grass which succeeds best in autumn crops. An abundant production of tillers during mild winters provides many seed heads that shed a vast quantity of seed in July; 59 000 seeds/m² were recorded by Moss (1978). Black grass has been traditionally associated with areas of heavy, wet soils which are used for autumn-sown crops.

Agropyron repens Beauv., common couch, is a perennial grass which survives by seeds and rhizomes that overwinter in the soil giving abundant shoot growth during summer whenever free of competition on arable fields. A major weed of arable England in the 1960's, it declined after the introduction of new techniques of control (Cussans, 1970) but has continued to be present in areas of mixed cereal and grassland farming in Western and Northern Britain, as have *Agrostis gigantea*, black bent and *Arrhenatherum elatius*, false oat grass (also known as onion couch).

All these grass weeds reduce the yield of crops, cause difficulties in harvesting and may contaminate the produce. For these reasons their control is considered of major importance.

Wild oat has been surveyed previously. In 1951 Thurston (1954) obtained 621 samples of wild oat from fields in England chosen on a non-random basis. The species were identified and a map was prepared showing the occurrence of *A. fatua* alone or in mixture with *A. ludoviciana*: the former area covered N.E., E., S.E. and Central Southern England, while the latter was limited to the South Midlands and South-East of England. In 1972, Phillipson (1974) reported on a survey of 1291 fields on 674 randomly chosen farms. The survey excluded the intensive cereal growing areas of

England, and N. and W. Scotland. It showed the extent of infestation in areas not previously associated with wild oat: 74% of the cereal area in S.W. England, 63% of N. England, 25% of E. Scotland and 15% of N. Ireland was infested. In 1969, Waterson & Davies (1973) found only 0.8% of the barley area of West Scotland to be infested with wild oat (*A. fatua* and *A. strigosa*), although the weed was found on 18% of known barley growing farms. Courtney & McCallion (1976) surveying 5098 fields in N. Ireland in 1975 recorded wild oat on 34% of cereal holdings: one quarter of the barley area contained wild oat. According to Perring & Walters (1976) *A. strigosa* has been rarely seen in England since 1930 but is more common in the Hebrides. Waterson & Davies (1973) found it most in Argyll and Bute.

Surveys of black grass have been extremely limited. In 1966 and 1967 Thurston (1968) examined 171 samples obtained from a non-random selection of fields in England, and associated the weed with cereal and herbage seed crops. More information was provided by the Phillipson survey of 1972: in the area surveyed, most black grass was found in S.E. (23% of cereal area), S.W. (16%) and W. Midlands of England (14%). The weed was not found in E. Scotland, N. England or N. Ireland.

There appears to have been no large-scale survey of couch grass, though Waterson & Davies (1973) found common couch on 77% of barley-growing farms in West Scotland.

The past decade has seen major changes in the methods of cereal production in Britain. The amalgamation of farms into bigger units and the concentration of high value cash crops on the best soils near potential markets or processing factories have increased specialization in large-scale cereal growing on much of the remaining arable soils. There has been a widespread adoption of techniques of reduced cultivation. Numerous herbicides and other crop protection chemicals have been used by farmers in an effort to reduce the grass weeds and other problems caused by the repeated growing of cereals. In such a changing situation there is a need to survey all aspects of husbandry, and in particular grass weeds which are major problems for cereal farmers (Elliott, 1975).

This paper reports a survey of the incidence of wild oat, black grass and couch grass. The objects of the survey were threefold: (1) to ascertain the presence and abundance of wild oat and black grass seed heads in cereal crops in England and Wales, and of wild oat and couch grass in Scotland and Northern Ireland; (2) to determine what control measures had been undertaken on selected fields; and (3) to obtain cultural information about the farm as a whole relating to the weeds and their control.

SURVEY METHODS

The survey was planned and co-ordinated by a group appointed by the Steering Committee of the National Wild Oat Advisory Programme (NWOAP). Lists of sample and standby farms were obtained from the Census Branch of the Ministry of Agriculture, Fisheries and Food (MAFF) (for England and Wales), the Department of Agriculture for Scotland (DAFS), and the Department of Agriculture for Northern Ireland (DANI). About 100 holdings on which cereals were grown were selected for survey within each of the eight regions of the Agricultural Development and Advisory Service (ADAS) in England and Wales (Ministry of Agriculture, Fisheries and Food, 1977*a*), the three areas served by the Scottish Agricultural Colleges and Northern Ireland. The selection from the 1976 census files was systematic within regions, the probability of selection of each holding being proportional to its total cereal area. Holdings with less than 2 ha of cereals were excluded. Thus, within a region, each selected holding represented an equal area of cereals.

An introductory letter was sent by regional co-ordinators to the selected farmers, explaining the

aims of the survey and asking for their co-operation. When for some reason it was impossible to survey a farm, a replacement was supplied by the regional co-ordinator, but there were very few replacements. The farm visits were made by qualified staff of ADAS, the three Scottish Colleges and DANI; they were briefed by written instructions supplied through regional co-ordinators.

Completed survey forms were coded by the ADAS Extension Development Unit at Reading and the data analysed at Rothamsted using the Rothamsted general survey program (Yates, 1975). A preliminary report to the Steering Committee was prepared at the Weed Research Organization (WRO), issued to participating organizations and published in December 1977 (Ministry of Agriculture, Fisheries and Food, 1977*b*).

Farmer interview, field selection and field information

The survey was carried out on 1153 farms and on 2250 fields (Table 1). The number of farms per region was in the range 90–99 except in Scotland. The county of Perth is divided between East and West Scottish College areas; but for this survey the whole county was included in East Scotland. Postal addresses were used to select the farms. In a

Table 1. Cereal crops surveyed

Country/region	Percentage of cereal area surveyed		No. of farms visited*	No. of fields examined sown in:	
	Autumn-sown	Spring-sown		Autumn	Spring
England	43	57	659	542	753
S.E.	41	59	99	85	109
S.W.	40	60	90	75	97
E.	60	40	97	102	86
E.M.	49	51	93	90	95
W.M.	37	63	90	71	108
Y./L.	30	70	93	70	116
N.	14	86	97	49	144
Wales	13	87	99	28	165
Scotland	5	95	297	56	524
E.	7	93	107	29	143
W.	1	99	88	8	162
N.	3	97	102	19	219
N. Ireland	< 1	99	98	1	181
All	37	63	1153	627	1623
				Total	2250

Statistical validity of results

Standard errors of percentages in the tables are approximately binomial: $\pm \sqrt{\frac{p(100-p)}{n}}$ where $p = \% \text{ of area}$ in question and n is the number of sampled farms (or fields if less). Thus, for $n = 100$:

% area with weeds	10	20	40
	90	80	60
Approximate s.e. \pm	3	4	5

* See above.

small number of cases the farm location was dissimilar to the postal address. In consequence there are small discrepancies in the tables which are not considered to affect the results. In England 542 fields were of autumn cereal and 753 were spring cereal reflecting the approximate proportions of these crops; but in Wales, Scotland and N. Ireland few fields of winter cereals were recorded due to the predominance of spring cereals in these countries.

Holdings were visited in each locality at the most appropriate time for easy inspection of seed heads of the weeds: this was in early July in Southern England and in August in parts of Scotland. Farmers were first asked whether they had wild oat (or couch grass or black grass) anywhere on their farm and whether they had a general policy for control or elimination of these weeds.

The individual fields on which cereals were grown were then listed as either sown in autumn (before February) or in spring (February or later). Using a table of random numbers, one autumn sown and one spring sown field were selected for detailed observation. If there was only one cereal field on the holding, details were recorded for that field and if all fields were either autumn sown or spring sown, two of these were selected.

For the selected fields details were recorded of soil type (Eagle, 1976), cultivations, current cropping and the crops grown in the previous 5 years. Roguing (hand pulling) for wild oat control and use of herbicides, fungicides or insecticides alone and in mixture since the previous harvest were recorded. If the previous crop was a cereal, the method of straw disposal was noted. The years when the grass weeds were first observed on fields and whether the farmer thought they were tending to increase or decrease were also recorded.

Field assessment

For each of the selected fields an assessment of weed infestation was made in the following way. On entering the field a starting point was located by taking 40 paces along the boundary from the nearest corner and then 3 paces into the crop. From this point, a strip 2 m wide (delineated by carrying a stick) was examined while walking round a square with sides of 100 paces, the first side being at right angles to the field boundary. The 40 paces were occasionally adjusted so that the square walk could be fitted into small or irregularly shaped fields and, if necessary, a rectangle with a perimeter of 400 paces, rather than a square, was walked. For each side of the square the number of wild oat (and black grass or couch grass) seed heads seen was recorded by crossing off symbols marked on the form. To avoid excessive counting in heavily

infested areas, if 75 heads were observed on a side the number of paces by which this count was reached was recorded and counting for that weed recommenced on the next side of the square. In calculating the degree of weed infestation, a standard conversion factor of 1.2 paces per metre has been assumed.

The method of assessment could not prove the absence of a weed from a surveyed field, only provide a reasonable likelihood of its being recorded if present. The results will therefore tend to underestimate the weed presence.

Recognition charts were provided to assist in identifying the survey weeds, with a request to state which individual species of wild oat or couch grass had been identified and the approximate proportion in which these were present. Two typical seed heads of each species present (and of black grass and couch grass) were collected and sent for independent identification by members of the U.K. Agricultural Supply Trades Association, by specialists of the three Scottish Colleges, or by DANI. Instances of disagreement were resolved by a panel of weed botanists provided by WRO and Rothamsted.

RESULTS

The occurrence and degree of infestation of survey weeds

Wild oat

Wild oat was stated by the farmer to have been seen recently on 95% of the farms surveyed in England, 34% in Wales, 65% in Scotland and 30% in N. Ireland. Although wild oat was detected on 67% of the cereal area of England there were small differences between regions, the least being in W.M. (47%) and the most in E. region (76%) (Table 2). The area of occurrence in Scotland was less than England being 37% overall with most in N. region. Wales and N. Ireland contained less than the other countries with 13 and 16% respectively. As spraying of herbicides for wild oat control and/or roguing (hand removal) had occurred on some fields the values in Table 2 are under-estimates of the natural occurrence and degree of infestation (see Tables 9 and 16).

In all countries and regions *A. fatua* accounted for much the greatest area of infestation: in contrast, *A. ludoviciana* which was generally less present, was recorded in the West Midlands of England but only occasionally elsewhere. *A. strigosa* occurred in very small proportions in various parts of the United Kingdom. *A. ludoviciana* was often recorded as being mixed with *A. fatua*.

The estimates of infestation in Table 3 relate to sprayed and unsprayed fields. Only 6% of the cereal area of U.K. contained more than one seed head/m² (10000/ha), though the proportion in

E. region was 11%: the area at this level of infestation in Wales, Scotland and N. Ireland was insignificant. Of the infested land the majority in all regions and countries had less than 1 seed head/10 m² (1000/ha), however there were appreciable areas of infestation higher than this figure particularly in England.

Black grass

Black grass was surveyed in England and Wales only. This weed was stated to have been seen on

50% of the farms in England but only 2% in Wales. There were marked regional differences being most in E., E.M. and S.E. regions and least in W.M., Y./L. and N. regions (Table 4). In all regions a greater proportion of winter cereal was infested than of spring cereal, however 27% of spring cereal in E. region contained black grass. As with wild oat, spraying would have reduced the apparent occurrence and degree of infestation.

In those regions of England where black grass occurred appreciably it was present in a wide range

Table 2. Wild oat: occurrence on farms and on surveyed area and species distribution as percentage of surveyed area by region and country

Country/ region	Farmers reporting wild oat (%)	Cereal area with wild oat (%)			Species distribution (% of cereal area)				
		Autumn	Spring	All	<i>A. fatua</i>	<i>A. ludoviciana</i>	<i>A. strigosa</i>	<i>A. fatua</i> + <i>A. ludoviciana</i>	<i>A. fatua</i> + <i>A. strigosa</i>
England	95	67	67	67	64	<1	<1	1	0
S.E.	97	67	62	64	62	<1	0	1	0
S.W.	88	63	71	68	65	0	1	<1	0
E.	99	73	80	76	75	0	0	1	0
E.M.	98	74	75	75	72	0	0	2	0
W.M.	88	48	47	47	36	6	0	5	0
Y./L.	94	53	67	63	62	0	0	0	0
N.	89	46	54	53	52	0	0	0	0
Wales	34	29	10	13	13	0	<1	0	0
Scotland	65	37	37	37	37	0	0	0	0
E.	75	39	35	35	35	0	0	0	0
W.	27	18	16	16	16	0	0	0	0
N.	69	42	50	50	50	0	0	0	0
N. Ireland	30	—*	16	16	15	0	<1	0	<1
All	89	66	58	61	59	<1	<1	<1	<1

* Figure excluded because only one field recorded.

Table 3. Wild oat: infestations grouped by number of seed heads per hectare and expressed as percentage of surveyed area in each region or country

Country/region	None	< 250	250-500	500- 1000	1000- 2500	2500- 5000	5000- 10000	10000- 50000
England	33	25	7	8	8	7	5	6
S.E.	37	21	7	11	9	7	4	6
S.W.	32	25	9	6	13	7	2	6
E.	24	23	8	9	7	9	9	10
E.M.	25	30	10	9	9	8	4	6
W.M.	53	24	5	3	4	3	5	2
Y./L.	37	32	6	9	7	3	3	2
N.	47	21	3	5	12	6	4	2
Wales	87	4	2	2	2	0	1	2
Scotland	63	23	5	3	3	2	1	<1
E.	65	24	5	3	2	1	1	0
W.	84	12	2	0	2	0	0	0
N.	47	26	8	5	5	4	2	2
N. Ireland	84	9	1	1	1	3	1	1
All	39	24	7	7	7	6	4	5

Note: a negligible proportion contained more than 50000 seed heads/ha.

Table 4. *Black grass and couch grass: occurrence on farms and on surveyed cereal fields*

Country/region	Farmers reporting weed (%)	Cereal area infested (%)			Infested area also with wild oat (%)
		Autumn	Spring	All	
Black grass					
England	50	33	13	22	82
S.E.	61	38	20	27	85
S.W.	40	22	4	11	91
E.	77	44	27	38	79
E.M.	60	33	19	26	85
W.M.	22	11	7	8	100
Y./L.	26	17	5	8	0
N.	2	3	0	1	0
Wales	2	0	0	0	0
Couch grass					
Scotland	92	92	88	88	
E.	98	92	89	89	
W.	93	77	85	85	
N.	74	97	87	87	
N. Ireland	68	100*	66	67	

Species of couch grass identified: % of surveyed area†

	<i>A. repens</i>		
	Alone	With <i>A. gigantea</i>	With <i>A. elatius</i>
Scotland	68	8	5
E.	70	10	0
W.	72	5	1
N.	62	6	13
N. Ireland	42	6	3

* Only one field recorded.

† All other species and combinations of species accounted for less than 4% of surveyed area in each region.

of densities (Table 5). Only 5% of the infested area in England had less than 250 seed heads/ha and 5% had more than 10000 seed heads/ha. The highest infestations occurred where the highest proportion of infested area occurred.

Couch grass

Couch grass occurred on 92% of farms in Scotland and 68% of those in N. Ireland (Table 4). Some 88% of cereal crops in Scotland and 67% in N. Ireland were recorded as containing couch grass.

There are several species commonly described as couch grass. Most of the grass that was positively identified (81%) was *A. repens* growing alone or in mixture with other grasses. *A. gigantea* achieved a maximum proportion of 10% with *A. repens* in E. Scotland, and 6% in that mixture in N. Ireland. *A. elatius* occurred in mixture with *A. repens* on 13% of the area in N. Scotland and less elsewhere (Table 4).

Since herbicides are not used for selective control of couch grass in a cereal crop, the infestations were those occurring without chemical suppression in 1977. Couch grass commonly occurred at densities up to 10000 seed heads/ha but infestations above that level were present in a small proportion (Table 5). Infestation above 50000 seed heads/ha was negligible in Scotland and did not occur in N. Ireland. There were no regional differences in Scotland: N. Ireland tended to have less substantial infestations than those in Scotland.

Most of the infestations of all three survey weeds have been present for more than 5 years and must be regarded as long standing (Table 6).

In England generally farmers thought that wild oat is decreasing rather than increasing, particularly in E., S.E. and E.M. regions where the weed has been traditionally abundant. In N. England, Wales and W. Scotland, however, where wild oat has not been troublesome in the past, increases

Table 5. Black grass and couch grass: infestations grouped by number of seed heads per hectare and expressed as percentage of surveyed area in each region and country

Country/region	None	< 250	250-500	500-1000	1000-2500	2500-5000	5000-10000	10000-50000
Black grass								
England	79	5	2	2	4	3	1	4
S.E.	73	5	3	2	8	3	2	4
S.W.	89	4	2	0	<1	2	0	2
E.	63	10	3	4	5	5	1	7
E.M.	74	4	2	4	5	2	3	4
W.M.	92	2	1	2	1	1	<1	1
Y./L.	92	3	1	<1	1	1	2	0
N.	100	0	0	0	0	0	0	<1
Wales	100	0	0	0	0	0	0	0
Couch grass								
Scotland	12	14	8	12	13	17	15	9
E.	11	17	9	13	15	13	13	9
W.	15	11	6	10	14	18	18	7
N.	13	12	7	12	9	23	15	9
N. Ireland	33	18	8	7	12	7	5	9

Note: a negligible proportion contained more than 50000 seed heads/ha.

Table 6. Duration of infestations, percentage of infested area by year in which the weed was first seen

Year	Wild oat	Black grass	Couch grass
1977	4	5	3
1976	4	2	7
1975	4	6	6
1974	6	5	8
1973	6	4	4
Before 1973	66	64	68
Not known	10	14	5

were reported more often than decreases. The pattern for black grass is very similar except that the regions where increases predominate are the S.W. and Y./L. (Table 7).

Weed control by chemicals and roving

Differences in farmers' attitudes to wild oat control are evident in Table 8. The great majority intended to reduce or eliminate the weed with a minority intent on holding the weed at its present level or on doing nothing. In Scotland, Wales and three regions of England more than half the farmers intended eradication. It should also be noted that 10% of farmers in S.W. England, 19% in Wales and 12% in W. Scotland intended to do nothing about the weed.

Herbicide use

Most of the cereal area of the United Kingdom was treated with a herbicide for the control of

broad-leaved weeds: there were only minor regional differences. The use of a wild oat herbicide occurred on 36% of the cereal area of England, 5% of Wales, 2% of Scotland and 1% of N. Ireland (Table 9). A herbicide against black grass was used on 15% of the cereal area of England and none of Wales. Treatment against couch grass occurred on 4% of Scottish cereals and 2% of those in N. Ireland.

Of the area known to be infested with wild oat in England 45% was treated: there were marked regional differences, 64% of infested area was treated in E. region but only 18% in W.M. Some 7% of infested area in Scotland and 10% in N. Ireland was treated. Of the area infested with black grass in England 39% was treated, there being considerable regional variation. Only 4% of the area of Scotland and 2% of N. Ireland which was infested with couch grass was treated.

There are many herbicides available to British farmers for the control of annual grass weeds; they are usable at different times according to the manufacturers' recommendation. About three-quarters of the herbicide use was after the cereal crops had emerged, and 63% was in the spring (Table 10). The proportions used pre-sowing, pre-emergence and post-emergence in the winter were minor and in the range of 10-14%. The most commonly used herbicides were difenzoquat (26% of usage), tri-allate (18%), iso-proturon (12%), benzoylprop-ethyl (11%) and barban (11%). These figures need to be judged in relation to the adverse weather in autumn and winter 1976-7

Table 7. *Farmers' impressions of changes in weed populations as percentage of infested area*

Country/ region	Wild oat			Black grass		
	Increase	Decrease	Static	Increase	Decrease	Static
England	21	46	34	25	41	35
S.E.	20	36	44	16	40	44
S.W.	27	41	32	45	16	39
E.	13	57	30	21	47	32
E.M.	18	49	34	31	33	36
W.M.	31	36	33	18	54	28
Y./L.	26	41	33	41	36	23
N.	37	32	31	—*	—*	—*
Wales	43	27	30	—*	—*	—*
				Couch grass		
Scotland	31	32	38	23	32	45
E.	32	32	36	23	35	42
W.	33	19	48	26	29	45
N.	30	33	37	21	30	49
N. Ireland	30	40	30	23	26	51

* Insignificant presence.

Table 8. *Farmers' attitude to wild oat control: statements of intention as percentage of infested area*

Country/ region	Elimi- nate	Reduce	Hold	Do nothing
England	45	43	8	3
S.E.	33	50	15	2
S.W.	44	38	7	10
E.	35	52	10	1
E.M.	59	32	6	1
W.M.	53	31	5	7
Y./L.	60	37	2	2
N.	45	45	9	1
Wales	72	0	8	19
Scotland	62	26	5	8
E.	68	23	3	6
W.	53	29	6	12
N.	55	28	7	9
N. Ireland	35	43	22	0
All	46	41	8	3

which may have affected farmers' choice of herbicide (see p. 630).

In U.K. as a whole some 56% of the area receiving grass herbicides was treated against wild oat alone as compared with only 4% against black grass alone and 8% against couch alone: however black grass was often sprayed in association with other weeds (Table 11). Some chemicals (glyphosate, difenzoquat and benzoylprop-ethyl) were usually used against specific single weeds; but others (isoproturon, metoxuron, paraquat and barban)

were used against individual weeds or combinations of weeds.

A high proportion (92%) of the area treated received the recommended dose of herbicide. There was very little resort to doses higher than recommended. However there was occasional use of doses lower than recommended against black grass and wild oat with broad-leaved weeds; the areas involved were small (Table 12).

Relatively little mixing of crop protection chemicals occurred on farms: only 305 000 ha out of 3.9 million ha received such mixtures. Of the area treated, 49% received a proprietary product based on a single chemical: 39% received a proprietary mixture (Table 13). Since many of the percentages are based on relatively little use, they should be treated with caution: the figures are given because of the current interest in farm mixing of chemicals.

The control of weeds by herbicides

Since it was not possible to leave unsprayed areas in fields which would indicate the degree of control achieved by a herbicide, only indirect methods can be used to assess herbicide performance.

In general, farmers were well satisfied with herbicide performance in that 77% of the treatments were regarded as good or excellent while only 4% of the whole were regarded as poor (Table 14). The individual figures in this table should be treated with caution since they are based on widely differing areas of herbicide application. Herbicides used to

Table 9. Area over which herbicides were used as percentage of total area, and as percentage of area infested by each weed

Country/ region	% of total cereal area receiving herbicide for:				% of infested areas receiving herbicide for:		
	Broad- leaved weeds	Wild oat	Black grass	Wild oat + black grass	Wild oat	Black grass	Wild oat + black grass†
England	84	30	9	6	45	39	32
S.E.	83	24	7	4	37	24	18
S.W.	77	17	4	2	26	39*	20
E.	83	49	18	14	64	49	46
E.M.	88	36	11	7	48	43	30
W.M.	83	9	1	<1	18	17*	3
Y./L.	85	21	0	0	33	—	—
N.	92	24	0	0	46	—	—
Wales	84	5	0	0	43*	—	—
			Couch grass			Couch grass	
Scotland	91	2	4		7	4	
E.	95	2	4		5	4	
W.	93	1	4		4*	4	
N.	82	5	3		9	3	
N. Ireland	96	1	2		10*	2	
All	85	26			42		

* Figure unreliable due to small area involved.

† Included in previous two columns.

Table 10. Time of herbicide application against wild oat and black grass; area treated with each herbicide as percentage of total treated area

Herbicide	Time of application:			Total
	Pre-sowing or pre- emergence	Post-emergence		
		Autumn	Spring	
Paraquat	3	—	—	3
Tri-allate	16	1	1	18
Chlortoluron	2	1	1	4
Isoproturon	2	5	5	12
Metoxuron	—	Not known		3
Barban	—	1	10	11
Difenzoquat	—	2	24	26
Flamprop-methyl	—	—	2	2
Flamprop-isopropyl	—	—	9	9
Benzoylprop-ethyl	—	1	10	11
Totals	23	11	63	96

All other herbicides accounted individually for less than 2% of total.

control both grass and broad-leaved weeds were regarded as satisfactory less often than special purpose products. There was no evidence that farmers who used a dose other than that recommended achieved a different herbicide performance.

The use of a herbicide against a particular weed

did not usually ensure the absence of that weed, since 78% of the area treated against wild oat, 70% of that treated against black grass and 100% of that treated against couch grass was subsequently found to contain the weed (Table 15). Appreciable infestations (more than 10000 seed heads/ha) were found on 8% of land treated against wild oat, 20% treated against black grass and 13% treated against couch grass. A comparison of the columns of treated and untreated for each weed in Table 15 also indicates that populations of all three grass weeds were proportionately less on the unsprayed than the sprayed areas, but it must be remembered that only areas with appreciable infestations would have been treated.

Roguing of wild oat

Roguing is the practice of hand removal of wild oat when it occurs in a very light infestation (less than 500 seed heads/ha), at a time of year when the plants are easily visible in a cereal crop, usually in July or August. About half the infested area of England and Wales contained roguable levels of wild oat; the proportion in Scotland and N. Ireland was higher (Table 16).

Although a chemical glove is available for roguing, reports of its use were insignificant in number; virtually all roguing was by hand-pulling. Roguing was carried out before the survey visit on

Table 11. *Farmers' objectives: weeds against which grass-killing herbicides were used. Percentage of each herbicide used against different weed populations*

Herbicide	Wild oat	Black grass	Couch grass	Broad-leaved weeds	Wild oat + black grass	Wild oat + broad-leaved weeds	Black grass + broad-leaved weeds	WO + BG + broad-leaved weeds	Others	% of all grass herbicides
TCA	—	—	9	—	—	—	—	—	—	1
Aminotriazole	—	—	6	—	—	—	—	—	—	<1
Paraquat	2	22	9	25	3	—	9	12	84	15
Glyphosate	—	—	76	4	—	—	—	—	5	7
Tri-allate	21	—	—	4	19	—	—	—	1	14
Terbutryne	—	—	—	1	3	3	—	—	—	<1
Chlortoluron	1	23	—	—	17	6	—	—	2	3
Isoproturon	1	42	—	7	39	—	71	38	5	8
Metoxuron	—	13	—	11	4	8	18	28	—	2
Methabenzthiazuron	—	—	—	41	—	—	2	—	3	3
Barban	10	—	—	5	7	74	—	22	—	9
Chlorfenprop-methyl	2	—	—	3	—	—	—	—	—	1
Difenzoquat	35	—	—	—	3	—	—	—	—	20
Flamprop-methyl	2	—	—	—	5	—	—	—	—	1
Flamprop-isopropyl	12	—	—	—	—	10	—	—	—	7
Benzoylprop-ethyl	15	—	—	—	—	—	—	—	—	9
All grass herbicides	56	4	8	5	7	3	2	2	13	100

Area 844 000 ha

This table refers to the United Kingdom as a whole.

Table 12. *Dose of herbicide used to control a particular weed population, expressed as percentage of area treated*

Weeds	Dose recom-		Area
	Higher mended	Lower ('000 ha)	
Wild oat	2	92	6 465
Black grass	0	84	16 30
Couch grass	2	97	1 62
Broad-leaved weeds	3	92	5 3096
Wild oat & black grass	0	97	3 57
Wild oat & broad-leaved weeds	0	84	16 22
Black grass & broad-leaved weeds	0	100	0 20
Wild oat + black grass + broad-leaved weeds	0	100	0 14
Others	3	76	21 99
All	3	92	5 3867

12% of the area infested with wild oat in England, 4% in Wales, 22% in Scotland and 10% in N. Ireland. In England there were minor differences between regions (range 7–19%). In E. Scotland a greater area had been rogued than in W. or N. Scotland (32 v. 15 and 14%). In all countries and regions apart from E. Scotland a greater area was intended to be rogued later than had already been rogued. During the survey visits wild oat was seen

Table 13. *Percentage of all herbicide applications which were mixed with other herbicides or pesticides*

Herbicide	Factory mixed	Farm mixed	% of all herbicide applications
For broad-leaved weeds	48	15	78
Glyphosate	0	0	1
Paraquat	0	1	4
Chlortoluron	0	14	<1
Isoproturon	0	5	2
Metoxuron	42	29	<1
Methabenzthiazuron	0	0	<1
Terbutryne	0	0	<1
Tri-allate	0	0	3
Barban	31	0	2
Benzoylprop-ethyl	0	0	2
Chlorfenprop-methyl	0	20	<1
Difenzoquat	0	3	4
Flamprop-isopropyl	0	3	1
Flamprop-methyl	0	40	<1
% of whole	39	12	100

on 50% of the area of England that had been rogued, 79% in Wales, 36% in Scotland and 19% in N. Ireland; indicating a failure to eliminate the weed in many fields. However the numbers of seed heads were small (10–20/ha). Only 2% of the sampled fields had been both chemically treated and rogued before the survey visit.

Table 14. *Farmers' impressions of herbicide performance as percentage of total use*

Herbicides	Weeds	Performance				Area (%)
		Excellent	Good	Moderate	Poor	
Benzoylprop-ethyl Chlorfenprop-methyl Difenzoquat Flamprop-methyl Flamprop-isopropyl	Wild oat	27	48	19	6	8
Tri-allate Barban	Wild oat, black grass Broad-leaved*	11	46	29	14	5
Chlortoluron Isoproturon Metoxuron	Black grass Wild oat Broad-leaved	15	58	19	8	3
Methabenzthiazuron Terbutryne	Black grass Broad-leaved	26	46	26	2	< 1
Glyphosate Paraquat	Couch grass Various	15	73	12	0	1
Broad-leaved herbicides	Broad-leaved	33	55	6	6	4
All		10	67	20	3	78
		13	64	19	4	100

* Including a commercial mixture with growth regulator herbicides.

Table 15. *Infestation of wild oat, black grass or couch grass as a percentage of untreated area, and area previously treated with a grass-killing herbicide*

Seed heads/ha	Wild oat		Black grass		Couch grass	
	Untreated	Treated	Untreated	Treated	Untreated	Treated
None	45	22	83	30	15	0
< 500	30	34	6	20	23	29
500-1000	6	11	1	11	11	4
1000-2500	6	11	3	9	13	14
2500-5000	5	8	2	4	15	30
5000-10000	4	6	1	6	14	9
10000-50000	4	7	2	17	9	12
> 50000	1	1	1	3	1	1
Area ('000 ha)	2749	939	2888	260	522	18

Soil type and previous cropping in relation to weed presence

In a previous section the occurrence and infestation of the survey weeds are presented according to country and region. However the results indicate that weed presence is not primarily associated with geographical location but with other factors.

Of the seven soil textural descriptions allowed, three accounted for 90% of the area sampled, these were light (L), medium (M) and heavy (H) (Table 17). Although there was an indication that wild oat occurred more on heavy soil than light in England, the major difference was with black grass. This weed was clearly associated with heavy and very heavy soils and occurred on light soils to the extent of only 5% of that soil's area. Weed infestation did not appear associated with soil type in Scotland.

Appreciable infestations of all three weeds were associated with a previous history of cereal crops. Absence or presence at a low level of wild oat or black grass was associated with a previous history of grass cropping; couch grass was however often abundant after grass cropping. Mixed cropping produced an intermediate infestation of wild oat and black grass (Table 17). On similar soil and with similar previous crops wild oat was consistently more prevalent in England than in Scotland or N. Ireland. Country, previous cropping and soil texture were three factors which affected the incidence of wild oat. In England, where the sample was large enough to examine the question, the average incidence of wild oat for a given cropping pattern and soil type was almost identical for winter and spring sown cereals.

Black grass occurred more widely in E. and S. England than in the rest of England and Wales:

this difference was consistent for all cropping pattern and soil texture groupings. Under similar soil and cropping conditions, black grass infestations tended to be heavier in winter than in spring cereals.

Couch grass was so generally prevalent in Scotland and N. Ireland that the factors affecting its occurrence are not readily distinguishable.

Other agronomic information

During the survey information was collected which was subsequently not found to be connected

Table 16. Percentages of wild oat infested area with less than 500 seed heads/ha rogued* before survey visit or intended to be rogued; effectiveness of roguing

Country/ region	With < 500 seed heads/ha	Rogued	Intended to be rogued	Rogued area on which wild oat was seen later (%)
England	48	12	27	50
S.E.	44	11	24	40
S.W.	50	9	32	67
E.	41	10	16	54
E.M.	53	17	27	64
W.M.	62	7	41	27
Y./L.	60	19	45	49
N.	45	12	35	34
Wales	46	4	34	79
Scotland	76	22	27	36
E.	83	32	18	32
W.	88	15	4	29
N.	64	14	34	39
N. Ireland	63	10	17	19

* Removal of weed by hand.

with weed occurrence or weed control. This information is presented here.

Disposal of previous straw crop

In studying the information on straw disposal it must be remembered that the summer of 1976 was exceptionally dry and the cereal harvest was early. On the one hand, burning was easy to achieve but on the other, farmers were cautious about burning because of the danger.

Very little straw was chopped and spread; much was baled and removed from the field, particularly in N. England, Wales, Scotland and N. Ireland (Table 18). In most regions of England, apart from the North burning was widespread, particularly where an autumn crop was to be sown; an appreciable amount of the whole straw crop was included in the burn. There was no association of weed occurrence and method of straw disposal.

Field size

There were marked differences in field size according to region and country. In the Eastern region of England 51% of the area was of fields greater than 10 ha and 16% greater than 20 ha; by contrast, in N. Ireland 59% of the land was in fields of less than 4 ha and only 5% in fields greater than 10 ha (Table 19). The other regions were between these two extremes. These results are only approximately indicative of the general situation in British agriculture because the survey procedure for selecting farms avoided all those with less than 2 ha of cereals.

Soil textures

Sand, peat and very heavy soils accounted for only a minor proportion of the textures that were

Table 17. Weed incidence by cropping pattern and soil type; log (seed heads/ha + 1)

Previous crops	Mainly cereals*			Mixed			Mainly grass†		
	L	M	H	L	M	H	L	M	H
Wild oat									
England	1.8	2.0	2.6	1.4	1.8	2.1	0.7	1.0	1.3
Scotland	1.2	1.2	1.4	1.0	0.8	0.8	0.5	0.5	0.6
Wales and N. Ireland	(0.8)	1.1	(2.2)	(0.3)	0.4	(0.8)	0.1	0.2	0.1
Black Grass									
E. and S. England	0.6	1.0	1.9	0.1	0.7	1.9	—	0.6	0.5
Rest of England and Wales	0.1	0.1	0.8	—	0.1	0.5	—	—	0.2
Couch grass									
Scotland	3.3	3.1	3.0	2.9	2.6	2.6	2.8	2.5	2.5
N. Ireland	All soils together	2.9			2.8			1.7	

Figures in parentheses less than 25 sampled fields.

By using log (seed heads/ha + 1) equal differences in this measure correspond closely to equal factors in the (geometric mean) infestation per hectare.

* At least three cereal crops in previous 5 years.

† At least three grass crops in previous 5 years.

Table 18. Disposal of 1976 cereal straw: method of disposal as percentage of area of straw grown

	Chopped and spread	Baled	Baled stubble burned	All burned
Crop sown autumn 1976				
England	3	43	23	32
S.E.	3	43	36	18
S.W.	0	48	40	12
E.	0	38	15	47
E.M.	9	34	21	35
W.M.	2	58	29	10
Y./L.	9	40	1	50
N.*	6	88	4	1
Wales*	0	61	38	0
Scotland*	4	83	5	9
N. Ireland*	0	100	0	0
Crop sown spring 1977				
England	1	70	15	14
S.E.	2	64	27	7
S.W.	0	71	22	6
E.	2	55	16	27
E.M.	0	74	7	19
W.M.	0	78	12	9
Y./L.	4	65	10	21
N.	1	89	3	7
Wales	0	90	10	0
Scotland	1	93	6	< 1
E.	2	88	10	0
W.	2	99	0	0
N.	0	97	2	1
N. Ireland	0	98	2	0

* Figures unreliable due to small area involved.

recorded. Most of the cereal area was in winter wheat or spring barley on soils varying from light to heavy (Table 20). Autumn and spring wheat occurred more on soils classified as heavy or very heavy than on light or very light soils; with barley there was no difference in this respect, both winter and spring barleys occurring equally on light and heavy soils. As indicated in a previous section, soil type influenced the occurrence of wild oat and black grass.

Cultivations

The options open to the farmers in preparing their land for sowing were to mouldboard plough followed by secondary cultivations, to use combinations of tine or disk cultivation without ploughing or to direct drill without prior cultivation. Mouldboard ploughing was the commonest approach in all countries and regions and particularly on land for spring sowing, with only small regional differences (Table 21).

There was a different situation on land for autumn sowing. In South and East England, which

contains more cereals than any other region, 67% was ploughed and 30% was cultivated several times. Other regions of England varied in the extent of non-ploughing. In Scotland and N. Ireland where relatively little autumn cereal is grown, ploughing before autumn cereal was the dominant choice. Direct drilling achieved very minor use, accounting for 1% of sowing of autumn cereal in England and negligible proportions elsewhere. Although up to six cultivations occurred before sowing, about two-thirds of the sowing was after two or three cultivations, with no difference between autumn and spring sowings.

Date of sowing

During 1977 more than 90% of the autumn cereal was sown in all areas between 24 September and 2 December, a period of 10 weeks (Table 22). Within this period there was very little difference in time between North and South or East and West of the United Kingdom: half the winter cereal had been planted by the week beginning 29 October in East and South England, and in W. Scotland and

N. Ireland, while a similar situation was reached in N. Scotland by 5 November. However it should be noted that relatively little winter cereal is sown in N. Britain.

Spring sowing was affected by geographical location, the areas falling into two broad groups. England, Wales and E. Scotland had in common a start to the main period of sowing around 1 March with most of the area sown by mid-April. The remainder of Scotland and N. Ireland was slower to start: the main sowing period commenced on 26 March and was not completed until 7 May. Since sowing is markedly affected by weather the dates might be different in other years.

DISCUSSION

Comparison of results of 1977 survey with other surveys

The year chosen for this survey (1977) involved adverse weather conditions. The autumn of 1976 was extremely wet and therefore not conducive to

the application of pre-emergence or post-emergence (winter) herbicides to autumn cereals or chemicals for couch grass control. The spring of 1977 was similarly wet and windy thereby making difficult the application of foliar herbicides. A letter of enquiry sent out to herbicide salesmen in June 1977 confirmed the view that over much of Central and Southern England there had been an unusually small use of soil-acting chemicals in autumn sown cereals.

A comparison can be made of some of the results of this survey and one carried out in 1972 (Phillipson, 1974) (Table 23). The 1972 survey was limited to four regions of England, one of Scotland as well as Wales and N. Ireland. Certain questions asked in 1977 were not asked in 1972. Black grass was surveyed in E. Scotland and N. Ireland in 1972 but not in 1977. The 1977 survey was of all cereals, the 1972 survey excluded oats. Otherwise the two surveys followed similar designs.

Area of occurrence

The proportion of farms stated to be infested with wild oat increased between 1972 and 1977 in every region other than in Wales; the increases were particularly substantial in N. England, E. Scotland and N. Ireland. However the proportion of cereal area actually found infested was often not as high in 1977 as in 1972. These differences may be due to a greater awareness of the weed by farmers in 1977 and to a greater use of herbicides. The figures for black grass do not indicate a significant increase or decrease of this weed except in S.E. England where it has increased slightly and W.M. England where it has decreased slightly. North England has remained with little black grass.

Comparisons can also be made with two other surveys. In West Scotland 16% of cereal area was infested with wild oat in 1977 compared with 0.8% of barley area in 1969 (Waterson & Davies, 1973). In N. Ireland 16% of cereal area was infested in 1977 compared with about 25% of barley area in 1975 (Courtney & McCallion, 1976).

Table 19. *Percentage of surveyed area on fields of different sizes*

Country/region	Field size (ha)			
	< 4	4-10	10-20	> 20
England	10	47	32	12
S.E.	5	45	37	13
S.W.	12	39	29	20
E.	7	42	35	16
E.M.	9	47	38	6
W.M.	13	55	25	7
Y./L.	9	51	27	14
N.	15	49	30	6
Wales	30	54	8	8
Scotland	14	54	25	8
E.	4	49	34	13
W.	17	60	19	4
N.	19	53	22	6
N. Ireland	59	37	3	2

Table 20. *Percentage of autumn and spring sown cereal grown on different soils*

Cereal	Soil							% of all cereals
	Sand	Very light	Light	Medium	Heavy	Very heavy	Peat	
Autumn-sown								
Wheat	1	2	13	47	31	4	2	30
Barley	< 1	6	20	48	26	0	0	6
Oats	0	27	8	11	44	10	0	< 1
Spring-sown								
Wheat	0	2	16	47	29	6	0	2
Barley	3	4	21	47	22	2	1	59
Oats	2	6	32	36	22	1	1	2
All cereals	2	4	18	47	25	2	1	100

Table 21. *Cultivations for 1977 cereal: percentage of areas prepared by different methods*

	Mouldboard ploughed	Not ploughed	
		Direct drilled or cultivated once	Cultivated several times
For autumn-sown cereal			
S.E., E., E.M. England	67	3	30
S.W., W.M. England, Wales	74	4	22
Y./L., N. England, E. Scotland	77	4	19
W. Scotland, N. Ireland	100	0	0
N. Scotland	100	0	0
For spring-sown cereal			
S.E., E., E.M. England	89	1	10
S.W., W.M. England, Wales	91	1	8
Y./L., N. England, E. Scotland	95	< 1	5
W. Scotland, N. Ireland	96	< 1	3
N. Scotland	100	0	0

Table 22. *Dates of sowing in autumn 1976 and spring 1977: percentages sown during fortnightly periods*

Date of sowing	S.E., E., E.M. England	S.W., W.M. England, Wales	Y./L., N. England, E. Scotland	W. Scotland, N. Ireland	N. Scotland
Autumn					
-23 Sept	2	4	2	0	0
24 Sept.-7 Oct.	19	11	2	0	0
8 Oct.-21 Oct.	17	17	28	24	23
22 Oct.-4 Nov.	20	19	24	32	27
5 Nov.-18 Nov.	23	29	23	44	27
19 Nov.-2 Dec.	12	15	20	0	29
3 Dec.-	7	5	< 1	0	0
Spring					
-25 Feb.	5	2	1	0	1
26 Feb.-11 Mar.	14	15	17	3	11
12 Mar.-25 Mar.	23	24	19	10	11
26 Mar.-8 Apr.	28	28	35	42	19
9 Apr.-22 Apr.	22	27	22	30	32
23 Apr.-6 May	8	4	6	11	20
7 May-20 May	1	1	1	2	5
21 May-	0	< 1	0	1	2

Herbicide use

A comparison of the areas treated with a herbicide for broad-leaved weeds (1977 and 1972 surveys) shows that there were increases in N. England, E. Scotland and N. Ireland but small decreases in S.E., S.W. and W.M. England. These differences may be partly attributable to the very adverse weather for spraying in S. England in 1976-7 and to a use of herbicides combining action against grass weeds with a degree of effect on broad-leaved weeds. There was a substantial increase in the use of herbicides against wild oat and/or black grass in S.E., S.W. and N. England in 1977 as compared with 1972.

During the 5 year interval between the surveys

there was a substantial increase in the numbers of herbicides available for the control of grass weeds. The three herbicides most commonly used in 1972, which were paraquat, tri-allate and barban, declined in proportion of total area sprayed; while benzoylprop-ethyl increased (from 4 to 11% of area treated).

The wild oat problem

Only the most exhaustive scrutiny of the whole field can establish positively the presence or absence of a weed. The field walk represented a compromise in the effort necessary to maximize the chance of recording a weed if it was present while conserving the short time available for each farm visit. Thus a record of presence may be accepted as

Table 23. *Comparison of surveys in 1977 and 1972 (Phillipson, 1974)*

		S.E.	S.W.	W.M.	N.	Wales	E. Scotland	N. Ireland	
% of farms with:	Wild oat	1977	97	90	94	91	40	83	40
		1972	95	87	85	78	51	52	26
Black grass		1977	65	41	24	3	—*	—*	—*
		1972	52	39	33	1	12	2	0
% of cereal area with:	Wild oat	1977	64	68	48	53	13	35	16
		1972	71	74	59	63	31	25	15
Black grass		1977	27	11	8	1	0	—*	—*
		1972	23	16	14	0	2	0	0
% of cereal area treated with herbicide against:	Broad-leaved weeds	1977	83	77	83	92	84	95	96
		1972	89	85	88	86	84	82	76
Wild oat and/or black grass		1977	31	21	10	24	5	—*	—*
		1972	16	11	10	4	1	1	0

* Not surveyed.

fact but a record of absence may more nearly mean such a minor presence (if at all) as not to have been recorded. Many surveyors encountered difficulty in identifying the different species of *Avena*, and because of this may have missed collecting specimens of all the species present. A verified presence may be taken as definite but the non-provision of a specimen cannot be a guarantee of absence.

Wild oat occurs as a weed throughout England, being present on 97% of farms and 67% of the cereal area: only in W. Scotland, Wales and N. Ireland is it much less common, yet N. Ireland was believed to be largely wild oat free a decade ago, so a presence on 30% of farms in that country is a notable change. A comparison with the 1972 survey suggests a continued increase in wild oat presence on farms in the Western and Northern United Kingdom. The observed infestations were mostly light and less than 10000 seed heads/ha. In England many fields had been sprayed and would provide a population well below (perhaps only 10%) what would have occurred naturally. It is concluded that both substantial and light infestations exist in Southern Britain: elsewhere in the North and West where little spraying occurred there is a wide spread of light infestation. Clearly *A. fatua* is the core of the agricultural problem.

Wild oat is associated with the frequent growing of cereal crops and with those soils on which frequent cereal growing is common. This finding agrees with Waterson & Davies (1973) in W. Scotland. Where the past history of the field was grass there were not appreciable infestations of the weed; arable crops other than cereals in the rotation tended to reduce the occurrence of substantial infestation. Thus grass and other arable crops

assisted farmers in the West and North in preventing the build-up of wild oat. Those farmers of East and South England, who are severely limited in the crops other than cereals that they can grow, have to rely on herbicides to limit the weed.

Black grass in England

Although some black grass was found in Wales its presence was insignificant and the agricultural problem is in England. Black grass, unlike wild oat, does not occur throughout the cereal areas of England. The areas of greatest occurrence are in E., E.M. and S.E. regions of England with a lesser presence in the West and North. Where it occurred there were greater proportions of high infestation than with wild oat, perhaps due to the ability of black grass to produce many seed heads from a single plant. A comparison of the 1972 and 1977 distribution of black grass does not suggest a major movement of the weed into new areas.

Black grass appears positively associated with heavy and very heavy soils on which autumn cereals were being grown. A previous history of grass was associated with a virtual absence of the weed and other arable crops diminished its presence. However 27% of the area of spring cereal in E. region contained black grass and 18% of the infestation occurred on medium soils. With black grass there appear to be opportunities of cultural control based on crops other than autumn cereals as is evidenced by the weed's lack of success in areas where autumn cereals represent a minor part of the rotation. However this can be only a part remedy for the farmer on heavy soils where autumn cereals are preferable: such farmers must rely on herbicides to control the weed.

Couch grass in Scotland and N. Ireland

Nearly all the couch grass was identified as *Agropyron repens* with only small contributions of *Agrostis gigantea* and *Arrhenatherum elatius*. Couch grass was widespread throughout Scotland and N. Ireland (92 and 68 % of farms respectively) and in a range of densities up to 50 000 seed heads/ha. In W. Scotland 93 % of farms were infested compared with 77 % in 1969 (Waterson & Davies, 1973). Since it is a perennial plant which spreads in arable land by means of underground rhizomes it is not possible to estimate the plant population from a count of seed heads. An average of 1 seed head/m² (10 000/ha) is regarded as an appreciable presence.

Couch grass showed no particular association with soil type or previous cropping history. A significant point is the high incidence of couch grass after mainly grass crops. It has been shown by experimentation that rhizomes can survive well under grass (Cussans, 1973), this survey provides confirmation that grass does not provide a control of the weed as has been believed.

The use and success of control measures

Since control measures for all the survey weeds are technically available to farmers it was an important part of the survey plan to ascertain farmers' attitudes to control measures they were using, and success they were achieving. In respect of wild oat the great majority of farmers expressed an intention to eliminate or reduce the weed, only a small proportion proposed to do nothing about it. How active were they in fulfilling these objectives?

Roguing is a slow and tedious task but the only practicable means of achieving near elimination of a low population of wild oat (< 500 seed heads/ha). With or without previous spraying 48 % of the infestations in England, 76 % in Scotland, 46 % in Wales and 63 % in N. Ireland were at this low level. At the time of the survey roguing had occurred on only a minor part of the infested area (a maximum of 22 % had occurred in Scotland); admittedly more roguing was intended. Unfortunately wild oat was subsequently found on 47 % of all the land that had been rogued. This evidence indicates that roguing was not being applied as widely or as successfully as is needed to eliminate wild oat.

In considering the use of herbicides it is necessary to distinguish between South and East England where black grass and wild oat frequently occur together and the remainder of the United Kingdom where wild oat occurs without black grass. In E. and E.M. regions of England there was a substantial use of herbicides, mostly post-emergence, for the control of these two weeds but in S.E., S.W. and W.M. regions the proportion of infested area sprayed was less. In those areas of heavy infesta-

tions where farmers have been aware of the grass weeds for many years much use is made of chemicals, elsewhere less use is made, such as in S.W. and W.M. regions where only 27 and 19 % of the wild oat infested area was sprayed. However 46 % of the wild oat area in N. region and 43 % in Wales were sprayed. Scotland seems to behave differently from England in that regardless of region very little spraying for wild oat control was practised, however more roguing occurred.

Although farmers generally expressed satisfaction with herbicide performance, spraying did not lead to the absence of wild oat, black grass or couch grass: appreciable infestation (> 1000 seed heads/ha) occurred on 32 % of the area treated against wild oat, 39 % of that treated against black grass and 72 % of that treated for couch grass. Herbicides, presumably applied to substantial infestations of perhaps more than 10 000 seed heads/ha, caused apparent light infestations, mostly less than 1000/ha.

The significance of the seed heads after spraying lies in those seeds which would ripen and be shed to the ground, thereby adding to the soil burden of seeds and perpetuating the infestation in future years. To the farmers who sought elimination by roguing the seed heads, albeit few in number, meant the continued presence of the weed in the coming years. To the farmers who sought reduction by herbicides a surviving population of 1000 seed heads/ha might mean 20 000–30 000 seeds/ha to perpetuate the infestation. Nevertheless the farmers of East and South England, unlike those in other areas, thought that wild oat was diminishing and this may be an indication that herbicides have reversed a previous trend of increase.

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