THE PROBLEM OF WEEDS IN HERBAGE SEED CROPS

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The growing of grass and clover for seed production has become an important section of British Agriculture, yielding somewhere in the region of 35,000 tons of seed annually representing some £6,000,000 to the agricultural purse.

Since 1939, when Britain was compelled to produce her own seed, the increase has been rapid with a peak in 1949/50 when no less than 150,000 acres were harvested. Since that peak year there has been a drop, but indications are that the present acreage of about 100,000 will be maintained.

A considerable amount of this seed is taken as a catch crop, e.g. some of the Broad Red and Wild White Clover crops, and no special effort goes into the growing of such crops, but a large acreage is grown specially for seed. These crops demand a great deal of thought and work. They are also subject to an inspection scheme carried out by Technical Officers of the N.A.A.S. on behalf of the Plant Breeding Station responsible for the introduction of the particular strain and the Seed Production Committee of the N.I.A.B. It is with these crops and the issue of Certificates following field inspections that this paper is mainly concerned.

There are two major factors controlling the issue of a field approval certificate.

(1) The crops must conform to the genetical standards laid down by the Plant Breeding Station responsible for the introduction of the strain. The protection of this genetical purity by good isolation thus avoiding cross pollination is also an essential part of the scheme.

(2) The final sample of seed must not contain more than 0.5% by weight of total weed seeds in order to qualify for a certificate.

Generally the destruction of weeds in cereals and other major farm crops is carried out in order to remove competition, and in so doing increase the yield of grain or roots. The removal of weed from the herbage seed crop for this purpose is also important, but much more damage can be caused if the seeds of the weeds present find their way through the various cleaning processes and contaminate the final sample and therefore cause rejection. Uncertified seed usually realises 3d. - 6d. per lb. less than the certified sample. This means that on an average crop of seed a loss of £15 - £20 per acre can occur, not to mention the loss of good seed caused by extra cleaning. In very dirty crops this can be as high as 10 - 15 per cent.

Unfortunately many of our seed crops are failing to reach the declared standards; consequently far too much uncertified seed finds its way to the consumer. Often such uncertified samples have been responsible for spreading noxious weeds into districts which were previously free from them.

Table I indicates the extent of contamination by weeds that occurs in a normal season. These records are the results of inspections in the East Midland Province during 1952. Many of the crops classified as "Deferred" contained too many weeds on field inspection to qualify for a certificate, but the processor of the seed is given an opportunity to submit a sample for second consideration after cleaning. Most of the "Rejections" were on account of excessive weed content.

TABLE I

EAST MIDLAND PROVINCE

HERBAGE SEED INSPECTION REPORTS 1952

		Recommended	Deferred	Rejected
Perennial Ryegrass	S23	798½	265¾	44
" "	S24	27	10	39¾
" "	S101	220¾	58	23
Italian Ryegrass	S22	9½	-	8¼
Cocksfoot	S37	816½	319¾	21
"	S26	744¾	344¼	-
"	S143	1740¾	699	188½
Red Fescue	S59	108	6	59
Meadow Fescue	S215	354½	190¼	31½
" "	S53	192	75	-
Timothy	S48	572¼	725	81½
"	S17	172¼	278½	22¾
"	S50	47¼	85½	10
White Clover	S100	126½	315½	30
" "	S184	78¾	186½	63
Red Clover	S151	34½	98½	126
" "	S123	184	145½	20

Total acreage field approved	6183½ =	58.3% total inspections.
Total acreage deferred pending satisfactory seed sample	3793½ =	35.9% of total inspections.
Total acreage of complete rejection	607½ =	5.8% of total inspections.
Total	10584	

There are three stages at which an attempt is isually made to reduce the p possibility of rejection, and in each of these stages the control of weeds plays an important part.

Stage I

When a farmer decides to grow a crop for seed production he must obey certain conditions laid down by the appropriate Plant Breeding Station. The field must have carried at least three successive arable crops before the grass or clover is sown. It must be free from volunteer types of the species to be sown and from weeds likely to be difficult to separate from the seed crop. In order that the officer concerned can make a reasonable assessment an application for stock seed must be made before the field is ploughed, so that injurious species can be identified. A great deal can be done at this stage towards producing a clean sample, although the crop will not be harvested until two years later. However, in spite of these precautions many crops are badly contaminated when harvested.

Stage II

During the season when the crops are harvested an inspection is carried out by N.A.A.S. Officers at some time between May and August, the date depending on the species - e.g. Cocksfoot will be examined in late May or early June but Red Clover will not be seen until August.

If the Officer is satisfied with the genetical purity of the strains a record is made of the weeds present and their frequency, and on the basis of this record the crops are classified as "Recommended", "Deferred", or "Rejected".

Table II lists the weeds that are important and the numbers that the Welsh Plant Breeding Station scheme tolerates. If however the crop is so weedy that it is impossible to determine its trueness to type, or the numbers are in excess of the standards laid down, it is rejected on the spot and must not be taken for seed.

TABLE II

SCHEDULE E
RULE 16
LIMITS FOR CERTAIN WEED PLANTS

(1) In any crop the number of weed plants of each of the species named in the following list and likely to be seed-bearing in the crop at the time of harvest shall not on the average exceed the number stated. (See Special Note overleaf.)

GENERAL LIST APPLICABLE TO ALL CROPS	Number of plants per square yard
Carduus spp. (Thistles)	2
Rumex spp. (Docks and/or Sorrels)	2

(2) In each particular crop in the following list the number of weed plants of any species named in the list, and likely to be seed-bearing in the crop at the time of harvesting, shall not, on the average, exceed the number stated. (See Special Note overleaf.)

SPECIAL LIST			Number of plants per square yard
Geranium pusillum and/or G. molle	(Small flowered crane's bill, and/or Dove's foot crane's bill)	in WHITE CLOVER	1
Matricaria inodora	(Mayweed)	" " "	1
Prunella vulgaris	(Self-heal)	" " "	1
Sherardia arvensis	(Field madder)	" " "	1
Holcus lanatus	(Yorkshire fog)	" " "	1
Lychnis alba	(White campion)	" " "	2
Plantago lanceolata	(Ribgrass)	In RED CLOVER	½
Daucus carota	(Wild carrot)	" " "	½
Geranium dissectum	(Cut-leaved geranium)	" " "	1
Matricaria inodora	(Mayweed)	In TIMOTHY	½
Sisymbrium officinale	(Hedge mustard, etc)	" "	½
Plantago major	(Broad plantain)	" "	1
Cerastium vulgare) Stellaria media)	(Chickweeds)	" "	1
Crepis virens	(Smooth hawksbeard)	" "	1
Urtica spp.	(Nettles)	" "	1
Lychnis alba	(White campion)	" "	2
Holcus lanatus	(Yorkshire fog)	" "	2
Alopecurus agrestis	(Blackgrass)	In COCKSFOOT AND FINE FESCUES	1
Holcus lanatus	(Yorkshire fog)	" " "	1
Bromus spp.	(Soft brome, etc.)	" " "	2
Alopecurus agrestis	(Blackgrass)	In RYEGRASS, MEADOW AND TALL FESCUE	1
Bromus spp.	(Soft brome, etc.)	" "	1
Holcus lanatus	(Yorkshire fog)	" "	2

Special Note. The total number of weed plants of the species listed in paragraphs 1 and 2 above and likely to be seed-bearing in the crop shall not exceed on the average the equivalent in numbers of two dock plants per square yard.

THE PRESENCE OF ANY DODDER WILL DISQUALIFY THE CROP.

CROPS CONTAMINATED IN EXCESS OF THE ABOVE LIMITS SHALL NOT BE HARVESTED FOR SEED OR THRESHED.

(Extract from Welsh Plant Breeding Station Seed Crop Certification Scheme.)

Stage III

Where the crop is "Deferred" the merchant, after cleaning the seed, may submit a sample to the appropriate Plant Breeding Station and if on analysis this sample contains less than 0.5% by weight total weed seed it will qualify for the field approval certificate.

In addition to this scheme which is controlled by the Seed Production Committee and the Plant Breeding Stations, the Wilts., Hants. and Dorset Seed Growers Association and the Lincolnshire Seed Growers Association operate a comprehensive certification scheme whereby all crops which are genetically approved are subjected to systematic sampling before and after processing. Only those crops with less than 0.5% by weight total weed seeds receive the certificate and sealed label of the Association. A crop thus qualifying is guaranteed to be true to type, and of a high standard of purity.

In spite of the strict observance of the precautions listed above, Table III which is an extract from the Lincolnshire Seed Growers' Association's Report for 1952 shows the amount of weed seed that has escaped all the treatments by the farmer's threshing machine and the merchant's cleaning equipment and so become impurities in consumer samples.

TABLE III

COMPREHENSIVE CERTIFICATION SCHEME FOR PEDIGREE HERBAGE SEED (L.S.G.A. AREAS)

WEED SEED INCIDENCE IN 1951 HARVEST CROPS

The following information has been compiled from analysis reports from seed testing of samples of both "as threshed" and processed seed carried out by the Official Seed Testing Station, Cambridge.

For example:- In Cocksfoot, Campion was found in 9 crops as threshed and shown remaining in 3 samples after cleaning but whereas the average content of campion in the 9 crops was 1.14%, in the 3 cleaned samples the average was only 0.09%.

To facilitate reading the following example is given:-

Yorkshire Fog — Average Content — 4 in 22 (Farm 0.36%, Cleaned Seed 0.10%) indicates that 22 farm samples contained this weed seed with an average content of 0.36% and in 4 cases was still present in the cleaned seed with a decreased average content of 0.10%.

1. COCKSFOOT (All strains - 134 crops)

(N.B. - 8 crops not included as check sample results were not available).

For simplicity of tabulation the following symbols are used:-

A = Average weed content in farm samples.
B = Average weed content in cleaned seed.

(i)	Curled Dock	-4 in 27	A = 0.17%	B = 0.08%
	Yorkshire Fog	-4 in 22	A = 0.36%	B = 0.10%
	Campion	-3 in 9	A = 1.1%	B = 0.09%
	Blackgrass	-4 in 13	A = 0.26%	B = 0.23%
	Annual Meadowgrass	-3 in 14	A = 0.01%	B = 0.04%
	Prickly Sowthistle	-3 in 15	A = 0.06%	B = 0.01%

(ii) The most common weeds in order of frequency were:-
Curled Dock; Yorkshire Fog; Prickly Sowthistle; Annual Meadowgrass; Blackgrass; *Barren Brome Grass; Chickweed; *Shepherds Purse; Campion; Soft Brome Grass. (*completely extracted by seed cleaning).

(iii) The following though appearing infrequently were not eliminated in every case but were reduced in content:-
Forget-me-not; Floating Foxtail; Sheeps Sorrel; Thistle.

2. RYEGRASS (S.23 and S.101 only - 44 crops)

(N.B. - 6 crops not included as check sample results not available).

(i)	Annual Meadowgrass	-7 in 37	A = 0.10%	B = 0.02%
	Chickweed	-5 in 25	A = 0.62%	B = 0.01%
	Yorkshire Fog	-3 in 18	A = 0.08%	B = 0.01%
	Wild Oat	-1 in 2	A = 0.48%	B = 0.15%

(ii) The most common weeds in order of frequency were:-
Annual Meadowgrass; Chickweed; Yorkshire Fog; Curled Dock; Mouse-eared Chickweed; *Scentless Mayweed; *Prickly Sowthistle; *Barren Brome Grass; *Cleavers; *Poppy. (*completely eliminated).

(iii) The following though appearing infrequently were not eliminated in every case but were reduced in content:-
Campion; Twitch.

3. TIMOTHY (All strains - 60 crops)

(N.B. - 6 crops not included as check samples results were not available)

(i)	Blackgrass	-4 in 14	A = 0.55%	B = 0.18%
	Scentless Mayweed	-2 in 3	A = 0.07%	B = 0.06%
	Self Heal	-1 in 2	A = 0.06%	B = 0.01%
	Fat Hen	-2 in 6	A = 0.33%	B = 0.06%
	Groundsell	-1 in 2	A = 0.01%	B = 0.01%
	White Campion	-1 in 1	A = 0.30%	B = 0.10%
	Chickweed	-2 in 8	A = 0.06%	B = 0.06%

(ii) The most common weeds in order of frequency were:-
Curled Dock; Blackgrass; Prickly Sowthistle; Chickweed; *Broad Plantain; Thistle; Mouse-eared Chickweed; *Annual Meadowgrass; *Shepherds Purse; Fat Hen; Poppy. (*completely eliminated)

4. MEADOW FESCUE (S.215 and S.53 - 13 crops)

(N.B. - 1 crop not included as check sample result was not available.)

(i)	Small Nettle	-1 in 1	A = 0.50%	B = 0.20%
	Blackgrass	-4 in 5	A = 0.34%	B = 0.10%
	Soft Bromegrass	-5 in 8	A = 0.21%	B = 0.07%
	Chickweed	-3 in 7	A = 0.26%	B = 0.04%

(ii) The most common weeds in order of frequency were:-
Soft Brome Grass; Chickweed; Annual Meadowgrass; Blackgrass; *Speedwell; Prickly Sowthistle; Yorkshire Fog; Forget-me-not; *Mouse-eared Chickweed. (*completely eliminated).

5. RED FESCUE (S.59 - 4 crops)

Ratstail Fescue - 2 in 4 A = 0.23% B = 0.18%
Other weeds appearing were Annual Meadowgrass; Chickweed; Prickly sowthistle, and in each case these were completely eliminated by seed cleaning.

6. WHITE CLOVER (S.100 - 8 crops)

(N.B. - 2 crops not included as check sample results were not available)

(i)	Chickweed	-1 in 1	A = 0.1%	B = 0.01%
	Soft Cranesbill	-1 in 1	A = 0.1%	B = 0.01%
	Blackgrass	-1 in 2	A = 0.06%	B = 0.01%

(ii) The most common weeds in order of frequency were:-
Mouse-eared Chickweed; Curled Dock; *Broad Plantain; Annual Meadowgrass; *Creeping Buttercup; (*completely eliminated)

7. WHITE CLOVER (S.184 - 9 crops)

(N.B. - 2 crops not included as check sample results were not available)

(i)	Self Heal	-2 in 3	A = 0.11%	B = 0.06%
	Blackgrass	-2 in 3	A = 0.44%	B = 0.01%
	Curled Dock	-3 in 5	A = 2.9%	B = 0.01%
	Yorkshire Fog	-1 in 3	A = 0.27%	B = 0.10%
	Broad Plantain	-2 in 7	A = 0.46%	B = 0.01%

(ii) The most common weeds in order of frequency were:-
*Mouse-eared Chickweed; Broad Plantain; Curled Dock; *Creeping Buttercup; *Prickly Sowthistle. (*completely eliminated)

8. RED CLOVER (S.123 and S.151 - 15 crops)

(i)	Orache	-1 in 3	A = 0.37%	B = 0.5%
	Curled Dock	-4 in 11	A = 0.13%	B = 0.01%

(ii) The most common weeds in order of frequency were:-
Curled Dock; *Broad Plantain; *Prickly Sowthistle; *Cut-leaved Cranesbill; *Chickweed; *Mouse-eared Chickweed; *Forget-me-not; *Knotgrass. (*completely eliminated)

This conference is mainly concerned with destroying weeds by chemical means and may easily ask why this problem cannot be solved by this method. Where the crop establishes quickly and is grown in wide rows without a companion plant, spraying in the early stages with growth regulating substances does give an effective control of many broad leaved weeds, but often grasses such as Timothy are so slow to germinate and establish that weeds such as Chickweed have smothered the young seedlings before the crop is fit to spray. Cocksfoot on the other hand does establish quickly and the problem is not so serious.

Perennial Ryegrass and Meadow Fescue are usually sown broadcast in association with a legume, and care must be taken to avoid damaging this companion plant as it may be the main seed crop in subsequent years.

The clovers, both red and white, are a really difficult problem, as they are usually undersown in a cereal crop. By the time this corn crop is harvested and the legume is strong enough to spray, such weeds as Cranesbill, Buttercups, and Plantains are also well established and are almost impossible to destroy without damaging the legume.

Annual grassy weeds, e.g. Black Grass and Sterile Brome are probably the most difficult problem. Their distribution appears to be associated with the areas most suitable for seed growing and it is becoming increasingly difficult to find districts that are climatically suitable for Cocksfoot, Meadow Fescue and Ryegrass which are free from these weeds.

Experimental work has already begun on spraying established seed crops in areas badly contaminated with Black Grass. It is hoped that these weed seedlings will be more susceptible than the well established seed crop, and thus permit selective chemical weed control.

Another problem which is worrying technical officers is the effect of the growth regulating substances on the plant and in particular the time of flower emergence. Generally the contaminating grasses produce their flowers anything from 10 - 15 days earlier than the bred types and this is the main characteristic by which the inspector distinguishes between the strains which he has to examine. If a crop is found to contain a high proportion of early flowering types it is automatically rejected.

If spraying therefore influences the flowering times, the whole basis of the present inspection scheme breaks down. Last year a crop of Meadow Fescue part of which was sprayed on two different dates and part not sprayed was found to have three distinct flowering dates, with a maximum difference of three weeks, in spite of having been sown on the same day with seed from the same parcel. Under the rules of the inspection scheme such a crop would be rejected outright, but growing-on tests have since shown that in spite of this difference, the progeny of the crop still behaved true to type.

It is very encouraging to learn that some experimental work is already being done in this field.

I have listed above just a few of the weed problems which we as technical officers and inspectors encounter in our work. Herbage seed growing has come to stay in this country, and there is also a keen desire within the industry to build up a substantial export market. Our home-grown species and strains are accepted as being superior in performance to commercial seeds, but if they are to compete with seeds from other countries, they must be free from noxious weeds.

Index of Species

Weeds

Annual Meadow Grass	Poa Annua
Annual Nettle	Artica urens
Black Grass	Alopecurces myosuroides
Broad Leaved Plantain	Plantago major
Chickweed	Stellaria media
Cleavers	Galium aparine
Couch Grass	Agropyron repens
Cut Leaved Cranesbill	Geranium dissectum
Creeping Buttercup	Ranunculas repens
Curled Dock	Rumex crispus
Dove's Foot Cranesbill	Geranium molle
Fat Hen	Chenopodium album
Forget-me-not	Myosotis arvensis
Groundsel	Senecio vulgaris
Knotgrass	Polygonum aviculare
Mouse Eared Chickweed	Cevastuim vulgatum
Orache	Atriplex patula
Poppy	Papaver rhocas
Prickly Sow Thistle	Sonchus oleraceus
Rat's Tail Fescue	Vulpia myuros
Scentless Mayweed	Matricaria maritima
Self Heal	Prunella vulgaris
Shepherds' Purse	Capsella bursa-pastoris
Soft Brome	Bromus mollis
Speedwell	Veronica arvenis
Sterile Brome	Anisantha sterilis
Wild Cat	Avena fatua
Yorkshire Fog	Holcus lanatus

Grasses

Cocksfoot	Dactylis glomerata
Meadow Fescue	Festuca pratensis
Perennial Ryegrass	Loluim peremne
Timothy	Phleum pratense
Red Clover	Trifolium pratense
White Clover	Trifolium repens

PRELIMINARY OBSERVATIONS ON THE EFFECT OF 2.4-D ON MORPHOLOGICAL DEVELOPMENT IN GRASSES

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Summary

Single spaced plants of Cocksfoot (Dactylis glomerata) were sprayed with 2.4-D (amine) at 9 developmental stages. Plants of Meadow Fescue, (Festuca pratensis) Timothy (Phleum pratense) and Perennial Ryegrass (Lolium perenne) were sprayed at 10 developmental stages.

Tubular leaf malformations were recorded in Meadow Fescue and Timothy after spraying when the growing points were in the vegetative stage.

Extra spiklets were produced in Meadow Fescue after spraying at the first 6 developmental stages, and it is suggested that this reflects the variation in development of different tillers on the same plant.

Bunched inflorescences in Meadow Fescue and ear malformations in Timothy were recorded after early spray applications. This may be a secondary effect.

Severe stem malformations were noted in Timothy after spray applications at the early developmental stages.

Abnormal ears were recorded in Perennial Ryegrass but some of these occurred in the control plots. Spraying appeared to increase the severity of this abnormality in the early stages of the plants development.

Introduction

Reports have been received by the Seed Production Branch of the N.I.A.B. of damage to grass seed crops which might be attributable to the use of herbicides. The published evidence to support or refute these reports was very incomplete. It was decided therefore to conduct a preliminary trial at Cambridge to ascertain if spraying with herbicides at certain times causes damage to grass seed crops and, if so, whether this can be avoided by applications during certain periods, as in cereals.

Halliday and Templeman (3) reported that Timothy for seed was unaffected by M.C.P.A. if applied when the plants were between 6-14 inches high. On the other hand Cocksfoot treated when 1-1½ inches high was reduced in growth by 1 lb.M.C.P.A.

The effect of 2.4-D on Timothy was studied at 6 centres in Sweden by Åberg and Hagsand (1) who found that the best time to spray was when the crop was 15-25 cms. (6-10 inches) high. Late spraying resulted in lodging of the crop while early applications when the Timothy was about 10 cms. high resulted in ear damage and yellowing of the plant.

Mathews (4) has stated that no damage occurs to grass seed crops in New Zealand provided the herbicides are applied before the flower heads are formed.

This report deals only with the effect of 2.4-D on four grass species - Perennial Ryegrass, Cocksfoot, Timothy and Meadow Fescue - in the first harvest

year, and is based on one years work only. The results given can therefore only be taken as tentative suggestions and not definite recommendations.

Experimental procedure

To enable a close study to be made of the grass seed heads prior to harvest this preliminary trial was conducted on single spaced plants. Each row of 10 plants constituted a plot.

Spraying was carried out at each developmental stage of the plants with 2.4-D (amine) at 1.5 lbs. acid equivalent per acre. Each application was randomised within a block and each block replicated 4 times.

Applications were made to each plant individually by means of a micro-sprayer with a solid cone jet at a pressure of 30 p.s.i. To prevent "drift" a screen was placed round the plant during spraying.

A satisfactory criterion for the developmental stages of the plant had to be found. Grasses being perennial high tillering plants, no one main tiller or even a number of main tillers can be distinguished in the early spring. It is therefore impracticable to count the number of leaves per main tiller as in cereals. The height of the plant is also an unsatisfactory criterion as it depends on many factors such as the age of the stand, the level of fertility, and the management of the crop in the previous autumn and winter.

A third method is to examine the growing point of the grass and to use the morphological development of this as a criterion of the developmental stages of the plant. This method was used in the experiments described below but it has certain limitations, for in a mixed population which constitutes a grass "strain" there is a considerable variation in the appearance of the apex at any one time both between different plants of the same strain, and, between different tillers of the same plant due to the large number of tillers produced. The developmental stages used were those which showed on the majority of the growing points examined at one particular time and are therefore relative rather than absolute.

Experimental Results 1954

Meadow Fescue (Festuca pratensis)

S.53, in which the seed head normally emerges in the last week of May was used in this trial. The growing points were examined every week and the spray was applied at each developmental stage.

TABLE I

DEVELOPMENTAL STAGES IN MEADOW FESCUE

Developmental Stage	Appearance of The Growing Point	Average Height of Plants in Cms.
1	Apex short.2 vegetative primordia.	5.7
2	Apex elongated. 4-6 vegetative primordia and double ridges.	8.6
3	Secondary reproductive primordia forming.	10.6
4	Tertiary reproductive primordia at centre of apex.	13.8
5	Ridges of glumes forming on advanced floret buds at centre of apex.	16.8
6	Terminal bud formed. Glumes visible on all floret buds.	18.5
7	Anthers budded off in floret buds.	28.0
8	Ears in boot stage. Anthers elongated.	32.1
9	Ears emerged.	50.1
10	Anthesis.	66.2

All the plants treated at Stage 1 and 60% of those treated at Stage 2 developed tubular leaves (Plate I). Many of the ears either failed to emerge or emerged with difficulty due to these abnormal leaves (Plate II) thus reducing the number of fertile tillers at harvest.

Abnormal ears were recorded in those plants treated at stages 1-6 inclusively. By far the most common abnormality was the production of extra spikelet branches. Normally two main branches arise from the lower nodes of the inflorescence in Meadow Fescue but in plants treated at these stages tillers were found which had 3 or 4 branches arising from one node (Plate III).

Treatment at stages 1-3 caused abnormal ears on the earlier tillers, while treatment at stages 4-6 caused the abnormality to occur on the late tillers. Most damage resulted from spraying at stage 2 when the reproductive primordia were forming though not yet visible as definite protuberances.

Some plants treated at stages 1 and 2 had a few tillers showing bunched inflorescences (Plate III) but this may have been a mechanical secondary effect from the tubular leaves.

TABLE II

PERCENTAGE OF ABNORMAL EARS IN MEADOW FESCUE

Developmental Stage	Percentage of Ear Abnormalities			Angular Transformation
	Primary Tillers	Late Tillers	Total	
1	13.6	-	13.6	21.64
2	20.2	-	20.2	26.74
3	7.6	1.9	9.5	17.95
4	0.9	6.7	7.6	15.96
5	-	2.9	2.9	9.81
6	-	2.3	2.3	8.67

Standard Error for 500 tillers 1.273
P. < 0.05 = 3.64
P. < 0.01 = 4.62
Block differences are not included.
Figures refer to both branched and bunched inflorescences.

Timothy (Phleum pratense)

Timothy is late maturing and consequently the development of reproductive primordia on the growing point starts later in the spring than in Meadow Fescue. S.51 in which the seed heads normally emerge in the middle of June was used in this trial.

TABLE III

DEVELOPMENTAL STAGES IN TIMOTHY

Developmental Stage	Appearance of The Growing Point	Average Height of Plant in Cms.
1	Apex short 2-3 vegetative primordia.	7.3
2	Apex elongated 5-9 vegetative primordia.	10.7
3	Double ridges and secondary reproductive primordia.	17.6
4	Secondary reproductive primordia on apex, with tertiary reproductive primordia in centre.	22.9
5	Tertiary reproductive primordia along most of apex. Secondary primordia at tip, quaternary primordia at the centre of apex.	27.4
6	Terminal bud formed. Quaternary reproductive primordia on most of apex with ridges of glumes in the centre.	32.1
7	Anthers budded off in floret buds. Glumes covering developing floret buds, with long awns.	42.5
8	Boot stage. Anthers elongated in floret buds. Base of glume elongating same length as awns.	51.3
9	Ears emerged.	65.7
10	Anthesis.	93.8

Severe tubular leaf was recorded in all plants sprayed at stages 1 and 2. Many ears had difficulty in emerging while others were still in a contorted state at the base of the plant at harvest time, consequently the number of seed heads was reduced.

Stem malformations were recorded in plants sprayed at stages 1 and 2 and to a lesser degree in those sprayed at stages 3 and 4. (Plate IV).

Ear abnormalities occurred in plants sprayed at stages 1 and 2. The most pronounced effect was the failure of florets to develop on parts of the inflorescence leaving a bare rachis. Similar gaps were occasionally found in untreated plants and were due to insect damage. The only difference between these two types is that, generally, spray damage is accompanied by a twisted rachis. Bent ears were also recorded. (Plate V).

TABLE IV

PERCENTAGE OF ABNORMALITIES IN TIMOTHY

Developmental Stage	Percentage of Abnormal Tillers			Angular Transformation		
	Stems	Ears	Total	Stems	Ears	Total
1	24.4	6.3	30.7	29.58	14.53	33.62
2	18.7	5.0	23.7	25.59	12.9	29.12
3	11.1	-	-	19.49	-	-
4	5.1	-	-	13.03	-	-
5	0.3	-	-	1.71	-	-

Standard Error for 1,000 tillers = 0.911.
P.< 0.05 2.52
P.< 0.01 3.31
Block differences are not included.

Perennial Ryegrass (Lolium perenne)

S.23, a late strain normally emerging at the end of May, was used in this trial.

TABLE V

DEVELOPMENTAL STAGES IN PERENNIAL RYEGRASS

Developmental Stage	Appearance of Apex	Average Height of Plants in Cms.
1	Apex short 2-3 Vegetative primordia.	5.3
2	Apex elongated 4-7 Vegetative primordia.	7.6
3	Double ridges at base of apex. Secondary reproductive primordia appearing at top of apex.	11.9
4	Secondary reproductive primordia from base to tip of apex.	12.7
5	Ridges of glumes in centre of apex.	13.5
6	Terminal bud formed. Anthers budded off in floret buds.	17.7
7	Anthers elongated in floret buds at centre of apex.	20.6
8	Boot stage. Anthers well developed in all developing florets.	24.3
9	Ears emerged.	34.1
10	Anthesis.	59.6

The results from this trial are complicated in the first place by the occurrence in untreated plants of ear malformations similar in all respects to those found in sprayed plants and secondly by the high tillering capacity of Perennial Ryegrass with a very wide variation in the developmental stages within each plant.

No leaf malformations were recorded. Both branching of the ear and bunching at the tip of the inflorescence were noted in the treated and untreated plants. Spraying at stages 1-3 caused most damage while those plots treated at stages 4 and 5 showed fewer abnormal inflorescences. The

least affected plots were those treated at stages 6-10 which showed about the same amount of damage as the control.

Ears with opposite spiklets instead of the normal alternate arrangement were found in plants treated at stages 1-5 but were absent from the later treatments and the control. (Plate VI)

Cocksfoot (Dactylis glomerata)

This is an early maturing grass in which the ears normally emerge about mid-May. 4 strains were used in this trial - S.37, S.143, Scotia and Roskilde. Only 9 sprayings were done, the last at anthesis being excluded due to the plants being taller than the screen so that it would have been impossible to stop spray drift.

TABLE VI

DEVELOPMENTAL STAGES IN COCKSFOOT

Developmental Stage	Appearance of The Growing Point
1	Apex short. Vegetative primordia.
2	Apex conical. Double ridges above vegetative primordia.
3	Apex conical. Secondary reproductive primordia.
4	Apex conical. Tertiary reproductive primordia at centre and secondary primordia at top.
5	Quaternary reproductive primordia developing at centre.
6	Terminal bud forward. Glume ridges at base and elongating in the centre.
7	Inflorescence intermodes elongation. Anthers budded off.
8	Boot stage. Anthers elongated in floret buds. Inflorescence very elongated.
9	Ears emerged.
10	Anthesis.

In 1954 none of the sprayed plants developed any marked abnormality either of the leaves or the seed heads.

Discussion

Both leaf and ear abnormalities can occur in some grasses after spraying with 2.4-D (amine). The exact extent of this type of damage and the factors affecting it have yet to be fully worked out but this preliminary work suggests that many problems have to be resolved before any definite recommendations can be made.

One aspect requiring study is a satisfactory criterion of the developmental stages for use in the field. This may be difficult due to the many and varied influences mentioned earlier in this report.

There is also the problem of the different fromulations and rates of application that may be used.

The preliminary results indicate that leaf malformations are developed by plants with convolute leaves (Meadow Fescue and Timothy) but not by those with conduplicate leaves (Perennial Ryegrass and Cocksfoot). This may be due to the larger number of "motor" cells in the former two species.

The production of extra spiklets in Meadow Fescue is apparently due to spraying at a time when the reproductive primordia are being formed but are not yet visible as definite protuberances on the growing point. Some tillers are in this suceptible stage when the main bulk of tillers are showing well formed glumes. This shows the variation in developmental stages between tillers on the same plant which complicates the assessment of all these results.

Both the "bunching" of the ear in Meadow Fescue and the ear abnormalities in Timothy seem to be mechanical secondary effects from the tubular leaf abnormality rather than a direct effect of the spray on the developing inflorescence.

The results obtained in the Ryegrass trial are difficult to evaluate due to the presence of abnormal inflorescences in the control plots. These abnormalities have been noted for some time in both Perennial and Italian Ryegrass but whether they are due to genetical, phsiological, or a combination of both factors is not known. Spraying from stages 1-5 did appear to increase the number of branched inflorescences and it was from treatments at these stages that the production of opposite instead of alternate spiklets was observed.

The Cocksfoot trial was disappointing in that no damage was recorded although there have been reports of malformed ears in Cocksfoot both in this country and in Sweden. The apparent resistance recorded at Cambridge in 1954 may have been due to a combination of many factors such as the dry conditions in the early part of the season, a very open autumn which induced the plants to produce a large amount of vegetative growth, and the relatively large amount of sclerenchyma in the leaves of Cocksfoot.

None of the trials showed any sterility in the seed heads as a result of late applications of 2.4-D. This may be due to cross pollination in grasses which might have nullified any effect of the 2.4-D on anther and pollen formation in the treated plants.

These preliminary and tentative results from one years work suggest that there are certain stages in the development of these grasses when they are susceptible to 2.4-D and at these times it would be inadvisable to spray until more is known about the extent of the resultant damage.

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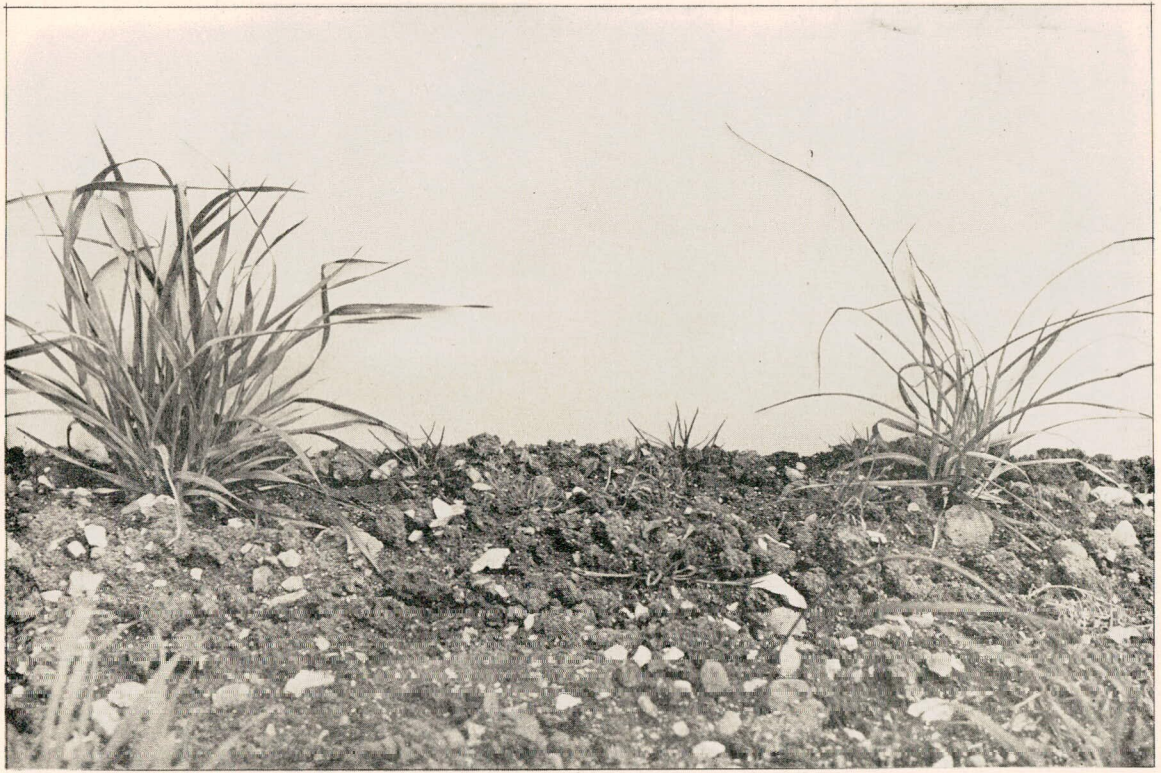

PLATE I Meadow Fescue - Tubular Leaf Abnormality
Plant on left unsprayed.

PLATE II Meadow Fescue - Inflorescence emergence hindered by tubular leaves.

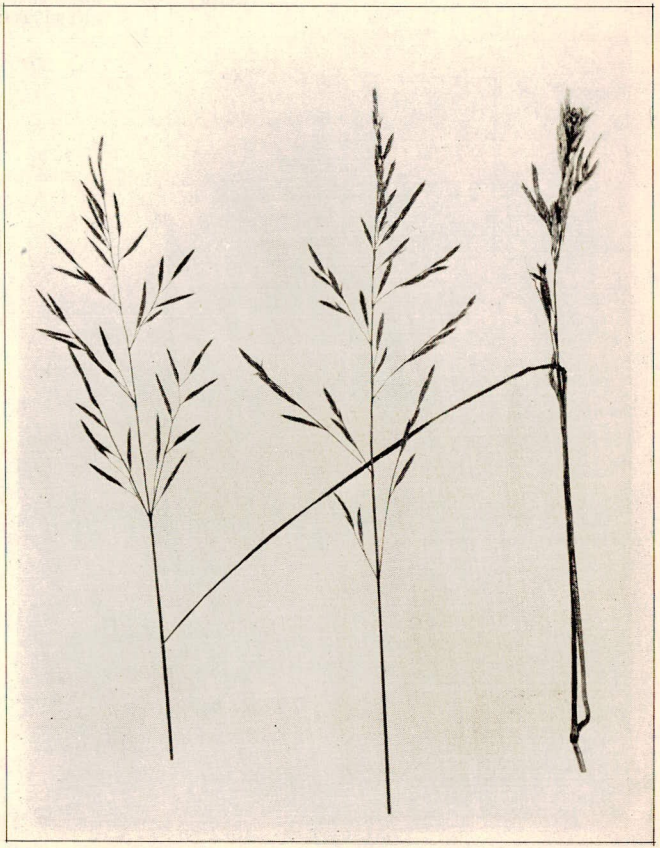

PLATE III Meadow Fescue - Ear Abnormalities Control plant in the centre. Others sprayed with 2,4-D (amine).

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PLATE IV Timothy:- Stem abnormalities.
All these plants sprayed with 2.4-D (amine).

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PLATE V Timothy - Ear Abnormalities
Control plant right centre, rest sprayed with 2.4-D (amine).

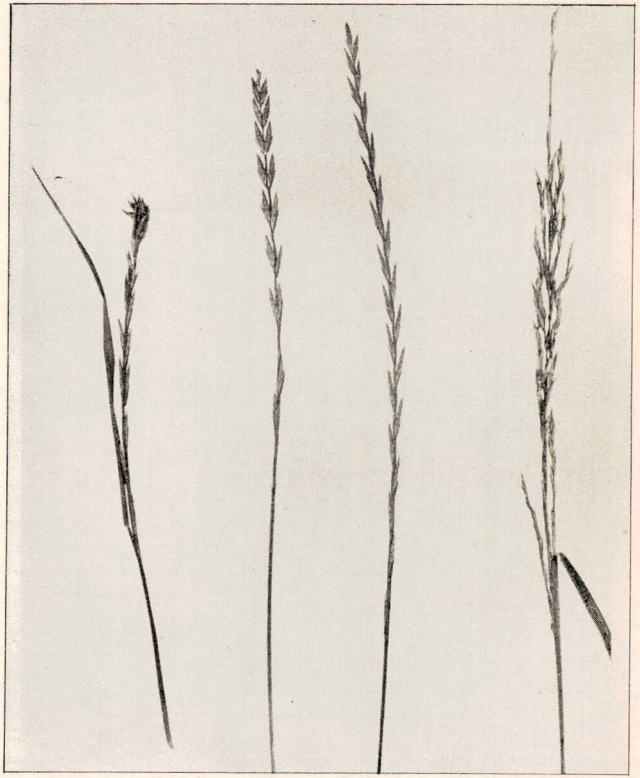

PLATE VI Perennial Ryegrass - Ear Abnormalities
Control plant right centre. Rest sprayed with 2.4-D (amine).
Note:- Ear abnormalities similar to the two outside plants were observed in unsprayed control plots in 1954.

Mr. B. G. Hartt: Mr. Williams has presented a picture that is particularly disturbing to those of us who are concerned with seeds, whether it be the growing or the inspection of them, or their processing. One field in three of Aberystwyth seed crops turned down because of too many weeds, is certainly a rather black record. This loss of crop and the expense of costly cleaning certainly needs our attention.

Mr. Williams has said that the east is the right place to grow herbage seed. Well, I come from the south and in Hampshire, Wiltshire and on the borders of Dorset we think we can grow seed. Our main problems in these areas are grass weeds. We can grow all sorts of weeds very happily, but grasses such as Yorkshire fog, blackgrass and sometimes couch are the main problem. Professor Sanders' remedy of cultivations has so far been our only real answer although I hope that before long we shall hear of new methods of selective chemical control for some of these really serious grass weeds.

Mr. Jeater has given us an interesting account of the important work that he has started. I know there are many pitfalls in the spraying of grass seed crops and am interested to learn about some of them. I would like to ask him, although perhaps it's a little outside his paper, whether there is any indication that we must watch for similar difficulties with the clover seed crop, particularly red clover? I would also like to know if he thinks it might be possible to make the task of spraying the grass seed crops easier and safer by management practices such as the judicious use of nitrogen, both in the autumn and the spring, and will the addition of nitrogen have any influence on the liability of the plants to form distorted heads?

Mr. R. S. L. Jeater: In reply to Mr. Hartt's first question concerning clovers, we haven't worked with them as yet at the N.I.A.B. It was only last year that we started with grasses. Obviously management is going to be of considerable importance, but I don't think that it will be possible to influence appreciably the development of the primordia. It will be possible to effect the vigour of the crop but not to change the pattern of bud development, which is mainly a photoperiodic response.

Mr. J. D. Fryer: I was privileged to see Mr. Jeater's plots this summer in Cambridge and was impressed by the damage that can be caused by the use of 2,4-D on timothy in particular; I believe the 2,4-D applications which caused the deformities and very obvious damage to the plants were made in April or possibly the end of March. I would like to know from Mr. Williams whether commercial practice does indicate that an application of MCPA or 2,4-D is likely to be required for weed control at around this time of year? What, at the moment, Mr. Williams, are the commercial applications for these weedkillers on herbage seed crops of this type?

Mr. O. G. Williams: Many weeds can be dealt with in the first year, the maiden year, when the crop is in the seedling stage. This method of control is usually only partly satisfactory and the farmer has to spray again in the spring of the harvest year. Inspectors are often asked by farmers who find their fields infested with docks and thistles: "May we go in here and at least stop these plants from seeding". The seed inspection scheme lays down that the number of certain seed bearing weeds present in the crop shall be below a specified number. Quite often a farmer may get away with his field approval if he can by some means or other, by about mid-May to mid-June, show that the weeds present will not be seed bearing. I feel that it's going to be very, very difficult to control weeds in the maiden year, and that in consequence it will have to be done in March or April and even into May of the harvest year.

Mr. W. Ochiltree: Has Mr. Jeater compared MCPA with 2,4-D?

Mr. R. S. L. Jeater: We haven't tried MCPA at all.

Concerning a point raised by Mr. Fryer, we did ask the N.A.A.S. Inspection Officers to send us reports of any crops that they came across that had been sprayed. Reports were received from Mr. Williams' area and from the Wiltshire, Hampshire and Dorset areas and the majority referred to S 48 Timothy. Farmers appeared to spray at the end of May or the first two or three days of June. Except for one case, where there was a report that the flowering had been later and irregular, none of these reports gave any indication at all of malformation. These observations 'tie up' fairly well with my work which showed that Timothy would generally be past the susceptible stage by the end of May.

Mr. F. P. Cattle: It is a practice in Lincolnshire to sow certain grass seed crops under peas; the grasses being sown in wide rows at right angles to the rows of peas. The peas are then sprayed with DNBP to control annual weeds and after the pea crop is harvested the grass seed crop can be inter-row cultivated.

Mr. O. G. Williams: We in Lincolnshire feel very happy indeed about this method of undersowing pea crops with grass seed crops. When the pea crop is well up we sow either in between or across the peas and we do get a useful yield of grass seed in the next harvest year, whereas normally we would have had to sacrifice the seed crop in that particular season. Such a method does give an opportunity to keep the crops clean by inter-row cultivation but, of course, it only applies to crops such as cocksfoot and timothy which are grown in wide rows. A difficulty comes when we are growing ryegrass and perhaps to a lesser extent meadow fescue which are sown broadcast and usually in association with a legume.

Our biggest concern is, of course, the graminaceous weeds, such as blackgrass, which is associated with the drier arable areas where we like to grow our seed crop. Blackgrass is becoming a very real problem, even with cocksfoot where it is possible to cultivate in between the rows. In the autumn of the year following the taking of the first seed crop a mass of blackgrass seedlings often establish themselves, and are subsequently responsible for the rejection of the crop.

The other important weed is Poa annua, particularly in crops of Poa pratensis or Poa trivialis grown for seed.