No. 8200080

THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

Germinal Holdings Limited

Whereas, THERE HAS BEEN PRESENTED TO THE

Secretary of Agriculture

AN APPLICATION REQUESTING A CERTIFICATE OF PROTECTION FOR AN ALLEGED NOVELVARIETY OF SEXUALLY REPRODUCED PLANT, THE NAME AND DESCRIPTION OF WHICH ARE CONTAINED IN THE APPLICATION AND EXHIBITS, A COPY OF WHICH IS HEREUNTO ANNEXED AND MADE A PART HEREOF, AND THE VARIOUSREQUIREMENTSOF LAW IN SUCH CASES MADE AND PROVIDED HAVE BEEN COMPLIED WITH, AND THE TITLE THERETO IS, FROM THE RECORDS OF THE PLANT VARIETY PROTECTION OFFICE, IN THE APPLICANT(S) INDICATED IN THE SAID COPY, AND WHEREAS, UPON DUE EXAMINATION MADE, THE SAID APPLICANT(S) IS (ARE) ADJUDGED TO BE ENTITLED TO A CERTIFICATE OF PLANTVARIETY PROTECTION UNDER THE LAW.

NOW, THEREFORE, THIS CERTIFICATE OF PLANT VARIETY PROTECTION IS TO GRANT UNTO THE SAID APPLICANT(S) AND THE SUCCESSORS, HEIRS OR ASSIGNS OF THE SAID APPLICANT(S) FOR THE TERM OF fifteen YEARS FROM THE DATE OF THIS GRANT, SUBJECT TO THE PAYMENT OF THE REQUIRED FEES AND PERIODIC REPLENISHMENT OF VIABLE BASIC SEED OF THE VARIETY IN A PUBLIC REPOSITORY AS PROVIDED BY LAW, THE RIGHT TO EXCLUDE OTHERS FROM SELLING THE VARIETY, OR OFFERING IT FOR SALE, OR REPRODUCING IT, IMPORTING IT, OR EXPORTING IT, OR USING IT IN PRODUCING A HYBRID OR DIFFERENT VARIETY THEREFROM, TO THE EXTENT PROVIDED BY THE PLANT VARIETY PROTECTION ACT (7 U.S.C. 1542, AS AMENDED, 7 U.S.C. 2321 ET SEQ.)

CHEWINGS FESCUE

'Countess'

In Testimony Whereof, *I have hereunto set my hand and caused the seal of the* Plant Variety Protection Office *to be affixed at the City of* Washington *this* 24th *day of* March *in the year of our Lord one thousand nine hundred and* eighty-three.

Attest:

Kenneth A. [illegible]
Acting
Commissioner
Plant Variety Protection Office
Grain Division
Agricultural Marketing Service

John R Block
Secretary of Agriculture

U.S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL MARKETING SERVICE
LIVESTOCK, MEAT, GRAIN &SEED DIVISION

APPLICATION FOR PLANT VARIETY PROTECTION CERTIFICATE

(Instructions on reverse)

FORM APPROVED: OMB NO. 0581-0005

No certificate for plant variety protection may be issued unless a completed application form has been received (5 U.S.C. 553).

1. NAME OF APPLICANT(S): GERMINAL HOLDINGS LIMITED

2. TEMPORARY DESIGNATION:

3. VARIETY NAME: COUNTESS

4. ADDRESS (Street and No. or R.F.D. No., City, State, and Zip Code): COMMERCIAL ROAD, BANBRIDGE, CO. DOWN, N. IRELAND.

5. PHONE (Include area code): BANBRIDGE 24585 OR 22521

FOR OFFICIAL USE ONLY

PVPO NUMBER: 8200080

6. GENUS AND SPECIES NAME: FESTUCA RUBRA ssp. COMMUTATA

7. FAMILY NAME (Botanical): GRAMINEAE

FILING DATE: 3/5/82
TIME: 11:30 [x] A.M. [ ] P.M.

8. KIND NAME: CHEWINGS FESCUE

9. DATE OF DETERMINATION: 25/11/80

FEES RECEIVED
AMOUNT FOR FILING: $ 500.00
DATE: 3/5/82
AMOUNT FOR CERTIFICATE: $ 250.00
DATE: 2/23/83

10. IF THE APPLICANT NAMED IS NOT A "PERSON," GIVE FORM OF ORGANIZATION (Corporation, partnership, association, etc.): PRIVATE LIMITED COMPANY

11. IF INCORPORATED, GIVE STATE OF INCORPORATION: PRIVATE LIMITED COMPANY REGISTERED IN THE U.K.

12. DATE OF INCORPORATION: 1963

13. NAME AND ADDRESS OF APPLICANT REPRESENATIVE(S), IF ANY, TO SERVE IN THIS APPLICATION AND RECEIVE ALL PAPERS: MR. SAM K. McCAUSLAND

14. CHECK APPROPRIATE BOX FOR EACH ATTACHMENT SUBMITTED

a. [✓] Exhibit A, Origin and Breeding History of the Variety (See Section 52 of the Plant Variety Protection Act.)

b. [✓] Exhibit B, Novelty Statement

c. [✓] Exhibit C, Objective Description of the Variety (Request form from Plant Variety Protection Office.)

d. [✓] Exhibit D, Additional Description of the Variety

15. DOES THE APPLICANT(S) SPECIFY THAT SEED OF THIS VARIETY BE SOLD BY VARIETY NAME ONLY AS A CLASS OF CERTIFIED SEED? (See Section 83(a) of the Plant Variety Protection Act.) [ ] Yes (If "Yes," answer items 16 and 17 below) [✓] No

16. DOES THE APPLICANT(S) SPECIFY THAT THIS VARIETY BE LIMITED AS TO NUMBER OF GENERATIONS? [ ] Yes [✓] No

17. IF "YES" TO ITEM 16. WHICH CLASSES OF PRODUCTION BEYOND BREEDER SEED? [ ] Foundation [ ] Registered [ ] Certified

18. DID THE APPLICANT(S) FILE FOR PROTECTION OF THE VARIETY IN THE U.S. OR OTHER COUNTRIES? [✓] Yes (If "Yes," give names of countries and dates) [ ] No

UNITED KINGDOM 27/10/80

19. HAVE RIGHTS BEEN GRANTED IN THE U.S. OR OTHER COUNTRIES? [ ] Yes (If "Yes," give names of countries and dates) [✓] No

20. The applicant(s) declare(s) that a viable sample of basic seeds of this variety will be furnished with the application and will be replenished upon request in accordance with such regulations as may be applicable.

The undersigned applicant(s) is (are) the owner(s) of this sexually reproduced novel plant variety, and believe(s) that the variety is distinct, uniform, and stable as required in Section 41, and is entitled to protection under the provisions of Section 42 of the Plant Variety Protection Act.

Applicant(s) is (are) informed that false representation herein can jeopardize protection and result in penalties.

SIGNATURE OF APPLICANT: S.K. O'L'Causland — DATE: 25/2/1982

SIGNATURE OF APPLICANT: — DATE:

1

FORM LMGS-470 (9-81) (Edition of 1-78 is obsolete)

/INSTRUCTIONS

General: Send an original copy of the application and exhibits, at least 2,500 viable seeds, and *$500* fee *($250 filing fee and $250 examination fee)* to U.S. Department of Agriculture, Agricultural Marketing Service, Livestock, Meat, Grain and Seed Division, Plant Variety Protection Office, National Agricultural Library Building, Beltsville, Maryland 20705. *(See section 180.175 of the Regulations and Rules of Practice,)* Retain one copy for your files. All items on the face of the form are self-explanatory unless noted below.

Item

9 Give the date the applicant determined that he had a new variety based on (1) the definition in section 41 (a) of the Act and (2) the date a decision was made to increase the seed.

14a Give: (1) the genealogy, including public and commercial varieties, lines, or clones used, and the breeding method; (2) the details of subsequent stages of selection and multiplication; (3) the type and frequency of variants during reproduction and multiplication and state how these variants may be identified and (4) evidence of uniformity and stability.

14b Give a summary statement of the variety's novelty. Clearly state how this novel variety may be distinguished from all other varieties in the same crop. If fhe new variety most closely resembles one or a group of related varieties: (1) identify these varieties and state all differences objectively; (2) attach statistical data for characters expressed numerically and demonstrate that these differences are significant; and (3) submit, if helpful, seed and plant specimens or photographs of seed and plant comparisons clearly indicating novelty.

14c Fill in the Exhibit C, Objective Description form, for all characteristics for which you have adequate data.

14d Describe any additional characteristics that are not described, or whose description cannot be accurately conveyed in Exhibit C. Use comparative varieties as is necessary to reveal more accurately the description of characteristics that are difficult to describe, such as plant habit, plant color, disease resistance, etc.

15 If "Yes" is specified *(seed of this variety be sold by variety name only as a class of certified seed)* the applicant may NOT reverse his-affirmative decision after the variety has either-been sold and-so labeled, his decision published, or the certificate has been issued. However, if the applicant specified "No," he may change his choice. *(See section 180.16 of the Regulations and Rules of Practice.)*

16 See section 42 of the Plant Variety Protection Act and section 180.7 of the Regulations and Rules of Practice.

RECEIVED MAR 5 1982 U.S. DEPARTMENT AMS, LPG&S DIV. PVPO

APPLICATION FOR PLANT VARIETY PROTECTION CERTIFICATE

Exhibit A:	ORIGIN AND BREEDING HISTORY OF THE VARIETY
Breeder:	The Queen's University of Belfast, Northern Ireland
Variety Name:	Countess
Species:	Festuca rubra spp communtata
Kind Name:	Chewings fescue
Parentage:	Selection from the variety Highlight
Breeding Method:	Hybridisation and polycrossing of selected segregates

SELECTION AND MULTIPLICATION

The variety Highlight was chosen for this programme as preliminary experiments had shown that it had a higher tolerance to Aminotriazole than other Chewings fescue varieties.

A large number of seedlings was exposed to a carefully determined dose of Aminotriazole which gave mortality rates of 95 to 99%. Surviving plants were grown to maturity and allowed to cross pollinate in collective isolation. The progeny was subject to a further selection using a higher dose of Aminotriazole. This selection procedure was repeated for four generations until a satisfactory degree of tolerance had been achieved.

A final population of approximately 350 plants was planted in a field nursery plot. The plot was sprayed with a dose of Aminotriazole which was effective in removing approximately 5% of variants which had a low herbicide tolerance.

No additional variants were noted in the final population and this was attributed to the fact that Countess had been bred exclusively from the single variety Highlight.

The morphological characteristics of Countess have been observed to remain uniform and unchanged in successive sexually reproduced generations.

FORM APPROVED: OMB NO. 0581.0055

EXHIBIT C
(Fine Leaved Fescues)

U.S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL MARKETING SERVICE
LIVESTOCK, MEAT, GRAIN & SEED DIVISION
PLANT VARIETY PROTECTION OFFICE
BELTSVILLE, MARYLAND 20705

OBJECTIVE DESCRIPTION OF VARIETY
FINE LEAVED FESCUES
(Festuca spp.)

NAME OF APPLICANT(S)	TEMPORARY DESIGNATION	VARIETY NAME
		Countess

ADDRESS *(Street and No. or R.F.D. No., City, State, and Zip Code)*

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Place the appropriate number that describes the varietal character of this variety in the boxes below. Use leading zeroes when necessary (e.g., [0 8 9] or [0 9]). Characteristics described including numerical measurements, should represent those that are typical for the variety. Measured data should be for SPACED PLANTS. Royal Horticultural Society or any recognized color fan may be used to determine plant colors; designate system used: _____ Describe location of test area, conditions and number of plants used: Northern Ireland. 500 space plants

1. SPECIES: (With comparison varieties for use below - use varieties within species of application variety)

[1]

1 = *F. rubra ssp. commutata* (Chewings) — 11 = Cascade, 12 = Highlight, 13 = Jamestown, 14 = Banner, 15 = Barfalla
2 = *F. rubra* ssp. *litoralis* (Creeping Red) — 21 = Dawson, 22 = Starlight, 23 = Merlin, 24 = Pennlawn
3 = *F. rubra* ssp. *rubra* (Spreading Red) — 31 = Boreal, 32 = Ruby, 33 = Fortress, 34 = Ensylva
4 = *F. ovina* (Sheep) — 41 = Covar
5 = *F. longifolia* (Hard) — 51 = Durar, 52 = Biljart (C-26), 53 = Scaldis
6 = *F. tenuifolia* (Fine-Leaved Sheep) — 61 = Panda, 62 = Barok
7 = Other *(Specify)* *F.* _____

2. CYTOLOGY:

[4 2] Chromosome Number [1] Ploidy — 1 = diploid, 2 = tetraploid, 3 = hexaploid, 4 = octoploid

3. ADAPTATION: (0 = Not Tested; 1 = Not Adapted; 2 = Adapted)

[0] Northeast [0] Southeast [0] North Central [0] Pacific N.W. [2] Other *(Specify)* Temperate British

4. MATURITY: Date First Headed (panicle emergence) Location(s) of Trail(s) Northern Ireland Lat 54° 23'

[2] Maturity Class:
1 = Very Early (Covar) 2 = Early (Highlight) 3 = Medium Early (Boreal, Dawson)
4 = Medium Late (Cascade, Ruby) 5 = Late (Jamestown, Agram) 6 = Very Late

Data Headed 8 May

[1 0] Days earlier than [1 5]
Maturity same as [1 2]
[ ] Days later than None [ ]
} Comparison Variety

5. PLANT HEIGHT: (At maturity; to top of panicle; Average of 10 tallest culms)

[2 0] mm height
[0 8 9] mm shorter than [1 1]
Height same as [1 5]
[0 7 8] mm taller than [1 2]
} Comparison Variety

6. GROWTH HABIT: (Mature)

[2] 1 = Erect (Ruby) 2 = Semi-erect (Highlight) 3 = Prostrate (Silvana)

7. RHIZOMES:

[ ] mm Length [ ] mm Width [ ] mm Internode length

[1] 1 = Absent (Highlight) 2 = Weakly Creeping (Dawson) 3 = Strongly Creeping (Boreal) 4 = Very Strongly Creeping (Fortress)

4

8. LEAF BLADE:

[ ] Color: 1 = Light Green (Starlight) 2 = Medium Light Green (Highlight) 3 = Medium Dark Green (Ruby, Agram) 4 = Dark Green (Jamestown, Manoir) 5 = Bluegreen (Saphir) 6 = Graygreen (Scaldis) 7 = Other (Specify) _____

[1] Glaucosity (Sowing Year): 1 = Absent (Koket) 2 = Present (Vendome)

a1 Anthocyanin: 1 = Absent 2 = Present [ ] Hairs (Basal) 1 = Absent 2 = Present

[1] Margins: 1 = Smooth 2 = Semi-rough 3 = Rough

[1] Margin folding (closure): 1 = Rolled inward (closed-Highlight) 2 = Flat (open-Jamestown, Engina)

[ ] Width class:
1 = Very Fine (Agram, Frida) 2 = Fine (Jamestown, Highlight, Banner, Dawson)
3 = Medium Fine (Fortress, Ruby, Scaldis) 4 = Medium Coarse (Engina)

[102] mm Length (flag leaf)

[14] mm Shorter than [11]
Blade length same as [15] } Comparison Variety
[19] mm Longer than [12]

[550] mm Width (flag leaf)

[020] mm Narrower than [13]
Blade width same as [15] } Comparison Variety
[035] mm Wider than [12]

9. LEAF SHEATH:

a1 Anthocyanin (seedling): 1 = Absent (Highlight) 2 = Present (Jamestown, Fortress, Marga)

[1] Auricle Hairiness: 1 = Absent 2 = Present

[1] Margins: 1 = Open (Highlight) 2 = Closed (Jamestown)

10. PANICLE (Mature plant):

[1] Shape: 1 = Narrow-tapering 2 = Ovate 3 = Oblong 4 = Other (Specify) _____

[2] Type: 1 = open 2 = Intermediate 3 = Compact

a 1 Orientation: 1 = Erect 2 = Nodding

[1] Branch Pubescence: 1 = Glabrous 2 = Pubescent

[4] Anther Color:

[4] Glume Color (At 50% flowering): 1 = Yellowish Green 2 = Green 3 = Bluish Green 4 = Purplish 5 = Reddish 6 = Other (Specify) _____

[118] mm Length

[08] mm Shorter than [11]
Panicle length same as [13] } Comparison Variety
[18] mm Longer than [12]

11. PALEA:

[2] Hairs (On keels or margins): 1 = Absent (Banner) 2 = Short (Agram, Scaldis, Olds) 3 = Long (Rainier, Fortress, Jamestown)

5

12. LEMMA (Mature):

3	Hairs: 1 = Absent (Jamestown) 2 = Several 3 = Many (Highlight)		
56	mm Lemma Length		
02	mm Shorter than	11	Comparison Variety
	Lemma length same as	12	
03	mm Longer than	13	
072	mm Lemma Width		
011	mm Narrower than .	11	Comparison Variety
	Lemma width same as .	15	
010	mm Wider than .	14	
2	Awns: 1 = Absent 2 = Present		
15	mm Awn Length		
02	mm Shorter than	12	Comparison Variety
	Awn length same as .	14	
05	mm Longer than	11	

13. SEED (With lemma & palea):

c4	Size Class (g/1000 seed): 1 = < .9g (Biljart, Dawson) 2 = .9 – < l.lg (Jamestown, Highlight) 3 = 1 .1 – 1.3g (Fortress, Novorubra) 4 = > 1.39 (Boreal. Golfrood)		
1393	rng per 1000 seed		
0437	mg per 1000 seed less than .	14	Comparison Variety
	Seed Weight same as .	11	
0339	mg per 1000 more than	12	

14. DISEASE, INSECT, AND NEMATODE REACTION (0 = Not Tested, 1 = Susceptible, 2 = Resistant):

0	Melting-out *Drechslera poae* (*Helminthosporium vagans*)	0	Stripe rust I? *striiformis*
0	Leaf spot *D. siccans*	a0	Leaf rust *P. poae-nemoralis*
0	Net blotch *D. dictyoides*	c0	I? *crandallii*
c0	Leaf spot *Bipolaris sorokiniana*	0	Pythium Blight *Pythium ultimum*
c0	Brown patch *Rhizoctonia solani*	2	Red thread *Corticium fusciforme*
0	Powdery mildew *Erysiphe graminis*	0	Dollar spot *Sclerotinia homoeocarpa*
0	Stripe smut *Ustilago striiformis*		Insect _____
c0	F. Patch, Pink snow-mold *Fusarium nivale*		Nematode _____
0	Fusarium blight *F. tricinctum, F. roseum*		Other _____
0	Gray snow mold *Typhula iotana*		Other _____
0	Stem rust *Puccinia graminis*		Other _____

6

15. GIVE VARIETY OR VARIETIES THAT MOST CLOSELY RESEMBLE THE APPLICATION VARIETY. For the following characteristics indicate Degree of Resemblance by placing the column marked, D.R., one of the following numbers:

1 = Application variety is less than comparison variety. 2 = Same As
3 = More than, better, greater, darker, more disease resistant. etc.

CHARACTER	VARIETY	D.R.	CHARACTER	VARIETY	D.R.
Rhizome Length	N / A		Growth Habit	Highlight	2
Leaf Width	Barfalla	2	Leaf Color	Barfalla	2
Panicle Color	Highlight	2	Panicle Shape	Banner	2
Winter Color	Highlight	2	Cold Injury	Highlight	1
Shade Tolerance	Highlight	2	Heat	Unknown	
Drought	Highlight	2	Disease*		
			Corticium fucifome	Waldorf	2

* *Specify each disease evaluated.*

16. ADDITIONAL DESCRIPTION: (Use additional sheets as required)
Describe all characteristics that cannot be adequately described in the form above in Exhibit D. Comparative varieties should be used as may be appropriate, such as for disease. Append all comparative trial and evaluation data, including measured characters, environmental, and disease tests.

Countess is resistantto the know lethal dose of Aminotriazole for Grasses.

Cultivars of Amenity Grasses which are tolerant of herbicides for Weed Grasses would facilitate the selective removal of undesirable Weed Grasses from turf and seed fields of these cultivars.

Ref. LEE H. and WRIGHT C.E. (1981)

Effective selection for Aminotriazole tolerance in Festuca and Agrostis Turf Grasses

	PERCENTAGE MORTALITY	
	1 kg/ha	2 kg/ha (Aminotriazole)
Countess	2	11
Highlight	59	91
Poa annua	87	100
Holcus lanatus	84	100

COUNTESS 8200080

EXHIBIT D : ADDITIONAL DESCRIPTION OF THE VARIETY

Chapter 6 Effective Selection for Aminotriazole Tolerance in Festuca and Agrostis Turf Grasses[1]

H. LEE AND C.E. WRIGHT

ABSTRACT

Selection for aminotriazole tolerance was carried out in the three amenity grasses most valuable for high quality turf in temperate regions — Chewings Fescue *(Festuca rubra* subsp. *commutata),* browntop bent *(Agrostis tenuis)* and creeping bent *(Agmstis stolonifera)* — with a view to producing lines with a level of resistance which would permit complete control of grass weeds and rogues in lawn and seed fields by spraying with the herbicide. After three or four selection cycles, depending on species, a comparative asssessment of the various generations of selection was carried out on seedlings in the glasshouse. It was found that resistance as defined by ED50 values (the amount of herbicide estimated to kill SO% of seedlings) had been approximately doubled by each cycle of selection in all three species. In the final selections there was almost negligible seedling mortality to 1.56 kg ha-' aminotriazole, an amount shown to eliminate two important weed species — annual meadow grass *(Poa annua)* and Yorkshire fog *(Holcus lanatus).*

Additional key words: Poa annua, Holcus lanatus, Weed control.

INTRODUCTION

Eradication by herbicides of dicotyledonous weeds in amenity grass is common practice but the removal of weed grasses which differ little in morphological, physiological or biochemical characteristics from the sown turf species presents a difficult problem.

Examples are becoming more frequent in which chemicals have been found that can selectively remove a weed from its closely related crop species (e.g., chlorfenpropmethyl to control wild oats *(Avena fatua)* in spring oats *(Avena sativa)* (Anon., 1980) and there have been some recent reports of weed grass control in grass situations. For example, asulam was effective for the selective control of several grass weeds in established St. Augustine grass *(Stenotuphrum secundatum),* 'Tifway' Bermuda grass *(Cynodon dactylon)* and 'Emerald' zoysiagrass *(Zoysia matrella)* (Neel et al., 1979), and DSMA and MSMA for smooth crabgrass *(Digitaria ischaemum)* control in Kentucky bluegrass *(Poa pratensis)* (Jagschitz, 1977).

However, such chemicals are likely to be available only by chance as a

[1]A contribution from the Dep. of Agric. Botany, The Queen's University of Belfast, Northern Ireland, United Kingdom.

8

spin-off from research in other areas of weed control as the cost of synthesizing and developing pesticides on an industrial scale prohibits specific effort being aimed at any other than problems in major world crop species.

An alternative approach is to take an existing broad spectrum herbicide which is capable of killing all weed and sown species and develop cultivars of the lawn species resistant to that herbicide. An area sown with such resistant cultivars could be maintained free of both grass and broad-leaved weeds by the simple expedient of spraying with the herbicide.

Whereas the cost of developing a new herbicidal product from laboratory synthesis to first commercial sales is of the order of £10M (Robinson, 1978) and the time scale for such development is 7 to 10 years, the cost of a breeding programme to produce a herbicide-tolerant cultivar is likely to average a fraction of that cost at about £0.5M, the time scale remaining aproximately the same.

The concept of breeding of resistance to herbicides arises as a corollary to the emergence of resistant weed plants following repeated application of herbicides, e.g., resistance in *Senecio vulgaris* to atrazine (Ryan, 1970). Likewise it has already been shown to be feasible in crop plants, e.g., resistance to triazines in *Brassica campestris* (Souza Machado et al., 1978) to 2,4-D in *Lotus corniculatus* (Devine et al., 1975) and to paraquat and dalapon in perennial ryegrass *(Lolium perinne)* (Faulkner, 1976, 1978).

With a view to assessing the possibilities of breeding for herbicide tolerance in amenity species the responses of twelve grass species to a range of foliar-absorbed and root-absorbed grass-killing herbicides were investigated in Queen's University, Belfast (Fisher and Faulkner, 1975). Festuca species in general were relatively tolerant but browntop bent was susceptible to the majority of herbicides. The most promising herbicide for use with two of the amenity species involved in the breeding programme was aminotriazole. The ED50 values (i.e., the concentration of herbicide which kills 50% of seedlings) with respect to aminotriazole of *Festuca rubra* and *Agrostis tenuis* was greater than those of lawn invading species such as perennial ryegrass *(L. perenne)* and rough stalked meadow grass *(Pou trivialis)*.

Breeding of aminotriazole-tolerant cultivars of the three amenity species most valuable for high quality, fine turf situations in temperate countries — Chewings fescue *(F. rubru* subsp. *commututa)*, browntop bent *(A. tenuis)* and creeping bent *(Agrostis stolonifera)* — was commenced in 1972.

MATERIALS AND METHODS

Highly reputed cultivars of each of the three species — 'Highlight' Chewing fescue, 'Bardot' browntop bent and 'Penncross' creeping bent — were chosen as basic material for selection.

Following preliminary experimentation to assess a suitable rate of aminotriazole application, for each species capable of achieving a mortality of

about 95 to 99%, at least 10,000 seeds of each species were sown in trays filled with aminotriazole-treated compost and seedlings selected as described by Fisher and Wright (1977). The surviving plants, approximately 400 per species, were grown to maturity and allowed to inter-pollinate in collective isolation, yielding Selection 1 (Sel. 1) seed. The progenies produced were subjected to a further cycle of selection, a more severe selection pressure being applied using a higher dose rate of herbicide. Recurrent mass selection was carried out by using increasingly higher dose rates of herbicide for either three or four generations producing Selection 2 (Sel. 2), Selection 3 (Sel. 3) and, for *F. rubra* subsp. *commutata* Selection 4 (Sel. 4) seed. Selection was ceased when, using the results of simple unreplicated tests, it was considered that adequate tolerance had been obtained.

To assess the increase in tolerance which had occurred per generation of selection and to determine the relative tolerance of the final selection as compared to that of the original unselected parent cultivar and common weed grasses, a separate replicated trial was set up in April, 1980 for each of the three amenity species. Seeds of each selection and parent cultivar were individually sown as rows in trays having internal dimensions of 335 by 215 by 50 mm and containing 3.5 kg of potting compost. To represent common grass lawn weeds annual meadow grass *(Poa unnua)* and Yorkshire fog *(Holcus lanatus)* were included as rows in each experiment and the position of each of three selection generations, parent cultivar and weed row was fully randomised within four replicates. The trays were placed in a glasshouse for the duration of the experiments. When the majority of emerged seedlings had reached the two-leaf stage of growth they were foliar sprayed using a pneumatic sliding precision laboratory sprayer with 0.1, 0.25, 0.63, 1.56 or *3.90* (i.e., rates increasing by x 2.5) kg ha-' aminotriazole. Any one-leaf seedlings were also sprayed but excluded from the observations by means of tagging. After three to four weeks seedling survival was recorded to determine percentage mortality. ED50 values for each of the selection lines were obtained following a probit transformation (Finney, 1971).

When Sel. 4 seed of Chewings fescue became available a second test involving this species only was carried out in September, 1980 using the same methods.

RESULTS AND DISCUSSION

P. annua was clearly highly susceptible to aminotriazole being totally killed in two out of three trials by the 0.63 kg ha^{-1} application (Fig. 1) and an almost identical response (omitted from the figure) was obtained for *H. lanatus*. The unselected parent controls showed 70% or more mortality to the herbicide applied at 1.56 kg ha^{-1}. For all three species selection proved to be highly effective in increasing tolerance to aminotriazole.. By the end of the third selection cycle, lines of *F. rubra* subsp. *commutata* and of *A. tenuis* had been produced which were highly tolerant, very few seedlings succumbing to

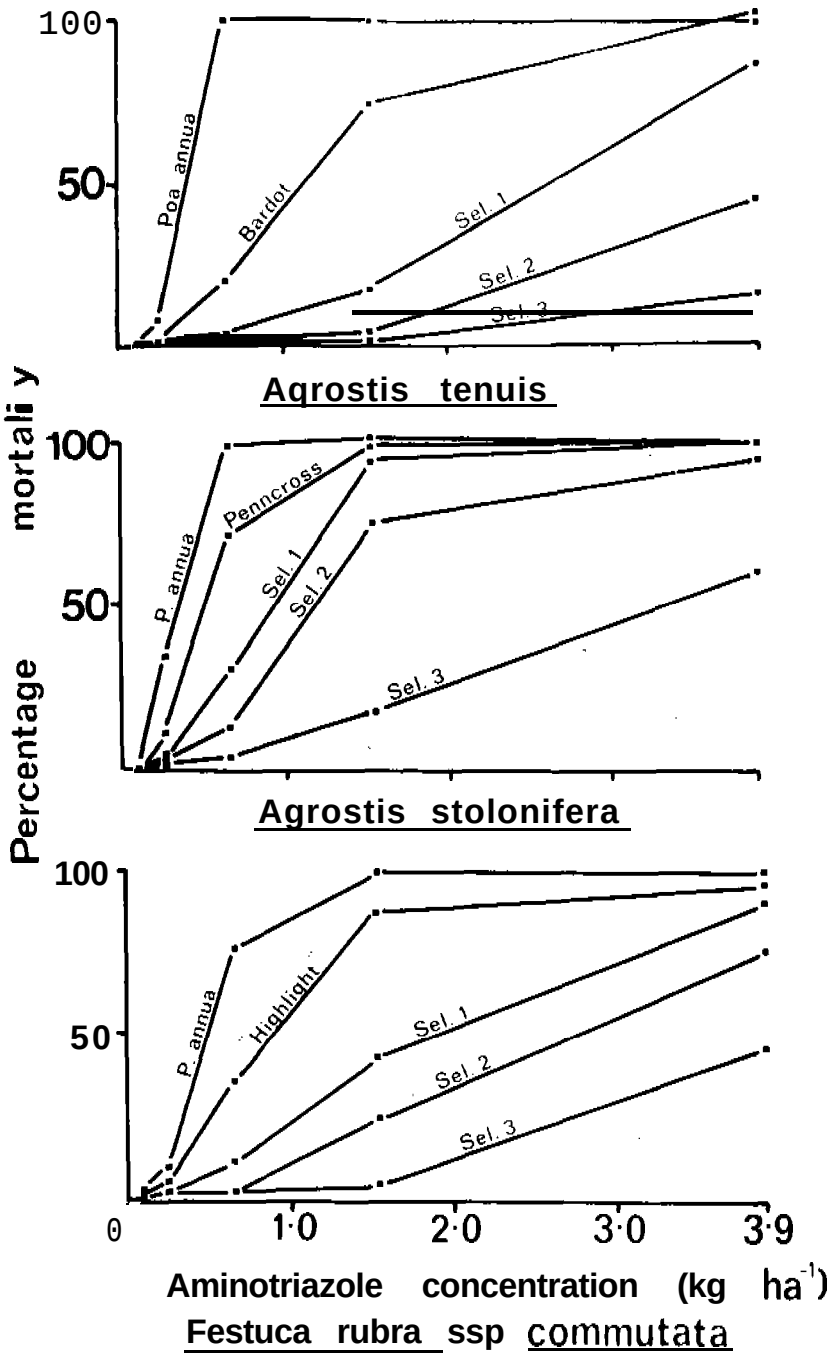

Fig. 1. Percentage morality of *Poa annua* and of three amenity grass species each represented by three selections (Sel. 1, 2 and 3) and an unselected parent cultivar.

the 1.56 kg ha^{-1} rate, while in Sel. 3 of *A. stolonifera* only 15% of seedlings died. At the highest application, 3.9 kg ha^{-1}, 40 to 60% of the seedlings of *F. rubra* subsp. *commutata* and *A. stolonifera* survived and *A. tenuis* continued to exhibit excellent tolerance with only 1.5% mortality.

Confidence intervals (95%) for the ED50 values of the unselected parent and the cycles of selection for any species did not overlap indicating that the values were significantly different. The values (Table 1) show that each cycle of selection was capable of approximately doubling resistance with variation in species response resulting in the ED50 values for Sel. 3 being x 19, x 7 and x 5 those of the unselected parent for *A.* tenuis, *A. stolonifera* and *F. rubra* subsp. *commutatu* respectively.

Table 1. ED50 values for the various selections of the three species.

Material	*Agrostis tenuis*	*Agrostis stolonifera*	*Festuca rubra* subsp. *commutata*	
	spring	spring	spring	autumn
	kg ha^{-1}†			
Unselected parent	1.06	0.46	0.75	0.49
Selection 1	2.39	0.11	1.64	0.80
Selection 2	4.20	1.14	2.50	1.19
Selection 3	19.80	3.35	4.06	1.66
Selection 4				2.51
Poa *annua*	0.41	0.29	0.44	0.42
Holcus lanatus	0.43	0.36	0.68	—

† Amount of aminotriazole required to kill 50% of seedlings

In the separate test in autumn of *F. rubra* subsp. *commutata* involving Sel. 4, apparently lower levels of resistance were exhibited (Table 1). The lower resistance was attributed to an interaction between environment and herbicidal activity, the latter being lower under the warmer autumn conditions. The expected differences between cycles of selection, however, were largly maintained.

Seed of Sel. 3 of *A. tenuis* and of Sel. 4 of F. *rubra* subsp. *commutatu* have been submitted as new cultivars, named 'Duchess' and 'Countess' respectively, for Plant Breeders Rights in the United Kingdom but further cycles of selection will be required in *A. stolonifera* to attain an equally satisfactory level of tolerance.

It should be possible to eliminate both weeds and weed grasses from lawns sown with these new cultivars alone or in mixture by spraying with aminotriazole at a field dose rate giving equivalent effect to 1.56 kg ha-' in the glasshouse. The level of resistance achieved is of such an order as to indicate that they will be unaffected should double the dose which will kill grass weeds be applied by accident or by overlapping when spraying.

There are further advantages in having herbicide-resistant cultivars. During seed multiplication of non-resistant cultivars little can be done normally to rectify contamination particularly by volunteer plants of the same species or by weed grasses producing seeds which are of the same general

shape and size as the crop species and which are therefore difficult to clean out mechanically from the seed produced. Both these problems could be overcome in aminotriazole resistant cultivars by spraying.

The ability to produce pure cultivar stands during seed production should reduce the likelihood of certification problems and virtually clean seed could be harvested making cleaning processes much easier and less costly. Because of the unique herbicide-tolerance character disputes on variety distinctness or identification could be easily settled.

The possibility of weeds evolving resistance is not considered to be a hazard as at any given site the number of applications of aminotriazole will be small. Also the destruction of a lawn presents no problem as, apart from normal cultural means, the cultivars resistant to aminotriazole can be eliminated by the use of any other grass-killing herbicide. The production of cultivars with resistance to grass-killing herbicides should provide a new system of good lawn management available to greenkeepers and home lawn managers alike.

ACKNOWLEDGEMENTS

The authors are grateful to Germinal Holdings Limited, Banbridge, Northern Ireland, for the financial support to Queen's University, Belfast, which enabled this research programme to be undertaken.

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