ADAS

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Project Title: NARCISSUS NECK ROT INVESTIGATION

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ACTION FOR GROWERS

No recommendations for the control of neck rot are given in this report. The results which indicate the causal organisms and some of the possible factors affecting neck rot are given.

Neck rot is not only caused by *Fusarium oxysporum* (the basal rot pathogen), but it can also be caused by *Botrytis narcissicola* (the smoulder pathogen) and *Penicillium hirsutum*.

Neck rot caused by *Fusarium oxysporum* was related to stocks with a history of this disease.

There appeared to be less *Botrytis narcissicola* neck rot in narcissus crops grown after cereals than non-cereals.

There appeared to be less *Botrytis narcissicola* neck rot affected bulbs following foliar sprays of Rovral or Ronilan in the field in the first and second year.

There appeared to be fewer bulbs affected with *Penicillium hirsutum* neck rot in crops which were planted 6 inches deep or less.

More *Penicillium hirsutum* and *Botrytis narcissicola* neck rot affected bulbs were found where trash was present in the trailer.

More *Penicillium hirsutum* neck rot affected bulbs were found where bruising was also present.

In the few cases where post-lifting formaldehyde dips were used for controlling basal rot, *Penicillium hirsutum* neck rot was aggravated.

Recommendations for further work

The evaluation of fungicides for the control of *Fusarium oxysporum* basal and neck rot is being carried out at HRI, funded by the HDC.

The effect of fungicides applied as foliar sprays in the field should be evaluated for *Botrytis narcissicola* and *Penicillium hirsutum* neck rot control.

SUMMARY

Bulb samples from 101 stocks were tested in this three year project; 32 in the first year, 25 in the second and 44 in the third. Thirty seven cultivars were represented in bulbs sent for testing. Neck rot could mainly be attributed to the pathogenic fungi *Fusarium oxysporum, Botrytis narcissicola* and *Penicillium hirsutum;* only 5.8% of the bulbs had none of these pathogens present.

Fusarium oxysporum was found in 51% of the samples and 32% of all the bulbs tested. *Fusarium oxysporum* was mainly responsible for bulb rots to the base plate and the lack of bulb emergence. Resistance in *Fusarium oxysporum* to MBC (Storite and Benlate) was found in isolates from 12 out of 22 samples tested in 1991. This is the first case of resistance detected in *Fusarium oxysporum* from Narcissus.

Cultivars which had a mean of 5 bulbs per sample or more affected with *Fusarium oxysporum* were Bravoure, Carlton, Dick Wilden, Flower Drift, Fortune, Golden Ducat, Golden Harvest, Mary Copeland and mixed stocks of Carlton/Magnet and Carlton/Fortune.

***Fusarium oxysporum* neck rot was related to a stock problem** i.e. basal or neck rot in the stock or that of incorrect hot water treatment (i.e. overtreated or treated late). Fewer bulbs were affected with *Fusarium oxysporum* where no foliar fungicide had been applied either in the second year or in both years, where trash was found in the trailer, and in weed-free crops.

Botrytis narcissicola was found in 76% of samples and 34% of all the bulbs tested and caused either complete bulb rots, rots of the neck or rots extending to the middle of the bulb but rarely to the base plate. *Botrytis narcissicola* neck rot apparently contributed to poor bulb emergence.

Cultivars which had a mean of 5 bulbs per sample or more affected with *Botrytis narcissicola* were Actaea, Apotheose, Barrett Browning, Bellisana, Birma, Cheerfulness, Dutch Master, Hollywood, Ice Follies, La Riante, Pink Pride, Rembrandt, Spellbinder, Standard Value, Tahiti and Unsurpassable.

Botrytis narcissicola was **not** related to smoulder problems in the stock at the previous dry bulb inspection. Fewer bulbs were affected in crops following a cereal crop, where foliar fungicides had been applied in the first, second or in both years, in weedy crops,

where no trash was found in the trailer or where fungicide dips had been applied pre-storage.

Penicillium hirsutum was found in 92% samples and 58% of all the bulbs tested and caused rots of the neck, rots extending to the middle of the bulb, complete bulb rots and also to a lesser extent rots extending to the base plate. *Penicillium hirsutum* neck rot slightly reduced bulb emergence.

In the single stock of cv. Magnificence, neck rot was caused only by *Penicillium hirsutum.* Cultivars which had a mean of 5 bulbs per sample or more affected with *Penicillium hirsutum* were Actaea, Apotheose, Barrett Browning, Bellisana, Birma, Bridal Crown, Dutch Master, Flower Drift, Gold Medal, Golden Harvest, Hollywood, Ice Follies, La Riante, Magnet, Magnificence, Majesty, Mount Hood, Red Goblet, Rembrandt, Sempre Avanti, Standard Value, Tahiti, Unsurpassable and Yellow Sun.

Penicillium hirsutum was **not** related to blue mould problems in the stock at the previous dry bulb inspection. There were fewer bulbs affected with *Penicillium hirsutum* neck rot where nitrogen fertiliser had been applied, amongst those which had been planted 6" deep or less, where foliar fungicides were applied in the second year, where there was no trash in the trailer, in weedy crops, or where there was little or no bruising.

The following factors apparently had no effect on the incidence of neck rot caused by *Fusarium oxysporum, Botrytis narcissicola* and *Penicillium hirsutum*:

* pre-planting dips,
* phosphate fertiliser,
* potash fertiliser,
* nitrogen top dressing,
* soil types,
* cultivations either in the first or second autumn,
* foliar disease in the field,
* flower picking,
* use of acid,
* top bashing,
* ridge topping,
* topping height,
* harvester agitation,

* drying time,
* stack height in store
* other (field) problems.

There was apparently no effect of previous crop, foliar fungicides applied in the first year or fungicides applied pre-storage on neck rot caused by *Fusarium oxysporum* or *Penicillium hirsutum*.

There was apparently no effect of nitrogen fertiliser and bruising on neck rot caused by *Fusarium oxysporum* and *Botrytis narcissicola*.

NARCISSUS; INVESTIGATION OF THE CAUSAL ORGANISMS AND PRE-DISPOSING FACTORS OF NECK ROT

INTRODUCTION

The objective of this work was to determine causal organisms and factors pre-disposing bulbs to neck rot.

MATERIALS AND METHODS

From each consignment of bulbs, twenty which showed a rot when cut across the neck were taken. Ten of the bulbs were sent to the Central Science Laboratory at Harpenden. There bulbs were cut longitudinally, a description of the rot was made, and the causal organisms isolated and identified. Isolations were made from ten leading edges of rot per bulb (Fig 1). This part of the work was jointly funded by the HDC and by Plant Health Division of MAFF. The remaining ten bulbs were grown on at ADAS Starcross in the first two years and at ADAS Kirton in the third year to determine effects of neck rot on growth and flowering. A questionnaire was completed by growers to attempt to identify any pre-disposing factors, e.g. cultural conditions or husbandry which may affect neck rot incidence.

Statistical Analysis

Data were analysed with comparisons made using a Wilcoxon-Mann-Whitney test (a non-parametric equivalent to the 2 sample t-test. Tests were made and median average values were compared and the average number of bulbs and the number of observations or comparisons are given. Differences between average numbers of bulbs were significant (Signif.) when $P < 0.05$. Significance is indicated as * $P<0.05$ ** $P<0.01$ *** $P0.001$ and NS = not significant $P>0.05$

The pathogen names have been abbreviated in tables to (*Fus oxy*) *Fusarium oxysporum*, (*Bot nar*) *Botrytis narcissicola* and (*Pen hir*) *Penicillium hirsutum*.

RESULTS

Bulb samples from 101 stocks were tested, 32, 25 and 44 in the first, second and the third years respectively. In addition, in the third year, 5 samples were re-tested. The majority of samples were from the Eastern Counties.

Cultivars

During the 3 years of the investigation 37 cultivars were tested. (Table 1).

Table 1 Number of Narcissus cultivars tested

Cultivar	No. of samples	Cultivar	No. of samples
Dutch Master	15	Apotheose	1
Golden Harvest	14	Barrett Browning	1
Carlton	12	Bellisana	1
Scarlett O'Hara	5	Bravoure	1
Fortune	4	Bridal Crown	1
Standard Value	4	Dick Wilden	1
Magnet	3	Golden Ducat	1
Birma	3	Gold Medal	1
Sempre Avanti	3	Hollywood	1
Actaea	2	Lady Winifred	1
Cheerfulness	2	La Riante	1
Flower Drift	2	Magnificence	1
Ice Follies	2	Majesty	1
Mixed	2	Mary Copeland	1
Mount Hood	2	Music Hall	1
Pink Pride	2	Red Goblet	1
Rembrandt	2	Spellbinder	1
Unsurpassable	2	Tahiti	1
Yellow Sun	2	Yellow Cheerfulness	1

The main cultivars affected were the commonly grown Dutch Master, Golden Harvest and Carlton. However, a wide range of cultivars were affected. It was not possible to determine the extent of cultivar susceptibility as all the twenty bulb samples taken showed neck rot symptoms and could have been from one net or from a several tonne consignment.

Fungi Isolated

The results from individual samples are given in Appendix 1.

The main fungi isolated (% bulbs affected) from 1010 bulbs (101 bulb samples each of ten bulbs) and which could be considered as pathogens, were *Fusarium oxysporum* (32.2%) *Botrytis narcissicola* (33.7%) and *Penicillium hirsutum* (58.2%). The other fungi detected were considered to be saprophytes. All fungi found are listed below.

Table 2 Fungi isolated from Narcissus bulbs

Pathogenic fungi	% bulbs affected #
Penicillium hirsutum	58.2
Botrytis narcissicola	33.7
Fusarium oxysporum	32.2
Saprophytic fungi	
Ophiostoma (Ceratocystis) narcissi	15.2
Penicillium pinophilum	20.3
Penicillium thomii	9.2
Other *Penicillium* spp.	2.5
Aspergillus flavus	2.4
Aspergillus niger	0.2
Botrytis cinerea	1.4
Cladosporium sp.	0.1
Epicoccum sp.	0.4
Fusarium culmorum	0.1
Fusarium poae	0.2
Geotrichum candidum	0.2
Gliocladium sp.	0.1
Humicola sp.	0.5
Oidiodendron sp.	0.8
Phoma glomerella	3.4
Rhizopus sp.	1.8
Stemphyllium sp.	0.2
Trichoderma sp.	4.1
Trichoderma viride	2.0
Ulocladium sp.	0.1
Verticillium nigrescens	0.1
Verticillium sp.	0.2

From 1010 bulbs (101 samples, each of ten bulbs).

Bulbs with none of the 3 pathogens present

Of the 1010 bulbs, 12 had no neck rot, 998 had neck rot and of these, only 58 had none of the 3 pathogens present (i.e. 5.8%). Of the 998 bulbs with neck rot, 28 (2.8%) had *O. narcissi* in the absence of the 3 pathogens.

Table 3 Relationship between cultivars and bulbs without any of the 3 pathogens present

Cultivar	Number of bulbs	
Dutch Master	21	(150)#
Golden Harvest	6	(140)
Carlton	6	(120)
Cheerfulness	6	(20)
Pink Pride	3	(20)
Birma	2	(30)
Standard Value	2	(40)
Fortune,	2	(40)
Majesty	2	(10)
Unsurpassable	2	(20)
Actae	1	(20)
Bridal Crown	1	(10)
Dick Wilden	1	(10)
La Riante	1	(10)
Rembrandt	1	(20)
Tahitii	1	(10)
	58	

Total number tested

Fungicide Resistance

In 1991, *Fusarium oxysporum* isolates from 22 samples were tested for resistance to MBC (Storite and Benlate). *Fusarium* isolates from affected bulbs in 12 samples were found to be resistant. (Appendix II)

Neck rot texture and colour

A dry brown rot was found in only one sample - cv. Golden Harvest. Moist and dry mainly brown rots were found in 7 samples, 5 of which were cv. Dutch Master, one cv. Magnet and one cv. Golden Harvest The remaining samples (93) had moist dark brown/black rots. (Table 4)

The relationship between pathogens, colour and rot texture on individual bulbs is given in Appendix VII. Although the colour range and textures could be associated with any of the pathogens or combination of the pathogens there was an indication that a black moist rot could often be caused by *Fusarium oxysporum* and a light brown rot by *Penicillium hirsutum* or *Botrytis narcissicola.*

Table 4 Number of samples with different rot texture and colour

No. of samples	1	7	93
Rot texture	dry	dry moist	moist
Rot colour	brown/black	brown	brown/dark brown/black

Neck rot pathogens and different neck rot symptoms

Different pathogens produced different symptoms (Fig 2). Rots to the base were more likely to be caused by *Fusarium oxysporum* and not by *Botrytis narcissicola. Botrytis narcissicola* and *Penicillium hirsutum* produced neck, middle of the bulb and complete bulb rots and the latter also caused base plate rots to a lesser extent. (Table 5)

Table 5 Association of pathogens on bulbs with different neck rot symptoms

Type of rot	Number of bulbs affected *Fus oxy* Average# No. of bulbs	*Fus oxy* No.## Comp	*Bot nar* Average No. of bulbs	*Bot nar* No. Comp	*Pen hir* Average No. of bulbs	*Pen hir* No. Comp
Neck	0.0	34	3.5	34	7.0	34
Middle	5.0	32	3.0	32	7.0	32
Base	8.0	21	0.0	21	3.0	21
Complete rot	0.0	14	7.0	14	6.0	14
Significance	***		**		**	

- Average number of bulbs affected.
- Number of comparisons made.

Neck rot pathogens, samples affected and bulbs affected per sample

In 49% of samples, no *Fusarium oxysporum* was detected. In 12% of samples, all ten bulbs were affected with *Fusarium*. Approximately half the number of samples affected with *Botrytis narcissicola* had between one and five bulbs affected. Most samples (92%) were affected with *Penicillium hirsutum*. (Table 6)

Table 6 Narcissus samples, bulbs affected with neck rot and pathogens

Categories of No. of bulbs affected/sample of 10 bullbs	% Samples falling into the categories 0	1-5	6-9	10
Fusarium oxysporum	49	21	19	12
Botrytis narcissicola	24	48	26	3
Penicillium hirsutum	8	34	41	18

Neck rot pathogen, narcissus cultivar and rot type

The rot types were defined as follows:

a) neck rot which was confined to the neck

b) middle rot which extended to the middle of the bulb

c) base rot which extended to the base

d) bulb rot which was a complete rot or decay of the bulb (Fig 3).

The description of the rot type (averaged per cultivar) is presented in Table 7 and is in the order of most bulbs showing that symptom. The results of the individual cultivars are given together with the mean number of bulbs affected with the various pathogens. (Table 7).

In most of the cultivars neck rot was caused by more than one of the pathogens. In the single stock of cv. Magnificence, however, neck rot was caused only by *Penicillium hirsutum,* but this stock had been dipped in formalin post-lifting, which may have aggravated *Penicillium hirsutum.* In none of the cultivars was *Botrytis narcissicola* the sole cause of neck rot.

Table 7 Narcissus cultivar, rot type and pathogens Mean No. of Bulbs Affected

Cultivar	No. of Samples	Rot Type	*Fus oxy*	*Bot nar*	*Pen hir*
Actaea	2	Middle & Base	2	7	7
Apotheose	1	Bulb Rot & Middle	0	6	10
Barrett Browning	1	Bulb Rot	0	10	6
Bellisana	1	Bulb Rot & Middle	0	8	6
Birma	3	Neck & Middle	0	6	9
Bravoure	1	Middle & Base	9	3	3
Bridal Crown	1	Base	1	0	9
Carlton	12	Base & Middle	7	1	4
Cheerfulness	1	Bulb Rot & Middle	0	8	5
Dick Wilden	1	Base	8	0	1
Dutch Master	15	Neck & Middle	0	6	6
Flower Drift	2	Base	6	4	6
Fortune	4	Base & Middle	7	2	3
Gold Medal	1	Middle	0	1	9
Golden Ducat	1	Base & Middle	10	1	0
Golden Harvest	14	Neck & Middle & Base	5	2	6
Hollywood	1	Bulb Rot & Base	1	8	9
Ice Follies	2	Middle	1	5	10
La Riante	1	Middle	0	5	7
Lady Winifred	1	Base & Neck	4	1	3
Magnet	3	Middle	2	2	7
Magnificence	1	Base	0	0	10
Majesty	1	Middle & Base	7	0	7
Mary Copeland	1	Bulb Rot	9	0	1
Mixed - Carlton/Fortune	1	Base, Middle & Bulb Rot	10	0	0
Mixed - Carlton/Magnet	1	Base, Middle & Bulb Rot	10	1	6
Mount Hood	2	Middle	0	4	10
Music Hall	1	Base, Neck & Middle	4	1	3
Pink Pride	2	Neck & Middle	0	7	5
Red Goblet	1	Middle	0	3	9
Rembrandt	2	Middle & Base	2	5	8
Scarlett O'Hara	5	Bulb Rot & Middle	7	1	5
Sempre Avanti	3	Neck & Middle	0	4	8
Spellbinder	1	Bulb Rot	0	10	5
Standard Value	4	Middle & Bulb Rot	3	4	7
Tahiti	1	Middle	2	5	8
Unsurpassable	2	Neck & Middle	0	7	6
Yellow Cheerfulness	1	Mid & Bulb Rot	0	1	3
Yellow Sun	2	Neck & Middle	3	4	7

Neck rot pathogens in cultivars with no *Fusarium*

In 15 cultivars, Apotheose, Barrett Browning, Bellisana, Birma, Cheerfulness, Gold Medal, La Riante, Magnificence, Mount Hood, Pink Pride, Red Goblet, Sempre Avanti, Spellbinder, Unsurpassable and Yellow Cheerfulness, *Fusarium oxysporum* was not detected and was not associated with neck rot (Table 8). In samples where no *Fusarium oxysporum* was detected, the main pathogen found was *Penicillium hirsutum* (from 75% of the bulbs) and *Botrytis narcissicola* (from 50% of the bulbs). The main pathogens affecting cv. Dutch Master were *Penicillium hirsutum* and *Botrytis narcissicola; Fusarium oxysporum* was only isolated from two bulbs out of the 150 tested.

Table 8 Pathogens detected in bulbs with no *Fusarium*

	Mean No. of Bulbs Affected		
Cultivar	*Fus oxy*	*Bot nar*	*Pen hir*
Apotheose (1)#	0	6	10
Barrett Browning (1)	0	10	6
Bellisana (1)	0	8	6
Birma (3)	0	6.3	9
Cheerfulness (1)	0	4.5	4
Gold Medal (1)	0	1	9
La Riante (1)	0	5	7
Magnificence (1)	0	0	10
Mount Hood (2)	0	3.5	10
Pink Pride (2)	0	6.5	5
Red Goblet (1)	0	3	9
Sempre Avanti (3)	0	4	8.3
Spellbinder (1)	0	10	5
Unsurpassable (2)	0	7	5.5
Yellow Cheerfulness (1)	0	1	3

Number of stocks

Neck rot pathogens in cultivars with all bulbs affected with *Fusarium*

Botrytis narcissicola and *Penicillium hirsutum* were also found in a few bulbs, in samples infected with *Fusarium* (Table 9)

Table 9 Pathogens detected in samples with all bulbs affected with *Fusarium*

	Mean No. of Bulbs Affected		
Cultivar	*Fus oxy*	*Bot nar*	*Pen hir*
Carlton (4/12)#	10	1	1.5
Flower Drift (1/2)	10	0	1
Golden Ducat (1)	10	1	0
Golden Harvest (2/4)	10	0	0.5
Mixed - (Carlton/Magnet) (1)	10	1	6
Mixed - (Carlton/Fortune) (1)	10	0	0
Scarlett O'Hara (1/5)	10	0	4
Standard Value (1/4)	10	1	0

Number of stocks affected

Neck rot pathogens and previous cropping

There was apparently no effect of the previous crop on the number of bulbs affected with *Fusarium oxysporum* or *Penicillium hirsutum* neck rot but significantly fewer bulbs were affected with *Botrytis narcissicola* neck rot in bulb crops following cereals. (Table 10)

Table 10 Effect of previous cropping on the number of bulbs affected with neck rot

	Cereals		Non cereals		
	Average No. of bulbs	No. Comp	Average No. of bulbs	No. Comp	Signif.
Fus oxy	3.0	34	0.0	34	NS
Bot nar	1.0	34	4.0	33	*
Pen hir	6.0	34	6.0	33	NS

Neck rot pathogens and planting depth

There was apparently no effect of planting depth on *Fusarium oxysporum*, or *Botrytis narcissicola* neck rot in the bulbs. There were fewer ($P = 0.049$) *Penicillium hirsutum* neck rot affected bulbs amongst those which had been planted 6" or less. (Table 11)

Table 11 Effect of planting depth on the number of bulbs affected with neck rot

	6" or less		More than 6"		
	Average No. of bulbs	No. Comp	Average No. of bulbs	No. Comp	Signif.
Fus oxy	3.0	48	0.0	19	NS
Bot nar	2.0	48	2.0	19	NS
Pen hir	5.0	48	8.0	19	*

Neck rot pathogens and foliar fungicides applied in the first year

It was likely that there were fewer *Botrytis narcissicola* affected bulbs following dicarboximide treatments (Table 12). There was no effect of fungicides applied in the first year on *Fusarium oxysporum* or *Penicillium hirsutum* neck rot.

Table 12 Effect of foliar fungicides in the first year on the number of bulbs affected with neck rot

Fungicide year 1	*Fus oxy*		*Bot nar*		*Pen hir*	
	Average No. of bulbs	No. Comp	Average No. of bulbs	No. Comp	Average No. of bulbs	No. Comp
Dicarboximide	4.0	12	0.5	12	7.5	12
MBC	1.0	50	2.5	50	5.5	50
None	4.5	2	3.5	2	4.0	2
Significance	NS		*		NS	

Neck rot pathogens and foliar fungicides applied in the second year

Differences were found in the numbers of bulbs affected with *Fusarium oxysporum* and *Botrytis narcissicola* in crops sprayed with foliar fungicides in the second year. It was likely that there were fewer *Fusarium oxysporum* affected bulbs following no fungicide, and fewer *Botrytis narcissicola* bulbs following foliar sprays of dicarboximide fungicides. Although very close to the level of significant (P = 0.055), it was likely that fewer *Penicillium hirsutum* affected bulbs were found following dicarboximide and MBC foliar fungicide treatments. (Table 13)

Table 13 Effect of foliar fungicides in the second year on the number of bulbs affected with neck rot

Fungicide year 2	*Fus oxy*		*Bot nar*		*Pen hir*	
	Average No. of bulbs	No. Comp	Average No. of bulbs	No. Comp	Average No. of bulbs	No. Comp
Dicarboximide	4.5	14	1.0	14	5.5	14
MBC	3.0	30	2.0	30	4.0	30
None	0.0	7	7.0	7	10.0	7
Significance	*		*		NS	

Neck rot pathogens and foliar fungicides applied in both years

Results of foliar fungicides applied in both years were similar to the effect of fungicides applied in the second year. There was no effect of foliar fungicides applied in both years on the numbers of bulbs affected with *Penicillium hirsutum.* It was likely that fewer bulbs were affected with *Botrytis narcissicola* neck rot following dicarboximide foliar sprays applied in both years and fewer bulbs affected with *Fusarium oxysporum* following no fungicide treatment (P =0.05). (Table 14)

Table 14 Effect of foliar fungicides in the both years on the number of bulbs affected with neck rot

Fungicides both years	*Fus oxy*		*Bot nar*		*Pen hir*	
	Average No. No. of bulbs	No. Comp	Average No. No. of bulbs	No. Comp	Average No. No. of bulbs	No. Comp
Dicarboximide	4.0	16	1.0	16	6.5	16
MBC	1.0	53	3.0	53	5.0	53
None	0.0	10	6.0	10	8.5	10
Significance	*		*		NS	

Neck rot pathogens and weeds

Fewer *Fusarium oxysporum* affected bulbs were found in clean crops than weedy crops, but the opposite was the case for *Botrytis narcissicola* and *Penicillium hirsutum* neck rot. (Table 15)

Table 15 Effect of weeds on the number of bulbs affected with neck rot

	Clean crop		Weedy crop		
	Average No. of bulbs	No. Comp	Average No. of bulbs	No. Comp	Signif.
Fus oxy	0.0	59	8.0	13	**
Bot nar	2.0	59	0.0	13	*
Pen hir	7.0	59	2.0	13	**

Neck rot pathogens and trash in the trailer

More bulbs were affected with *Botrytis narcissicola* and *Penicillium hirsutum* (Fig 4 & Table 16) but fewer with *Fusarium oxysporum*, where trash was present in the trailer.

Table 16 Effect of trash in the trailer on the number of bulbs affected with neck rot

	Trash in trailer		No trash in trailer		
	Average No. of bulbs	No. Comp	Average No. of bulbs	No. Comp	Signif.
Fus oxy	0.0	16	3.0	53	*
Bot nar	5.5	16	1.0	53	*
Pen hir	7.5	16	5.0	53	**

Neck rot pathogens and fungicides pre-storage

There was no apparent effect of fungicides applied pre-store on the numbers of bulbs affected with *Fusarium oxysporum*, or *Penicillium hirsutum* neck rot. However, it was likely that the dip treatments of MBC or formaldehyde, had an effect on the number of bulbs affected with *Botrytis narcissicola*. (Table 17)

Table 17 Effect of fungicides pre-storage on the number of bulbs affected with neck rot

Fungicides pre-storage	*Fus oxy*		*Bot nar*		*Pen hir*	
	Average No. of bulbs	No. Comp	Average No. of bulbs	No. Comp	Average No. of bulbs	No. Comp
None	0.0	47	3.0	47	7.0	47
ULV Storite	4.5	8	2.0	8	6.5	8
Dips	3.0	13	1.0	13	5.0	13
Significance	NS		*		NS	

Neck rot pathogens and bruising

There was no apparent effect of bruising on the numbers of bulbs affected with *Fusarium oxysporum* or *Botrytis narcissicola* but more bruised bulbs were affected with *Penicillium hirsutum* neck rot. (Table 18)

Table 18 Effect of bruising on the number of bulbs affected with neck rot

	Bruising		No bruising		
	Average No. of bulbs	No. Comp	Average No. of bulbs	No. Comp	Signif.
Fus oxy	1.0	35	2.0	32	NS
Bot nar	2.0	35	2.0	32	NS
Pen hir	7.0	35	1.0	32	***

Neck rot pathogens and stock problems

Fusarium oxysporum neck rot incidence was correlated with particular stocks i.e. history of *Fusarium* neck or basal rot or incorrect hot water treatment application i.e. over treatment or treated late. *Botrytis narcissicola* or *Penicillium hirsutum* neck rot were not related to smoulder or blue mould problems respectively in the previous dry bulb inspection of the stock. (Fig 5 & Table 19)

Table 19 Effect of stock problem on the number of bulbs affected with neck rot

	Stock problem		No stock problem		
	Average No. of bulbs	No. Comp	Average No. of bulbs	No. Comp	Signif.
Fus oxy	8.0	33	0.0	43	***
Bot nar	1.0	33	5.0	43	**
Pen hir	4.0	33	8.0	43	***

Neck rot pathogens and bulb emergence

Fusarium oxysporum had a significant detrimental effect on bulb emergence while *Botrytis narcissicola* and *Penicillium hirsutum* had very little effect. (Fig 6) It would appear that *Fusarium oxysporum* rots which extended to the middle and to the base plate of the bulbs (Table 5, Fig 2) were responsible for lack of bulb emergence but this was not necessarily so for *Botrytis narcissicola* and *Penicillium hirsutum*. (Table 20)

Table 20 Effect of pathogens on bulb emergence

	Fus oxy		*Bot nar*		*Pen hir*	
No of bulbs emerged #	Average No. No. of bulbs	Comp	Average No. No. of bulbs	Comp	Average No. No. of bulbs	Comp
0-2	8.0	34	1.0	34	0.0	34
3-7	0.0	39	4.0	39	5.0	39
8-10	0.0	28	5.5	28	8.0	28
Significance	***		***		***	

A total of 10 bulbs were planted

There were no effects of the following factors on neck rot caused by *Fusarium oxysporum, Botrytis narcissicola* and *Penicillium hirsutum.*

* HWT pre-planting dips compared with HWT pre-planting dips with added MBC fungicides.

* No phosphate or potash fertiliser compared with fertiliser applied.

* No nitrogen top dressing compared with top dressing applied.

* Crops grown on sand, light medium or heavy silt, peat chalk loam or clay soil types.

* Whether cultivations were carried out or not carried out in the first or second autumn.

* Whether the flowers were picked or not.

* Whether there was foliar disease in the field or not.

* Whether acid was used or not.

* Whether the crop was top bashed or ridge topped or not.

* Whether the topping height was above, at the surface or below the ridge.

* Whether there was low, moderate or high harvester agitation.

* Whether the drying time in store was less or greater than 10 days.

* Whether the stack height was less or greater than 5'.

* Whether there were other problems associated with the stack i.e. rain in the windrow, bulbs moist going into store, slow drying of bulbs or not.

DISCUSSION

In this study, neck rot could mainly be attributed to the pathogenic fungi *Fusarium oxysporum, Botrytis narcissicola* and *Penicillium hirsutum;* only 5.8% of the bulbs had none of these pathogens present. **Before this investigation neck rot was attributed only to *Fusarium oxysporum*.** The commonest saprophytic fungi present were *Penicillium pinophilum* (20.3%) and *Ophiostoma (Ceratocystis) narcissi* (15.2%).

One of the reasons for this work was to investigate the cv. Dutch Master which did not produce dark brown/black neck rot symptoms. Symptoms in a third of the Dutch Master samples were mainly brown rots and were not attributed to *Fusarium oxysporum*. This work showed that although the colour range and textures could be associated with any of the pathogens or combination of the pathogens there was an indication that a black moist rot could often be caused by *Fusarium oxysporum* and a light brown rot by *Penicillium hirsutum* or *Botrytis narcissicola* and this could serve as a useful guide when inspecting samples.

Fusarium oxysporum

Fusarium oxysporum was found in 51% of the samples and 32% of the bulbs. *Fusarium oxysporum* was mainly responsible for bulb rots to the base plate and the lack of bulb emergence. Unlike basal rot caused by *Fusarium oxysporum*, neck rot caused by the same pathogen did not produce a complete decay or rot of the bulb. By contrast, both *Botrytis narcissicola* and *Penicillium hirsutum* did produce a complete rot of the bulb. Resistance in *Fusarium oxysporum* to MBC (Storite and Benlate) was found in 12 out of 22 samples tested in 1991. This was the first case of resistance detected in *Fusarium oxysporum* from narcissus. The extent and importance of resistance is not known, neither is the incidence of failures of disease control with MBC fungicides. *Fusarium oxysporum* neck rot was related to a history of *Fusarium* basal rot or neck rot in the stock or that the stock was incorrectly hot water treated prior to planting. Possibly the incorrect hot water treatment i.e. overtreated or treated late may have made stocks more prone to *Fusarium* neck rot. Stock problem is likely to be the main factor in determining *Fusarium oxysporum* neck rot. It is difficult to explain why fewer bulbs were affected with *Fusarium oxysporum* when no foliar fungicides had been applied either in the second year or in both years, with trash in the trailer, or from weed-free crops.

Botrytis narcissicola

Botrytis narcissicola was found in 76% of the samples and 34% of the bulbs and caused complete bulb rots, rots of the neck and rots extending to the middle of the bulb but rarely to the base plate. *Botrytis narcissicola* neck rot gave some reduction in emergence. *Botrytis narcissicola* was not related to a stock problem with smoulder. It is interesting that there were fewer bulbs affected following foliar sprays of dicarboximide fungicides i.e. Rovral and Ronilan applied in the first, second and both years. This result indicates that the use of foliar fungicides can be critical in determining the incidence of *Botrytis narcissola* neck rot and warrants further investigation. It is difficult to explain why fewer bulbs were affected following a cereal crop, in weedy crops, or with no trash in the trailer. It is also of interest that fewer bulbs were affected where fungicide dips, were used (i.e. MBC fungicides or formaldehyde applied pre-storage). The resistance status of *Botrytis narcissicola* to MBC fungicides is not known, but this result indicates many isolates of *Botrytis narcissicola* are still sensitive to MBC products.

Penicillium hirsutum

Penicillium hirsutum was present in 92% of the samples and 58% of the bulbs and caused rots of the neck, rots extending to the middle of the bulb, complete bulb rots and also to a lesser extent rots extending to the base plate. *Penicillium hirsutum* neck rot gave a slight reduction in bulb emergence. In the single stock of cv. Magnificence neck rot was only caused by *Penicillium hirsutum*. *Penicillium hirsutum* was not related to a stock problem with blue mould. Fewer bulbs were affected with *Penicillium hirsutum* neck rot where nitrogen fertiliser had been applied, amongst those which had been planted 6" deep or less, where foliar fungicides had been applied in the second year, and with no trash in the trailer, in weedy crops, or with little or no bruising. The resistance status of *Penicillium hirsutum* to MBC fungicides is not known.

There was no effect of the following factors on neck rot caused by *Fusarium oxysporum*, *Botrytis narcissicola* and *Penicillium hirsutum*: pre-planting dips phosphate fertiliser, potash fertiliser, nitrogen top dressing, cultivations either in the first or second autumn, foliar disease in the field, flower picking, use of acid, top bashing, ridge topping, topping height, harvester agitation, drying time, stack height in store or other (field) problems. It was surprising that there was no effect of other field problems on *Botrytis narcissicola* and especially on *Penicillium hirsutum* as these

would have been encouraged by slow drying and moisture in store. There was no effect of previous crop, foliar fungicides applied in the first year or fungicides applied pre-storage on neck rot caused by *Fusarium oxysporum* and *Penicillium hirsutum.* There was no effect of nitrogen fertiliser and bruising on neck rot caused by *Fusarium oxysporum* and *Botrytis narcissicola.*

ACKNOWLEDGEMENTS

We are grateful to Mr Don Wilson and to all the growers who participated in this investigation for their help in supplying samples and completing the questionnaires.

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APPENDIX I

NARCISSUS NECK ROT

Number of bulbs (total 10) from which the respective fungi were isolated 1991

Sample Number	Cultivar	General description of rot	*Fusarium oxysporum*	*Botrytis narcissicola*	*Penicillium hirsutum*	*Penicillium pinophylum*	*Ceratocystis narcissi*	*Trichoderma viride*	*Aspergillus flavus*	*Verticillium nigrescens*	*Stemphyllium sp.*	*Rhizopus sp.*	*Epicoccum sp.*	
1K	Golden Harvest	Grey/brown dry limited to neck		1	8	4	6	1				1	1	
2K	Golden Harvest	Dark brown/black moist extending down from neck (but not to basal plate)	10		1		1							
3K	Golden Harvest	Dark brown. Variable - dry/moist; some limited to neck others with rot down to basal plate	3	1	5	4	3							
4K	Flower Drift	Black moist Extending down from neck in a few cases reaching basal plate	10		1									
5K	Birma	Grey/brown moist general discoloration but not reaching basal plate		3	8	4	6							
6K	Dutch Master	Brown moist/dry mainly confined to neck region		5	4	6	2	1			1	1		
7K	Standard Value	Brown moist with darker brown areas, general discoloration (affecting practically whole of bulb)		4	8	1	7							

NARCISSUS NECK ROT

Number of bulbs (total 10) from which the respective fungi were isolated 1991

Sample Number	Cultivar	General description of rot	*Fusarium oxysporum*	*Botrytis narcissicola*	*Penicillium hirsutum*	*Penicillium pinophylum*	*Ceratocystis narcissi*	*Trichoderma viride*	*Aspergillus flavus*	*Verticillium nigrescens*	*Stemphyllium sp.*	*Rhizopus sp.*	*Epicoccum sp.*	
8K	Carlton	Black moist extending down from neck, often to basal plate	10				1	1						
9K	Dutch Master	Grey/dark brown moist general discoloration (afffecting practically whole bulb)		1	6	1	3					4		
10K	Carlton	Brown/dark brown moist general discoloration of neck and sometimes rest of bulb		2	9								1	
11K	Mixed	Black moist Extending down from neck in most cases reaching basal plate	10											
12K	Carlton	Dark brown/black moist extending down from neck in a few cases reaching the basal plate	10	2										

NARCISSUS NECK ROT

Number of bulbs (total 10) from which the respective fungi were isolated 1991

Sample Number	Cultivar	General description of rot	*Fusarium oxysporum*	*Botrytis narcissicola*	*Penicillium hirsutum*	*Penicillium pinophylum*	*Ceratocystis narcissi*	*Trichoderma viride*	*Aspergillus flavus*	*Verticillium nigrescens*	*Stemphyllium sp.*	*Rhizopus sp.*	*Epicoccum sp.*	
13K	Dutch Master	Brown moist/dry mainly confined to the neck region		7	4	3	7		2					
14K	Dutch Master	Brown moist/dry extending down from neck in some cases but not reaching basal plate		5	7	5	3						1	
15K	Golden Harvest	Dark brown/black moist Extending down from the neck in most cases reaching basal plate	10											
16K	Golden Ducat	Brown/black moist Extending down from neck in most cases reaching basal plate	10	1										
17K	Music Hall	Variable. Some with brown confined to neck others with black, moist extending down from neck in most cases reaching the basal plate	4	1	3	1	2		2			1		*F. oxysporum* isolated where rot black and extending.
18K	Scarlettt O'Hara	Black moist In most cases whole of bulb affected	9	1	1		1							

NARCISSUS NECK ROT

Number of bulbs (total 10) from which the respective fungi were isolated 1991

Sample Number	Cultivar	General description of rot	*Fusarium oxysporum*	*Botrytis narcissicola*	*Penicillium hirsutum*	*Penicillium pinophylum*	*Ceratocystis narcissi*	*Trichoderma viride*	*Aspergillus flavus*	*Verticillium nigrescens*	*Stemphyllium sp.*	*Rhizopus sp.*	*Epicoccum sp.*	
19K	Fortune	Black moist In most cases whole of bulb affected	8	1									1	
20K	Lady Winifred	Variable. Some with brown confined to neck other with black moist extending down to basal plate.	4	1	3		2					1		*F. oxysporum* isolated where black rot extending down from neck
21K	Gold Medal	Brown/black moist Extending down from neck in most cases, but not reaching basal plate		1	9		2					3		
22K	Magnet	Brown/black moist Extending down from neck and most cases reaching basal plate.	7		1		1		1					
23K	Dutch Master	Variable. Some with brown confined to neck others with brown moist extending down but not to basal plate (one bulb had basal but no neck rot)		4	5	9	5		1					*F. oxysporum* isolated from bulb with only basal rot

NARCISSUS NECK ROT

Number of bulbs (total 10) from which the respective fungi were isolated 1991

Sample Number	Cultivar	General description of rot	*Fusarium oxysporum*	*Botrytis narcissicola*	*Penicillium hirsutum*	*Penicillium pinophylum*	*Ceratocystis narcissi*	*Trichoderma viride*	*Aspergillus flavus*	*Verticillium nigrescens*	*Stemphyllium sp.*	*Rhizopus sp.*	*Epicoccum sp.*
24K	Carlton	Black moist Extending down from neck to basal plate in every bulb.	10									1	
25K	Mary Copeland	Brown/black moist general discoloration and rotting of almost every bulb.	9		1	1						1	
26K	Yellow Sun	Variable. Some with brown confined to neck but most with brown/black moist affecting most of bulb.	6		4	1	1			1			
27K	Standard Value	Brown/black moist General discoloration and rotting of almost every bulb.	10	1		1						1	
28K	Mixed	Brown/black moist General discoloration and rotting of every bulb	10	1	6								
29K	Scarlettt O'Hara	Brown/black moist General discoloration and rotting of almost every bulb	8		2								

NARCISSUS NECK ROT

Number of bulbs (total 10) from which the respective fungi were isolated 1991

Sample Number	Cultivar	General description of rot	*Fusarium oxysporum*	*Botrytis narcissicola*	*Penicillium hirsutum*	*Penicillium pinophylum*	*Ceratocystis narcissi*	*Trichoderma viride*	*Aspergillus flavus*	*Verticillium nigrescens*	*Stemphyllium sp.*	*Rhizopus sp.*	*Epicoccum sp.*
30K	Fortune	Variable. Some with brown confined to neck others with brown/black moist discoloration affecting whole bulb	7	2	3	1							
31K	Carlton	Variable. Most with brown confined to neck, some with brown/black moist extending from neck to basal plate.	3	2	2		1						
32K	Magnet	Brown/dark brown Variable - dry/moist; some limited to neck others with rot almost down to basal plate			10		1						

NARCISSUS NECK ROT

Number of bulbs (total 10) from which the respective fungi were isolated 1992

Sample Number	Cultivar	General description of rot	*Fusarium oxysporum*	*Botrytis narcissicola*	*Penicillium hirsutum*	*Penicillium pinophylum*	*Ceratocystis narcissi*	*Trichoderma viride*	*Aspergillus flavus*	*Botrytis cinerea*	*Geotrichum candidum*	*Rhizopus sp.*	*Fusarium poae*	*Fusarium culmorum*	
33K	Dutch Master	Brown, moist/dry, mainly confined to neck region		2	8	1	7							1	
34K	Golden Harvest	Black, moist, extending down in most cases but not to basal plate	9	3	1	2	4								
35K	Actaea	Black moist Extending down in most cases, to basal plate in a few		9	5	6	5		2				1		
36K	Dutch Master	Brown/black, moist extending down in a few cases, but not to basal plate	1	6	6	4	7		4						
37K	Dutch Master	Brown/black, moist, extending down in a few cases, but not to basal plate		6	4	1	9		3						
38K	Dick Wilden	Brown/black, moist, extending down to the basal plate in most cases	8		1		1								
39K	Carlton	Brown/black, moist, most confined to neck but a few extending down to basal plate	3		7		1		2						*F. oxysporum* isolated where rot extending

NARCISSUS NECK ROT

Number of bulbs (total 10) from which the respective fungi were isolated 1992

Sample Number	Cultivar	General description of rot	*Fusarium oxysporum*	*Botrytis narcissicola*	*Penicillium hirsutum*	*Penicillium pinophylum*	*Ceratocystis narcissi*	*Trichoderma viride*	*Aspergillus flavus*	*Botrytis cinerea*	*Geotrichum candidum*	*Rhizopus sp.*	*Fusarium poae*	*Fusarium culmorum*	
40K	Dutch Master	Brown/black, moist, confined to neck		5	10	3	7	1	1	3					
41K	Standard Value	Brown/black, moist, mainly confined to neck but a few extending down but not to basal plate		6	10	2	10		1		1				
42K	Carlton	Brown/black, moist, extending down to basal plate in most cases	8		3	1	2	1							*F. oxysporum* not isolated where rot confined to neck
43K	Dutch Master	Brown/black, moist, confined to neck		5	7	8	6		1						
44K	Carlton	Brown/black, moist, extending down to basal plate in most cases	9		1	2	1	2		1					*F. oxysporum* not isolated where rot confined to neck
45K	Scarlett O'Hara	Black, moist, extending down to basal plate; whole bulb rotted in several cases	10		4							1			

NARCISSUS NECK ROT

Number of bulbs (total 10) from which the respective fungi were isolated 1992

Sample Number	Cultivar	General description of rot	*Fusarium oxysporum*	*Botrytis narcissicola*	*Penicillium hirsutum*	*Penicillium pinophylum*	*Ceratocystis narcissi*	*Trichoderma viride*	*Aspergillus flavus*	*Botrytis cinerea*	*Geotrichum candidum*	*Rhizopus sp.*	*Fusarium poae*	*Fusarium culmorum*	
46K	Golden Harvest	Brown/black, moist, mainly confined to neck but extending down to basal plate in a few cases	4		7		1			1					*F oxysporum* only isolated where rot extending
47K	Birma	Brown/black, moist, mainly confined to neck but extending down slightly in a few cases		7	10	3	4			3					
48K	Rembrandt	Brown/black, moist, extending down in most cases but only to the basal plate in 1 bulb	4	5	8	1		2							
49K	Unsurpassable	Brown/black, moist, confined to neck		8	5	2	4	3			1	1			
50K	Actaea	Brown/black, moist, extending down in some cases but only to basal plate in 2 bulbs	3	5	8	1	6	1		1					*F. oxysporum* only isolated from one of the bulbs where rot reached basal plate
51K	Golden Harvest	Brown/black, moist, extending down to basal plate in most cases; whole bulb rot in many cases	8	1	3	1									*F. oxysporum* not isolated from the 2 bulbs where rot only extended down slightly

NARCISSUS NECK ROT

Number of bulbs (total 10) from which the respective fungi were isolated 1992

Sample Number	Cultivar	General description of rot	*Fusarium oxysporum*	*Botrytis narcissicola*	*Penicillium hirsutum*	*Penicillium pinophylum*	*Ceratocystis narcissi*	*Trichoderma viride*	*Aspergillus flavus*	*Botrytis cinerea*	*Geotrichum candidum*	*Rhizopus sp.*	*Fusarium poae*	*Fusarium culmorum*	
52K	Rembrandt	Brown/black, moist, extending down in a few cases but not to basal plate		4	7		1		2	1			1		*Fusarium* basal rot in 2 bulbs (not extending from the neck)
53K	Magnificence	Dark brown, moist, extending down to basal plate in most cases			10			1	1						
54K	Bridal Crown	Brown/black, moist, extending down to basal plate in most cases	1		9	1	5			1					
55K	Carlton	Brown/black, moist, extending down to basal plate in most cases	9	1	2		1	2	1			1			
56K	Fortune	Brown, dry, confined to neck in 2 bulbs Brown/black, moist, extending down to basal plate in all other bulbs	8		2			2				1			*F. oxysporium* not isolated from the 2 bulbs with rot confined to neck
57K	Mount Hood	Brown/black, moist, extending down but not to basal plate			10	2	1								

NARCISSUS NECK ROT

Number of bulbs (total 10) from which the respective fungi were isolated 1993

Sample Number	Cultivar	General description of rot	*Fusarium oxysporum*	*Botrytis narcissicola*	*Botrytis cinerea*	*Penicillium hirsutum*	*Penicillium thomii*	*Penicillium pinophylum*	*Phoma glomerata*	*Ophiostoma narcissi*	*Trichoderma spp.*	*Fusarium solani*	*Oidiodendron sp.*	*Gliocladium sp.*	*Ulocladium sp.*	*Humicola sp.*	*Stemphylium sp.*	*Aspergillus niger*	*Cladosporium sp.*	Other *Penicillium spp.*
58 K	Dutch Master	Brown/dark brown, moist, extending down slightly	1	10		3	2	1		7	1				1		1			
59 K	Dutch Master	Brown/dark brown, moist, mainly confined to neck, but some extending down slightly		9		6	4			9						1				
60 K	Dutch Master	Brown/dark brown, moist, mainly confined to neck, but some extending down slightly		7	1	4	6	8		6										
61 K	Pink Pride	Brown, moist, mainly confined to neck, but some extending down slightly		5		2	1	1		5										
62 K	Carlton	Brown/black, moist, mainly confined to neck, but some extending down slightly. One bulb completely rotted (brown/soft)		2		9	5	1		6	2									
63 K	Carlton	Black, moist, extending down to basal plate in half the bulbs	10	2	1	6				3	4									
64 K	Fortune	Black/brown, moist, extending down in half the bulbs but not to basal plate	5	4		7	7	4		1										

NARCISSUS NECK ROT

Number of bulbs (total 10) from which the respective fungi were isolated 1993

Sample Number	Cultivar	General description of rot	*Fusarium oxysporum*	*Botrytis narcissicola*	*Botrytis cinerea*	*Penicillium hirsutum*	*Penicillium thomii*	*Penicillium pinophylum*	*Phoma glomerata*	*Ophiostoma narcissi*	*Trichoderma spp.*	*Fusarium solani*	*Oidiodendron sp.*	*Gliocladium sp.*	*Ulocladium sp.*	*Humicola sp.*	*Stemphylium sp.*	*Aspergillus niger*	*Cladosporium sp.*	Other *Penicillium spp.*
65 K	Golden Harvest	Brown/black, moist, extending down in half the bulbs but not to basal plate	3			8	1			9	1									
66 K	Scarlett O'Hara	Black/brown, moist, extending down to basal plate in half the bulbs. One bulb completely rotted (black/soft).	8			8	1													1
67 K	Golden Harvest	Black/brown, moist, mainly confined to neck but some extending down slightly	1	2		10	2			1									1	
68 K	Yellow Cheerfulness	Black/brown, moist, extending down but not to basal plate. One bulb completely rotted (brown/soft).		1		3	4		5	3	3	4								
69 K	Sempre Avanti	Black/brown, moist, mainly confined to neck but some extending down slightly		8		7	5	5		4	2									
70 K	Dutch Master	Brown, moist, one bulb with rot confined to neck, others with rot extending down to varying degrees but not to basal plate		8		10	4	9		3			2							

NARCISSUS NECK ROT

Number of bulbs (total 10) from which the respective fungi were isolated 1993

Sample Number	Cultivar	General description of rot	*Fusarium oxysporum*	*Botrytis narcissicola*	*Botrytis cinerea*	*Penicillium hirsutum*	*Penicillium thomii*	*Penicillium pinophylum*	*Phoma glomerata*	*Ophiostoma narcissi*	*Trichoderma spp.*	*Fusarium solani*	*Oidiodendron sp.*	*Gliocladium sp.*	*Ulocladium sp.*	*Humicola sp.*	*Stemphylium sp.*	*Aspergillus niger*	*Cladosporium sp.*	Other *Penicillium spp.*
71 K	Dutch Master	Brown, moist, one bulb completely rotted (brown/soft) others with rot extending down to varying degrees but not to basal plate		8		10	6	7		3			2							3
72 K	Red Goblet	Brown/dark brown, moist, extending down in most cases but not to basal plate		3		9		3	2	3	2									
73 K	Mount Hood	Brown/dark brown, moist, extending down in most cases but not to basal plate		7		10	4	3		2										
74 K	Sempre Avanti	Brown/dark brown, moist, mainly confined to neck but some extending down slightly		1		8		3		3	1					1				
75 K	Bravoura	Black/brown, moist, extending down to the basal plate in half the bulbs	9	3	1	3	5	3		2										
76 K	Golden Harvest	Black/brown, moist, extending down in most cases, to the basal plate in one case	7	2		1		1		3	6									1

NARCISSUS NECK ROT

Number of bulbs (total 10) from which the respective fungi were isolated 1993

Sample Number	Cultivar	General description of rot	*Fusarium oxysporum*	*Botrytis narcissicola*	*Botrytis cinerea*	*Penicillium hirsutum*	*Penicillium thomii*	*Penicillium pinophylum*	*Phoma glomerata*	*Ophiostoma narcissi*	*Trichoderma spp.*	*Fusarium solani*	*Oidiodendron sp.*	*Gliocladium sp.*	*Ulocladium sp.*	*Humicola sp.*	*Stemphylium sp.*	*Aspergillus niger*	*Cladosporium sp.*	Other *Penicillium spp.*
77 K	Unsurpassable	Brown, moist, mainly confined to neck, but some extending down slightly		6		6	4	3		1										
78 K	Golden Harvest	Brown, moist, extending down slightly		1		10	1		5	7										
79 K	La Riante	Brown, mainly moist, extending down slightly		5		7	2		4	7	1		1							
80 K	Sempre Avanti	Black/brown, moist, mainly confined to neck but some extending down slightly		3		10	2	3		4	2		2							
81 K	Majesty	Black, moist, extending down in most cases, to the basal plate in one case	7			7	8	2		7										
82 K	Carlton	Black, moist, extending down to the basal plate in most cases	8	1		8	4	1		6										2

NARCISSUS NECK ROT

Number of bulbs (total 10) from which the respective fungi were isolated 1993

Sample Number	Cultivar	General description of rot	*Fusarium oxysporum*	*Botrytis narcissicola*	*Botrytis cinerea*	*Penicillium hirsutum*	*Penicillium thomii*	*Penicillium pinophylum*	*Phoma glomerata*	*Ophiostoma narcissi*	*Trichoderma spp.*	*Fusarium solani*	*Oidiodendron sp.*	*Gliocladium sp.*	*Ulocladium sp.*	*Humicola sp.*	*Stemphylium sp.*	*Aspergillus niger*	*Cladosporium sp.*	Other *Penicillium spp.*
83 K	Birma	Black, moist, mainly confined to neck, but some extending down slightly. One bulb with top half completely rotted (black/soft)		9		9		3	2	6										4
84 K	Yellow Sun	Black/brown, moist, mainly confined to neck, but some extending down slightly		7		10	6	6		2	1									2
85 K	Tahiti	Black/brown, moist, extending down in most cases but not to the basal plate	2	5		8	3	8	4	4	3		1							
86 K	Ice Follies	Brown, moist, mainly confined to neck but some extending down slightly	1	1		10	3	1	7	4										2
87 K	Golden Harvest	Black/brown, moist, mainly confined to neck, some extending down slightly but reaching the basal plate in one case. Two bulbs with extensive rot on side of bulb (brown/soft)	3	3		8		5		8										1

NARCISSUS NECK ROT

Number of bulbs (total 10) from which the respective fungi were isolated 1993

Sample Number	Cultivar	General description of rot	*Fusarium oxysporum*	*Botrytis narcissicola*	*Botrytis cinerea*	*Penicillium hirsutum*	*Penicillium thomii*	*Penicillium pinophylum*	*Phoma glomerata*	*Ophiostoma narcissi*	*Trichoderma spp.*	*Fusarium solani*	*Oidiodendron sp.*	*Gliocladium sp.*	*Ulocladium sp.*	*Humicola sp.*	*Stemphylium sp.*	*Aspergillus niger*	*Cladosporium sp.*	*Other Penicillium spp.*
88 K	Golden Harvest	Brown/black, moist, mainly confined to neck but some extending down to basal plate in three cases [NB F.oxysporum only found in two of the bulbs with rot reaching the basal plate]	3	4		7	2	1		2			1					1		5
89 K	Cheerfulness	Black/brown, moist, six bulbs completely rotted (Dark brown/soft) others with rot extending down slightly		8		5	3	3	1	2	4									

NARCISSUS NECK ROT

Number of bulbs (total 10) from which the respective fungi were isolated 1993

Sample Number	Cultivar	General description of rot	*Fusarium oxysporum*	*Botrytis narcissicola*	*Botrytis cinerea*	*Penicillium hirsutum*	*Penicillium thomii*	*Penicillium pinophylum*	*Phoma glomerata*	*Ophiostoma narcissi*	*Trichoderma spp.*	*Fusarium solani*	*Oidiodendron sp.*	*Gliocladium sp.*	*Ulocladium sp.*	*Humicola sp.*	*Stemphylium sp.*	*Aspergillus niger*	*Cladosporium sp.*	*Verticillium sp.*	Other *Penicillium spp.*
90K	Apotheose	Brown/black, moist, five bulbs almost completely rotted (brown/soft), others with rot extending down slightly		6		10	1	1		3			1								4
91K	Magnet	Brown, moist. Three bulbs almost completely rotted (brown/soft), others with rot extending down slightly		6		10		6		4						2				1	2
92K	Fortune	Brown/black, moist, confined to neck or extending down slightly except in one bulb where basal plate affected [*F. oxysporum* isolated in latter]	1	1		10	4	9		3	1					1					4
93K	Flower Drift	Brown, moist, four bulbs almost completely rotted (brown/soft), others with rot extending down to basal plate	1	8		10		7		2			1							1	2

NARCISSUS NECK ROT

Number of bulbs (total 10) from which the respective fungi were isolated 1993

Sample Number	Cultivar	General description of rot	*Fusarium oxysporum*	*Botrytis narcissicola*	*Botrytis cinerea*	*Penicillium hirsutum*	*Penicillium thomii*	*Penicillium pinophylum*	*Phoma glomerata*	*Ophiostoma narcissi*	*Trichoderma* spp.	*Fusarium solani*	*Oidiodendron* sp.	*Gliocladium* sp.	*Ulocladium* sp.	*Humicola* sp.	*Stemphylium* sp.	*Aspergillus niger*	*Cladosporium* sp.	*Verticillium* sp.	Other *Penicillium* spp.
94K	Standard Value	Brown, moist, five bulbs almost completely rotted (brown/soft), others with rot extending down slightly		6		8	3	1		4	1										1
95K	Hollywood	Brown, moist, six bulbs almost completely rotted (brown/soft), others with rot extending down to basal plate in most cases	1	8		9	2	7		2											4
96K	Barrett Browning	All bulbs completely, or almost completely rotted (brown/soft)		10		6		3	1		3										
97K	Golden Harvest	Brown/black, moist, mainly confined to neck but extending down to basal plate in three cases [*F. oxysporum* found in two of the latter]	2	3		10	1	4		6	1										

NARCISSUS NECK ROT

Number of bulbs (total 10) from which the respective fungi were isolated 1993

Sample Number	Cultivar	General description of rot	*Fusarium oxysporum*	*Botrytis narcissicola*	*Botrytis cinerea*	*Penicillium hirsutum*	*Penicillium thomii*	*Penicillium pinophylum*	*Phoma glomerata*	*Ophiostoma narcissi*	*Trichoderma spp.*	*Fusarium solani*	*Oidiodendron sp.*	*Gliocladium sp.*	*Ulocladium sp.*	*Humicola sp.*	*Stemphylium sp.*	*Aspergillus niger*	*Cladosporium sp.*	*Verticillium sp.*	Other *Penicillium spp.*
98K	Dutch Master	Brown/black, moist, rot extending down slightly except in one bulb which showed almost complete general rotting (brown/soft)		6		10	1	4		4						1					
99K	Scarlett O'Hara	Brown, moist, six bulbs almost completely rotted (brown/soft), others with rot extending down slightly		6		10		7													1
100K	Pink Pride	Brown, moist, six bulbs almost completely rotted (brown/soft), others with rot extending down slightly		8		8		1	1	3	1										
101K	Ice Follies	Brown, moist, five bulbs almost completely rotted (brown/soft), others with rot extending down slightly		9		9		1	1		1							1			1

NARCISSUS NECK ROT

Number of bulbs (total 10) from which the respective fungi were isolated 1993

Sample Number	Cultivar	General description of rot	*Fusarium oxysporum*	*Botrytis narcissicola*	*Botrytis cinerea*	*Penicillium hirsutum*	*Penicillium thomii*	*Penicillium pinophylum*	*Phoma glomerata*	*Ophiostoma narcissi*	*Trichoderma spp.*	*Fusarium solani*	*Oidiodendron sp.*	*Gliocladium sp.*	*Ulocladium sp.*	*Humicola sp.*	*Stemphylium sp.*	*Aspergillus niger*	*Cladosporium sp.*	*Verticillium sp.*	Other *Penicillium spp.*
102K	Standard Value	Brown, moist, five bulbs almost completely rotted (brown/soft), others with rot extending down slightly		6		10	1	1													2
103K	Bellisona	Brown/black, moist, six bulbs almost completely rotted (brown/black, soft), others with rot extending down nearly to basal plate		8		6		4	1	2	2										
104K	Dutch Master	Brown, moist, two bulbs almost completely rotted (brown/soft), others with rot extending down slightly		7		9		5		3											
105K	Spell Binder	Brown, moist, all ten bulbs completely rotted (brown/soft). Sclerotia present internally and externally in one bulb		10		5		2	1	1											
106K	Ice Follies	Brown, moist, seven bulbs almost completely rotted (brown/soft), others with rot extending down nearly to the basal plate		10		4	1	2		1	1										

NARCISSUS NECK ROT - *FUSARIUM OXYSPORUM* F. SP. NARCISSI RESISTANCE TESTS TO BENLATE AND STORITE

Resistance testing was checked against 5 ppm benomyl and also 5 ppm thiabendazole, with growth checked after c. 4 and 7 days. Results are as attached.

		Fusarium oxysporum f. sp. narcissi					
		Ex Harpenden			Ex Starcross		
Sample No.	Cultivar	No of isolate	No resistant to:- benomyl	thiabendazole	No of isolate	No resistant to:- benomyl	thiabendazole
2K	Golden Harvest	10	10#	10#	2#	2#	2#
3K	Golden Harvest	3	3#	3#	2#	2#	2#
4K	Flower Drift	10	0	0	0	0	0
8K	Carlton	10	0	0	0	0	0
11K	Mixed	10	5#	4#	4	0	0
12K	Carlton	10	0	0	0	0	0
15K	Golden Harvest	10	0	0	0	0	0
16K	Golden Ducat	10	0	0	0	0	0
17K	Music Hall	4	0	0	0	0	0
18K	Scarlett O'Hara	9	0	0	0	0	0
19K	Fortune	8	0	0	0	0	0
20K	Lady Winifred	4	0	0	2	0	0
22K	Magnet	7	6#	6#	0	0	0
23K	Dutch Master	2	1#	1#	0	0	0
24K	Carlton	10	2#	2#	5	0	0
25K	Mary Copeland	9	2#	2#	2	0	0
26K	Yellow Sim	5	3#	3#	0	0	0
27K	Standard Value	10	9#	9#	5	0	0
28K	Mixed	9	2#	2#	2	0	0
29K	Scarlett O'Hara	9	4#	4#	2	0	0
30K	Fortune	4	1#	1#	4	0	0
31K	Carlton	3	0	0	0	0	0

Resistant strains

NARCISSUS NECK ROT TRIAL ADAS STARCROSS
PLANTED 27 SEPTEMBER 1991

Sample No	Plant emergence counts (No/10) 26/2/92	4/3/92	12/3/92	18/3/92	26/3/92	14/4/92 (mother)	14/4/92 (daughter)
1K	8	8	8	8	8	8	5
2K	0	2	2	2	2	1	1
3K	10	10	10	10	10	10	6
4K	0	0	0	0	0	0	0
5K	None planted						
6K	8	10	10	10	10	6	7
7K	0#	0	0	0	0	0	0
8K	None planted						
9K	None planted						
10K	0	0	0	0	0	0	0
11K	0	0	0	0	0	0	0
12K	0	0	0	0	0	0	0
13K	9	10	10	10	10	10	11
14K	6	7	8	8	8	7	7
15K	1	1	1	1	1	2	1
16K	1	2	2	2	2	0	2
17K	0	2	3	3	3	2	4
18K	0	0	0	0	0	0	0
19K	1	1	1	1	1	1	1
20K	6	6	6	6	6	8	5
21K	2	5	6	6	8	8	5
22K	6	7	7	7	7	6	4
23K	8	8	8	8	9	9	4
24K	2	3	3	3	4	4	4
25K	0	0	0	1	1	1	0
26K	4	4	4	4	4	4	3
27K	0	0	0	1	1	1	0
28K	1	1	2	2	2	1	0
29K	0	0	0	0	0	0	0
30K	3	4	5	6	8	10	6
31K	4	6	7	7	7	7	5
32K	0	0	0	0	0	0	0

2/10 only planted

NARCISSUS NECK ROT TRIAL 1992 ADAS STARCROSS NO'S 33-44 PLANTED 24 SEPTEMBER, NO'S 45-57 PLANTED 1 NOVEMBER

Plant emergence final counts (No/10)#

Sample No	22/2/93
33K	10
34K	2
35K	3
36K	10
37K	10
38K	0
39K	9
40K	5
41K	10
42K	0
43K	9
44K	1
45K	0
46K	6
47K	3
48K	5
49K	5
50K	5
51K	2
52K	5
53K	4
54K	4
55K	4
56K	4
57K	6

In some instances more than 10 bulbs planted but final emergence counts adjusted to number out of 10.

NARCISSUS NECK ROT EXPERIMENT 1993 ADAS KIRTON
NO'S 58-63, 65-67, 70-106K PLANTED 4 NOVEMBER

Sample No	27.4.94 Bulb emergence final count (no/10)	27.4.94 Nos bulbs with flowers
58	10	10
59	10	10
60	9	9
61	8	6
62	9	9
63	1	1
65	5	5
66	0	0
67	7	7
70	10	10
71	8	8
72	7	5
73	6	5
74	5	4
75	0	0
76	4	4
77	7	6
78	8	8
79	6	5
80	9	6
81	2	0
82	1	1
83	5	1
84	10	10
85	7	6
86	4	4
87#	3	3
88	0	0
89	5	0
90	6	1
91	10	9
92	8	8
93	2	10
94	8	6
95	5	3
96	7	6
97	7	7
98	8	6
99	4	4

NARCISSUS NECK ROT EXPERIMENT 1993 ADAS KIRTON
NO'S 58-63, 65-67, 70-106K PLANTED 4 NOVEMBER

Sample No	27.4.94 Bulb emergence final count (no/10)	27.4.94 Nos bulbs with flowers
100	8	7
101	9	8
102	9	9
103	7	5
104	7	2
105	3	1
106	8	8

No's 64, 68, 69 not planted as only 10 bulbs received and sent to Harpenden.
Only 8 bulbs

APPENDIX VI

Results of tests on duplicate samples the first sample (1) was sent in the summer 1994 and the second (2) in early autumn 1994.

		No of bulbs affected		
		Pathogen		
No	Cultivar	*Fus oxy*	*Bot nar*	*Pen hir*
(1) 58K	Dutch Master	1	10	3
(2) 70K	Dutch Master	0	8	10
(1) 60K	Dutch Master	0	7	8
(2) 71K	Dutch Master	0	8	10
(1) 64K	Fortune	5	4	7
(2) 92K	Fortune	1	1	10
(1) 61K	Pink Pride	0	7	4
(2) 100K	Pink Pride	0	8	8
(1) 101K	Ice Follies	0	9	9
(2) 106K	Ice Follies	0	10	4

Neck Rot pathogens , rot colour and texture - individual affected bulbs. (Total number of bulbs 998)

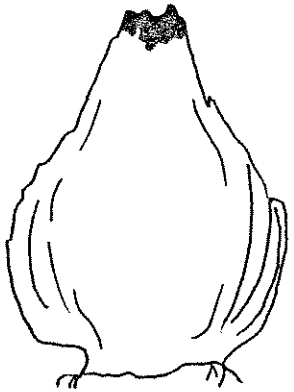
Pathogen	Rot Texture					
	Moist			Dry		
	Black	Dark Brown#	Light Brown	Black	Dark Brown*	Light Brown
Fusarium oxysporum	124	83	26	1	2	0
Penicillium hirsutum	56	89	134	1	9	6
Botrytis narcissicola	6	26	61	0	0	0
F. oxysporum, P.hirsutum & B. narcissicola	4	1	4	0	0	0
F. oxysporum & P.hirsutum	35	21	4	0	1	1
F. oxysporum & B. narcissicola	5	4	7	0	0	0
P.hirsutum & B. narcissicola	32	55	139	0	2	1
None of the three pathogens present	14	14	25	1	2	2

Includes rots described as dark brown/black or black/dark brown.

JD160641.doc

Fig. 1 SAMPLING AND PROCESSING

A sample consisted of 20 bulbs showing neck rot symptoms



10 bulbs sent to CSL Harpenden for fungal isolation

10 bulbs sent to ADAS Starcross/Kirton for growing on

At CSL Harpenden 10 isolations were made from each bulb
(as indicated by arrows) and the fungi identified.

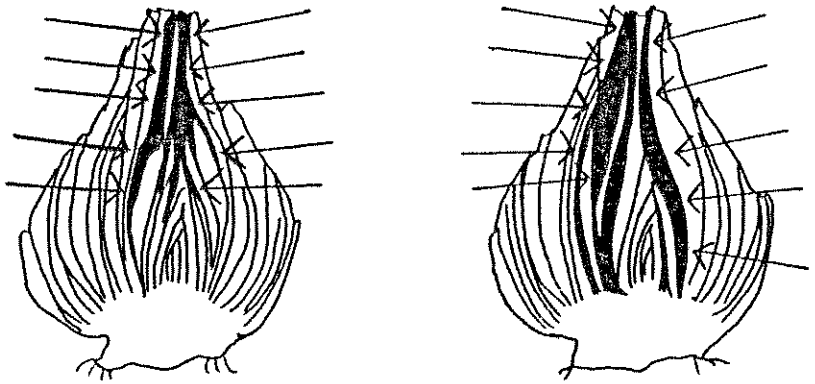


Fig. 2 PATHOGENS AND NECK ROT SYMPTOMS

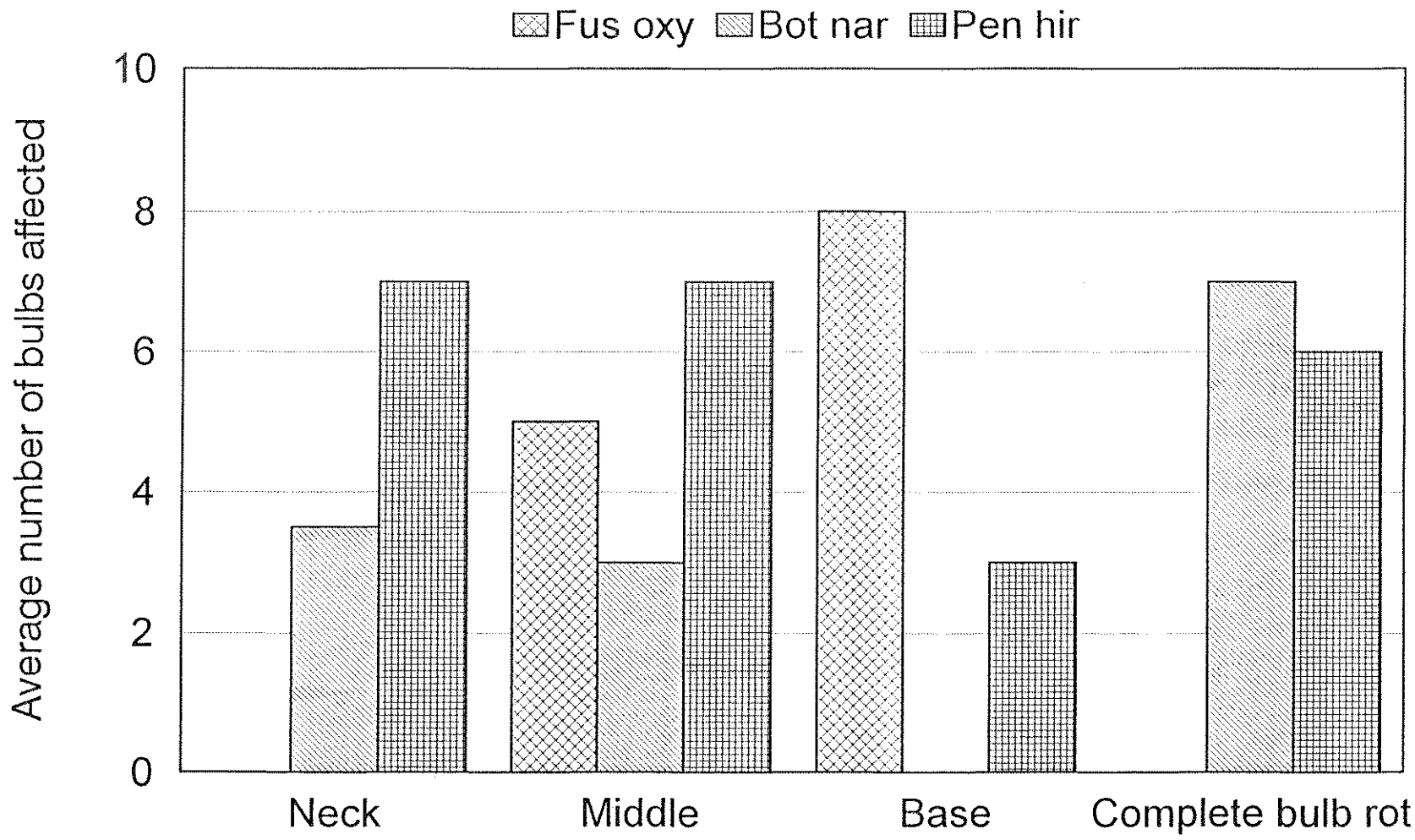
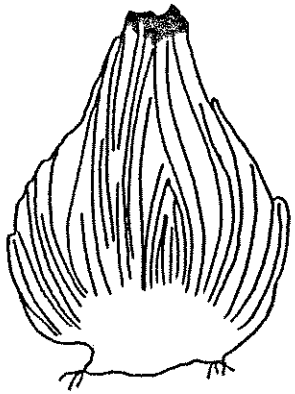
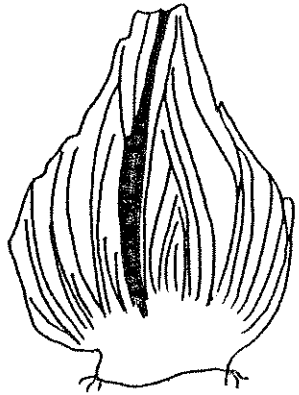


Fig. 3 NARCISSUS NECK ROT SYMPTOMS

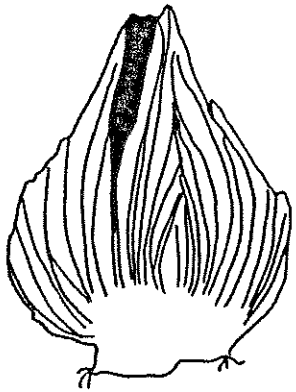
Neck



Base



Middle



Complete Bulb Rot

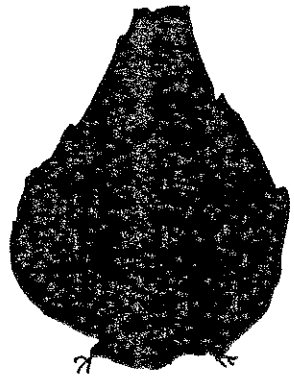


Fig. 4 PATHOGENS AND TRASH IN TRAILER

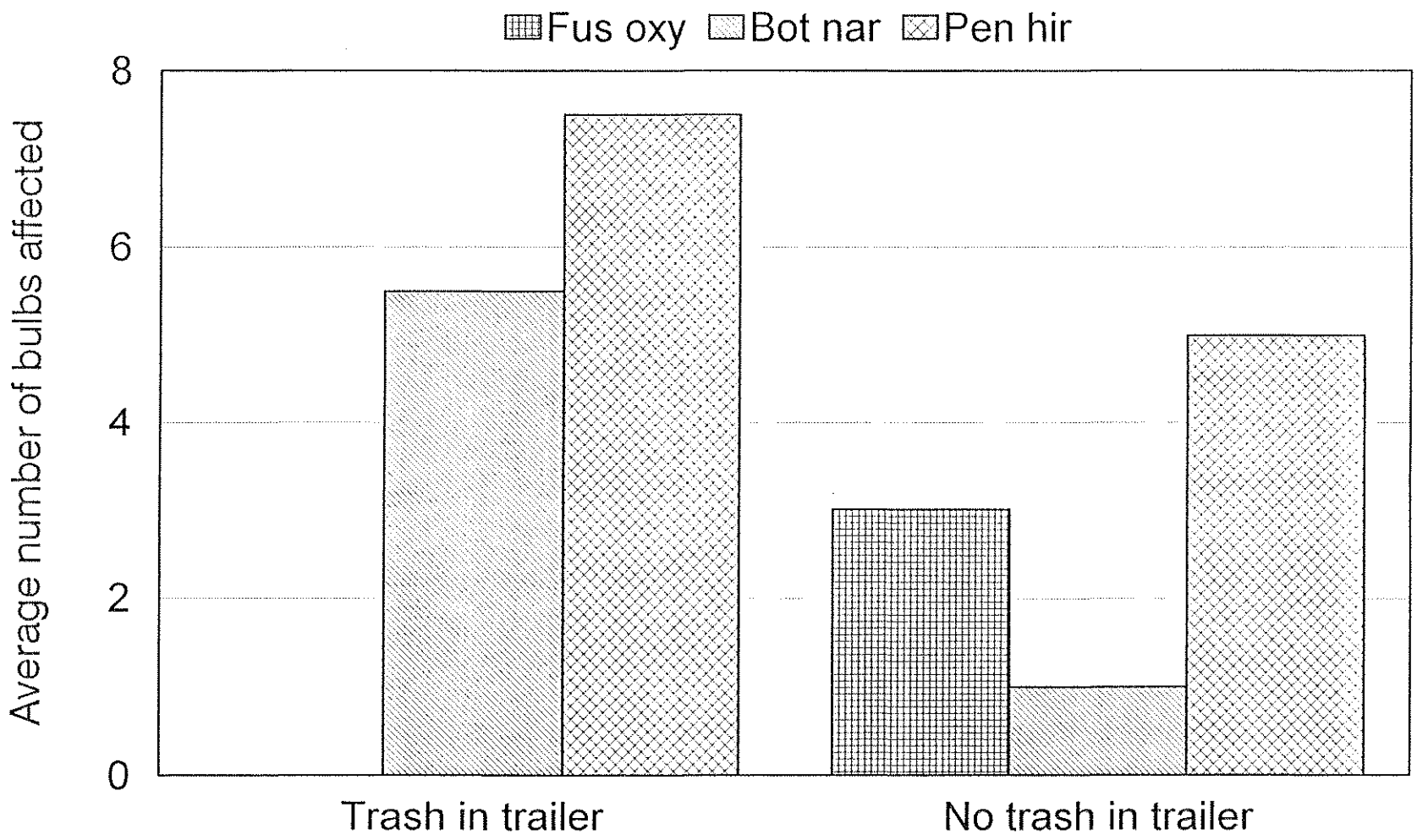


Fig. 5 STOCK PROBLEM AND NECK ROT

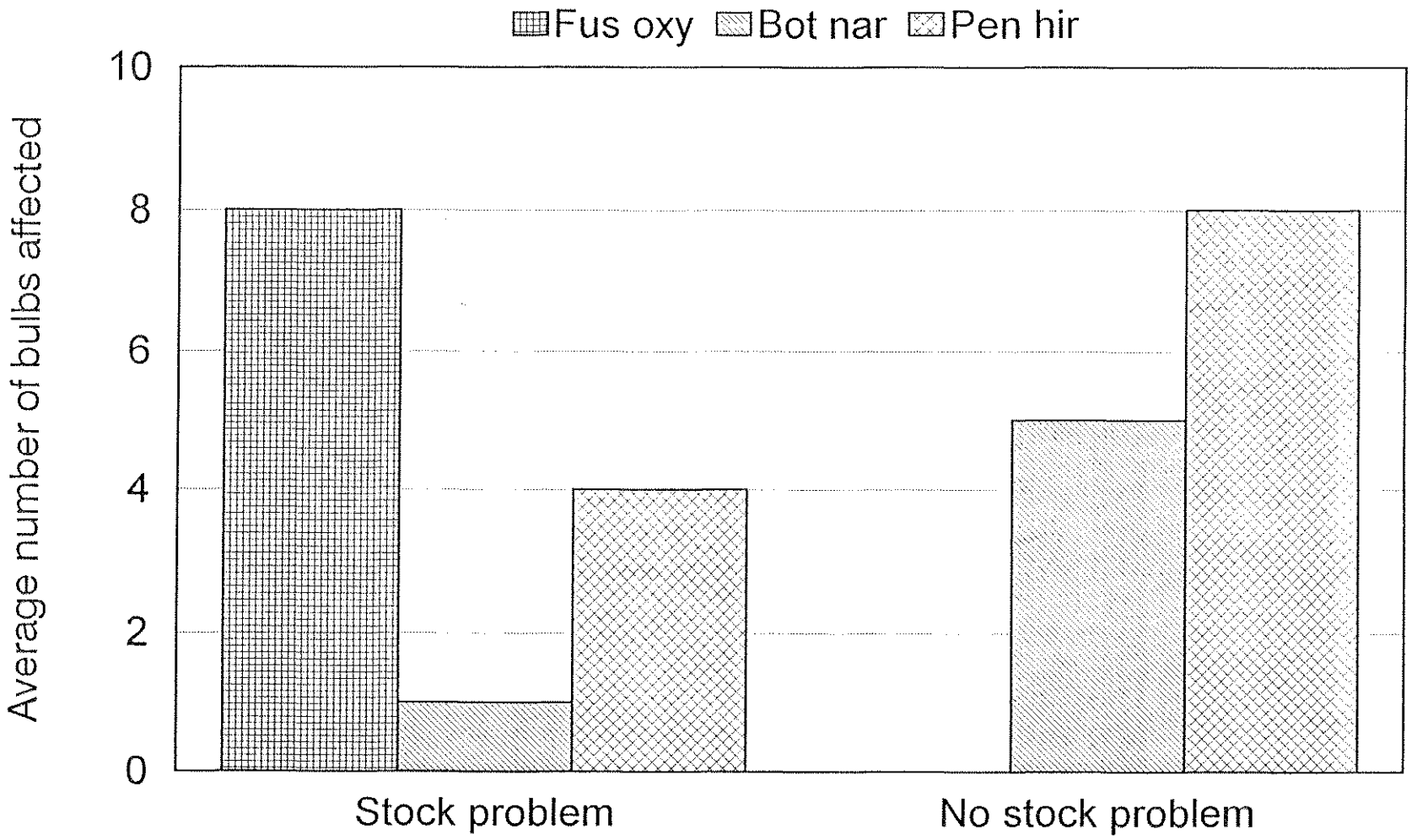
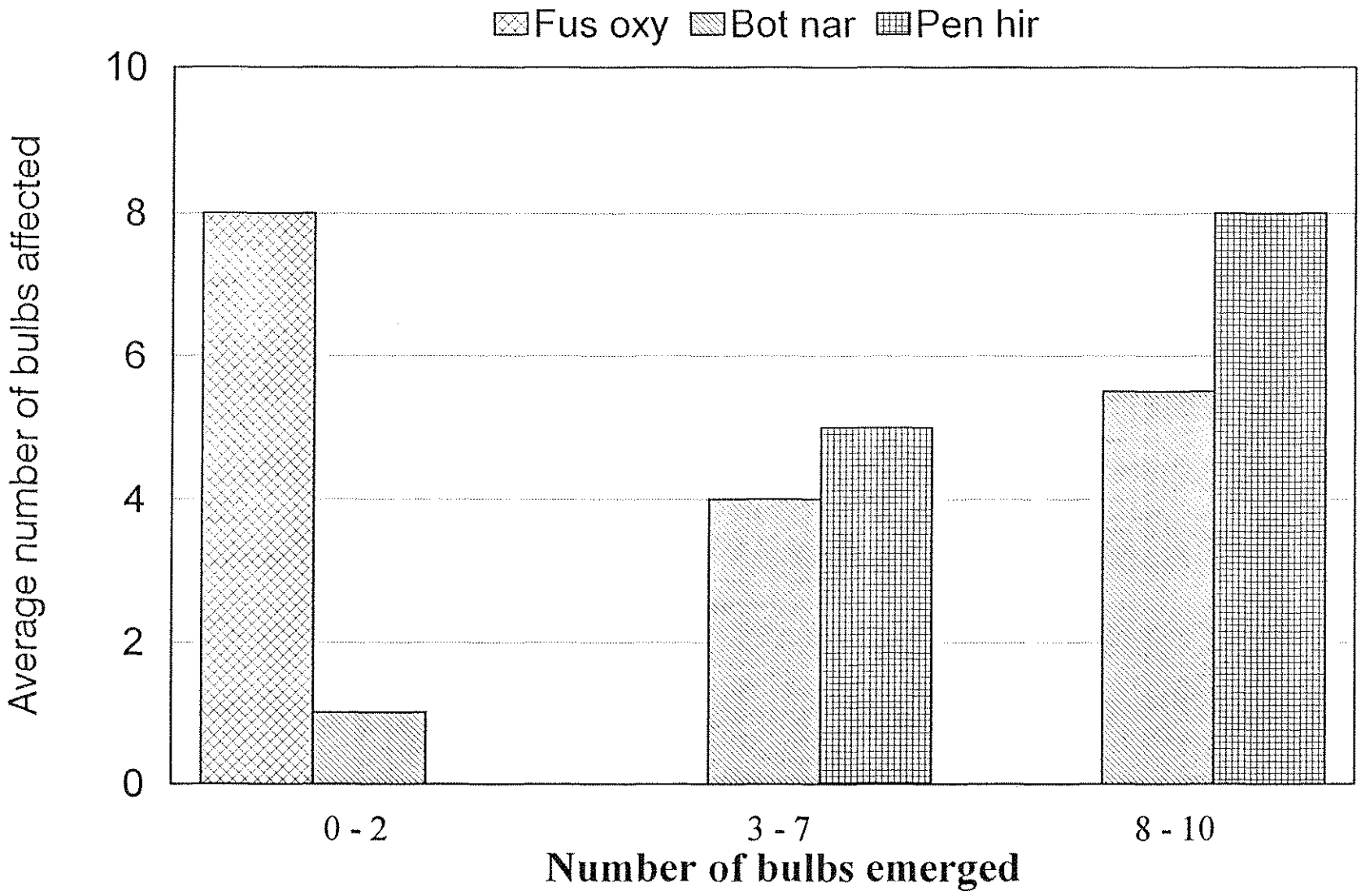


Fig. 6 PATHOGENS AND BULB EMERGENCE



AUTHENTICATION

I declare that this work was done under my supervision according to the procedures described herein and that this report represents a true and accurate record of the results obtained.

.....
Signature

DR J M Ll DAVIES
Contract Manager

Report authorised by:

.....
Signature

DR. W.F. CORMACK
Research Team Manager
ADAS Terrington Research Centre

Date .....

Contract between ADAS and CSL (hereinafter called the "Contractors") and the Horticultural Development Council (hereinafter called the "Council") for a research/development project.

PROPOSAL

1. TITLE OF PROJECT **Contract No: BOF/28**

NARCISSUS NECK ROT: INVESTIGATION OF THE CAUSAL ORGANISMS, PRE-DISPOSING FACTORS AND RECOMMENDATIONS FOR CONTROL AND/OR FURTHER R & D.

2. BACKGROUND AND COMMERCIAL OBJECTIVE

Neck rot is a major cause of rejection of bulb consignments submitted for export. Linfield (1990) isolated *Penicillium, Trichoderma* and *Botrytis* spp. from affected neck tissues of failed bulb consignments. The most common fungus isolated was *Fusarium oxysporum* f.sp.*narcissi* and this was the only one found to be pathogenic. Dickens at the Harpenden Laboratory isolated similar fungi. At Kirton *Rhizoctonia* sp has been isolated but in 1990 *Botrytis/Sclerotinia* spp were the only fungi isolated from affected necks.

In recent years there has been a change in neck rot symptoms from dark brown lesions (mainly caused by the basal rot fungus) to light brown/ginger coloured lesions. Also there have been changes in cultural practices with earlier harvesting of more immature crops and more mechanical harvesting direct into store in the Eastern counties. The objective is to focus on the factors causing neck rot.

REFERENCE

Linfield, Christine A., (1990). Neck rot disease of *Narcissus* caused by *Fusarium oxysporum* f. sp. *narcissi*. Proceedings 5th International Symposium on Flower Bulbs 1989. *Acta Horticulturae No 266 pp 477-482*

3. POTENTIAL FINANCIAL BENEFIT TO THE INDUSTRY

Results would lead to:-

1) A reduction in the number of consignments for export being rejected because of neck rot.

2) An increase in quality of bulbs for the home market.

3) Avoidance of problems of 'latent infection' ie. symptoms developing later, after the bulbs have been processed.

Results are likely to be economic to implement.

4. SCIENTIFIC/TECHNICAL TARGET OF THE WORK

a) Identification of causal organisms.

b) Identification of pre-disposing factors e.g. cultural/husbandry factors.

c) Growing on of neck rot affected bulbs.

d) Identify control measures and/or need for further R & D.

5. CLOSELY RELATED WORK - COMPLETED OR IN PROGRESS

Some work in the 1970s has been carried out by Dickens (unpublished). Linfield (1990) working in the early 1980s concluded that neck rot was caused by *Fusarium oxysporum* f sp *narcissi*. This work was primarily aimed at basal rot disease and was inconclusive as regards to neck rot. It is considered that other fungal pathogens are also involved.

6. DESCRIPTION OF THE WORK

During post-lifting inspection of commercial Narcissus stocks by growers or marketing company representatives, bulbs showing progressive neck rot disease symptoms will be sampled. Besides the above arrangement PHSI will bring to the attention of the relevant company and/or the HDC project leader the number of any stock in which any neck rot symptoms at or more than 1% irrespective of whether sufficient bulbs have been found to fail the stock for export purposes. Where possible, 20 affected bulbs from each stock will be sent to Dr Dickens at the Central Science Laboratory at Harpenden, half the number will be used for culturing and fungal identification and the other half will be sent to ADAS Starcross for planting in the ground and these will be assessed during the following season for growth, flowering and bulb rotting. Up to 50 consignments, will be processed, mainly from the Eastern counties and the South West, but will include other areas.

A questionnaire will be prepared and growers will be interviewed regarding cropping details and husbandry aspects of the identified bulb consignments.

Full co-operation of growers is required regarding sampling of bulbs and the completion of the questionnaire.

The work in years 2 and 3 may be modifield as a result of experience gained in the first year.

7. COMMENCEMENT DATE AND DURATION

July 1991 - 3 years

8. STAFF RESPONSIBILITIES

Project Leader: Dr J M Ll Davies, Plant Pathology Department, ADAS, Government Buildings, Willington Rd, Kirton, Boston, Lincs. PE20 1EJ Tel: 0205 722391.

Key collaborative staff:
Mr Owen W Jones, Plant Pathology Department, ADAS, Staplake Mount Starcross, Exeter EX6 8PE
Tel: 0626 890481.

Dr J S W Dickens, MAFF, Central Science Laboratory, Hatching Green, Harpenden, Herts. AL5 2BD. Tel 0582 715241.

9. LOCATION

Kirton, Starcross, and Harpenden

10. COSTS

Year 1		
ADAS	5441	(Plus interview costs - see note below)
Central Science Laboratory	3407	(In each year this represents half the costs as half will be done under Dr Dickens' government commissioned project)
Year 2		
ADAS	5985	(Plus interview costs - see note below)
Central Science Laboratory	3747	
Year 3		
ADAS	6584	(Plus interview costs - see note below)
Central Science Laboratory	4121	

N.B. The ADAS costs do not include any money to cover the costs of conducting the interviews. The maximum cost to HDC for the interviews (assuming 50 growers would be involved) will be £3024 in 1991, £3326 in 1992 and £3658 in 1993.

11. PAYMENT

On each quarter day the Council will pay to the Contractors in accordance with the following schedules:

CSL

Quarter/Year	1991	1992	1993	1994
1	-	852	937	1030
2	-	851	936	1030
3	852	937	1031	-
4	852	937	1030	-

ADAS

Quarter/Year	1991	1992	1993	1994
1	-	1360	1496	1646
2	-	1360	1496	1646
3	1361	1497	1646	-
4	1360 [+3024*]	1496 [+3326*]	1646 [+3658*]	-

* INTERVIEW COSTS:

The figures represent the maximum cost to HDC and they will be reduced if fewer than 50 growes are involved. ADAS will invoice HDC separately for the interview costs in the fourth quarter of each year. The cost will be based on the time spent interviewing each grower (including travelling time) and will not exceed the amounts stated.

TERMS AND CONDITIONS

The Council's standard terms and conditions of contract shall apply.

Signed for the Contractor (s)

Signature M. J. Griff

Position R&D Manager

Date 5/9/91

Signed for the Contractor (s)

Signature.....

Position.....

Date.....

Signed for the Council

Signature.....

Position CHIEF EXECUTIVE

Date 2.9.91

Contract between ADAS and CSL (hereinafter called the "Contractors") and the Horticultural Development Council (hereinafter called the "Council") for a research/development project.

PROPOSAL

1. TITLE OF PROJECT **Contract No: BOF/28**

NARCISSUS NECK ROT: INVESTIGATION OF THE CAUSAL ORGANISMS, PRE-DISPOSING FACTORS AND RECOMMENDATIONS FOR CONTROL AND/OR FURTHER R & D.

2. BACKGROUND AND COMMERCIAL OBJECTIVE

Neck rot is a major cause of rejection of bulb consignments submitted for export. Linfield (1990) isolated *Penicillium, Trichoderma* and *Botrytis* spp. from affected neck tissues of failed bulb consignments. The most common fungus isolated was *Fusarium oxysporum* f.sp.*narcissi* and this was the only one found to be pathogenic. Dickens at the Harpenden Laboratory isolated similar fungi. At Kirton *Rhizoctonia* sp has been isolated but in 1990 *Botrytis/Sclerotinia* spp were the only fungi isolated from affected necks.

In recent years there has been a change in neck rot symptoms from dark brown lesions (mainly caused by the basal rot fungus) to light brown/ginger coloured lesions. Also there have been changes in cultural practices with earlier harvesting of more immature crops and more mechanical harvesting direct into store in the Eastern counties. The objective is to focus on the factors causing neck rot.

REFERENCE

Linfield, Christine A., (1990). Neck rot disease of *Narcissus* caused by *Fusarium oxysporum* f. sp. *narcissi*. Proceedings 5th International Symposium on Flower Bulbs 1989. *Acta Horticulturae No 266 pp 477-482*

3. POTENTIAL FINANCIAL BENEFIT TO THE INDUSTRY

Results would lead to:-

1) A reduction in the number of consignments for export being rejected because of neck rot.

2) An increase in quality of bulbs for the home market.

3) Avoidance of problems of 'latent infection' ie. symptoms developing later, after the bulbs have been processed.

Results are likely to be economic to implement.

4. SCIENTIFIC/TECHNICAL TARGET OF THE WORK

a) Identification of causal organisms.

b) Identification of pre-disposing factors e.g. cultural/husbandry factors.

c) Growing on of neck rot affected bulbs.

d) Identify control measures and/or need for further R & D.

5. CLOSELY RELATED WORK - COMPLETED OR IN PROGRESS

Some work in the 1970s has been carried out by Dickens (unpublished). Linfield (1990) working in the early 1980s concluded that neck rot was caused by *Fusarium oxysporum* f sp *narcissi*. This work was primarily aimed at basal rot disease and was inconclusive as regards to neck rot. It is considered that other fungal pathogens are also involved.

6. DESCRIPTION OF THE WORK

During post-lifting inspection of commercial Narcissus stocks by growers or marketing company representatives, bulbs showing progressive neck rot disease symptoms will be sampled. Besides the above arrangement PHSI will bring to the attention of the relevant company and/or the HDC project leader the number of any stock in which any neck rot symptoms at or more than 1% irrespective of whether sufficient bulbs have been found to fail the stock for export purposes. Where possible, 20 affected bulbs from each stock will be sent to Dr Dickens at the Central Science Laboratory at Harpenden, half the number will be used for culturing and fungal identification and the other half will be sent to ADAS Starcross for planting in the ground and these will be assessed during the following season for growth, flowering and bulb rotting. Up to 50 consignments, will be processed, mainly from the Eastern counties and the South West, but will include other areas.

A questionnaire will be prepared and growers will be interviewed regarding cropping details and husbandry aspects of the identified bulb consignments.

Full co-operation of growers is required regarding sampling of bulbs and the completion of the questionnaire.

The work in years 2 and 3 may be modifield as a result of experience gained in the first year.

7. COMMENCEMENT DATE AND DURATION

July 1991 - 3 years

8. STAFF RESPONSIBILITIES

Project Leader: Dr J M Ll Davies, Plant Pathology Department, ADAS, Government Buildings, Willington Rd, Kirton, Boston, Lincs. PE20 1EJ Tel: 0205 722391.

Key collaborative staff:
Mr Owen W Jones, Plant Pathology Department, ADAS, Staplake Mount Starcross, Exeter EX6 8PE
Tel: 0626 890481.

Dr J S W Dickens, MAFF, Central Science Laboratory, Hatching Green, Harpenden, Herts. AL5 2BD. Tel 0582 715241.

9. LOCATION

Kirton, Starcross, and Harpenden

10. COSTS

Year 1		
ADAS	5441	(Plus interview costs - see note below)
Central Science Laboratory	3407	(In each year this represents half the costs as half will be done under Dr Dickens' government commissioned project)
Year 2		
ADAS	5985	(Plus interview costs - see note below)
Central Science Laboratory	3747	
Year 3		
ADAS	6584	(Plus interview costs - see note below)
Central Science Laboratory	4121	

N.B. The ADAS costs do not include any money to cover the costs of conducting the interviews. The maximum cost to HDC for the interviews (assuming 50 growers would be involved) will be £3024 in 1991, £3326 in 1992 and £3658 in 1993.

11. PAYMENT

On each quarter day the Council will pay to the Contractors in accordance with the following schedules:

CSL

Quarter/Year	1991	1992	1993	1994
1	-	852	937	1030
2	-	851	936	1030
3	852	937	1031	-
4	852	937	1030	-

ADAS

Quarter/Year	1991	1992	1993	1994
1	-	1360	1496	1646
2	-	1360	1496	1646
3	1361	1497	1646	-
4	1360 [+3024*]	1496 [+3326*]	1646 [+3658*]	-

* INTERVIEW COSTS:

The figures represent the maximum cost to HDC and they will be reduced if fewer than 50 growes are involved. ADAS will invoice HDC separately for the interview costs in the fourth quarter of each year. The cost will be based on the time spent interviewing each grower (including travelling time) and will not exceed the amounts stated.