

Project title: Narcissus: screening new varieties for basal rot susceptibility

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The results and conclusions in this report are based on a series of experiments conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.

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GROWER SUMMARY

Headline

A total of 111 daffodil bulb stocks have been screened for basal rot incidence under high disease pressure. Of 48 varieties and selections tested one-year-down for three consecutive years and two-year-down for one year 15 named varieties and selections had an average of <5% infection with basal rot. Of a further 63 varieties and selections tested twice as one-year-down and once in a two-year-down test 42 had on average <5% infection with basal rot.

Background and expected deliverables

Basal rot is the most important bulb-borne fungal disease of narcissus in the UK. The fungus causes root rot, premature leaf senescence and after lifting, bulbs feel soft and may become completely rotted. For many years the two major daffodil varieties 'Golden Harvest' and 'Carlton', together with many others, have recorded varying, but significant, basal rot losses and have had to be routinely treated with fungicides.

Daffodil breeding at Rosewarne Experimental Horticulture Station and the Glasshouse Crops Research Institute created a large pool of new varieties that have not been screened for basal rot susceptibility as part of an assessment programme.

The aim of the project is to give growers data on the susceptibility of these new clones to basal rot. The project employs a test which has previously been successfully applied to a range of Rosewarne raised clones, and existing commercial cultivars (Tompsett, 1986). To date, no reliable laboratory screening technique has been developed. The field test consists of planting healthy bulbs of each stock next to inoculator bulbs (*Fusarium* – infected 'Golden Harvest' bulbs) and assesses the test varieties for basal rot losses over one or two years.

Summary of the project and main conclusions

At the top of the table 1 are the known industry standard basal rot 'resistant' varieties St. Keverne and Kerensa (St. Keverne x Malvern City). Varieties with less than an average of 5% infection, of which there are fifteen, were considered to be 'resistant'.

The variety Dutch Master is an industry standard and is considered to be 'moderately susceptible' to basal rot. In results up to 2008, 10 stocks were more susceptible than Dutch Master (17.25%). These included three other well-known 'standards', Red Devon, Standard Value and Golden Ducat. Newer stocks also within this category are CABGA 24, 42, 49, 52 and 55, Loch Owskeich and Knight of St. John.

Table 1 Average incidence of basal rot (%) in daffodil stocks after 4 seasons data

Variety/selection	% bulbs with basal rot symptoms*	Basal rot resistance/susceptibility
ST. KEVERNE	0.00	Resistant
Kerensa	0.00	Resistant
Chinita	0.75	Resistant
St. Peter	1.00	Resistant
Lancaster	1.00	Resistant
Rosemoor Gold	1.50	Resistant
CABGA 65/45/2	1.50	Resistant
CABGA 50	1.50	Resistant
Talwyn	2.25	Resistant
Cornish Chuckles	2.25	Resistant
CABGA 37	2.75	Resistant
Veryan	3.00	Resistant
Beauvallon	3.50	Resistant
Trelawney Gold	4.25	Resistant
Jersey Roundabout	4.75	Resistant
Jersey Torch	5.50	Moderately resistant
CABGA 47	5.75	Moderately resistant
Jedna	5.75	Moderately resistant
Dellan	6.00	Moderately resistant
Emblyn	6.25	Moderately resistant
CABGA 21	6.75	Moderately resistant
Tamara	7.00	Moderately resistant
CABGA 20	7.50	Moderately resistant
CABGA 39	7.75	Moderately resistant
CABGA 8	8.50	Moderately resistant
CABGA 22	8.50	Moderately resistant
Gold Crest	8.50	Moderately resistant
Golden Anniversary	9.00	Moderately resistant
CABGA 38	9.25	Moderately resistant
Gold Crown	9.50	Moderately resistant
Marjorie Hine	10.75	Moderately susceptible
CABGA 48	11.75	Moderately susceptible
Tibet	12.00	Moderately susceptible
Kingscourt	12.25	Moderately susceptible
Irish Minstrel	12.5	Moderately susceptible
Brabazon	13.75	Moderately susceptible
CABGA 19	14.25	Moderately susceptible
DUTCH MASTER	17.25	Moderately susceptible
RED DEVON	17.5	Moderately susceptible
CABGA 24	17.5	Moderately susceptible
Loch Owskeich	18.5	Moderately susceptible
CABGA 49	23.75	Susceptible
Knight of St. John	25.5	Susceptible

Variety/selection	% bulbs with basal rot symptoms*	Basal rot resistance/susceptibility
CABGA 55	28.5	Susceptible
GOLDEN DUCAT	30.0	Susceptible
CABGA 52	55.0	Susceptible
CABGA 43	66	Susceptible

*% are based on plots of 10 bulbs

Table 2. Average incidence of basal rot (%) in daffodil stocks after 3 seasons data

Variety/Selection	% bulbs with basal rot symptoms	Basal rot resistance/susceptibility
Abba	0.00	Resistant
Actaea Seedling	0.00	Resistant
323	0.00	Resistant
24Q	0.00	Resistant
66C	0.00	Resistant
35D	0.00	Resistant
134	0.00	Resistant
68H	0.00	Resistant
650	0.00	Resistant
106	0.33	Resistant
104	0.33	Resistant
Brackenhurst	0.66	Resistant
51C	0.66	Resistant
30D	0.66	Resistant
124	0.66	Resistant
2J	0.66	Resistant
121	0.66	Resistant
401	0.66	Resistant
Poetaz Seedling	0.66	Resistant
Estramadrura	1.00	Resistant
Pink Charm	1.00	Resistant
442	1.00	Resistant
Cornish Vanguard	1.33	Resistant
CABGA 51	1.50	Resistant
Foxhunter	1.66	Resistant
Rose of May	1.66	Resistant
23G	1.66	Resistant
Articol	2.00	Resistant
29K	2.00	Resistant
45J	2.50	Resistant
718	2.50	Resistant
Camilla	2.33	Resistant
19F	2.33	Resistant
77	3.00	Resistant
36D	3.00	Resistant
10P	3.33	Resistant
Double Actaea	3.66	Resistant
68K	4.33	Resistant
385	4.66	Resistant
Smiling Maestro	5.00	Resistant
Cornish Pride	5.00	Resistant
Eden Gold	5.00	Resistant

Variety/Selection	% bulbs with basal rot symptoms	Basal rot resistance/susceptibility
Seagreen	5.33	Moderately resistant
Furbellow	5.33	Moderately resistant
Lady Sainsbury	5.66	Moderately resistant
635	6.00	Moderately resistant
2E	6.33	Moderately resistant
344	6.66	Moderately resistant
Tripartite	8.33	Moderately resistant
Mellen	8.66	Moderately resistant
High Life	10.00	Moderately resistant
Treglisson	11.33	Moderately susceptible
Flambards	12.00	Moderately susceptible
70H	12.66	Moderately susceptible
47B	13.00	Moderately susceptible
470	14.00	Moderately susceptible
Ganilly	15.66	Moderately susceptible
194	17.30	Moderately susceptible
38H	17.66	Moderately susceptible
232	19.66	Moderately susceptible
530	20.30	Susceptible
Nanpusker	20.66	Susceptible
Camelot	21.00	Susceptible

*% are based on plots of 10 bulbs

This trial of 63 stocks contained no 'standard' varieties and the levels of basal rot, in general, were lower than in the first batch of 48 stocks screened. It is suggested that varieties that are recorded with 5% or less basal rot infection of which there are 42 should be considered as 'resistant'. This trial contains 36 un-named seedlings raised at the Glasshouse Crops Research Institute some 25 years ago. Many of these were raised from 'resistant' parents including St. Keverne.

Financial benefits

The data generated on the susceptibility to basal rot of 111 daffodil varieties and selections has generated better understanding of these stocks and will allow growers to discard the susceptible stocks and focus priority treatment and propagation on the best stocks (i.e. those demonstrating basal rot resistance).

Action points for growers

- Growers holding the stocks of the bulbs screened for basal rot susceptibility will now be able to assess them for future priority treatment or as candidates for destruction.
- Stocks exhibiting disease resistance should be selected for priority propagation and cultivation, subject to them satisfying other commercial requirements.

- Stocks recorded as susceptible to basal rot, but with other highly desirable attributes should be observed closely on growers' farms for symptoms of the disease and this may necessitate adopting special cultural practices for disease control. This may include applying fungicide treatments.

SCIENCE SECTION

Introduction

Basal rot (*Fusarium oxysporum f. sp. narcissi*), is the most serious bulb-borne fungal disease of narcissus worldwide. The fungus causes root rot, premature leaf senescence and after lifting, bulbs feel soft and may become completely rotted. Basal rot has been damaging daffodil crops for at least 100 years and remains one of the most intransigent problems with virtually all growers suffering losses from the disease every year. The disease causes major problems in the bulb trade, especially exports, and its presence in consignments can lead to rejections. For many years the two major daffodil varieties 'Golden Harvest' and 'Carlton', together with many others, have recorded varying, but significant, basal rot losses and have had to be routinely treated with fungicides. The replacement of these varieties with resistant stocks is long overdue.

Daffodil breeding at Rosewarne Experimental Horticulture Station and the Glasshouse Crops Research Institute created a large pool of new varieties that have not been screened for basal rot susceptibility as part of an assessment programme. Resistant parents such as 'St. Keverne' were regularly used in this breeding work. The parent lines used in these programmes offer good possibilities of resistance but clones selected in the latter years of the programme still need to be tested.

The aim of the project is to give growers data on the susceptibility of these new clones to basal rot. The project employs a test which has previously been successfully applied to a range of Rosewarne raised clones, and existing commercial cultivars (Tompsett, 1986). To date, no reliable laboratory screening technique has been developed. The field test consists of planting healthy bulbs of each stock next to inoculator bulbs (*Fusarium* – infected 'Golden Harvest' bulbs) and assesses the test varieties for basal rot losses over one or two years.

Materials and Methods

Trial design and bulb stocks

Healthy test bulbs of each stock were planted next to rotted 'Golden Harvest' bulbs in which the presence of *Fusarium* has been confirmed.

48 different stocks of narcissus were tested for basal rot susceptibility in 2005/6 and 2006/7 and a further 63 in 2006/7. The bulbs were supplied by growers, who provided 50 bulbs per stock. These had not been treated with a fungicide dip in the past two years.

Each selection was exposed to a high level of *Fusarium* inoculum over one and two growing seasons.

Production of infected bulbs (inoculators)

Each year 'Golden Harvest' bulbs were artificially infected by cutting the base plate of the bulbs, immersing them in an infected *Fusarium oxysporum* f. sp. *narcissi* dip and then storing them at 25°C for up to 4 weeks to allow symptoms to develop. Only those inoculators showing clear symptoms of basal rot infection, that is, softness and whitish *Fusarium* sporulation around the base plate were used as inoculators.

Planting and layout of the trial

Each autumn, bulbs of each stock were planted by hand, in nets, in a double row furrow, 100 mm apart each way. An inoculator bulb was then placed next to each test bulb. Tubular netting was used to contain the test bulbs. This ensures that none are lost, that each can be accounted for in the test and that no portion of the inoculator, should it survive, is mistakenly included in the result. Separation of the test bulbs in the tubular netting makes it possible to record losses accurately.

For each variety, two blocks of ten bulbs were planted adjacent to each other. Therefore for each variety:

- The one-year test comprised 2 replicates x 10 bulbs per plot
- The two-year test comprised 2 replicates x 10 bulbs per plot

Over a 4-year period each stock will be subjected to 4 x one-year tests and 2 x two-year tests. This will provide 12 sets of data over 4 years. There will be 10 spare bulbs per stock kept to replenish the plots if required.

In all respects, the cultivation of the trials followed standard bulb production management.

Assessment of the trial

Each year after one or two growing seasons, the bulbs from each trial (consisting of 48 plus 63 varieties) were lifted. To advance the expression of disease these were stored at 25°C for 2 weeks and then at ambient temperature until recording and re-assembling for replanting. A visual assessment for the presence of basal rot was then made and the weight of healthy bulbs recorded.

Assessment of infection was made by:

Not infected = bulb has survived and perhaps increased in weight or number, or

Infected = bulb rotted or an obvious gap, often with bulb residue, in the net.

The bulbs not infected with basal rot were used to re-establish the plots with 10 bulbs as before. Where there were insufficient survivors, spare bulbs (originally 10) were used to make up the numbers. Sometimes when this was insufficient the stock has been eliminated from the trial.

A factor accounting for bulb losses and some inconsistency in results has been the occurrence of narcissus fly especially in the two-year-down bulbs. Steps are being taken to reduce the incidence of Narcissus fly attack in future by applying HWT, chlorpyrifos and burning over. It is worth pointing out that the tests conducted in 1980/89 were routinely treated with aldrin to control this pest. This pesticide was banned in 1989.

Analysis of results

The results were recorded as the number and % of rotted bulbs and the weight of firm bulbs remaining. The weight of firm bulbs remaining compared with the planted weight is expressed as % weight remaining. It will be seen that bulb weight increase (or survival) is generally inversely related to the severity of the disease attack.

A full analysis of results will be done in 2009 after 4 years work.

Results

Results are presented in two sections.

Part 1 is the trial planted in 2005 for which there are 4 sets of data.

Part 2 is the trial planted in 2006 for which there are 3 sets of data.

This information has been combined in the column of mean values .

Results (Part 1)

The 48 varieties first planted in 2005 presented in order of basal rot susceptibility after 4 sets of results. (Columns 1,2 &4 = 1-year down, Columns 3 = 2 –year down)

Variety	% bulbs with basal rot symptoms*					% weight remaining				
	Mean %	1	2	3	4	Mean %	1	2	3	4
ST. KEVERNE	0.00	0	0	0	0	148	161	158	137	134
Kerensa	0.00	0	0	0	0	141	122	167	113	161
Chinita	0.75	0	0	0	3	117	114	99	106	150
St. Peter	1.00	0	0	0	4	123	148	88	127	129
Lancaster	1.00	4	0	0	0	110	120	106	103	111
Rosemoor Gold	1.50	0	2	1	3	185	208	213	177	140
CABGA 65/45/2	1.50	0	3	0	3	164	182	160	193	121
CABGA 50	1.50	3	3	0	0	85	111	65	66	97
Talwyn	2.25	0	6	0	3	133	159	125	145	104
Cornish Chuckles	2.25	0	6	3	0	96	122	83	86	93
CABGA 37	2.75	0	0	0	11	124	147	95	129	126
Veryan	3.00	3	7	2	0	107	136	86	102	103
Beauvallon	3.50	0	14	0	0	86	88	48	73	135
Trelawney Gold	4.25	4	6	7	0	112	110	95	96	146
Jersey Roundabout	4.75	4	0	7	8	92	95	80	89	104
Jersey Torch	5.50	8	0	0	14	84	94	71	78	91
CABGA 47	5.75	10	0	6	7	104	94	63	105	153
Jedna	5.75	5	3	0	15	151	204	34	247	119
Dellan	6.00	9	10	2	3	102	117	94	91	106
Emblyn	6.25	9	3	0	13	121	173	115	78	117
CABGA 21	6.75	18	6	0	3	98	92	57	98	146
Tamara	7.00	2	14	2	10	104	116	5776	112	112
CABGA 20	7.50	14	10	6	0	107	86	105	167	71
CABGA 39	7.75	3	17	5	6	122	106	93	153	137
CABGA 8	8.50	3	8	15	14	127	175	105	137	92
CABGA 22	8.50	3	7	7	17	119	140	118	118	98
Gold Crest	8.50	8	12	5	9	101	120	67	131	84
Golden Anniversary	9.00	3	6	13	14	118	136	131	94	110
CABGA 38	9.25	13	0	24	0	160	153	178	163	146
Gold Crown	9.50	15	8	0	15	109	147	62	113	115
Marjorie Hine	10.75	27	2	0	14	111	153	90	120	79
CABGA 48	11.75	7	14	7	19	89	124	55	83	93
Tibet	12.00	6	19	4	19	77	104	53	79	70
Kingscourt	12.25	6	26	6	11	97	121	78	72	117
Irish Minstrel	12.5	16	20	7	7	92	100	61	79	127
Brabazon	13.75	34	11	8	2	92	125	56	55	130
CABGA 19	14.25	0	19	17	21	128	147	131	108	126
DUTCH MASTER	17.25	34	15	20	0	103	127	89	86	110
RED DEVON	17.5	35	14	3	18	111	96	119	138	92
CABGA 24	17.5	34	7	18	11	80	78	65	55	123
Loch Owskeich	18.5	43	13	5	13	79	61	70	79	107
STANDARD VALUE	22.75	19	36	36	0	60	90	57	33	-
CABGA 49	23.75	50	20	9	16	76	71	57	81	93
Knight of St. John	25.5	22	37	17	26	95	153	89	55	84
CABGA 55	28.5	50	30	19	15	55	42	37	48	93

Variety	% bulbs with basal rot symptoms*					% weight remaining				
	Mean %	1	2	3	4	Mean %	1	2	3	4
GOLDEN DUCAT	30.0	44	27	20	29	75	88	72	63	78
CABGA 52	55.0	66	44	-	-	48	50	46	-	-
CABGA 43	66	82	50	-	-	17	19	15	-	-

*% are based on plots of 10 bulbs

Results (Part 2)

The 64 varieties first planted in 2006 presented in order of basal rot susceptibility after 3 sets of results. (Columns. 1&2 + 1-year down, Columns 3 = 2-year down)

Var.	% Basal rot				% weight remaining			
	Mean %	1	2	3	Mean %	1	2	3
Abba	0.00	0	0	0	139	128	176	112
Actaea Seedling	0.00	0	0	0	145	130	201	105
323	0.00	0	0	0	133	130	172	97
24Q	0.00	0	0	0	128	127	141	116
66C	0.00	0	0	0	134	119	168	115
35D	0.00	0	0	0	147	157	116	168
134	0.00	0	0	0	154	149	119	195
68H	0.00	0	0	0	117	125	98	128
650	0.00	0	0	0	119	129	139	88
106	0.33	0	1	0	135	136	138	130
104	0.33	0	0	1	155	144	116	205
Brackenhurst	0.66	0	2	0	110	132	107	92
51C	0.66	0	2	0	130	137	128	125
30D	0.66	0	0	2	142	133	195	97
124	0.66	0	0	2	104	121	101	91
2J	0.66	0	0	2	140	144	136	140
121	0.66	0	0	2	146	143	148	148
401	0.66	2	0	0	155	134	193	139
Poetaz Seedling	0.66	0	2	0	115	108	135	103
Estramadrura	1.00	0	0	3	128	124	160	100
Pink Charm	1.00	3	0	0	122	113	139	115
442	1.00	3	0	0	114	111	130	102
Cornish Vanguard	1.33	0	0	4	69	73	85	48
CABGA 51	1.50	0	3	-	90	71	108	-
Foxhunter	1.66	0	0	5	127	142	126	114
Rose of May	1.66	3	0	2	86	82	105	70
23G	1.66	3	2	0	99	126	69	103
Articol	2.00	0	0	6	125	135	155	84
29K	2.00	6	0	0	99	105	113	78
45J	2.50	5	0	-	163	127	199	-
718	2.50	5	0	-	147	154	139	-
Camilla	2.33	0	0	7	123	131	147	92
19F	2.33	3	0	4	147	138	151	152
77	3.00	9	0	0	114	101	135	105
36D	3.00	0	0	9	147	164	162	114
10P	3.33	2	3	5	134	138	135	128
Double Actaea	3.66	0	2	9	88	91	115	58

Var.	% Basal rot				% weight remaining			
	Mean %	1	2	3	Mean %	1	2	3
68K	4.33	0	2	11	124	140	120	111
385	4.66	2	5	7	137	153	135	123
Smiling Maestro	5.00	2	5	8	99	102	114	82
Cornish Pride	5.00	3	0	12	80	45	153	41
Eden Gold	5.00	7	4	4	72	62	108	46
Seagreen	5.33	11	5	0	95	91	127	66
Furbellow	5.33	5	0	11	103	100	98	110
Lady Sainsbury	5.66	0	0	17	108	77	185	62
635	6.00	11	0	7	98	107	106	81
2E	6.33	0	0	19	137	149	153	108
344	6.66	9	1	10	111	121	127	85
Tripartite	8.33	7	5	13	107	77	201	35
Mellen	8.66	8	2	16	70	76	82	51
High Life	10.00	5	5	20	79	59	114	65
Treglisson	11.33	8	14	12	73	87	52	80
Flambards	12.00	4	7	25	88	98	97	68
70H	12.66	6	10	22	93	122	108	48
47B	13.00	0	6	33	106	138	115	65
470	14.00	12	5	25	98	104	133	57
Ganilly	15.66	0	13	34	124	163	92	118
194	17.30	5	0	47	101	115	140	47
38H	17.66	0	8	45	105	145	110	60
232	19.66	9	8	42	81	107	97	40
530	20.30	13	24	24	78	95	61	78
Nanpusker	20.66	29	3	30	71	48	114	50
Camelot	21.00	45	3	15	85	70	91	94

Discussion

The project is due to run until 2009 by which time there will be 6 sets of data for trial 1 and 4 sets of data for trial 2. The above are therefore interim results which will be consolidated further.

Between 1980 and 1989 the project leader applied the same screening test to a range of varieties and un-named seedlings raised at Rosewarne EHS. The new data can now be placed alongside the former records as a means of adding confidence to the figures.

A selection of these comparative data confirms that there is reasonable consistency in trends in the results.

Variety	% basal rot infection
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(CABGA No)	Mean 1980 – 1989 tests	Mean 2005 – 2008 tests
GOLDEN DUCAT	59	30
DUTCH MASTER	31	17
RED DEVON	19	18
Talwyn	18	2
Golden Anniversary (1)	16	9
Cornish Pride (19)	13	5
Emblyn	12	6
Patrick Hackett (8)	11	6
Dellan	8	6
Tamara	5	7
Jedna	4	6
ST. KEVERNE	0	0
Kerensa	0	0
Rosemoor Gold (46)	0	2
Cornish Chuckles (80)	0	2

The tests conducted in 1980-89 sought to avoid the release and distribution of new seedling stocks to the industry that were highly susceptible to basal rot. The threshold was set at that of Dutch Master a variety that is moderately prone to disease in commercial practice. In the tests over 9 seasons Dutch Master averaged a 31% Loss compared with Golden Harvest and Carlton at 83 and 85 % respectively.

The current trials conducted in the Isles of Scilly show lower levels of basal rot than the original Rosewarne tests. We have speculated as to the reason for this and think it may be due to the lower soil fertility of the site on the Isles. Bulb yield have also tended to be low due to losses from narcissus bulb fly for which there is no fully effective control.

Throughout all the past tests and so far in this current work the variety 'St. Keverne' has shown a high level of resistance. Past research showed that, unlike many other varieties it responds to fungal attack by producing barriers tissue within the base plate.

Breeding work using St. Keverne as a parent has increased the number of resistant stocks likely to become available to the grower and it is worth noting that most of the un-named stocks in the Part 2 trial have St. Keverne as one parent.

This constitutes a generally favourable situation for the industry as it moves into an era of reduced fungicide availability.

Technology Transfer

An outline of the results has been presented at several Bulb Grower's Forum Meetings at the Duchy College, Rosewarne, the most recent being on 18 November 2008 when data for 3 year's work was presented.

HDC News Report October 2006.