

CONTRACT REPORT

No. AR/92/01

BULB ONIONS; EVALUATION OF  
NORTH AMERICAN VARIETIES  
FOR THEIR STORAGE LONGEVITY  
(FV 81)

ADAS

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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.

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## Summary

Seven varieties (Benchmark, Citadel, Flame, Rocket, Taurus, XPH 3243 and Zerti), mainly from North American sources, and not currently commercially grown in the UK, were compared with five standard varieties for their ability to store well without a pre-harvest application of maleic hydrazide in either ventilated ambient or cold storage conditions.

Several of the 'novel' types of bulb onion appeared to perform better in storage assessments than most of the commercial standard varieties in terms of reduced internal shoot growth and sprouting. The most promising in terms of storage longevity were Benchmark, Flame, XPH 3243 and Spirit in the absence of maleic hydrazide, and Benchmark, Flame, Rocket and XPH 3243 in the presence of maleic hydrazide. Of these varieties Benchmark, Flame, Rocket and Spirit gave good marketable yields. In terms of quality, Benchmark and XPH 3243 were good, but with oval bulbs. Rocket had good quality and round bulbs. Overall, Benchmark, Flame, Rocket and XPH 3243 appear most promising and warrant further evaluation.

## Objectives

- (a) To identify the period of production out of ventilated ambient or cold storage, in the absence of a sprouting suppressant, that could be covered using naturally long-storing varieties.
- (b) To evaluate varieties obtained from North American sources with a good natural storage longevity.

## Introduction

The HDC are currently sponsoring a study at HRI Kirton to determine the best regime for long term storage of onions. Onion growers expressed an interest in extending the work to include a range of potentially long-storing varieties from both North American and European sources. By using such varieties, either medium term storage under ventilated ambient conditions, or long-term storage under very cold conditions might be achieved without using maleic hydrazide sprout suppressant.

## Materials and methods

### Site

The experiment was conducted at ADAS Arthur Rickwood on a peaty loam topsoil (36-66 cm) with 29% organic matter content over a silty clay loam, of the Adventurers' Shallow series.

### Treatments

#### a) Varieties

##### i) Novel types - not typically grown in the UK

	<u>Seed source</u>
Benchmark	Asgrow
Citadel	"
Flame	"
Rocket	"
Taurus	"
XPH 3243	"
Zerti	Guedlinburger Saatgut

##### ii) Commercial standard

Caribo	S+G/BS
Hystar	El/Bejo
Marco	NIZ
Spirit	El/Bejo
Sturon	S+G/BS

#### b) Sprouting suppressant

- i) Without maleic hydrazide
- ii) With maleic hydrazide

c) Storage regime

i) Ventilated ambient conditions (-0.9°C to 8.9°C)

ii) Cold storage conditions (-0.5°C to 1.5°C)

Treatment application

The maleic hydrazide was applied as c.p. Mazide 25 at 8 l/ha in 600 l/ha water to individual plots using an Oxford Precision Knapsack Sprayer at 2 bar pressure.

Husbandry

The varieties were drilled on 14 March 1991 using a Stanhay Webb Mark II drill. There were four rows per 1.68 m bed width arranged at 35-25-35 cm spacing to accommodate two rows of a shelter crop of barley for wind erosion control between the inner and outer rows of onions. Each plot was 6 m in length. They were grown to a good commercial standard (see Appendix I). Each variety received an application of maleic hydrazide at its 10-20% foliar fallow stage. They were harvested within ten days of reaching 80% foliar fallow. The bulbs were dried and cured, and then either placed into ventilated ambient storage or into cold storage. The ventilated ambient conditions comprised reducing the temperature of the onions by mid-December to a target of 0-1°C, and holding the crop at this temperature until assessed in March and May. However, the temperature achieved ranged from -0.9°C to 8.9°C during this period. The cold-stored onions were placed into cold storage from early October and the temperature of the store slowly reduced to a target of -1°C (actual temperature ranged from -0.5 to -1.5°C), and held in this condition until assessed in May and July. When the cold-stored onions were removed from store, they were allowed to thaw over a period of seven days prior to assessment.

## Assessments

A test of germination ability was made on all varieties to assist drill calibration. The plant populations were recorded after establishment on 8 May, and again, at harvest. The crop was observed during the season, and the number of bolted plants recorded. The yields in marketable size grades were recorded after drying and curing. The quality was assessed on 8 November out of ventilated ambient storage, which was also taken as a baseline pre-storage assessment for both storage regimes. Onions stored at ventilated ambient conditions were removed for quality and sprouting assessments on 18 March and 5 May. Samples of those held in cold storage conditions were removed for similar assessments on 6 May and 14 July.

## Design

The trial design was a randomised block, with three replicates. Each block was fully randomised for both variety and sprouting suppressant treatments. From two of the replicates, each whole plot was used for yield determination. Samples from plots within the third replicate were used for the storage treatments.

## Results

### Plant establishment

For most varieties, seed germination was good at over 90%, but Zerti, Caribo and Sturon were lower at 85, 70 and 86 % respectively. The drill was calibrated accordingly, such that when recorded on 8 May and subsequently at harvest there were small differences in plant population. However, these differences were significant ( $P < 0.001$ ), with higher plant populations for Hystar and Caribo, and lower populations for Sturon.

The date of maturity, number of bolted plants and plant population at harvest are given in Table 1.



## Maturity

The earliest variety was XPH 3243 which was ready in mid-August. This was followed by Benchmark, Citadel, Flame, Rocket and Taurus which were mature a week later. Caribo, Spirit and Sturon matured a few days later with Zerti, Hystar, and Marco the last to mature in late August.

## Bolting

The level of bolting over all varieties was low. However, there was a relatively high number of bolted plants of variety Citadel.

Table 1 Date of maturity and plant population (plants/m<sup>2</sup>) and percentage of bolted plants at harvest.

Variety	Maturity date	Plant population (plants/m <sup>2</sup> )	Bolted (%)
Benchmark	21 August	59	0
Citadel	21 August	51	6.2
Flame	21 August	53	0.8
Rocket	21 August	56	1.8
Taurus	21 August	57	0.2
XPH 3243	14 August	56	0
Zerti	27 August	58	0
Caribo	23 August	66	0
Hystar	27 August	68	0
Marco	27 August	60	0
Spirit	23 August	55	0.1
Sturon	23 August	51	0
Mean		58	0.8
SED (22 d.f.)		3.4	0.85
CV%		8.3	156

The yield in marketable size grades and total yield are shown in Table 2.

Table 2 Yield (t/ha) in marketable size grades.

Variety	Yield (t/ha)			Total
	40-50 mm	50-60 mm	60-80 mm	
Benchmark	13.0	15.6	7.2	39.8
Citadel	11.5	9.5	1.7	27.4
Flame	10.8	16.1	9.8	39.8
Rocket	12.3	15.8	6.3	38.4
Taurus	13.0	14.1	5.3	36.6
XPH 3243	13.2	13.6	4.7	35.4
Zerti	13.3	15.9	5.1	37.2
Caribo	14.0	17.6	7.7	42.6
Hystar	15.6	17.3	6.1	42.7
Marco	13.1	18.8	7.3	41.8
Spirit	10.8	17.6	11.0	41.3
Sturon	12.9	13.0	3.5	32.3
Mean	12.8	15.4	6.3	37.9
SED (22 d.f.)	1.09	1.77	1.52	3.04
CV %	12.0	16.3	34	11

### Yield

The mean yields in each category were fairly typical for the season, but there were marked differences between the varieties. There were high total yields for four of the commercial standard varieties, and also for Benchmark, Flame and Rocket. Citadel and Sturon had relatively low total yields. The preferred marketable sizes are above 50 mm (Appendix II). In this category, Flame, Rocket and Benchmark, gave acceptable yields.

### Defective bulbs

There were few defective bulbs when assessed after drying and curing in November. These comprised 0.35% of thicknecked bulbs, 0.18% of rotted bulbs, 0.04% of split bulbs and 0.007% of mechanically damaged bulbs. There were no significant differences between the varieties.

### Quality prior to long-term storage

The scores for bulb quality and skin protection are given in Table 3. Comments on the quality of the bulbs in early November are given in Appendix III.

The bulbs were firm and all had at least two brown scales for skin protection. At that stage, Taurus and Caribo were given slightly higher skin protection scores than the other varieties.

Benchmark, Taurus and XPH 3243 were slightly more elliptical in shape than the market currently prefers, and both Spirit and Sturon rather flatter.

**Table 3** Bulb quality and skin finish characteristics at the end of drying and curing, but before long term storage (8 November)

Variety	skin colour	skin protection	bulb shape	shape uniformity	bulb firmness	comments
Benchmark	7	5	7	8	9	2 medium
Citadel	8	6	6	7	8	2 medium
Flame	7	4	6	5	8	2 thick
Rocket	6	6	6	7	9	2 medium
Taurus	7	7	7	7	9	2 thick
XPH 3243	5	4	7	7	8	2 thick
Zerti	5	6	4	7	9	3 thick
Caribo	7	7	5	7	9	2 thick
Hystar	5	6	5	7	9	2 thick
Marco	7	6	5	6	9	2 thick
Spirit	5	5	3	7	8	2 thick
Sturon	5	6	3	6	9	2 thick

Key to quality scores

Skin Colour

0 = white

9 = dark brown

Skin protection

0 = few, thin skins

9 = many, thick skins

Bulb shape

0 = flat

5 = globe

9 = elliptical

Shape uniformity

0 = not uniform, variable

9 = very uniform

Bulb firmness

0 = soft

9 = very firm.

**Maleic hydrazide**

The use of this chemical sprouting suppressant had no effect upon either maturity, yield or quality by 8 November assessment. The effects of maleic hydrazide had begun to show in the 18 March assessment out of ventilated ambient storage, as shown in Table 4.

Table 4 Skin protection and bulb firmness scores, and mean length (mm) of internal shoot following removal from ventilated ambient storage on 18 March.

Variety	Skin protection		Bulb firmness		Internal shoot length (mm)	
	Score 1		Score 2			
sprout suppressant	-	+	-	+	-	+
Benchmark	5	4	9	8	38.9	9.9
Citadel	5	3	9	9	36.0	33.4
Flame	5	6	8	9	36.1	12.9
Rocket	5	5	7	9	41.6	9.9
Taurus	6	3	8	8	38.2	14.6
XPH 3243	5	4	9	9	25.0	5.7
Zerti	6	6	8	9	21.5	24.9
Caribo	6	7	9	9	35.1	28.7
Hystar	6	6	9	9	34.2	29.8
Marco	6	5	9	9	30.9	29.0
Spirit	6	6	9	9	23.4	21.8
Sturon	6	6	9	9	23.3	21.3

Key            1. Skin protection            2. bulb firmness            \* 65mm is at the top of the bulb  
0 = few, thin skins            0 = soft  
9 = many, thick skins        9 = very soft

### Ventilated ambient storage

The bulbs had retained their firmness at the 18 March assessment. However, their skin protection scores had generally decreased since 18 November. The internal green shoot had begun to grow for all treatments. There was little apparent difference between the varieties although the internal shoot was shortest for Benchmark, Rocket and XPH 3243 in the presence of maleic hydrazide. The bulbs had already exceeded their storage longevity in these conditions by 18 March. The assessment made on 5 May (Table 5) was purely for experimental purposes. On that date many bulbs were sprouting. The level of sprouting was least for XPH 3243, Benchmark and Spirit. The use of maleic hydrazide appeared to make little difference for several varieties (Benchmark, Citadel, XPH 3243, and Spirit). However, its use had made an apparent reduction for several other varieties, such as Flame where there were no sprouted bulbs.

Table 5 Bulb firmness score, percentage of sprouted bulbs and length (mm) of internal shoot following removal from ventilated ambient storage on 5 May.

Variety	Sprout suppressant	Bulb firmness score #		% sprouting		Internal shoot length (mm)	
		-	+	-	+	-	+
Benchmark		6	8	3	3	49	42
Citadel		6	6	6	7	53	54
Flame		5	6	21	0	63	42
Rocket		5	7	39	1	56	43
Taurus		5	5	41	8	56	41
XPH 3243		5	5	1	1	38	34
Zerti		7	7	44	22	54	46
Caribo		8	8	31	9	59	60
Hystar		7	8	49	18	59	53
Marco		8	9	16	18	65#	60
Spirit		8	7	5	4	50	45
Sturon		8	7	20	12	35	40

# score

# shoot at top of bulb

Key

- |                       |                  |
|-----------------------|------------------|
| 1. Skin protection    | 2. bulb firmness |
| 0 = few, thin skins   | 0 = soft         |
| 9 = many, thick skins | 9 = very soft    |

### Cold storage

Bulbs were removed from cold storage on both 6 May and 14 July. They were allowed to thaw gradually from their frozen state for several days prior to assessment. From the 6 May removal (Table 6) bulbs had retained a fair degree of firmness, which scores were higher than for the ventilated ambient stored bulbs. The use of maleic hydrazide apparently made a very slight improvement to the bulb firmness scores. All bulbs had a developing internal shoot. In the absence of maleic hydrazide the shoot was shortest for Flame and XPH 3243. The application of maleic hydrazide appeared to reduce the length of the internal shoot for all varieties. By 23 July (Table 7) the bulb firmness scores had reduced for most varieties but remained consistently high for Caribo. Several varieties showed no signs of sprouting. However, all varieties had a well-developed internal shoot, both with and without maleic hydrazide.



Table 6 Bulb firmness score, percentage of sprouted bulbs and length (mm) of internal shoot following removal from cold storage on 6 May (assessed 19 May)

Variety	sprouting suppressant	Bulb firmness score		Length (mm) of internal shoot	
		-	+	-	+
Benchmark		7	8	22.8	12.7
Citadel		7	7	31.3	30.3
Flame		7	7	13.7	3.4
Rocket		7	7	31.4	25.0
Taurus		6	7	37.9	16.2
XPH 3243		7	7	13.7	9.7
Zerti		7	8	29.0	27.9
Caribo		8	9	28.2	20.9
Hystar		9	9	22.2	14.5
Marco		9	9	36.0	29.5
Spirit		8	9	26.1	10.3
Sturon		8	9	23.8	16.5

Table 7 Bulb firmness score, percentage of sprouted bulbs, length (mm) of internal shoot following removal from cold storage on 14 July (assessed 23 July)

Variety	sprout suppressant	Bulb firmness score		No (%) of sprouted bulbs		Length (mm) of internal shoot	
		-	+	-	+	-	+
Benchmark		7	7	0	0	42	26
Citadel		6	4	2	5	47	43
Flame		6	7	0	0	47	39
Rocket		6	7	2	0	62	30
Taurus		6	7	3	0	58	32
XPH 3243		8	7	0	0	39	27
Zerti		7	7	2	0	42	54
Caribo		8	9	0	0	39	39
Hystar		7	8	0	0	43	21
Marco		5	7	12	0	61	63
Spirit		7	8	0	0	52	40
Sturon		7	8	0	0	45	34

## Discussion

The twelve varieties of onion performed either adequately or well in the field and all gave acceptable marketable yields. At the onset of storage, but after drying and curing, all bulbs were deemed to be firm with at least two thick skins. There were differences in the overall skin protection scores at this stage such that Taurus and Caribo had particularly good thick skins. However, all were 'marketable' on 8 November, given that the market would accept 'flat' bulbs such as Spirit or Sturon, or 'elliptical' bulbs such as Benchmark, Taurus or XPH 3243 (in most cases, at this time of year only shape scores of 4 - 6 would be accepted by the markets). The bulbs were then stored in two ways, either in ventilated ambient storage - a form of controlled barn storage which avoids excessive cold or warm temperatures, or in cold storage where the temperature is accurately maintained to allow freezing of bulbs without their sustaining cold injury. From the ventilated ambient storage Benchmark, Rocket and XPH 3243 appeared to perform best, but only in the presence of maleic hydrazide. By 5 May XPH 3243, Benchmark and Spirit looked most promising. From the first assessment out of cold storage on 6 May, assessed on 19 May, the degree of development of the internal shoot in the absence of maleic hydrazide appeared to be shortest for Flame and XPH 3243. By 23 July, all varieties had a well-developed internal shoot which would be unacceptable to the market.

## Conclusions

1. Several of the 'novel' types of bulb onion, not typically grown in the UK, appeared to perform better in unreplicated medium and long-term storage assessments than the commercial standard varieties. These were Benchmark, Rocket and XPH 3243, and to a lesser extent Flame.

2. In the absence of maleic hydrazide all varieties appeared to perform similarly when assessed out of ventilated ambient storage in March, although, by May, Benchmark, Citadel, XPH 3243 and Spirit showed minimal sprouting compared with the other varieties. When assessed out of cold storage in May, Flame and XPH 3243 had relatively less well-developed internal shoots, although, by 14 July, all varieties had long internal shoots.

3. The presence of maleic hydrazide sprout suppressant improved bulb firmness, and decreased the rate of sprout development in most cases.

4. In ventilated ambient conditions Benchmark, Citadel, XPH 3243 and Spirit appeared to perform the best in the absence of maleic hydrazide. In the presence of maleic hydrazide Benchmark, Flame, Rocket and XPH 3243 performed best.

5. In cold storage Flame and XPH 3243 performed best in the absence of maleic hydrazide.

6. The best overall varieties in terms of resistance to sprouting were Benchmark, XPH 3243, Rocket and Flame. Of those, Benchmark and Flame gave the highest marketable yields, which were similar to commercial standard varieties. Flame and Rocket had the better shaped bulbs. Rocket had the best bulb firmness score.

### Acknowledgements

The assistance of staff of the Horticulture Research International Kirton, where the onions were cold stored, and the help from the Asgrow Seed Company, are gratefully acknowledged.

### Recommendations

1. The more promising of the varieties should be re-evaluated on two soil types, and husbandry techniques explored, to gain first-class quality onions which have good natural storage longevity.
2. The storage samples should be replicated for statistical comparison and replicated storage.

## Appendix I

Site	ADAS Arthur Rickwood	
Field	Owens Piece: peaty loam	
Previous cropping	1990 Sugar beet 1989 Winter wheat 1988 Winter wheat pH 7.0 soil indices P3 K3	
Crop diary		
Cultivations	20 December	ploughed and furrow pressed
	11 March	cultivated using rotary harrow
Husbandry	14 March	drilled using Stanhay drill
	25 March	barley shelter drilled
	18 June	trial hoed
Herbicides	3 April	4.32 kg/ha ai propachlor + 2.24 kg/ha ai chlorpropham + 0.6 kg/ha paraquat as 9 l/ha cp Ramrod Flo + 5.6 l/ha cp CIPC + 3 l/ha cp Gramoxone in 600 l/ha water
	3 May	0.45 kg/ha ai chlorbufam + 0.56 kg/ha ai chloridazon as 2.25 l/ha cp Alicep in 500 l/ha water
	20 May	0.042 kg/ha ai fluazifop-P-butyl as 0.3 l/ha cp Fusilade in 250 l/ha water + Agral at 1 l/1000 l of water
	4 June	0.125 kg/ha ai fluazifop-P-butyl as 1.0 l/ha cp Fusilade in 500 l/ha water + Agral at 1 l/1000 l of water
	10 July	2.88 kg/ha ai propachlor as 6 l/ha cp Ramrod Flo in 400 l/ha water
	22 July	1.75 kg/ha ai cyanazine as 3.5 l/ha cp Fortrol in 400 l/ha water
Insecticides	13 March	2.8 kg/ha ai carbofuran as 28 kg/ha cp Yaltox applied at drilling
	31 July	7.5 ml/ha ai deltamethrin as 0.3 l/ha cp Decis in 1000 l/ha water (thrip control)
	21 August	as above
Fungicides	25 July	1.0 kg/ha ai chlorothalonil as 2.0 l/ha cp Bravo + 280 ml/ha cp Bond in 200 l/ha water

Sprouting suppressant	7 August	2 kg/ha ai maleic hydrazide as 8 l/ha cp Mazide 25 in 600 l/ha water to Citadel
	14 August	2 kg/ha ai maleic hydrazide as 8 l/ha cp Mazide 25 in 600 l/ha water to Taurus, Rocket, Flame, Benchmark, XPH 3243
	16 August	2 kg/ha ai maleic hydrazide as 8 l/ha cp Mazide 25 in 600 l/ha water to Caribo, Sturon, Spirit
	20 August	2 kg/ha ai maleic hydrazide as 8 l/ha cp Mazide 25 in 600 l/ha water to Marco, Zerti, Hystar
Irrigation	10 June	25 mm
	13 July	25 mm
	27 August	25 mm
Fertiliser	4 December	80 kg/ha $P_2O_5$ + 120 kg/ha $K_2O$
	4 April	40 kg/ha N
	7 May	40 kg/ha N
Trace elements	7 May	9 kg manganese sulphate in 250 l/ha water
	30 May	9 kg manganese sulphate in 250 l/ha water
	14 June	9 kg manganese sulphate in 250 l/ha water
	28 June	9 kg manganese sulphate in 250 l/ha water
	17 July	9 kg manganese sulphate in 250 l/ha water
	9 August	8 kg/ha Epsom salts in 300 l/ha water
	19 August	as above
Harvest	21 August	Citadel
	28 August	Taurus, Rocket, Flame, Benchmark, XPH 3243
	30 August	Caribo, Sturon, Spirit
	3 September	Hystar, Marco, Zerti
Post harvest assessment	8 November	Removal out of store for grading and assessment
Removal from storage for quality and sprouting assessments	18 March	Ventilated ambient stored onions
	5 May	Ventilated ambient stored onions
	6 May	Cold stored onions (assessed on 19 May)
	14 July	Cold stored onions (assessed on 23 July)

Appendix II

Table 8. Marketable yield (t/ha) over 50 mm in diameter

Variety	Marketable yield over 50 mm t/ha
Benchmark	27.8
Citadel	11.2
Flame	26.0
Rocket	22.2
Taurus	19.3
XPH 3243	18.3
Zerti	21.0
Caribo	25.3
Hystar	23.4
Marco	26.1
Spirit	28.5
Sturon	16.4
Mean	21.7
SED (22 df)	2.94
CV%	19.1



### Appendix III

Comments on the quality of the novel types of onions in early November.

Benchmark These bulbs were oval with a good shape uniformity. They were very firm with adequate skin protection.

Citadel These bulbs were dark brown in colour with fairly good skin protection and bulb firmness scores. (This variety was very susceptible to bolting.)

Flame These bulbs had soft necks with poor skin protection.

Rocket The larger bulbs tended to be wrinkled which made the bulbs look old. These bulbs were very firm with thick skins, and a good skin protection score.

Taurus These bulbs were oval in shape, but very firm and with good skin protection.

XPH 3243 These bulbs were oval and firm. They looked attractive as they had thin necks and good uniformity. The skin protection was not as good as other varieties.

Zerti These bulbs were rather flat, and with a lot of doubled bulbs especially in the larger size grades. The bulbs were very firm with good skin protection.

#### Appendix IV

A further comparison between the varieties was made using storage regime to obtain the replication, although it is accepted that the varieties were obtained from single plots in the field. The results for the mean of assessments made in early May are given in Table 9.

Table 9 Mean of two storage systems for bulb firmness scores, percentage of sprouted bulbs and length (mm) of internal shoot in early May.

Variety	Bulb firmness score #	% sprouted	shoot length (mm)
Benchmark	7.0	1.5	40
Citadel	5.5	5.5	52
Flame	6.0	5.7	48
Rocket	6.4	11.5	49
Taurus	5.9	14.5	45
XPH 3243	6.4	0.5	35
Zerti	7.0	19.2	50
Caribo	8.5	11.0	49
Hystar	7.8	18.5	44
Marco	7.3	12.5	55
Spirit	7.6	2.5	47
Sturon	7.6	8.7	39
Mean	6.9	9.3	46
SED (23 df)	0.73	8.3	5.18
CV (%)	15	126	16

# shoot at top of bulb.

#### Comment

The analysis of variance revealed highly significant ( $P < 0.001$ ) differences both between the storage regimes and the maleic hydrazide treatments. It also showed that there were significant ( $P < 0.05$ ) differences between the varieties in terms of their bulb firmness scores. Caribo was particularly firm, and Citadel not firm. Variety XPH 3243 had the shortest internal shoots compared with other varieties. The differences in numbers of sprouted bulbs observed between varieties were not significant. There were no significant interactions.

## Appendix V

### Weather records 1991

	Extremes		Temperatures (°C)				Daily sunshine (Hours)		Rainfall (mm)	
	Air		Grass	Accumulated day degrees above 6°C		Mean soil temp at 10 cm	Current Year	24 Yr Mean	Current Year	24 Yr Mean
	Max	Min	Min	Current Year	24 Yr Mean					
Jan	13.1	- 4.8	- 9.4	12	24	2.7	2.6	17	30.0	41.8
Feb	13.9	-11.7	-10.0	15	20	2.0	1.5	2.4	22.5	31.2
Mar	18.5	- 3.2	- 8.0	100	51	6.9	3.0	3.2	34.8	42.4
Apr	21.3	- 3.0	- 7.4	80	86	8.1	4.6	4.7	39.6	37.5
May	23.6	- 2.6	- 8.0	153	170	11.9	3.8	5.9	14.6	47.9
June	22.5	0.2	- 3.9	217	255	13.6	4.6	6.3	86.5	52.8
July	28.3	8.5	4.9	368	328	19.3	7.0	6.1	29.4	41.6
Aug	27.5	5.0	1.5	374	327	18.9	6.9	6.4	18.1	48.4
Sept	29.5	2.2	- 2.1	275	255	15.3	6.0	4.7	34.4	38.3
Oct	21.2	- 2.9	- 7.1	155	164	9.7	2.7	3.2	21.0	46.7
Nov	15.8	- 2.6	- 6.8	62	62	5.9	1.9	2.2	41.9	50.3
Dec	14.8	-10.3	-14.5	39	33	4.9	1.8	1.6	16.9	43.9
Total				1850	1775		46.4	48.4	389.7	522.8
March to August				1292	1217				223.0	270.6

Notes: For the purposes of this table:

1. Reading taken at 0900 hours GMT
2. A temperature of at least 6°C (42°F) is normally considered necessary for plant growth. Accumulated temperatures (day degrees) above 6°C are a measure of plant growth during the month.