

Effect of harvest time on storage loss and sprouting in onion

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Storability of onion is affected by timing of harvest. However, the optimal time for maximum yield and maximum storability do not necessarily coincide. This study aimed to determine the most suitable harvest time for obtaining a high bulb yield with high quality and storability. Storage experiments were conducted on onions produced in field experiments at a research field and on farms in four years. Results indicate that harvesting could be delayed to 100% maturity, or even longer, without a marked increase in storage loss. In rainy years, late harvest is likely to impair the quality. The incidence of sprouting in shelf life tests varied considerably between years. An early harvest before 50% maturity and a delayed harvest increased the risk of sprouting. It may be concluded that the harvesting of onions for long-term storage can be timed to take place between 50% maturity and even some weeks after complete maturity without a loss in storage quality. Therefore, it is possible to combine high yield and good storage quality.

Key words: *Allium cepa*, maturity, postharvest losses, shelf life, storage

Introduction

Onion is regarded as suitable for long-term storage. Under Finnish conditions, the storage period may be as long as 8 months. During storage, onions are exposed to different forms of storage loss, e.g. water loss due to transpiration, respiratory losses of dry matter, microbial infections, physiological disorders (e.g. watery scales, Hoftun 1993) and activation of growth, leading to formation of roots and sprouting. Post-harvest sprouting has received much attention as a ma-

ajor physiological factor limiting the storage life of onion. Use of maleic hydrazide and γ irradiation as sprouting inhibitors has eased the problem (Komochi 1990), but increasingly negative attitudes towards these methods call for the search for other solutions (Grevsen and Sørensen 1999).

Sprouting may be prevented by an appropriate storage temperature. The optimal temperature for sprouting is around 15°C (Komochi 1990), but varies from one cultivar to another (Miedema 1994). Although temperature hinders sprouting during cold storage, sprouting may

present a serious problem after storage, that is in shelf life. The longer onions have been stored the more common and faster is sprouting after storage (Grevsen and Sørensen 1999).

Timing of harvest affects the susceptibility of onions to sprouting (Dowker and Fennell 1974, Ward 1979). Komochi (1990) concluded in his review that the optimal time of harvest for the least sprouting is at 50–100% foliar fall-over. Stow (1976) proposed that substances inhibiting post-harvest sprouting are produced in the leaves and translocated to the bulb at the end of the growing period. He suggested that too early a harvest prevents the translocation, whereas a late harvest may allow the destruction of the inhibitors. The unfavourable effect of late harvest on sprouting has been reported in many studies (Dowker and Fennell 1974, Ward 1979, Füstös et al. 1994, Böttcher 1999).

Wheeler et al. (1998) showed that a higher preharvest temperature increased sprouting during storage. The year-to-year variation in susceptibility to sprouting may, therefore, be related to weather conditions in the growing season. This was also observed by Rutherford and Whittle (1982), who found that onions from the coolest season had the longest storage life.

Harvest time may also have some effects on rotting (Dowker and Fennell 1974, Tucker and Drew 1982, Füstös et al. 1994, Böttcher 1999) and rooting (Böttcher 1999). Usually a late harvest is reported to be harmful for the storage life of onion (Kepka and Sypien 1971, Böttcher 1999). Late harvesting also leads to a lower quality of skins: in late harvested onions, the number of dry scales is lower and scales are easily cracked and loosened (Kepka and Sypien 1971).

The information available on the effect of harvest time on storage life hence suggests that the crop should be harvested in time before complete maturity. However, results on yield trends late in the season indicate that early harvest leads to some loss in the quantity of yield (Suojala 2001). The objective of this study was to determine an appropriate time for harvesting bulb onions for long-term storage, when aiming at high yield and high storage quality.

Material and methods

The material used in the storage experiments originates from field experiments conducted at the MTT Agrifood Research Finland, Horticulture, at Piikkiö (60°23'N, 22°30'E) and on vegetable farms in southern Finland in 1996–1999. Onion (cv. Sturon) was grown from sets in all experiments. The experiments are reported in greater detail by Suojala (2001).

Experimental design

There were four to six harvests in each experiment. At Piikkiö in 1996 and 1997, the experimental design included planting time in main plots and harvest time in subplots. Whole plots were arranged in randomised complete block design with four replicates, and subplots were randomised separately within each whole plot. In other experiments, harvest time was the only factor under study and a randomised complete block design with three replicate blocks on farms and four blocks at Piikkiö was used. Planting and harvest times and maturity stages at different harvests are presented in Table 1.

The onions were harvested by hand from an area of 4.8–9.6 m² per plot in different experiments and dried with their leaves attached. In 1996, the onions were dried in a heated and ventilated greenhouse at 20–30°C. In 1997–1999, onions were dried in an onion store provided with continuous air circulation (26°C) through the onion mass.

Storage

The onions from all the experiments were kept in the same store at Piikkiö. The onions were stored in net packages, and air flow was conducted through the onions whenever the air was cooled. The temperature during storage was 0–1°C. The relative humidity of the store could not be controlled and it became too high caus-

Table 1. Planting and harvest dates and dates for analysis of storage loss in different experiments. Maturity at different harvests is presented (in parentheses) as the percentage of onions with softened pseudostem.

Site		1996	1997	1998	1999	1996	1997
Planting dates	A	14 May	15 May	13–15 May	10–11 May	Farm 1: 18 May	Farm 1: 6 May
	B	23 May	26 May			Farm 2: 13 May	Farm 2: 14 May
	C	3 Jun	5 June			Farm 3: 15 May	
Harvest dates (maturity stage)	H1	12 Aug (1–31)	6 Aug (14–93)	5 Aug (19)	4 Aug (99)	13 Aug (0–70)	12 Aug (20–90)
	H2	22 Aug (51–100)	18 Aug (97–100)	19 Aug (90)	18 Aug (100)	27 Aug (20–90)	26 Aug (90–100)
	H3	2 Sep (95–100)	28 Aug (100)	2 Sep (100)	1 Sep (100)	11 Sep (60–100)	9 Sep (100)
	H4	12 Sep (100)	8 Sep (100)	16 Sep (100)	15 Sep (100)	24–25 Sep (90–100)	23 Sep (100)
	H5	23 Sep (100)	18 Sep (100)				
	H6	3 Oct (100)	29 Sep (100)				
Analysis of storage loss		14 Jan	19 Jan	11 Feb	8 Feb	20 Jan	20 Jan
		17 Mar	16 Mar	20 Apr	17 Apr	19 May	11 May
		16 May	11 May				

ing rooting in onions at the end of the storage period.

In 1996 and 1997, storage losses were analysed in the middle of January, March and May in the Piikkiö experiments and in the middle of January and May in the farm experiments (Table 1). In 1998 and 1999, analyses were performed at the beginning of February and end of April. Weight loss during storage was calculated, after which dry leaves and loose dry scales were removed. The bulbs were graded as saleable, rooted, sprouted, diseased or spoiled due to other factors (e.g. wilting). The proportions of the various grades were calculated as percentages of the total fresh weight of bulbs after storage. To evaluate their shelf life, saleable onions were stored for a further 4 weeks at 17°C. After 4 weeks, the bulbs were graded as after the cold storage and the proportions of the grades were calculated as percentages of bulb weight before the shelf life test.

Weather conditions

Weather data were obtained from the meteorological station of the Finnish Meteorological Institute located less than 600 m from the experimental fields at Piikkiö; they are reported in the former paper (Suojala 2001). The years 1996

and 1998 were colder than the long-term average, whereas 1997 and 1999 were warmer. In 1996, precipitation was relatively high up to July, but the autumn was dry. In 1997, in contrast, the early part of the growing season was dry and the latter part rainy. 1998 was unusually rainy and 1999 was characterised by very low precipitation.

Statistical analysis

Response variables were the percentages of weight loss, total storage loss, rooted onions and diseased onions during cold storage and in shelf life tests and the percentage of sprouted onions in shelf life tests at each time of analysis. Data were analysed by repeated measures analysis of variance, with time of storage as the repeated factor. The SAS MIXED procedure (Littell et al. 1996) was used to fit the mixed models by the restricted maximum likelihood (REML) estimation method.

If the rates for e.g. diseased or sprouted onions were very low, the data were not analysed statistically, or only some of the data (e.g. the latest date of analysis) were used. A few observations were missing from some of the data. The highest number of missing, five, was in the shelf life test of onions at Piikkiö in 1997. If the anal-

ysis of data revealed a deviant observation, that caused abnormality in the deviation of the residuals, the effect of the deviant observation was studied by omitting it from the data. However, in most cases the deviant observation did not affect the interpretation and was thus not excluded from the final analysis.

This paper presents only the test results for total storage loss and total loss and sprouted onions in shelf life tests, since they contain the most important information given by the data. Percentages of loss are represented in figures as least square means over storage times.

Results

Losses during cold storage were mainly due to rooting. In most years, the occurrence of storage diseases was very low, only a few percent, which is considered to have no practical significance for the storage performance. Only in 1999 did storage diseases affect c. 10% of the onions stored. During cold storage, no sprouting occurred. In 1998 and 1999 wilting and in 1998 physiological disorder "watery scales" resulted in some spoilage.

In shelf life tests, sprouting was the main problem in 1996. In 1997, sprouting was very rare and most of the loss was caused by rooting and wilting. In 1998, most of the damage was due to sprouting and wilting and in 1999, due to rooting and wilting. Diseases generally accounted for less than 5% of the loss in the shelf life test.

1996 experiment

At Piikkiö, total loss during cold storage was affected by harvest time (Table 2, Fig. 1), the loss being highest in H1 and H2. In January and March, the average losses were low, 0.3% and 7.2%, but in May the loss was considerably higher, 63.5% (standard error of the mean = SEM

2.27). Most of the loss was due to rooting. The occurrence of diseases was very low. Planting time had no effect on storage losses, and there were no significant interactions between fixed factors.

In shelf life tests, total loss was highest in H1, followed by H5 and H6. The significant interaction between harvest and storage time arises from the smaller differences between harvests in January. Total loss was higher in March (42.6%) and May (48.5%) than in January (11.2%) (SEM 3.2). Most of the loss was due to sprouting which was highest in H5 and H6 in January and in H1 in March and May. On average, sprouting was highest in H1 (Fig. 1). In onions from planting 1, sprouting was more common (on average 20.4%) than in planting 2 (14.9%) or planting 3 (9.3%) (SEM 1.62). There was a significant interaction between planting time and storage time, but in each shelf life test, sprouting was highest in planting 1 and lowest in planting 3, the differences being largest in May. The average proportions of sprouted onions were 6.9%, 5.8% and 31.9% (SEM 1.68) in January, March and May, respectively. Onions formed roots only in the test beginning in March, in which the proportion of rooted onions was highest in H6. The number of diseased onions was very low.

On farms, total loss in cold storage was very low in January (1.8%) and high in May (67.7%) (SEM 1.78). There were many observations of zero loss in January, which caused the distribution of residuals to be abnormal in data for January. Therefore, the results of the analysis of the whole data should be interpreted with caution. However, the results are the same when data from May alone are analysed. The total loss was highest on farm 2 (average 40.7%), followed by farm 1 (34.9%) and farm 3 (28.6%) (SEM 2.17). Total loss was clearly highest in H1, but in January it was very low in onions from all harvests. Loss was mainly due to rooting, which followed the patterns of total loss. Diseases were found mainly in the yield from farm 2, average 5.1%. On farm 1, the proportion of diseases was 0.6% and on farm 3 1.2% (SEM 0.93).

Table 2. Probability values of fixed factors in different experiments.

	Cold storage Total loss	Shelf life Total loss	Sprouted	Cold storage Total loss	Shelf life Total loss	Sprouted
<i>Piikkiö</i>	<i>1996</i>			<i>1997</i>		
Planting (P)	0.295	0.116	0.006	0.567	0.753	^x
Harvest (H)	0.041	<0.001	<0.001	<0.001	0.005	
P * H	0.108	0.510	0.177	0.168	0.888	
Storage time (S)	<0.001	<0.001	<0.001	<0.001	<0.001	
P * S	0.676	0.067	0.017	0.688	0.425	
H * S	0.120	0.031	<0.001	<0.001	0.104	
P * H * S	0.345	0.745	0.564	0.096	0.613	
<i>Farms</i>	<i>1996</i>			<i>1997</i>		
Farm (F)	0.021	0.410	0.354	0.024	0.695	0.709 ^y
Harvest	0.011	0.105	<0.001	0.003	0.011	0.014
F * H	0.505	0.174	0.110	0.581	0.784	0.037
Storage time	<0.001	<0.001	<0.001	<0.001	<0.001	
F * S	0.076	0.118	0.654	0.055	0.746	
H * S	0.023	0.164	<0.001	0.002	0.023	
F * H * S	0.434	0.151	0.204	0.316	0.540	
<i>Piikkiö</i>	<i>1998</i>			<i>1999</i>		
Harvest	<0.001	<0.001	0.005	0.002	0.002	0.047
Storage time	<0.001	0.001	0.009	0.007	0.039	0.002
H * S	0.005	0.273	0.004	0.306	0.322	0.017

^x Data not analysed statistically due to low occurrence.

^y Only data from May used.

In shelf life tests, total loss was affected only by storage time, loss being 9.0% in January and 52.1% in May (SEM 2.78). Although the effect of harvest time seems to be considerable (Fig. 1), it was not statistically significant ($P = 0.105$). However, sprouting was significantly highest in H1, although the effect was much larger in May than in January, when sprouting occurred only at the average rate of 4.0%. In May the average level of sprouting was 26.3% (SEM 1.87). In addition to sprouting, total loss comprised wilting, which was lowest in H1. Rooted or diseased onions were found only occasionally.

1997 experiment

At Piikkiö, storage loss was very low, less than 1%, in January and in March, and hence analysis

of the whole data resulted in abnormal distribution of residuals. However, the outcome is the same when the interpretation covers only data from May, when the average total loss was 44.9%. Harvest time had a strong influence on total loss in May, which was lowest in H1 and highest in H4 and H6. Storage loss was mostly due to rooting, which showed the same pattern as total loss.

In shelf life tests, the average total loss was 4.3% in January, 17.1% in March and 29.5% in May (SEM 1.30–1.35). Harvest time affected total loss, which was highest in H4, H5 and H6. Rooting occurred only in March (7.5%) and May (14.1%) (SEM 1.64–1.69). Only some onions were spoiled by sprouting and disease. The differences in total loss between harvest times are due to wilted onions, which were more common in the yield from H4–H6. Planting time had no effect on any variables analysed.

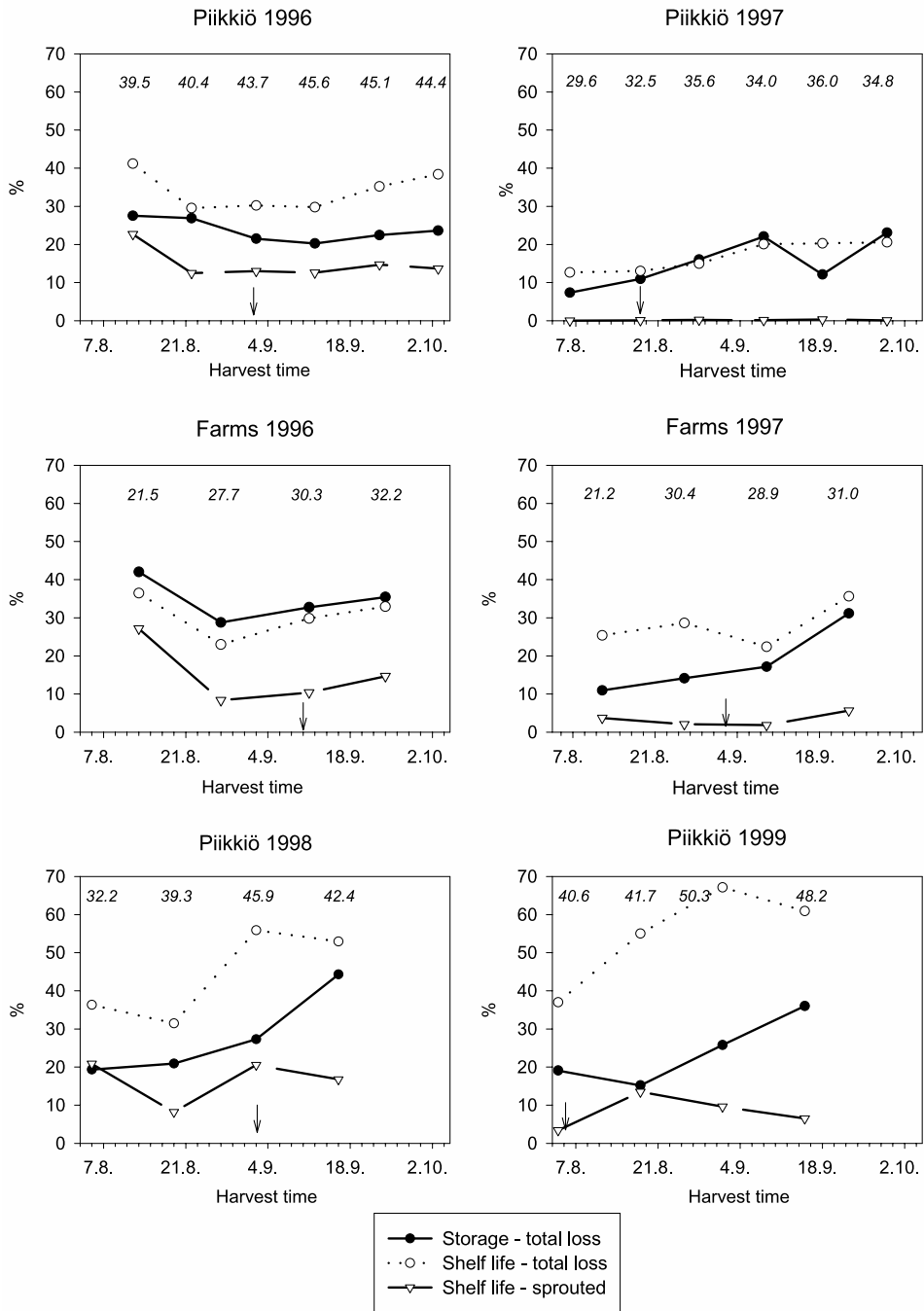


Fig. 1. Total loss in cold storage and shelf life tests and percentage of sprouted onions in the yield from different harvests. Figures are least square means over storage times, and in 1996 and 1997, over planting times/farms. Arrows indicate the average time for 100% maturity, which, however, varied between plantings and farms (see Table 1). Numbers at the top of the plots are the average total yields (1000 kg/ha) at each harvest time.

On farms, total loss was 3.3% in January and 33.4% in May (SEM 3.14). Total loss differed between farms, the average being 23.9% on farm 1 and 12.8% on farm 2 (SEM 2.22). Loss was highest in H4, but the effect was clear only in May, because the overall loss was so low in January. Rooting accounted for most of the total loss in May. The level of diseases was less than 5%.

In shelf life tests, the average loss was 5.7% in January and 50.3% in May (SEM 2.67). No large differences between harvests were found in January, but in May the loss was much higher in onions from H4 than in those from earlier harvests. Rates for diseased onions were 1.1% in January and 4.5% in May (SEM 0.80). Sprouted onions were most common in H4 on farm 1 and in H1 and H4 on farm 2. However, sprouting was less abundant than in the preceding year. Wilted onions accounted for approximately one third of the total loss.

1998 experiment

The average loss during cold storage was 7.4% in February and 48.5% in April (SEM 1.49). The effect of harvest time differed at the two dates of analysis: in February the loss was almost as high in H3 as in H4; in April H4 had the highest loss. Rooting accounted for most of the loss, in addition to which wilted and physiologically damaged onions occurred in H3 and H4. Storage diseases affected only 0.9% of onions in February and 1.8% in April (SEM 0.37).

In shelf life tests, total loss was 21.1% in February and 67.2% in April (SEM 3.34). The loss was much higher in H3 and H4 than in the earlier harvests. The rate of sprouting was high, 7.3% in February and 25.9% in April (SEM 2.23). In February, the rates of sprouting were highest in H3 and H4 (11.0–11.6% vs 2.7–4.0% in H1 and H2), whereas in April, the highest level of sprouting was in H1 and the lowest in H2. Occurrence of diseases was highest in H3 and H4. In addition, there were high levels of wilted onions in H3 and H4 in April, resulting in a high total loss.

1999 experiment

The total storage loss was highest in H4 and lowest in H1 and H2 in both February and April. The average loss was 15.1% at the first date of analysis and 33% at the second (SEM 1.92). Rooted onions accounted for most of the total loss and were most abundant in H4. The proportion of diseased onions was 7.2% in February and 9.8% in April (SEM 0.96), and at both time points, the rate was highest in H1.

After cold storage, total loss was higher in April (62.8%) than in February (47.1%) (SEM 3.11–3.22). The loss was lowest in H1 and increased up to H3. Similarly, rooting was lowest in H1. Sprouting was observed in 3.9% of onions in February and in 12.6% in April (SEM 1.17–1.19). In February, most sprouted onions were found in H2 and H3; in April the rate of sprouting was highest in H2. The bulk of the diseased onions were found in H1. In addition, wilted onions were most common in the yield from H3 and H4.

Discussion

Components of storage loss

Rooting of onions accounted for most of the storage loss at low temperature. The high incidence of rooting was caused by the high humidity of the store, since it is generally recommended that relative humidity should be kept below 70–75% to avoid root formation (Komochi 1990). Had the humidity been lower, storage loss would probably have been very low. Storage diseases did not cause any significant problems; only in 1999 did diseases account for one third of the total storage loss. The low level of diseases was probably due to the use of appropriate crop rotation in the experimental fields and the fungicide treatment of onion sets prior to planting. In the 1998 yield, the physiological disorder known as watery scales was observed to some extent,

Table 3. Average sprouting rate in shelf life tests and seasonal weather conditions at Piikkiö.

Piikkiö	1996	1997	1998	1999
Average sprouting (%)	14.8	0.1	16.6	8.3
Mean temperature May–September (°C)	12.5	14.6	12.8	14.3
Precipitation May–September (mm)	328	319	377	155
Irrigation May–September (mm)	0	45	0	118
Precipitation 3 weeks before H 1 (mm)	11	93	65	11

mainly in the onions from the latest harvests. Watery scales arise when the CO₂ concentration is too high or the O₂ concentration too low inside the bulb: concentrations above 10% are reported to increase the risk (Hoftun 1993). The most critical period for a high CO₂ concentration is between maturation and complete drying of the bulbs (Solberg 1997). High precipitation in August and September is thought to increase the number of affected bulbs (Solberg 1997). Therefore, the occurrence of the disorder in 1998 is probably related to the wetness of the field before harvest. The problem is usually intensified in late harvests (Solberg 1997), which was also seen in our data.

In shelf life tests, losses were mainly due to sprouting, rooting and wilting. The incidence of sprouting was highest in 1996 and 1998 and lowest in 1997. Since the storage conditions did not differ markedly between the years, the variation in sprouting rates must have been caused by growing conditions.

Wheeler et al. (1998) reported that sprouting was reduced by low growing temperatures. Our findings do not support the beneficial effect of a cool growing season, since in 1996 and 1998, both of which were cooler than the long-term average, the percentage of sprouting was high (Table 3). The high level of sprouting may also have been related to high precipitation in these years. Grevsen and Sørensen (1999) found that omitting irrigation during the 3-week maturation period before the expected harvest time significantly retarded sprouting after storage. Scrutiny of precipitation during the 3-week period before the first harvest at Piikkiö (Table 3) reveals no relationship between low precipitation and a low

incidence of sprouting. For example, in 1996, when the beginning of the growing season was rainy, precipitation was only 11 mm during the 3 weeks before the first harvest and yet sprouting was very common. Neither does precipitation during the whole season seem to be clearly related to sprouting incidence, although the highest sprouting rates were observed in the years with the highest precipitation. Even so, in the very dry season, 1999, there was still a moderate level of sprouting.

The discrepancy in results is such that the analysis of weather data does not give any clear explanations for the year-to-year variation in sprouting. The susceptibility of onions to sprouting has also been related to the chemical composition of bulbs, an issue that was not analysed here. Rutherford and Whittle (1984) examined onions from five seasons and noted that the amount of fructose at harvest was directly related to storage duration (on the basis of sprouting). Suzuki and Cutcliffe (1989) reported that onion cultivars with a short storage life have a low concentration of fructans and a high concentration of fructose at harvest. These partly contradictory results show that further investigations are needed to shed light on the great variation in storability and incidence of sprouting.

Effect of planting time

Planting time generally had no effect on storage loss, despite differences in the maturity stage and average bulb size of onions from different plantings. The only statistically significant effect was in sprouting at Piikkiö in 1996, when the sprout-

ing rate was highest in onions from the earliest planting. This may have been due to the size of the onions, since those from the earliest planting had the highest mean weight, and large onions are thought to be more prone to sprouting (Ward 1979). However, the mean size of the bulbs also varied between farms, whereas no differences in sprouting rates were found between farms.

Optimal harvest time for high storage quality

The results show that harvesting can be delayed to 100% maturity without a marked increase in storage loss or decline in shelf life quality. In most experiments, storability was not impaired, even if the yield was harvested 2–4 weeks after 100% leaf fall-down. In the rainy year of 1998, delayed harvest was unfavourable for the quality of the yield. Late harvesting may, however, lead to partial loss and splitting of outer scales (Tucker and Drew 1982), which may result in increased rates of respiration, weight loss and sprouting (Apeland 1971). The quality of scales was not evaluated systematically here, but it would seem that the problem of scale quality is pronounced in rainy years.

The disadvantage of an early harvest was discernible, especially in 1996. Harvesting the onions before 50% maturity resulted in high storage loss and a high level of sprouting, which is in accordance with the hypothesis of sprouting inhibitors (Stow 1976).

The background to the variation in storability at different maturity stages is not clear. Nilsson (1980) concluded that the variation in storage performance cannot be explained by differences in chemical composition. Susceptibility to sprouting has been tentatively attributed to translocated inhibitors (Stow 1976), but control of the other components of storage loss is unclear. In our study, most of the loss during cold storage

was due to root formation. In his review, Komochi (1990) suggested that rooting, like sprouting, is affected by dormancy. However, the outer rooting, in which roots develop from the outer surface of the stem plate, appears to be almost free of dormancy and is promoted by high humidity in the store.

Effect of growing site

Some differences found in storage performance between growing sites in 1996 and 1997 were probably related to the cultivation history of the field. Despite differences in maturity stages at harvest, soil properties, cultivation techniques and microclimate, the effect of harvest time was more or less uniform on different farms and at Piikkiö. Therefore, climatic factors seem to determine a large proportion of the storage potential. The overwhelming influence of growing season on plant development and growth is a very common feature, which, however, has not been understood or utilised properly. We have not yet identified the climatic factors that affect changes in plant composition and quality and therefore have no measures to control them. More emphasis should be laid on analysing the background of the year-to-year variation in plant growth and development.

In conclusion, our experiments under northern conditions suggest that the harvesting of onion for long-term storage can be timed to occur between c. 50% maturity and even some weeks after complete maturity without any significant risk of poor storage quality. In rainy years, delaying harvest until over 100% maturity can, however, be harmful. Late harvest maximises the yield and minimises the need for and cost of artificial drying. Planting time has no clear effect on the storage performance of onion grown from sets. The variation between years in storability is substantial and requires further research.

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SELOSTUS

Sadonkorjuuajan vaikutus sipulin varastohävikkiin ja varastoinnin jälkeiseen versomiseen

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Sadonkorjuuajaika vaikuttaa sipulin varastokestävyyteen. Korjuuoptimi ei kuitenkaan ole välttämättä sama tavoiteltaessa korkeaa satoa tai hyvää säilyvyyttä. Tämän tutkimuksen tavoitteena oli määrittää suotuisin sadonkorjuuajaika, kun päämääränä on sekä määrältään että varastolaadultaan hyvä sato. Neljänä vuonna tehdyissä varastointikokeissa käytettiin puutarhatuotannon tutkimusyksikössä ja eteläsuomalaisilla tiloilla viljeltyä satoa. Tulosten mukaan sadonkorjuuta voidaan lykätä 100 %:n tuleentumiseen asti, ja jopa pidempään, ilman varastohävikin merkittävää

lisääntymistä. Sateisina vuosina myöhäinen korjuu kuitenkin saattaa heikentää laatua. Sipuleiden versomisaltius vaihteli huomattavasti vuosittain. Varhainen, ennen 50 %:n tuleentumisastetta ajoitettu sadonkorjuu ja viivästetty korjuu lisäsivät versomisriskiä. Tutkimuksen mukaan pitkäaikaiseen varastointiin tarkoitettu sipuli voidaan korjata 50 %:n ja 100 %:n tuleentumisasteen välillä, jopa pari viikkoa täyden tuleentumisen jälkeen varastolaadun heikkenemättä. Näin ollen on mahdollista saavuttaa yhtä aikaa korkea sato ja hyvä varastokestävyys.