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THE RESPONSE OF TWO SHORT-DAY ONION CULTIVARS TO CURING WITH SOLAR RADIATION IN PLASTIC TUNNELS

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ABSTRACT

Short-day onion (*Allium cepa* L) production in Florida is limited mainly by poor keeping quality associated with inadequate curing. Curing is a drying process which removes about 5% of the water. A plastic tunnel accumulated heat from solar radiation, which raised air temperatures, lowered relative humidity, promoted drying and protected the bulbs inside the tunnel from rain. Curing efficiency was determined by weight loss, shelf life and quality of bulbs of 'Yellow Granex 33' ('Granex') and 'Texas Grano 502' ('T.G. 502') grown in organic (muck) and mineral (sand) soils and cured in windrows and plastic tunnels. Both 'Granex' and 'T.G. 502' had good appearance and quality after curing, particularly when grown in sand. Weight loss of 'Granex' was 5.5% and 'T.G. 502' 7.5% after 25 days of curing. 'Granex' had 6.4% and 'T.G. 502' 24.3% decay after 51 days of room temperature storage. Muck and sand grown onions had the same weight loss during curing, but after 51 days of storage, onions grown in sand had less weight loss and decay than those grown in muck. Windrowed onions lost 9.2% weight and tunnel cured onions 3.8% in 25 days curing. Tunnel cured onions had significantly more decay than windrowed onions at the end of 51 days of storage. Interactions among cultivars x soils x methods of curing were found to be significant. Yield, keeping quality and appearance were maximized when 'Granex' was grown in sandy soil and cured in plastic tunnels or windrows when no rain occurred. Regression analysis indicated a relationship between weight loss and time. 'Granex' required 11 days and 'T.G. 502' six days of windrow curing to attain 5% weight loss. 'Granex' reached 5% weight loss in 22 days and 'T.G. 502' in 11 days when cured in the tunnel. This suggests that a monitoring process is needed to ascertain when 5% weight is attained.

RESUMEN

La produccion de cebolla (*A. cepa* L) de corto día en Florida se limita mayormente por la corta vida poscosecha asosciada con curación inadequada. Curación es un proceso desecativo que elimina alrededor de 5% del agua. Un tunel, de polictileno acumuló calor de radiación solar, que subió las temperaturas del aire, bajó la humedad relativa, fomentó secamiento y protejó los bulbos dentro del tunel de la lluvia. Eficiencia de curación fue determinado por disminución de peso, duración de vida poscosecha y calidad de bulbos de 'Yellow Granex 33' ('Granex') y 'Texas Grano 502' ('T.G. 502') cultivados en suelos organicos (muck) y minerales (arena) y curados en amontonamientos a aire libre o en tuneles de plastico. 'Granex' y 'T.G. 502' tenían buena apariencia y calidad después de curación, particularmente cuando fueron cultivados en suelo arenoso. Después de 51 dias de curación la disminución de peso de 'Granex' era 5.5% y la de 'T.G. 502' era 7.5%. Después de 51 dias de almacenamiento a temperaturas medianas, 'Granex' sufrió 6.4% de pudrición, y 'T.G. 502' sufrió 24.3% de pudrición. Cebollas cultivadas en suelos orgánicos y suelos arenosos tenián la misma disminución de peso durante curación, pero después de 51 dias de almancenamiento, las cebollas de suelo arenoso sufrieron menos disminución de peso y pudrición que las de suelo orgánico. Cebollas en amontonamientos perdieron 9.2% del peso y cebollas en tuneles perdieron 3.8% del peso en 25 días de curación. Después de 51 días de almacenamiento, las cebollas curadas en tuneles sufrieron significativamente mas pudrición que las cebollas curadas en amontonamientos. Se encontró interacciones significantes entre variedades y suelos y métodos de curación. Rendimiento calidad en almacenamiento y apariencia fueron mayores cuando 'Granex' fue cultivado en suelo arenoso y curado en tuneles de plástico o en amontonamientos sin lluvia. Analisis de regresión indicó una relación entre disminución de peso y tiempo. 'Granex' exigió 11 días y 'T.G. 502' exigió 6 días de curación en amontonamientos para obtener un 5% disminución de peso cuando fueron curados in tuneles. Los datos sugieren que se precisa un método para determinar cuando se obtiene la disminución de 5% del peso.

Keywords: Onions, Yellow Granex 33, Texas Grano 502, Weight loss, Windrows, Storage, Decay.

In order to reverse cold induction and prevent premature bolting in celery, seedlings were enclosed in clear plastic tunnels. It was found that temperatures at midday were so high that top leaves of the seedlings were seriously scorched. Heat accumulation from solar radiation inside the tunnels could therefore apparently be used for drying or curing onions. Although cultivar testing and other research had been carried out extensively by the Florida Experiement Station system, large commercial onion production has not materialized. Poor keeping quality of the bulbs due in part to inadequate curing is one of the limiting factors. Curing is a drying process which removes water primarily from the external scales of the bulbs. Well cured bulbs have dried necks, outer scales which are paper thin and rustle to the touch, and improved keeping quality. Most onions in Florida are cured in the field by solar radiation. Some growers windrow onions in the field for several days and trim tops and roots before sorting and bagging them in the packing house. Other growers trim tops and roots, place the onions in mesh bags and leave them in the field for curing for several days before packing. A few trim and sort onions in the field in pallet boxes and send them to market in bulk as soon as possible. Depending on frequency and amount of rain field curing can be a failure (3). Other sources of energy have been tested for curing onions with promising results (2, 4, 5). However, there is no energy source less expensive than solar radiation. Beginning in the mid-seventies, the plastic tunnel concept was intensively studied, compared, improved upon, and demonstrated in farmers' fields. Solar energy was selected instead of other sources for drying onions because of the need to reduce oil consumption. Also, the system is inexpensive, easy to handle, and adaptable for mechanization and use in remote areas. This paper presents some of the results obtained from curing onions by solar radiation. The objectives of these studies were: 1) to compare the response of two onion cultivars grown in histosols (Pahokee much) and a spodosol (Oldsmar fine sand) for quality before and after curing in windrows and plastic tunnels; 2) to assess the effect of all these components on keeping quality of bulbs during storage and 3) to test the feasibility of using the tunnel system in commercial production fields.

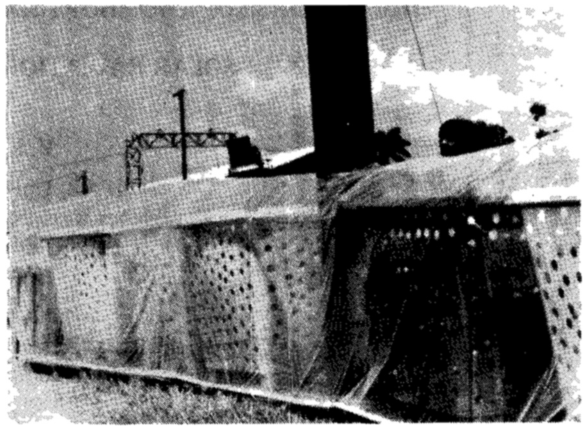

FIGURE 2

Materials and methods

'Yellow Granex 33' ('Granex') and 'Texas Grano 502' ('T.G. 502') were grown in raised beds following standard procedures (12). Seedings were planted with a narrow-row Planet Jr. planter during early fall. The narrow-row consisted of 3 closely spaced rows about 4cm apart, with 30cm between each set of 3 narrow-rows. Usually 3 sets per row/bed and 2 sets per row/bed were used for mineral and muck soil respectively. Seeding, harvesting and other procedures were conducted similarly on the same date in sand and muck grown onions, weather permitting. Maleic hydrazide (MH) was applied at a rate of 7 liter/ha 2 weeks before harvest. When approximately 20% of the tops fell over, the onion roots were undercut with an inclined sharp blade or a square rotating bar to hasten drying and maturity. This procedure was repeated after a rain or if the soil dried slowly. Onion bulbs of medium to large size were harvested (April and May depending on the year) by hand. After being cured in windrows the tops and roots were trimmed. Bulbs were trimmed when harvested for the tunnel curing treatments and placed in slotted pallet boxes.

The plastic tunnel was constructed over pallet boxes measuring 102 x 122 x 91cm, which held approximately 450kg of bulbs. Pallet boxes filled with onions were forklifted and placed side by side in a row. A 15 x 15cm welded wire mesh was stapled to the outside of the boxes, forming a semicircular roof of the tunnel which supported the plastic (Fig. 1). A 4 mil plastic sheet 3.75m wide was placed over the roof and sides of the boxes and held in place with nailed wood strips (Fig. 2). As the boxes were placed side by side, the welded wire and plastic were extended over the boxes forming a tunnel. The tunnel began with a heat-collecting section about 3m long that gradually extended over the tops and sides of the boxes. The tunnels were erected in the direction of the prevailing winds to increase air circulation. A chimney-like metal tube 5m long was suspended in the center of the tunnel to increase air movement. Crumpled paper over the bulbs prevented sunburn when clear plastic was used.

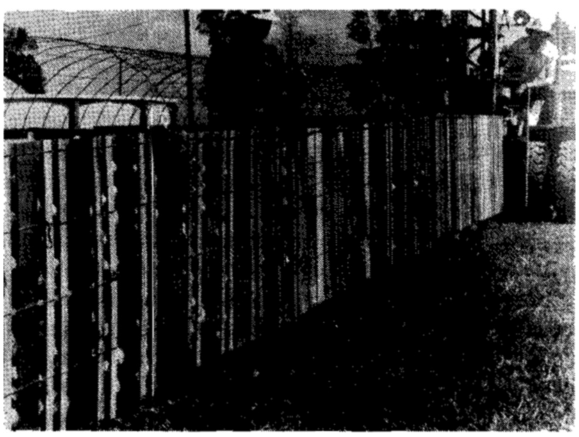

FIGURE 1

The experiment was analyzed as a randomized complete block design consisting of 6 replications. A treatment usually consisted of a pallet box or equivalent. Pallet boxes were divided with slotted partitions into 2 or 4 treatments when necessary with several boxes comprising the block or replication. The windrow cured onions were placed in boxes for storage by treatments. At the beginning, dry weights were compared to assess differences in curing. Later weight loss was expressed as a percentage of initial weight. A 5% weight loss was considered the threshold for adequate curing. The amount of decay and other disorders were expressed as a percentage of the last weight measured. Tunnel cured onions were stored in the same tunnels in the field or transferred in the same pallet boxes to a barn. Windrow cured onions were trimmed and transferred to a barn for storage in wooden boxes. Quality of the final product (appearance) was assessed by the experimenter and aides on a five point scale, from very poor to very good without sorting for size.

All weather parameters were measured. Temperatures were recorded with a multiple probe continuous Honeywell recorder at different depths inside the onion filled pallet boxes. Relative humidity was calculated from wet and dry bulb readings inside the tunnel. Solar radiation was obtained from integrated solar pyranometer in Langleys (gram calories per cm^2) at the Everglades Research and Education Center in Belle Glade. Rainfall was automatically recorded.

When curing in plastic tunnels with forced air, a high speed 45cm electric fan with 1472 liter/sec capacity was installed at the entrance of the heat collector. It was thermostatically activated when the air temperature reached 32.5 °C.

Results and discussion

Plastic tunnels raised the air temperature which in turn lowered the relative humidity and promoted drying of the bulbs. However, heat distribution was affected by position, i.e. depth, in the box (Table 1).

Table 1. Mean air temperatures (°C) in clear plastic tunnel at four depths and four time periods inside pallet boxes full of onions (Factorial 2 × 2 × 2 × 2).

Depth (cm)	Time			
	0800	1200	1600	2400
0	26.7	35.3	34.9	24.0
15	24.7	27.2	28.4	24.2
38	22.9	23.8	23.9	23.5
76	21.8	23.4	25.0	21.2
Relative Humidity	88	44	50	100

Mean — 523.35 Langleys/day and no rainfall during curing.

Temperatures at the top of the boxes rose rapidly as the day advanced and began to decrease after midafternoon. Air temperature changed more slowly at depths of 15, 38 and 76cm. Temperatures were dependent on the color of the plastic that was used. Temperatures were higher in clear plastic tunnels than in black, with mean differences of 3.0, 4.3, 3.1 and 0.2 °C at 0800, 1200, 1600 and 2400 hours, respectively. Some sunburing of the top layer of onions occurred with clear plastic. Straw or crumpled paper on top of the onions eliminated this disorder.

Temperatures decreased during the night, with the rate of heat loss being more rapid at the top of the onion layer. Temperatures near the bottom of the box underwent smaller changes from day to night. Variations in temperature inside the tunnel also occurred from day to day depending on cloud cover. Temperatures of 55 ° on top, 32 °, 30 ° and 24 °C at depths of 15, 61 and 76cm respectively were often recorded at midday under sunny skies. Variations in temperature caused by onion depth and relative humidity caused by time of day probably had different effects on the rate of curing.

Effect of curing method on dry weight.

Curing increased percent dry weight regardless of curing method (Table 2). Curing in windrows for 20 days with no rainfall appeared to be slightly better than tunnel curing. Tunnel curing was better than windrows curing after 22 days with rainfall. Under rainy conditions, windrowed onions actually showed an increase in water content (less dry weight). This indicates that with rainy weather tunnels are more efficient than windrows. Both windrowed and tunnel cured onions showed an increased percentage of dry matter regardless of the cultivar after 6 days of additional curing with no rainfall.

Table 2. Percentage dry weight of bulbs of two onion cultivars grown in organic soils after curing in windrows and in plastic tunnels with and without rainfall.

Curing		Dry weight	
Treatment	Days	Granex 33 (%)	Texas Grano 502 (%)
No rain			
	0	7.20	—
Tunnel	20	7.38	—
Windrow	20	7 43	—
With rain[z]			
	0	6.96	6.79
Tunnel	22	7.38	6.78
Windrow	22	5.50	5.75
Tunnel	28	8.25	7.33
Windrow	28	7.03	6.86

[z]Seven rains fell (12 mm) during the 22-day curing period, and curing time was extended to 28 days.

Effect of curing methods on weight loss after curing and storage.

When bulb weight loss was measured after 14 days curing and 52 days storage 'T.G. 502' lost more weight than 'Granex' (Table 3). Windrowed onions lost more weight than tunnel cured onions after curing and storage. There were no losses due to decay or other disorders, indicating the excellent appearance and keeping quality of sand-grown onions. Onions with greater weight loss during curing continued to have greater weight loss in storage. It is not clear if a 5% weight loss is too much bulbs. 'T.G. 502' lost more weight than 'Granex'. 'T.G. 502' matures one or two weeks later than 'Granex', consequently, since they were harvested the same day, the bulbs of 'T.G. 502' may have contained more water and thus dried at a faster rate than did the more mature 'Granex'. This may indicate that greater water loss does not necessarily mean better curing if the bulbs are immature. The results also indicate that with no rainfall, windrow curing is more effective than tunnel curing.

Table 3. Bulb weight loss of two onion cultivars grown in mineral soils after 14 days of curing in windrows and in plastic tunnels and 52 days of storage at room temperature.

Treatments	Weight loss		Marketable	
	Curing (%)	Storage (%)	Yield (%)	Appearance
Cultivar (C)				
Granex 33	4.2	13.1	86.9	Good
T.G. 502	6.0	20.6	79.4	Good
Significance	**	**	**	
Curing method (M)				
Windrows	7.2	21.5	78.5	Good
Plastic Tunnel	3.1	12.3	87.7	Good
Significance	**	**	**	Good
C × M	NS	NS	NS	

NS — nonsignificant, ** — significant at 1% level.

Effect of clear and black plastic on tunnel curing and storage.

No differences were found in curing, storage, diseases and discolloration of the bulbs due to plastic color (Table 4). This indicates that the plastic tunnel is suitable for storage as well as for curing. However, it is advisable not to prolong storage in a tunnel unnecessarily because weight loss was more pronounced and decay increased as compared with bulbs stored in small wooden boxes inside a barn. 'T.G. 502' had more decayed and discolored bulbs than 'Granex' after 65 days of storage in tunnels. The black discoloration was produced by a saprophytic fungus of the *Aspergillus* family that thrives just below the outer dry scale of the onions. The fungus does not cause decay, but reduces the good appearance of the bulbs. The experimental bulbs were considered marketable since onions in the supermarket showed the same discoloration.

Table 4. Effect of plastic color on percentage of marketable weight, decayed and discoloration of bulbs of two onion cultivars grown in mineral soils after 11 days of curing in plastic tunnels plus 65 days of storage in the same tunnels

Treatments	Marketable onions		Defects after storage	
	Curing (%)	Storage (%)	Decayed (%)	Discoloration (%)
Plastic color (P)				
Clear	97.3	87.5	5.0	38.5
Black	96.8	88.3	6.0	36.5
Significance	NS	NS	NS	NS
Cultivar (C)				
Granex	97.8	91.0	3.5	25.3
T.G. 502	96.3	85.3	7.5	49.8
Significance	**	**	**	**
P × C	NS	NS	**	NS

NS — nonsignificant, ** — significant at 1% level.

Effect of forced air circulation inside the tunnel on weight loss.

Windrowed onions dried faster than those in tunnels with or without forced air (Table 5). Eight, 19 and 25 days were needed for curing in windrow, forced air and non-forced air, respectively, for the two cultivars. These differences is curing days were presumably caused by the small depth (20cm) of the onion mass over a large surface for the field windrowed onions, in contrast to 76cm depth in the tunnel. Air forced into the tunnel only slightly increased the drying rate from the non-forced air treatment, probably because most of the air took the path of least resistance, between the top layer of onions and the plastic roof. A different type of structure is needed if forced air circulation is to be used for curing - one which forces the air through the onion mass. The interactions were significant for final quality. Forced air tended to minimize the effect of cultivars, whereas in windrows and non-forced air, differences between cultivars were magnified. 'Granex' windrowed and 'Granex' in the tunnel had less decay and more marketable onions than 'T.G. 502' (1).

Table 5. Percentage weight loss of onion bulbs of two cultivars grown in organic soils when cured in plastic tunnels with and without forced air and in windrows in the field[z] from 5 to 25 days.

Curing method	Cultivar	Curing days 5	8	11	19	25	Mean weight loss	Final quality: Sunburned and rots	Marketable
		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Windrowed	Granex	2.4	4.6	5.6	6.0	9.0		3	97
Windrowed	T.G. 502	3.2	6.5	8.3	9.0	12.5	10.8	10	90
Non-forced air	Granex	1.9	2.5	3.2	3.9	4.7		5	95
Non-forced air	T.G. 502	2.3	3.4	4.8	6.0	7.7	6.2	17	83
Forced air	Granex	1.6	2.8	3.7	4.7	6.1		12	88
Forced air	T.G. 502	2.5	3.5	4.6	5.6	7.5	6.8	13	87
Mean for cultivar									
Granex							6.6		
T.G. 502							9.2		
Significance									
Method		NS	NS	*	NS	**	**	*	*
Cultivar		NS	NS	NS	*	**	**	**	**
Interactions		NS	NS	NS	NS	NS	NS	*	*

[z]Windrowed onions were kept at room temperature after 11 days of curing.
NS — nonsignificant, * and ** significant at 5 and 1% level respectively.

Weight losses were measured 5 times during the 25 days of curing. Regression models for weight loss over time were calculated for 'Granex' and 'T.G. 502' cured in windrows and tunnels (Fig. 3). Weight loss was linearly correlated with curing days ($R^2 = 0.87$ to 0.95). When cured in windrows with no rainfall, 11 days were sufficient for 'Granex' to reach 5% weight loss, while 'T.G. 502' required 6 days. With tunnel curing, 22 days were needed for 'Granex' to reach 5% weight loss; 'T.G. 502' required 11. These results agree with the generalization that the longer the curing, the greater the weight loss (7). Tunnel curing requires more days than windrow curing if no rain falls. Cultivars differed in curing and storage characteristics as previously reported by others (10, 11). Bulb density and respiration rates were not different between bulbs of keepers and poor keepers (13). A high rate of water loss was characteristic of poor keepers. This agrees with the rate of water loss of 'T.G. 502' being faster than 'Granex'. 'T.G. 502' generally needed fewer days than 'Granex' to attain 5% weight loss, but it also decayed faster. Curing in onions can be defined as an accelerated rate of drying of the outer scales and necks to protect them from infection during storage. Well matured, disease-free bulbs eventually cure slowly (lose weight with time) without benefit of a specific curing period. If high

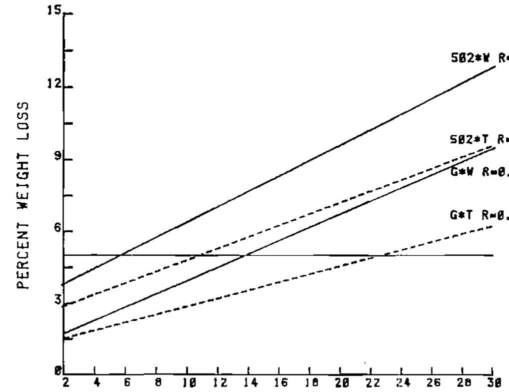

FIGURE 3

humidity and relatively high temperatures persist, however, even cured bulbs will decay in time (9). Well matured sand-grown onions, some cured and some uncured, were stored in several tomato boxes in a well ventilated barn. Neither cured nor uncured 'Granex' had any decay after 4 months, while only 7 bulbs decayed in the 'T.G. 502' uncured treatment.

Onions need to be cured to improve their keeping quality during storage and marketing (2, 5, 7, 8, 13); but no data exist as to how much curing is necessary and what criteria need to be met. This situation is confounded by reports of successful storage with uncured onions (6, 12) as well as with those cured for from 1 to several days. Amount of weight loss depends on the cultivar and perhaps on the degree of maturity. 'T.G. 502' consistently lost more weight and lost it faster than 'Granex'. This may have been because 'T.G. 502' was physiologically immature or because it was inherently more succulent, or both. The rate of weight loss is inversely correlated to keeping quality (13) and also appears to be a characteristic of the cultivar (10, 13). It is suggested that monitoring all components (cultivars, maturity, soil type, diseases, etc.) as well as weight loss could provide a better measure of the length of curing necessary. This is important both to expedite marketing and also because excessive curing appears to influence weight loss in storage. Excessive curing and long storage reduced final yields. A longer curing period does not seem to improve the keeping quality of cultivars which are inherently poor keepers such as 'T.G. 502'. Bulbs with dried necks and outer scales and weight loss approaching 5%, were considered cured.

Progress has been made to mechanize onion harvesting (3, 11). The various mechanical handling sequences are detrimental to keeping quality, especially for short-day onions. The tunnel method reduces handling to a minimum because onions could be cured and stored in the same pallet boxes.

Combined effect of varieties, soils and MH on curing and storage

Main effects and interactions are presented in Table 6. 'T.G. 502' lost more weight during curing and storage and had more decayed bulbs than 'Granex' after 51 days in storage. Muck grown onions lost more weight and had more decay than those grown in sand. Windrowed onions lost significantly more weight than those in tunnels, and the latter had significantly more decay. No effect was found due to MH in curing or storage.

Table 6. Percentage weight loss of onion bulbs after 25 days of curing plus 15 and 51 days of storage in two cultivars, grown in organic and sandy soils with and without malaic hydrazide and cured in windrows and in tunnels (A 2 × 2 × 2 × 2 factorial).

Treatments		Weight loss				
		Curing[z]	Storage			
		25 days (%)	40 days (%)	Decayed (%)	76 days (%)	Decayed (%)
Granex 33	(C)	5.48	8.13	1.00	13.04	6.44
T.G. 502		7.51	11.31	9.80	20.94	24.30
		**	**	**	**	**
Muck	(S)	6.47	10.45	10.62	18.71	25.92
Sand		6.51	8.81	0.27	15.26	4.82
		NS	NS	**	*	**
Windrow	(M)	9.19	11.01	4.63	18.04	8.71
Tunnel		3.80	8.25	6.26	15.94	22.03[y]
		**	**	NS	NS	**
No chemical	(Ch)	6.71	9.49	4.87	17.09	14.03
Maleic hydrazile		6.28	9.77	6.02	16.89	16.71
		NS	NS	NS	NS	NS
Significant interactions						
		C × M**	C × Ch*	C × S**	C × S**	C × S**
		C × Ch**			S × M**	C × M*
		S × Ch*				S × M*
		C × S × M**				C × S × M*

[z]No rain fell during curing (523.35 Langleys/day).
[y]Some of the decayed bulbs were due to accidental water damage.
NS — not significant, * and ** significant at 5 and 1% level respectively.

There was a significant interaction between cultivars and methods of curing and soils (Table 7). 'Granex' lost more weight than 'T.G. 502' in tunnels, whereas with windrows, 'Granex' lost less weight than 'T.G. 502'. This indicates that tunnel curing was more effective for 'Granex' and that windrow curing was more effective for 'T.G. 502'. Weight loss after 51 days of storage showed similar results as those for curing, except that 'T.G. 502' lost more weight than 'Granex' in the tunnel. 'T.G. 502' cured in windrows lost more weight than 'Granex' regardless of soil type; with tunnel curing 'Granex' grown in muck lost more weight than 'T.G. 502' grown in muck or sand (Table 8). 'T.G. 502' had more weight loss than 'Granex' after 51 days of storage, regardless of curing method and soil type except when grown in sand and cured in windrows. The longer the curing and storage period, the lower was the yield of salable onions (7).

Table 7. Percentage weight loss of bulbs of two onion cultivars during curing and storage in relation to curing methods.

Cultivars	Method Windrow (%)	Method Tunnel (%)	Mean (%)
	Curing for 25 days		
Granex	6.8	4.2	5.8
T.G. 502	11.6	3.4	7.1
Mean	9.2	3.8	
	Storage for 51 days		
Granex	14.9	11.1	13.0
T.G. 502	21.1	20.7	20.9
Mean	18.0	15.9	

Table 8. Percentage weight loss of bulbs of two onion cultivars due to methods of curing and soil type after 25 days of curing plus an additional 51 days of storage.

Cultivars	Soil	Method	Weight loss Curing (%)	Weight loss Storage (%)	Decayed (%)
Granex	Muck	Windrow	5.9	9.7	5.3
Granex	Muck	Tunnel	5.3	12.1	19.5
Granex	Sand	Windrow	7.7	20.2	0.0
Granex	Sand	Tunnel	3.1	10.2	1.1
T.G. 502	Muck	Windrow	11.8	26.2	20.7
T.G. 502	Muck	Tunnel	2.9	26.9	58.2[z]
T.G. 502	Sand	Windrow	11.4	16.1	8.8
T.G. 502	Sand	Tunnel	3.9	14.6	9.4

[z]Accidental water damage.

Performance of tunnel system in relatively large operations.

The tunnel method lends itself to mechanization (3, 11). Slotted pallet boxes full of trimmed bulbs were rapidly forklifted and put side by side in the field and the tunnel formed with wire and plastic as the harvest progressed. The amount of onions cured varied from 5 to 20 tons. In some trials rain fell during part of the curing period. Regardless of weather conditions, curing in a tunnel was equal to windrow curing or any method of field curing used by the farmer. However, keeping quality could not be determined because the onions were shipped as soon as the field cured onions were ready. These results were obtained with muck grown onions, which are more susceptible than sand grown onions to decay and present more keeping problems. The last commercial trial was conducted at Basore farm using 'T.G. 502' cured and stored in tunnels for about 25 days. No differences with the bag-cured system were detected.

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