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Delayed Harvest Reduces Yield of Dry Red Chile in Southern New Mexico

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Abstract. **Mature red chile fruit [*Capsicum annuum* (L.)] were harvested over 3 years at 2 locations in southern New Mexico to determine the effects of harvest date on yield and color. Yields peaked in late October or early November and then declined linearly through December or January. Declines were correlated highly with fewer marketable pods harvested due to detachment or discoloration. The detachment of mature red pods over the test period was affected differentially by cultivar. Color (in ASTA units) varied from good commercial levels to substandard ones between years, but the color of late-harvested pods was normally equal to or better than that from earlier-harvested fruit.**

Mildly pungent chile produced for dry red powder is an important crop for southern New Mexico growers. Harvesting usually begins after 15 Sept. and may continue into January. Delayed harvesting results in natural fruit drying, reducing the fossil fuel energy consumed in artificial drying. Delayed harvest also spreads out the demand for harvesting labor and reduces capital costs for processing and harvesting equipment. Few quantative data are available on yield and quality effects of delayed harvest in arid climates. Leyendecker (4) reported molds proliferated in pods following a hard freeze, which adversely affected quality of New Mexico chile. Palevitch et al. (6), working in Israel, reported that dry fruit yields were not affected by delaying harvest 28 days, and the color intensity increased during late-summer field drying. However, Kanner et al. (2) showed that color of stored powder deteriorated more rapidly when produced from fruits allowed to dry on the plant. In New Mexico, it commonly is assumed that yield and quality decline as harvest is delayed after pod maturity. This report summarizes data collected over 3 years at 2 locations to determine effects of harvesting date on dry red fruit yields and color.

Uniform stands with mature plants were selected at 2 sites in southern New Mexico (Las Cruces and Roswell). For experiments conducted in Las Cruces, harvested plots of 'New Mexico No. 6–4' or 'NuMex R. Naky' consisted of a single row, 1.01 m wide and 3.1 m long. At Roswell, plots were established in fields planted with 'California Mild'. The plots were 1.01 m wide and 0.92 or 1.0 m long in 1980 and 1981, respectively. Cultural management procedures were normal commercial practices.

All fully red, nonblemished pods were harvested from the plants by the same person

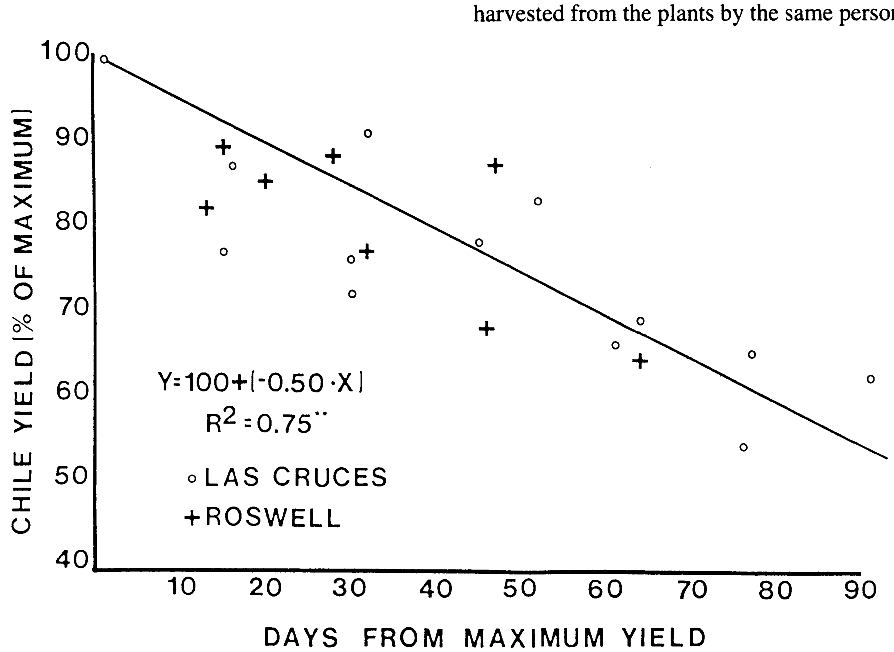

Fig. 1. The regression of delayed harvest on percentage of maximum dry red chile yield for 6 tests conducted at 2 locations over 3 years.

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Table 1. Effect of harvest date on yield, pod number, and mean pod weight of mature dry red chile in Las Cruces, N.M. ('New Mexico No. 6-4' planted 22 Apr. 1980). Treatments were replicated 3 times.

Harvest dates 1980	Marketable yields[z] (MT/ha)	No. pods/[z] 3.1 m row	Mean pod wt (g)
20 Oct.	2.5	116	7.5
20 Nov.	1.8	87	7.4
20 Jan.	1.6	77	7.2
Significance (linear)[y]	**	**	NS

[z]Correlation coefficient between number of pods and yield = 0.97**.
[y]Significant at 1% level (**) or nonsignificant (NS).

Table 2. Effect of harvest dates on yield, pod number, mean pod weight, and color of mature dry red chile in Las Cruces, N.M. ('New Mexico No. 6-4' planted 19 Mar. 1981). Treatments were replicated 3 times.

Harvest dates (1981–1982)	Marketable yields[z] (MT/ha)	No. pods/[z] 3.1 m	Mean pod wt (g)	Color[y] (ASTA)
15 Oct.	4.7	196	7.2	53
1 Nov.	5.2	231	6.7	82
15 Nov.	4.0	151	8.3	73
1 Dec.	4.0	186	6.3	56
15 Dec.	4.1	176	7.0	109
1 Jan.	3.5	150	7.0	83
15 Jan.	2.9	134	6.5	80
1 Feb.	2.9	120	7.2	72
Significance[x]				
Linear	**	**	NS	NS
Quadratic				**

[z]Correlation coefficient between number of pods and yield = 0.80**.
[y]Analysis conducted after 1 Feb. for all samples.
[x]Significant at 1% level (**) or nonsignificant (NS).

Table 3. Effect of harvest date and cultivar on yield, fruit number, mean pod weight, and color of mature dry red chile in Las Cruces, N.M. (planted 16 Mar. 1982). Treatments were replicated 3 times.

	Marketable yields (MT/ha)[z]			No. pods/3.1 m row				
Harvest dates (1982–1983)	'NM No. 6-4'	'NuMex R. Naky'	Mean	'NM No. 6-4'	'NuMex R. Naky'	Mean	Mean pod wt (g)[y]	Color (ASTA)[x]
15 Oct.	3.7	3.1	3.4	138	128	133	7.7	88 b
1 Nov.	3.5	2.6	3.1	138	104	121	7.4	128 a
16 Nov.	3.4	2.9	3.2	138	128	133	7.0	105 ab
6 Dec.	3.2	2.6	2.9	127	100	114	7.2	122 a
16 Dec.	1.9	2.5	2.2	81	110	96	7.1	119 a
1 Jan.	2.1	2.4	2.3	80	102	91	7.5	129 a
Mean	3.0	2.7		117	112			
Significance[w]								
Harvest date			L**			L*	NS	**
Cultivar	NS			NS			*	NS
Interaction	L**			L**			NS	NS

[z]Correlation coefficient between number of pods and yield = 0.95**.
[y]Mean pod weight for 'N.M. No. 6-4' was 7.5 g and 'NuMex R. Naky' was 7.1 g.
[x]Cultivar analysis conducted after 1 Jan. 1983.
[w]Significant at 1% (**), 5% (*), or nonsignificant (NS); L = linear.

Table 4. Effect of harvest date on yield, pod number, and mean pod weight of mature dry red chile ('California Mild') planted at 2 locations in Roswell, N.M., 1980. Treatments were replicated 6 times.

	Location L[z] (planted 20 March)			Location K[z] (planted 1 Apr.)		
Harvest dates 1980	Marketable yields (MT/ha)	No. pods/ 0.92 m	Mean pod wt (g)	Marketable yields (MT/ha)	No. pods/ 0.92 m	Mean pod wt (g)
15 Oct.	3.1	49	5.4	1.9	31	5.5
5 Nov.	2.7	43	5.4	2.0	37	4.7
1 Dec.	2.2	40	4.7	1.7	34	4.3
18 Dec.	2.2	37	5.0	1.6	31	4.4
Significance[y]		NS		NS	NS	
Linear	*		*			**

[z]Correlation coefficient between number of pods and yield: Location L = 0.94**; Location K = 0.93**.
[y]Values were significant at 1% (**), 5% (*) or nonsignificant (NS).

at each location within each year, dried at 60° to 65°C, and weighed. Detached, acceptable red pods also were gathered off the ground at Roswell, and included in the yield determination. Carotenoid color analysis was conducted on a sample after the last harvest according to the American Spice Trade Association (ASTA) official method and was reported in ASTA units (5).

Yields declined from a maximum in October or early November at all test sites, and these declines were significant in 4 of the 5 locations (Tables 1–5). Significant correlation coefficients between yields and pod numbers show that most of the variation in dry yield (64% to 94%) is accounted for by the number of marketable pods harvested from plants. If marketable, detached pods were collected and weighed (as was done at Roswell). Yields still declined, but losses were not as large (Tables 4, 5). Significant decreases in the average pod weight also occurred in these tests (Tables 4, 5) — possibly the result of weight losses of detached pods, a difference in cultivar response, or both. The regression of delayed harvest (in days) on percentage of the maximum yield in all years and locations showed a highly significant linear decline, which accounted for almost 75% of the yield variation (Fig. 1).

The number of pods harvested on the plants during the fall and winter of 1982–1983 was affected differentially by cultivar, which, in turn, similarly affected dry red yields (Table 3).

Weather and cultural factors also can influence fruit drying. An early, hard freeze ruptures cells of succulent fruit. The cell contents then accumulate in the pod tip, creating a favorable environment for microorganisms. The contaminated fruit ferment (2). Such damage in these tests was most apparent at location K (Roswell) in 1980 (Table 4) where the grower apparently overfertilized with N, causing late maturity and relatively low yield. The maturing, succulent fruits were damaged severely by a hard freeze. Compaction during bulk handling from field to drier causes additional yield losses when liquid cell contents leak. The procedures in this test did not evaluate this source of yield loss.

The effects of harvest date on extractable color were inconclusive (Tables 2, 3, 5). Processors report that highest color usually occurs before a freeze when the maximum number of pods have matured. Generally, processors consider a product with an ASTA value of 120 or more as acceptable in color. The results show a wide difference in color between years, but the color of late-harvested pods was normally equal to or better than that from early-harvested fruit. This effect could be caused by the harvesting procedures, where only well-mature, uniformly red fruit were selected for harvest, or because the analyses were conducted on all samples after the final harvest, or both. If color degradation is involved, it would have to be more extensive on stored whole pods compared to fruit weathered in the field. This finding was unexpected. Others report a color

Table 5. Effect of harvest date on yield, pod number, and mean pod weight of mature dry red chile ('California Mild') at location H in Roswell, N.M., 1981. Treatments were replicated 8 times.

Harvest dates 1981	Marketable yields[z] (MT/ha)	No. pods[z] 1.0 m.	Mean pod wt (g)	Color[y] (ASTA)
15 Oct.	3.8	55.0	6.6	120
30 Oct.	3.5	52.1	6.4	113
13 Nov.	3.4	56.7	5.7	117
1 Dec.	3.4	53.4	6.1	128
Significance (linear)[x]	NS	NS	**	NS

[z]Correlation coefficient between number of pods and yield = 0.91**.
[y]Analysis conducted after 1 Dec. 1981.
[x]Significant at 1% level (**) or nonsignificant (NS).

loss with stored dried powder (1, 2, 3), and it is possible the color in whole pods similarly degrades in storage. No definite reason for the difference is suggested.

The results support the conclusion that yields are reduced linearly by 0.5% per day as harvest is delayed past early November. vember. Delayed harvest did not alter color under the conditions of these tests. A producer would be able to reduce losses from late harvests by gathering all red pods, including those on the ground, a practice which is only partially achievable under commercial circumstances.

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Response of Shore Juniper To Ozone Alone and in Mixture with Sulfur Dioxide and Nitrogen Dioxide

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Abstract **A single 4 hour exposure of shore juniper, *Juniperus conferta* Parl., to 0.3 ppm O_3, alone or in combination with 0.15 ppm nitrogen dioxide and/or sulfur dioxide, produced a significant number of small (<3 mm), elongate, tan foliar lesions 2 to 4 days after exposure. The injury symptoms were not identical to those associated with shore juniper decline.**

Shore junipers, growing in North Carolina often show chlorosis of basal needles, progressing to necrosis and proceeding up the plant stem. The absence of obvious biotic causes of shore juniper decline (SJD) suggested that ozone (O_3) or other atmospheric pollutants may cause or contribute to SJD. The contributions of edaphic parameters to SJD have been reported elsewhere (3).

Conifers generally are less susceptible to O_3 injury than hardwoods (1, 2), and different species of the same genus often do not respond to pollutants in the same way (5, 7). Responses of junipers to O_3 vary (8). Exposures at 0.1 ppm O_3, 6 hr/day for 4 consecutive days in each of 4 weeks followed by an additional week of like exposures at 0.2 ppm caused increased shoot elongation of *J. chinensis* L. 'Pfitzeriana' (Pfitzer juniper) but did not affect shoot elongation of *J. sabina* L. 'Tamariscifolia' (Tamarix juniper). Similar exposures to 0.2 ppm followed by 0.4 ppm O_3 inhibited shoot elongation of Tamarix juniper but not Pfitzer juniper. Neither species developed visible symptoms of injury due to O_3.

Nitrogen dioxide and sulfur SO_2 may act additively or synergistically with O_3 to produce injury to plants (10, 11, 13). Acute exposure often produces visible symptoms on sensitive species (6, 7), whereas chronic exposure under natural or controlled conditions produces changes in growth (6, 8, 9). This study was undertaken to determine if shore juniper is sensitive to acute exposure to O_3 alone and in combination with NO_2 and SO_2.

Cuttings were rooted in sand in the greenhouse. After 1 year, cuttings were transplanted to a 1 soil : 1 sand : 1 peat mixture (by volume) in 10 cm clay pots and were grown outside under shade. Plants began developing new growth about 2 months prior to exposure. One month prior to exposure, plants were moved to a charcoal filtered greenhouse maintained at about 30°C. Plants were 28-months-old at the time of exposure (July).

Shore juniper plants were divided into 3 groups of 32 plants. Each group of 32 plants was exposed separately for one 4-hr period to charcoal filtered air, 0.3 ppm O_3, 0.15 ppm NO_2, and 0.15 ppm SO_2 alone and in all possible combinations (8 treatments). Each treatment contained an experimental unit of 4 plants. Thus, the experiment involved 96 plants (3 replications, 8 treatments, and 4 plants per treatment). The pollutants were dispensed into continuous stirred tank reactor (CSTR) exposure chambers (4) located in a charcoal filtered air greenhouse. Ozone was generated by electrical discharge in dry oxygen. Nitrogen dioxide and SO_2 were supplied from separate tanks containing 1% of each gas in dry nitrogen. Ozone and NO_2 concentratons were monitored with chemiluminescence monitors (Monitor Labs, Inc., San Diego, CA 92121) and SO_2 with a flame photometric analyzer (Meloy Laboratories, Inc., Springfield, VA 22151). Gas analyzers were calibrated using a portable Model 8500 Monitor Labs calibrator. Exposure chambers were monitored continuously during exposure and ranged from 27° to 37°C with a mean of 33°. One week after exposure, visible injury was evaluated by counting the number of lesions. Data were analyzed by ANOVA as a 3 × 2 factorial experiment in a completely randomized design.

There were traces of visible injury on the control plants and plants exposed to NO_2 and/or SO_2. These symptoms did not seem to be

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