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Afterripening and Harvesting Effects on Tabasco Pepper Seed Germination Performance

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Abstract. **Field emergence of Tabasco pepper (*Capsicum frutescens* L.) often requires 10 to 14 days even under optimum conditions. Methods to increase and accelerate Tabasco seed germination were investigated. Seed were extracted from orange and red fruit harvested at 150, 195, and 240 days from transplanting. The influence of fruit maturity on seed germination performance was significant over all harvest times. Seed extracted from red fruit had a significantly greater germination rate and final germination percentage than seed from orange fruit. Germination performance of seed extracted from red fruit harvested 150 days after transplanting was superior to that of seed harvested from orange fruit and to seed harvested later in the growing season. Results indicate that Tabasco seed extracted from red fruit responds favorably to a period of dry afterripening. A 21-day period at 25°C appears to be optimum for improving germination percentage and rate.**

Pepper (*Capsicum annuum* L. and *C. frutescens* L.) seed germination and seedling emergence is often slow and nonuniform even under optimum environmental conditions (1, 3, 11, 13). Days to 50% emergence of 19 cultivars representing four species of *Capsicum* ranged from 14 to 23 days (11). Germination and emergence rate of Tabasco pepper is generally slower than most pepper types (11, 12). Variations in fruit location on the plant (4, 9) and in fruit maturity at seed harvest (2, 11) have been observed to influence seed germination performance.

Early work by Cochran (2) and Odland (8) showed that germination of pepper (*C. annuum*) seed was highest immediately after extraction from the fruit; however, Randle and Honma (11) recently found that seed of some *Capsicum* species exhibit an afterripening requirement that could be satisfied by a period of warm, dry storage. The time required to satisfy the afterripening period at 24°C differed between *Capsicum* species and cultivars.

Pepper sauce producers use many different hot pepper types, but one type commonly processed is Tabasco pepper. Individual processors often supervise crop production for seed to be able to provide growers with a seed source for contract production the following year. Work on Tabasco pepper seed produced under the supervision of the McIlhenny Co. (Avery Island, La.) by Rivas et al. (12) determined seed germination and seedling emergence characteristics over a wide range of temperature. At all temperatures, however, germination of untreated seed was ≤60%. Clearly, this low germination percentage is undesirable. This study was designed, therefore, to investigate the influence of fruit maturity, harvest time, and afterripening on Tabasco pepper seed germination performance.

Tabasco pepper continuously produces flowers and fruit over a 3- to 4-month period in the Gulf Coast area. Orange and red fruit of 'McIlhenny Select' Tabasco were therefore harvested for seed extraction at 150, 195, and 240 days from transplanting in 1984 and 1985. Harvest times were in September, October, and November, and correspond to the time and length of a typical red Tabasco fruit harvest season. Time, as days from transplanting, was used as an index of crop maturity or age. Determination of fruit color at harvest was made by use of the Munsell Standard Color Difference method, where minimum orange = 7.5 YR, 7/12 and minimum red = 10R, 5/16 (7). Fruit color was used as an index of fruit maturity during each harvest. Depending on temperature, the change in Tabasco fruit color from pure orange to pure red will require from 4 to 8 days. Immediately following harvests, pure orange and pure red fruit were macerated carefully by hand to avoid damaging seed coats and placed separately in dilute HCl (1:20) for 5 min at 25°C to facilitate separation of seed from placental tissue and to disinfect seed coats. Seeds were then rinsed of acid and debris with copious amounts of running water, followed with a final distilled water rinse. Seeds from red and orange fruit were patted dry between paper towels (sur-

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Table 1. Effect of fruit maturity and harvest time of 21-day afterripened Tabasco seed on germination percentage, mean rate of germination (MRG), and germination performance index (GPI) over 2 years.

Fruit maturity (color)[z]	Harvest (days after transplanting) 150	195	240
		Germination (%)	
orange	52 cd[y]	54 cd	48 d
red	81 a	69 b	63 bc
		MRG	
oranage	11.3 bc	11.5 bc	13.0 c
red	8.1 a	9.9 ab	8.8 a
		GPI (germination %/MRG)	
orange	4.6 c	4.1 c	4.1 c
red	10.0 a	7.2 b	7.5 b

[z]Color determination of pure orange and red fruit made with the Munsell System of Color Notation (7).
[y]Mean separation within germination variable by Duncan's multiple range test, $P = 5\%$.

Table 2. The effect of length of afterripening period at 25°C on germination percentage, mean rate of germination (MRG), and germination performance index (GPI) of seed extracted from pure red Tabasco fruit 150 and 240 days after transplanting in 1985.[z]

Afterripening period (days)	Germination (%)	MRG (days)	GPI (germination %/MRG)
	150 days after transplating		
0	57	7.0	8.0
7	64	7.6	8.2
14	70	7.1	9.8
21	86	6.9	12.7
28	80	6.9	11.5
Contrasts			
0 vs. 7, 14, 21, 28	**	NS	**
7 and 14 vs. 21 and 28	**	**	**
21 vs. 28	NS	NS	NS
	240 days after transplanting		
0	32	7.1	5.1
7	40	7.8	5.2
14	46	7.5	6.1
21	64	6.9	9.3
28	59	7.0	8.5
Contrasts			
0 vs. 7, 14, 21, 28	**	NS	**
7 and 14 vs. 21 and 28	**	**	**
21 vs. 28	NS	NS	NS

[z]Seed moisture at start of afterripening period was 34% and stabilized at 21 days at 6.9%.
NS,**Nonsignificant and significant at the 0.01% level, respectively.

Table 3. The effect of length of afterripening period at 25°C on germination percentage, mean rate of germination (MRG), and germination performance index (GPI) of seed extracted from pure orange Tabasco fruit 150 and 240 days after transplanting in 1985.[z]

Afterripening period (days)	Germination (%)	MRG (days)	GPI (germination %/MRG)
	150 days after transplanting		
0	42	10.6	4.0
7	31	11.1	2.8
14	38	10.4	3.6
21	34	10.8	3.2
28	36	10.2	3.1
Contrast			
0 vs. 7, 14, 21, 28	NS	NS	NS
7 and 14 vs. 21 and 28	NS	NS	NS
21 vs. 28	NS	NS	NS
	240 days after transplanting		
0	28	9.2	3.0
7	28	9.6	2.9
14	34	9.4	3.6
21	50	9.0	5.7
28	29	9.5	3.1
Contrasts			
0 vs. 7, 14, 21, 28	*	NS	NS
7 and 14 vs. 21 and 28	**	NS	**
21 vs. 28	**	NS	**

[z]Seed moisture at start of afterripening period was 37% and stabilized at 21 days at 6.9%.
NS,*,**Nonsignificant and significnt at the 0.05% and 0.01% levels, respectively.

face-dried) and placed in petri dishes on moistened filter paper in incubators in the dark at 25°C for germination tests (12); or placed two to three seeds deep on paper towels on trays in incubators in the dark at 25° for the initiation of afterripening periods. A temperature of 25° was chosen for all germination tests based on the work of Rivas et al. (12). Every 7 days thereafter, for a 28-day period, 400 seeds were removed from seed undergoing afterripening, and germination tests were conducted. All germination tests consisted of eight replicates of 50 seeds each placed in 9-cm petri dishes on one layer of Whatman #2 filter paper moistened with 4-ml of distilled water. Germination counts were performed daily under light during the 21-day incubation period, and a seed was considered to have germinated at first sign of radicle protrusion through the seed coat. Seed moisture was determined prior to germination tests as percent dry weight. Germination percentage and mean rate of germination (MRG), the mean number of days for radicle emergence, were calculated as in Rivas et al. (12). In addition, a germination performance index (GPI) also was calculated in a manner similar to Melville et al. (6) and Pill and Fieldhouse (10) to integrate both rate of germination and total germination.

$$MRG = \frac{\Sigma T_n N_n}{\Sigma N_n} \text{ and}$$

$$GPI = \frac{\text{germination percentage}}{MRG}$$

where T_n = day and N_n = number of seed germinated on T_n. The greater the GPI value, the greater the seed germination performance. An analysis of variance was performed and treatment differences were tested by mean separation and single degree of freedom contrasts.

Fruit maturity effects on Tabasco seed germination performance were significant over all harvest dates (Table 1). As found by others (2, 11), seeds extracted from red-ripe pepper fruit had a faster germination rate than seeds extracted from less-mature fruit. Contrary to other work (11) with pepper, however, seeds extracted from immature orange Tabasco fruit not only germinated at a slower rate, but also less completely. In all harvests, performance of seeds extracted from red-ripe fruit was superior to that of seeds from orange fruit.

Tabasco fruit harvest in the Gulf Coast area normally begins in early September (150 days after transplanting) when about 50% of the fruit on the plant achieves pure red color. It is at this time that fruit should be harvested for seed extraction to realize optimum germination peformance (Table 1). As the season progresses, performance of seeds extracted from red fruit decreases. There were no significant differences in seed dry weights between different harvests (data not shown). Possibly because Tabasco fruits so heavily for such a long harvest season, depletion of available soil nutrients late in the growing season may be adversely affecting subse-

Table 4. Effect of afterripening for 21 days at 25°C on commercially produced[z] Tabasco seed germination percentage, mean rate of germination (MRG), and germination performance index (GPI).

Treatment	Germination (%)	MRG (days)	GPI (germination %/MRG)
No afterripening	58	8.9	6.4
Afterripening	94	7.1	13.2
$LSD_{0.05}$	8.0	0.5	1.1

[z]Exact harvest time of this 1985 seed lot unknown.

quent seed performance (5, 9). Performance of seeds extracted from orange, immature fruit, however, was not significantly influenced by harvest date. Germination percentage, rate, and performance index were not affected by harvest, and at all times were significantly poorer than performance of seeds from red fruit. Mean dry weights of 100 seeds extracted from orange and red fruit were 0.40 and 0.43 g, respectively, and suggest that differences in cotyledonary and endospermic food reserves do not account for seed performance differences.

The effect of the length of an afterripening period at 25°C on performance of Tabasco seeds extracted from red fruit at 150 and 240 days after transplanting is presented in Table 2. Afterripening response of seeds harvested from orange and red fruit at 195 and 240 days after transplanting was similar; consequently, only data of the 150- and 240-day harvests are presented for comparison in Tables 2 and 3. At time of extraction from red fruit, seed moisture was 34%. During the afterripening period, seed moisture decreased to 9.5%, 8.9%, and 6.9% at 7, 14, and 21 days following extraction, respectively. Moisture of seed extracted from orange fruit was initially 37%, and decreased to 6.9% 21 days following extraction in a manner similar to seed from red fruit. Randle and Honma (11) evaluated two cultivars of *C. frutescens* and observed that germination rate of both cultivars was stimulated by either a 2- or 4-week period of afterripening at 24°. The origins of the seeds tested in their work was Brazil and Columbia. The origin of 'McIlhenny Select' Tabasco pepper seed tested in this study is believed to be Mexico. Data in Table 2 indicate that a 21-day period of afterripening at 25° is optimum for stimulation of germination performance of seeds from red fruit, regardless of harvest. Germination percentages of seeds extracted from red fruit harvested 240 days after transplanting were about 20% lower than seeds harvested at 150 days. There was no apparent difference in seed germination rate between different harvests.

Afterripening effects on seeds extracted from orange fruit differed little, with the exception of a 21-day treatment effect on the seed germination percentage of seeds harvested 240 days after transplanting (Table 3). Although germination percentage appeared to be stimulated, there was not a significant afterripening treatment difference in the germination performance index. The data therefore indicate that seeds extracted from immature Tabasco fruit not only possess low germination performance characteristics (2, 11), but also do not respond significantly to afterripening treatment.

Tabasco pepper producers will generally select red-ripe fruit for seed extraction late (±240 days after transplanting) in the harvest season, immediately prior to first expected frost. The response of commercially produced Tabasco seed to a 21-day afterripening period on paper towels in the dark in incubators at 25°C is presented in Table 4. This seed lot was extracted from pure red fruit and was allowed to dry in a pepper sauce processing plant for 2 to 3 days, at ≈60–70% RH and 20° to 25° day and 10° to 15° night temperatures. The exact harvest date of the seed is unknown. As a result of afterripening treatment, germination percentage, rate, and performance were all significantly improved. Data from this study indicate that, regardless of time of seed harvest, Tabasco pepper seeds extracted from red fruit respond favorably to a 21-day afterripening period at 25°.

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