GERMINATION STUDIES WITH CELERY SEED

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Abstract. **Studies on the uniformity and speed of germination of celery seed were conducted in greenhouse and growth chambers. Seeds of 'Florida 2-14' obtained from the outer three rings of the flowering umbel had higher germination and velocity coefficient than seeds from the inner two rings. Germination velocity coefficients of 'Florida 2-14' and 'Florida 683' increased progressively as the density and the diameter of the seeds increased. The germination velocity of the seed was also increased by eight cycles of wetting with water and drying. Specific seed soaking treatments of NaOCl, ethephon, coconut milk and an isotonic solution also resulted in increased germination velocity coefficients. Soaking treatments using 6-furfurylamino purine resulted in increased germination and greater velocity coefficient under conditions of high surface daytime temperature (50° C) and soluble salt concentration on the soil surface in excess of 10,000 ppm.**

Celery growers are seeking procedures of plant production which can result in greater mechanization and subsequent lowering of labor costs. The success of such increased mechanization would be abetted by higher and more uniform germination of celery seed than presently observed. The emergence of celery seedlings may span a period of several weeks and this spread in time results in poor uniformity and stunting of late-emerging plants. Previous studies with vegetable seed germination have indicated that there are methods which have induced more uniformity. It was the purpose of this study to apply some of these procedures to celery seeds. Previous tests have indicated that larger seed size (2) and greater density (4) of many vegetable seeds result in higher germination. The carrot, an Umbelliferae as celery, has its seed germination response affected by the location of the seed on the inflorescence (6). Soaking of celery seed has been noted to accelerate germination and a series of soaking and drying cycles, 'hardening', has benefited germination (3). An addition of growth regulators to a soaking solution has stimulated germination with some vegetables. These include cytokinin, as found in coconut milk (10); a kinetin, 6-furfurylamino purine (8) and ethephon (1). Reports have also indicated that increased germination of vegetable seeds have been enhanced by solutions of sodium hypochlorite (NaOCl) (9) or soaking in hypertonic solutions (KNO_3 and K_3PO_4) (5).

Materials and Methods

A series of laboratory and greenhouse experiments were conducted at Gainesville, Florida, in 1972 to study the effect of several handling procedures or treatments on the development of celery seed. Basic data obtained included total germination percentages and the germination velocity coefficient, the latter calculated by the formula suggested by Kotowski (7).

$C = 100)\ A_1 + A_2 + \ldots . A_n / A_1T_1A_2T_2 \ldots . A_nT_n$

C = coefficient of germination
A = number of seedlings picked out.
T = number of days after planting, corresponding to A

The higher the value derived using this formula the faster the rate of germination.

Medias used in the germination tests were either muck, a modified Cornell mixture composed of equal parts peat and vermiculite, or two layers of Whatman No. 2 filter paper. In all experiments, seeds were germinated using a randomized block design of four replications. Germination counts were initiated 6-9 days after planting and continued until further germination increases were negligible. Total germination percentages were subjected to arcsin transformation before statistical analysis.

Seeds of 'Florida 2-14' were used in all tests with seeds of 'Florida 683' being also used in several experiments.

Test 1: Germination tests were conducted in the greenhouse at 15-25°C using a modified Cornell mixture with 'Florida 2-14' celery seed from five distinct rings of the umbel of five plants collected in seed fields in California.

Test 2: Seeds of both cultivars were separated into 4 density groups using sucrose solutions of

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known specific gravity. These specific gravity groups were as follows: A—less than 1.229; B—1.228-1.378; C—1.379-1.472; D—greater than 1.473. The seeds were germinated on a media of muck in flats at 20° ±1° C.

Test 4: Seeds of both cultivars were subjected to treatments consisting of from five to eight cycles of hardening. A hardening cycle consisted of soaking for 24 hours in distilled water followed by 24 hours of air drying. All treated seeds at the end of the hardening treatments were air dried to their original weight and then germinated on filter paper at 20° ±1° C.

Test 5: A series of tests were conducted with 'Florida 2-14' celery seed in which the seeds were soaked in several growth regulating solutions. These included 1.05 and 5.25% NaOCl solutions for a two-hour soak; aerated coconut milk at concentrations of 10 and 100 percent for 24 hours combined with a study of vacuum infiltration; and the soaking for six days in an aerated hypertonic solution of one percent potassium nitrate and one percent tribasic potassium phosphate. In the latter tests, additional treatments tested the renewal of the hypertonic solution or the check of distilled water after the first day of soaking.

Test 6: A concentration of 40 ppm of cytokinin, 6-furfurylamino purine, (Kinetin) was used to treat seed for 0, 5, 10 minutes respectively in combination with an additional one-minute soak of an ethylene generator (2, chloroethyl) prosphonic acid (ethephon) at 0, 10, 100, or 1,000 ppm. All samples were soaked in distilled water or solution for a total of 71 minutes. Seeds were sown using a modified Cornell mixture as a planting media in a greenhouse whose temperatures ranged from 27° C at night to 50° C during the day.

Results and Discussion

The location of the seed in the umbel of the celery plant influenced the subsequent germination (Table 1). The older seed had higher germination percentages and greater germination velocity coefficients. The time difference in the development of seed from the outer ring (Number one) and the inner ring is approximately two months and thus the germination differences noted in this test between rings are presumed to be due to maturity. The bulk of a seed lot harvested under commercial practice would be from ring two and three, and those in the outer or older ring often shatter and are lost.

Celery seed of a diameter greater than 0.800 mm of both 'Florida 2-14' and 'Florida 683' had a higher total germination percentage and speed of germination than seed of a diameter from 0.577 to 0.703 mm (Table 2). However, more than 50 percent of the total weight of seed from each cultivar was found in the size range of 0.577 to 0.703 mm and it would not be practical to discard this large quantity of seed.

Table 1. Total germination percentages and germination velocity coefficients of 'Fla 2-14' celery seed as affected by umbel ring location.[z]

Umbel ring[y]	Total germination percentage	Germination velocity coefficient
1	93.3 a	8.9 a
2	88.8 a	9.1 a
3	88.2 a	8.6 ab
4	73.2 b	7.6 b
5	21.4 c	4.3 c

[z]Mean separation between averages by Duncan's multiple range test, 5% level.

[y]Older seed found in ring 1.

No differences in germination percentages were found as a result of density of seed; however, the heavier seed with a specific gravity of 1.379 or higher had an increase in the germination velocity coefficient compared to those seed with a specific gravity of less than 1.229.

The effect of hardening celery seed by the use of alternating cycles of wetting and drying was found to effect the germination velocity as found with carrots by Austin *et. al.* (3). The use of eight cycles was found to increase the speed of germination with both cultivars of celery as shown in Table 3 when compared to no hardening treatment or only five or six cycles. Seeds of 'Florida 683' and 'Florida 2-14' celery treated with eight cycles began germination respectively on the second and third day after planting.

The soaking of the celery seed for two hours in 1.50% NaOCl resulted in a germination veloc-

Table 2. The effect of seed diameter on the total germination percentage and the germination velocity coefficient of 'Florida 2-14' and 'Florida 683' celery seed.[z]

Seed diameter mm	Total germination percentages		Germination velocity coefficients	
	'Fla 2-14'	'Fla 683'	'Fla 2-14'	'Fla 683
0.800 +	90.3 a	89.4 a	12.1 a	15.1 a
0.704-0.799	89.0 a	87.1 ab	11.6 b	15.0 a
0.577-0.703	84.4 b	81.5 b	10.5 c	13.7 b
0.499-0.576	-	65.6 c	-	12.5 c
Unsized	84.8 b	82.5 b	10.6 c	13.4 b

[z]Mean separation between averages by Duncan's multiple range test, 5% level.

ity coefficient of 13.5 as compared to 11.9 for seed soaked in distilled water. This is similar to the results reported by Taylor (9) in 1949. A concentration of 5.25% NaOCl was found to be detrimental to germination.

The soaking of seed in coconut milk was effective in increasing the germination velocity only at 100% concentration combined with the use of vacuum infiltration. The use of a vacuum had been suggested as a technique to stimulate seed germination as the seeds would be more uniformily immersed.

Soaking the seed in an aerated hypertonic solution consisting of 1% KNO_3 and 1% K_3PO_4 for six days did not result in increased germination of celery seed when compared to untreated dry seed; however, the germination velocity coefficient was increased to 11.03 from 8.65. Such an increase in speed of germination is similar to reports by other researchers with hypertonic solutions (5).

The media used for the test using several concentrations of ethephon combined with varying lengths of soaking with 40 ppm kinetin was found to have a soluble salt concentration in the surface ¼ inch of over 10,000 ppm. The results under this high soluble salt level and high temperatures are shown in Table 4. Ethephon was not effective in increasing the germination velocity coefficient; however, an interaction of ethephon with kinetin

Table 3. The effect of five to eight hardening cycles upon the germination velocity coefficient of 'Fla 2-14' and 'Fla 683' celery seed.

No. of hardening cycles	Germination velocity coefficient	
	'Fla 2-14'	'Fla 683'
0	11.9 c[z]	14.9 c
5	21.4 b	23.7 b
6	21.3 b	25.1 b
7	23.6 ab	26.2 b
8	26.8 a	29.7 a

[z]Mean separation between averages by Duncan's multiple range test, 5% level.

Table 4. The effect of kinetin and ethephon soaks on the germination velocity coefficients of 'Fla 2-14' celery seed.[z]

Kinetin Minutes in soak	Ethephon ppm				
	0	10	100	1,000	Ave
0	5.6	5.8	6.1	5.7	5.8
5	6.3	5.6	6.4	6.3	6.2
10	5.8	6.5	5.7	5.9	6.2
Average	6.2	6.0	6.1	5.9	

[z]Interaction kinetin x ethephon significant at 1% level.
Main effects not significant.

was noted. An increase in the germination velocity coefficient was obtained using a 10-minute soak of kinetin if less than 100 ppm of ethephon was used. Higher concentrations of ethephon under the conditions of high soil surface daytime temperatures of 50° C and concentrations of soluble salts over 1,000 ppm in combination with kinetin were not beneficial.

Literature Cited

1. Abeles, F. B. and J. Lonski. 1969. Stimulation of lettuce seed germination by ethylene. **Plant Physiology** 44:277-280.
2. Alam, Z. and S. J. Locascio. 1965. Effect of seed size and depth of planting on broccoli and beans. **Proc. Fla. State Hort. Soc.** 78:107-112.
3. Austin, R. B., P. C. Longden and J. Hutchinson. 1969. Some effects of hardening carrot seed. **Ann. Bot.** 33:883-895.
4. Clark, V. A. 1903. Seed selection according to specific gravity. **Proc. Amer. Soc. Hort. Sci.** 1:40-41.
5. Harrington, J. E. 1968. Factors affecting seed environment. **Veg. Crop Management.** Jan. 1968: 6-10.
6. Hawthorn, L. R., E. H. Toole and V. K. Toole. 1962. Yield and viability of carrot seeds as affected by the position of the umbel and the time of harvest. **Proc. Amer. Soc. Hort. Sci.** 80:401-407.
7. Kotowski, F. 1926. Temperature relation to germination of vegetable seed. **Proc. Amer. Soc. Hort. Sci.** 23:176-184.
8. Smith, O. E., W. L. Yen and J. M. Lyons. 1968. The effect of kinetin in overcoming high-temperature dormancy of lettuce seed. **Proc. Amer. Soc. Hort. Sci.** 93:444-453.
9. Taylor, C. A. 1949. Some factors affecting germination of celery seed. **Plant Physiology** 24:93-102.
10. Van Overbeck, J., M. E. Conklin and A. F. Blakesler. 1941. Factors in coconut milk essential for growth and development of very young datura embryo. **Science** 94:350-351.

PLANTING AND THINNING SYSTEMS FOR 'FLORIDA SWEET', AN sh_2 SUGAR RETENTION SWEET CORN HYBRID

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Abstract. **'Florida Sweet' carries the high quality sh_2 sugar retention factor and the tendency to produce lower stands than regular sweet corn (su_1). Sweet corn closely seeded and thinned by hand produces better plant populations and yields than when planted to final stand (no thinning). Cost and scarcity of labor for hand thinning made it imperative to investigate other methods of thinnning. 'Florida Sweet' can be thinned satisfactorily with the John Deere electronic thinner. Best spacing and plant stand were obtained with 2 to 3.5 inches seed spacing when the plants were 2 inches tall and the cutting knife was 6 inches long. The performance of the electronic thinner was equally good when seeding with the John Deere plateless or the International cyclone seeder with 2.5 and 3.5-inch seed spacing, respectively. Thinning speed was 1 to 1.2 mph.**

'Florida Sweet', a hybrid sweet corn for fresh market carries a high sugar retention factor, shrunken 2 (sh_2), which differs from regular sweet corn (su_1). This new cultivar maintains its high eating quality and fresh appearance for much longer storage periods than regular sweet corn. This quality is very desirable for sweet corn grown for distant markets. However, seeds with sh_2 are low in starch content in the endosperm, resulting in smaller, more wrinkled seed than regular sweet corn. The relatively low reserve food supply in the seed plus susceptibility to seedling root rots may result in lower germination and stand. Therefore, measures should be developed to assure yields comparable to those from normal sweet corn when planting to stand (no thinning). This investigation was initiated in the spring of 1972 to find methods or systems to help insure good stands of 'Florida Sweet'.

Guzman and Kahl (3) found that drilling seeds of 'Iobelle' and 'Gold Cup', standard sweet corn hybrids, 4 inches apart and thinned (8- to 10-inches apart) improved yields over the "planted to final stand" treatment (8-10 inches). Yield increase was more than sufficient to overcome the cost of hand thinning. Guzman (1) compared sweet corn hybrids and found that 'Florida Sweet' ('EES 279') produced 221 and 'Iobelle' (check) 222 crates per acre in the spring of 1970 under conditions of heavy rainfall. During the spring of 1969, 'Florida Sweet' yielded 290, 'Illinichief Extra Sweet' (also containing the sh_2 gene) 250 and 'Iobelle' 355 crates per acre. The relatively high yields in these tests were due in part to planting two to three seeds every eight inches and thinning

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