for control of difficult to control winter annuals like Carolina geranium, especially if appied with a shielded sprayer.

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SEED ORIENTATION, SEED QUALITY AND THEIR EFFECT ON EMERGENCE AND SEX EXPRESSION IN CUCUMBER[1]

D. J. CANTLIFFE
Vegetable Crops Department, IFAS, University of Florida, Gainesville, FL 32611

Additional index words. Cucumis sativus, pickling cucumber, slicing cucumber, plant growth, female flowering.

Abstract. **In order to determine the effects of seed storage on sex expression in cucumber (Cucumis sativus L.), seeds were aged at high temperature and humidity. This led to a reduction in seed vigor and an alteration of sex expression in a gyneocious hybrid cultivar. More male flowers reached anthesis on this cultivar aged under stressful conditions for 15 days or more and fewer females reached anthesis on plants derived from seed aged for 90 days. Seed storage stress had no effect on sex expression in a gyneocious breeding line, even after 90 days. Cucumber seeds were placed with radicle ends at different angles with respect to gravity to determine the effect of seed placement on germination on paper towls and emergence in soil. Placement had little effect on germination or emergence but horizontal or upper vertical placement led to the greatest seedling vigor. The results clearly show the need for proper seed storage conditions and precision seed placement to insure high quality seeds and rapid seedling development for potentially optimum yield in cucumbers.**

Commercial production of cucumbers has depended more on the use of hybrid female cultivars in recent years in the production scheme. Many of these cultivars do not produce all female flowers, and under the stressful conditions of Florida's spring and fall crops, the hybrids may have a profuse male flowering habit.

Many factors are known to influence sex expression in cucumber. These include light intensity (1), temperature (2), photoperiod (3, 5), and conditions which might lead to early loss of cotyledonary tissue. Generally, any condition which leads to stress on early plant growth can result in a shift of the predominately female flowering habit to a male flowering pattern in gynoecious hybrid cucumber cultivars. Thus, in Florida fall plantings of cucumber can be made during August and September when day and night temperatures are extremely high (ie, in excess of 30°C day and 25°C night), and where water stress can be a major problem, especially when subsurface irrigation practices are used.

Other factors can cause reduced seedling growth during early plant development, including soil crusting and poor seed quality. These factors have not been investigated as to their potential effect on alteration of sex expression in cucumber. It was the purpose of the present research to determine what effect reduced seed vigor had on sex expression in cucumber and whether or not seed placement had any influence on early seedling growth rates.

Materials and Methods

Effect of seed aging on germination and seedling growth. Seeds of 'Pioneer' pickling cucumber and its female parent line 'MSU 713-5' were aged by placing them under conditions of high relative humidity and temperature according to the procedures of James (4). The duration of these conditions was varied from 0 to 90 days. After the aging period was completed the seeds were dried at 10°C and 50% relative humidity for 1 week. Germination tests were run on paper towels placed in an incubator at 25°C. Percent germination, radicle length average, and seedling fresh and dry weights were recorded after 7 days.

Effect of seed aging on sex expression. Seeds from each of the 2 cucumber cultivars and 6 aging treatments were planted in 15-cm plastic pots containing a vermiculite-peat (1:1) medium amended with fertilizer and lime. The plants were grown in the greenhouse at approximate temperatures of 25°C day and 20°C night under natural light intensities and photoperiods of 13 hr. At anthesis the male flowers were recorded (node and date) and removed and the female flowers were tagged. This was done for the first 10 nodes. The plants were grown for 60 days, then measured and the plant fresh weights were taken.

Effect of seed placement on germination and seedling growth, laboratory experiment. Slicing cucumber seeds, cv. Poinsett, were placed on germination paper on a drawn horizontal line. The radicle end was placed vertical, horizontal, or at an angle with respect to gravity (see Fig. 1). The papers were moistened with distilled water and then placed vertically in wire trays in an incubator at 25°C. Germination was recorded daily for 7 days after which radicle lengths were measured and fresh and dry weights were taken.

Effect of seed placement on germination and seedling growth, greenhouse experiment. 'Poinsett' seeds were placed as described for the previous experiment, except that the seeds were placed directly in soil in 15 cm pots. The seeds were covered with approximately 1.5 cm of soil and watered. The greenhouse was maintained at 28°C day and 22°C night temperatures. Emergence was counted daily until seeds no longer came up; then the seedlings were cut at the soil surface and fresh and dry weights were taken.

Germination rate index (GRI) and emergence rate index (ERI) were calculated according to previously published procedures (6).

Results and Discussion

Germination of aged 'Pioneer' and 'MSU 713-5' cu-

[1]Florida Agricultural Experiment Stations Journal Series No. 6062.

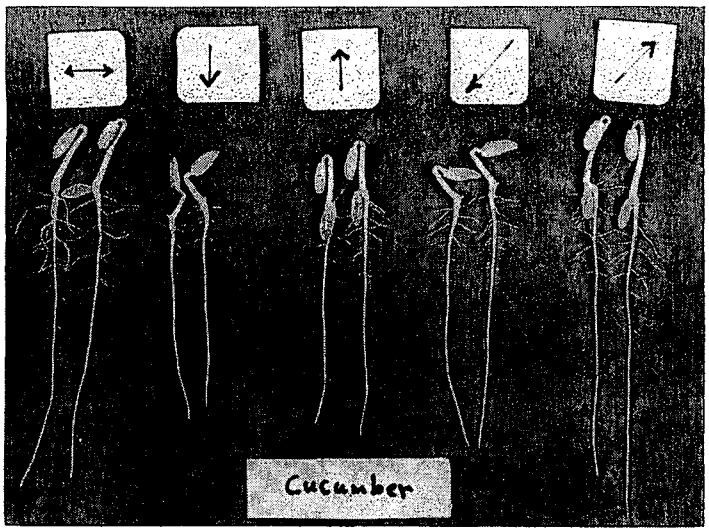

Fig. 1. Seven-day-old cucumber seeds germinated in the incubator at 25°C. Arrow depicts location of the radicle with respect to gravity. Towels were placed vertically in wire baskets in the incubator. Note location of the seed coat after germination.

cumbers were lower than that of nonaged seeds after 90 days of aging (Table 1). Seed vigor as depicted by seedling growth measurements was significantly reduced from nonaged seeds after as little as 15 days of aging. Radicle lengths were affected sooner after aging in 'MSU 713-5' than in 'Pioneer'. Seedling fresh and dry weight data were variable after the different periods of aging but weights were consistently lower than the nonaged seeds in 'Pioneer' after 45 days aging, and in 'MSU 713-5', after 60 days for fresh weights and 90 days for dry weights. Thus, after prolonged accelerated aging seed vigor was reduced before germination (seed vitality) was affected.

When cucumbers were grown in the greenhouse, sex expression and final plant heights and fresh weights were not affected in 'MSU 713-5' by the aging treatments (Table 2). Although usually not significant, the number of days to anthesis of the first female flower was generally delayed by accelerated aging treatments.

In the gynoecious hybrid 'Pioneer', the number of male flowers in the first 10 nodes was increased and the number of female flowers decreased after accelerated aging (Table 3). After 15 days of aging the number of male flowers on these 10 nodes increased from approximately 3 to 9. After 90 days of aging the number of female flowers reaching anthesis decreased from about 10 to 6. The appearance of the first female flower was delayed by 8 days in this same treatment. Plant height of the 'Pioneer' plants over the entire growing period was reduced by most of the seed aging treatments.

Thus, seed accelerated aging treatments reduced seed vigor, which led to reductions in plant growth rates and in alteration of sex expression in hybrid 'Pioneer' cucumbers. Sex expression in the female inbred line 'MSU 713-5' was previously reported to be unaffected by cotyledon removal (2), alteration of light intensity, and only slightly affected by temperature (1), while sex expression in 'Pioneer' was altered considerably by all of these factors. It is apparent that if gynoecious hybrid cucumbers are stressed by conditions which reduce the quality of the seed then sex expression may be adversely affected.

When germinated on paper towels under laboratory conditions germination percentage and germination rate index were unaffected by placement of the radicle end on the paper (Table 4). Radicle lengths were longer on seeds which had radicles placed horizontally or vertically upward with respect to gravity. Fresh and dry weights were variable among treatments.

Total emergence was also not affected by radicle place-

Table 1. Effect of seed aging on germination and vigor of 'Pioneer' and 'MSU 713-5' cucumbers.

Aging time (days)	Germination (%)		Average fresh wt (mg)		Average dry wt (mg)		Average radicle length (cm)	
	Pioneer	MSU	Pioneer	MSU	Pioneer	MSU	Pioneer	MSU
0	97a[z]	80ab	290a	333a	20.2a	23.5a	11.6a	14.8a
7	97a	90a	293a	276a	21.2a	20.4a	12.2a	14.3a
15	90a	63ab	157b	290a	12.5b	24.2a	10.6ab	11.8b
30	83a	73ab	260a	145bc	21.6a	20.9a	7.4abc	8.5c
45	90a	57b	124b	278a	10.0bc	22.5a	9.1ab	9.4c
60	87a	70ab	58c	166b	7.8bc	20.7a	6.3bc	7.3c
90	57b	53b	38c	63c	5.2c	9.7b	3.7c	2.8d

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

Table 2. Effect of seed aging on sex expression and growth of 'MSU 713-5' pickling cucumbers.

Length of aging (days)	No. of flowers to node 10		No. first flowering node		Days to flower		Final ht (cm)	Final fresh wt (g)
	Male	Female	Male	Female	Male	Female		
0	1.0	8.8	2.0	1.5	44	33b[z]	91.5	97.2
7	3.2	7.5	3.5	2.5	44	38ab	99.5	110.5
15	4.5	7.2	1.8	3.5	40	39ab	102.2	101.5
30	0.5	8.8	0.8	3.0	43	38ab	99.0	106.2
45	1.5	9.8	1.5	2.0	44	39ab	109.8	97.8
60	2.0	7.2	1.5	3.0	46	41a	90.5	102.8
90	1.5	8.0	1.2	3.2	46	40ab	103.2	119.2
	NS[y]	NS	NS	NS	NS		NS	NS

[z]Mean separation in columns by Duncan's multiple range test, 5% level.
[y]NS = not significant at the 5% level.

Table 3. Effect of seed aging on sex expression and growth of 'Pioneer' pickling cucumbers.

Length of aging (days)	No. of flowers to node 10		No. first flowering node		Days to flower		Height	Fresh wt
	Male	Female	Male	Female	Male	Female	(cm)	(g)
0	3.2b[z]	9.8a	2.5	3.2ab	43	38cd	127.0a	154.0a
7	4.8ab	9.5a	2.2	1.5b	43	43b	109.5abc	107.8b
15	9.0a	9.2ab	3.0	2.8ab	41	36d	123.8a	148.0a
30	8.8a	7.0ab	3.0	3.0ab	44	40c	114.8ab	108.8b
45	4.8ab	7.8ab	2.5	2.8ab	44	39c	88.5cd	78.5b
60	13.0a	6.2ab	2.0	5.5a	43	43b	97.0bcd	91.0b
90	8.3a	5.7b	3.3	5.0a	47	46a	80.2d	70.7b
			NS[y]		NS			

[z]Mean separation in columns by Duncan's multiple range test, 5% level.
[y]NS = not significant at the 5% level.

Table 4. Effect of seed placement on 'Poinsett' cucumber germination and seedling growth under laboratory conditions.

Radicle end placement[z]	Germination		Weight (g)		Radicle length (cm)
	%	GRI[y]	Fresh	Dry	
→	96	3.7	406ab[x]	21a	15.9ab
→	97	3.6	361b	18b	15.0b
→	98	3.6	403ab	20a	17.0a
↓	98	3.5	406ab	19ab	15.1b
↑	99	3.8	437a	21a	17.1a
	NS[w]	NS			

[z]Head of arrow = radicle end.
[y]Germination rate index.
[x]Mean separation in columns by Duncan's multiple range test, 5% level.
[w]NS = Not significant at the 5% level.

ment in soil with respect to gravity; however, seeds with the radicle end upward had the most rapid rate of emergence (ERI) and the greatest seedling fresh and dry weights (Table 5). Seeds with radicle placement horizontal to gravity had similar high fresh weights.

It was obvious that seed placement in cucumber is extremely important for proper removal of the seed coat (Fig. 1). If the radicle and peg (foot on the radicle with which the seed coat is pried off the cotyledons) are not aligned properly then the seed coat will adhere to the cotyledons during emergence. This ultimately slows down the germination process and can place additional stress on the young seedling especially under dry soil conditions. If seedling growth is retarded other developmental processes such as sex expression might eventually be adversely affected. This latter point needs further research.

Table 5. Effect of seed placement on 'Poinsett' cucumber emergence and seedling growth under greenhouse conditions.

Radicle end placement[z]	Emergence		Weight (%)	
	%	ERI[y]	Fresh	Dry
→	93	4.9b[x]	779b	58bc
→	91	4.5b	776b	53bc
→	92	4.7b	1604a	63b
↓	92	4.1b	939b	46c
↑	98	6.7a	1464a	74a
	NS[w]			

[z]Head of arrow = radicle end.
[y]Emergence rate index.
[x]Mean separation in columns by Duncan's multiple range test, 5% level.
[w]NS = not significant at the 5% level.

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