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The Influence of Abscisic Acid in Cranberry Seed Dormancy[1]

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Abstract. **The germination of non-dormant (light treated) seeds of cranberry, (*Vaccinium macrocarpon* Ait. cv. Early Black) is inhibited by exogenous abscisic acid (ABA). Mechanical scarification enhances this inhibitory influence, almost complete inhibition occurring at 100 ppm ABA. Extracts of dormant seeds also inhibited germination whereas extracts of non-dormant seeds did not. Gas-liquid chromatographic analyses indicate the presence of much higher amounts of ABA in the extracts of dormant seeds compared to non-dormant seeds. These observations suggest that ABA may be a controlling factor in cranberry seed dormancy.**

Cranberry seeds are dormant at harvest and need to be subjected to temps of about 3 to 5°C for at least 60 days before adequate germination is possible (2, 6, 9, 11). However, Devlin and Karczmarczyk (7) have shown that cranberry seeds are photoblastic and will germinate immediately after harvest without a cold treatment if given the proper amount of light. They have also shown that gibberellic acid (GA) can enhance dark germination of chemically scarified cranberry seeds but has only a neglibible effect on unscarified seeds. Their work suggests that the seed coat is a barrier to the uptake of exogenously applied GA.

In the present work the influence of ABA on cranberry seed germination was studied. Our data suggest that ABA may be a controlling factor in cranberry seed germination and that light, and possibly GA, negate its effect.

Seeds from freshly harvested cranberries were soaked for 24 hr in distilled water or in different solutions of ABA. For some of the experiments the seeds were punctured with a fine needle (mechanical scarification) before being soaked. The imbibed seeds were then placed in Petri dishes containing 3 pads of filter paper (Whatman No. 1, 9 cm) and 5 ml of water or ABA solution. When extracts of dormant and non-dormant seeds were used to test their effect on germination they were applied to the seeds in the same manner as the ABA solutions. Each Petri dish held 50 seeds and one of the pads of filter paper was used to cover the seeds. The glass top of the Petri dish was not used. Instead the dishes were sealed in plastic bags to retard evaporation. Constant conditions of light (white, 10.8 klx, and continuous) and temp (25° ± 1°C) were maintained by allowing the seeds to germinate in a Percival growth chamber (Model E-540). Since light in the growth chamber had to penetrate the plastic bag and filter paper pad covering the seeds, only about 4.3 klx actually reached the seeds. After 20 days, germination was recorded. Each experiment was replicated 4 times.

For extraction tests, 5, 15, and 25 g samples of dormant and non-dormant seeds were used. To break dormancy unscarified dry seeds were subjected to 10 days of light (10.8 klx) at 25° ± 1°C. Before being extracted the seeds were ground into a fine powder with a Wiley mill (20 mesh screen). The seed powder was then mixed with 80% acetone and the mixture allowed to stand for 5 days at 5°C. The crude extract was then filtered (Whatman No. 1 filter paper), the acetone evaporated, and the residue redissolved in 45 ml of distilled water. This final preparation was then tested for its effect on seed germination.

The acetone extract of ABA was prepared and analyzed by GLC following the methods (using 3% instead of 5% liquid phases) of Davis et al. (5). A Varian 2700 Moduline was used. The instrument was equipped with a stainless steel column (152 x 0.32 cm) containing 3% QF-1 on 100/120 Varaport 30. The initial temp was 60°C. The linear temp increase was 8° per min and final temp was 230°.

Although seeds from freshly harvested cranberries will not germinate unless exposed to light (7), light-induced germination can be inhibited by ABA (Table 1). The lowest concn used (0.01 ppm) inhibited germination 26%, the highest concn (100 ppm) inhibited 67%. Mechanical scarification before application of ABA enhanced inhibition, almost complete inhibition occurring at 100 ppm (Table 1).

The inhibitory effect of exogenously applied ABA suggested that endogenous ABA may be a factor in cranberry seed germination. Extracts of dormant and non-dormant seeds were therefore tested for their influence on germination, the assumption being that extracts from dormant seeds would contain more ABA and thus have a greater inhibitory effect. Application of the extract from dormant seeds reduced germination, depending on the concn, 25 to 49% in non-scarified seeds and 22 to 64% in scarified seeds (Table 2). However, when seeds were treated with extracts from non-dormant seeds, no significant inhibition was noted even with 25 g equivalents of extract (Table 2).

Table 1. Effect of ABA on the germination of non-scarified and scarified cranberry seeds.

Seed treatment	Germination (%) ABA (ppm) 0	0.01	0.1	1	10	100
Non-scarified	94.0	67.5	63.5	46.5	40.5	27.0
Scarified	89.5	52.5	42.5	39.0	29.5	5.0

LSD, 1% = 11.45.
LSD, 5% = 8.54.

Table 2. Effect of acetone extracts of dormant and non-dormant cranberry seeds on germination of scarified and non-scarified non-dormant seeds.

Source of extract	Concn (g-eq/45 ml)	Germination (%) Non-scarified	Scarified
Dormant seed	0	91.5	81.5
	5	67.0	60.0
	15	57.0	46.0
	25	42.5	17.5
	LSD 4% = 6.1		
	1% = 8.3		
Non-dormant seed	0	93.0	83.0
	5	96.0	82.5
	15	94.5	83.0
	25	93.0	77.5
	LSD 5% = 6.0		
	1% = 8.1		

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GLC analyses of extracts from dormant and non-dormant cranberry seeds indicated that considerably more ABA was present in the dormant seed extract (Fig. 1).

Numerous studies have shown that exogenously applied ABA is a potent inhibitor of seed germination (10, 12, 13). In other studies ABA was found to be naturally present at a high level in dormant seeds and at a much lower level when the same seeds were no longer dormant. For example, Sondheimer et al. (14) determined that high levels of ABA are present in ash seeds prior to stratification and low levels following stratification. In the present study considerably more ABA was found in dormant as compared to non-dormant cranberry seeds. Apparently cranberry seeds immediately following harvest have a high level of ABA, a circumstance that prevents their germination. When exposed to sufficient light ABA concn drops to a non-inhibitory level and germination takes place.

Devlin and Karczmarczyk (7) have shown that exogenously applied GA enhances dark germination of scarified cranberry seeds. The influence of GA in the barley endosperm assay and in the growth of dwarf maize or dwarf peas can be counteracted by exogenously applied ABA (1, 3, 4). The two compounds may be mutually antagonistic. For example, Sondheimer and Galson (13) found that GA antagonizes the inhibitory effect of ABA on the germination of excised ash embryos. Similar results have been obtained with the sprouting of potato buds and with the elongation of genetically tall corn leaf sections (8). Thus it seems entirely possible that the GA enhanced dark germination of cranberry seeds found by Devlin and Karczmarczyk (7) could be due to the applied GA counteracting the inhibitory influence of endogenous ABA.

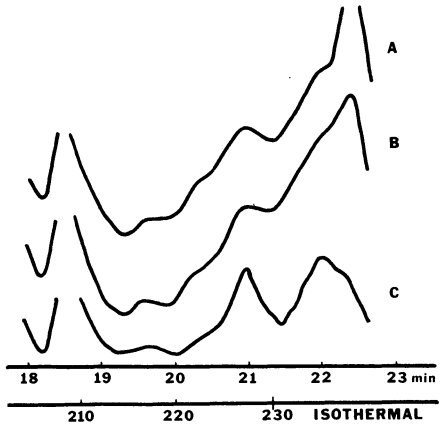

Fig. 1. Gas-chromatographic traces of silylated (TMS) extracts of dormant and non-dormant cranberry seeds. Peaks at the extreme right indicate the presence of ABA. A = Extract of dormant seeds fortified with ABA; B = Extract of dormant seeds; C = Extract of non-dormant seeds.

Literature Cited

1. Addicott, F. T. K. Ohkuma, O. E. Smith, and W. E. Thiessen. 1966. Chemistry and physiology of abscisin II, an abscission accelerating hormone. *Adv. Chem.* 53:97-105.
2. Bain, H. F. 1933. Cross pollinating the cranberry. *Wis. State Cranberry Grower's Assoc. Annu. Rpt.* 47:7-11.
3. Brown, G. N. and C. Y. Sun. 1973. Effects of abscisic acid on senescence, permeability and ribosomal patterns in mimosa hypocotyl callus tissue. *Physiol. Plant.* 28:412-414.
4. Chrispeels, M. J. and J. E. Varner. 1967. Hormonal control of enzyme synthesis: on the mode of action of gibberellic acid and abscisin in aleurone layers of barley. *Plant Physiol.* 42:1008-1016.
5. Davis, L. A., D. E. Heinz, and F. T. Addicott. 1968. Gas-liquid chromatography of trimethylsilyl derivatives of abscisic acid and other plant hormones. *Plant Physiol.* 43:1389-1394.
6. Demoranville, I. E. 1974. The effect of temperature on germination of cranberry seeds. *Cranberries* 38:7.
7. Devlin, R. M. and S. J. Karczmarczyk. 1975. Effect of light and gibberellic acid on the germination of Early Black cranberry seeds. *Hort. Res.* (in press).
8. Galston, A. W. and J. Davies. 1970. Control mechanisms in plant development. Englewood Cliffs, N. J.: Prentice-Hall.
9. Greidanus, T., J. B. F. Rigby, and M. N. Dana. 1971. Seed germination in cranberry. *Cranberries* 36:13.
10. Khan, A. A. 1968. Inhibition of gibberellic acid-induced germination by abscisic acid and reversal by cytokinins. *Plant Physiol.* 43:1463-1465.
11. Rayner, M. C. 1929. The biology of fungus infection in the genus *Vaccinium*. *Ann. Bot.* 43:56-70.
12. Sankhla, N. and D. Sankhla. 1968. Reversal of (±)-abscisin II induced inhibition of lettuce seed germination and seedling growth by kinetin. *Physiol. Plant.* 21:190-195.
13. Sondheimer, E. and E. C. Galson. 1966. Effect of abscisin II and other plant growth substances on germination of seeds with stratification requirements. *Plant Physiol.* 41:1397-1398.
14. ———, D. S. Tzou, and E. C. Galson. 1968. Abscisic acid levels and seed dormancy. *Plant Physiol.* 1443-1447.

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Frost Tolerance in Strawberry Cultivars[1]

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Abstract. **A range of 3°C was observed in flower frost tolerance in 21 cultivars of strawberry (*Fragaria* × *ananassa.* Duch.). Fruits were more susceptible to damage than flowers or buds. 'Gala' and 'Robinson' were among the least tolerant cultivars while 'Earlidawn' and 'Catskill' were the most tolerant to flower injury. Origin of cultivar had no relationship to flower frost tolerance.**

In cold climates, frost damage and winter injury are important to the production and maintenance of a strawberry planting. Frost damage is of primary concern during the spring as growers take advantage of cultural methods to produce an early crop. Overhead irrigation can be used to protect plantings; however, many growers do not have an adequate system nor can the minimum temp be predicted accurately. Most studies have been conducted on crown and root hardiness, but no correlation exists between spring flower or bud hardiness and crown or root hardiness (2, 7). This study was conducted to determine the amount of variability among present cultivars in flower frost tolerance. Such information might enable recommendations to be made to growers on tolerant cultivars and enable the breeder to initiate a breeding program for frost tolerance.

Flowers, fruits and flower buds are killed or damaged in several ways: 1) complete killing of the whole primordium, 2) variable damage within the flower truss, 3) damage to flower parts or 4) injury to part of the vascular tissue of the peduncle (3). Factors which influence hardiness include physiological condition of the plant, stage of truss development, duration and rate of temp drop, and cultivar (1, 2, 8).

Bazzocchi (1) investigated spring frost resistance of 105 strawberry cultivars, and found that the percentage of killed flowers was related to the place of origin of the cultivar, the more northerly cultivars being more tolerant. Flowers protected by leaves were more resistant while flowering date was of little importance. Stancevic (10) reported significant differences in survival among 12 European strawberry cultivars after a late spring frost of −3°C.

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