Interspecific and Intraspecific Pollination Effects in Rabbiteye and Southern Highbush Blueberry

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Abstract. To determine the effects of pollen source on blueberry production, we made a partial diallel set of crosses involving seven rabbiteye (*Vaccinium ashei* Reade) and seven southern highbush (SH; *V. corymbosum* L.) parents. Pollination of rabbiteye blueberry flowers with SH pollen reduced fruit set, seeds per berry, and berry weight and increased fruit development period (FDP) compared to pollination with rabbiteye pollen. Pollination of SH flowers with rabbiteye pollen resulted in about the same fruit set and FDP but fewer seeds per berry and slightly lower berry weight compared to intraspecific pollination. Self-pollination significantly decreased the number of seeds per berry and berry weight and increased FDP in SH. Pollination of rabbiteye and SH flowers with mixed pollen produced the same results as intraspecific pollination. Using 'Tifblue' and 'Baldwin' (rabbiteye) as the pollen parent significantly increased FDP in rabbiteye blueberry. Using 'Georgiagem' and 'Cape Fear' as pollen parents produced the longest FDP, and using 'O'Neal' and 'Gulfcoast' produced the shortest FDP in SH blueberry. The heaviest berries were produced by using 'Blue Ridge', 'O'Neal', and 'Gulfcoast' (SH) as pollen parents on SH females. These results suggest that xenia possibly could be used to increase yield and reduce FDP in blueberry.

We anticipate that southern highbush (SH; mostly *V. corymbosum*) will increasingly be planted close to rabbiteye blueberry plants. Little information is available on the effects of interspecific pollination on fruit production. Fruit set was reduced in studies of the fecundity of interspecific crosses (Lyrene, 1988, 1990), suggesting that yield reduction may result from interspecific pollination. Although highbush blueberry has traditionally been considered self-fertile, studies of 'Sharpblue' pollination (Lang et al., 1990; Lyrene, 1989) indicated a need for cross-pollination.

To our knowledge, no direct pollen effect on maternal plant tissue has been reported in blueberry. "Metaxenia" was coined to describe such an effect, but Denney (1992) argued that this term was created superfluously and erroneously to cover phenomena already designated by the term "xenia." He listed references on quantitative and qualitative xenic effects for many genera. Metaxenic effects have been reported for several fruit, including cherry (*Prunus avium* L.) (Stancevic, 1971), pear (*Pyrus communis* L.) (Nyeki, 1972), and raspberry (*Rubus idaeus* L.) (Colbert and de Oliveria, 1990). In deference to Denney (1992),

xenia is used as the preferred term in this report.

Our objectives were to 1) compare intraspecific with interspecific pollination effects in rabbiteye and SH blueberry, 2) compare pure rabbiteye and pure SH pollination to pollination with mixed highbush and rabbiteye pollen, and 3) investigate possible xenic effects in blueberry.

Materials and Methods

In 1989, twelve 2-year-old plants of seven rabbiteye and seven SH cultivars were obtained from a commercial nursery and transplanted from 3-liter to 9-liter pots. The plants were fertilized with Osmocote (14N-6P-12K) (Sierra Chemical, Milpitas, Calif.) and grown on a concrete slab with daily irrigation until sufficient chilling was achieved in Jan. 1990. Three replications of two plants each from each cultivar were arranged as a randomized complete block in a heated greenhouse (night minimum 20°C). The remaining plants were placed in the greenhouse and designated as pollen parents. All plants were of uniform size, vigor, and number of flowers per plant.

The rabbiteye and SH blueberry cultivars were crossed in an incomplete diallel scheme (Table 1). Mixed pollen was obtained by mixing about equal volumes of pollen from each male parent used in the study. When a female parent had sufficient flowers and was at the proper stage for crossing, pollen from all the appropriate male parents was applied so that all flowers within a replication were at a simi-

lar bud position and flowering date. To facilitate having all pollen available at the same time, it was collected in depression slides and stored 1 or 2 days in a refrigerator before use. Three replications of eight pollinations per cross were used. Berries were collected as they ripened, refrigerated in sealed plastic bags, and weighed. Then seeds were removed by macerating the berries in a blender, decanting the floating tissue, and leaving the heavy seeds in water. Data consisted of fruit set (the percentage of pollinations that produced a berry), fruit development period (FDP), mean berry weight, and mean number of normal-looking, heavy seeds per berry produced by self-pollination, intraspecific pollination, interspecific pollination, and pollination with mixed rabbiteye and SH pollen. We analyzed the data by general linear models procedure (SAS Institute, 1985). Mean separations were by individual degree-of-freedom contrasts.

Results and Discussion

Pollination of rabbiteye blueberry flowers with SH pollen reduced fruit set, number of seeds per berry, and berry weight, and increased FDP compared to pollination with rabbiteye pollen (Table 2). Such pollination was almost as deleterious as self-pollination. The low fruit set was consistent with results of previous pollination studies (Galletta, 1975; Lyrene, 1988, 1990). Pollination of rabbiteye flowers with mixed pollen produced about the same results as pollination with rabbiteye pollen.

Self-pollination of SH flowers resulted in about the same fruit set as pollination with other SH pollen (Table 3). However, the number of seeds per berry and berry weight were significantly lower, and FDP increased significantly with self-pollination. Lyrene (1989) reported decreased fruit set for self-pollinated 'Sharpblue', but Lang et al. (1990) reported results from self-pollinated 'Sharpblue' similar to our results involving seven SH cultivars.

SH flower pollination with rabbiteye pollen resulted in about the same fruit set and FDP but fewer seeds per berry and slightly lower berry weight compared to intraspecific pollination (Table 3). Pollinating SH with rabbiteye pollen had less effect than pollinating rabbiteye with SH pollen.

No significant difference was found between the effects of using mixed pollen and intraspecific cultivar pollen on SH flowers (Table 3). These results differ from the report by Lyrene (1989) in which mixed pollen of 'Sharpblue' (75%) and 'O'Neal' or FI 2-1 (25%) reduced fruit set, berry weight, and seeds per berry, and increased FDP of 'Sharpblue'. The differences maybe explained by Vander Kloet (1991), who showed that when the number of pollen donors is increased, the effect on seed set is cumulative. Our mixed pollen was ≈43% from six donors of the same species, 7% selfed, and 50% from six donors of a different species. Thus, in our study, the effects of six donors in only 43% of the pollen applied to the stigma was equal to 100% cross-pollination. These results suggest that inter-

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Table 1. Cultivars and partial diallel crossing scheme used in pollination study of blueberries.

Female	Male														
	Rabbiteye							Southern highbush							
	Tifblue	Brightwell	Beckyblue	Bonita	Climax	Briteblue	Baldwin	Sharpblue	Avonblue	Georgia-gem	Gulfcoast	Cape Fear	O'Neal	Blue Ridge	Mixed
Rabbiteye															
Tifblue	X ^a	X		X		X		X	X	X	X	X	X	X	X
Brightwell		X	X		X		X	X	X	X	X	X	X	X	X
Beckyblue	X		X	X		X		X	X	X	X	X	X	X	X
Bonita		X		X	X	X		X	X	X	X	X	X	X	X
Climax	X		X		X		X	X	X	X	X	X	X	X	X
Briteblue		X			X	X	X	X	X	X	X	X	X	X	X
Baldwin	X		X	X			X	X	X	X	X	X	X	X	X
Southern highbush															
Sharpblue	X	X	X	X	X	X	X	X	X		X		X		X
Avonblue	X	X	X	X	X	X	X		X	X		X		X	X
Georgia-gem	X	X	X	X	X	X	X	X		X	X		X		X
Gulfcoast	X	X	X	X	X	X	X		X		X	X	X		X
Cape Fear	X	X	X	X	X	X	X	X		X		X		X	X
O'Neal	X	X	X	X	X	X	X		X			X	X	X	X
Blue Ridge	X	X	X	X	X	X	X	X		X	X			X	X

^aCross was made between cultivars.

Table 2. Effect of pollen source on four fruit traits in rabbiteye blueberry.

Pollen source	Fruit set (%)	Seeds/berry (no.)	Berry wt (g)	Fruit development period (days)
Self	40	44	1.3	95
Highbush	36	49	1.3	100
Mixed ^a	62	65	1.8	88
Rabbiteye	68	65	1.8	81
Significance				
Rabbiteye vs. self	**	**	**	**
Rabbiteye vs. highbush	**	**	**	**
Rabbiteye vs. mixed	NS	NS	NS	NS

^aEqual amounts of rabbiteye and southern highbush pollen.NS, **Nonsignificant or significant at $P \leq 0.05$, respectively.

Table 3. Effect of pollen source on four fruit traits in southern highbush blueberry.

Pollen source	Fruit set (%)	Seed/berry (no.)	Berry wt (g)	Fruit development period (days)
Self	68	59	1.6	65
Rabbiteye	72	59	1.8	58
Mixed ^a	80	61	1.9	56
Highbush	71	73	2.0	55
Significance				
Highbush vs. self	NS	**	**	**
Highbush vs. rabbiteye	NS	**	*	NS
Highbush vs. mixed	NS	NS	NS	NS

^aEqual amounts of rabbiteye and southern highbush pollen.NS, *, **Nonsignificant or significant at $P \leq 0.05$ or 0.01 , respectively.

planting several cultivars to serve as pollinizers may overcome the effects of selfing or inter-specific pollination in highbush blueberry plantings.

The pollen parent significantly affected FDP in rabbiteye and SH blueberry (Tables 4 and 5). There was a trend for pollen from late-ripening cultivars to produce a longer interval from pollination to the ripening stage and pollen from early ripening cultivars to produce a shorter interval. Effects of pollen parent on time of ripening has been reported for date palm (*Phoenix dactylifera* L.) (Swingle, 1928), sweet cherry (Stancevic, 1972), and pear (Nyeki, 1972). Consistent with our results,

pollen from early ripening, sweet-cherry cultivars accelerated maturation 1–7 days, and pollen from late-ripening cultivars retarded maturation. The effects of xenia may have a major economic impact in rabbiteye blueberry production if pollen parents could be selected that produce ripe fruit ≈ 10 days earlier than when market prices drop because of increased supply. Early ripening SH would fill an unsupplied market window for fresh-market and export fruit at premium prices.

The pollen parent also affected berry weight in SH blueberry (Table 6). This phenomenon is consistent with increased fruit size in date palm (Swingle, 1928), common bean

(*Phaseolus vulgaris* L.) (Freytag, 1979), raspberry (Colbet and de Oliveria, 1990), and pear (Nyeki, 1972) ascribed to xenia. As suggested by Hellman and Moore (1983), xenia may be responsible for the lack of correlation between degree of genetic relationship and fruit, seed, and seedling characteristics in some crosses. Possibly, xenia could be used for identifying the best pollinizer parents in mixed cultivar plantings.

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Table 4. Effect of parent on fruit development period (FDP) in rabbiteye blueberry.

Cultivar	FDP (days)	
	Cultivar as fruiting parent ^z	Cultivar as paternal influence ^z
Tifblue	90 a	91 a
Baldwin	97 a	89 a
Beckyblue	76 b	87 ab
Bonita	76 b	86 abc
Brightwell	80 b	81 bc
Climax	81 b	81 bc
Brightblue	79 b	80 c

^zLeast square mean separation by *t* test at $P \leq 0.05$.

Table 5. Effect of parent on fruit development period (FDP) in southern highbush blueberry.

Cultivar	FDP (days)	
	Cultivar as fruiting parent ^z	Cultivar as paternal influence ^z
Georgiagem	51 c	64 a
Cape Fear	58 c	61 ab
Avonblue	65 a	59 ab
Sharpblue	54 bc	58 bc
Blue Ridge	56 b	56 bc
O'Neal	48 c	52 c
Gulfcoast	54 bc	52 c

^zLeast square mean separation by *t* test at $P \leq 0.05$.

Table 6. Effect of pollen parent on berry weight in southern highbush blueberry.

Pollen parent	Berry wt (g)	
	Cultivar as fruiting parent ^z	Cultivar as paternal influence ^z
Blue Ridge	2.2 ab	2.1 a
O'Neal	2.5 a	2.0 ab
Gulfcoast	2.0 bc	2.0 ab
Avonblue	1.5 d	1.9 bc
Cape Fear	2.1 bc	1.8 c
Georgiagem	1.8 cd	1.8 c
Sharpblue	2.0 bc	1.7 c

^zLeast square mean separation by *t* test at $P \leq 0.05$.

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