

## Emasculation And Pollination Studies On Upland Cotton Flowers

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### Summary

Flowers of upland cotton, Gossypium hirsutum L., received various emasculation and pre-pollination treatments that were designed to determine the effects of those treatments on crossing success. Boll set and recovery of hybrid seed were just as high from flowers that had the calyx, corolla, and staminal column removed (severe emasculation), as from those that had been emasculated by merely slitting the corolla and removing only the anthers. Furthermore, boll set in severely emasculated flowers (84%) was comparable to that in self-pollinated (81%) or open-pollinated flowers (84%). On the other hand, bollset was reduced significantly from flowers that had had the ovary injured during emasculation (6%). Treating severely emasculated flowers with 30% ethanol immediately after emasculation virtually eliminated self-pollination and allowed us to emasculate and pollinate flowers the same morning rather than emasculating the afternoon before pollinating. Percent boll set was reduced from flowers that had been treated with ethanol (71%), compared to self-pollinated (88%) or open-pollinated (87%) flowers, but we found the reduction acceptable in our breeding program.

Gossypium hirsutum L., is sometimes difficult in the severe summer environment at Phoenix. A major problem is heat-induced pollen sterility but this problem has been overcome in certain cultivars by selecting for heat tolerance (Fisher, 1975). Another potential problem is the emasculation technique used. The traditional ("thumbnail") technique is removal of the calyx, corolla, and staminal column with the thumbnail and covering the stigma with a short length of paper soda straw to avoid contamination and pollination the following morning.

Brown and Lee (1976) showed that boll set of an old Sea Island stock, As-2, of G. barbadense L., was reduced significantly by removal of the corolla, while boll set of a modern G. barbadense cultivar, 'Pima S-4' and a modern G. hirsutum one, 'Carolina Queen', was unaffected. Emasculating flowers the morning of pollination rather than the afternoon before (if the procedure could be made to work) seems to offer certain advantages, as follows: 1) lower temperature increases worker efficiency; 2) the flower buds to be emasculated are larger and thus easier to locate; 3) the stigmas have less opportunity to desiccate; and 4) the soda straws covering the stigmas are less likely to be lost before pollination. A serious disadvantage, however, is the possibility of self-contamination, even when flowers are emasculated as early as 0200h (Wilson and Stapp, 1984).

The objectives of the studies reported in this paper were to determine whether a less stringent emasculation technique would increase hybrid boll set and whether treatment of stigmas with 30% ethanol, as suggested by Lee (1980) would eliminate the disadvantage of self-contamination in morning-emasculated flowers. An ancillary objective was to determine the effect on boll set of nicking the ovary with the thumbnail during emasculation, a common form of

damage.

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### Materials And Methods

Plants of 'Deltapine 61' (DPL-61) as pistillate parents, and TM-1 R (Red plant) as staminate parents, were grown at the University of Arizona Cotton Research Center, Phoenix, in 1982, and at the Arizona State University Laboratory, Tempe, in 1983. Experimental design was a randomized complete block with two replications in 1982 and with four replications in 1983. Each plot was one row of 20 plants. Plants were spaced 46cm apart in rows 1 m apart.

In 1982, three hand-emasulation techniques were used in early morning (0200-0400) on flowers of DPL-61, due to open the same day, as follows: 1) the corolla was slit and the anthers were teased out with a pair of forceps; 2) the corolla and staminal column were removed, using the "thumbnail" technique; 3) the corolla and staminal column were removed and the ovary was nicked with the thumbnail, exposing a few ovules in one locule of the ovary. Emasculated stigmas were covered with short lengths of paper soda straws, then pollinated with TM-1R pollen later in the morning. In addition, flowers on separate rows were self-pollinated by attaching a V-shaped paper clip to the apex of a flower bud to prevent it from opening. Flowers on still other rows were tagged and allowed to open-pollinate. These procedures were repeated daily for 5 days (M-F) during the height of the summer crossing season, beginning 22 June.

In 1983, flowers of DPL-61 were emasculated, between 0500-0700 h on the day of pollination, using the thumbnail technique, on four rows per replication. On the fifth row, flowers were self-pollinated, and on the sixth row, flowers were allowed to open-pollinate. The following combinations of 30% ethanol/pollination were applied to the four emasculated rows: 1) no ethanol, no pollen; 2) no ethanol, pollination with TM-1R pollen; 3) ethanol, no pollen; 4) ethanol, pollination with TM-1R pollen. These procedures were repeated daily for two 6-day periods, 23 to 29 June (26 June was skipped), and 5 to 11 July (10 July was skipped).

In both 1982 and 1983, all emasculated, selfed and open-pollinated flowers were tagged and dated. Tagged, open bolls were counted and seedcotton was harvested at appropriate times. Seedcotton was weighed and ginned, lint and seed examples were weighed and seed were counted. At least one hundred seed (if available) from each plot were germinated. Seedlings were scored as red (hybrid) or green (selfed). Analysis of variance and the FLSD test (Carmer and Swanson, 1971) were used to analyze the data and to compare means.

### Results And Discussion

In 1982, no deleterious effects on boll or seed set or boll or seed weights were observed when the corolla and staminal column were removed prior to pollination (Table 1). In fact, crossed boll set and seedcotton, seed, and lint yield per boll and seed size were not significantly lower than for selfed or open-pollinated bolls, an unexpected result (Wilson and Stapp, 1984). Ninety four percent of the bolls developing from damaged ovaries abscised, and the ones that set produced significantly less seedcotton, seed, and lint per

boll than did bolls that developed from undamaged ovaries. Results suggest that damaged flowers should be discarded rather than pollinated.

In 1983, boll set was significantly higher for selfed and open-pollinated bolls than for crossed bolls (Table 2). Even though plants treated with ethanol produced significantly less fruit set than the untreated ones, the treatment, was deemed satisfactory for our breeding program. The ethanol treated and pollinated plants, as calculated from the data in Table 2, yielded only 34 selfed seed from 620 emasculated flowers (0.05 seed/flower). The results from pollinating untreated flowers emphasize the hazard involved: the ethanol untreated and pollinated plants produced 11,680 seed from 685 emasculated flowers (17.1 seed/flower), but 25.7% were selfed seed. The ethanol untreated and unpollinated plants produced 5,25 seed from 615 emasculated flowers (8.5 seed/flower), all of them selfed.

Crossed bolls, when compared to self- and open-pollinated bolls, had significantly fewer seed/boll, and the seedcotton, seed, and lint boll weighed significantly less. Seed of crossed bolls were larger, presumably because of fewer seed per boll.

The ethanol treatment has practically eliminated the self-contamination disadvantage associated with emasculating and pollinating flowers on the same morning. The ethanol treatment thus eliminates the need to emasculate flowers the previous afternoon or very early in the morning of the day of pollination under artificial lights. Our new crossing procedure is as follows: we begin emasculating at 0500h, or as early as it is light enough to see in the field, using the thumbnail technique of removing the calyx, corolla, and staminal column from flower buds that are scheduled to open the same morning. We immediately thereafter treat the stigma with a squirt of 30% ethanol dispensed from a polyethylene bottle. We then cover the exposed stigma with a 10mm length of paper soda straw, and mark the emasculated flower with a length of surveyor's flagging ribbon. We pollinate the emasculated flower later in the morning with a selected staminate flower and mark the crossed flower by slipping a snapon plastic tag on the peduncle.

#### Literature Cited

Brown, William, Jr., and J.A. Lee. 1976. Effects of emasculation on boll set in three stocks of cultivated Gossypium. *Crop Sci.* 16:599-602.

Carmer, S.G., and M. R. Swanson. 1971. Detection of differences between means: a Monte Carlo study of five pairwise multiple comparison procedures. *Agron. J.* 63:940-945.

Fisher, W.D. 1975. Heat induced sterility in upland cotton. p.85. In: Brown, J.M. (ed.). *Proc. Beltwide Cotton Prod. Res. Conf., National Cotton Council, Memphis, Tenn.*

Lee, J.A. 1980. Cotton. p. 313-325. In: Fehr, W.R., and H.H. Hadley (eds.). *Hybridization of Crop Plants.* Amer. Soc. \*Agron., Madison, Wis.

Wilson, F.D., and B.R. Stapp. 1984. Crossing success in cotton in Arizona as affected by irrigation, number of flowers pollinated, and time of emasculation. \**Agron. J.* 74:457-460.

**Table 1. Effects of Various Emasculation Treatments on Boll and Seed Set in Upland Cotton**

Treatment	Flowers		Boll set		Selfed seedlings		Seeds/boll		Boll weight		Seed weight	
	(no.)	(%)	(no.)	(%)	Total (no.)	Hybrid (no.)	Seedcotton (g)	Seed (g)	Lint (g)	Seed (mg)	Lint (mg)	(mg)
Corolla slit only	221	74.8 a*	13.60 b	26.4 a	22.8 a	4.91 a	2.83 a	1.96 a	107.7 a			
Corolla removed:												
Ovary undamaged	218	83.8 a	1.30 c	23.2 ab	22.9 a	4.49 a	2.61 a	1.81 a	112.5 a			
Ovary damaged	213	6.3 b	0.06 c	17.4 b	17.4 b	3.11 b	1.79 b	1.31 b	98.6 a			
Self-pollinated	282	80.5 a	100.00 a	--	0.0 c	5.00 a	2.91 a	2.04 a	--			
Open-pollinated	241	83.6 a	--	--	0.0 c	5.04 a	2.92 a	2.06 a	--			

\*Means with letter(s) in common, within columns, are not significantly different, according to an FLSD test (P=0.05).

Table 2. Effects of Ethanol Treatment on Crossing Success in Upland Cotton

Treatment	Flowers		Boll set		Selfed seedlings		Seeds / boll		Boll weight			Seed weight (mg)
	(no.)	pollinated	(%)	(%)	Total (no.)	Hybrid (no.)	Seedcotton (g)	Seed (g)	Lint (g)			
No ethanol--no pollen	615		52.1 d*	100.0 a	16.4 d	0.0 b	2.76 e	1.63 d	1.00 d	102.7 d		
No ethanol--pollen	685		78.3 b	25.7 b	21.8 c	16.2 a	4.01 c	2.36 b	1.47 b	108.3 c		
Ethanol-- no pollen	620		1.1 e	100.0 a	4.9 e	0.0 b	0.96 f	0.51 e	0.29 e	116.2 b		
Ethanol-- pollen	664		70.9 c	1.3 c	16.5 d	16.5 a	3.19 d	1.95 c	1.11 c	119.8 a		
Self-pollinated	643		88.1 a	100.0 a	24.7 b	0.0 b	4.40 b	2.48 b	1.73 a	101.3 d		
Open-pollinated	683		87.4 a	--	26.3 a	0.0 b	4.65 a	2.69 a	1.81 a	102.2 d		

\*Means with letter(s) in common, within columns, are not significantly different, according to an FLS test (P=0.05).