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and  
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1) Pollen movement to male sterile soybeans in southern Illinois.

The effective use of genetic male sterility in soybeans requires controlled pollen movement. Soybean pollen is carried by insects with bees usually considered the most likely candidate in Illinois. The following experiment was designed to determine how far soybean pollen can be carried to fertilize male sterile soybeans when pollen is also available from adjacent plants.

Equal amounts of 'Williams', a white flowered variety, and a backcrossed line of Williams containing  $ms_2$  were mixed together and planted in 75 cm rows in a plot 30 m long and 15 m wide. The male sterile line was segregating in a 6:1 ratio for male fertility and male sterility. The plot was bordered on the south and east by grass which was mowed throughout the summer and no crops were planted for at least one hundred meters in either of those directions. On the other two sides 'Calland', a purple flowered variety which matures similarly to Williams, was planted. The experiment was conducted at the S.I.U. Belleville Research Center east of St. Louis, Missouri.

At harvest each of the 20 rows was divided into ten 3 m segments and seeds from all male sterile plants within each segment were bulked. The seeds were germinated in the greenhouse, and the percent of purple hypocotyl seedlings was determined. For the purpose of calculation, all distances are measured from the edge of the Calland planting to the center of the area under consideration. In total, 268 male sterile plants were harvested with an average of 27 seeds per plant.

Table 1 lists the percentage of Calland-pollinated seeds from 50 areas of the field. Each area is 3 m long and 4 rows or 3 m wide. This table is arranged so that by moving from left to right, the distance across-rows from Calland increases and by moving from top to bottom the distance within the row from Calland increases. The means for within-row distances are given in the far right column and the means for across-rows distances are given on the bottom line. These data are graphically represented in Figure 1 by simple linear regression of the percent Calland-pollinated seeds on the distance from the Calland pollen source measured for both within- and across-rows distances.

The decrease in Calland-pollinated seeds as the distance across-rows increases was expected. The regression equation of  $Y = 7.53 - 0.523X$  (Fig. 1) is very similar to one reported by Boerma and Moradshahi (1975) in Georgia ( $Y = 6.46 - 0.476X$ ). The within-row data seems to be inconsistent, since the percent of Calland-pollinated seeds reaches a minimum at 13.5 m and then steadily increases until at 28.5 m it is approximately 40% of the 1.5 m value. The simple linear regression line has very little slope ( $-0.106$ ) and examination of the data points indicates a quadratic response (Fig. 1). However, if only the data for the first 15 m are included, the regression equation is  $Y = 7.41 - 0.497X$  which is almost identical to the across-rows regression equation (Fig. 1).

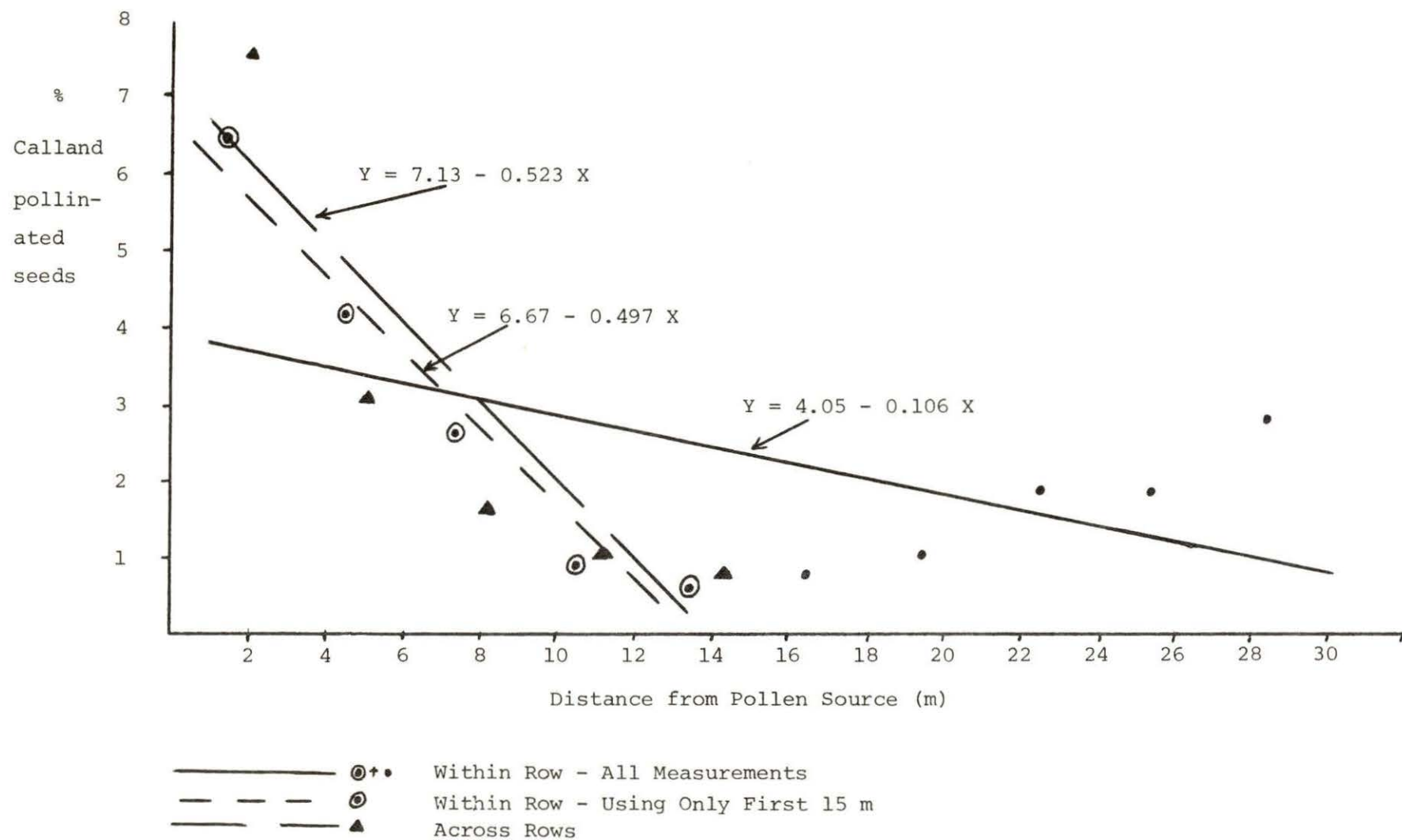


Fig. 1 Mean Percentage of Calland Pollinated Seeds from Williams-ms<sub>2</sub> ms<sub>2</sub> Plants for Within and Across-Rows Distances from Calland Soybeans

Table 1  
Percent of Calland pollinated seeds from seeds  
harvested from Williams  $ms_2ms_2$  plants

Distance from Calland within-row	Distance from Calland across rows (m)					Mean % of Calland pollinated seeds	
	2.25	5.25	8.25	11.25	14.25	All rows	Rows within 5m of Calland omitted
C A L L A N D							
1.5	15.9	12.1	6.8	1.7	4.0	6.4	5.4
4.5	8.9	3.9	7.5	0.0	0.0	4.2	2.9
7.5	C 10.2	3.4	1.6	0.0	1.2	2.6	1.7
10.5	A 7.1	2.1	0.0	0.0	0.0	G 0.9	0.3
13.5	L 3.1	0.0	0.0	0.0	0.0	R 0.6	0.0
16.5	L 4.0	3.2	0.0	0.0	0.0	A 0.8	0.4
19.5	A 17.2	0.0	1.5	0.0	0.0	S 1.0	0.2
22.5	N 3.4	2.9	0.0	1.3	1.3	S 1.8	1.4
25.5	D 5.6	0.0	0.5	2.3	0.0	1.8	0.9
28.5	9.2	0.0	0.8	0.5	1.0	2.8	0.7
G R A S S							
Mean % of Calland- pollinated seeds	7.6	3.1	1.6	1.0	0.8		

The grass borders were chosen to be a neutral area which would allow soybean pollen to enter the male sterile population from only two directions. However, it seems as if the grass had a positive influence on pollen movement. A cursory examination would suggest that the effect is seen only in the within-row measurements, but if the mean percent of Calland-pollinated seeds is calculated for within-row distances omitting the first column of Table 1, or the across-rows distance closest to Calland, the linear increase between 15 and 30 m disappears (Table 1). This suggests that the pollen vectors are more active near the grass, but that the percentage of pollen contamination increases noticeably in those areas which are close to both the grass and the pollen source. This is evident in both corners of the Williams block where Calland adjoins the grass. There is some evidence that pollen moves more freely within the row than across-rows which may help explain the more pronounced effect on the within-row measurements (Boerma and Moradshahi, 1975; Jaycox, 1970). Also the pollen vectors may have been moving from the pollen source (Calland) into the grass and then back into the male sterile block which could account for the small areas of relatively high pollen contamination in the corner of the plot farthest from the pollen source.

It seems that for a plot completely surrounded by soybeans the data for the first 15 m in both directions would be applicable, with the exception that the area which is adjacent to the grass may be inflated. These data suggest that a buffer area of approximately 10 m of soybeans should eliminate almost all pollen contamination into a male sterile intermating block in southern Illinois, and a 5 m buffer area would allow less than 5% contamination.

#### References

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2) Five marker genes independent of  $ms_2$ .

In 1976 several crosses were made to determine if any linkage existed between  $ms_2$  and selected genes from the Genetic Type Collection (Bernard and Weiss, 1973).

The results from the  $F_2$  generation are presented in Table 1 with  $a = XY$ ,  $b = xY$ ,  $c = Xy$  and  $d = xy$  for the gene pairs listed in the form  $Xx$  and  $Yy$ . The ratio of products method (Immer and Henderson, 1943) was used to determine the percentage recombination.

$F_2$  ratios were also counted for the cross T259 x T256 ( $df_4$ ); however, no double recessive class was observed so no ratio of products could be calculated. By the use of  $\chi^2$  it was determined that an unusual segregation for  $Ms_2$   $ms_2$  had occurred but no linkage was detected. The crosses involving  $y_{10}$  and  $y_{13}$  also had fewer than expected male sterile plants which affected the ratio of products, but the  $\chi^2$  test gave no indication of linkage.

Table 1  
 $F_2$  linkage tests

Genes	a	b	c	d	Sum	%R $\pm$ SE	Linkage phase
T259 ( <u>Ln Ln</u> <u><math>ms_2</math> <math>ms_2</math></u> ) x T41 ( <u>ln ln</u> <u><math>Ms_2 Ms_2</math></u> )							
<u>Ln ln</u> <u><math>Ms_2</math> <math>ms_2</math></u>	102	33	33	18	163	52 $\pm$ 5.7	R
T259 ( <u><math>Y_{10}</math> <math>Y_{10}</math></u> <u><math>ms_2</math> <math>ms_2</math></u> ) x T161 ( <u><math>y_{10}</math> <math>y_{10}</math></u> <u><math>Ms_2</math> <math>Ms_2</math></u> )							
<u><math>Y_{10}</math> <math>y_{10}</math></u> <u><math>Ms_2</math> <math>ms_2</math></u>	135	21	5	2	163	> 55	R
T259 ( <u><math>Y_{13}</math> <math>Y_{13}</math></u> <u><math>ms_2</math> <math>ms_2</math></u> ) x T230 ( <u><math>y_{13}</math> <math>y_{13}</math></u> <u><math>Ms_2</math> <math>Ms_2</math></u> )							
<u><math>Y_{13}</math> <math>y_{13}</math></u> <u><math>Ms_2</math> <math>ms_2</math></u>	184	23	18	1	226	39 $\pm$ 5.5	R
T259 ( <u><math>Wm</math> <math>Wm</math></u> <u><math>ms_2</math> <math>ms_2</math></u> ) x T235 ( <u><math>wm</math> <math>wm</math></u> <u><math>Ms_2</math> <math>Ms_2</math></u> )							
<u><math>Wm</math> <math>wm</math></u> <u><math>Ms_2</math> <math>ms_2</math></u>	83	18	22	4	127	48 $\pm$ 6.8	R
T259 ( <u><math>Lf_2</math> <math>Lf_2</math></u> <u><math>ms_2</math> <math>ms_2</math></u> ) x T255 ( <u><math>lf_2</math> <math>lf_2</math></u> <u><math>Ms_2</math> <math>Ms_2</math></u> )							
<u><math>Lf_2</math> <math>lf_2</math></u> <u><math>Ms_2</math> <math>ms_2</math></u>	72	30	12	7	121	55 $\pm$ 6.4	R

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### 1) Selection of a maternally inherited male-sterile trait in soybeans.

The induction of male sterility in soybeans with the use of ethidium bromide (EB) was reported in 1977 (Burton, 1977). Further investigations have provided evidence that the sterility of one of the plants recovered from mutagenesis is maternally inherited.

In 1976, large samples of 'Ransom', 'Jackson' and 'Lee 74' seeds were treated with EB and planted in the field (the  $M_1$  generation). Twelve phenotypically male-sterile plants, 7 Ransom, 4 Jackson and 1 Lee 74, were selected from this population (Burton, 1977). The  $M_2$  progeny from these plants were presumably hybrids, having a random fertile genotype as the male parent. These progeny were expected to be sterile if the induced  $M_1$  sterility was due to cytoplasmic factors, provided a dominant fertility restorer gene had not been contributed by the male parent. The progeny were expected to be male-fertile or a mixture of sterile and fertile if the induced  $M_1$  sterility was due to a single dominant nuclear gene or due to environmental factors.

Seed from the 12 plants selected in 1976 were planted in the field in 1977 (the  $M_2$  generation). Eleven of the 12 had fertile progeny. The other, a selection from Ransom, had only five progeny which survived to maturity, and all had phenotypes characteristic of genetic male-sterile ( $ms_1ms_1$ ) plants (reduced pod set, mostly one-seeded pods, and they remained green past the normal Ransom maturity). In addition, all of the plants had leaves with more than three leaflets. The seed from these plants were presumably hybrids with an unknown male parent. The plants were bordered on either side by male-fertile Ransom plants which should have increased the likelihood that Ransom was the male parent.

Three or four seeds from each plant were grown in the greenhouse during the 1977-78 winter (the  $M_3$  generation). The multi-leaflet trait was not expressed in these plants. At maturity, 15 plants had pods and 3 plants had none. The plants with pods averaged 14 pods/plant and 1.3 seeds/pod.