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Effect of Gynoecious Expression on Yield and Earliness of a Fresh-market Cucumber Hybrid

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Abstract. **Three versions of the hybrid 'Meridian 76' ('Marketmore 76' x 'Tablegreen 72') differing in sex expression were used to evaluate the effect of gynoecious expression on fruit yield and earliness. The versions tested were gynoecious x gynoecious (GxG), gynoecious x monoecious (GxM), and monoecious x monoecious (MxM). In 2 years of testing, the gynoecious (GxG and GxM) hybrids had 99% to 100% pistillate flowers on the first 10 nodes of the main stem of the plant, whereas the monoecious (MxM) hybrid had 3% to 5% pistillate flowers. The monoecious hybrid had a higher percentage of U.S. Fancy and No.1 fruits and a lower percentage of culls than the gynoecious hybrids. There were few significant differences in yield among the 3 hybrids. The gynoecious hybrids were earlier than the monoecious hybrid, but there were no important differences in the yield of marketable fruit after the first harvest in either year. The GxM hybrid had a significantly higher yield than the MxM hybrid in the first harvest for both years. The GxM hybrid tended to outyield the GxG hybrid as well, but the differences were not always significant. The gynoecious hybrids (especially the GxM hybrid) of 'Meridian 76' provided an advantage in early yield but not in yield summed over all harvests (6 to 8 depending on year), compared to the monoecious hybrid.**

Most of the new cultivars of fresh-market cucumbers (*Cucumis sativus* L.) being developed by U.S. seed companies for field production are gynoecious hybrids (often called predominately-female hybrids). These are produced by crossing a gynoecious with a monoecious inbred. It is an efficient system for hybrid production, because it provides a method for minimizing the amount of self-pollination of the gynoecious inbred and ensures that most of the seed harvested will be the desired hybrid.

However, it also is possible to produce hybrid seed by crossing inbreds of other sex types using growth regulators to convert the seed parent into a gynoecious phenotype and the pollen parent into a monoecious phenotype. For example, a monoecious hybrid can be produced by spraying the monoecious seed parent with ethephon (2-chloroethanephosphonic acid) to convert it into a gynoecious phenotype (2). An all-gynoecious hybrid can be produced by spraying the pollen parent with gibberellic acid (7) or silver nitrate (10) to convert it into a monoecious phenotype. Thus, although it is easy for seed companies to produce gynoecious x monoecious hybrids, the question arises as to which type of hybrid (monoecious, predominately-female or all-gynoecious) is best from the standpoint of yield, earliness, and quality under field production conditions.

Gynoecious x monoecious hybrids originally were proposed by Peterson and Weigle (6) as a method for reducing the cost of producing hybrid seed. Gynoecy was found to be controlled by 2 major genes, *m* and *f* (8). Other types of inbreds have been proposed for use as parents to provide a higher level of gynoecious expression in the hybrid than gynoecious x monoecious types. For example, Mulkey and Pike (5) proposed that gynoecious x hermaphroditic hybrids be developed where 100% gynoecious sex expression was needed.

More recently, however, gynoecy has been considered to be an essential character for breeding cultivars with superior performance. Denna (1) suggested that one of the characteristics that should be included is the development of the ideal high-yielding cucumber inbred in gynoecious sex expression. Miller (4) found that up to 87.5% of the gynoecious plants in a gynoecious-monoecious mixture (hybrid + pollinator) resulted in an earlier and higher yield than mixtures with higher concentrations of the monoecious pollinator. The yield advantage for highly gynoecious mixtures was significant for the first few harvests (out of 5 to 8 total). On the other hand, Tasdighi and Baker (9) studied various hybrid combinations of gynoecious, monoecious, and hermaphroditic inbreds. Some hybrids performed well, but no trends toward superiority of the gynoecious hybrids emerged. Lower and Miller (3) found that monoecious pickling cucumber hybrids performed as well as comparable gynoecious x monoecious hybrids for yield and earliness.

The objective of this study was to determine whether a high level of gynoecious expression would be a desirable objective in developing fresh-market cucumber hybrids where high yield and early maturity are the major considerations.

Materials and Methods

The experiment was conducted for 2 years using small plots (1.5 × 3 m) harvested 8 times in 1981 and 6 times in 1983. The fresh-market cucumber hybrid 'Meridian 76' was chosen for the experiment because the parents were available in gynoecious and monoecious versions. Thus, it was possible to develop 3 versions of the hybrid that differed for gynoecious expression. These were developed as follows: the gynoecious x gynoecious hybrid (GxG) was 'Marketmore 76F' x 'Tablegreen 72F', the gynoecious x monoecious (GxM) hybrid was 'Marketmore 76F' x 'Tablegreen 72', and the monoecious x monoecious hybrid was 'Marketmore 76' x 'Tablegreen 72'. 'Marketmore 76' and 'Marketmore 76F' are isogenic, with at least 5 backcrosses involved in their development from the original 'Marketmore' (H. Munger, personal communication). 'Tablegreen 72' and 'Tablegreen 72F' are isogenic as well, with at least 5 backcrosses involved in their development from the original 'Tablegreen'.

The 3 hybrids were planted at the Horticultural Crops Research Station near Clinton, North Carolina, in a randomized complete block design with 4 replications in 1981 and 6 replications in 1983. Planting dates were 18 June for the 1981 crop and 3 May for the 1983 crop. Plots were overplanted and thinned

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to final stand at the first leaf stage. The population density was 64,000 plants/ha in 1981 and 48,000 plants/ha in 1983. Rows were on raised, shaped beds 1.5 m apart (center to center). Border rows of 'Marketmore 76' were planted on each side of the 3 harvested plot rows to provide sufficient pollen for the gynoecious hybrids. Bee hives were located near the test plots.

The soil had been treated the previous October with nematicide, dichloropropene at 93.4 l/ha. Prior to bed formation in the spring, 90N–20P–74K (kg/ha) fertilizer was broadcast. At that time, tank-mixed bensulide and naptalam were incorporated at the rates of 9.9 and 4.5 kg a.i./ha, respectively. Postplant fertilizer consisted of a sidedress application of 34 kg/ha N. Irrigation was applied as needed to supplement natural rainfall and to provide about 25 to 38 mm of water to the field each week.

Fruit were harvested twice weekly for a total of 8 times (30 July through 24 Aug.) in 1981 and 6 times (27 June through 14 July) in 1983. They were graded into U.S. Fancy, No. 1, No. 2 and cull, and then counted and weighed. Data were analyzed by combining grades to produce quality yield (Fancy + No. 1), marketable yield (Fancy + No. 1 + No. 2). and total yield (Fancy + No. 1 + No. 2 + cull). Sex expression was measured by classifying as staminate or pistillate the first 10 nodes of the main stem on 10 plants in each plot. Means were compared using Fisher's LSD calculated from the analysis of variance.

Results and Discussion

In both years, the gynoecious hybrids (GxG and GxM) had more pistillate flowers in the first 10 nodes of each plant than the monoecious hybrid (MxM), and a higher percentage of nodes were pistillate (Table 1) The percentage of pistillate flowers was 99% to 100% for the gynoecious hybrids, with 4.8 to 8.0 of the first 10 nodes having pistillate flowers on them. The monoecious hybrid had fewer pistillate flowers, and a lower percentage of the first 10 nodes were pistillate.

The percentage of grade Fancy + No. 1 fruit generally was higher for the monoecious hybrid (56% to 63%) than for the gynoecious hybrids (28% to 56%). There also was a lower percentage of culls in the monoecious hybrid, ranging from 6% to 10% compared with 14% to 18% for the gynoecious hybrids. Although the trends were strong, the differences were not significant. The increased percentage of cull fruits in the gynoecious hybrids probably resulted from the heavy load of fruit that set on each plant when the vine was still relatively small. That fruit load would place stress on each plant, making it likely that the fruit be misshapen. The cull fruits were, in some cases, due to poor pollination as a result of weather conditions that were unfavorable for bee activity. Pollen availability should not have been a problem, since 3 of the 5 rows in the field had monoecious hybrid or monoecious inbred (the border rows of the field) plants, so the gynoecious hybrids had more pollen available to them than they would have in a normal production situation.

There were no significant differences among the 3 hybrid versions of 'Meridian 76' for yield, either for fruit weight or number (Table 2). Whereas the monoecious hybrid performed better for quality yield than for marketable or total yield, it was not significantly different from the gynoecious hybrids in any case. It is interesting to note that the rankings for yield of the 3 hybrids were not the same for fruit weight as for fruit number. For example, the GxM hybrid had the lowest weight, but the GxG hybrid had the lowest number of Fancy + No. 1 fruit in 1981. For yield of marketable fruit in 1981, the GxM hybrid had the lowest weight, but the MxM hybrid had the lowest number. In all instances the differences were not significant and could, therefore, be attributed to random error.

The most important difference between the gynoecious hybrids and the monoecious hybrid was in earliness of yield. The gynoecious hybrids tended to have higher quality yield and higher total yield than the monoecious hybrid in the first 1 or 2 harvests in 1981 and in the first harvest in 1983 (Table 3). Interestingly, the GxM hybrid outyielded the other 2 hybrids in the first harvest for both years. (The difference between the GxG and GxM hybrids was not significant in 1983, but the trend was there, nonetheless.) That result is difficult to explain. The GxG and

Table 1. Sex expression and grade distribution of fruit for 3 'Meridian 76' fresh-market cucumber hybrids differing in gynoecious genotype.

Hybrid type[z]	Pistillate flowers/plant		Fancy + No. 1 fruit (%)	Culls (%)
	%[y]	No.[x]		
	Summer 1981[w]			
GxG	100	7.4	28	15
GxM	99	8.0	39	14
MxM	3	0.2	56	6
LSD (5%)	4	0.6	7	NS
	Spring 1983[v]			
GxG	100	4.8	56	15
GxM	100	6.0	43	18
MxM	5	0.4	63	10
LSD (5%)	6	2.0	12	NS

[z]G:gynoecious parental inbred; M:monoecious parental inbred.
[y](No. of pistillate flowers/total no. of flowers) x 100 in the first 10 nodes of a 10-plant sample per plot.
[x]No. of pistillate flowers in the first 10 nodes of a 10-plant sample.
[w]Data are means over 4 replications and 8 harvests of plants grown at 64,000/ha.
[v]Data are means over 6 replications and 6 harvests of plants grown at 48,000/ha.

Table 2. Fruit yield[z] for 3 'Meridian 76' fresh-market cucumber hybrids differing in gynoecious genotype.

Hybrid type[y]	Quality yield		Marketable yield		Total yield	
	Wt. (MT/ha)	No. (1000/ha)	Wt. (MT/ha)	No. (1000/ha)	Wt. (MT/ha)	No. (1000/ha)
			Summer 1981[x]			
GxG	11.3	37	30.7	115	33.4	132
GxM	10.9	40	25.9	106	29.7	130
MxM	17.8	63	26.5	101	28.0	110
LSD (5%)	NS	NS	NS	NS	NS	NS
			Spring 1983[w]			
GxG	21.5	59	30.3	90	34.2	105
GxM	16.6	49	28.9	94	33.6	115
MxM	17.5	51	25.8	85	29.2	94
LSD (5%)	NS	NS	NS	NS	NS	NS

[z]Presented as quality yield (Fancy + No. 1 grade fruit), marketable yield (Fancy + No. 1 + No. 2), and total yield (Fancy + No. 1 + No. 2 + cull).
[y]G:gynoecious parental inbred; M:monoecious parental inbred.
[x]Data are means over 4 replications and 8 harvests of plants grown at 64,000/ha.
[w]Data are means over 6 replications and 6 harvests of plants grown at 48,000/ha.

Table 3. Cumulative yield of marketable fruits over all harvests for 3 'Meridian 76' fresh-market cucumber hybrids differing in gynoecious genotype.

Yield[z]	Hybrid type[y]	Yield (MT/ha) of fruits in harvest							
		1	1–2	1–3	1–4	1–5	1–6	1–7	1–8
		Summer 1981[x]							
Total	GxG	0.3	9.7	15.3	20.6	25.2	30.8	32.2	33.4
	GxM	2.0	10.0	13.3	17.8	22.4	26.8	27.9	29.7
	MxM	0.4	5.4	10.7	15.6	19.7	25.6	26.6	28.0
	LSD (5%)	1.1	3.9	NS	NS	NS	NS	NS	NS
Quality	GxG	0.3	5.3	8.2	8.7	9.5	10.7	10.8	11.3
	GxM	1.8	3.9	5.9	7.9	9.0	9.9	10.1	10.9
	MxM	0.4	4.5	9.1	12.2	14.0	16.3	16.7	17.8
	LSD (5%)	0.8	NS	NS	NS	NS	NS	NS	NS
		Spring 1983[w]							
Total	GxG	2.5	7.6	22.2	28.4	30.7	34.2	---	---
	GxM	4.1	7.0	19.8	26.3	27.9	33.6	---	---
	MxM	0.6	3.1	16.2	21.8	24.1	29.2	---	---
	LSD (5%)	2.7	NS	NS	NS	NS	NS	---	---
Quality	GxG	1.6	4.1	16.2	18.5	20.2	20.6	---	---
	GxM	3.2	4.0	12.1	14.1	14.6	16.6	---	---
	MxM	0.6	2.5	11.8	13.9	15.1	17.5	---	---
	LSD (5%)	1.9	NS	NS	NS	NS	NS	---	---

[z]Total yield is Fancy + No. 1 + No. 2 + cull; quality yield is Fancy + No. 1 grade fruit.
[y]G:gynoecious parental inbred; M:monoecious parental inbred.
[x]Data are means over 4 replications of plants grown at 64,000/ha.
[w]Data are means over 6 replications of plants grown at 48,000/ha.

GxM hybrids were similar in sex expression, and should have been similar in earliness as well. Tasdighi and Baker (9) found that gynoecious inbred lines of pickling cucumbers had 94% of the nodes pistillate compared with 12% pistillate nodes for monoecious lines. However, yield was the same for the 2 types for both total and marketable fruits. Their study differed from this one in that pickling cucumber lines were used, and yield was measured for once-over harvest.

Gynoecious hybrids offer advantages in earliness, but appear to be susceptible to the stress caused by a heavy fruit load when several pistillate flowers are pollinated and begin developing on the plant at about the same time. That stress results in poorly-shaped fruits and increases the percentage of culls. Thus, the earliness of gynoecious hybrids must be balanced against their tendency to produce more No. 2 and cull fruits. Monoecious hybrids have the advantage of developing a larger plant before fruit set than gynoecious hybrids and in setting fewer fruit at a time, permitting them to develop higher quality.

The GxM hybrid version of 'Meridian 76' had a higher early yield than the GxG and MxM hybrids, and there was a tendency for gynoecious hybrids to outyield monoecious hybrids in the first few harvests. However, there was no significant difference among the gynoecious and monoecious hybrids for yield summed over all harvests. The most important differences between gynoecious and monoecious hybrids were that gynoecious hybrids had more pistillate flowers in the first 10 nodes of each plant, more grade No. 2 and cull fruits, and higher yield in the first harvest of the crop. However, the monoecious hybrid tended to produce increased yields of quality fruits and caught up in yield with the gynoecious hybrids by the 2nd harvest. For growers, therefore, monoecious hybrids would require less handling of cull fruits. However, in North Carolina, fresh-market cucumbers are often harvested only a few times because of low prices for fruit harvested later in the season. Thus, gynoecious hybrids (especially the GxM type) offer an advantage in early yield when the price for fresh produce is highest.

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