Yield of *Cucurbita moschata* Lines and Hybrids Grown in Sonora, Mexico.

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Introduction: *Cucurbita moschata* Duchesne is widely cultivated in Mexico, mainly under rain-fed conditions. In Northwest Mexico, landraces of this species are known as Cehualca (or Segualca) and are grown for mature fruit consumption mostly during the summer-fall season. In the coastal valley of Hermosillo, Sonora, improved varieties of winter squash are grown for the export markets mainly to the USA and Japan. Kabocha squash (*C. maxima*), Acorn and Spaghetti (*C. pepo*), and Butternut (*C. moschata*) are typically sown in August and picked in November and December. Landraces of *C. moschata* and *C. argyrosperma* are grown in the state of Sonora in elevated areas with higher rainfall than the valleys, and are sown in July and picked in October and November.

The yields of winter squash are highly variable; 'El Dorado', a tropical hybrid of *C. moschata* reached 90 ton.ha-1 grown under drip irrigation and plastic mulch (6). In another work with C. moschata, a high yield of 85 ton.ha-1 was obtained for the tropical hybrid C-42 x La Segunda by transplanting and using mulching and row cover in a favorable year, but the yield decreased to 43 ton.ha-1 by direct seeding without mulching and row cover in the same year. The previous year (1998) was humid and the yield under the last method was 28 ton.ha-1 (11). Experimental yields of *C. moschata* landraces obtained in the Department of Agriculture and Animal Science of the University of Sonora (DAG) during the summer-fall season under furrow irrigation, changed from 7.9 to 17.8 ton.ha-1 (3), and from 1.2 to 24.6 ton.ha-1 for the winter-spring season (10). The yield was improved by increasing the plant population reaching 30.3 ton.ha-1 for the summer-fall season of 1988 using 0.33 plants per square meter (8).

Halloween types of winter squash were evaluated and it was found that the yield increased significantly by setting pollinators. The cultivar Libby´s Select (*C. moschata*) had the highest yield (74.8 ton.ha-1) while the *C. pepo* cultivars Appalachian and Mammoth Gold had yields of 54.3 and 30.6 ton.ha-1 respectively (13). Similar results were reported with other cultivars of *C. pepo* of the same type with a high yield of 51.9 ton.ha-1 (1). The commercial yields of Kabocha grown in Sonora usually fluctuate from 12 to 18 ton.ha-1 (personal communication, Ing. Ricardo Navarro) while in Australia high experimental yields, around 43 ton.ha-1, may be reached with an average of 21.1 ton.ha-1. The interspecific hybrid 'Tetsukabuto' (*C. maxima x C. moschata*) had a yield of 66 ton.ha-1 (7). C. argyrosperma germplasm evaluated at DAG had yields between 3.2 and 38.8 ton.ha-1 for the spring season and from 4 to 28 ton.ha-1 for the fall season (9). Some germplasm had very low fruit set during the spring season and for the fall season the yield limiting factor was infection with squash leaf curl virus (SLCV), a whitefly-transmitted geminivirus (2). Feeding of immature stages of the biotype B of Bemisia tabaci, induces the squash silverleaf (SSL) disorder in squash (12).

The objective of this work was to evaluate the yield of five C. moschata lines of the round fruit type obtained at DAG and 15 hybrids obtained between these lines, and to make observations

about their reaction to SSL and SLCV during the summer-fall season.

Materials and Methods: The experiment was conducted at the experimental farm of DAG during the summer-fall season of 2000. The material tested consisted of five C. moschata, round-type lines obtained at DAG. The previous season these lines were selfed and sibbed, and direct and inverse crosses were done between them obtaining enough seed to conduct a yield trial for 15 hybrids. Lines 301 and 303 are resistant to SSL while lines 101 and 102 are susceptible, and line 282 shows tolerance exhibiting only mild silvering. All the lines show field resistance to SLCV.

The soil was conventionally prepared by plowing and disking, and was irrigated twice before planting to allow annual and perennial weeds to grow and then to be sprayed with glyphosate. Melon beds were formed with 4 m center to center and fertilized with N-P-K (17-17-17) at a rate of 400 kg.ha-1. Seeds were sown on August 25 in moist soil with two lines per bed and two seeds per hill which were 50 cm apart. Seedlings were later thinned leaving one plant per hill. The experiment was furrow irrigated weekly or as needed depending on the weather. No pesticides were used during the whole growing period despite insect and disease pressure.

Fruits were picked once on December 21 and 22, they were weighed in groups of three to five, and immature and off-shape fruits were discarded. The experimental plots measured 7 m and a completely randomized design with two replicates was used for ANOVA and a Tukey test was used for mean separation. A contrast test was used to compare the individual yield of each hybrid with their parents.

Results and Discussion: The fruit yield changed from 17.1 to 42.6 ton.ha-1 with an average of 32.5 ton.ha-1 (Table 1). Hybrids had an average yield of 35.6 ton.ha-1 while lines produced 23.2 ton.ha-1. Despite these differences in yield, only two groups of significance were obtained (Tukey 0.05). However, when each hybrid was compared to both parents, it was observed that hybrids 102 x 301, 282 x 101, 282 x 102, 282 x 301, 301 x 102, 301 x 282, 303 x 101 and 303 x 282 had highly significant yields ($P>0.01$) and hybrids 102 x 303 and 301 x 101 had a significantly higher yield ($P>0.05$). Similarly, C. moschata hybrids obtained from tropical varieties produced higher yields than their parents (6, 11). Our results are also similar to those reported by Rulevich et al. (11) when they used direct seeding without mulching and polyester cover in a year with high rainfall conditions under which they had a yield of 28 ton.ha-1. In October, during fruit development, we had high rainfall, conditions which favored the presence of foliar diseases such as Alternaria leaf spot.

These yields are typical of C. moschata grown in our area with very low or without pesticide applications and show that hybrid vigor shows up in our materials developed from local landraces. In a very similar experiment with C. argyrosperma, hybrid vigor was not so evident (9).

It was observed (results not shown) that only lines 301 and 303 were resistant to SSL and that line 282 showed slight silvering. All hybrids obtained from SSL resistant x susceptible crosses were susceptible. Also, hybrids derived from crosses using line 282 as a parent showed slight silvering, and hybrids between the two resistant lines were resistant showing dominance of SSL, a condition previously reported (5). All lines and hybrids showed field resistance to SLCV; only line 301 had two

plants (from 10 readings) with slight symptoms. No sampling for virus identification was done in this experiment, but a neighboring C. moschata plot of the butternut type was positive for both SLCV-restricted and SLCV-extended host range (4). All lines and hybrids developed yellowing of basal leaves before maturity but its origin could not be determined.

These results show that it is possible to grow C. moschata lines or hybrids during the summer-fall season in our area and perhaps in other locations without using pesticides and have a reasonable yield. These materials may be grown organically as well. In comparison, commercial varieties of the acorn, spaghetti, butternut, and kabocha squash have to be sprayed for insect and disease control.

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Table 1. Fruit weight and yield for 5 lines and 15 hybrids of *Cucurbita moschata* evaluated in Sonora, Mexico in year 2000.

Line or hybrid	Fruit weight (kg)	Fruit yield (ton.ha^{-1})	Groups (Tukey 0.05)
303 x 301	4.3	42.6	a
102 x 303	3.3	42.4	a
303 x 282	3.4	39.5	ab
102 x 301	3.1	39.2	ab
282 x 101	4.1	38.8	ab
282 x 102	4.9	38.0	ab
301 x 102	3.2	37.7	ab
301 x 282	2.7	36.6	ab
282 x 301	3.6	36.4	ab
102 x 101	3.0	35.4	ab
301 x 101	3.4	35.1	ab
301 x 303	2.7	30.1	ab
303 x 301	2.7	30.0	ab
101 x 301	2.6	29.9	ab
303	1.9	28.8	ab
102	4.3	28.1	ab
101	3.0	24.4	ab
102 x 282	3.1	22.8	ab
301	1.6	17.4	b
282	2.8	17.1	b