

Behavior of Asparagus Cultivars in a Semi-Arid Environment: Curacavi, Chile

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Abstract

Three cultivar evaluation studies conducted at Curacavi, Chile have reaffirmed the intuitive introduction, almost twenty years ago, and the widespread plantation of the cultivar UC 157 F₁ which has proven to be quite adequate and the dominance of this cultivar is justified by its high yields and high quality. These studies have been conducted to evaluate various cultivars for their yields and spear quality in light of the present market conditions demanding smaller spear sizes. The appearance of new cultivars counsel a continued effort in studies of cultural practices and evaluation of cultivars to respond to the growers and market needs.

INTRODUCTION

The asparagus crop is a relevant component of vegetable production in Chile. Before 1980, the country had less than 300 ha producing only white asparagus, which were predominantly sold in the internal market. However, during the 80's, the establishment of the so-called free market economy, coupled with strong policies to increase exports, led to a rapid increase in area and to a transformation of the crop aiming to produce green asparagus to be exported, counter-season, to Northern hemisphere markets. After a rapid increase that led to a peak of over 6,960 ha in 1990, the area decreased and has stabilized at around 4,100 ha, distributed in a zone extending almost 1,000 km north to south, from latitude $\pm 33^{\circ}\text{S}$ to $\pm 43^{\circ}\text{S}$. Asparagus spears are exported as fresh, frozen, dehydrated or canned products to many countries, and the FOB value of all exports has fluctuated between US\$ 15 to US\$ 20 millions in the last five years (Krarup, 2002).

The rapid increase of the asparagus crop was done without evaluation of new cultivars and, intuitively, most of the area was planted with UC derived material such as UC-157 F₁, UC-157 F₂ and UC-72 (Krarup and Krarup, 1990). The evaluation of cultivars, although an on-going, expensive and many times tedious process, is indispensable to attain the best economic returns for any crop. This is especially relevant in the case of asparagus because of the perennial nature of the crop and the problems posed by replanting; the decision to plant any given cultivar of asparagus will have long term consequences on economic yield and is not easily reversible. On the other hand, the time period needed for cultivar evaluation is long. It has been suggested or postulated that

a minimum of between two (Busnell et al., 1985) to four harvest periods (Corriols, 1985) is necessary to have a good indication of long time performance, with some relative changes expected in later harvests. The gap between cultivar release and evaluation results, together with the pressing need of growers to establish the crop, advises an early and wide dissemination of results of the evaluations of cultivars.

In Chile, as a result of the greater relevance of the crop and the continuous release of new cultivars, an effort has been made during the last 15 years to evaluate some of these cultivars. The first systematic evaluation of asparagus cultivars was started in 1985, being part of the 1st International Asparagus Cultivars Trial (1st IACT), directed by M. Nichols. In 1994, the 2nd International Asparagus Cultivars Trial (2nd IACT), directed by B. Benson, was installed at the same site. Finally, in 1998, a new trial was initiated with a few selected control and promising cultivars planted with different plant populations in the Asparagus Cultivars and Population Trial (ACPT), to respond to the growing interest in higher plant populations. This publication summarizes the highlights of these three evaluation trials carried out in Curacaví, a semi-arid region in the center of Chile, that could be exemplary for similar areas.

* Funded by Project Fondecyt N° 1940747 and Project Fondecyt N° 1990135.

MATERIALS AND METHODS

The three evaluations to be reported have been conducted at the experimental farm of the Universidad Católica de Chile, located in Curacaví (33°25'S, 71°11'W). The site has a semi-arid climate, with 360 mm of rainfall concentrated from mid-autumn to the end of winter (April to September), and a mean annual temperature of 13,95° C (min. = 6.3° C and max. = 21.6° C). The growing season for asparagus can extend for almost 9 months, from September to May, with the following average temperatures for the period: max. = 23.8° C, media = 15,6° C, and min. = 7.4° C, and with an average relative humidity close to 50%. The soil conditions at the site are presented in Table 1.

Table 1. Characteristics of a representative soil sample in Curacaví, Chile.

Soil Type	Inceptisol
Soil Texture	Sandy Loam
pH	6,89
Organic Matter	1,75%
Salinity, Suspension	0,86 dS/m
Salinity, Extract	1,46 dS/m
Available N	53 ppm
Available P	40 ppm
Available K	157 ppm
Microelements	Adequate

The 1st IACT included 11 cultivars that were seeded in October 1985 and transplanted in August, 1986. The experimental layout was a randomized complete block design, with four replicates of 8 m long rows, separated 1.5 m, with plants every 0.33 m in the row (25 plants/replicate) to attain a plant population of 22.222 pl/ha. The 2nd IACT included 15 cultivars that were seeded in November 1994 and transplanted in October 1995. The experimental layout had the same design characteristics as the 1st IACT. The ACPT included 6 cultivars that were seeded in containers in July 1999 and transplanted in December 1999. The experimental layout had the same general design characteristics as the 1st IACT but included 2 population treatments for each cultivar: 22.222 pl/ha as described, and 44.000 pl/ha, attained with rows at 1m and with plants every 0.225 m in the row.

Cultural management of the trials was done following usually recommended practices. These include: furrow irrigation according to requirements, an annual fertilization applied before harvest (50 kg each of N, P and K) and after harvest (50 kg N), foliage removal and weed control with herbicides (trifluraline plus diuron or other) and soil pests control with an insecticide (lorsban or dyphonate) before harvest, once a year. No fungicides have been used because the plants have not shown significant diseases. In general, trials have had almost complete establishment and survival of plants during the evaluation period, with very slight differences among cultivars.

Harvesting has been initiated in all trials a year after the establishment of the crop in the experimental site, at the initiation of the second season of growth in spring. Harvest was done daily, for different periods of time according to age of the plants. At harvest, the total yield of spears was recorded in the field and, immediately after in a packing shed, the following fractions by weight were determined:

- **exportable fraction:** corresponds to 22.5 cm long, straight spears, with tight bud scales and without any defects, acceptable to be exported in five classes according to diameter at the base (5.0 to 9.9 mm, 10.0 to 14.9 mm, 15.0 to 19.9 mm, 20.0 to 24.9 mm and over 25.0 mm). This fraction is the result of selection according to specific parameters of quality and is the relevant fraction for growers focused in exports. The term marketable fraction or yield is not used because it will vary depending on the ability or interest of the farmers to sell a marginal part of the culls.
- **cuttings fraction:** corresponds to the sum of the basal pieces remaining after trimming the spears of the exportable fraction to a length of 22.5 cm, and
- **culls fraction:** corresponds to the rest of the spears harvested that are less than 22.5 cm long or less than 5 mm in diameter, with any branch 5 mm over bud scales, bent, twisted, damaged or with clear disease symptoms. A small percentage of this fraction could still be marketed as tips or as spears in secondary markets.

RESULTS AND DISCUSSION

The results of the 1st IACT indicated different responses in total yield and exportable yield among cultivars. The data for the third year's harvest shown in Table 2 reveals that total yields varied between 4750 kg/ha (Franklim) to 7259 kg/ha (Jersey Giant). These yields are about average for commercial plantations of the same age, but somewhat lower than expected in a trial and were due to a rainy spring. However, the third year's harvest is presented because it serves to make a point about quality: the exportable yields will be higher and similar among cultivars in a short harvest or with low average temperatures. Thus, Gijnlim, Jersey Giant and UC-157 F1 had very similar and close to 60% exportable yield but, as will be shown with data of the 2nd IACT where these cultivars were used as controls, the situation is not always the same.

Cuttings percentages, between 10.3 % (Franklim) and 13.8% (Tainan), and culls percentages, from 18.8% (Tainan) to 32.0% (Franklim) are also somewhat lower than

usual because spears grew slowly. In all cases the major component of the culls fraction are ramified or feathery spears and, in general, European cultivars developed for white production tend to be more prone to this problem.

One of the most interesting results of this trial for Chilean production was the fact that UC-157 F1 was the second highest total yielding cultivar and showed high exportable yield. This somewhat validated the intuitive selection made by specialists and growers to plant it in the country. The results of this and other harvests of the same 1st IACT also made clear that total yields in the site are medium to high compared to reported yields in other areas, and that total yield should not be used as the sole criterion to select a cultivar; in fact, it can be quite misleading if not coupled to quality.

Table 2. First International Asparagus Cultivars Trial: total yield and yield fractions after the third harvest (62 days)

Cultivar	YIELD			Cuttings %	Culls %
	Total (kg/ha)	Exportable			
		(kg/ha)	%		
Cito	4929	3155	64,0	11,2	24,8
Del Monte	6136	3832	62,5	12,8	24,8
Franklim	4750	2741	57,7	10,3	32,0
Gijnlim	5535	3212	58,0	10,4	31,6
Jersey Giant	7259	4310	59,4	12,5	28,1
Larac	5541	3205	57,8	10,9	31,2
Largo 17-3	6465	3930	60,8	11,3	27,9
Lucullus 234	6982	4443	63,6	11,5	24,9
Lucullus 310	6013	3589	59,7	11,0	29,3
Tainan N°1	6010	4055	67,4	13,8	18,8
UC-157 F1	6713	4082	60,8	12,1	27,0

The data of the 2nd IACT (Table 3) show that in a normal spring with a usual harvest period (75 days), the yield potential of the asparagus crop in Curacaví can be quite high, but is markedly influenced by the cultivar. Jersey Giant, Valprima and Gijnlim yielded over 15.000 kg/ha, while cultivars such as Purple Passion, Argo y Diego produced less than half of that amount. However, even such large total yield differences do not allow outright selection of cultivars because quality characteristics and the relationship total yield/quality have to be considered and, therefore, exportable yield is the adequate and relevant variable to select a cultivar.

Data in Table 3 indicate that exportable yield values ranged from 1,817 kg/ha in Argo to 8,679 kg/ha in UC-157 F1, an almost five times difference between cultivars that

is not seen in total yield. The marketable yield, or exportable yield in this case, exacerbates the differences between cultivars as already demonstrated in other studies (Nichols and Fisher, 1999). Using this parameter, UC-157 F1, Atlas and JWC1, with exportable yields of 8.679, 7.043 and 6.876 kg/ha respectively, are the most attractive cultivars. Again, this trial confirms that UC-157 F1 was a fortunate choice.

The exportable yields expressed in percentage are lower than those reported in Table 2, varying from as low as 28.1% in Abril to a high of 58.5% in Purple Passion, because of the longer harvest period with higher average temperatures. It is interesting to note that these percentages are not related to total yield. For example, Jersey Giant had the highest total yield but one of the lowest exportable yields because of early feathering, while Purple Passion had the lowest total yield and the highest exportable yield, because its spears do not branch until quite long. In this more prolonged and hotter harvest period, UC-157 F1 had 57.9%, Gijnlim had 41.1% and Jersey Giant only 31.7% of the total production as exportable yield, revealing that UC-157 F1 kept its quality and is clearly better adapted to Chilean spring conditions.

Table 3. Second International Asparagus Cultivars Trial: total yield and yield fractions after the fourth harvest (75 days)

CULTIVAR	Total yield Kg/ha	Exportable yield		Cuttings %	Culls %	Spear weight g
		kg/ha	%			
Abril	10372	2256	21,8	16,9	61,3	19,2
Argo	6043	1817	30,0	15,5	54,5	18,6
Atlas	13729	7043	51,3	16,6	32,1	24,6
Ciprés	14579	6359	43,6	18,9	37,5	23,5
Diego	6678	2503	37,5	17,9	44,6	14,3
Eros	10362	3132	30,2	17,7	52,1	18,3
Gijnlim	15540	6390	41,1	18,2	40,7	19,2
Golia	12502	4530	36,2	17,6	46,2	23,4
Jersey Giant	17987	5701	31,7	18,9	49,4	20,0
JWC1	14319	6876	48,0	18,9	33,1	21,5
Purple Passion	5758	3371	58,5	14,6	26,9	26,8
Taramea	12455	3972	31,9	20,2	47,9	17,7
UC157 F1	14997	8679	57,9	18,6	23,5	23,1
UC157 F2	10563	5323	50,4	17,5	32,1	19,4
Valprima	16244	4843	29,8	19,0	51,2	23,0

Another quality characteristic that has become quite relevant in cultivar selection in the last few years is spear size, measured as weight or caliber. Preferences in most markets have changed. Jumbo or extra large sizes that used to get premium prizes in many markets are presently hard to sell and consumers prefer medium to large sizes, which are more demanded and fetch better prizes (Paske, 1996). As can be seen in Table 3, average spear weight of the exportable yield varies markedly between cultivars, from 14.3 g in Diego to 26.8 g in Purple Passion.

Size distribution of spears according to their diameter (Figure 1) shows that cultivars like Purple Passion, Atlas, Ciprés and Golía, the heaviest ones, have almost 30% of their exportable spears with diameters over 20 mm while other cultivars such as Diego, Abril and Eros present less than 10% in the same categories. UC-157 F1 has about 22% and Atlas about 27% of the spears over 20 mm and, although these cultivars are still the best choice for Chilean conditions, growers and exporters would like their spears to be lighter or thinner

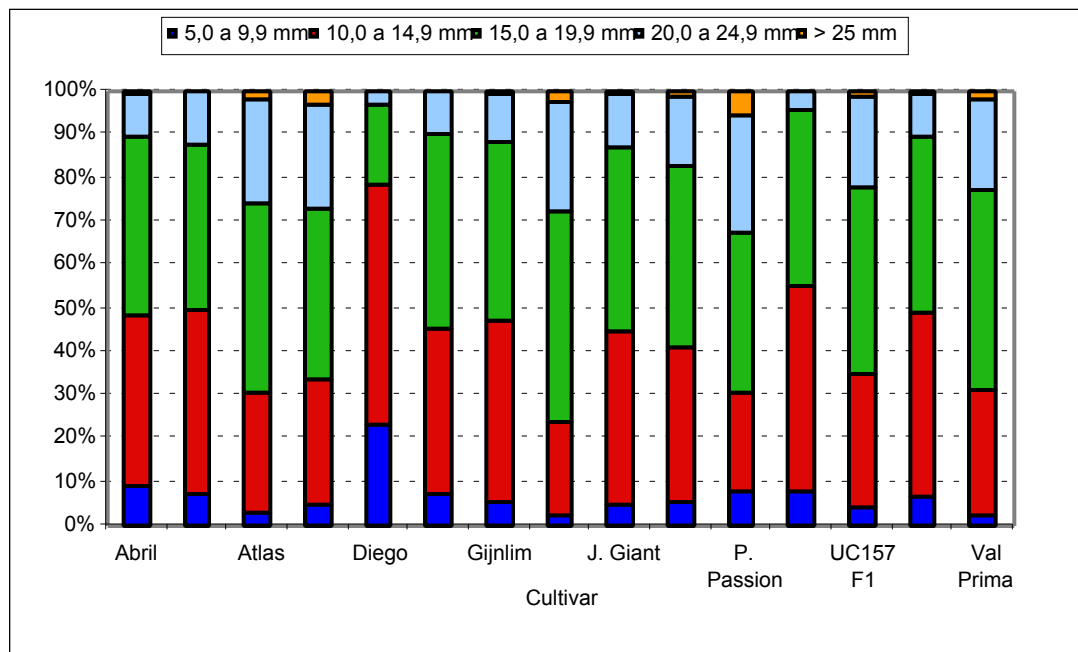


Figure 1. Second International Asparagus Cultivars Trial: per cent distribution of exportable yield according to spear diameter.

Different studies have shown that, for a given cultivar, size of spears depends partially in plant density (McCormick and Thomsen, 1990) . The Asparagus Cultivars and Populations (ACPT) established in 1999 has as main objectives to evaluate six cultivars planted at two plant densities, to measure cultivar and spear size response. Results of the second harvest carried out in 2001 for 45 days (Figure 2), although still very early in the production life span, are quite consistent with yield relationships observed between Atlas, Jersey Giant, JWC 1, UC-157 F1 and UC-157 F2 in previous trials. Pacific 2000, included because yields are supposed to be higher and quality comparable to JWC1, has had a promising performance and shows the need of evaluating new cultivars as they are released.

Plant density had a clear effect on total and exportable yield of all cultivars. The average total yield (exportable yield) of all cultivars is 5.442 (2.944) kg/ha with 22.222 pl/ha and 7.790 (4.066) kg/ha with 44.444 pl/ha. This implies 43% more total yield and 38% more exportable yield at the higher plant density. The average spear weight (data not shown) was slightly affected by plant density, with only a 4.8% decrease in weight at the higher density, although it is expected that this effect may be more marked in later harvests (McCormick and Thomsen, 1990).

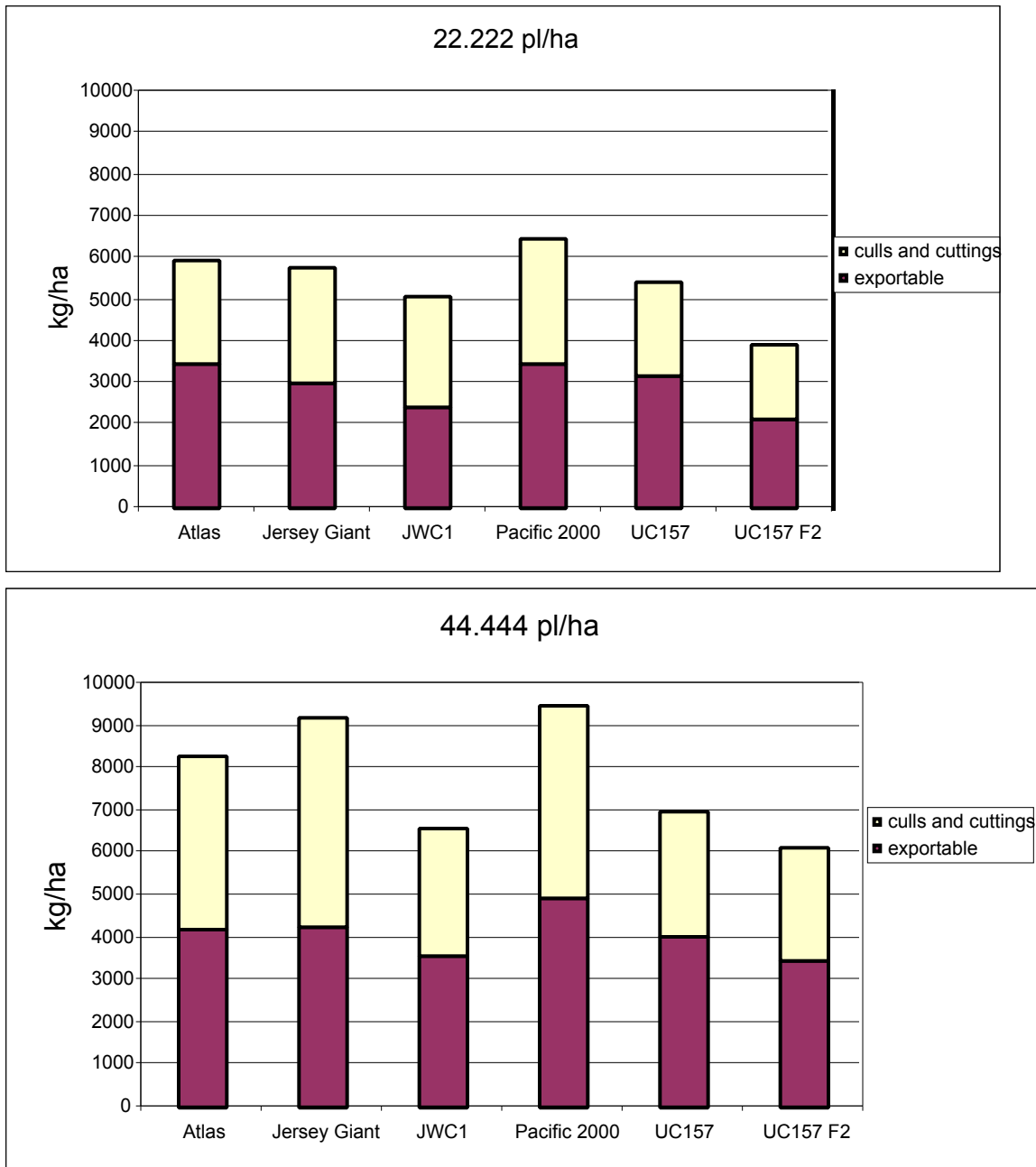


Figure 2. Total yield and yield fractions after the second harvest (45 days) of six asparagus cultivars planted in two different populations.

CONCLUSIONS

- The progressive asparagus cultivar trials reported not only have provided objective data to select best adapted cultivars to Chilean conditions, but have also set the base and identified adequate controls for future evaluations.
- The intuitive introduction, almost twenty years ago, and the widespread plantation of the cultivar UC-157 F1 has proven to be quite adequate and the dominance of this cultivar is justified by high yields and high quality.
- Present market conditions demanding smaller spear sizes and the appearance of new cultivars counsel a continued effort in studies of cultural practices and evaluation of cultivars to respond to the growers and market needs.

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