# AN OVERVIEW OF PRICKLY PEAR CULTIVATION IN THE CENTRAL PART OF MEXICO

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## INTRODUCTION

The semiarid regions of the central part of Mexico host the greatest genetic diversity of prickly pear in the world and the greatest cultivated areas of prickly pear in the world. This variability is found in both cultivated and wild populations. The cultivated plantations are grown in organized plantations in monoculture or intercropped with traditional crops (e.g. corn, beans) and in the backyards of rural homes. The wild populations form patches of plants, with population densities that vary from 100 to 1,000 plants per hectare. These wild *Opuntia* stands form an integral part of the natural ecosystems of these semiarid regions. The prickly pear species that produce edible fruits are: *Opuntia ficus-indica, O. streptacanthae, O. lindheimeri* and *O. robusta.* In wild populations the most important species is *O. streptacanthae.* In the backyard of rural homes and commercial orchards the most common species is *O. ficus-indica* and hybrids that resulted from crosses between *O. ficus-indica* and *O. streptacanthae.*

The use of prickly pear as a biotic resource dates back to mesoamerican civilizations, but it was not until the 1950's when modern commercial plantings started in Mexico. During the last decade prickly pear has become an important fruit crop, due to the fact that the cultivated area showed a dramatic increase in size. In 1980 prickly pear was cultivated on over 10,000 hectares while for the present year (1991) it is estimated to be cultivated on more than 60,000 hectares. The increase in the area of commercial plantations is a strategy of the inhabitants of the semiarids regions of Mexico, who wish to avoid the disastrous consequences of frequent severe droughts on crops and livestock. In this paper we attempt to present in brief a general overview of prickly pear cultivation in Mexico.

## GEOGRAPHICAL DISTRIBUTION

The majority of the commercial plantations are located in two main production centers. The most important is found in the highlands of the semiarid regions of the central-north part that comprises the states of Zacatecas, San Luis Potosi, Aguascalientes, Jalisco, and Guanajuato in which the cultivated area is estimated to be greater than 35,000 hectares. The other center is situated in the central-south region which includes territorial parts of the states of Hidalgo, Mexico, Tlaxcala, and Puebla, in which prickly pear grows in an area of approximately 15,000 hectare. There are other production centers, however they are dispersed and occupy relatively small areas (Figure 1).

The commercial plantations in the central north region, are found at elevations from 1,800 to 2,200 m above sea level. The summer rainfall varies from 400 to 500 mm per annum with a bimodal pattern of distribution. Some years rains occur during the winter months. However, in most of the years the dry period coincides with the winter and spring seasons. The average temperature during the year varies from 16 to 18 C. Most of the soils are shallow and derived from igneous rocks, with a sandy-loam soil texture. The soil pH ranges from moderately acid (5.1-6.0) to slightly acid (6.1-6.7). The organic matter content is low (0.8-1.8%). The natural vegetation is composed mainly of grasses of the genus *Buchloe, Sporobolus, Bouteloua*, and *Muhlbergia.*

In the central-south part, the cultivated prickly pear populations are grown on different types of soils. The main types are: feozem, vertisol, and luvisol. The feozem is the most abundant type, which is characterized by the presence of a superficial dark layer, rich in organic matter and mineral nutrients. The luvisols are distinguished by a subsoil clay accumulation, with a pH that fluctuates from slightly acid to extremely acid. The vertisols are more fertile than the feozem and luvisols with a high clay content.

In this region the commercial plantations occur in areas with an elevation from 1,800 to 2,400 meters above sea level, and a rainfall from 400 to 700 mm per annum. The annual average temperature varies from 14 to 18 C.

Prickly pear plantations that are established in localities where the mean annual rainfall is less than 300 mm, are severely affected by the drought. The effects of drought are further exacerbated by browse from wildlife that face a scarcity of food from natural vegetation. Another important limiting factor is soil pH, since few commercial varieties grow satisfactorily in alkaline soils; most prefer acid soils.

## VARIABILITY IN PRICKLY PEAR

### Fruit Ripening Time

Although the variability of prickly pear varieties is relatively abundant in Mexico, this variation is considerably reduced in modern commercial plantations (Table 1). In Figure 2 are presented the fruit ripening periods of a selected number of varieties growing in the backyard of rural homes, wild populations and commercial orchards. The existence of a wide variability in the periods of fruit ripening is evident. Most of the varieties showed fruit ripening from July to September. A few of them had early ripening (May-June) or late ripening (November-December). It is important to notice that in the backyard are found early, intermediate and late ripening varieties. In contrast most of the varieties growing in cultivated orchards are intermediate ripening varieties. Most of the species of wild populations are intermediate, while a few of them like "cascarona" are late ripening.

Figure I_ Geographical distribution of prickly pear plantations in Mexico.

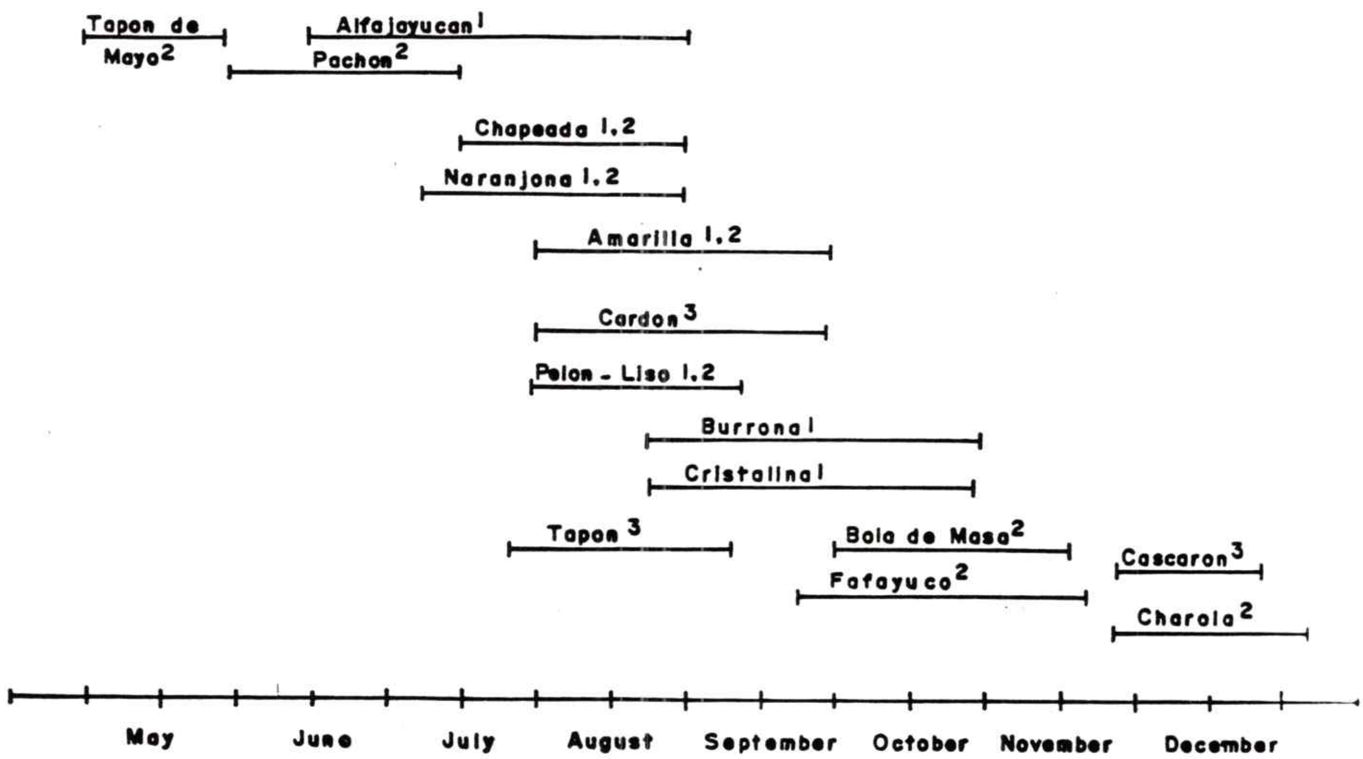


Figure 2 - Fruit ripening periods of the most important prickly pear varieties in cultivated populations[1], backyard of rural homes and wild populations[3].

Fruit Size and Color

In Table 2 is presented the variability in size and color of selected pricklypear varieties growing in wild and cultivated populations. The variation in fruit size, i.e. 60 to 240 g is particularly striking. The biggest fruits are produced in cultivated orchards and the smallest are produced in wild populations. The fruits with the greatest weight are commonly found in prickly varieties with green-clear color. In most of the varieties the non-edible part constitutes between 40 to 60% of the total fruit weight.

**Table 1.** Varieties of Prickly Pear cultivated in Mexico.

| Common name | Fruit color | Producer state | Fruit ripening period |
|---|---|---|---|
| Blanca Alfafayucan | green-clear | Mexico<br>Hidalgo<br>Tlaxcala<br>Guanajuato | July-September |
| Blanca Chapeada | green-clear | Zacàtecas<br>San Luis Potosi<br>Jalisco | July-September |
| Amarilla Huesona | yellow-brown | Aguascalientes<br>Zacatecas<br>San Luis Potosi | August-September |
| Amarilla Naranjona | yellow-orange | Jalisco<br>Zacatecas | July-August |
| Rojo Pelon | red-purple | San Luis Potosi<br>Guanajuato | July-August |
| Blanca Cristalina | green-clear | Zacatecas | September-October |
| Blanca Burrona | green-clear | Jalisco<br>Zacatecas | September-October |
| Blanca de Castilla | green-clear | Zacatecas<br>Aguascalientes | August-September |
| Papanton | green-clear | Zacatecas | August-September |

**Table 2.** Variability of average fruit weight and their components in Prickly Pear varieties growing on wild and cultivated populations. (Pimienta y Mauricio, 1989).

| Common name | Fruit weight (g) | Fruit color | Edible part weight (g) | Non-edible part weight (g) | |
|---|---|---|---|---|---|
| | | | | peel | seed |
| Cristalina[1] | 240 | green-clear | 152 | 79 | 8 |
| Pepinillo[1] | 190 | green-clear | 107 | 77 | 7 |
| Blanca[2] | 179 | green-clear | 96 | 76 | 5 |
| Calabazona[2] | 175 | green-clear | 103 | 66 | 6 |
| Fafayuco[1,2] | 166 | green-clear | 77 | 82 | 7 |
| Blanca de[1] Castilla | 148 | green-clear | 75 | 67 | 6 |
| Amarilla[1,2] | 143 | orange-yellow | 79 | 60 | 4 |
| Chapeada[1,2] | 128 | green-clear | 63 | 61 | 5 |
| Camuesa[2] | 128 | red-purple | 72 | 51 | 5 |
| Pelon-liso[1,2] | 116 | red | 59 | 52 | 5 |
| Charola[2] | 89 | red-dark | 42 | 44 | 3 |
| Cardona[3] | 59 | red-dark | 20 | 37 | 2 |

[1]Fruit collected in commercial plantations.
[2]Fruit collected in backyard of rural homes.
[3]Fruit collected in wild populations.

Chemical Composition

Recently Delgado and Pimienta (in press) completed an extensive evaluation of the chemical composition of both pulp and seeds in fruits of wild and cultivated prickly pear varieties growing in the plateau Potosino-Zacatecano and neighboring states. Although this evaluation was made on over 100 different varieties, the results of 19 selected varieties is presented in Table 3.

**Table 3.** Variation in the chemical composition of the pulp of wild and cultivated prickly pear varieties and forms (Delgado and Pimienta, In press).

| Common name | T. Soluble solids (%) | Total sugars (%) | Reducing sugars (%) | Ascorbic acid (mg/100g) | pH | Acidity expressed as malic acid (%) |
|---|---|---|---|---|---|---|
| Alfajayucan | 13 | 14 | 8 | 31 | 6.8 | 0.033 |
| Mexicana | 14 | 15 | 14 | 27 | 6.6 | 0.040 |
| Papanton | 13 | 14 | 9 | 21 | 6.8 | 0.037 |
| Pepinillo | 14 | 12 | 9 | 19 | 7.1 | 0.027 |
| Pelon-liso | 15 | 14 | 8 | 17 | 6.4 | 0.049 |
| Chapeada | 14 | 15 | 8 | 28 | 6.6 | 0.037 |
| Camuesa | 13 | 15 | 8 | 15 | 6.7 | 0.037 |
| Fafayuco | 14 | 14 | 5 | 35 | 6.6 | 0.030 |
| Calabazona | 13 | 13 | 10 | 18 | 6.8 | 0.027 |
| Serrana | 15 | 17 | 9 | 41 | 6.5 | 0.046 |
| Amarilla | 13 | 13 | 8 | 5 | 6.6 | 0.046 |
| Roja | 16 | 15 | 10 | 14 | 6.7 | 0.030 |
| Blanca | 15 | 12 | 7 | 28 | 6.6 | 0.037 |
| Naranjona | 14 | 17 | 10 | 19 | 7.0 | 0.021 |
| Cardon de Castilla | 14 | 15 | 8 | 13 | 7.0 | 0.015 |
| Tapon | 11 | 12 | 7 | 26 | 6.9 | 0.024 |
| Cardon | 12 | 16 | 8 | 9 | 6.5 | 0.049 |
| Jarrillo | 15 | 17 | 9 | 9 | 7.0 | 0.037 |

The percentage of total soluble solids varied between 11 and 16% and the tot sugars from 12 to 17%. The reducing sugars had a greater range of variation, i.e. from to 14%. In the majority of the varieties, the percentage of reducing sugars was greater th 50%. However in the "mexicana" and "calabazona" the percentages of reducing sugar we extremely high.

Considerable variation was also found in the percentage of ascorbic acid. The highest value was found in the form "Serrana" (41mg/100g) and the lowest one with "Amarilla" (5mg/100g). An interesting observation was the fact that the highest contents of ascorbic acid were found in those varieties that produce fruits with pulp of green-clear color.

Less variation was found in the pH values, i.e. from 6.5 and 7.5. On the other hand, the percentage of titratable acidity had greater variation than pH; it varied from 0.015 to 0.049.

Another interesting observation was that the fruits with green-clear color pulp had the pigment chlorophyll. The content of chlorophyll varied from 2 to 11 mg/g. Chlorophyll a and chlorophyll b were detected in almost identical amounts, in most of the varieties.

The nutritive value of prickly pear compares favorably with other fruit crops such as apples, apricots, cherries, and oranges. The fruits may be considered as good source of vitamin C with a high calorific content. The relatively high sugar content of most of the varieties, allows the successful manufacture of a diversity of products like marmalade, jelly, juice, and compote (Cruz, 1981; Sawaya et al. 1983; Sepulveda y Saenz, 1990).

We also found considerable variation in the seed oil and protein contents (Table 4). It is important to notice that the oil content was higher in the seeds of fruits collected in wild populations than in cultivated populations. Less variation was registered in the protein contents and no clear differences in protein content between wild and cultivated varieties were observed (Table 4).

Most of fatty acids of the prickly pear seeds were unsaturated fatty acids. The most common fatty acids were : linoleic acid, oleic acid, palmitic, and stearic acid. Linoleic acid occurred in the highest percentage. The variation on the percentage of fatty acid on some selected prickly pear forms and varieties is shown in Table 5.

The high level of unsaturation, the high level of linoleic acid, and the absence of linolenic acid, indicates that prickly pear seeds might be an excellent source of edible oil for human consumption. The paste that is obtained after the process of oil extraction may be also an important forage for domestic fowl.

**Table 4.** Percentages of seed protein and oil in Prickly Pear varieties and forms (Delgado and Pimienta, In press).

| Common name | Oil (%) | Protein (%) |
|---|---|---|
| Tapon[3] | 20.0 | 8.6 |
| Cascaron[3] | 16.2 | 10.7 |
| Bola de Masa[2] | 15.4 | 8.2 |
| Fafayuco[1,2] | 14.4 | 8.3 |
| Redonda[2] | 14.4 | 8.3 |
| Cardona[3] | 14.2 | 9.3 |
| Pachon[2] | 11.6 | 8.5 |
| Chapeada[1,2] | 10.6 | 8.8 |
| Cristalina[1] | 10.1 | 7.1 |
| Amarilla[1,2] | 9.8 | 8.6 |
| Pelon-lisa[1,2] | 8.4 | 8.8 |
| Burrona[1] | 6.4 | 6.2 |

[1]Fruits collected in cultivated orchard.
[2]Fruits collected in backyard of rural homes.
[3]Fruits collected in wild populations.

**Table 5.** Variation in the percentage of fatty acids of selected prickly pear varieties and forms (Delgado and Pimienta, In press).

| | Fatty acid (%) | | | |
|---|---|---|---|---|
| Common name | Linoleic | Oleic | Palmitic | Estearic |
| Roja | 77.3 | 12.9 | 8.9 | 0.7 |
| Chapeada | 74.9 | 14.9 | 8.9 | 1.1 |
| Blanca | 74.5 | 13.7 | 10.5 | 1.3 |
| Pelon-Blanco | 70.7 | 14.1 | 14.9 | 0.9 |
| Mazuda | 68.9 | 15.9 | 14.9 | 0.7 |
| Apastillada | 68.7 | 18.1 | 14.3 | 0.9 |
| Calabazona | 67.3 | 17.3 | 14.4 | 0.9 |
| Pachona | 66.7 | 14.1 | 10.2 | 1.1 |
| Cardon | 61.1 | 23.4 | 13.2 | 2.4 |
| Tapon | 59.8 | 22.4 | 15.6 | 2.4 |

## THE STATUS OF PRICKLY PEAR COMMERCIAL PLANTATIONS

As we mentioned previously most of the commercial varieties ripen fruits during August and September, creating excess production that causes a negative impact on the prices of prickly pear in both national and international markets. Recent exploration of new markets in USA and Europe revealed a significant potential market for fresh prickly pear fruits. Unfortunately these countries were most interested in the red and yellow varieties which are only grown on small areas by Mexican prickly pear growers. The green varieties are most widely grown in Mexico. As a result of this market tendency, the growers have started planting red and yellow varieties. Perhaps in five more years plantations of yellow and red fruited varieties will be satisfying the new demand. As a consequence of this specific demand for fruit color, but not size or shape, the growers have been prompted to reexamine the prickly pear variability in the backyards of rural homes. Fortunately ample variability in fruit color fruit and date of ripening exists in these backyard populations.

Among the cultivated varieties, there are contrasting differences in fruit yield and quality, and also in the sensitivity to biotic and abiotic factors that affect growth and productivity. For instance, most of the prickly pear varieties that produce fruits with green clear color are highly productive and are vary adaptable to different soil types. In contrast the varieties that produce fruits of red color, have more specific requirements of soil type. This in part explains why varieties such as "Burrona" that produce the so-called green fruits are widely distributed, notwithstanding the somewhat poorer fruit quality. However, the green varieties are preferred by the producers because: they have high stable yields, their flowering occurs after the last spring frost, and the fruits are resistant to manipulations of harvest, selection, packing, and transportation. Prickly pear growers know that there are better varieties than those growing in commercial plantations, but these varieties which are found in backyards of rural homes have low yields, are easily damaged fruit and have early flowering.

Fruit yields are relatively low in most of the commercial plantings. Typical yields range from 2 to 8 tons per hectare although in some orchards the yields may be 20 t/hectare. Those yields are relatively low if we compare them with the yields reported in other prickly pear producing countries as Chile, Italy, and Southern Africa in which yields are reported to be greater than 30 tons per hectare (Gibson and Nobel, 1986; Brutsch, 1984; Barbera, 1987) The low yields are in part due to the fact that most growers do not use any cultural practices (fertilization, pruning). As a result of this lack of attention, the plants have poor growth and low yields. Apparently the absence of cultural practices creates a condition of physiological weakness, that makes prickly pear more sensitive to damage caused by pest and diseases, and environmental stresses (e.g. drought, low temperature).

A recent trial found a significant response of fertilization on fruit yield in prickly pears. This experiment evaluated the combined effect of manure and mineral fertilizers on the fruit yield of young and old prickly pear orchards. In table 6 is presented the response of fertilization on fruit yield of the young orchard (3 years at the start of the experiment) and of the old orchard (25 years at the start of the experiment). The fruit yield response in the young orchard was detected two years after the first application (1985). In both years (1987 and 1988) in which we registered a yield response, the majority of the treatments showed yields greater than the control. The combination of manure and nitrogen was synergistic in providing greater yields than either treatment alone. The nitrogen alone treatment did not significantly increase fruit yield. An important observation was that P205 fertilization increased yield over the manure and nitrogen treatment.

In the old orchard we found that 3 years (1987) after the beginning of the experiment, there was a dramatic increase in fruit yield with addition of mineral fertilizers. In the third year, treatments 6 and 8 which had the highest doses of manure and mineral fertilizers, obtained yields close to 28 ton/hectare. Once again, a low fruit yield was obtained when nitrogen alone was applied. However, low yields were also obtained in the treatment in which manure alone was applied (Table 7).

Empirical field observations on commercial prickly pear orchards show that pruning alone, may be effective in promoting fruit yields. This effect is more pronounced in old orchards (over 20 years).

Despite the fact that the prickly pear growers are convinced that the cultural practices are beneficial for their orchards, they do not perform them. This is because most prickly pear growers face economic restrictions that does not allow to them to invest in their orchards. This is compounded by the fact the sale prices and markets are variable and uncertain.

**Table 6.** Effects of mineral fertilizers and manure on the response on fruit yield in a young prickly pear orchard (Mondragon y Pimienta, 1987).

| | Treatment | | | | | Fruit Yield (ton/ha) | |
|---|---|---|---|---|---|---|---|
| Number | CM (ton/ha) | N Kg/ha | $P_2O_5$ Kg/ha | $K_2O$ Kg/ha | BM (ton/ha) | 1987 | 1988 |
| 1 | 3 | 20 | | | | 4.8 | 5.5 |
| 2 | 3 | 40 | | | | 4.4 | 8.6 |
| 3 | 6 | 20 | | | | 3.6 | 5.3 |
| 4 | 6 | 40 | | | | 4.3 | 8.4 |
| 5 | 0 | 20 | | | | 0.5 | 1.2 |
| 6 | 9 | 40 | | | | 5.9 | 7.9 |
| 7 | 3 | 0 | | | | 3.6 | 5.7 |
| 8 | 6 | 60 | | | | 4.5 | 11.2 |
| 9 | 6 | 40 | 20 | | | 6.2 | 11.8 |
| 10 | 6 | 40 | 0 | 20 | | 6.0 | 8.2 |
| 11 | 0 | 0 | 0 | 0 | 6 | 4.8 | 6.1 |
| 12 | 0 | 0 | 0 | 0 | 0 | 0.8 | 0.6 |

CM = Chicken Manure.
BM = Bovine Manure.

During the last several years the prickly pear growers have become aware of the increased damage caused by pests and diseases that severely affects fruit yield and fruit quality. The research oriented to the control of pests and diseases in prickly pear is scarce. It is paradoxical, that there is more information available on the biological control of natural prickly pear populations using phytophagous insects, than in the control of those insects. In spite of the lack of information on the control of parasites that affect prickly pear, growers have started applying agrochemicals to reduce damage caused by insects. This situation needs to be prevented, to avoid the environmental impact on the natural equilibrium of insect population.

**Table 7.** Effects of mineral fertilizers and manure on the response on fruit yield in an old prickly pear orchard (Mondragon y Pimienta, 1987).

| | Treatment | | | | | Fruit Yield (ton/ha) | | | |
|---|---|---|---|---|---|---|---|---|---|
| # | CM (ton/ha) | N Kg/ha | $P_2O_5$ Kg/ha | $K_2O$ Kg/ha | BM (ton/ha) | 1985 | 1986 | 1987 | 1988 |
| 1 | 3 | 20 | | | | 2.9 | 3.8 | 15.1 | 11.3 |
| 2 | 3 | 40 | | | | 3.9 | 2.9 | 22.2 | 16.9 |
| 3 | 6 | 20 | | | | 3.0 | 3.1 | 22.1 | 12.5 |
| 4 | 6 | 40 | | | | 3.0 | 4.5 | 24.1 | 14.8 |
| 5 | 0 | 20 | | | | 2.6 | 2.3 | 16.1 | 7.3 |
| 6 | 9 | 40 | | | | 3.1 | 5.6 | 27.7 | 13.8 |
| 7 | 3 | 0 | | | | 1.9 | 2.3 | 9.7 | 6.5 |
| 8 | 6 | 60 | | | | 2.7 | 4.0 | 27.7 | 13.8 |
| 9 | 6 | 40 | 20 | | | 2.1 | 5.2 | 25.5 | 16.3 |
| 10 | 6 | 40 | 0 | 20 | | 1.9 | 4.1 | 21.7 | 15.9 |
| 11 | 0 | 40 | 0 | 0 | 6 | 2.6 | 4.3 | 18.0 | 13.8 |
| 12 | 0 | 0 | 0 | 0 | 0 | 2.7 | 1.8 | 8.3 | 5.1 |

CM = Chicken Manure.
BM = Bovine Manure.

## SOME CONSIDERATIONS ABOUT PRICKLY PEAR DOMESTICATION

The variability of prickly pear in wild and cultivated conditions of the semiarid zones of Mexico, has resulted in various studies of the members of the cacti family. Several authors believe that this variability arose via natural hybridization associated with polyploidy and geographical isolation (Gibson and Nobel, 1986; Trujillo, 1986; Pimienta and Mauricio, 1989). The differences in fruit size found in wild and cultivated prickly pear populations are undoubtedly due to differences in ploidy levels, since previous cytogenetic studies revealed the existence of different levels of ploidy (Sosa, 1964; Heras et al. 1988; Saveja et al. 1988; Brutsch, 1984). An interesting conclusion that emerged from these studies, is that the prickly pear varieties and forms with highest chromosome number are commonly found in cultivated conditions (2n=66 and 2n=88).In contrast the lower chromosome numbers are found in wild populations (2n=22 and 2n=44).

The changes in ploidy levels that are commonly expressed by an increase in vegetative vigor (cladode size) and reproductive vigor (fruit size), perhaps played an important role in the process of prickly pear domestication. During the early stages of prickly pear domestication, the prickly pear phenotypes with higher ploidy levels, with vigorous cladodes and bigger fruits were probably preferentially selected and established vegetatively in the backyards of the inhabitants of the semiarid regions. These clones were used to satisfy human consumption needs, as fodder for cattle, and in some cases as a medicinal plant. Through time the farmers joined and conserved ex-situ an ample diversity of prickly pear species in backyards of rural homes. In this way, the rural populations dispersed in the semiarids regions of Mexico, not only became reservoirs of prickly pear germplasm, but also contributed to the evolution of this species.

The artificial sympatric conditions created by the number and diversity of species that grow close together in small areas and the opportunities for pollination (gene flow) greatly stimulated the evolution of these cultivars in backyard environments. The backyards also contributed to the exit of the new hybrids, since their environment favored seedling establishment and development.

Thus, the backyards of rural homes constitutes a gene pool of authentic reservoirs of prickly pear germplasm, that could be invaluable for future breeding programs, and as unique biological material for basic evolutionary studies.

The first commercial plantations were established using vegetative material from outstanding phenotypes of the backyards of rural homes. The selection of these phenotypes must have been quite rigorous, since the prickly pear growers needed to consider factors in addition to fruit quality and size. Such additional factors include those related with adaptation and resistance to environmental stresses (e.g. drought, salinity, low temperature), predation caused by wildlife, aspects related with market demands (e.g. fruit color and shape) and perhaps most importantly, the resistance of fruits to handling during harvest and postharvest.

## OPPORTUNITIES AND NEEDS FOR BASIC AND APPLIED RESEARCH

One of the factors that limit the consumption of prickly pear fresh fruits, is the relatively high number of seeds. The reduction in both seed size and number is perhaps one of the most important challenges in prickly pear research. The attempts to overcome this limiting factor have not been successful due to an incomplete understanding of some basic embryological concepts in prickly pear fruit development. For instance, some researchers have attempted to obtain parthenocarpic prickly pear fruits (fruits without seeds). However, this is not possible with this type of fruit, since recent anatomical studies on the origin of the edible part of prickly pear fruits, revealed that the pulp differentiated from epidermal cells of the funicular envelope that surrounds the ovule (Pimienta and Engleman, 1985). These workers also found that the differentiation of epidermal cells into pulp required the stimulus of ovule fertilization (Rosas and Pimienta, 1986). In practical terms, it will not be feasible to obtain parthenocarpic fruits, as in fruit crops like apple, pear, or peach, because in those fruits, the edible part differentiates from floral parts that surrounds the ovules (e.g. ovary, floral tube), and not from fertilized ovules as it occurs in prickly pear fruits.

A more logical approach will be the artificial induction of seed abortion. Some growth regulators (auxin and gibberellins), apparently have the capacity to induce seed abortion in prickly pear fruits (Ortiz et al. 1988). However, at the present time use of these chemicals are too costly for the Mexican growers. Another possibility will be the artificial pollination of polyploid cultivated varieties with pollen derived from wild diploid or tetraploid varieties. Hence, the crosses between wild and cultivated varieties will produce fruits with uneven number of chromosomes (e.g. triploid, pentaploid). In this case the resulting seeds will be small and shrunken (abortive seeds), because although the embryo is functional, the endosperm is defective. Fruits with a high number of abortive seeds are common in prickly pear populations growing in the backyard of rural homes. That is because these places have considerable diversity of sympatric species growing together that differ in their chromosome number.

The recent literature has reported the industrial use of prickly pear fruits (Sawaya et al. 1983; Sepulveda and Saenz, 1988). It is well known, that the seed oil could be a good potential source of edible oil, but its low content appears to limit its commercial use (Sepulveda and Saenz, 1988). The pulp can be utilized successfully for the manufacturing of jams, marmalade, jelly, etc. (Sawaya et al. 1983). However, the technology available for the industrial transformation of prickly pear is not profitable. Possibly by combining the industrial transformation of different fruit by-products (peel, pulp, seeds) for human and/or animal consumption with the use of vegetative parts as a source of pectins, may make large scale food processing of prickly pear profitable. A research project that integrates the simultaneous industrial transformation of both vegetative and reproductive parts is needed.

Field observations of wild and cultivated pricklypear populations reveal great variation in the resistance and susceptibility of prickly pear to biotic and abiotic factors that affect its development and productivity. At this point information related with the origin and causes of genetical and phenotypical variation is lacking. This information is critically needed to define future breeding strategies to overcome limitations for adaptation (e.g. drought, salinity, low temperature), productivity (e.g. spring frosts, pests, diseases), and for fruit quality.

While there are studies on prickly pear taxonomy, there is a lot of confusion. The main reason for this confusion is because the majority of the descriptions were made with small samples, without considering the variability that exist in their natural habitats. Some of the classified specimens, are in reality varieties, geographic forms, hybrids, etc. (Bravo, 1978). There is an urgent need for biosystematic research in prickly pear, in order to establish a more coherent classification of both wild and cultivated species.

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