CIMMYT Tlaltizapán

March 27, 2001. Maize Program

Tlaltizapán,.....a short story.

Tlaltizapán is the name of a small town located in the center of the Mexican state of Morelos. "*Tlaltizapán*" is a name in the Náhuatl language (ancient Aztecs' language) that means "over white land" ("*tlalli*"=land, "*tiza*"=white dust, "*pan*" =over). Undoubtedly they were right, since a calcareous subsoil is characteristic of the region and in some areas this material is exposed on the surface. Associated with this characteristic is chlorosis observed on crops like maize, sugarcane and sorghum.

In 1549 the Village of San Miguel Tlaltizapán was founded as part of a huge property of Hernán Cortés, Marquis of Oaxaca Valley, the Spaniard who defeated the Aztecs in 1521, the so-called "Conquistador de México". In 1869, President Benito Juárez decreed the creation of the State of Morelos and the Village of San Miguel Tlaltizapán was recognized as the Municipality of San Miguel Tlaltizapán. In August 25th, 1885, another decree changed this name to Tlaltizapán de Pacheco, to honor the Morelos State Governor Mr. Carlos Pacheco. This name was changed to **Tlaltizapán de Zapata** in 1995, and so this is the actual official name for the town we simply know as Tlaltizapán.

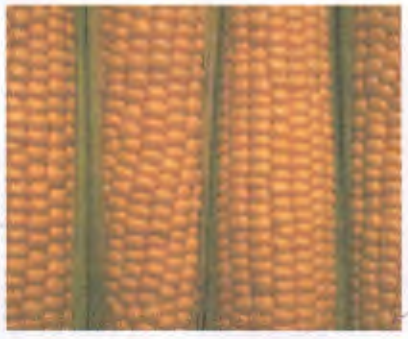
During The Mexican Revolution, Tlaltizapán was chosen in 1914 by General Emiliano Zapata Salazar for establishing his General Headquarters for strategic operations. On August 13th, 1916 these headquarters and the whole town itself was the scene of a bloody battle between the "Zapatistas" led by General Zapata and the "Carrancistas", a federal army led by General Amaro. General Zapata and his army were defeated and the entire town of Tlaltizapán was plundered and burned and 250 captured men were hanged in the main square. Zapata and some of his army escaped riding through "Las Juntas" (the land CIMMYT leases and calls the "Annex").

Zapata's headquarters is actually a small museum you can visit in town.

Geographical location: 18° 41' N. Latitude
99° 08' W. Longitude.
Altitude: 940 m. a.s.l. (3,083.2 ft.).
Average annual rainfall: 840 mm. (33.1 in.).
Rainy season: June through October.
Temperature range: 1.5° to 39.5° C.
(34.7° to 103.1° F.)
Average annual temperature: 23° C. (73.4° F.).
Cropping cycles: A-irrigated. November-April.
B-rainfed. May-October.

Location and Meteorological Characteristics of Tlaltizapán Experiment Station.

The climate in Tlaltizapán is an $A(w)_0$ type, described as *hot subhumid with summer rainfall*, according to Köppen's Climate Classification System modified in 1964 by E. García for the particular conditions of México.



Tlaltizapán Experiment Station was founded in 1969.
Its total surface is 46 hectare (113.6 acre).
The cropping area is 32 hectare (79 acre).

SOIL CHARACTERISTICS

Soils in the Station are black Vertisols developed from calcareous subsoil. They are heavy, cracking clay loam soils with more than 40% clay and > 50% of 2:1 minerals in the clay fraction by weight (Montmorillonitic class), and show marked shrinking and swelling with changes in moisture content. According to the U. S. Soil Taxonomy System this soil is tentatively an Isothermic Udic Pellustert.

Because of their characteristics, soils in the Station must be tilled between carefully defined moisture limits.

Average soil depth is 1.20 m, but in some parts of some blocks the calcareous parent material is very close to the soil surface or is mixed with the Ap horizon. The soil analyses made in 1996 on the main station showed the following results.

Clay (%)	41.2
Silt (%)	36.8
Sand (%)	22.0
Field capacity (% by weight)	36.3
Permanent wilting point (")	24.2
pH	7.8
E.C. (mmhos/cm)	0.64 - 2.7
C.E.C. (meq/100gr)	34.8 - 45.4
Organic matter (%)	1.65 - 2.13
P (Olsen) (ppm)	3.2 - 8.4
Ca (ppm)	5855 - 7865
Mg (ppm)	521 - 763
K (ppm)	209 - 396
Na (ppm)	32 - 78
Fe (ppm)	5.5 - 9.1
Mn (ppm)	7.8 - 13.3
Zn (ppm)	1.1 - 2.0
Cu (ppm)	0.9 - 2.4

Through time, soil structure of the main station has deteriorated. The intensity of use of the Station soils is the primary cause for this deterioration. When vertisols are not permitted to dry out between cropping cycles, structure may collapse.

The decline in overall performance on the station is related to.....

..... A declining soil structural situation caused by our failure to allow the soil to dry out thoroughly between crop cycles and to thus reform the natural blocky structure that is typical of a vertisol.

Lime-induced chlorosis has worsened as the structural situation has deteriorated, and as internal drainage has collapsed (infiltration rates have declined), leading to an increase in free Ca and in bicarbonate. High levels of bicarbonate seem to be directly related to non-availability of iron within the plant. And most of the harm from bicarbonates is due to soil degradation over time, as Ca is depleted and replaced with Na.

This underlying problem of deteriorated structure is supported by primarily, the observations that the landrace maize variety Puebla 209 is green and healthy on the Station but still yields much more on the Annex (a 15 ha. land leased by CIMMYT just 1 km. away from the main Station). So yield losses in this particular cultivar are not entirely due to chlorosis. And secondly, the application of $FeSO_4$ as a foliar spray on a regular basis has greened the leaves but has not fully restored yields even to those observed on station in plots not showing chlorosis.

The grinding up and redistribution of limestone within the soil through leveling and the use of the rotavator and a lot of conventional tillage, have worsened the situation by increasing the reactive surface of the limestone in the rooting zone.

Since 1991, CIMMYT has rented 15 ha of land 1 km from our main Station in order to implement a program of remedial actions to offset yield declines on it and to meet the needs of the Maize Program's breeding activities. This is The Annex Station.

The Rehabilitation Program.

While the calcareous nature of the soils on the Station can not be economically changed, **improvements in soil structure should do much to ameliorate root restrictions and the HCO_3^- -induced Fe chlorosis**. Thus, emphasis is being given to rehabilitative work that focuses on allowing the soils to shrink and swell (e.g., by growing deep rooted legumes like alfalfa to dry out the soil profile). Thus, soil structure and drainage should improve over time. Such improvement will not only allow better rooting volume and thus directly enhance nutrition and growth, but will also reduce the incidence of HCO_3^- - induced chlorosis when soils are wet.

In direct amelioration of chlorosis symptoms, many experimental factors have been tried over the years. The most viable solution is the application of iron sulfate (the present station practice). However, as mentioned, although the plants appear green after the spraying, yield potential is not fully restored. The actual tillage practices now tend towards a **more conservative tillage system**. The use of a rotavator and moldboard plow is forbidden on both the Station and the Annex and land rotation is a normal practice now. **Rotations are maize followed by velvetbean (*Mucuna deeringiana [sin. Stizolobium deeringianum]*), or alfalfa (*Medicago sativa*), or fallow.**

Irrigation and drainage systems in Tlaltizapán

Water is not a limiting resource in Tlaltizapán Experiment Station, actually. Our main water supply for irrigation and all the needs in our facilities is a spring localized 600 m north the station called "La Taza". It always carries good quality irrigation water (classified as C2-S1 type according to the Salinity Laboratory of the U.S.D.A.). Our second source of water is a small river called "Río Dulce". It also carries water all the year. During the rainy season after heavy falls the streams rise and sometimes flooding occurs in the lower parts of the station. Under rainy season conditions the water table can be as close as 0.5 m from the soil surface in plots near the river.

Water coming from "La Taza" spring is conducted through an earthen canal following the highest level on station. Along it are installed 10 lift-gates from which water flows through a network of 25 cm (10 in.) diameter asbestos pipes to an alfalfa valve at the corner of each plot where diesel motor-pumps can be connected to run hand-moved sprinkler irrigation systems on a 9.0 m x 14.0 m grid [pipes are 102 mm (4 in.) in diameter]. Six inch (152 mm) gated pipes [gates every 762 mm (30 in.)] can also be connected. The sprinkler irrigation system is used for germination and early stand establishment, and the gravity furrow system is used after plants are > 45 cm (18 in.) high because risers for sprinklers are 50 cm (20 in.) high. Field slope for gravity irrigation is 0.3%.

In cases when water is scarce due to neighbor farmers upstream irrigating their crops, or leaks along the canal (there is not any covering) or insufficient discharge from the source; motor-pumps are installed by the edge of the "Río Dulce" river to feed the upper canal, or to directly run sprinkler or gravity systems.

There are also available two different irrigation systems that are used for irrigating green manure crops mainly. These are 8 hand-moved large output sprinklers and a large self-propelled sprinkler (turbine drive water-reel).

DRAINAGE. The drainage system is an open drain parallel system. It consists of open concrete boxes every 25 m linked by concrete pipes of 30 cm to 38 cm (12 to 15 in.) in diameter. Pipes are about 1.0 m underground. Average slope for drainage ranges from 1.0% to 1.5% depending on natural slope between fields. The volume collected from the drainage system is discharged into the "Río Dulce" stream.

The last analyses of water for irrigation were made on July 1991. Average results were as follows:

pH	8.3
E.C. (mmhos/cm)	0.57
Ca^{++} (mol/m^3)	2.69
Mg^{++} (mol/m^3)	1.27
Na^{+} (mol/m^3)	0.65
K^{+} (mol/m^3)	0.08
CO_3^{--} (mol/m^3)	0.94
HCO_3^{-} (mol/m^3)	3.62
Cl^{-} (mol/m^3)	0.25
SO_4^{--} (mol/m^3)	1.29
SAR (meq/L)	0.46
B (mg/L)	0.13
Dissolved solids (mg/L)	407.7
Soluble Sodium (%)	13.9
PO_4 (mg/L)	0.0 (P)
NH_4 (mg/L)	1.0 (N)
NO_3 (mg/L)	32.2 (N)

As mentioned earlier, water is not a limiting resource in Tlaltizapán Experiment Station. Unfortunately this favorable situation is not expected to last for a long time. Population in Tlaltizapán is growing each year, new urban settlements are being created, and so the demand for essential services like water is growing. Recently the municipality commenced the extraction of water from the La Taza spring (our main source for irrigation) to provide service to neighborhoods in town (29 Lt./sec, 24 hr.).

Settlements around the station are increasing their population each year and new ones are being created. For example, a new complex for 360 families was built in December 1997 at just 100 m from the main Station by the way to the Annex. Another issue is farmers abandoning their cropping land and selling it for buildings or shearing it to their descendants. With time, these factors are going to put pressure on the availability of water and also have the potential to affect the activities in our Experiment Station.

Field Operations and Soil Conditioning in Tlaltizapán Experiment Station and The Annex

The actual tillage and field operations on station vary only when they are considered to be an experimental variable within a related research goal, or when events in nature make us alter them.

The standard sequence is:

1. Hand harvest of all remaining cobs and hand lifting of discarded cobs.
2. Maize chopping. (Flail chopper).
3. Incorporation of maize residues. (Ridger).
4. Sprinkler irrigation for germination of volunteer seed (once or twice).
5. Disk harrow.
6. Chisel plow.
7. Tandem disk harrow.
8. N fertilization 100 kg N/ha (Ammonium sulfate with 20.5 % N) + P fertilization 60 kg P_2O_5/ha (Triple superphosphate with 46% P_2O_5). Both mixed and broadcasted with a spreader.
9. Ridging. Rows are 0.75 m appart.
10. Bed forming. (Bed shaper).
11. Seed treatment. A mixture of one insecticide (thiodicarb), one fungicide (captan), a sticker, and water, is used.
12. Hand hill seeding.
13. Seed covering. (Covering scraper with press wheel). Seeding depth is 5 cm.
14. Preemergent herbicide application. Atrazine 1.1 kg/ha + metolachlor 1.2 kg/ha. (Tractor mounted sprayer).
15. Germination sprinkler irrigation.
16. Insecticide application for "fall armyworm" control (*Spodoptera frugiperda*).
17. Hand thinning.
18. Insecticide application for "fall armyworm" (*Spodoptera frugiperda*) control. Granules directed to the whorl.
19. Second N fertilization. 100 kg N/ha. (Ammonium sulfate with 20.5% N banded at cultivation time).
20. Ferrous sulfate sprayings (when needed). The solution: 1 % w/v of $FeSO_4.7H_2O$ + 0.5 % w/v of foliar urea + 0.1 % v/v of surfactant + water. The rate is 400 lt./ha.
21. Pollination activities at maize silking and tasseling stages.
22. Hand harvest and cob selection.
23. Insecticide treatment of ears for "grain weevil" (*Sitophilus zeamais*) and "larger grain borer" (*Prostephanus truncatus*) control.
24. Seed drying on the ear. Commercial dryer at 36ºC for 72 hours.
25. Shelling. Electric sheller.
26. Seed packing.

Material resources on Station.

Besides buildings, the equipment available in Tlaltizapán Experiment Station is:

- 10 tractors. (Power: 82.03 kW, 82.03 kW, 74.57 kW, 67.11 kW, 59.66 kW, 59.66 kW, 59.66 kW, 52.20 kW, 37.29 kW, 29.83 kW).
- 7 diesel motor-pumps. (3 six cylinder and 4 four cylinder).
- 1 stationary six cylinder diesel motor with synchronous AC generator.
- 12 vehicles (2 Nissan double-cab, 4 Nissan pick-up, 1 Nissan sedan, 5 Chevrolet pick-up).
- 1 base for C.B. two-way radio communications, 2 mobiles and 7 portable radios.
- 4 personal computers.

- Implements: ridger, duckfoot cultivator, mouldboardless plow, flail chopper (2), disk harrow, tandem disk harrow, chisel plow, chisel harrow, covering scraper (2), bed shaper (2), rotary hoe, disc plow, rotavator (3), subsoil plow.

- Agricultural machinery: seed drill planter, zero-till precision planter, plane (2), hay chopper, flywheel cutter (3), row crop field chopper, fertilizer spreader (3), scraper (2), tractor mounted sprayer (4), tractor mounted bucket fertilizer spreader (2), surface roller, rear tipping trailer, non-tipping trailer (2), high clearance sprayer, tractor mounted hydraulic soil sampler, grain auger-type elevator, tractor mounted head loader, and lift truck.

Human Resources on Station

For operative and administrative purposes, permanent personnel on station is organized into two groups. One group is formed by 18 administrative and field assistants, and is paid every two weeks. The other group is formed by 35 workers divided into 4 categories with different salaries according to their position. This group is paid on a weekly basis.

Administratively, financially and operatively the Station is controlled by CIMMYT's Maize Program. The Field Superintendent reports to the Associate Director of the Maize Program.

All the mentioned personnel are nationally-recruited.

Some of the characteristics of station personnel are:

- Average age: 44 yr. (63 to 28 yr.).
- Gender: 4 women / 49 men.
- Av. seniority: 15 yr. (30 to 4 yr.).

The Tlaltizapán Experiment Station's personnel is formed by:

- Alejandro López - Field Superintendent.
- Pedro Gálvez -Superintendent' Assistant.
- Lilia A. Casales -Administrative Assistant.
- Celina Muñoz - Administrative Assistant.
- Eva Barreto -Administrative Assistant.
- Agustín Chepetla -Irrigation Assistant.
- Ramón Rodríguez - Agricultural Machinery Assistant.
- Benito Gómez -Field Personnel Assistant.
- Juan Carlos Bahena -Field Asst. for Crop Physiology.
- Honorio Corrales -Second Field Asst. for Crop Physiology.
- Pedro Chepetla -Field Asst. for Plant Pathology.
- Mario Gómez -Field Asst. for Entomology.
- Demetrio Soto -Field Asst. for Lowland Tropical Germplasm Development.
- Angel Hernández -Second Field Asst. for Lowland Tropical Germplasm Development.
- Alfredo Morales -Field Asst. for Prebreeding.
- Prisco Reyes -Field Asst. for Subtropical Germplasm Development.
- Simón Pastrana -Second Field Asst. for Subtropical Germplasm Development.
- José Gálvez - Field Asst. for Maize and Wheat Molecular Genetics.

- Celestino Zárate -Mechanic.
- Agustín López -Agr. Mach. Operator.
- Ausencio Riquelme -Agr. Mach. Operator.
- Fernando Valle -Agr. Mach. Operator.
- Enrique Ortega -Driver/Shopping.
- Esteban Castillo -Warehouseman.
- Marcelo Ramírez -Warehouseman.
- Leopoldo Téllez -Mason.
- Francisco Delgado -Welder.
- Arturo Gómez -Watchman.
- Martín Padilla -Watchman.
- Félix Pastrana -Watchman.
- Adolfo Pastrana -Watchman.
- Gerardo Reyeros –Watchman.
- Ramona Calderón -Cleaning.
- Dióscoro Calderón -Field Worker.
- Jorge García -Irrigator.
- Alberto Gil -Field Worker.
- Alberto Lagunas -Field Worker.
- Fidel Morán -Field Worker.
- José Rivera -Irrigator.
- Alejandro Vázquez -Field Worker.
- Zenén Bahena -Field Worker.
- Fermín Cervantes –Field Worker.
- Cármen Figueroa -Field Worker.
- Doroteo Gómez -Field Worker.
- Raúl Morales -Field Worker.
- Lino Muñoz -Field Worker.
- Reyes Páramo -Field Worker.
- Gaudencio Román -Field Worker.
- Sabás Solís -Field Worker.
- José Solís -Field Worker.
- Margarito Torres -Field Worker.
- Aristeo Vázquez -Field Worker.
- Jorge Amacende -Field Worker.

SEASONAL WORKERS

Temporary field workers are hired according to the work load planned on a weekly basis. This means that their number is variable every week, being high during the most labor demanding activities such as hand seeding, pollination and harvest.

The responsibility for determining the amount of temporary labor each week belongs to the Field Superintendent. For this purpose every Thursday the Assistants to the Sub-programs submit their requests of labor for the coming week explaining what activities are going to be carried out. Based on the total number of field workers requested, the Field Superintendent decides how many temporary workers should be hired taking into account the available number of permanent field workers, and if the programmed work load is concentrated in one specific day or if it is constant through the week.

Temporary workers are hired every Friday morning and the duration of their contract is 8 consecutive weeks (3 minimum - 9 maximum).

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INTERNATIONAL MAIZE AND WHEAT IMPROVEMENT CENTER. MAIZE PROGRAM.

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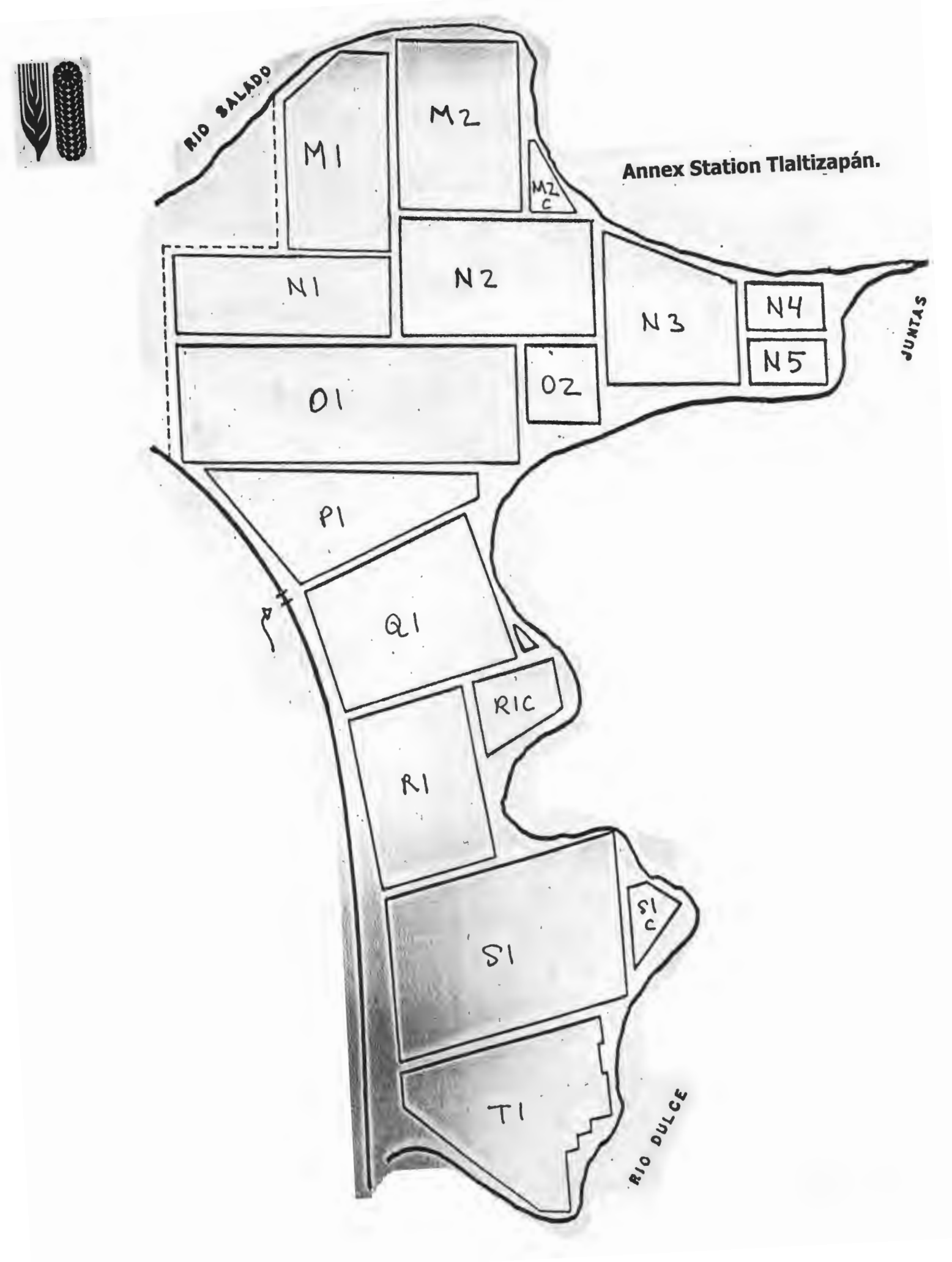
Tlaltizapán Experiment Station.


Annex Station Tlaltizapán.
RIO SALADO
M1
M2
M2 C
N1
N2
N3
N4
N5
JUNTAS
O1
O2
P1
Q1
R1C
R1
S1
S1 C
T1
RIO DULCE

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