GUAJILLO, INIFAP. VARIETY OF MIRASOL PEPPER FOR THE HIGH LAND OF MEXICO

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SUMMARY. The objective of this study was to evaluate genotypes of mirasol "guajillo" pepper which have been evaluated in San Luis Potosi, México. Actually there are not varieties of mirasol pepper in the national market consequently, formers use regional seeds, effecting negatively fruit quality and yields. During this study, a Guajillo INIFAP variety was generated; this variety's produce yields higher than 2.3 t/ha of dry pepper.

INTRODUCCION. El chile *Capsicum annuum* L. es la hortaliza que más se emplea en la alimentación del pueblo. En nuestro país cada año se siembran más de 30 mil hectáreas de chile Mirasol Guajillo siendo después del tipo Jalapeño de los más importantes por su superficie sembrada. La explotación de este tipo de chile se realiza en un 90% en el Altiplano Norte Centro de México que abarca los estados de San Luis Potosí, Zacatecas, Durango, Aguascalientes y Guanajuato con rendimientos de 1.3 a 1.5 t/ha de chile seco con una baja calidad comercial en muchos de los casos. La obtención de estos rendimientos se debe a que un 95% del área de producción es establecida con materiales o genotipos criollos cuya semilla se obtiene en forma artesanal por los productores en predios de producción donde predomina la mezcla de subtipos y tipos de chile, observándose en el cultivo una variabilidad marcada en cuanto a tipo de planta, ciclo vegetativo, forma, tamaño, color y número de frutos por planta. Una estrategia para mejorar la producción así como para obtener tolerancia a organismos dañinos como plagas y enfermedades es el uso de mejoramiento genético. Diversos autores han realizado diferentes métodos de mejoramiento en chile como selección familial (2), selección masal (3) y (5) y selección uniseminal (1). El objetivo del estudio es generar variedades de chile Mirasol Guajillo que superen las 2.0 t/ha de chile seco y que superen en uniformidad, calidad y precocidad a los genotipos usados en la región.

MATERIALES Y MÉTODOS. Esta variedad es resultado de la selección MG-20105 de chile Mirasol Guajillo, proviene de una colecta individual realizada en 1994 en la localidad de Luis Moya, Zacatecas. En el siguiente año se establece en el Campo Experimental Palma de la Cruz, SLP en donde se caracteriza y se realiza selección individual con el propósito de buscar una mayor uniformidad en la calidad de fruto y un mayor número de frutos por planta, así como acortar el ciclo vegetativo de la planta. Además en este mismo periodo se efectúan cruzamientos dentro de la misma familia en plantas sobresalientes, en el periodo 1995-1996 se realizaron 2 ciclos de selección masal, de esta forma se obtiene la línea MG-20105-5m que dio origen a Guajillo INIFAP. Dicho genotipo ha sido evaluado en ensayos de rendimiento durante el periodo 1996-1999.

RESULTADOS. Esta variedad presenta plantas con un follaje vigoroso y alcanza una altura de 95-100 cm, con una ramificación dicotómica lo que produce dos ramas primarias y cuatro ramas secundarias mismas que continúan bifurcándose en forma ascendente hasta alcanzar un diámetro o cobertura de planta de 70 cm. Las hojas son grandes de forma oval con un ancho de limbo que alcanza los 3.3 cm, son de un color verde intermedio. Esta variedad carece de pubescencia en tallo y hojas, la primera ramificación de la planta va de 12-15 cm de la base del tallo, el grosor del tallo principal es de 1.1 a 1.4 cm y el de las ramas primarias es de 0.7 a 0.9 cm. Inicia la floración a los 55 días después del trasplante, su ciclo vegetativo de trasplante a cosecha de frutos en rojo-fresco es de 130-140 días después del trasplante. Los frutos de la variedad Guajillo INIFAP son de tamaño grande de forma alargada cilíndrica con terminación apical redondeada, su comercialización es en estado deshidratado o seco y presenta un tamaño de 14 a 17 cm de largo y de 3.5 a 4.2 cm de ancho con un pedúnculo de 4.9 cm de largo, es de fácil desprendimiento.

Cuadro 1. Características botánicas de la variedad de Chile Mirasol. Guajillo INIFAP.

Características botánicas	Variedad	
	Guajillo INIFAP	VR-91
Altura de planta	95-100 cm	50-60cm
Cobertura	65 cm	50 cm
Altura a la 1° ramificación	12-15 cm	10-12cm
Número de ramas primarias	2	4-6
Color de la hoja	Verde semi oscuro	Verde claro
Tamaño de la hoja	8 cm largo por 3.3 cm ancho	8 cm largo por 2.8cm ancho
Días de floración	55	45
Días a inicio de cosecha	130-140	115-120
Tipo de producción	Escalonada	Escalonada

Su color es verde intenso antes de llegar a la madurez, rojo semiobscuro al madurar y rojo obscuro en estado deshidratado o seco. Su relación peso fresco-peso seco es de 4.3:1, la variedad Guajillo INIFAP produce en promedio 19 frutos por planta y su máxima producción se puede alcanzar efectuándose de dos a tres cosechas de chile rojo fresco, la pungencia de este fruto es considerada como una picosidad intermedia.

Cuadro 2. Producción de fruto en t/ha de chile seco obtenido con la variedad Guajillo, INIFAP. En diferentes localidades y ciclos agrícolas.

Localidad	Año	Rendimiento t/ha	
		Guajillo INIFAP	Testigo VR-91
Altiplano Potosino	1996	3.4	3.0
Altiplano Potosino	1997	3.1	2.7
El barril SLP	1997	2.6	2.0
Altiplano Potosino	1998	3.0	2.3
Salinas SLP	1998	2.3	2.0
Chaparroza Zac.	1998	2.8	-
Salinas SLP	1999	2.9	2.4

En las diferentes localidades evaluadas la variedad presenta producciones superiores a las 2.2 t/ha de chile seco superando entre un 30 y 40% a los criollos de la región y entre un 10 a 15% supero en rendimiento al testigo la variedad VR-91, además de ser superior en el aspecto de calidad de fruto al presentar una manifiesta uniformidad en tamaño y forma de fruto. Esta variedad presenta su máximo potencial de rendimiento al realizar dos cosechas de fruto rojo fresco.

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EFFECT OF DIFFERENTS FACTORS ON THE MORPHOGENESIS OF CHILE HABANERO (*Capsicum chinense)* IN VITRO

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Chili pepper was one of the first domesticated crops in Mesoamerica. It is a very common ingredient of Mexican food whereas around the world it is eaten by one of each four persons, making chili pepper the most used spiced after salt.
In Mexico, 1 284 601 tons of green chili peppers were produced in 1998 being Chihuahua, Sinaloa and Zacatecas the majors producers (50% of national production), while Yucatan produced only the 0.22%, manly from "Habanero" chili.

"Habanero" chili (*Capsicum chinense* Jacq.) is native of South America, it is well-known in Mexico although is only harvested in Yucatan, Quintana Roo, Campeche and Tabasco.

Biotechnological techniques have been applied to chili pepper in many countries but most reported studies have been conducted whit *C. annuum*, whereas *C. chinense* had been less studied.

Due to the recalcitrance associated to "in vitro" morphogenesis of *C. annuum*, the development of studies aimed to understand the effect of different factor affecting morphogenesis in "Habanero" pepper (*C. chinense*) is an evident necessity. In the present work, seeds germination from different varieties of "Habanero" chili using six different concentrations of AG_3 (0-0.5 mg/l) were evaluated, as well as the effect of infrared light on germination. On the other hand, different levels of BAP and kinetin combined with IAA and NAA on the formation of multiples shoots and callusing was also evaluated as well as the effect of gas interchange on plantlet.

Our result showed that germination was favored by the addition of AG_3 on seed of long-term storage. The development of plantlet and shoot formation was evaluated in ventilated and non-ventilated containers and better results were observed when filter to improve gas exchange were used. IR radiation dose improved the germination quality as well as the development of "in vitro" plantlet. A very variable response was obtained when morphogenesis was induced from leaf, plantlet shoots or decapitated seeds, depending on the combination of growth regulators employed. Obtained results are discussed.

THE HABANERO ORANGE CHILLI CROLE OF YUCATAN

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INTRODUCTION. The Habanero Chilli (*Capsicum Chinese Jaq)* domesticated in the Peninsula of Yucatan, region this strongly established to the regional diet it is a Creole representative species of the zone. In the last years the culture of the spicy one has been intensified due to its characteristic of being one of the spicy more than that are brought worldwide and by demand so much on the domestic like international market, there are brought hundreds of varieties of the species Capsicum Chinese, but one refers specifies with the name "Habanero" to the Peninsula of Yucatan.

MATERIALS AND METHODS. In the search of the rescue and the conservation of the genetic resources of the of Habanero chilli orange Creole has caught to recover the Creole typical germ plasma of the Habanero chilli by means of the collection I increase and refreshment of materials that preserve the Creole typical characteristics of Habanero orange one, his adjustment, yield quality and type of fruit and the typical orange color. The germ plasma used for the present study has been obtained by several cycles of selection preserving the wide variability that has the germ plasma provenience of diverse regions of the Peninsula of Yucatan.

VARIETAL DESCRIPTION. Little plant a green dark color presents, without pubescence, the cycle of life is semi-preen, there does not present antocianina the plant, the height of the plant 65 and 86 cm. With a density of intermediate ramification. His habit of growth is erect, does not present amacollamiento to the base of the stem.

FLOWERESCENCE It presents between the 80 to 100 days of it. He sows, each one presents many flowers in raceme but in individual asilla depending this fertilization in the culture the color of flower are white, and his round form. The length is a minor of 1.5 mm with anthers of white colour the length of the filament is of 2.0 mm, Exertion is of the stigma appears exert, masculine sterility is not observed, pigmentation does not present the chalice, the margin of the chalice is toothed type.

FRUIT. The days to fructification are between120 and 140 days of established the culture, the color of the fruit in intermediate condition is green, the period of fructification can extend even more than 90 days, colour of the fruit in mature condition is orange, the form of fruit is acampanulado, the thickness of the wall of the fruit is of 1.5 mm. Number of lóculos way belongs to three.

SEED. The color of the seed is yellow straw, his rough surface, and the size of intermediate type, weight of 1000 seeds ranges between 6 and 8 grams with a number of seeds for fruit that different between 20 and 50 depending on the conditions in which one handles the culture.

CONCLUSIONS. El rescues of the genetic diversity that the Habanero chilli presents, represents an irreparable value besides the fact that it constitutes a changeable and modifying source of the own species.

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GENETIC DIVERSITY OF THE HABANERO CHILE (*Capsicum Chinense jaq.*) IN YUCATAN. RESCUE OF GENETIC DIVERSITY

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INTRODUCTION. El chilli represents an important source of income for the producers dedicated to this culture, In the last years it has taken an important summit so much nationally and internationally, they are multiple the uses to which this being destined the product that goes from the consumption up to the industry and in this they are also very diverse his destinies. The Habanero chilli is a Creole representative species of the region of the Peninsula of Yucatan where it has been domesticated and nowadays this established to the regional diet, is in each of the regional saucers. The intensive production and technified of the culture, the introduction of the improved species, the loss of the practice for the traditional producers of obtaining his own seed, as well as factors as plagues and diseases, they have Tecnificate the culture, the introduction of the improved species, the loss of the practice for the traditional producers of obtaining his own seed, as well as factors as plagues and diseases, they have Influenced severely in the Creole species a severe genetic erosion being detected in the species.

OBJETIVE. Rescue the genetic diversity that there presents the Habanero chilli (*Capsicum Chinese Jaq*.) Creole in the region of the Peninsula of Yucatan by means of the collection and characterization phenological beside establishing the bases of a program of improvement and formation of varieties with characteristics superior to the existing ones

MATERIALS AND METHODS. Actually in the experimental field Uxmal, is carried out a program of rescue of the genetic diversity of the Creole species by means of the obtaining of germ plasma with Creole characteristics, catching to select on characters as type and form of fruit, orange color typical of the Creole chilli of the region, thickness and hardness of pericarp, aroma typical of Habanero typical chilli and fruits triloculados between the characters that the producer demands.

RESULTS AND DISCUSION. It has realized for a period of four years diverse incursions into diverse regions of the condition and in the Peninsula with the intention of collecting germplasm Creole that the typical characteristics assemble previously described to level back yard, it is a common practice of preserving his seeds of diverse chilli as well as others of eatable use and where it has been possible to obtain some of the collected materials, it is possible to find between the variability of diverse germ plasma colours of fruit, type and form, and great variability in type of plant. In the following picture 1 the advance is indicated in the realized collections.

In the experimental field Uxmal besides the rescue of the genetic diversity and of the characteristics of the of Habanero chilli, one possesses materials advanced in the process of improvement the approach to obtain varieties with top characteristics, as for the advances in exploratory studies one has found response of genetic resistance to some Gemini virus which brings as consequence the possibility of generating in a short time varieties resistant to the virosis caused by the white small fly. Initiating also exploratory studies for Capsicum's concentration in the collected species.

CONCLUSIONS. It has advanced in the rescue and characterization of the Creole germ plasma of Habanero chilli, orange chilli of Yucatan. Nowadays one possesses a group of Creole varieties improved to initiate a program of genetic improvement. Improved resistant varieties have been identified to Gemini virus with which it is feasible using in the improvement for the resistance the virosis caused by white small fly.

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DIFFERENTIAL RESPONSE OF JALAPEÑO GENOTYPES TO THE DAMAGE FOR PEPPER WEEVIL *Anthonomus eugenii* Cano (COLEOPTERA: CURCULIONIDAE)

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SUMMARY. The cultivation of chili has a great importance in Mexico, where are sown between 140,000 and 175,000 hectares. One of the problems that more affect the yield of this vegetable is the incidence of pepper weevil. To constitute an efficient integrated control, it is important to include tolerant genotypes to the damage of pepper weevil. For the above-mentioned 18 genotypes of jalapeño pepper were transplanted to look for tolerant genotypes to this insect and to characterize its response to the damage of this plague. The main results obtained were: The lines: LED-2046 and LED-9853-2. 2. Presented the highest fruit percentages that arrived to crop (overalls in the time of bigger incidence of the pepper weevil) and low percentages of damaged fruits for pepper weevil for what they are considered tolerant. The lines: LED-2279-3. 3. 1. 2. 1 and LED-2111A-10. 3. 2. 2. 1 have a high yield and they are precocious, characteristics desirable mentioned by Berdegue and collaborators (1994), which can take advantage to establish a control integrated to the damage of the plague. F_2 of Mitla, F_2 of Perfect and LED-2046, presented the smallest percentage of fallen fruits and inside these most was damaged for pepper weevil, that which locates them in a category integrated by the non preference and tolerance mechanisms. In this respect, Berdegue and collaborators (1994), consign to the quick fall of the damaged fruits as a desirable characteristic to tolerate to the plague.

INTRODUCTION. Mexico is among the four main countries producing of chili, with a superficies sown that it varies from 140,000 to 175 000 hectares and a volume of production of 1. 5 million tons. Also, it has a great diversity of chili types to obtain varieties and hybrid with high production and fruit quality and tolerant to plagues and diseases.
The high incidence of the pepper weevil is one of the main problems that limit the productivity of the chili, which causes production losses of until 75% (Golff and Wilson, mentioned by Velasco, 1969). The plants tolerate the damage by the plagues through the mechanisms of: preference, antibiosis and tolerance (Nas 1978). The level of damage that the plague insects cause depends mainly on the chili type (Amaya, mentioned by Anaya, 1969) and of the genotype (Sifuentes, 1985). Chili lines exist with synchronized and concentrated production of fruits that remove the fruits damaged for pepper weevil more easily and that they generally suffer smaller levels of damage that those that retain them for more time.
The search of genetic tolerance to the damage for the pepper weevil in chili varieties is an important aspect to establish an efficient integrated control against this plague.
With support in the above-mentioned the current investigation had as objectives: to look for lines of chili tolerant jalapeño to the damage for pepper weevil and to characterize the response of 18 genotypes of chili jalapeño to the incidence of the mentioned insect.

MATERIALS AND METHODS. In the experimental field of Delicias, Chihuahua-INIFAP, 18 genetic materials of chili jalapeño were transplanted in plots of 5 m of long, with two rows of plants. The distances between rows and plants were respectively of 46 and 30 centimeters. The treatments were distributed at random in an experimental design of blocks with three repetitions. The 18 lines of chili jalapeño were obtained in the experimental field of Delicias, Chih. , by individual selections in populations segregates of lines of Veracruz and of populations F2 and F3 of crosses of desirable plants.

The variables evaluated were: 1). Yield and precocity, 2). Percentage of harvested fruits, 3). Number of produced fruits and percentage of fallen and damaged, 4). Percentage of damaged fruits and 5). Number of harvested fruits.

RESULTS AND DISCUSION. The main results obtained were: 1). In most of the variables, significant differences were detected among the genotypes, 2). The lines: LED-2046 and LED-9853-2. 2, presented the highest fruit percentages that arrived to crop (overalls in the time of bigger incidence of the pepper weevil) and low percentages of damaged fruits for pepper weevil for what they are considered tolerant, 3) LED-2279-3. 3. 1. 2. 1 and LED-2111A-10. 3. 2. 2. 1 have a high yield and they are precocious, characteristics desirable mentioned by Berdegue and collaborators (1994), which can take advantage to establish a control integrated to the damage of the plague. 4). F_2 of Mitla, F_2 of Perfect and LED-2046, presented the smallest percentage of fallen fruits and inside these most was damaged for pepper weevil, which locates them in a category integrated by the non preference and tolerance mechanisms. In this respect, Berdegue and collaborators (1994), consign to the quick fall of the damaged fruits as a desirable characteristic to tolerate to the plague.

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EFFECT OF CLEAR THE FRUIT FOR THE QUALITY OF THE SEEDS OF HABANERO PEPPER (C*apsicum chinense* JACK) PRODUCED IN YUCATÁN, MÉXICO

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INTRODUCTION. Habanero Pepper is sowed mainly in Yucatan México , where exist a large diversity of genetic variety according the agro ecological conditions where this crop is produced (Bautista *et al*., 1997 y 1999), with a smaller surface in Campeche and Quintana Roo, México . The majority of the actual requirements of seeds for this crop used in Yucatan comes from Creole cultivars that are produced by the same producers to cover their own needs, and in second place trade the excess of product in the surrounding area to obtain the seeds the farmers use handcraft labor, few producers keep in mind save seeds for the next crop but others select from the biggest fruits in the plant or the first fruits produced at the main branch of the plant. Another producers use the residual fruits not sold as fresh fruits (Pozo, 1992). The producers do not follow any procedure to improve the seeds and fruits, due they do not select the best plants for seeds, their crops have a mixtures and variety of plants and fruits, so it becomes in a crop with less quality and performance. The previous reasons made me develop this research on effect of clearing the fruit for the quality of the seeds of Habanero Pepper in open field with the objective to produce good quality of seeds.

MATERIAL AND METHODS. As the result to produce a good quality seed of Habanero Pepper from cultivars improved by means of the mass selection (8 cycles of improvement) in Maní Yucatan, this research was carried on at the horticulture unit named " Lol ´Ic " (pepper flower), San Antonio, Conkal, Yucatan, México in open field conditions. To transplant the crop in the field was dug a plant hole (0.40 m wide x 0.40 m depth), adding 100 g of stock manure, 60 g of chicken manure well disinfected, with 4 g of fenamidofos per hole. The irrigation system used was spaghetti, set apart each one 2 m along the mainline , 0.80 m between rows and 0.50 m from hole plant to hole plant. A random design with 10 repetitions was used in this experiment, a media test (Tukey) was used too. The repetitions was determined on base of clear the fruits per plant: 10 fruits per plant (T1) , 20 fruits per plant (T2), 30 fruits per plant (T3), 40 fruits per plant (T4), 50 fruits per plant (T5), 60 fruits per plant (T6), 70 fruits per plant (T7), 80 fruits per plant (T8), 90 fruits per plant (T9) and 100 fruits per plant (T10), beside the proof (T0) that consisted in do not apply the clearing of the fruits per plant. Fertirrigation was used in this research. During the flowering, Methomilo was applied in dose of 250 g ha^{-1}. And oxamil 1.0-1.5 L ha^{-1}, to control *Anthonomus eugenii*, Cupravit was used too. To prevent diseases Tribaqú and Agrimixin 500 in dose of 1 kg ha^{-1} were used weekly with rotation of this pesticide. The weed control was made using the herbicide paraquat in dose 1 L ha^{-1}.

The variables in this experiment were: height of plants, performance (weight fresh fruit), total weight of the seed, vigourosity proof and viability rate.

RESULTS AND DISCUSSION. Treatments T0, T10 and T9, were the best for the total weight variable of the seeds with 45.2, 34.8 and 30.6 g per plant, respectively. Even when the proof T0 surpassed slightly all the treatments cleaning the fruits per plant, statistically (Tukey proof) displayed the same behavior that the treatments T6, T5, T4, T3, T2, T1. The proof displayed the lesser rate of germination (50% aprox.) meanwhile T7, T8, T9 and T10 displayed 68, 65, 60 and 60% of germination respectively. Which indicate than the more quantity of fruit smaller is the rate of germination (less quality). This behavior is associated with seeds malformed in larger number of fruits per plant (spotted, malformation and flat seeds.).

The percentage of germination in the treatments T2, T3, T4, displayed the highest effect of cleaning the fruits in the plant (100%). This show up that the quantity of fruits per plant have a direct effect in the germination of the seeds, so you get a good sizes but the seeds achieve a good strength, good germination, meanwhile in the case of the total fruits, those were smaller in sizes and less quality of the seeds. Although the proof got a major seed weight per plant but the lesser rate in germination, compared with the best treatments.

CONCLUSIONS. According to the results gotten in the treatments with 90 and 100 fruits per plant, they were the best, although they surpass the proof they were superior to the proof as soon as the percentage of germination given by 10% aprox. The highest quality of seeds (germination) was achieved with a clear of 20-40 fruits per plant.

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NEW BREEDING LINES OF "MIRASOL" AND "ANCHO" TYPE PEPPERS (*Capsicum annum*) FROM ZACATECAS, MEXICO

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INTRODUCTION. A great diversity of wild and cultivated peppers is present in Mexico, they are consumed as fresh or dry fruits, either as spicy or mild flavors (7). Zacatecas is the leader for growing dry peppers of the types "mirasol or guajillo", "ancho", "puya", "mulato", "de árbol", and "guajón" in Mexico (3). An average of 38,995 hectares of peppers were harvested in Zacatecas from 1998 to 2000, 70% of them were allocated for dry fruit production, and the other 30% to the fresh fruit consumption market; 1.6 and 9.9 t h-1 are the average yields for dry and fresh fruit, respectively, in this area (12). These yields are low due to: a) use of native, neither selected nor benefited seed, b) effect of root disease organisms, insect pests, and agronomic management practices deficient, c) limited and unproperly use of pesticides, and d) deficient management of irrigation water (3). Pepper cultivars have been obtained using the pedigree breeding system in Mexico (6, 8); yield and fruit quality are the two main characteristics to breed into the new "mirasol" and "ancho" pepper cultivars for the north central region of Mexico. The "mirasol" cultivar VR-91 showed a yield 6.2, 5.3 and 3.2 t h-1 of dry fruits (all the yields to be reported from now on will be as for dry fruit production) for the Mexican states of Aguascalientes, Durango and San Luis Potosi, respectively (8). The "guajillo" cultivar San Luis yielded 3.2 t h-1 versus 2.9 t h-1 of the cultivar INIFAP at San Luis Potosi (9). The "mirasol" breeding line LEMZ-7 (Mirasol Zacatecas) produced 6.2 t h-1, and it had a 20.5% statistically significant higher yield than the native cultivar "Calera" at Durango (5); the same LEMZ-7 line, and the native cultivar "Chupaderos", produced 3.127 and 3.436 t h-1, and showed statistically significant higher yields of seven other cultivars evaluated at Zacatecas (10), while there were no significant differences when they were planted at Aguascalientes (4). In short, the breeding line LEMZ-7 had a different potential yields depending on the place were is grown, and Durango is the best place for use this pepper cultivar. With regards to the "ancho" type cultivars, no significant differences in yields were found in Durango, where 1.3 and 0.7 t h-1 were harvested from the Ancho San Luis and the breeding line LEAZ-6 (Ancho Zacatecas), respectively (5); the same trend was found at Aguascalientes when these cultivars were tested, and the higher yield was obtained with the LEAZ-6 pepper line (1.336 t h-1) (4). On the other hand, the pepper breeding lines LEAZ-10 and LEAZ-7 had significant higher yields, 3.009 and 2.149 t h-1, respectively, than the other cultivars evaluated at Zacatecas (10). Comparing the "ancho" and the "mirasol" results, two things are clear: a) the yield potential of the "ancho" peppers is lower than the "mirasol" ones, and b) the yield potential of both type of peppers is affected greatly by the edaphic/climatic conditions of the place were they are grown. Selecting new breeding lines of "mirasol" and "ancho" peppers for higher yields and dry fruit quality was the aim of this experiment.

MATERIALS AND METHODS. Two different experiments were run, one for "mirasol" and the other for "ancho" peppers, during 1997, 1999 and 2000, at the Experimental Research Station of Zacatecas (CEZAC) of the National Research Institute for Forestry, Agriculture and Livestock of Mexico. The experimental site is located on the 22º54'34" of north latitude, 102º39'33" of west longitude, and 2,197 m above sea level. Five "mirasol" cultivars were tested: LEMZ-7 (Mirasol Zacatecas), LEMZ-8, LEMZ-10, and the native cultivars Calera and Chupaderos. The "ancho" type cultivars evaluated were: LEAZ-6 (Ancho Zacatecas), LEAZ-8, LEAZ-10, Ancho San Luis, and the native cultivar Calera. Planting dates were the 17 and 28 of April, and 10 of may, for 1997, 1999, and 2000, respectively. A randomized block design with three replicates was used, the experimental plot had four rows (0.76m wide, 5m long, and 0.25m separation among pepper plants). Fruit yield of dry pepper production was evaluated by harvesting the two central rows (7.6 m^2). Seedlings were grown in the CEZAC greenhouse. The fertilization rate utilized was 220-100-150, split in four parts: the first one (00-100-150) was applied before planting time, the second one (70-00-00) eight days after planting; the next one (75-00-00) fifteen days after the second one, and the last one (75-00-00) fifteen days after the third one. Furrow irrigation was the method used for watering the crop at planting time, three and eight days after planting, and six more times during the growing season. Flea beetle control was achieved spraying 0.5 kg/ha of metomyl 90 WP. Weight of dry fruits sorted as first, second and "pinto" classes were the variables measured. Data were analyzed using a conventional analysis of variance (ANOVA), and mean were separated with the Tuckey test at 95% probability.

RESULTS. "Mirasol" pepper. Statistically significant differences were found only during the 1997 season, when the cultivars Ancho Zacatecas, LEMZ-8, and the native cultivars Chupaderos and Calera showed the higher yields (5.726, 5.928, 5.047 and 4.831 t h-1, respectively), compared to the LEMZ-10 cultivar (Table 1). These potential yields are much higher than the average (1.6 t h-1) that is harvested at the Zacatecas state level. Pepper yields of the five cultivars were not significant different during the 1999 and 2000 season (Table 1). However, the Mirasol Zacatecas cultivar had a potential yield of 4.76 t h-1, when averaged over the three years of evaluation, which is 0.165 to 0.639 t h-1 numerically superior to the other cultivars (Table 1); this cultivar also has shown outstanding results when tested on other Mexican states like Durango and Aguascalientes (4, 5). Under ferti-irrigation conditions, the Mirasol Zacatecas cultivar has yielded 5.6 and 5.0 t h-1 during the 2000 and 2001 seasons, respectively, in Zacatecas. Even though fruit quality data is not shown, this cultivar also produces a higher proportion of extra and first class fruits than other pepper materials. In short, the Mirasol Zacatecas breeding line shows a yield potential that allows it at least to compete, but most of the time, it is above the other cultivars currently planted in this region, therefore it can be a new option for the north central part of the chili production area of Mexico, and it is intended to be released as an open pollinated cultivar.

Table 1. Dry fruit yield (t h-1) of five "mirasol" type pepper cultivars at the Zacatecas Experimental Station, Mexico.

Cultivares	1997	1999	2000	Prom.
Mirasol Zac.	5.726 a	4.684 a	3.869 a	4.760
LEMZ-8	5.918 a	3.638 a	4.230 a	4.595
Chupaderos	5.047 a	4.276 a	3.859 a	4.394
C. Calera	4.831 a	4.470 a	3.183 a	4.161
LEMZ-10	4.540 b	4.414 a	3.410 a	4.121
Average	5.212	4.296	3.710	4.406

Means with the same letter along the same column are not significantly different according to the Tuckey test at 95% probability.

"Ancho" pepper. Pepper cultivars Ancho Zacatecas, LEAZ-10, LEAZ-8 and Ancho San Luis showed statistically significant higher yields of dry chili (4.8 to 3.8 t h-1), compared to the wild cultivar Calera (2.7 t h-1, Table 2) during 1997. A similar trend was observed in 1999, but this time, it was the Ancho San Luis cultivar with the lowest yields (Table 2). Yields were no significant different among cultivars in 2000 (Table 2). In summary, the Ancho Zacatecas cultivar had a potential yield of 3.43 t h-1, when averaged over the three years of evaluation, which is 0.225 to 0.976 t h-1 numerically superior to the other four cultivars tested (Table 2). This same cultivar has been tested on larger plots with commercial growers; it has shown yields of 4.3 and 2.7 t h-1 during 2000 and 2001, respectively, and represents an average increase of 29% over the highest yields obtained by the grower planted cultivars (1, 2). The variable "ancho" pepper yields, over years and places, is similar to the response obtained with the "mirasol" peppers (4, 5, and 10). However, the Ancho Zacatecas pepper breeding line has demonstrated a good potential yield, and superior fruit quality over the cultivars currently planted in this region, therefore, it is intended to be released as a new open pollinated cultivar.

Table 2. Dry fruit yield (t h-1) of five "ancho" type pepper cultivars at the Zacatecas Experimental Station, Mexico.

Cultivares	1997	1999	2000	Prom.
Ancho Zac	4.839 a	3.222 a	2.213 a	3.425
LEAZ-10	4.183 a	2.500 a	2.828 a	3.170
LEAZ-8	3.844 a	2.660 a	2.876 a	3.127
A. San Luis	3.859 a	1.108 b	2.380 a	2.449
C. Calera	2.682 b	2.593 a	1.906 a	2.394
Average	3.881	2.417	2.440	2.913

Means with the same letter along the same column are not significantly different according to the Tuckey test at 95% probability.

CONCLUSIONS. The breeding lines "mirasol" type pepper LEMZ-7 (Mirasol Zacatecas) and "ancho" type pepper LEAZ-6 (Ancho Zacatecas) have shown yields numerically superior, and better dry fruit quality than the commercial grown peppers at Zacatecas, therefore, they are good candidates to be released as new pepper cultivars.

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DETERMINACIÓN DE CAPSAICINOIDES EN CHILE HABANERO (*Capsicum chinense Jaq)*, COLECTADOS EN YUCATÁN

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INTRODUCCION. El estado de Yucatán cuenta con la mayor diversificación de chiles criollos en el país; entre los que se encuentra el habanero (*Capsicum chinense*, L.); cuyo origen se desconoce aunque se cree que es originario de América del Sur de donde fue introducido a Cuba y de ahí a la península de Yucatán. (Canul, 1996)

Se cree que la difusión del *Capsicum Chinense* fue desde la costa amazónica a la costa del Perú. La nomenclatura "chinense" es un enigma, puesto que su procedencia americana era conocida en 1776, cuando fue catalogada por Jacquin. (Long-Sólis 1986).

Chile Habanero. El estado de Yucatán cuenta con la mayor diversificación de chiles criollos en el país; entre los que se encuentra el habanero (*Capsicum chinense*, Jaq.); cuyo origen se desconoce aunque se cree que es originario de América del Sur de donde fue introducido a Cuba y de ahí a la península de Yucatán. (Canul, 1996)

El chile habanero posee una raíz principal de tipo pivotante, la cual profundiza de 0.40 m – 1.20m, con raíces secundarias extendidas en el suelo. Su tallo es erecto, de color verde con o sin coloración violeta de los nudos; con una altura de 0.3 – 1.2 m. Dependiendo de la variedad posee 4 ramas primarias y 4 secundarias, carece de pubescencia a veces puede estar cubierto de pelos o tricomas (Canul, 1996).

Capsicinoides. La pungencia es la sensación de calor en los chiles debido a los alcaloides conocidos como capsicinoides y están influenciados por el genotipo, practicas de cultura y el medio ambiente. (Zewdie-Bosland, 2000).

Los dos capsicinoides responsables del 90% de la pungencia en los chiles, son la capsicina y la dihidrocapsicina. (Betts, 1999).

La capsicina tiene la siguiente fórmula condensada: C18H27O3N, con un peso molecular de 305. 199 g/g-mol. Forma cristales en forma de aguja, es inodora, con un punto de fusión de 64.5ºC y un punto de ebullición de 210 –220ºC. A una presión de 0.01 mm Hg, se sublima a 115 º C y presenta su máxima absorción en UV a 227 – 228 nm. Es soluble en éter etílico, alcohol etílico, acetona, alcohol metílico, tetracloruro de carbono, benceno y álcalis calientes. Es insoluble en agua fría (García y Ortega, 1996).

La dihidrocapsicina tiene la siguiente formula condensa: C18H29O3N y un peso molecular de 307.215 g/g-mol, forma cristales de color blanco opaco inoloro pero con una fuerte pungencia. Su punto de fusión varia entre 65.5 y 65.8 º C, presenta su máxima absorbencia en UV por debajo de 230 nm y sus propiedades de solubilidad son idénticas a las de la capsicina (Iwai y Susuki , 1977).

Como otros alcaloides de las plantas los capsicinoides son acumulados y posteriormente sufren cambios bruscos de degradación durante el desarrollo del fruto.(Iwai y col, 1979; Susuki y col 1980). Esto es particularmente interesante en los frutos Capsicum donde los capsicinoides son sintetizados en la placenta. Los capsicinoides son acumulados en las vacuolas de las células epidemiales de la placenta, hasta ser metabolizados .

La cuantificación por el método de Scoville involucra una serie de catadores entrenados quienes evalúan la pungencia basados en una mordedura y duración de la pungencia asignándoles un valor determinado por el método. Este método se basa directamente en la percepción de la pungencia humano por lo que resulta un método subjetivo e irreversible (Betts, 1999).

Actualmente, el análisis de capsicinoides esta enfocada al uso de espectrofotometría, cromatografía de gases y cromatografía líquida de alta resolución (HPLC). Las técnicas que usan HPLC proporcionan al análisis exacto y eficiente del contenido y del tipo de capsicinoides presentes. (Collins y col, 1995).

OBJETIVO. Cuantificar el contenido de capsicinoides entre las distintas variedades colectadas

METODOLOGIA. Se utilizó el método de Collins y col (1995), modificado por Contreras y Yahia, 1998. Para le extracción se utilizaron 3 g de la muestra seca, con 30 ml de acetonitrilo. Se calentaran a 70ºC en un baño de agua durante 4 horas con agitación constante. Se dejaron enfriar a una temperatura ambiente y se filtraron.

El extracto de capsicinoides obtenido se filtró en una unidad de filtración con un filtro de nylon de 0.45 mm, la solución filtrada se paso a través de un cartucho C18Sep Park de 3 cc.
Ya acondicionado el concentrado, se utilizó el equipo HPLC Hewlett Packard serie 1100, con un detector de arreglo de diodos.
Las condiciones de trabajo incluyeron la utilización de una columna fase reversa C18 X Terra de 4.6 mm x 250 mm y fase móvil metanol - agua con una relación de 73/27. El tiempo de corrida fue de 20 minutos a un flujo de 0.5 mL/min. Se inyectaran 20 ml de la muestra (2 inyecciones por muestra), y la longitud de onda empleada para el análisis será de 280 nm.

RESULTADOS Y DISCUSIÓN. Se recolectaron 26 colectas mejoradas las cuales para efecto del trabajo se diferenciaron con la clave VMUX y nueve colectas criollas diferenciados con la clave, CCUX.

Contenido de capsicinoides entre las 160 000 – 240,000 Unidades Scoville.	
Colectas	Unidades Scoville
VMUX8	160911
VMUX5	168604
CCUX5	171015
VMUX6	180128
CCUX8	182481
VMUX21	185207
VMUX22	198378
VMUX14	205671
VMUX20	217075
VMUX9	235421

Contenido de capsicinoides entre las 110,00 – 159 000 Unidades Scoville.	
Colectas	Unidades Scoville
CCUX3	112703
VMUX18	115122
VMUX19	122896
VMUX25	124317
CCUX2	124826
VMUX11	125451
VMUX24	128848
VMUX3	130137
VMUX4	130137
VMUX2	136480
VMUX10	136823
VMUX15	144717
CCUX6	145997
VMUX12	147452
VMUX7	157712
VMUX23b	158221
CCUX3	112703
VMUX18	115122

Las líneas mejoradas colectadas fueron de color naranja/amarillo, al igual que la mayoría del las líneas criollas a excepción de las líneas CCUX1 y CCUX2 que fueron rojas y la CCUX3 de color blanco.

Contenido de capsicinoides entre las 60,000 – 109 000 Unidades Scoville.	
Colectas	Unidades Scoville
VMUX16	66722
CCUX4	69107
CCUX1	74170
VMUX13	88959
VMUX23a	96140
VMUX1	106446
CCUX9	107028

En el cuadros anteriores se pueden observar los el contenido de Capsainoides en diversas variedades colectadas en el estado de Yucatán.

Como se puede observar los rangos del contenido de capsicinoides en las diferentes colectas varían desde los 60, 000 hasta las 230, 000 Unidades Scoville.

Estos resultados nos dan una visión más alta del contenido de este alcaloide en las diferentes colectas del estado de Yucatán, lo que nos permite clasificar el chile habanero para diferentes fines, que puede ser desde materia prima para la elaboración de productos hasta la elaboración de productos farmacéuticos.

La variación en la cantidad se debe a diferentes factores ambientales, el tiempo de cosecha así como a la variedad a la que pertenecen (Zewdie-Bosland, 2000).

CONCLUSIÓN. La determinación del contenido de capsicinoides en las colectas de chile habanero del estado de Yucatán nos da un esquema más amplio para un apropiado uso de las diferentes variedades dependiendo de cual va a ser su uso final.

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CHANGES IN THE LEVELS OF CAPSAICIN DURING CALLUS GROWTH OF JALAPEÑO PEPPER AS A RESULT OF THE PRESENCE OF BIOSYNTHETIC PRECURSOS AND MICROBIAL ELICITORS

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ABSTRACT

The chili pepper, *Capsicum annuum*, represents one of the most important native species cultivated throughout the country with annual crop productions reaching close to one million tons/year, however 35% of this is lost due to diseases and few industrial alternatives. One possibility is to increase and isolate higher amounts of the major substance present in plant cells known as capsaicins. In this context, our research goal focused in the induction of capsaicin biosynthesis as result of chemical precursors along the metabolic pathway like shikimic acid, ferulic acid, and vanillin, used as constitutive elements in the MS medium by calli formation, previously obtained by growing hypocotyl explants of sterilized germinated Capsicum seeds kept in darkness. Best callus induction was achieved using 15 ppm of IAA and 1 ppm BAP, after 25 days of cultivation under a daily photoperiod of 16 hr. Similarly, *Rhodococcus fasciens* extracts were used as a new added nutrient in the MS medium to monitor the microbial induction of capsaicin during callus growth. The analysis were performed by HPLC, resulting in close to 7.5 fold increased in capsaicin concentration under ferulic acid treatment, while shikimic acid seems to have little positive effect. Vanillin treatment increased close to 6 times capsaicin content up to the second week of callus growth with a sharp decline in phenolic concentration after that. Bacterial treatment showed a positive effect increasing capsaicin concentration throughout the experimental period. However, a decline was observed in the last week of the experimentation probably due to the fact that a shift in the metabolic pathway occurred in which cell lignification increased.

PEPPER PRODUCCIÓN SYSTEM (*Capsicum anuum* L.) IN DURANGO, MÉXICO

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In Mexico the pepper is one of the most important horticultural cultures after the tomato, annually there are about 110 thousand hectares cultivated per year, of a wide variety of pepper types, among those that highlight as the most important the types are: "mirasol, mulatos, jalapeños, pasilla, serranos, habanero and of árbol".

The state of Durango participates in the national production with an annual surface of around three thousand hectares where harvests takes place the types width, mirasol, crystalline, of tree and cora mainly, with yields average 1.3 tons of dry pepper and 8 tons for consumption in green. The region producer in the state, understands the municipalities of Poanas, Nombre de Dios, Vicente Guerrero, San Juan del Rio, Peñon Blanco, Guadalupe Victoria and Durango.

This cultivation settles down in very varied climate conditions and floor, using different cultivation methods according to the pepper type and the region where it is cultivated. it is characterized to be a cultivation that requires of a lot of work investment (150 wages for hectare) to be harvested, from the establishment of the nurseries, large hoe, harvests and classification for the sale of there the regional and state importance.

The system of pepper production understands the plant production for the transplant, necessary in most of the horticultural cultivation, at regional level he/she is carried out through nurseries or nurseries that he/she consists On preparing small land areas to which are given special attention, distributing in the floor a great quantity of seeds to obtain this way many plants. Depending from the surface to cultivate is the size or I number of nurseries, in general 20 square meters of nursery are needed by hectare or of 800-1000 gr. of seed depending on the pepper type or variety. Still when for the state of Durango varieties of improved seeds are recommended and it is difficult to consent to them, for what is common the use of Creole seeds that you/they are selected cycle to cycle for the producers, representing one of the weak aspects of the production since favorable problems of illnesses, genetic degeneramiento for the mixtures intravarietal, low yield for surface unit, heterogeneity in the final product and -I eat-- consequence problems in the commercialization.

The preparation of the land where it will be carried out the definitive plantation, it considers a trail to erase the furrows and residuals of the previous cultivation, a deep fallow and one or two trail steps with the purpose of that the floor is well fluffed, these activities force to have an enough and opportune access to the agricultural machinery.

You continues with the one furrowed previous to the transplant and it is made following the curves of level of the land to avoid pounds, that can cause the incidence of illnesses regularly and leaving a separation among furrows of 82 centimeters. The transplant is carried out in a manual way, from final of March until principles of May, conform to he/she waters the land placing in the rib from the furrow to level of the water and among the fingers to protect the small roots being placed 3 plants by bush to assure the establishment at a distance of 40 centimeters to have population's of 30 000 undergrowth density for hectare. In watering the number and frequency are determinate for the rain fall, environmental temperature, floor type and more important to the readiness of water in the preys and the programming in the watering units for pumping. however, in general form, one can say that after the overwatering which is carried out to the 8 days after the transplant is given from 5-8 watering to intervals of 20-25 days among each one, being considered enough to satisfy the necessities of humidity required by the cultivation.

After the overwatering the first cultivation is made together with the fertilization which is with the help of urea and superphosphate of triple calcium to reason of 2 bundles for one followed by the large hoe (" tapapie ") to eliminate the overgrowths of the loin of the furrow and "aporcar" the plants, in general this activity is carried out after each cultivation or weeding hoe until before the foliage of the plants closed the furrows.

The different systems of pepper production in Durango show the heterogeneity under the climatic, topographical soil and socioeconomic conditions, in those that the technological process is supported, however still it is common to observe for the southeast of the state the traditional forms of plantation in cross, being an indicator of the economic limitations that you/they face those producing of the region which prefer to have smaller population of plants for surface unit to avoid the expense for manpower.

The system of pepper production in the region is characterized to prevail the half use of inputs of the technological package in the relative thing to chemical fertilizers, plantation densities, under or null use of improved seeds of high potential and agrochemical.

SEED TREATMENT WITH SALICYLATES MODIFIES STOMATAL DISTRIBUTION, STOMATAL DENSITY, AND THE TOLERANCE TO COLD STRESS IN PEPPER SEEDLINGS

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ABSTRACT. The objective of this study was verify if the exogenous application of salicylic acid (SA) and sulfosalycilic acid (SSA) induces resistance to cold stress in pepper seedlings. Seed application of AS 10^{-4} M and SSA 10^{-4} M was effective in inducing seedling resistance to cold stress, manifested as significantly more plant fresh and dry weight. On the other hand SA and SSA 10^{-3} M and 10^{-5} M showed a negative effect on seedling growth. Stomatal index and stomatal density were negatively affected by SA and SSA 10^{-3} M. On the other hand SA and SSA 10^{-4} and 10^{-5} M increased the stomatal index and stomatal density in abaxial side, showing the opposite response in the adaxial side.
Index Words: *signaling, salycilic acid, stress resistance, leaf epidermis.*

INTRODUCTION. Environmental stress in plants gives rise to the activation of adaptation and defense responses. Between these is the induction of salicylic acid (SA) and their derivatives. In pepper seedlings the foliar application of SA increased the stomatal resistance and reduces the transpiration (Eris, 1983). On the other hand, It is well established (Larqué-Saavedra, 1978, 1979) that SA controls stomatal response, but it is not know if the response includes changes in the size, frecuency and distribution of stomata. The objectives of the present study was: (1) determine if the SA and a SA sulfur derivative applied as seed treatment can induce a cold tolerance response in pepper seedlings, (2) determine if SA and SSA modifies the frequency and relative distribution of stomata.

MATERIALS AND METHODS. The seeds of serrano pepper (*Capsicum annuum* cv. Tampiqueño 74) were placed in petri boxes filled with water and solutions of salicylic and sulfosalicylic acid at concentrations of 10^{-3}, 10^{-4}, and 10^{-5} molar. The seeds remained in the petri boxes for 6 hours and later germinated at constant temperature of 25° C and transferred to polystyrene containers. These germinated seeds were accommodated of such a form that they were had four repetitions of each one of the treatments with 30 plants for repetition. Lapsed 22 days we carried out the first one evaluation of plant growth. Six plants for repetition were removed of the containers in order to determine the fresh and dry weight. After the first growth evaluation was led the remaining seedlings to a stress condition consisting in subject it to low temperature (4° C) for 24 hours. Lapsed that time the plants were returned to the greenhouse. After four days of growth in the greenhouse in absence of any stress we were carried out the second plant growth evaluation. Finished this second evaluation of growth it was applied a second low temperature stress in the form before described. Upon finishing the cold treatment the plants were returned to the greenhouse for again permit four days of growth. A third growth evaluation was then completed. Coinciding with this last plant evaluation we carried out surface leaf impressions following the methodology described by Verdugo et al. (1999) for the determination of the stomatal index and stomatal density.

RESULTS AND DISCUSSION. The average result of the three samplings appeared in Table 1. Before the exposition to low temperature the plants did not exhibited significant differences. However, after the cold stress the plants with the highest weights were those with application of SA and SSA 10^{-4} M. This study demonstrated that the seed treatment with SA and SSA 10^{-4} M induced a better growth recovery of the plants subjected to low temperature. Other reports shows that the foliar application of SA increased the growth of soybean (Gutiérrez-Coronado et al., 1998) and wheat (López-Tejeda et al., 1998).
On the other hand it was observed that the SA 10^{-3} M gave rise to a significant decrease in the stomatal density and the stomatal index (Table 2). It is known that the stomatal density and the stomatal index are regulated for endogenous and environmental factors (Boetsch et al., 1996), while the decrease in the stomatal density was reported like a character of acclimatization in order to restrict the loss of water in a gradient of altitude (Schoettle and Rochelle, 2000). Both SA and SSA 10^{-4} M increased significantly the values of stomatal density and stomatal index in the abaxial side of the leaf but diminished them in the adaxial side. The lower concentration of 10^{-5} M equally gave rise to increments in the index and density of stomata, but statistically not significant.

Table 1. Weight of pepper seedlings exposed to cold stress. The results are the average of three samplings.

Treatment	Shoot fresh weight	Root fresh weight
Test	0.4402ab†	0.1969abc
SA 10^{-5} M	0.4312a	0.1755a
SSA 10^{-5} M	0.3459a	0.1539a
SA 10^{-4} M	0.5428bc	0.2537c
SSA 10^{-4} M	0.5554c	0.2476bc
SA 10^{-3} M	0.3708a	0.1661a
SSA 10^{-3} M	0.4036a	0.1805ab

† The numbers followed for the same letter are not statistically different (Duncan, 0.05).

Table 2. **Average results for stomatal index (SI) and stomatal density (SD) of pepper seedlings exposed to cold stress.**

	Adaxial side		Abaxial side	
Treatment	**SI**	**SD**	**SI**	**SD**
Test	0.183b†	113.33bc	0.275a	200.00ab
SA 10^{-5} M	0.188b	130.56c	0.323abc	233.33bc
SSA 10^{-5} M	0.170b	86.11b	0.348bc	255.56cd
SA 10^{-4} M	0.137ab	81.94b	0.379c	244.44bcd
SSA 10^{-4} M	0.175b	120.83c	0.379c	290.28d
SA 10^{-3} M	0.108a	44.44a	0.305ab	152.78a
SSA 10^{-3} M	0.187b	113.33bc	0.319abc	248.33bcd

† The numbers followed for the same letter are not statistically different (Duncan, 0.05).

CONCLUSIONS. Pepper seed treatment with salicylic (SA) and sulfosalicylic acid (SSA) 10^{-4} M induced better growth in plants exposed to low temperature episodes. High (10^{-3} M) and low (10^{-5} M) levels of SA and SSA gave rise to growth below those of the test plants. In absence of cold stress the height and the leaf number was negatively affected for the SA and the SSA. Seed application of SA and SSA modifies stomatal density, stomatal index, and the relative distribution of stomata in the adaxial and abaxial leaf surfaces of the seedling.

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PERFORMANCE OF CHILI PEPPER (*Capsicum annuum* L.) UNDER GREENHOUSE CONDITIONS IN DURANGO, MEXICO

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SUMMARY. In the State of Durango located in North Central Mexico, is located the Guadiana valley with favorable conditions to produce intensively orchard products. The production of Poblano chili pepper under greenhouse could be a good opportunity to produce high yields of supreme quality, rather than open field conditions. There had been carried out two tests in order to estimate the productivity of ten varieties and one hybrid under greenhouse conditions. The best varieties were Zac-1 and Zac-4 that yielded 46.5 and 44.2 ton ha^{-1} respectively, the hybrid WA-2011 yielded 46 ton ha^{-1}. Results of these tests showed that it is possible to produce good yields of Poblano peppers under greenhouse conditions in the Guadiana Valley of Durango.

INTRODUCTION. In Mexico are planted annually under irrigation more than 15 thoushand hectares of Poblano or Chile Ancho hot pepper. The main production area is located in the semi-arid region of the North-Center of the country, where are located the States of Guanajuato, San Luis Potosí, Durango, Zacatecas and Aguascalientes. There are also other less important production regions in the States of Sinaloa, Nayarit and Coahuila (2). At the present time exists an increased demand of fresh green Poblano pepper in the United States and other countries. There have been increased also the consumption of dry hot peppers in these countries where traditionally were consumed only sweet peppers, because the hot flavor is becoming popular also in other parts of the world. In the State of Durango the main producing regions are Guadiana, Poanas and Rodeo Valleys, with more than 3.35 thousand hectares planted with a mean yield of 7.7 ton ha^{-1}, producing 25.9 thousand metric tons with a value superior to $51 million pesos (1).

Producers usually sow only land race varieties and they don't use modern planting technology; these are the main reasons because they have low yields and products of poor quality. The objective of the present study was to identify and to select better cultivars of Poblano pepper utilizing drip irrigation and plastic mulching under greenhouse conditions to improve the yield and quality of Poblano pepper production in Durango.

MATERIALS AND METHODS. The study was carried out under greenhouse conditions (without temperature, humidity and light control) in the National Institute of Research for Forestry, Agriculture and Livestock (INIFAP) at Durango Research Station. The general conditions inside the greenhouse were alkaline soil with low organic matter, medium capacity of cationic exchange, no salinity and high calcium and magnesium content. Durango research station is at 1890 masl. Eleven cultivars, a comercial hybrid and ten open pollinated varieties, were planted in two tests. The first test was planted in May 21st and the second one on May 24th 2000. In both tests a completely randomized block design with four replications were used in planting beds of 1.6 x 6 m. There were planted an equivalent population of 25-thoushand plants ha^{-1} in a double row planting system irrigated with a dripped belt. The total fertilizing formula (NPK) applied was 170-140-160. Soil humidity near field capacity was controlled with tensiometers. Fruit production is reported in ton ha^{-1}.

RESULTS. A total of four harvests were made at 99, 127, 157 and 190 days after planting. Total yield of both tests are presented in Table 1. High statistical significance ($p < 0.01$) were encountered only in the first test, where the hybrid WA-2011 and the varieties Dgo-5, Zac-1 and Zac-4 were in the same group of significance (LSD $p < 0.05$) with a mean of 46.0, 42.2, 46.5 and 44.2 ton ha^{-1} respectevely. In the second test, nevertheless the no significant differences among cultivars, Zac-1, Zac-4, Dgo-3 and WA-2011 had the highest fresh fruit yield, with 43.6, 43.2, 43.1 and 41.2 ton ha^{-1}, respectively. The mean yield in greenhouse 42.2 ton ha^{-1} was highly greater than the mean of 7.7 ton ha^{-1} produced under field conditions. The main production limits observed were pests, mainly aphids and worms.

Table 1. Fresh fruit production (ton ha^{-1}) of Poblano hot pepper under greenhouse conditions in Durango, Mexico. INIFAP 2002.

Cultivar	1° Test	2° Test	Mean
WA-2011	50.8	41.2	46.0
Dgo-5	49.3	35.0	42.2
Zac-1	49.3	43.6	46.5
Zac-4	45.2	43.2	44.2
Dgo-1	43.0	36.9	39.8
Dgo-2	42.7	38.2	40.4
Zac-2	42.6	40.8	41.7
Dgo-4	41.9	40.4	41.2
Zac-5	41.6	41.5	41.2
Zac-3	41.1	36.2	38.7
Dgo-3	40.7	43.1	41.9
Mean	**44.4**	**43.6**	**42.2**
LSD $p < 0.05$	**5.6**	**5.0**	
C of V. (%)	**15.6**	**14.5**	

CONCLUSIONS. The mean yield of the open pollinated varieties Dgo-5, Zac-1 and Zac-4 of two tests was at the same statistical level than the hybrid WA-2011 (wich seed is very expensive). The fruit quality for these four cultivars was high and the same for all of them. These results suggest that it is possible to grow hot Poblano peppers with advantages under greenhouse conditions in Durango because the level of productivity is about 5 times the fruit harvested under field conditions.

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EFFECT OF CONTROLLED ATMOSPHERES ON QUALITY OF GREEN PEPPER POBLANO (ANCHO)

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Keyrwords: Controlled Atmospheres (CA), Chile Poblano, Chile Ancho, *Capsicum annum*

ABSTRACT. Chile Poblano (ancho) was stored under different Controlled Atmospheres. Oxygen concentrations of 5, 10, 15 and 21% oxygen were used. Carbon dioxide concentrations applied were 5 and 10%.Temperatures tested were 0, 5, 10, 15^o C and ambient temperature. Parameters evaluated were ascorbic acid, acidity, soluble solids, firmness and color which were monitored weekly. Results showed that ascorbic acid decreased in a range of 11-70% loss, and it was affected by oxygen concentration and time. Acidity decreased with time, but it was not affected by temperature and oxygen concentrations. Soluble solids were not affected by gas concentrations, decreasing only with time. Firmness decreased significantly with time; however, it depends on oxygen and carbon dioxide concentrations. Weight loss was minimun and color was maintained at all temperatures. The best conditions to store chile poblano (ancho) were at temperature of 0^o C and 10% oxygen concentration.

INTRODUCTION. Controlled Atmosphere Storage (CAS) has been successful in maintain quality of fruits and vegetables. Modified Atmosphere Packaging, has also been used for the same purpose. Chile Poblano, is widely used in Mexico but postharvest studies on this type of chile are scarce. On the other side, reports have been numerous on bell pepper, specially, using MAP to enhance shelf life. Gonzáles-Tiznado, (1993) used bags from LDPE to extend shelf life of bell pepper for 20 days at 10^{o}C. In 1998, González et al., found that a treatment with hot water combined with packaging in bags from LDPE for 4 minutos a 53^o C was effective in lower respiration rate, reduce damage, maintain turgency and green color keeping the overall quality for 28 days at 8^{o}C. Other studies have used bell pepper in stripes and cubes storing them under controlled atmospheres using CO_2. Results have been mixed (López-Gálvez et al., 1997; Cantwell et al., 1998).

Regarding "Chile Poblano" (or ancho), it is highly perishable, with a shelf life of one to two weeks at ambient temperature. Refrigeration is not used neither Controlled Atmosphere Storage. In light of the above, these studies were carried out in order to evaluate the effect of Controlled Atmosphere Storage on quality parameters of "Chile Poblano".

MATERIALS AND METHODS. Chile Poblano was purchased from a local distributor "Chilera Serrano" of the Francisco Villa Market of the City of Durango, Mexico, within 24 hrs after harvest or the same day of harvest. The peppers were washed with water and soap, its weight and volume were determined; they were disinfected in a solution of sodium hypoclorite with 200 ppm for 5 minutes. Peppers were drained, dried and placed in the glass chambers in an average of eight peppers per jar.

The atmospheres evaluated were: O_2 concentrations of 5, 10 y 15% and the control at 21% and stored at 5°C of temperature (Experiment "A"; chile from Vicente Guerrero and Poanas, Dgo.). Another experiment, aimed to evaluate the effect of CO_2 in conjunction with O_2 utilized 5 and 10% O_2 with 0, 5 and 10 % of CO_2 and a control of 21% of O_2 and 0% of CO_2 (Experiment "B", chile from Sinaloa and Zacatecas states) at 0°C of temperature. A last experiment was carried out at 5, 10 and 21 % of O_2 with 0 and 10% of CO_2 at temperature of 0° (Experiment "C", chile from Poanas, Dgo).
The parameters evaluated were color (using the scale L, a, b., with a Mini Scan Hunter Lab Mod 4500L) ascorbic acid (Ranganna, 1977) acidity (A.O.A.C. No. 942.15, 1977) , soluble solids (Refractometer), acidity and firmness by punction using an Instron Universal Machine (Mod. 1132) with 5 Kgf.

Data was analyzed using the software STATISTICA for Windows, version 4.3, (Statsoftt, Inc., 1993, U. A.) with a level of significance of 5% (p £ 0,05).

RESULTS AND DISCUSSION
Ascorbic Acid. Mexican chile id an important source of ascorbic acid. Reported concentrations are in a range of 46.6-243 mg/100 g of dry weight (Wimalasiry and Wills, 1983; Nisperos-Carriedos et al., 1992; Howard et al, 1994;Lee et al 1995). Chile used for this studies was analyzed initially and the values found were: Vicente Guerrero (233 mg/100g), Poanas (262 /100g), Sinaloa (150 mg/100g) and Zacatecas (241 mg/100g). For all treatments evaluated, there was a decrease on these values and it was found that oxygen concentration and time had a significant effect on ascorbic acid loss. Losses were in the range of 11-70% (Figure 1).

Acidity. This value represent the amount of organic acids within the fruit, amount that is decreasing as fruits are maturing (Cantweell, 1994). It has been reported that acids present in Capsicum plans are malic and oxalic acids (Dewitt et al, 2000). The results of this study, showed that there was a loss of 25 % on the acidity value and time was the only parameter that affected this value. Neither oxygen or temperature were important (Figure not shown).

Soluble solids. were not affected by oxygen and carbon dioxide concentration and the results were affected just for the time of storage, trend that si confirmed by others authors that mention that soluble solids usually increase as fruit is ripening and once senescence is reach, this value decreases (Gorny and Kader, 1998), (Figure 2).

Firmness. Few studies have shown change in firmness of chile. For the studies reported here, with Chile Poblano it was found that firmness decreases for all treatments evaluated. For example, for chile from Poanas (Dgo), losses were in the range of 22% after 8 weeks of storage at 0o C, while at ambient temperature, after 2 weeks of storage, the value of firmness is similar to that obtained after 8 weeks. Experiments with CO_2 presented higher firmness loss (36%) while oxygen did not affect firmness significantly (Figure 3).

Weight loss. Weight losses for the atmospheres tested were in a range of 1-10%. At 0^o C after 8 weeks of storage, weight loss was around 5%, value compared with that reported by Lownds et al (1993), that found percentages of 16-25% (Figure not shown).

Color. For most experiments, values for color obtained were in the range of – 4 to -2, values that indicate green color. The temperatures of 0 and 5^{o}C kept the green color better, since those chiles stored at ambient temperature, changed to positive values sooner, which indicates a trend toward a red color (Figure 4).

CONCLUSIONS

Ascorbic acid loss is affected by oxygen and time, while color is affected by temperature. $C0_2$ affects significantly firmness, while oxygen do not affect this parameter. Oxygen concentration of 10% and a temperature of 0° C are the best conditions for keeping pepper quality; however, further studies are necessary in order to evaluate the possibility of chilling injury at this low temperature.

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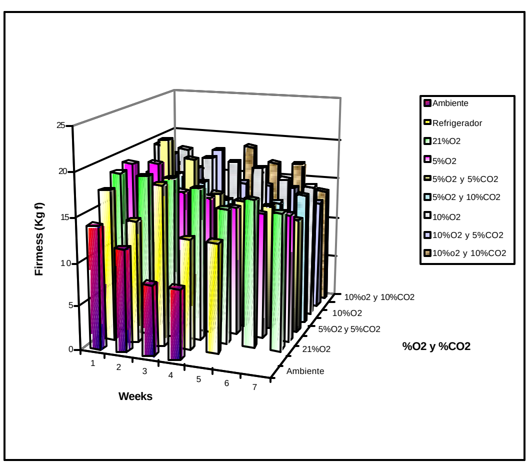

Figure 1. Effect of oxygen concentration and time on ascorbic acid in chile from Vicente Guerrero at 5° C.

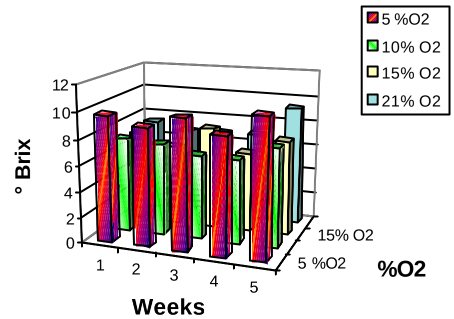

Figure No. 2. Effect of time and gas concentrations on soluble solids on chile verde from Poanas, Dgo at 0 °C

Figure No. 3. Effect of time and gas concentration on firmness of Chile Poblano c.v. ancho from Zacatecas at 0° C

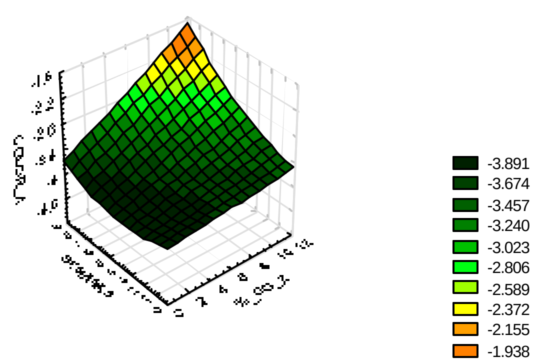

Figure 4. Effect of time and gas concentrations on Chile Poblano from Poanas, at 0° C

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INTERNATIONAL TRADE AGREEMENTS AND THE FUTURE OF THE SPICE SECTOR WITH SPECIAL REFERENCE TO PEPPER IN SRI LANKA

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ABSTRACT

Spices historically and currently have been an important industry in Sri Lanka where pepper takes a lead role. The industry grew notably during the last two decades. Natural, value added and organic spices have a considerable development potentials in the future. The progress will be governed by the international trade agreements. This paper addresses

the likely impacts of various trade agreements on such development options.

Major markets for Sri Lanka are South Asia, Middle East, Europe and the US. Indian market is the leader for pepper. Their tariff structure and the SPS requirements determine the market potential. There will be a notable market access increase under the new WTO tariffs structure, but the SPS requirements are the limiting factor. At present the quality of spices in Sri Lanka is affected by the presence of mould, high moisture content and aflatoxin attributed mainly to (a) poor weather conditions experienced by many producers with low cost processing technology; (b) poor storage facilities; (c) small scale nature of production units; and (d) early harvesting habits. The result is a loss of export volume of spices to an average of about 5,500 mt per year with a value of about two million US $ during 1990-2000 (34% of the total).

Introducing technology, human resource development, awareness creation, and central collection and processing arrangements are the internal strategies to combat the problem. Addressing more transparency and participation in the international standard setting processes, and obtaining technical assistance are the external strategies.

Sri Lanka has a high potential for promoting organic spices and organic pepper. However, TBT agreement creates the basis for various constraints for the progress. Production constraints, strict quality, certification and accreditation issues, national and regional standards and importing procedures, organic labelling, and stiff competition from other producers are the main obstacles. Sri Lanka however emphasises on increasing public awareness, promoting conservation farming, selecting proper varieties and promoting IPM to capture the increasing markets for organic spices.

The paper recommends to increase the competitiveness of the industry in line with the *factor conditions,* which addresses the production as well as other factors, the *demand conditions, related or supporting industries* concept which addresses presence of suppliers of similar products with internationally competitive quality, and finally, *the structure and nature of rivalry of related firms* where the cost-based competition is replaced with quality and high priced-based internal competition.

CHILI PIQUIN (*Capsicum annuum*) POPULATION AND HANDLING AGRO-FORESTRY STUDY IN NORTHEASTERN MEXICO

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INTRODUCTION. The biodiversity is lost according to natural habitats elimination. This loss is directly related to development models followed by different countries around the world, particularly those located in the tropics.

Harvest and extraction of wild species have been an advantage-benefit practice of natural resources, actually it continues in many communities worldwide. This traditional form of use along with the additional income to farmer family economy, is expressed as a cultural expression of a long process of man-environment interaction. Then, when the natural resources alternatives are proposed it is very important to regard an integral way of the economic, ecological and social-cultural aspects.

Traditionally the chili, along with pumpkin and maize has been the base of the feeding for the MezzoAmerica inhabitants and still subsists in many rural communities of Mexico. Specifically, chili piquin (*Capsicum annuum* Var. aviculare) is an annual plant, although it grows continuously in tropical zones. The *annuum* specie, is the most important since it includes majority of domesticated, wild and spontaneous chili peppers existing a great diversity of forms, sizes and colors of the fruits. This group includes so much to sweet chili peppers as to the very sharp ones as the chili piquin particular case.

Present study was developed in the Northeastern Mexico, where the greater territorial extension is framed within the arid and semiarid zones context of the country, which sometimes contains unique ecosystems in their type, formed mainly by scrubs where chili piquin is other of the vegetal components. Distribution is ample, integrated from the Southern part of United States to the Northwest of South America, being located next to rivers and agricultural fields. Regionally chili piquin is recognized by its small size, changing its name according to the collection region i.e. chili of chiapas, tlacuache tooth, chiltepin, bird tip, chili mosquitoe, among others. The study area includes the Victoria, Güemez, Hidalgo, Villagrán, Mainero and San Carlos Municipalities corresponding to State of Tamaulipas, and Linares, Hualahuises and Montemorelos Municipalities in State of Nuevo León.

MATERIAL AND METHODOS. The objective was to perform a chili piquin population study and propose an agro-forestry handling in order to help the anthropogenic pressure diminishment on the natural populations within the thorny Tamaulipas native scrub. General work is framed within the natural resources handling context being divided in four phases for its analyses: a) Description.- general ecological work area characterization and study species identification using bibliographical, biotic (samplings and quadrants) and abiotic information (physical site characterization and environmental information); b) Exploration.- socioeconomic aspects determination, such as the chili piquin resource-rural population inter-relationship within the study area (survey, approach of systems, projects evaluation including market study); c) Proposition.- viability to perform an agro-forestry handling *in-* and *ex-situ*, proposal (Literature, experts and farmers work meetings); and d) Experimental.- Proposals quantitative evaluation (design and statistical analysis).

RESULTS. Results from the first study estimation indicate that chili piquin resource belongs to *aviculare* variety, being associated with twenty vegetal families where *Fabaceae*, *Cactaceae* and *Asteraceae* are the most representative. In general terms, during the 1985 to 1998 period the above genera have been eliminated, or in a better case there is a 56% of natural vegetation alteration in the study area. Also, in this period, an alteration degree about growth of 11% in real terms for the farming activity was observed. Identified associated fauna and considered as seed scatterer agent includes the *Minus polyglottos*, *Toxostoma longirostre*, and *Crotalus atrox*. On the other hand, the greater natural chili piquin populations are in vertisol and rendzina types soils with smaller slopes of 2%. Chile piquin is developed suitably with temperatures of 21 to 24°C and 900 mm of precipitation distributed during the year.

CONCLUSION. The chili piquin resource extraction is used by the rural population like food condiment, medicinal, and generates extra-income for the farmers' family. In the study area two production seasons are defined, the early- on March, April and May and the delayed one on August, September, October and November. From the possible handling alternatives of that resource, it was proposed to evaluate the Agro-Forestry Systems (AFS) either *in-situ* and *ex-situ*; in both cases encouraging results are obtained. The first evaluation shows that for the AFS *in-situ* their application is in a short term, whereas the AFS *ex-situ* would be handled in the long term. Experimental results of the pruning variable in the AFS *in-situ*, illustrate that chili piquin supports up to 50% of vegetal cover elimination , and maintains its productive level for the following season, whereas if a 100% of the cover is eliminated its productive recovery would happen in more than two years under optimal conditions.

Considering all above mentioned, this study contributes for a better knowledge about the chili piquin, under its characterization, inventory, handling, domestication and benefits allowing foundations to reinforce either the regional and national policies for the actual natural germinal plasma preservation.

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EFECTS OF CONTAINER SIZE AND PROPAGATION TECHNIQUES USED FOR NURSERY PRODUCTION OF WILD CHILI PEPPER PLANTS (*Capsicum annuum* L. var. aviculare)

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SUMMARY. Production of wild chilli pepper plants in the nursery is becoming an important socio-economic activity in North-eastern Mexico. The development of commercial production of plants and genetic conservation techniques is required as native vegetation where wild chilli peppers prosper is being reduced every day. Effects of propagation systems used i.e. seeds or rooted twigs and container size (0.4 l, 5 l y 10 L) for production of wild chilli pepper plants were studied. Results showed no statistically significant differences ($p \leq 0.05$) regarding of the propagation systems used for plant height, stem diameter and plant cover. Regarding the container size results showed differences as big containers showed best results for the same parameters as above, when using plants obtained from seeds. No growth differences were found for plants propagated from twigs and placed in different container size.

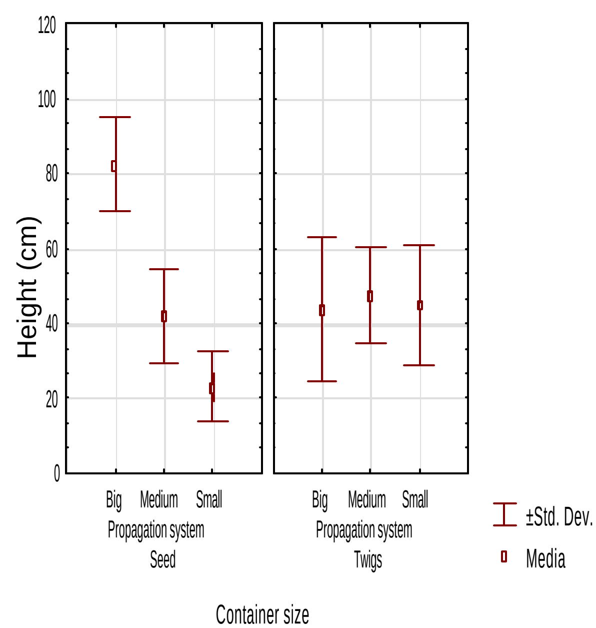
INTRODUCTION. Production of wild chilli pepper plants in the nursery is becoming an important socio-economic activity in North-eastern Mexico. The development of commercial production of plants and genetic conservation techniques is required as native vegetation where wild chilli peppers prosper is being reduced every day. This species is considered as a forest resource that has a potential for commercial production as it is good for human consumption and is well accepted for different culinary uses.

OBJETIVES. Effects of the propagation systems used i.e. from seeds or rooted twigs, and container size (0.4 l, 5 l y 10 L) for productions of wild chilli pepper plants were studied.

METHODOLOGY. This study was carried out in the nurseries of the Facultad de Ciencias Forestales de la U. A. N. L. From January 2001 to February 2002. Twigs were obtained from 2 year old wild chilli pepper plants that showed general good conditions, twigs were 15 centimetres long and a soil substrate of 1/3 soil, 1/3 germinaza and 1/3 perlite. Black polyethylene bags of three different sizes (i.e. 4, 5, and 10L) and a 400 thick measure. These bags were used in order to obtain one year old vigorous healthy plants that are ready for production of fruits, bags were filled up with soil mixture substrate and twigs placed in them, plants were watered every three days. Seeds were treated with giberelic acid (500ppm) for 24 hours and then placed in germination containers filled up with the same soil mixture substrate. Seedlings obtained were transplanted when they reached 10 cm in height to containers as used for twigs treatment.

RESULTS. Results showed no statistically significant differences ($p \leq 0.05$) for plant height, stem diameter and plant cover regarding of the propagation systems used. Container size results showed differences for the same parameters as above, when using plants obtained from seeds and big containers had best results. No growth differences were found for plants propagated from twigs and placed in different container size.

Effects of container size and propagation system used on plant height



DISCUSSION. Results showed that there were no statistically significant differences ($p \leq 0.05$) for plant height, stem diameter and plant cover regardless of the propagation systems used. Escalera (1985) and Montañez, (1993) reported that soil substrate humidity is a very important limiting factor when using twigs while seed scarification is also very important for getting good germination results. In this study these growth factors were considered and no plant growth problems were found.

Regarding container size for propagating the species, no plant growth differences were found as reported by Escalera (1985).

CONCLUSIONS. Wild chilli pepper propagated from twigs grow well in any container size whilst seedlings show best growth responses when growing in big containers (10L).

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WILD CHILLI PEPPER: A POTENTIAL FOREST RESOURCE FOR SUSTAINABLE MANAGEMENT IN NORTHEASTERN MEXICO

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INTRODUCTION. Wild chilli pepper fruits are very popular for consumption all around Mexico. In north eastern Mexico wild chilli peppers are an important resource for the economy of people living in rural communities (Medina *et al*., 2000). Fruits of this species are consumed either fresh or dried and they are processed in vinegar or sauce representing a promising potential market both in Mexico and USA (Medina, 1999; González, 1999). The main aim of this study was to evaluate the potential of *Capsicum annum var. aviculare* for its cultivation and sustainable development in rural communities. This study of sustainable management of wild chilli pepper was carried out by the following institutions Facultad de Ciencias Forestales (UANL), Instituto de Ecología y Alimentos (UAT) and INI FAP in several research centres in north eastern México and UAAAN., all of them supported under grant agreements by SIREYES-CONACyT and Paicyt (UANL). One of the objectives of this study is to generate the appropriated technology required for the sustainable management of the species in order to make a technology transfer for producers living in rural communities. This study includes information on propagation techniques, production, harvesting, processing, and socio economical importance of this species. Wild chilli pepper *Capsicum annum var. aviculare* is widely distributed and its common name varies in different places of Mexico (Almanza, 1993). This species is native to Mesoamerica and is an interesting species to be domesticated in North eastern Mexico due to its commercial value contributing significantly to the economy of rural communities. This due to the fact that this species grows and produces fruits when field activities are reduced and employment is scarce in rural communities. That is way wild chilli pepper is a promising species for sustainable management. *Capsicum annuum* L. var. *aviculare*, is native to the American continent, is associated to thornscrubs in North eastern Mexico (Verdugo *et al*., 1999). The genus *Capsicum* has 20-30 wild species and five domesticated taxa (Almanza, 1993; Hunziker, 1979; Eshbaugh, 1980 a; 1993). Despite the fact that considerable advances on taxonomical problems, origin, evolution and domestication problems have been made still there are many important aspects to be solved (Almanza, 1993).

METHODOLOGY. Field study was focused on ecology of population dynamics for the species, its socio economical role and generation of technology for sustainable management of this species.
Interviewing of people were carried out in field studies in order to obtain primary information; direct monitoring and secondary information were used in order to complete the reference frame of this work.

RESULTS. Results show that there is a need to elaborate and promote harvesting systems of the species supported by ecological, socio economical, socio cultural and regional technology characteristics focused on development of producers activities.

Management needs and sustainable strategies. One of the main aspects that are affecting wild populations of chilli peppers is the way in which fruits are harvested. This due to the fact that people cuts long branches of the plants instead of getting only the fruits. Thornscrubs vegetation communities where wild chilli pepper grows are being fragmented and diminished and these activities are contributing to its disappearance. Agroforestry systems have been proposed for management practices of wild chilli pepper (Medina, *et al*., 2000).

Ecological characteristics. Wild chilli pepper populations are commonly found at intermountain and pied mont sites where they grow mainly in vertisol or less frequently in rendzins soil types, plants are perennial, and its growth is increased by spring rains producing fruits in summer and autumn when it is commercialised by families in rural communities (Medina, 2000).

Associated vegetation. This species is commonly found in thornscrubs at the pied mont, apparently has its altitude limits at ca. 600-800 m.a.s.l., although it has been reported from places at 1000 m.a.s.l. The main vegetation types where this species has been located are: Thornscubs, followed by not thorny scrubs, forest of *Prosopis*, forest of Oak-Pine and medium size not thorny scrubs. In the latter lack of abundant rains does not allow its growth as in the other vegetation types. Some of the species of plants to which wild chilli plants are associated as nursering plants are *Helietta parvifolia, Diospyros palmeri, Acacia rigidula, Cordia boissieri, Leucophyllum texanum, Pithecellobium pallens.*

Fauna associated. Some animals that eat wild chilli peppers are birds such as: *Minus poliglottos*, *Toxostoma longirostre*, and *T. curvirostre;* reptiles as *Crolatus atrox* y *Drymarchon corais*. Insects that might represent a risk of becoming a pest for cultivated and domesticated *Capsicum annum* are *Torymus sp*. (gills formers), *Prodenia sp*. (defoliator), Borers from the family Gelechiidae and *Anthonomus eugenii*.

Phenology. Flowering periods of wild *Capsicum annum* might initiate at the end of the winter and it will be finished when high temperatures and low rains ranges arrive in summer, however as soon as rains and lower temperatures (ca. 25°C) arrive in the summer time it will start again and it will be finishing at the beginning of the winter when there are low temperatures and water regimes (Almaza, 1998). Climatic conditions might control growth and development of wild *Capsicum annum* plants, thus first flowers occur in may, the second in september and fruit production in june and october. Low temperatures with frost have negative effects on vegetative growth of this species, secondary branches might die but older lignified tissues may not be damaged (Montañez, 1993). When these conditions happened in winter a abundant production of new buds may occur at the beginning of the spring (Escalera, 1985)

Propagation. Thermo regulation with 4° C during 7 days has been reported in several communications as a good propagation method for the species. Natural dispersion of this species occurs at large by birds, furthermore seeds eaten by birds might germinate much more easily due to digestive enzymes that thinner seed coats Montañez, (1993). Twigs and branches of this species might produce roots and grow forming new clones and this may depend at large by humidity conditions used in the soil mixture substrate used as well as in physico-chemical properties of the soil mixture Escalera, (1985); and Montañez, (1993). Some other factors that might help to obtain new clones from branches and twigs in a relatively short time are size of the sampled material, season of the year, number of buds per branch, type of soil and humidity. Hot water (50°C by 5 min.) might increase the percentage of germinating seeds.

Production. Shadow percentages of 30% may increase the production of fruits per plant. Seeds storage at different temperatures (e.g. 5° C and a – 8 °C) for one year apparently have not effects on their germination ranges. Production of fresh fruits in the studied region is calculated in 50 tons during the spring-summer season and this may be increased to up to 125 tons during summer-autumn season. Mean prices in the last three years is of about $8.00 US dollars per kilo. Bromatological analysis show that wild chilli peppers have more vitamins than the cultivated serrano and jalapeño varieties.

Harvest. Harvesting of fruits is initiated after the main rains in august and september. However it is recommended to harvest during may-july and september-november and harvest should be made by cutting the chilli peppers together with their slender stem when this is going to be eaten fresh and secondary branches may be cut completely when to be eaten dry (Almaza, 1993). The amount of fruits recollected in the field per day may vary from 2-4.5 Kg. Depending on the abilities of the recollector.

Uses and processing. Fruits have been industrialised as oleoresins, canned hot sauces or dried. It is used as oleoresins for preparing certain type of meats, sousaches and as a complement included in Mayonnaise., catsup sauce and others (Mathew et al., 1971). In agriculture it has been used as repellent, it is also used for marine paints. It is also used by the Cosmetics industry for lipsticks and facial talcum. It is also used in chicken and fish food (Chemical Abstracts 1948; 1955), and it has also some medicinal properties such as: appetite stimulant, digestive, and to generate resistance to cold conditions.

CONCLUSIONS. This study has been making progress thanks to the activities carried out by the interdisciplinary working group in generating information on management, planning of research strategies as well as development of one Doctor degree Thesis and three of First degree Thesis.

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SELECTION AND CHARACTERIZATION OF PLANTS IN TWO POPULATIONS OF PIQUÍN PEPPER (*Capsicum annuum* L.) IN DELICIAS, CHIH.

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SUMMARY. They were carried out two collections of pepper Piquín, one coming from masal selection with free pollination (MSFP) and another coming from individual selection with free pollination (ISFP). The sowing was made in charolas in January 25 of 2001 and the transplant on March 29 of the same year, in independent plots. 21 plants were selectionated based on their precocity and fruits production , by means of the methods of combinated selection of complete and half brothers. Also, these plants were characterized for growth type, covering and plant height, stem pubescent degree, stem, leaf and fruit colour, length of leaf and fruit, and yield of fruits per plant. Lines were detected with good plant characteristics, yield and fruit quality.

INTRODUCTION. The piquin pepper, chiltepín, chili flea, of mount or wild, is the smallest in the chilis and it is practically in the whole coastal area of the Mexican Republic. It is a perennial plant although can die in time of drought or in the winter. It sprouts with the first rains and it has full production at the end of the season of rains, that is to say, of August to December, depending of locality. When it is fresh it is of green color and when dry off it changes to red color. The piquín pepper is found in the local markets to the end of the season of rains, when people collect it in the mount. This fruit is very felt like by the birds (for example zenzontles and chachalacas) therefore is necessary to pick up it before it matures. In the other hand it comes off from the plant when matures. In many places like Alamos Sonora, Tomatlán, Jalisco, Ocampo Tamaulipas, to mention alone some, it is sold fresh, dry, in sauces - among them the well-known Tabasco - and milled powdered. Occasionally it is found in small commercial plots, but these are more the exception that the rule (Laborde and Pozo, 1982; Lomelí, 1986).

The main characteristics of this chili type along all the costs where is found in wild state are the following ones:

a. It is broadly accepted, to the degree that displaces in great measure to the other chili types in the time in that it fructifies.
b. It has a very identified pungency, sometimes described as "rapturous or not rabid", that is to say that although it is very pungent that sensation disappears quick and easily.
c. In spite of the pungency, it is characterized as not irritating to the stomach; there are people that have problems of stomach ácidez who can only consume this chili type (Laborde and Pozo, 1982).

Inside the Program of Genetic Improvement of the Field Experimental Delicias, this chili type is one of those that are collecting and improving, for the obtaining of national varieties, since it can be constituted as an alternative cultivation for those producing of the region. Based on the above mentioned, and to the lack of information of their behavior at regional level, was carried out the present work with the purpose of obtaining data of characteristic morfológicas of the plant as well as of yield and fruit size, and to select plants with outstanding characteristics.

MATERIALS AND METHODS. Two collections were carried out: one of denominated chili Chiltepin in the cycle Sping-summer 1999, coming from a masal selection with free pollination (SMPL), and another of chili Piquín in the cycle Spring-summer 2000, coming from an individual selection with free pollination (SIPL). Later on, the sowing was made in January 25 of 2001 and the transplant on March 29. The useful parcel consisted of a bed of 1. 6 m of width and of 3 m of long with two repetitions. Once developed the plants and in the middle of period of production, they were selected in way visual, 21 plants based on their precocity and fruti production, by means of the method of combined selection of autobrothers and half brothers.
The data taken in the selected plants were: Type of growth, covering and height of the plant, stem pubescent degree, stem, leaf and fruit color, leaf and fruit lenght/width and yield of fruits for plant.

RESULTS AND DISCUSSION. In accordance with the table 1, a great variability was observed in stem and foliage characteristics, with exepción of the type of growth (ramified) that the only variable that stayed constant in the evaluated plants. In that way that, in the foliar covering or diameter was found a range of 0. 60 at 1. 05 m; in the plant height of 30 to 98 cm; in the leaves lenght of 1. 9 at 4. 2 cm; and in leaf width of 1. 1 at 2. 3 cm.

On the other hand, the stem color varied of clear green to green, with 57% of plants with lines or black tonalities along the same one; while, the stem pubescent (little or mediates) was presented in 95% of the plants. The leaves color varied of green to dark green.

In what refers to the production of fruits (Table 2), variability was appreciated in the precocity degree, fruit lenght and width and yield of fruits for plant. In precocity was found 33% of plants with early harvest that was presented from the 188 to 190 days after the transplant (3 at 5 October) , standing out the materials 1,2,7,8,11,18 and 21. The fruit length varied of 1. 1 at 2. 5 cm and the fruit width of 0. 5 at 1. 0 cm.

On the other hand, yield of fruits values were of 9.4 to 128 grams per plant, standing out the materials 1,17 and 19 with values of 96. 5, 128. 6 and 95. 0 grams per plant.

Table 1. Morphologic characteristics of plant and leaves in Piquín pepper plants. CEDEL-CIRNOC-INIFAP-SAGARPA. Spring-Summer 2001.

	Cover-age (m)	Growth Type	Plant height (cm)	Stem colour	Stem pube-scence		Leaf Length / width (cm)
1	1.00	Ram.	48	Green	Med.	Dark green	2,5 /1.2
2	0.73	Ram.	44	Light green	Few	Green	2,3 / 1.2
3	0.70	Ram.	62	GWBL	Med.	Dark green	3,8 / 1,9
4	0.85	Ram.	81	GWBL	Few	Green	2,7 / 1,6
5	0.82	Ram.	75	GWBL	Med.	Dark green	2,7 / 1,3
6	0.88	Ram.	69	Green	Med.	Dark green	3,1 / 1,4
7	0.83	Ram.	70	GWBL	Few	Dark green	2,4 / 1,2
8	0.75	Ram.	56	GWBL	Few	Green	1,9 / 1,1
9	0.65	Ram.	45	GWBL	Few	Green	2,6 / 1,5
10	1.02	Ram.	98	GWBL	Nula	Dark green	2,8 / 1,4
11	0.60	Ram.	30	GWBL	Med.	Green	2,6 / 1,4
12	1.05	Ram.	92	Green	Med.	Dark green	2,9 / 1,4
13	0.82	Ram.	98	GWBL	Few	Dark green	3,0 / 1,4
14	0.76	Ram.	81	Green	Med.	Dark green	4,4 / 2,3
15	0.70	Ram.	49	GWBL	Med.	Green	3,9 / 2,0
16	0.91	Ram.	48	GWBL	Few	Green	2,7 / 1,4
17	1.03	Ram.	62	Green	Med.	Green	2,8 / 1,5
18	0.80	Ram.	68	Green	Med.	Dark green	3,3 / 1,7
19	0.99	Ram.	94	Green	Med.	Dark green	4,2 / 2,2
20	0.76	Ram.	82	GWBL	Few	Green	3,2 / 1,6
21	0.65	Ram.	30	Green	Few	Dark green	2,8 / 1,3

Ram. = Growth with ramifictión acentued. GWBL = Color green with black línes.

Table 2. Characteristics of precocity, yield and fruits of Piquin pepper. CEDEL-CIRNOC-INIFAP-SAGARPA. Cycle Spring-Summer 2001.

Material	Fruit color		Fruit Length / Width (cm)	Yield per plant (gr.)	Fruit number per Plant
1	Red	Good	2,2 / 1,0	**96.5**	611
2	Red	Good	1,5 / 0,7	22.5	321
3	Red		1,5 / 0,8	22.5	246
4	Red	Med.	1,2 / 0,7	21.5	---
5	Red	Med.	1,1 / 0,5	18.5	370
6	Red		1,1 / 0,6	20.0	---
7	Red	Good	1,5 / 0,6	54.7	329
8	Red	Good	1,5 / 0,6	15.0	333
9	Red		----	9.4	---
10	Red	Med.	1,3 / 0,6	24.6	---
11	Red	Good	1,9 / 0,8	63.9	359
12	Red	Med.	1,6 / 0,6	58.6	586
13	Red	Med.	1,4 / 0,5	27.8	492
14	Red		2,0 / 0,7	54.5	368
15	Red		2,5 / 0,9	16.8	153
16	Red	Med.	1,5 / 0,8	----	---
17	Red	Med.	1,7 / 0,7	**128.6**	1017
18	Red	Good	1,7 / 0,8	17.4	190
19	Red		2,2 / 0,5	**95.0**	---
20	Red		1,6 / 0,7		---
21	Red	Good	1,6 / 0,9	23.3	---

CONCLUSIONS

1. Piquín pepper has a good adaptation and behavior in the Delicias, Chihuahua area.
2. 21 lines of piquín pepper were characterized and selected.
3. Lines of piquín pepper with good plant characteristics, yield and fruit quality were detected.

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PRODUCTION TECHNOLOGY FOR PIQUIN PEPPER (*Capsicum annuum* var. *aviculare*)

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INTRODUCTION. Wild hot pepper *Capsicum annuum* var *aviculare*, commonly known as "piquin" in Mexico, is distributed near the coastal areas up to 1,300 m altitude. The representative type of the species has an everlasting plant of deciduous fruits, very attractive to birds (Pozo *et* *al*, 1991). Pickersgill *et al* (1979) mentioned that wild pepper fruits are adapted for dispersion by birds: they are small, brilliant red, extremely hot, stand out of the foliage and are separated easily during ripeness. Maiti *et al* (1994) stated that piquín pepper might be considered as a "new crop" because it has been exploited for many years in its wild form. Commercial extensive sowings of piquin pepper do not exist. Almost all piquin production comes from harvesting wild plants, usually under overexploitation conditions, causing loss of biodiversity (Medina *et al*, 1998). The current main limitation for planting piquin as a commercial crop is its low seed germination (dormancy). In addition, research on developing production technology for piquin is limited. This study presents a progress report on the research project "Technology for Sustainable Production of Chile Piquín as a New Crop in Northeastern Mexico" at the INIFAP "Sur de Tamaulipas" Experimental Station.

SEED GERMINATION. Seeds of piquín pepper have a germination lower than 2% under natural conditions (fruits from wild plants). According to Almanza (1993), presence of wax and a hard epicuticular layer in piquin seed are related to the impermeability in the process of imbibing, favoring survival of the species in its natural habitat, but limiting its commercial exploitation. To study this problem, 11 seed treatments were evaluated (Table 1) using seed from a wild accession Tam 00-46, from San Carlos, Tamaulipas. The best treatment was seed immersion in a 5000 ppm solution of Giberelic Acid (GA) during 24 hours at 28°C, resulting in 66% germination; in contrast, seed control (not treated) had only 2% germination after 20 days of sowing (Table 1). Although there were not dramatic differences in seedling height after 20 days of sowing among treatments, seedling vigor was significantly affected in all treatments based upon HCl (Table 1).

SEEDLING PRODUCTION. Plastic trays (200 cavities) filled with a substratum based on sphagnum were used to produce piquin seedlings. Seed was treated with folpet to avoid fungi infection. Seedlings were fertilized with 200 ppm of N, 100 ppm of P and 200 ppm of K.

PLANT DENSITY. Piquín pepper yield was higher using densities of 3 and 4 plants/m^2 than 2 plants/m^2, particularly with accession TAM 00-64 (Table 2).

SHADING. Effect of 30% shading mesh on growth, yield, and fruit quality was evaluated for 10 regional piquin accessions. Shading increased yield by 155 % in relation to plants without shading.

INSECT PESTS AND DISEASES. Piquín is relatively tolerant to viral diseases, and resistant to leaf miner (*Liriomyza* sp.) and pepper weevil (*Anthonomus eugenii*) in its natural habitat. However, impact of these or other insect pests and diseases is not known yet under commercial sowings conditions.

Table 1. Induction of Seed Germination of Wild Piquín Pepper. CESTAM, 2002.

Treatment	Germination %	Plant Height (mm)*	Plant Vigor (Scale 1-5)
GA 5000 ppm (24 h)	66 a	35 a	4
GA 3000 ppm (24 h)	50 b	29 ab	4
GA 5000 ppm (24 h)	39 c	32 ab	4
GA 3000 ppm (24 h)	30 cd	31 ab	4
Water (48 h)	26 d	32 ab	4
Water (24 h)	15 e	29 ab	4
HCl 5% (15 min)	11 ef	29 b	2.5
HCl 5% (30 min)	9 ef	25 b	3
HCl 2% (30 min)	7 ef	27 ab	3
HCl 2% (15 min)	6 ef	28 ab	3
Control	2 f	28 ab	4

*20 days after sowing

Table 2. Effect of Plant Density on Height and Yield of 3 Accessions of Piquín Pepper. CESTAM, 2002.

Accession	Plants per m^2	Plant Height cm	Yield Kg ha^{-1}
TAM 00-46	4	39	885
	3	43	920
	2	37	925
TAM 00-64	4	55	1421
	3	57	1511
	2	47	568
TAM 00-68	4	42	636
	3	45	663
	2	47	554

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PRODUCTION OF PIQUIN PEPPER (*Capsicum annuum*, var. *aviculare*) UNDER GREENHOUSE CONDITIONS IN NORTHEASTERN MEXICO

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ABSTRACT. "Chile piquín", a wild hot pepper, is consumed fresh, dried, and in sauces in most areas of Mexico. All production comes from harvesting wild plants after the raining season. The current high value and demand for this pepper offers the possibility to become a potential crop in northeastern Mexico. The main objective of this study was to develop a production technology under greenhouse conditions for the commercial exploitation of this native plant. Three regional collections of piquín pepper are being tested under greenhouse conditions in Arteaga and Saltillo, Coahuila. Preliminary data indicate "San Carlos" collection has the best potential, with a cumulative yield of 143 g/plant so far.

INTRODUCTION. Currently, piquín pepper production in Mexico depends exclusively upon harvesting of wild plants, mainly by cutting the entire plant, with a subsequent deterioration of the natural environment and loss of germplasm. During last years, price of piquín pepper has been increasing, with a current value of 30 and 46 dollars/kg, fresh green and dried red, respectively. Piquín production is correlated to rainfall season; therefore, drought conditions prevailing in this area during the past years have affected its production. Under these conditions, demand for piquin in this region is supplied by fruits brought from southeastern Mexico (Chiapas and Oaxaca), which have a lower quality than local piquín according to consumers. An ongoing research project is being conducted in several locations of northeastern Mexico to develop a production technology for piquín as a commercial crop. The main objective of this experiment is to explore the technical feasibility of producing piquín pepper under greenhouse conditions.

MATERIALS AND METHODS. Growth and yield of three regional piquín collections were tested in two greenhouses at different temperature regimes: (a) 21-10 ºC (day-night) and (b) 23-18 ºC (day-night), located in Arteaga and Saltillo, Coahuila, respectively. The three piquín accessions were collected originally from: (a) Múzquiz, Coahuila; (b) San Carlos, Tamaulipas; and (c) a "japones" piquín type from Río Bravo, Tamaulipas. Seedlings (30 of each collection) were produced in 1-kg plastic bags in Río Bravo, Tamaulipas. When seedlings reached 20-30 cm height (early August 2001), they were transported to Coahuila, and immediately transplanted to 50x30x24 cm plastic boxes containing a substrate composed by ½ of coconut fiber, ¼ of peat moss and ¼ of perlite, and separated 1x1 m from each other. To prevent damage by diseases and insects, the following pesticides were applied: (a) propamocarb N 2 ml/l of water (damping off); (b) streptomycin 100 1g/l of water (bacterial spot); (c) imidacloprid 0.5 ml/l of water (white fly); and (d) custer 25 5ml/l of water (leaf miner). Plants were fertilized with 5 g each of N and P at transplanting. A second application (5 g) of N was made 30 days latter. K (5 g) was applied at flowering initiation. Three foliar application with micronutrients and NPK were made every 15 days. Plants were irrigated 2-3 times/week. Variables measured (every 15 days) included: Plant height and width; and fruit number and weight.

RESULTS AND DISCUSSION. Temperatures in the greenhouse at Arteaga were not suitable for growth and reproduction of piquín pepper. Under these "cool" conditions, particularly at night, plants grew slowly, and did not produce flowers, except for the "japones" type, which produced a few flowers and small fruits. In contrast, growth and yield of piquín pepper seemed to be optimum in the greenhouse at Saltillo (Table 1). The experiment is still being conducted, and plants continue flowering and fruiting.

Table 1. Growth and yield of three piquín collections under greenhouse conditions at Saltillo, Coahuila. 2002.

Collection	Plant height (cm)	Plant width (cm)	Yield/plant (g)*
S. Carlos	78	53	143
Japones	167	106	137
Muzquiz	67	58	96

*Cumulative yield of fresh green fruits after 5 harvests in 3 months.

CONCLUSION. Production of piquín pepper under greenhouse conditions is feasible. Continuous production throughout most part of the year under these optimum conditions offers an economical option to supply the high demand for this product in northeastern Mexico.

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EFFECT OF SHADING ON GROWHT AND YIELD OF 10 ACCESSIONS OF PIQUIN PEPPER (*Capsicum annum*, var. *aviculare*) IN FOUR LOCATIONS OF NORTHEASTERN MEXICO

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ABSTRACT. "Piquin" is a wild pepper, common to many areas of Mexico under 1,300 m altitude. The objective of this study was to determine the impact of black shading mesh (30%) on growth and yield of piquin pepper. Ten regional accessions of piquin were tested with and without shading mesh in four locations of Tamaulipas and Nuevo León. Shading increased piquin growth and yield up to 278 and 158%, respectively, in relation to plots without shading.

INTRODUCTION. "Chile piquin" is also known as "chile del monte", "chiltepin", "chiltecpin", "amash", "mosquito", "amomo", "enano", or "chile de pájaro", according to locations in Mexico. Piquin is consumed fresh, dried or in sauces, and have a unique and recognizable flavour; although it is extremely hot, the sensation disappears quickly. A growing interest for domesticating piquin pepper in Mexico is prompted by its increasing demand and price during the past years. An ongoing research project on germplasm preservation and developing commercial production technology for piquin is being conducted by INIFAP in collaboration with UAT and UANL in northeastern Mexico. This study reports the effect of shading on piquin growth and yield.

MATERIALS AND METHODS. Ten piquin accessions originally collected from Coahuila, Nuevo Leon and Tamaulipas (Table 1) were produced in trays and then in 1-kg plastic bags. When seedlings reached 20-30 cm height (early August 2001), they were transported and immediately transplanted in adjacent plots with and without a black shading mesh (30%) in four locations (Table 2). Four plants (replications) per accession were used in each plot and location. Variables measured (every 15 days) included: plant height and width, and fruit number and weight.

RESULTS AND DISCUSSION. Shading stimulated growth of piquin plants, with an average of 116% foliage increase at Río Bravo (Table 1). The minimum difference in growth between shading and without shading was observed in Gómez Farias accession, collected near the tropics. Piquin yield was increased up to 158% by shading in Río Bravo (Table 2). Yield was not different between shading and without shading at Victoria, probably because of the surrounding trees and mountains near this location, preventing a true comparison between these two conditions.

Table 1. Foliar factor (height x width = cm^2) of 10 piquin accessions with and without shading at Río Bravo, Tamaulipas, from September 2001 to August 2002.

Piquin accession	Foliage with shading	Foliage without shading	% Foliage increase by shading
Muzquiz	2530	1690	50
Castaños	9646	4336	122
Anahuac	6491	3391	91
Linares	8679	2830	207
Camargo	3960	1469	170
Burgos	4057	1976	105
San Carlos	4201	1414	197
Jaumave	11580	3061	278

Soto Marina	8956	5259	70
Gomez Farias	10944	7430	47
Average	**7104**	**3286**	**116**

Table 2. Cumulative yield (g/plant) of piquin pepper with and without shading in four locations of northeastern Mexico (average of 10 accessions), from September 2001 to August 2002.

Location	Yield with shading	Yield without shading	% Yield increase by shading
Río Bravo	209	81	158
Cuauhtémoc	162	64	153
Victoria	136	134	1
Anáhuac	182	148	23
Average	**172**	**107**	**61**

CONCLUSION. Shading mesh stimulated growth and yield of piquin pepper, a condition most likely related to its evolution in shaded areas under shrubs and trees.

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EFFECT OF VESICULAR-ARBUSCULAR MYCORRHIZA ON GROWTH AND YIELD OF PIQUIN PEPPER INTERCROPPED WITH CITRUS

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INTRODUCTION. Piquin (*Capsicum annuum*, var. *aviculare*), a wild hot pepper, has an important potential market and represents a valuable resource for genetic improvement programs (Votava *et al*., 2002). In northeastern México, an average production of 125 ton/year of fresh piquin is obtained, exclusively by gathering fruits from wild plants, mainly by cutting the entire plant, causing a potential loss of biodiversity (Villalón *et al*. 2001). There is a growing interest for domesticating and commercially exploiting piquin pepper in Mexico. Piquin grows under shrubs and trees in its natural habitat. Perennial crops (e.g. citrus) could be good options for intercropping piquin, providing shading, irrigation, fertilization, and other cultural practices at no extra cost, adding value to the orchard. This study presents the effect of mycorrhiza (*Glomus* spp.) on growth and yield of piquin pepper intercropped with citrus.

MATERIALS AND METHODS. This study was conducted in a 20-yr old orange orchard at the INIFAP General Terán Experiment Station in central Nuevo León, México. Thirty piquin seedlings (20-25 cm tall) each of four accessions from Tamaulipas (Table 1) were used in this experiment. Half of the seedlings of each accession was treated with 10 g of a mixture of soil and vesicular-arbuscular mycorrhiza (*Glomus intraradices* and *Glomus fasciculatus*) at transplanting; the other half of the piquin seedlings was not treated (check). Piquin seedlings were transplanted in rows 1.5 m from the citrus trunk and 1.0 m apart from each other, on August 17, 2001. Variables measured for piquin included plant height and width, stem width and yield (fresh).

RESULTS AND DISCUSSION. Growth and reproduction of piquin intercropped with citrus was similar to plants in the wild. Agronomic practices for citrus did not interfered with piquin nor vice versa. Shading provided by citrus trees seemed to be appropriate for piquin growth. Irrigation schedules for citrus apparently coincided with piquin water requirements. Mycorrhiza stimulated piquin growth (Table 1); plant height, plant width, and stem width were increased by 61, 56, and 25%, respectively, in relation to untreated plants. Mycorrhiza increased piquin yield by 135% in relation to untreated plants, a result of a production of more and larger fruits. Impact of mycorrhiza on *Capsicum* growth and yield has been also documented by Aguilera *et al*. 1999, Kim *et al*., 1999, Manjarrez *et al.* 1999, and Davies *et al*. 2002.

Table 1. Height (cm) of four piquin accessions with and without mycorrhiza, a year after transplanting. General Terán, Nuevo León, 2002.

Piquin accession	Height with mycorrhiza	Height without mycorrhiza	% Height increase by mycorrhiza
Camargo	120	71	69
Burgos	96	56	71
Soto la Marina	188	167	13
San Fernando	221	94	135
Average	**156**	**97**	**61**

CONCLUSIONS

(a) Intercropping piquin pepper in Citrus orchard is feasible. (b) Mycorrhiza stimulated piquin growth and yield.

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EFFECTS OF HUMIC SUBSTANCES AND MYCORRHIZAE ON PEPPER (*Capsicum annuum* L.) PLANT GROWTH

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ABSTRACT

A study was conducted to know the effect that have the humic substances and micorrhizae on the pepper growth and development. The work was settled down under greenhouse conditions. The pepper

plans were inoculated at seedling stage with Glomus intrarradices in two soil types (sandy and clayed) which were chemistry, physical and biologically) analyzed.
Significant differences were found between soil types for plant height and diameter. Also different responses according with the plant age. The best results such as earliness (days to harvest), plant fruit number, average fruit weight and fruit size.

ORGANIC BELL PEPPER PRODUCTION USING SEA-WEED AND RUMEN EXTRACTS

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INTRODUCTION. One way to protect the environment is to develop the organic agriculture, this without affect crops economic profit. Biostimulants, such as sea-weed and rumen extracts have been used to improve the fertilizers efficiency, but we don´tknow the effect of this extracts when they act whithout chemical fertilizers.

MATERIALS AND METHODOS. This works was realized during the year 2000 in Saltillo, Coahuila. México. We evaluated four traits 1.- The check, 2.-Sea-weed (2lt/ha in the irrigation water 3.-Ruminal extracts (7.5lt/ha in the irrigation water) and 4.-Sea-weed extract (1.5lt/ha leaf spray) plus ruminal extract (7.5 lt/ha in the irrigation water). The experiment design was a complete random blocks. The plot was of 619.2 m^2. In the irrigation water the products were applied three times at 20, 57 and 57 day after transplant (DAT) and the leaf spray was at 89 DAT. Were evaluated: Plant Height (PH), Stem Diameter (SD), Fruit number (FN), Fruit Average Weight (FAW) and Yield (Y).

RESULTS. The results obtained showed that the sea-weed extract produced the highest fruit average weight , with 22.81 grams more that the check. The rumen extract affected mainly the vegetative development increasing the plant height in 14% more that the check, and the stem diameter in 10.7 % more that the check . Appling sea-weed in the leaf spray plus the rumen extract to the soil increased the yield 13.93% more than the check; in 7.33 % than the sea-weed extract applied to the soil and 3.7 % that the rumen extract.

Table1. Results obtained in the evaluation of sea-weed and Rumen extract applied to the bell pepper organic production.

	Characters evaluated				
	PH (cm)	SD (cm	FN/ plant	FAW (grs)	Y Ton/ha)
Check	34.6	1.16	2.36	192.54	16.3
Seaweed	39.0	1.20	2.47	215.35	17.59
Rumen	45.2	1.30	2.33	208.94	16.98
Seaweed + Rumen	39.5	1.24	2.70	196.40	18.98
CV %	**13.40**	**9.85**	**6.35**	**12.04**	**12.4**

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PEPPER PRODUCTION AS INFLUENCED BY IRRIGATION FREQUENCY AND PLASTIC MULCH

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INTRODUCTION. Pepper is one of the most important irrigated crops in the Zacatecas State, Mexico. However, water is the main factor for farmers in this State. Therefore, water must be used efficiently. There are different alternatives to increase water efficiency in agriculture. The following are some of them: (a) irrigation systems used for moistening only the soil volume where roots grow (Ortiz *et al*., 1999; Kang *et al*., 2001); (b) irrigation frequency and quantity of water (Estrada *et al*., 1999; Jaimez *et al*., 1999): (c) mulching materials used for reducing water lost by evaporation (Ibarra and Rodriguez, 1993).

Although, water is the main limiting factor in agricultural production, in Zacatecas, gravity water is the most used watering system. The main disadvantage of this system is the enormous lost of water. In contrast, drip irrigation, now a days, is the most efficient plant watering system. In order to do a better and more efficient use of the water, we carried out a field experiment on which the effect of three watering frequencies and two mulching conditions on crop development and dry pepper fruit yield, and the water use efficiency (WUE) were determined.

MATERIALS AND METHODS. The experiment was carried out in La Blanca, on the Southwest of the Zacatecas State, Mexico (22º 41' N, 102º 4' W; 2140 m elevation). This is a semi-arid region with an annual mean rainfall of 370 mm. Physical and chemical soil characteristics were the following: pH, 7.6; texture, clay-loam; effective depth, 47 cm; electrical conductivity (EC), 0.73 dSm^{-1}; organic matter, 0.76 %.

The pepper (*Capsicum annuum* L.) cultivar used was 'Puya'. Transplanting was made on 0.80 m wide rows, using 0.40 m distances between plants. Drip irrigation was made using 0.20 m separated emitters. The amount of water applied was done based on daily evaporation corrected by the Kc.

The treatments evaluated were three levels of irrigation frequencies (each 1, 3 and 7 days), two mulching conditions (with and without mulch). The experimental design was a split-plots, where plots were the irrigation frequencies and the sub-plots the mulching conditions. Each plot was three 0.80 m wide rows by 20 m long (48 m^2). The evaluated area (14.4 m^2) was only an 18.0 m section of the central row.

The mulching material used was a white and black plastic film each color on each side and its caliber was 110. Each mulching strip had 7.5 cm diameter centered holes. Separation between holes was 40 cm.

The evaluated variables during crop development were plant height, stem diameter; leave, flower and fruit number. Measures were done at the beginning of the flowering, 44 days after transplanting (DAT); at the end of the second flowering (76 DAT); and at the fruit development stage (106 DAT).

Dry weight of the roots located in 10 x 10 x 10 cm cubes was determined at flowering beginning.

Dry fruit yield was classified as first and second quality, being first the fruits with uniform hard red color.

Water use efficiency was calculated dividing the fruit dry weight by the volume of water applied according to each treatment.

RESULTS AND DISCUTION. Plant height had no a significant difference with irrigation frequency treatments. The mulching effect was higher only at 44 DAT.

Leave number and stem diameter were bigger with mulch than without it, at 44 and 76 DAT. Flowering was promoted with mulch, only at 44 DAT. But the number of fruits was higher at the three (44, 76 and 106 DAT) evaluations. However, irrigation frequency didn't have effect on leaf and flower number, stem diameter and plant height.

Root dry weight increased 20 % more with mulch than without it. Root distribution of the Puya pepper cultivar in the soil volume was modified by mulch. The highest root dry weight was obtained at the 0-10 cm depth. Root dry weight was more reduced without mulch than with it. Root distribution in the soil volume was positive correlated with moisture and temperature.

Total fruit dry weight and the fruits of the first quality class were 57 % higher with mulch than without it. Similar results were obtained in the irrigation frequency treatments. Pepper yield was higher watering daily and each three days than watering each 7 days. These differences were higher 33 and 23 %, respectively. The fruit dry weight of the second quality class was affected by mulch, decreasing 40 %.

WUE (kg of dry fruit m^{-3} of water) was 0.532 and 0.320 with mulch and without mulch, respectively. However the irrigation frequency didn't have effect on WUE.
The irrigation frequency x mulch interaction showed no significance in any of the variables evaluated.

CONCLUTIONS. Mulch dad a positive effect on the total fruit production and on the fruit first quality. Also on the plant development (roots, plant height, stem diameter and the number of leaves, flowers and fruits). Irrigation frequency didn't have effect on plant development, but watering daily and each 3 days had higher production than watering each 7 days.

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DRY PEPPER RESPONSE TO FERTI-IRRIGATION EVALUATED IN ZACATECAS, MÉXICO

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INTRODUCTION. World-wide area planted with chili pepper has grown continuously during last the 20 years. For example, from 1969-71, 1'271,000 hectares were seeded, as compared to 1990 when 2'045,000 hectares were planted, representing an increase rate of 61% (Reyes, 1998). Mexico grow 3.9% and harvest 7.6% of the peppers produced word-wide in 1990. (Reyes, 1998). Since the 1980s, the state of Zacatecas has been the most important producer of dry pepper (Capsicum annum L.). in Mexico. During the period 1991-1996, 29, 032 t were harvested of "mirasol/guajillo" and "ancho" peppers, representing 51.16% of the domestic supply, and an income of 342,657,000 Mexican pesos on a yearly basis. (Reyes, 2001). Chili is the crop that uses more there labor in Zacatecas; in the last 5 years there have been harvested 30.000 hon. average and as each hectare requires 150 wages, this gives an average 4.500.000 wages per year. (Ledezma, 1995 y Bravo, 2002). Low availability of irrigation water is one of the limiting factors for food production in the semiarid region of Zacatecas, Mexico. Besides its high cost and scarcity, low water use efficiency decreases productiv ity and increases crop production cost. (Bravo, 1987). Drip irrigation offers many advantages as a method for water application in vegetable production. Because water is applied to the plant root zone through a controlled-discharge emitters that are either embedded into, embossed onto, or attached to plastic transmission tubing. In addition, liquid fertilizer may be injected and applied as needed. Thus, water and fertilizer application may by made more accurately and timely and fertilizer application may by made more accurately in response to plant needs. (Castellanos, 2000 and Clark, 1992).

Tomatoes fruit quality of may by improved when N and K are applied by drip irrigation compared with applying all fertilizer at the preplant time. (Hochmuth, 1992). Inconsistent results have been reported with regards to the portion of N and K to be applied in the preplant fertilizer. Some research shows a benefit to the addition of 20% to 40% of the N (and K if need) in the preplant fertilizer (Locascio et al., 1985). "Camelot" bell pepper was grown in a N fertigation study, the total application treatments were 64, 128, 192 and 256 kg/ha. Early and total-season marketable fruit yields increased linearly with N rates. (Shaw, 1996)

OBJETIVES. 1. Determine "Mirasol" pepper response to fluid sources of nitrogen, phosphorous and potassium, under drip irrigation.

EXPERIMENTAL PROCEDURE

Site. The field study was conducted during 2000 from April to December in the Experimental Station of INIFAP at Calera, Zacatecas. Mexico.
Soil is a mean texture, with 3.7% organic matter, pH of 7.5, 0.714 of $CEx10^3$, 0.0 of PSI.

Treatments and experimental design. Twelve treatments were studied in the present experiment: four levels of N while maintaining constant levels of P and K; three levels of P, while keeping constant the levels of N and K; and three levels of K, while constant levels of N and P. The list of treatments is presented in Table 1. Nitrogen, phosphorus and potassium were applied before planting (15% of total), and the rest, were applied weekly by using urea, phosphoric acid and potassium sulfate as the sources for N, P and K. Soil water was measured by TDR at 15, 30, 45 and 60 cm depth, two days a weekly. Water was applied to the crop every day, indicated by the TDR.

A randomized block design with three replications, using 2 beds 1.52 m wide and 12 m long as experimental plot was used. Seeds of mirasol pepper of as experimental cv. were planted in the greenhouse on February 10, 2000, and the seedlings were transplanted on april 25, 2000. Yield of dry chili in tons for hectare and the efficiency in the use of the water in kilograms of chili for cubic meter of applied water.

Table 1. Nitrogen, Phosphorus, Potassium, treatments. (Rates are in kg ha^{-1}).

Treatment	N	P_2O_5	K_2O	Other
1	**0**	75	200	No
2	**100**	75	200	No
3	**200**	75	200	No
4	**300**	75	200	No
5	200	**0**	200	No
6	200	**150**	200	No
7	200	75	**0**	**No**
8	200	75	**100**	**No**
9	200	75	200	Ca[1]
10	200	75	200	**Micro**[2]
11	0	0	0	No
12	300	150	200	No

[1] Ca = 10 kg/ha to foliate in 10 applications
[2] Micronutrientes = 10 kg/ha to foliate in 10 applications

RESULTS. Were the variables measured yield significant differences (p=0.06) for the N, P, K treatments were found. For Nitrogen, there is an increase of pepper up to 200 kg/ha. (Figure 1). A similar trend was found for P up until 75 kg/ha. (Figure 2). On the other hand, for K only the control had significantly lower yields. (Figure 3).

The most water efficient treatment was the 200-75-200 + Ca (N° 9), when 0.748 kg of dry peppers were harvested for each m^3 applied water. Whit this fertigation treatment, there is a 5X efficiency in water applied to the crop, because the average farmers harvest only 0.133 kg/ha of dry pepper for each m^3 of applied water.

Figure 1.- Yields dry pepper (TonHa) of four nitrogen levels in Zacatecas, México. 2000.

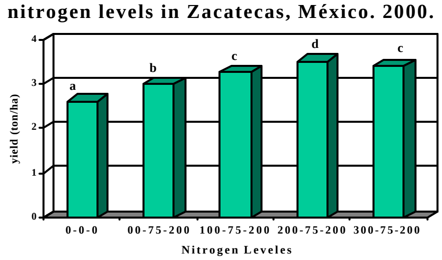
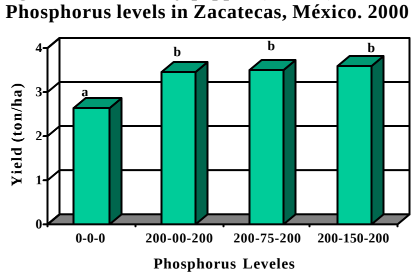


Figure 2.- Yields dry pepper (TonHa) of three Phosphorus levels in Zacatecas, México. 2000



CONCLUSIONS. "Mirasol" dry pepper has a good response to N (200 kg/ha) and P (75 kg/ha) fertigation. There is a need to study tehe effect of K on fruit quality of dry peppers. The fertigation systems allows to save more than %X the amount of water while keeping the yields that growers are obtaining currently.

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PROFITABILITY OF DRY CHILI PRODUCTION SYSTEM, ZACATECAS, MEXICO

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INTRODUCTION. The trend in the economy toward an open economy makes necessary to improve the technological level in the agricultural sector in order to be more competitive (Salinas, et al., 1999). It leads to expend more resources for reaching higher productivity levels (Kay, 1993).
This competition includes overalls reduction of subsidies and it implies optimization of resources (Sánchez et al., 1996), at the same time it causes adjustments in revenues and costs of production, rebounding directly in the profitability of crops that is an indicator of competitiveness of the production systems. In this work is presented a study about the profitability of the system of production of dry chili (*Capsicum annuum*) in the highland zacatecano (Mexico). Different aspects involved, in the productive process are analyzed, such us, technological level, costs,

yields and prices. This study developed given the importance of the dry chili in the Region North Centre of Mexico. The contribution of this region to the national supply of chili was about 33 thousand ton every year during 1990-2000. It represented 52.5% (SAGARPA, 2001) of national production. The production of this crop generated at the end of 1990´s was more than 912 millions of pesos. The objective is to determine whether the dry chili is profitable, given the technology applied by small, medium and large producers working with a conventional system classified in strata, at the same time a comparative analysis is made with the potential technology of the INIFAP in Zacatecas, under the hypothesis that the technology applied and the profitability of the production of dry chili, are related to each other and in function of the size of the property. The work is based on the indicators of profitability and scenarios of economic type are presented that allows to notice the risk of the investment. The potential technology, was the most the most profitable (172.17%) without considering the land cost (it produces) in compare with the conventional system. This represents 100.75% more than the stratum 1 (<10 h) that is where the applied technological level generates smaller dividends.

MATERIALS AND METHODS. The information for this study was obtained from a database the characterization of the system made for of production of dry chili in the state of Zacatecas (Reyes et al., 2001). The producers were classified according to the stratified random sampling, no proportional that consisted in dividing in subgroups (strata) for property size. A random sample was chosen whose number of studied elements is disproportional to the number of elements of this population (Mason and Lind, 1995). For designing of the sample it was considered to municipalities (6) and communities (27) with more land cultivated and producers at dry chili in 1994, at 10% significance level. The sample size was of 94 producers, being applied at 98 in total. They were formed four strata according to the number of cultivated hectares: <10 hectares, > 10 hectares, > 20 hectares, > 30 hectares. The evaluation of the technologies was based on the technical coefficients applied during the trial productive, of stratified producers and the potential technology recommended by the INIFAP in Zacatecas that consists fundamentally on the optimization and efficiency in the supply of inputs based on the requirements of the chili cultivation. The financial evaluation of the technologies is based on indicators of profitability (Gittinger, 1983): net present value, appraises it interns of profitability, the relationship cost benefit. The interest rate applied was CETES in real terms. In order to odentity the variables more important related with the yield of dry chili, It was made the analysis of simple correlation (Pearson). Once identified the variables associated to yield, were compared among treatments (property size) using a design of blocks totally at random, with different repetitions for each stratum. Also, a comparison of stockings was made (Tukey, P=0.05).

RESULTS AND DISCUSSION. According to the statistical analysis, it can settle down that the stratification of producers in ranges of 10 hectares was correct (Table 1). They were significant differences for the technology variable and yields among strata (size of the property). The heterogeneity among strata points out that the different applied technology levels, have direct influence in the production volume (Table 1) that coincides with experimental results found by Locascio and Fiskell (1977), O´Sullivan (1979), Batal and Smittle (1981), Brave et to the one. (2000) and Castellanos et al (2000). In the same way, taking into account the total of the sample, in the analysis of simple correlation, it can stand out that the variable with more correlation coefficient is the number of hectares 0.653 (Table 2). Nevertheless, on the simple correlation there was not difference statistic, significant difference was observed to obtain bigger yield as it increased the surface, when it was analyzed by property sizes (Table 1). In spite of the fact that the correlations for the nitrogen units, match and agrochemicals are smaller, they also are associated with the production of dry chili, as for the statistical difference among strata as for the positive correlation.

Table 1. Comparison of stockings of variables for treatment (Cycle agricultural spring/summer 2000).

MEANS PROOF	TREATMENTS			
	< 10 h	10 -< 20 h	20 -< 30 h	> 30 h
HECTARES	2.76 D	14.46 C	26.66 B	43.33 A
USN†	82.48 C	129.76 B	147.50 AB	153.67 A
USP††	57.53 C	108.31 B	126.50 AB	150.00 A
AGROCHEMICALS	2.43 B	2.23 C	2.57 B	3.11 A
WATERING	7.65 C	8.76 AB	9.36 A	8.97 B
WAGES	115.47 C	133.86 B	139.91 B	148.54 A
YIELDS (ton/ha)	1.46 D	1.85 C	2.10 B	2.28 A

† nitrogen Units
†† match Units
ABCD Stockings in the columns with different letter is statistically different (P <0.05).

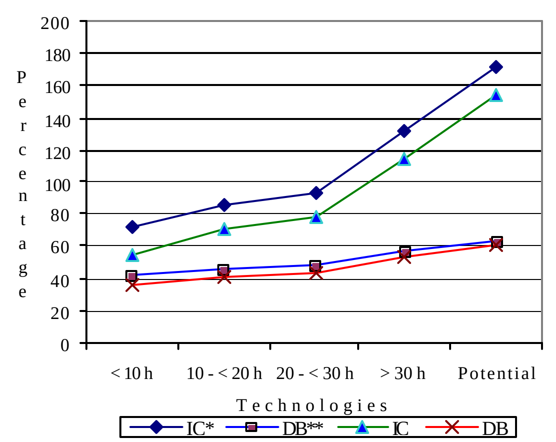
Table 2. Simple correlation for variable type (Cycle agricultural spring/summer 2000).

VARIABLE DEPENDENT	VARIABLES INDEPENDIENTS					
	ha	usN†	usP††	Agrochemicals	Number watering	Wages
YIELD (ton/ha)	0.6536	0.3279	0.2054	0.2299	0.0767	0.3019

† nitrogen Units
†† match Units

Profitability for technology type. Once determined the rates of profitability for the technologies, it can be observed that all are bove of the opportunity cost of the investment. It means that the investment for the production of dry chili was profitable. Therefore, it is better than to invest in a financial institution. Comparatively, the potential technology presents a bigger rate that of the stratified producer (size of the property). It was concluded that the better the technological level applied the bigger the profitability meaning better income level to producers. It was determined that the technology used in the stratum 1 (<10 h), it is smaller the profitability (71.42%). Also, the margin of safety (increase in costs and decrease of benefits) it is bigger for the potential technology (Figure 1).

Figure 1: Margin of safety per hectare of dry chili per type of technology, with and without cost of the earth (cycle spring/summer 2000)



IC = Increments in Costs
DB = Decrease in Benefits

CONCLUSIONS. Although the technology (stratified) applied by the producers is profitable, This profit is lesser than the potential technology. This results may encourage producers to adapt new technological levels which lead than to higher income levels therefore it willimprove their welfare level.

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SOIL TEMPERATURE AND SOIL MOISTURE IN SERRANO PEPPER (Capsicum annuum L.) WITH FERTIGATION AND MULCHING

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INTRODUCTION. Soil plastic mulch provides several benefits such as greater water retention, increase in soil temperature and nutrient availability, as well as a higher water and fertilizer use efficiency. Commercial evaluations of plastic mulch in tomato, cucumber, watermelon and cotton with Northwest Mexico farmers showed production increments of 47, 75, 120 and 210% respectively, with production costs 31, 34, 58 and 118% higher than control, respectively, but with economic profits 114, 112, 97 and 65% higher than control, respectively (Ibarra and Rodríguez, 1991). The present research work was carried out in view of the nutritions, economical and social importance of the pepper crop in Mexico, and motivated by the increase in agricultural area submitted to pressure irrigation and fertigation in recent years.

OBJECTIVE. The objective of the present work was to assess the effect of two N and two K fertigation levels applied through a drip system, with and without soil plastic mulch, on the temperature and moisture content of the soil, as well as on the Serrano pepper yield.

MATERIALS AND METHODS. The research work was conducted in the San Luis Potosí Campus of the Colegio de Postgraduados, in Salinas de Hidalgo, S.L.P., at an altitude of 2099 m. The soil is classified as calcidis Aridisol (Soil Survey Staff, 1995), medium textured with a petrocalcic horizon less than 19" deep, of alluvial origin and with limited agricultural use. A drip irrigation system was used, with PVC emitters in line at the top of the furrow, with a flow of 1.0 L hr^{-1} per dripper. The factors under study were: a) with and without plastic mulching, and b) four fertigation levels: 50 and 100 ppm N and 100 and 200 ppm K concentration levels. The amounts applied daily varied according to the evaporation registered in a type "A" evaporimeter. The control teatment was the traditional crop management without mulching, with a soil fertilization rate of 200-80-0 and with furrow irrigation. A split plot design was used, with treatments arranged in randomized blocks. Large plots corresponded to plastic mulching and the small plots to the fertigation levels. Soil temperature and moisture measurements were made every three days, at depths of 4" and 12", between 9.00 and 12.00 a.m.

RESULTS AND DISCUSSION. Total pepper fruit production of six cuts is reported in Table 1, The mean yield of mulched treatments (35.7 t ha^{-1}) exceeded in 87% to that of unmulched treatments (19.1 t ha^{-1}). The difference between both treatments is highly significant (a =0.05). There was no significance for differences among fertigation levels of for the interaction mulching x fertigation levels.

SOIL TEMPERATURE AND MOISTURE. Mean soil temperature at 4" depth of mulched treatments (19°C was 4°C higher than that of unmulched treatments (15°C). At 12" depth, the difference was 3.1°C higher in mulched soil (19.0°C) than unmulched soil (15.9°C) (Table 2). The higher soil temperature in the mulched treatments provided more favorable conditions for the physiological processes of the plant. Lal (1974) reported up to 8°C of temperature difference at 5 cm depth between mulched and unmulched soils, and this difference increases with increments in soil moisture (Mahrer et al., 1984).

Table 1. Total pepper fruit mean yields of six cuts, obtained under four fertigation levels and two mulching treatments.

Fertigation N-P-K (ppm)	mulched	Unmulched	means
		t ha^{-1}	
50-40-100	36.8	21.8	29.2 a
59-40-200	28.5	17.4	23.0 a
100-40-100	37.8	18.7	28.3 a
100-40-200	39.7	18.3	29.0 a
Control			6.7
Means	35.7 a	19.1 b	

CV = 37.23; $HSD_{0.05}$ mulching = 8.95 t ha^{-1}; $HSD_{0.05}$ fertigation levels = 10.1 t ha^{-1}

Table 2. Mean temperatures and moisture contents of mulched and unmulched soil at two depths and three time periods, during the growth of Serrano pepper.

	Temperature				Moisture			
Mulch	with		without		With		without	
Depth (cm)	10	30	10	30	10	30	10	30
Period	°C				%			
June	20.6	20.5	17.2	18.3	47.8	39.2	36.4	25.7
Jul-Aug	23.0	23.9	19.4	20.0	45.5	31.7	32.9	20.1
Sep-Oct	14.4	12.8	9.4	9.4	46.5	32.4	33.2	23.6
Mean	19.3	19.0	15.3	15.9	46.6	34.4	34.1	23.1

Table 2 shows soil moisture a difference of 12.5% (125 m^3ha^{-1}) between mulched (46.6%) and unmulched soil (34.1%) to a depth of 10 cm; whereas at a depth of 30 cm the difference in soil moisture content between mulched (32.4%) and ration, ablowing an economy of up to 50% in the total water applied to the soil during the crop growth period (Bennett *et al*., 1986), with a favorable effect on crops development and productivity.

Conclusions

- Soil plastic mulch increased soil temperature in 3 to 4°C and soil moisture content from 37% to 49%, resulting in a higher fruit production.
- Soil mulching and fertigation increased pepper fruit yield in more than 85% compared with traditional furrow irrigation and soil fertilization.

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GEMINIVIRUSES DETECTED IN HABANERO CHILLI PEPPER (*Capsicum chinense* Jac) IN YUCATAN PENINSULA

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INTRODUCTION. In México, the habanero pepper has been cultivated almost only in Yucatan peninsula. At the end of 1989 it was cultivated about 2000 hectares in this region, the major surface that has been cropped before. However, at the same time, a devastating geminivirus disease appeared in the peninsula causing total yield looses up to 30-70% of cultivated surface. This geminivirus disease caused germplasm losses too, forcing the farmer to change habanero pepper for another crop. Geminiviruses are probably the most important viral pathogens affecting horticultural crops in tropical and semitropical areas in Mexico; these pathogens are transmitted by a whitefly. Therefore, as in many countries, the management of these viruses lies, principally in spraying a lot of pesticides to reduce the populations of whitefly. One of this pesticide, imidacloprid, comes in the 90s and give hope to control the disease in the region, by the way many farmers begin to sow again the habanero crop with some successful, but in the last year (2001) the disease appeared like as severe as it used to be.

Alternative sources of resistance to Geminiviruses in habanero pepper have been looked for, but we need to know which geminivirus are in the region to direct correctly the crop improved. Therefore our goal in this work was to detect the principal Geminiviruses in habanero pepper in the peninsula of Yucatan.

METODOLOGY. For the last two years (2000-2001), we had collected samples of diseased plants of habanero chilli pepper in the most important habanero crop areas of the Yucatan Peninsula (15 locations: 5 from Yucatan, 5 from Campeche and 5 from Quintana Roo states). The collects had been done every three months and included pepper as well the most common weeds associated to the crop. The samples were analyzed by a combination of procedures. First, by dot blot hybridization using general (gene of capsid protein of Pepper huasteco virus, PHV) and specific probes (common region of PHV, Pepper golden mosaic virus, PepGMV; Tomato mottle virus, ToMoV; Bean golden mosaic virus, BGMV; Tomato yellow leaf curl virus, TYLCV and Taino tomato mottle virus, TToMoV). Selected samples were then analyzed by polymerase chain reaction (PCR) procedures using several primer sets. In some cases the PCR product had been cloned and sequenced to confirm the identity of the virus present.

RESULTS. It was detected Geminiviruses In all of the sites sampled. The principal Geminiviruses detected were PHV, TToMV and PepGMV. Although it was detected TyLCV, ToMoV and BGMV too. All of these viruses were detected in the 15 sites sampled with different incidence (Table 1). We can deduce the presence of at last one not characterized geminivirus in the region, because we could detected geminivirus in some samples by the general prove, but in these samples any other specific prove were positive in the trials.

Table 1: Geminiviruses detected in Yucatan peninsula and its proportion.

Localidad	1	2	3	4	5	6
Yucatan	**58**	**35**	16	32	**47**	19
Campeche	**44**	**21**	23	15	**43**	15
Quintana Roo	**57**	**37**	17	3	**40**	22

1 = PHV, 2 = PepGMV, 3 = TyLCV, 4 = ToMoV, 5 = TToMV and 6 = BGMV

As in another zones in our country, we detected mixtures of these Geminiviruses. The more common mixture was those where three different Geminiviruses were all at once, having 15% of the positive samples, the others mixtures were: with two Geminiviruses, 8%, with four 8%, with five 5% and with six 2%.
It is the first time that TToMV, ToMoV and BGMV are reported infecting habanero chilli pepper, by the way we considered the necessity of corroborate this detection.

On the other hand, we had detected up to 24 different weeds infected with Geminiviruses, in at least ten of them, we had detected mixed infections.

Now we have clearly focused that the improve of habanero pepper have to be in order to gain resistance or tolerance, in at last three of the most important Geminiviruses in the region, PHV, PepGMV and TToMV.

DETERMINATION OF COMPATIBILITY TYPE OF *Phytophthora capsici* Leo. ISOLATES COLLECTED IN THE BAJÍO REGION

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Keywords: *P. capsici* Leo., compatibility type, "pepper wilt"

INTRODUCTION. *P. capsici* L. was the pathogen identified as the causal agent of "pepper wilt". The presence of both compatibility types is required for sexual reproduction, oospore will be formed as a result of mating and will be a source of genetic variation (1). According to this information, the possibility that when both compatibility types are found in the same county state means that the potential for genetic recombination exists with the consequent, development of variability that the oomycete could express in its physiology, pathogenicity and response to fungicides, among other aspects, making control of this pathogen more difficult and complicated. Based on this background information the present study was proposed. The objective of this study was to determine the compatiblity type(s) of *P. capsici* isolates present in the county states where the study was conducted.

MATERIALS AND METHODS. Compatibility type of 8 isolates of *P. capsici* obtained from plants with "pepper wilt" symptoms were collected in 4 county states of Salvatierra and Silao, Gto counties was determined. In order to do this determination 5 cultures of *P. capsici* of known compatibility type were used, 2 were A1 and 3 were A2. The crosses were done in Petri plates with tomato juice agar. Tests with isolates of both compatibility types were performed by placing each isolate at 2cm from the isolate of known compatibility type, plates were incubated at room temperature in the dark, oospore formation was evaluated microscopically at 96 y 168 hrs, analyzing the mycelia formed from the crosses. The variable determined was oospore production.

RESULTS AND DISCUSSION. Isolates 8A, 8C y 8I of Sta. Rosa, county. of Salvatierra were identified as compatibility type A1, A1 y A2 respectively, establishing that in this county state both compatibility types were present, therefore the possibility of oospore formation in this area exists (Table 1). The isolate 7B of La Faja, county. of Salvatierra was A2, only one compatibility type was found in this county state (Table 1). The third county state of Salvatierra was San Nicolás, were isolates 6A and 6G resulted in A1 and A2 types respectively, having this county state also the potential to form oospores and genetic recombination likewise in San Miguel, Silao the isolates corresponding to 15C and 15H of San Miguel, county. of Silao were A2 and A1 (Table 1). Based on the information gathered in 75% of the county states under study both compatibility types were found, with the potential for sexual reproduction, with the consequent oospore formation and the development of variability.

Table 1. Compatibility type of 8 *P. capsici* isolates from Salvatierra and Silao, Gto.

No	isolates	Location	Compatibility type
1	8A	Sta. Rosa, Salvatierra	A1
2	8B	Sta. Rosa, Salvatierra	A1
3	8E	Sta. Rosa, Salvatierra	A2
4	7B	La Faja, Salvatierra	A2
5	6A	San Nicolás, Salvatierra	A1
6	6G	San Nicolás, Salvatierra	A2
7	15C	San Miguel, Silao	A2
8	15H	San Miguel, Silao	A1

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VIRUS DISEASES AFFECTING SWEET PEPPER (*CAPSICUM ANNUM*) IN QUIBOR VALLEY, VENEZUELA

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Abstract
Predominant production system in Quíbor Valley, Venezuela is vegetables crops of sweet pepper. 54% of sweet pepper national production takes in the Valley. However, in the last years this crops has been seriously affected by complex of viral symptoms characterized by a strong mosaic, curled heart, filiform leaves, dwarf and deformation de leaves. To determine causes of this situation samples of leaves were taken and then inoculated in ***Nicothiana benthamiana, Datura inoxia, Chenopodium amaranthicolor, Capsicum annuum*** var. Júpiter, Yolo Wonder y Capistrano, ***Capsicum frutences*** var. Green leaf and tomato hibryd Andino; Electronic microcopy and Elisa test to each sample were carried out. According to results, it was possible to reproduce ablisterlike, symptom, strong and very defined mosaics at leaves of all sweet pepper varieties and en Yolo Wonder a deformation ferlinke type. In green leaf fading and a soft mosaic were observed. Abundant particles as flexuose threads were observed, in field samples and in the indicators plants Yolo Wonder, Capistrano and D. inoxia, serology the following virus diagnosed: Tobacco rattle virus (TRV), Potato virus Y (PVY), Pepper mottle virus (PMMV), Cucumber mosaic virus (CMV), Tomato ringspot virus (ToRSV), Tobacco ringspot virus (TRSV), Tobacco etch virus (TEV) Tobacco mosaic virus (TMV).

HANDLING PHYTHOPATHOGENS ORIGINATED ON CHILI PEPPER (*Capsicum annuum L.*) SOIL IN TECAMACHALCO, PUEBLA

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Key words: Chili pepper, phytopathogens, mycorrizae, microparasites.

In Tecamachalco, Puebla, Mexico, the chili pepper (*Capsicum annuum L.*) cultivation has been replaced by the cultivation of other species, due to a decline in yield, caused by phytopathogens originated in the soil, such as *Pythium, Phytophthora, Rhizoctonia, Fusarium* and the nematode Thorne and Allen *Nacobbus aberrans*, which damage the plant's root systems and interfere with the absorption of water and nutrients, eventually causing the plant to wilt and die (3). Attempts to control these microorganisms have been carried out by applying chemicals, harvesting more resistant varieties, cultural practices, and others (1, 2, 4). Most of the region's small and medium scale chili pepper producers only use expensive chemicals, and they do so in large quantities. Taking this into account, the aim of this paper is to evaluate different strategies for handling phtyopathogens originated in the soil in chili cultivations in the Tecamachalco area; these strategies may reduce losses caused by such phtyopathogens.

An experiment was established with a split plot design by which the main plot was: 1) rotation, adjustments, and with cow manure (CM), 2) plot with rotation, adjustments, and no manure (NM), 3) plot with rotation, adjustments, and chicken manure (CHM). Before establishing these three parcels, all the land was harvested with cabbage and oat, respectively, and the remains of both crops were added to the soil. One month before the chili cultivation transplant, cow and chicken manures were added to the soil. The small parcels were: 1) experimental control (EC), 2) commercial control (CC), 3) mycorrizae (MY), and 4) microparasites (MP). In each small parcel, plantlets obtained in nurseries were transplanted and assigned plants, which were given different treatments. A healthy, native Miahuatecan chili seed, picked in the Tecamachalco area was selected and planted in 200-cavity polystyrene trays with pasteurized soil. Before the sowing took place, the latter was applied to treatments EC and CC; treatments MY and MP were added 5 grams of mycorrizae and microparasites, respectively. At the moment of transplanting, nematocide and fungicide were applied to CC. Each small plot contained 5 small furrows, each of which was 5 m long and 90 cm apart; the distance between one plant and the next was of 25 cm. Agriculture sulfur (95% S) was applied to the three large parcels, on a 672- 896 kg ha-1 dosage. Parcels CM and CHM were fertilized with ammonium sulfate on a 157 kg ha-1 dosage, and 133 kg ha-1 for plot NM. Likewise was done in plots CM and NM, with triple calcium superphosphate in dosages of 14 kg ha-1 and 79 kg ha-1, respectively. Foliar fertilizer was used in all treatments. Nematodes were sampled every 2 weeks, taking the plants from both lateral furrows of each small parcel, from whic h the number of nodes per plant and root volume were registered. In the three main furrows of each small parcel, every 20th plant was sampled, in order to evaluate height and wilting incidence due to phytopathogens; the chili peppers were harvested to evaluate yield. Analysis of variance and multiple comparison tests were done (Tukey ?=0.05), as well as to an epidemiological analysis.

Within the plot containing CM, the chili plants treated with MP and MI displayed the lowest area values under the disease progress curve, with values of 1069.25 and 1133.43, respectively. Likewise, the CC displayed the lowest incidence of wilting (34%) with an apparent infection rate of 0.0067 infected plants per day. Crop rotation and the inclusion of its residues into the soil, as well as organic adjustments lowered the number of gall and disease cases: the large plot with CHM had the tallest plants (36.06 cm) and the smallest amount of *Nacobbus aberrans* nematode nodules (101). Despite the fact that the yield was not major in any of the treatments the highest value was seen in the large plot with CHM (549.87 kg ha-1), and the small parcels with CC (499.08 kg ha-1), MP (455.24 kg ha-1) and MI (337.14 kg ha-1) treatments, although the difference between these was not significant.

The approaches used here reduce the occurrence of diseases caused by phytopathogens originated in the soil, and can help establish the starting point for an important method for treating chili pepper cultivations in the Tecamachalco and Puebla areas, as well as other regions in Mexico.

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ALTERATIONS OCASIONADAS BY *Phytophthora capsici* Leo. IN PLANTS OF HOT PEPPER (*Capsicum annuum* L.)

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The hot pepper (*Capsicum spp*.) takes a great importance in the Traditions, Culture and Diet of the Mexican People.

The "hot pepper wilt" (*Phytophthora capsici* Leo.) is the main illness of the hot pepper in some regions, that has done incosteable its cultivation.

The objective of this research is to determine the effect of *P. capsici* in the main physiological functions of hot pepper plant, both susceptible and resistant.

It was employed the aislament 6556 of *P. capsici* and the susceptible variety Mulato V-2 (MV-2) and the resistant line Criollo de Morelos-335 (CM- 335). The inoculations were performed with a suspension of 5,000 zoospores / ml and 20 ml by plant. For the demonstration of symptoms, the plants were incubated in a growth chamber.

1. TRANSPIRATION: It was determined by means of gravimetric method. The inoculated plants were weighed individually the same day of the inoculation and subsequently each 24 hours, until the tenth day. In this date, the MV-2 genotype inoculated reduced its transpiration in 89.26% regarding the MV-2 genotype without inoculating. In the CM-335 genotype, the reduction was 23.04%, which is not significant.

2. WATER POTENTIAL IN THE LEAF: a Scholander bomb was utilized. The initial reading was performed the day of the inoculation and subsequently each 24 hours until the ninth day. In the MV-2 genotype inoculated, its ?w was of -18.5 bars and in the MV-2 genotype without inoculation, was of -6.0 bars. In the CM-335 genotype inoculated and without inoculation fluctuated among -5.7 to -8.1 bars; in the first one of the cases, a drastic decrease was observed in the ?w of the leaf.

3. PRESSURE OF THE XILEMA: the same previous methodology was employed. The final reading in the eighth day in the MV-2 genotype was of -13.5 bars and in the remainder of the plants ranged from -5.4 to -6.6 bars In the MV-2 genotype, a strong alteration can be appreciated caused by *P. capsici*.

4. ESTOMATAL RHYTHM: The data were taken at 8:00, 12:00, 14:00 and 19:00 hours, since the initial day, to the seventh day after the inoculation. The readings were performed with a Porometer (Marks Licor, Mod. Li-609). The increase in the resistance to the diffusion in the MV-2 genotype inoculated occurred as of the third day after the inoculation, and to the seventh day was of 144 seg., Cm-1. The behavior of the MV-2 genotype without inoculation, CM-335 genotype inoculated and without inoculation, the resistance to the diffusion did not show significant differences.

It is concluded that *P. capsici* affects drastically the water metabolism in the plants of the MV-2 genotype inoculated, and no effect upon the CM-335 genotype inoculated, being resistant to that fungus. In the first days after the infection, the effect of *P. capsici* himself is not manifested in the plant inoculated but after the third day of the inoculation, the symptoms begin to be manifested and this due to that absorption of water by the radical system is suspended and the plant infected has to follow performing its physiological processes and takes the water that the plant utilizes for metabolism and is initiated the wilt to the death by the infection of *P. capsici*.

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