CULTIVARS TOLERANCE OF RED CHILE TO ROOT ROT: RESPONSE TO HIGH LEVELS OF SOIL MOISTURE.

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ABSTRACT

Red chili has several diseases which can cause extensive losses in both yield and quality. These diseases often mean the difference between profit and loops. In the last years the lost of crops were increased by the root rot, sometimes called phytophthora root rot. The fungus becomes a problem when soils are excessively wet because of over irrigation from either furrows or drip irrigation, and heavy rainfall or both. During 2000, the lost ones ascended to 250 million pesos. In general, high frequently irrigation with drip and furrow irrigation systems enhanced root rot in red pepper. The main objective of this study was to investigate the effects of soil moisture content on the disease incidence of root rot in partially tolerant genotypes of red chili.

Key words: Cultivars tolerance, Root rot, soil moisture.

INTRODUCTION

Zacatecas Mexico is the leading state in the production of red chili; where the rain is infrequent during the growing season and the farmers use meanly cultivars criollos (Crole) which are very susceptible to the root rot disease. Red chili has several diseases that can cause extensive losses in both yield and quality. These diseases often mean the difference between profit and loos. In the last years the lost of crops were increased by the root rot, sometimes called phytophthora root rot. The fungus becomes a problem when soils are excessively wet because of over irrigation from either furrows or drip irrigation, and heavy rainfall or both.

Only in 2000, the lost ones ascended to 250 million pesos. In general, high frequently irrigation with drip and furrow irrigation systems enhanced root rot in bell pepper (Ristiano 1991, and Cafe-Filho and Duniway 1996). Moreover, long periods of saturated soil are well known to increase the incidence and severity of plant chili diseases (Bowers and Mitchell 1990). Besides the disease progess of root rot appears to correlate with the first rains of the growing season (Biles et al 1992 and Mojarro 2002a). Mojarro (2002b) working for two years under field condition has shown an increase in disease with high frequency irrigation.

[1] INIFAP, CIRNOC, Campo Experimental Calera

For instance, plots given 120% of pan evaporation the residual soil moisture was very high (saturation point) during the growing season, evidently in these plots the soil pores were full of water, allowed the pathogens to promote root infection as high as 52% of sick plants at the end of the season.

Stolzy et al. (1985) suggested that the zoospores of Phytophthora spp. require water-filled pores to move through soil. Currently, in Mexico there are no chili pepper cultivars resistant to root rot disease. While soil moisture is certainly important, there have been no attempts to examine, under field condition, the effects of different soil moisture levels in partially resistant genotypes of red chili on the disease incidence of root rot. The main objective this study was to investigate the effects of soil moisture content on the disease incidence of root rot in partially tolerant genotypes of red chili.

MATERIALS AND METHODS

A field experiment was conducted out in the CEZAC-INIFAP in the 2000, in a soil with antecedents of contamination for fungal pathogens responsible of the disease of red chili plants. Experimental design was a split-plot arrangement with three replicates. Main plots were randomized irrigation treatments and the subplots were the randomized genotypes (anchos y mirasoles). Each treatment had 90 plants of red chili.

The irrigation treatments were 60 y 120 % of the pan evaporation, obtained from a climatologic station. And the genotypes were ANCHOS: LEAZ-6, LEAZ-8, LEAZ-10 and MIRASOLES: LEMZ-7, LEMZ-8, and LEMZ-10 which were planted April 25. These genotypes have been selected by MC Bertoldo Cabañas Cruz who is a Researcher of the INIFAP. Drip irrigation was used with an emitter spacing of 30 cm and a rate of 3.0 l/h/m. The amount of water applied was measured by a flow-meter. Fertilization was as followed 220 kg/ha (N), 100 kg/ha (P_2O_5) and 150 kg/ha (K_2O_5). The numbers of diseased plants per plot were counted weekly and yields of red chili were measured at harvest. The time variable was replaced for the Heat Degree Days, which was calculated as followed:

$$HDD = \sum_{n=1}^{n} \left(\frac{T\max - T\min}{2} \right) \text{-Tb}$$

where Tmax is maximum temperature, Tmin is minimum temperature and Tb is base temperature in this case 5°C.

RESULTS AND DISCUSSION

In all the drip treatments the amount of water of irrigation varied with the pan evaporation conditions (Table 1). Such as in 1999, the red chili plants were infested by the fungal pathogens as a result of the high regimens of residual soil moisture during the growing season (Figure 1).

Table 1. Means of plant disease incidence of root rot on red chili and applied water, in the field.

Pan evaporation (%)	Number of plant diseases	Applied water (cm)
60	32.2a	54.9
120	38.8b	86.2

Numbers in the same column followed by the same letter are not significantly different (p=0.05) according to the Duncan test.

Table 2. Means of disease incidence of root rot on genotypes, in the field.

GENOTYPE	Number of plant diseases	%	Yield (ton/ha)
LEAZ-10	39a	43	3.009
LEAZ-8	38.5a	42.7	2.321
LEAZ-6	35.2ab	39.1	2.149
LEMZ-10	35ab	38.8	2.641
LEMZ-8	40a	44	3.155
LEMZ-7	36.5ab	40.5	3.127

Numbers in the same column followed by the same letter are not significantly different (p=0.05) according to the Duncan test.

During the growing season residual soil moisture was measuring with the TDR sensor. The results are in Figure 1, for the 120% pan evaporation treatment. In both treatments the soil water content varied. The residual soil moisture was very high during the growing season in the plots with the 120% of pan evaporation. Evidently the pores in these plots were full of water (not evaluated), which was enough to create a good physical condition to be released and spread of zoospores (Bowers and Mitchell 1990).

The red chili plants were infested by the fungal pathogens, as a result of the high regimens of residual soil moisture during the growing season (Figure 1). For instance, the plots were 120% pan evaporation was the criterion, at the end of the season had significantly higher plant diseases than plots with 60% of pan evaporation (Table 1). The incidence of the disease in plots given 60% was 32.2, and in 120% 38.8 (Table 1). On the other hand, significant statistical differences were found between genotypes.

Disease levels were more severe with LEMZ-8, LEAZ-10, and LEAZ-8 (Table 2) than with LEAZ-6, LEMZ-10, and LEMZ-7. Eight times were collected the numbers of plant diseases of each genotype, during the season, in Figure 2 are shown the number of plant diseases related to the Heat Degree Days.

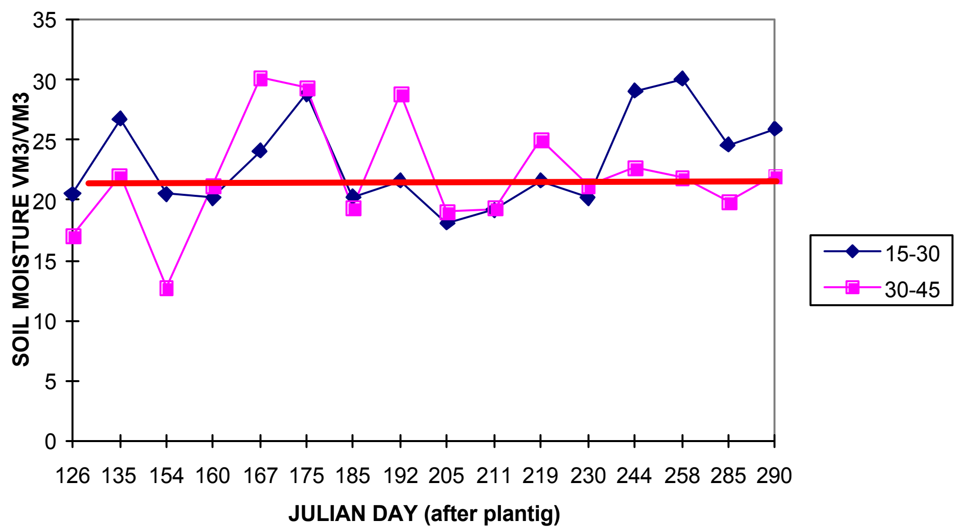

Figure. 1 Residual soil moisture during the growing season for the 120% of pan evaporation treatment, for two depths 15-30 and 30-45 cm. The red horizontal line is Field Capacity Point.

Disease incidence was compared statistically using an analysis of variance procedure. Repeated analysis of variance was used for data collected sequentially. Significant statistical differences were found for 7 data collected for comparing the tolerance effect of six genotypes on disease incidences.

The Zacatecas State has an annual rainfall mean of 350 mm; the majority of precipitation falls in late July and September early. The incidence of disease progress of plants of red chile appeared to correlate with the first rains of the growing season. For instance, for the 1999 season the incidence of the disease started on the 167th Julian day and for 2000 season it happened on the 157th Julian day (figure 4).

The arrows in Figure 4 indicate that 5 mm o more rainfall occurred in the previous week and also indicate the beginning of the incidence. After the first rainfalls the rate of the disease appeared to increase more in the plots given irrigation with 120% of pan evaporation in comparison to the plots given 60%. As was observed by Biles et al (1992)

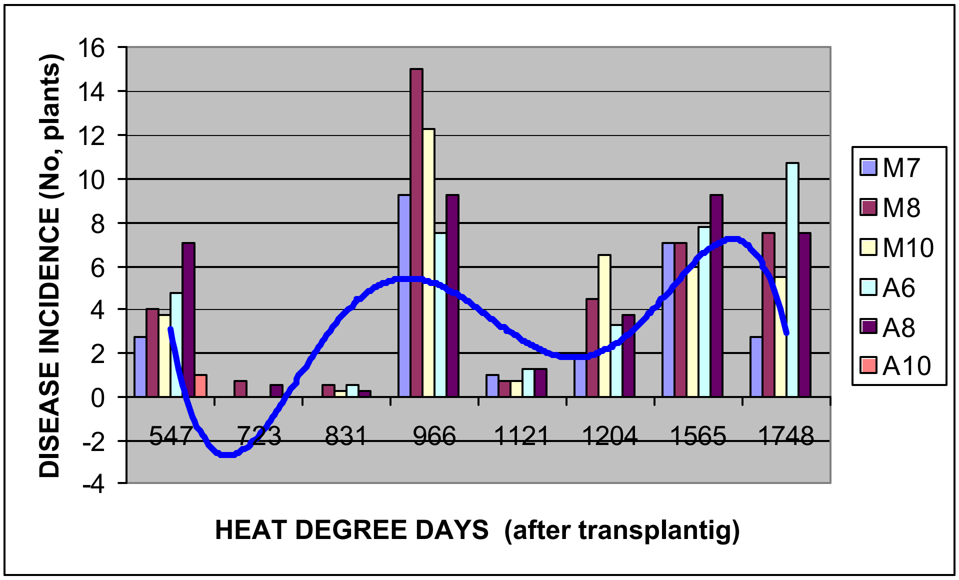

Figure 2. Disease incidences of root rot of six cultivars of red chile in drip irrigation.

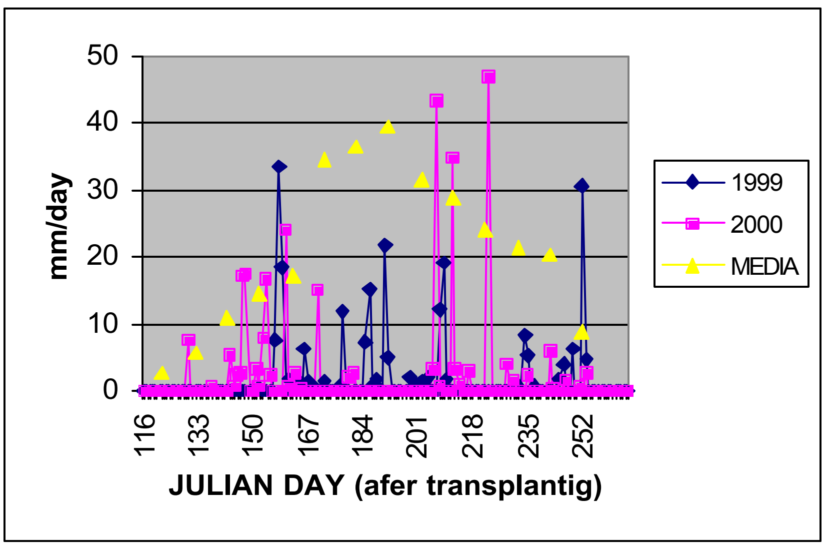

Figure 3. Daily precipitaton registered in the climatology station of INIFAP.

The effects of the soil moisture conditions on the disease incidence are very clear. The number of plant diseases was influenced by the two rates of pan evaporation. Others investigators also have shown an increase in disease with high frequent irrigation (Bowers and Mitchell 1990, Cafe-Filho and Duniway 1996 and Biles et al 1992). For instance, plots given 120% of the pan evaporation showed a very high residual soil moisture (saturation point) during the growing season, evidently in these plots the soil pores were full (Figure 1) of water, allowing the pathogens to promote root infection as high as 43% of sick plants at the end of the season.

As Stolsy et al (1965) was observed, more over Bowers and Mitchell (1990) showed that periodic saturation of soil increased disease incidence of bell pepper. On the other hand, the plots that received less water during the season reduced their numbers of sick plants. This data suggest that low soil moisture levels, applying 60% of pan evaporation, may be effective technique for management of root rot of red chile.

It is observed in the Figure 2 that the biggest incidence of plant diseases were registered between 850 to 960 units of heat, which was due to the conditions of soil moisture by irrigation, like it was discussed up and also, to the precipitation conditions that prevailed during the season. These two conditions caused that the levels of residual soil moisture registered were very superior to the value of the field capacity (Figure 1).

On the other hand the cultivars used in this experiment, the primary indication of the tolerance of the root rot was found in the LEAZ6, LEMZ10 and LEMZ7 and more important the ANCHOS which were more sensible to be infected by the pathogens that promote root rot infection than the MIRASOLES ones. The number of survived plants of these cultivars were more, even when they grew up under high levels of soil moisture, so they have the apparently plasticity to tolerate the pathogens that promote root infection. Cabañas (personal communication) has evaluated under field condition the LEMZ7 cultivar during the years 2000 and 2003.

His results shows the disease incidence in LEMZ7 was only 8% and 11% respectively and for the crole cultivar (criollo) used by the farmers 28.1% and 35% for the same years. We suggest that the causes of these results have to be investigated. The soil analysis in order to prove that fungus were present most be done, and also, the fungi which is responsible of these results must be identified. However, we can hypothesize, that the tolerance to root rot infection of these two cultivars could be due to their anatomic structure or some physiologic mechanisms, like cell-wall elasticity.

CONCLUSIONS

In summary, the results found in this work, support the asseveration that high soil moisture increases plant disease incidence. Also and very important, the speed of the incidence of plant diseases is seriously increased with the presence of precipitations. The number of plant diseases can be diminished applying only volumes of water to restore to soil field capacity. When drip irrigation is used and the soil is already contaminated by these fungals, it is recommended to apply volumes of water with 60% of pan evaporation. The tolerance of the root rot was found in the LEAZ6, LEMZ10 and LEMZ7 and the ANCHOS were more sensible to be infected by the pathogens that promote root rot infection. The MIRASOLES were less sensible. Some Farmers of the Zacatecas State, Mexico are using the LEMZ7 and LEAZ6 with excellent results.

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