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Effect of Irrigation Methods on Pepper Crown Rot Disease Caused by *Phytophthora Capsici* Leonian

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ABSTRACT

The study involved determining the relationships among irrigation methods (drip, basin & furrow) and pepper crown rot disease caused by *P. capsici* in Diyarbakır and Bismil in two seasons (2000-2001). The disease percentages were determined from the beginning of July to the end of the vegetation period at 10 days interval were insignificant in all experiments according to irrigation methods, but the highest value was recorded at drip irrigation plots. The disease percentages at the drip, basin and furrow irrigation methods were found as 78.39, 56.27 and 55.92%, respectively in Diyarbakır in 2000; 59.93, 46.40 and 57.49% in Diyarbakır in 2001; 16.51, 12.42 and 7.13% in Bismil in 2000; 59.06, 53.26 and 56.17% in Bismil in 2001; by taking into account the last values. The disease percentages were statistically insignificant in all experiments for irrigation methods. However, in drip irrigation plots the field irrigated regularly and also it may be irrigated much more than needed, so this increased the mortality of plants. The infected plants caused to lose most of the yield during the vegetative season. The wheat grain inoculation of *P. capsici* can be used artificially in soil inoculation.

Key Words: Pepper; *Capsicum annuum;* Crown rot disease; *Phytophthora capsici;* Irrigation methods

INTRODUCTION

Phytophthora blight, caused by *Phytophthora capsici*, is a devastating disease on peppers. *P. capsici* was first described by Leonin in 1922 on chili pepper in New Mexico. The disease was subsequently reported in many pepper growing areas in the world. Phytophthora blight causes yield losses up to 100% in pepper fields (Anonymous, 2001).

The pathogen has been seen in most of the plant species and the major hosts are red and green peppers, watermelon, cantaloupe, honeydew melon, cucumber, squash, tomato and eggplant (Erwin & Ribeiro, 1996; Anonymous, 2001).

Phytophthora blight of peppers (*Capsicum annuum*), occurs in most regions where this crop is grown. *P. capsici* infects roots, crowns, stems, leaves and fruit, causing seedling damping-off, stem lesion, stem blight, leaf spot and fruit rot of pepper (Shannon, 1989; Biles *et al*., 1993; Anonymous, 2001). The root and crown rot phase of the disease initially can appear on plants early in the growing season in areas of the field where soil remains saturated with water after an irrigation or rainfall. Subsequent periods of soil saturation encourage further disease development (Matheron & Porchas, 2002).

Epidemics of root and crown rot caused by (*Phytophthora* spp.) largely depend upon climate and soil conditions. Rainfall and soil moisture status are important factors stimulating *Phytophthora* root and crown rot (Bowers *et al.,* 1990; Cafe-Filho & Duniway, 1995). Since irrigation affects soil water conditions, the incidence of root rot disease can be potentially modified by changing irrigation practices (Xie *et al.,* 1999). The frequency of furrow irrigation and flooding duration has a direct effect on *Phytophthora* diseases (Bowers & Mitchell, 1990). Higher disease incidence and mortality of pepper plants occurred with more frequent irrigation and longer duration of flooding (Bowers & Mitchell, 1990; Cafe-Filho & Duniway, 1995). Zoospores and *P. capsici* are critical the primary propaguless causing pepper root and crown rot disease. Conditions of wet and dry cycles in soil is required to maintain the life cycle of most *Phytophthora* spp., the condition of wet–dry cycles in soil is required (Gisi *at al*., 1980). In practice, rainfall and periodic furrow irrigation usually provide a wet–dry cycle in soil, favoring sporangia formation during the drying period and zoospore release during the flooding (Bowers & Mitchell, 1990). It is likely that the disease can be greatly reduced if soil water status can be maintained at a relatively steady condition which prevents either sporangia production or zoospore release. The disease occurres because of soil conditions according to irrigation methods in this region of Turkey. There are no potential factors for climate conditions in South-East Region of Turkey because the region has dry hot weather without rainfall during the vegatative seasons.

The objective of present research was to determine the effect of drip, basin and furrow. irrigation methods on *Phytophthora* crown rot of pepper.

MATERIALS AND METHODS

The experiments were set up in randomized complete blocks with four replications at two locations (Diyarbakır & Bismil, in 2000 & 2001). Three irrigation methods (drip, basin & furrow) were applied to experimental units. Three isolates of. *P. capsici* were used as inoculum. The sweet pepper (*Capsicum annuum* L) variety Kandil of seedlings were transplanted in the field with 30x80 cm rows spacing and each plots includes 20 plants.

The fungus was isolated from infected pepper crown by surface 5 mm pieces of tissue with 1% NaOCl for 2-3 min, rinsing the sterile distilled water twice for 5 min, then planting the sections on corn meal agar (CMA). After 2-3 days, tips of peripheral hyphae from a growing colony were transferred to potato-dextrose agar (PDA). The culture was maintained on PDA slants at 5^0C in a refrigerator and was routinely transferred every 3 months on PDA for the maintenance. Wheat grains were used for inoculum production. The fungus was grown in erlenmeyers (250 ml) containing autoclaved wheat (parched cracked wheat, 800 g; water, 200 ml). The grains were inoculated with *P. capsici* isolates and incubated at 22 ± 1°C in darkness for 3 weeks. The soil was artificially infested with pieces of wheat grain inoculum of *P. capsici*, at a rate of 115 g/m^2 in Diyarbakır in 2000, and 66 g/m^2 in Diyarbakır and Bismil in 2001. Fields were inoculated at the first week of May before the seedlings transplanted. Plots in Bismil in 2000 were infested with the fungus [one Petri (having 9 cm diameter) contain/m^2] which was grown on PDA. In all experiments, the inoculum was mixed soil by a rototiller in 10-15 cm depth.

The seedlings were planted at the top of the ridge in the drip and furrow irrigation treatments, but into the center in the basin irrigation method at the third week of May in two locations. Drip irrigation was used with an emitter spacing of 30 cm and a rate of 2.0 h^{-1}. For drip irrigation plots, the lateral placed between two rows of pepper. In basin and furrow methods, the plants were irrigated when they required water during vegetative period. However, in drip irrigation, the required water was calculated by the Penman equation referenced to grass (Doorenbos *et al*., 1992), and the irrigation system was applied for two hours at intervals days. Also, the system was controlled manually. Disease incidence was determined at the end of the growth season. Analysis of variance of final disease incidence were calculated using MSTAT-C program, and mean values were compared by using Duncan's multiple range tests.

RESULTS AND DISCUSSION

The incidence at the drip, basin and furrow irrigation methods were 78.39, 56.27 and 55.92%, respectively in Diyarbakır in 2000; 59.93, 46.40 and 57.49%, in Diyarbakır in 2001; 16.51, 12.42 and 7.13%, in Bismil in 2000; 59.06, 53.26 and 56.17% in Bismil in 2001; by taking into account the last values (Table I, II). The disease percentages were gradually increased during the growing period of both locations.

The disease incidence was found high in three experiments in Diyarbakır 2000-2001 and in Bismil in 2001, but it was recorded low in Bismil in 2000, because this experiment area was inoculated by a little amount of *P. capsici* inoculum. A positive observed between the disease incidence and inoculum density for pepper crown rot (Biles *et al*., 1995; Rista, *et al*., 1995). The results showed that wheat grains inoculum produced high disease two locations in 2000 and 2001. Hence, the production and the application of the inoculum proved to be more practical and economical compared to the other methods employed in artificial inoculation. The disease percentages were statistically insignificant in all experiments according to irrigation methods, but the highest disease percentage was recorded at the drip irrigation plots. It was found that occurrence and spreading of crown rot disease of pepper depend on soil characters, field capacity and irrigation interval (Bowers & Mitchell, 1990; Bowers *et al*., 1990; Ristaino, 1991; Cafe-Filho *et al*., 1995). However, the location of emitters had major effects on incidence of disease plant, severity of root and crown rot symptoms, level of soil moisture and plant leaf water potential. The disease highest with emitters at the soil surface and in the plant row (Café-Filho & Duniway,

Table I. The disease percentage of crown rot of pepper (*P. capsici*) during the different times of vegetative season

Locations	Years	Irrigation Methods	Disease Percentage (%) According to Time 1	2	3	4	5	6	7	8	9	10
Diyarbakır		Drip	22.53	25.36	28.20	49.58	52.09	56.44	60.23	70.96	75.01	78.39
	2000	Basin	15.29	22.54	34.88	36.57	38.27	43.54	46.22	51.13	53.48	56.27
		Furrow	22.85	35.54	39.01	42.36	46.55	48.74	51.26	53.60	54.20	55.92
		Drip	17.66	22.75	38.70	42.56	44.15	48.65	50.90	53.38	56.69	59.93
	2001	Basin	17.21	23.17	30.15	34.69	36.87	39.38	41.58	42.49	42.49	46.40
		Furrow	34.03	39.66	46.06	47.10	49.55	52.69	55.90	56.94	57.49	57.49
Bismil		Drip	0.37	4.75	5.53	15.35	15.35	16.11	16.11	16.51	16.51	16.51
	2000	Basin	1.14	3.10	4.64	11.30	11.30	12.42	12.42	12.42	12.42	12.42
		Furrow	4.08	5.61	6.75	6.75	6.75	7.13	7.13	7.13	7.13	7.13
		Drip	16.92	34.27	39.85	47.31	49.64	53.15	57.90	59.06	59.06	59.06
	2001	Basin	21.50	30.97	36.34	45.19	47.27	50.05	51.75	52.77	53.26	53.26
		Furrow	22.82	35.71	45.70	49.09	51.49	55.06	55.67	56.17	56.17	56.17

Table II. The disease percentages of crown rot of pepper caused by *P. capsici*

Locations	Years	Irrigation methods	Disease percentages (%)	Year x location interaction for disease percentage (%)
		Drip	78.39a	
	2000	Basin	56.27a	63.53a**
Diyarbakır		Furrow	55.92a	
	2001	Drip	59.93a	
		Basin	46.40a	54.60a
		Furrow	57.49a	
	2000	Drip	16.51a	
		Basin	12.42a	12.02b
Bismil		Furrow	7.13a	
	2001	Drip	59.06a	
		Basin	53.26a	56.16a
		Furrow	56.17a	

* Within columns means between irrigation methods for every year and location followed by the same letter are not significantly different at the 0.05 probability.
** Within columns means between year x location interaction followed by the same letter are not significantly different at the 0.05 probability.

1996). Our results also demonstrated of the soil surface caused high disease density in all experiments. The drip irrigation caused the lowest mortality of plants, whereas furrow irrigation with low water input applied frequently caused lower mortality than flooding of the furrow and, thus it is recommend and economic management of the disease (Rista *et al*., 1995; Xie *et al*., 1999). Also, the disease incidence caused by *P. capsici* became greater after more irrigation or rainfall (Ristaino, 1991) and dispersal of *P. capsici* within rows in surface water (Ristaino *et al*., 1993). Our results suggest that the disease percentages were statistically insignificant in all experiments according to drip, basin and furrow irrigation methods, but the percentage was high at drip irrigation plots. However, drip irrigation is done regularly in plots and it may be irrigated much amount than needed without calculating the soil moisture. The soil moisture is an important factor for infection of *P. capsici.* The infected field increased the plant death and this caused to lose most of the yield during the vegetative season. The infection occured as crown rot symptons due to this the plants wilted and as a result all infected plants is dead in short time.

On the other hand the wheat grain inoculum of *P. capsici* can be used succesfully in soil inoculation.

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REFERENCES

Anonymous, 2001. Phytophthora blight of pepper. *Report on Plant Disease,* pp. 3. RPD No. 947. Department of Crop Sciences University of Illinois at Urbana-Champaıgn. (http://web.aces.uiuc.edu/vista/pdf_pubs/947.pdf)

Biles, C.L., M.M. Wall, M. Waugh and H. Palmer, 1993. Relationship of *Phytophthora* fruit rot to fruit maturation and cuticle thickness of new mexican-type peppers. *Phytopathology*, 83: 607–11

Biles, C.L., Bruton, B.D, M.M. Wall and M. Rivas, 1995. *Phytophthora capsici* zoospore infection of pepper fruit in various physical and environments. *Proc. Oklahoma Acad. Sci*., 75: 1–5

Bowers, J.H. and D.J. Mitchell, 1990. Effect of soil-water matric potential and periodic flooding on mortality of pepper caused by *Phytophthora capsici*. *Phytopathology*, 80: 1447–50

Bowers, J.H., R.M. Sonoda and D.J. Mitchell, 1990. Path coefficient analysis of the effect of rainfall variables on the epidemiology of *Phytophthora* blight of pepper caused by *Phytophthora capsici*. *Phytopathology*, 80: 1439–46

Cafe-Filho, A.C. and J.M. Duniway, 1995. Effects of furrow irrigation schedules and host genotype on *Phytophthora* root rot of pepper. *Plant Disease*, 79: 39–43

Cafe-filho, A.C., J.M. Duniway and R.M. Davis, 1995. Effect of frequency of furrowirrigation on root and fruits of squash caused by *Phytophthora capsici*. *Plant Disease*, 79: 44–8

Café-Filho A.C., J.M. Duniway, 1996. Effect of location of drip irrigation emitters position of *Phytophthora capsici* infections in roots on *Phytophthora* root rot of pepper. *Phytopathology*, 86: 1364–9

Doorenbos, J., W.O. Pruitt, A. Aboukhaled, J. Damagnez, N.G. Dastane, C. Van Den Berg, P.E., Rijtema, O.M. Ashford and M. Frere, 1992. *Crop Water Requirements,* 15–30. FAO Irrigation and Drainage Paper, 24

Erwin, D.C. and O.K. Ribeiro, 1996. *Phytophthora diseases worldwide,* American Phytopathological Society, St. Paul, MN

Gisi, U., G.A. Zentmyer and L.J. Klure, 1980. Production of sporangia by *Phytophthora cinnamomi* and *P. palmivora* in soils at different matric potentials. *Phytopathology*, 70: 301–6

Hartman, G.L. and Y.H. Huang, 1993. Pathogenicity and virulence of *Phytophthora capsici* isolates from Taiwan on tomatoes and other selected hosts. *Plant Disease*, 77: 588–91

Matheron, M.E. and M. Porchas, 2002. *Activity of actigard® on development of phytophthora root and crown rot on pepper plants,* (Vegetable Report, University of Arizona College of Agriculture and Life Sciences, index at:http://ag.arizona.edu/pubs/crops/az1292/)

Rista, L.M., M. Sillon and L. Fornasero, 1995. Effect of different irrigation strategies on the mortality of pepper by *Phytophthora capsici* Leonian in greenhouses. *Horticulture Argentina,* 14: 44–51

Ristaino, J.B., 1991. Influence of rainfall, drip irrigation and inoculum density on the development of *Phytophthora* root and crown rot epidemics and yield in bell pepper. *Phytopathology*, 81: 1312–20

Ristaino, J.B., R.P. Larkin and C.L. Campbell, 1993. Spatial and temporal dynamics of *Phytophthora* epidemics in commercial bell pepper fields. *Phytopathology*, 83: 1312–20

Shannon, E., 1989. *Chile Disease Control,* Cooperative Extension Service Guide H-219, New Mexico State University, Las Cruces, NM

Xie, J., E.S. Cardenas, T.W. Sammis, M.M. Wall, D.L. Lindsey and L.W. Murray, 1999. Effects of irrigation method on chile pepper yield and *Phytophthora* root rot incidence. *Agricultural Water Management*, 42: 127–42

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