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EFFECT OF IRRIGATION INTERVALS ON CHARCOAL ROT OF SUNFLOWER

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ABSTRACT

The experiment was conducted to observe the effect of irrigation intervals on diseases severity of charcoal rot and its consequence on growth and yield parameters of sunflower during spring season, 2015. The seeds of HO-1 sunflower variety were sown in a filed with no prior history of *Macrophomina phaseolina* (Tassi) presence. A 5mm diameter plug of virulent MPS16 isolate was inoculated on a stem of sunflower plant at 10 cm from soil surface when plant age was 40days. Four irrigations intervals set as treatments and equally applied in inoculated and un-inoculated plots. Maximum length of necrotic lesions (16.30±0.36cm) on stem and highest mortality percentage (13.07± 0.35) was recorded in inoculated plants of HO-1 variety received single irrigation whereas; minimum necrotic lesions (8.93 ± 0.35 cm) and lowest mortality (6.63 ± 0.19%) recorded from plots received four irrigations. Data also show significant differences in plant height and head diameter under water stress conditions. Small plants (118.10 ± 1.10 cm) and reduced head diameter (10.10 ± 0.76 cm) were produced in inoculated plants with single irrigation while, significantly tall plants (185.00 ± 1.53 cm) and increased head diameter (19.50 ± 0.76 cm) were obtained from uninoculated plants received four irrigations. 1000-seed weight and seed weight per plant also varied significantly due to different irrigation intervals. Minimum 1000-seed weight (23.90 ± 0.61 g) and seed weight per plant (25.60 ± 0.31 g) was obtained from inoculated plants of HO-1 sunflower variety given single irrigation whereas, maximum 1000-seed weight (56.00 ± 1.73 g) and seed weight per plant (63.10 ± 1.16 g) were recorded from un-inoculated plants given four irrigations. Similar pattern of yield loss was recorded in plots those were inoculated with the fungus and single irrigation while, increased yield per hectare was recorded from uninoculated plants received with four irrigations.

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INTRODUCTION

Sunflower (*Helianthus annuus* L.) belongs to the family Asteraceae; the *Helianthus* genus contains about 65 different species and all *Helianthus* species are native to North America. It is the second top ranking oil crop after soybean (Fick, 1989). Sunflower is considered as drought resistant crops, but in fact water utilization of sunflower is double that of sorghum consequently yield of the crop is badly affected due to water stress conditions (Anonymous, 2005). Sunflower yield is adversely affected with several diseases especially the damping off in the early stages and charcoal rot in the late stages of growth (Sackston, 1978; Ahmed *et al*., 1994) and a few studies were conducted for controlling these diseases (Mousa *et al*., 2006). Charcoal rot is a serious problem of sunflower crop caused by fungus *Macrophomina phaseolina* (Tassi) with infection up to 100% yield loss in the presence of high temperature and water stress near crop maturity (Khan, 2007). *M. phaseolina* gives severe attack in sunflower during vegetative growth period under water stress conditions (Eva *et al*., 2001). Symptoms of this disease usually appear after flowering stage of sunflower. General wilting is a prominent indication, later death of plant occurs. Due to rotting of roots, flow of nutrients and water to the head restricted consequently, seed size and weight badly reduced in severe infection. The disease becomes more economically important and encouraged by dry condition and hot season (Schwartz and Gent, 2016). Synthetic fungicides are massively applied to control Charcoal rot of sunflower. But the irrational and misuse, of chemicals has created several problems in environment including; unwanted chemical residuals in the commodity, environmental

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pollution, negative impact on non-target organisms and the health of consumers (Perez *et al*. 2010; Zapata and Smagghe 2010;Grünwald*et al*., 2014). The uses of various alternative methods were suggested world-wide for controlling this problem. Irrigations intervals affected the damping-off and charcoal-rot as well as the development of the plants and percentage of microbile in soil (Abou-Zeid*et al*., 1997 and 2003; Hussein *et al*., 2000; Ismail and Abd El Momen, 2007). Proper irrigation and low soil temperature reduced incidence of sunflower charcoal rot while, water stress and high temperature increased disease severity and affected growth and yield parameters of the crop (Pathak and Srivastava 2001;Karadimos*et al.,*2002). **S**oil moisture and temperature can effect on the intensity of *charcoal rot*, the average of disease incidence decreased as the moisture level increased from 40 to 100% (Arora and Pareek, 2013). However, at our knowledge, there is scarce of information and no comprehensive study referring to the effect of irrigation intervals on charcoal rot of sunflower has been undertaken. Therefore, the present study was carried out to evaluate the effectiveness of irrigation intervals on diseases severity of charcoal rot. The results of our study should aid the eco-friendly management of charcoal rot of sunflower.

MATERIALS AND METHODS

Field experiment: The experiment was conducted to observe the effect of irrigation intervals on diseases severity of charcoal rot and its consequence on growth and yield parameters of sunflower during spring season, 2015. The soil samples were taken before sowing of seeds, analyzed for presence of *M. phaseolina* isolates by using method **d**escribed by Mihail and Alcorn (1982). The filed was found free fungus population. The seeds of HO-1 sunflower variety were sown with hand drill in plot size of 4 rows of 5 meters long in a randomized complete block design with three replications. The seedlings were thinned before first irrigation to maintain plant to plant distance of 9 inches; whereas, row to row distance was kept 75 cm. Recommended agronomic practices like hoeing, weeding, fertilizer and earthing up were done as and when required as per traditional sunflower cultivation technology. The following treatments were applied:

T_1 = one irrigation (at 20th day after sowing)
T_2 = two irrigations (at 20th day after sowing and bud initiation stage)
T_3 = three irrigations (at 20th day after sowing, bud initiation, and flowering stage)
T_4 = four irrigations (at 20th day after sowing, bud initiation, flowering and seed development stage)

Field inoculation

Pure culture of MPS16 isolate of *M. phaseolina* was maintained of PDA medium. A 5mm diameter fungus plug was taken from active margin of fungus growth and was placed at toothpick-wounded site on the stem. The wounds were created in a stem of sunflower plant at 10 cm from soil surface when plant age was 40days. Parafilm was used to wrap the wound on stem. The un-inoculated plots were kept as control. The disease severity was rated by measuring length of necrotic lesion of charcoal rot from 10 plants per replication and mortality percentage from each treatment after maturity. The other growth and yield parameters of crop were recorded from inoculated and un-inoculated plants after maturity of the crop.

Statistical analysis

One-way analysis of variance (ANOVA) was conducted using the SPSS 20.0 software package to analyze differences between treatments. Differences among means were compared with Tukey's Honestly Significant Difference (HSD) test, and a P <0.05 was considered significant.. Sigma plot 10.0 was used to draw all figures. The percentage data were arcsine–square root transformed, and all count data were square root (x+1) or log 10 (x+1) transformed before being subjected to data analysis. The untransformed means are presented in the results.

RESULTS

Maximum length of necrotic lesions (16.30±0.36cm) on stemand highest mortality percentage (13.07±0.35) was recorded in inoculated plants of HO-1 variety received single irrigation whereas; minimum necrotic lesions (8.93±0.35 cm) and lowest mortality (6.63±0.19%) recorded from plots received four irrigations. We observed significant differences at necrotic lesions (F = 63.28; df = 3, 8; P< 0.01) and mortality (F = 86.23; df = 3, 8; P< 0.01) between the different irrigation intervals (Fig. 1).Significant differences observed in plant height inoculate (F = 45.68; df = 3, 8; P< 0.01), and Un-Inoculate (F = 32.50; df = 3, 8; P< 0.01); and head diameter inoculate (F = 10.42; df = 3, 8; P< 0.01), and Un-Inoculate (F = 41.10; df = 3, 8; P< 0.01) under different water stress conditions. Small plants (118.10±1.10 cm) and reduced head diameter (10.10±0.76 cm) were produced in inoculated plants with single irrigation while, significantly tall plants (185.00±1.53cm) and increased head diameter (19.50±0.76 cm) were obtained from uninoculated plants received four irrigations (Fig. 2). One thousand seed weight and seed weight per plant also varied significantly due to different irrigation intervals. Minimum 1000-seed weight (23.90±0.61 g) and seed weight per plant (25.60±0.31g) was obtained from inoculated plants of HO-1 sunflower variety given single irrigation whereas, maximum 1000-seed weight (56.00± 1.73 g) and seed weight per plant (63.10± 1.16 g) were recorded from uninoculated plants given four irrigations. ANOVA showed significant difference in one thousand seed weight at inoculate (F = 37.60; df = 3, 8; P< 0.01), and un-inoculate (F = 15.28; df = 3, 8; P< 0.01); and seed/plant at inoculate (F = 36.92; df = 3, 8; P< 0.01), and Un-Inoculate (F = 17.55; df = 3, 8; P< 0.01) (Fig. 3). Similar pattern of yield loss was recorded in plots those were inoculated with the fungus and single irrigation while, increased yield per hectare was recorded from uninoculated plants received with four irrigations.

DISCUSSION

Maximum length of necrotic lesions (16.30±0.36cm) on stem and highest mortality percentage (13.07± 0.35) was recorded in inoculated plants of HO-1 variety received single irrigation whereas; minimum necrotic lesions (8.93 ± 0.35 cm) and lowest mortality (6.63 ± 0.19%) recorded from plots received four irrigations.Significant differences in plant height and head diameter were seen under water stress conditions. Small plants (118.10 ± 1.10 cm) and reduced head diameter (10.10 ± 0.76 cm) were produced in inoculated plants with single irrigation

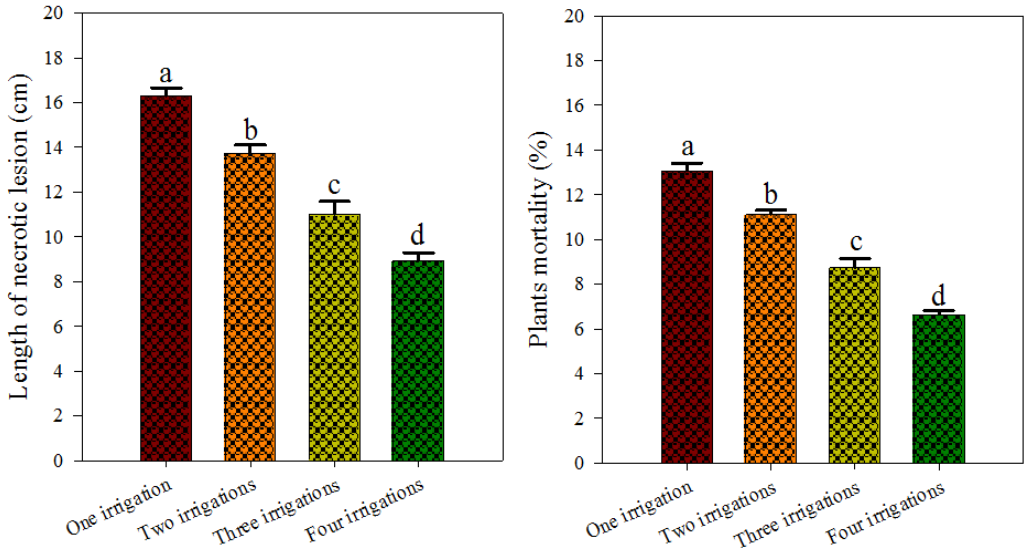

Fig. 1. Numbers (mean + SE) of water stress on disease severity and mortality of sunflower inoculated with *Macrophomina phaseolina*. Values are means of 3 replications. The mean numbers of water stress were analyzed by 1-way ANOVA, using a Tukey HSD post-hoc test at significance level of P < 0.05

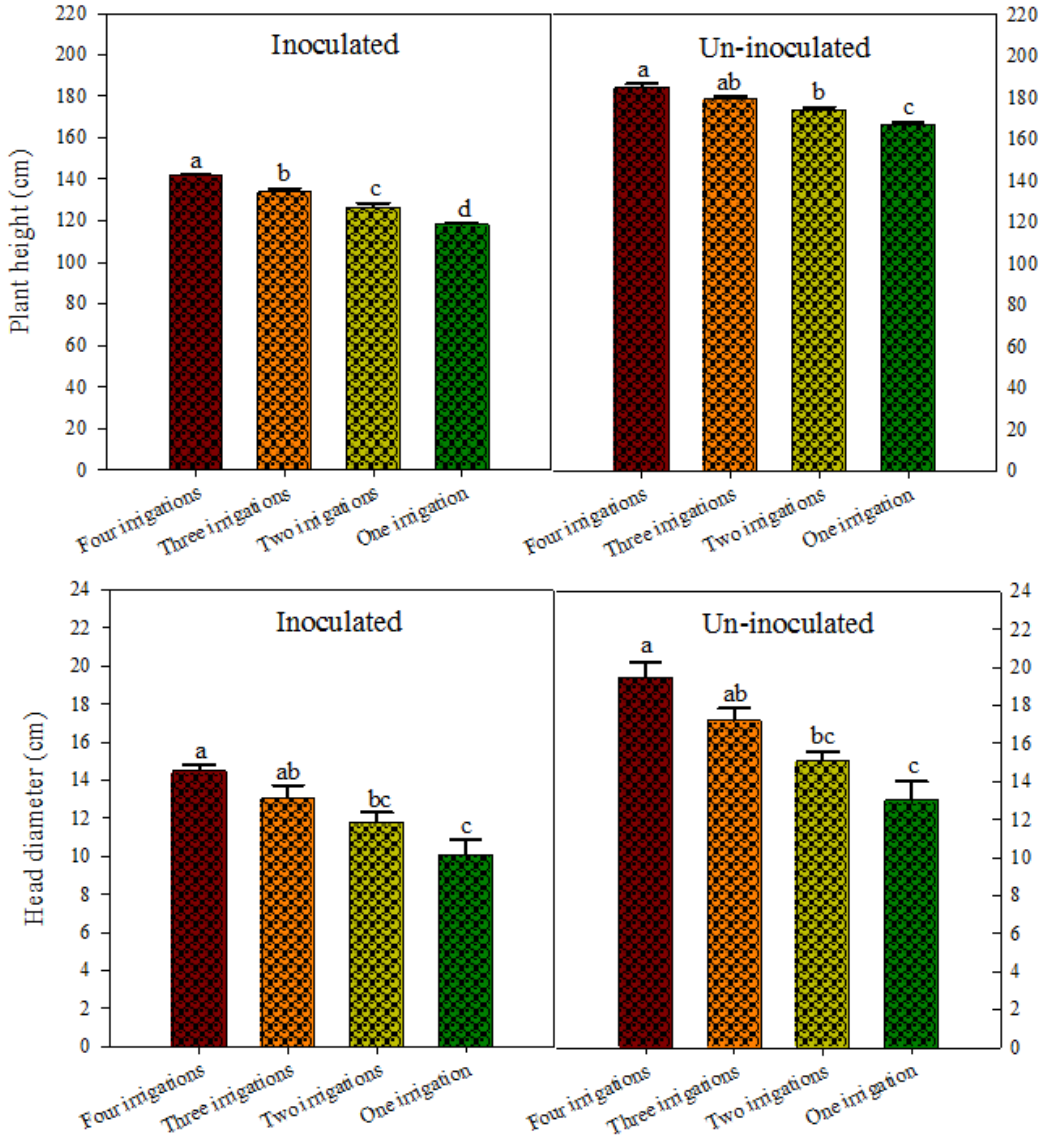

Fig. 2. Numbers (mean + SE) of water stress on plant height of sunflower inoculated with *Macrophomina phaseolina*. Values are means of 3 replications. The mean numbers of water stress were analyzed by 1-way ANOVA, using a Tukey HSD post-hoc test at significance level of P < 0.05

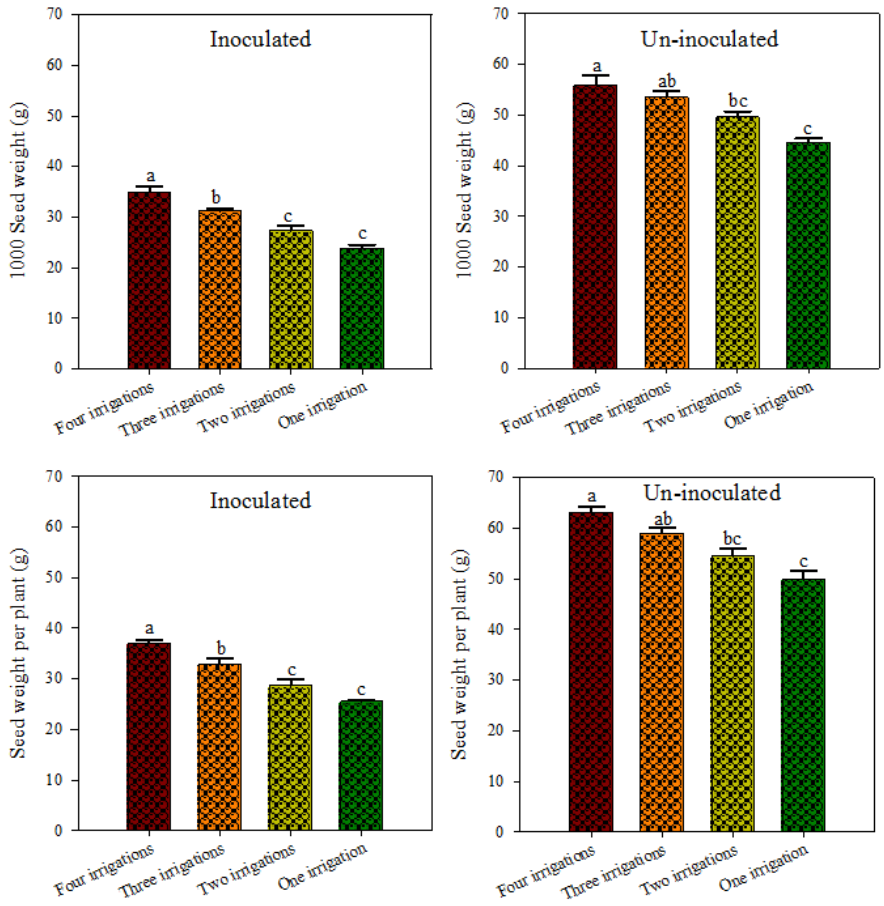

Fig. 3. Numbers (mean + SE) of water stress on 1000-seed weight and seed weight per plant of sunflower inoculated with *Macrophomina phaseolina*. Values are means of 3 replications. The mean numbers of water stress were analyzed by 1-way ANOVA, using a Tukey HSD post-hoc test at significance level of P < 0.05

while, significantly tall plants (185.00 ± 1.53 cm) and increased head diameter (19.50 ± 0.76 cm) were obtained from uninoculated plants received four irrigations. Schwartz and Gent (2016) reported that charcoal rot restricted flow of nutrients and water to the head consequently, seed size and weight badly reduced in severe infection. Mayek-Perez *et al.* (2002) also found increased charcoal rot incidence and reduced plant growth under water stress condition. Similar results related with water stress effect on disease incidence and severity of charcoal rot in different crops was observed by Karadimos *et al.* (2002), Singh and Sirohi (2003) and Sarova *et al*. (2003). Thousand seed weight and seed weight per plant also varied significantly due to different irrigation intervals. Minimum 1000-seed weight (23.90 ± 0.61 g) and seed weight per plant (25.60 ± 0.31 g) was obtained from inoculated plants of HO-1 sunflower variety given single irrigation whereas, maximum 1000-seed weight (56.00 ± 1.73 g) and seed weight per plant (63.10 ± 1.16 g) were recorded from uninoculated plants given four irrigations. Similar pattern of yield loss was recorded in plots those were inoculated with the fungus and single irrigation while, increased yield per hectare was recorded from uninoculated plants received with four irrigations. Khan, (2007), Khan (1984) and Mirza (1984) reported 100% yield loss in the presence of high temperature and water stress near crop maturity of sunflower.

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