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Impact of climatic variables on the population of *Trichoderma* sp. in the rhizosphere of black pepper

Manju Mohan, E. , Surendra, Gopal K. ✉

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Abstract

The present study was undertaken with an objective to determine the impact of climatic variables on the population of *Trichoderma* sp. in the rhizosphere of black pepper. Rhizosphere soil samples were obtained from pepper plantation at a monthly interval for one year. *Trichoderma* sp. population were assessed at monthly interval along with weather parameters from July, 2015 to June,2016. The number of *Trichoderma* sp. were maximum in July and lowest in June. The correlation between weather parameters on the population of *Trichoderma* sp. revealed that the population increased with an increase in rainfall and relative humidity, whereas it decreased by an increase in temperature. The results of the present studies showed that climatic variables affect the population of *Trichoderma* sp. in the rhizosphere of black pepper. However, further studies are needed to confirm it.

Key words: ***Black pepper, Rhizosphere, Trichoderma, Weather Variables***

Introduction

Among the spices, black pepper (*Piper nigrum* L.) is an important spice in Kerala. Rao (2011) conducted a study on the impact of climate on the black pepper of Kerala and found the black pepper highly susceptible to climate change. Black pepper needs humid and warm climate. Excess rainfall followed by an extended dry period is harmful for the growth and yield of black pepper in Kerala (Rao, 2003). There are several useful microorganisms present in the plant rhizosphere of black pepper to help the plant overcome the impact of climatic variables. Anandaraj (2000) reported that in the rhizosphere of black pepper have many antagonistic microorganisms belonging to *Trichoderma* and *Gliocladium* . Rita Noverizaa and Tricita H. Quimio (2004) also reported that *Penicillium, Paecilomyces* and *Aspergillus* were the most dominant in the rhizosphere of black pepper. In the process of mitigation of abiotic stresses in plants by soil beneficial microflora, microbial community are also influenced by changes in weather and microclimatic parameters. Abiotic stresses affect the productivity of plantation crops as well as the microbial activity in soil. Extreme conditions such as prolonged drought, intense rains, high temperatures, frost and low temperatures significantly affect plants and soil microorganisms. Nguyen *et al.* (2018) reported that the deleterious effects of prolonged drought on plant productivity was due to negative impact on microbial abundance and community structure which reduced the nutrient availability. *Trichoderma* species are effective biological control agents against several soilborne diseases (Lumsden *et al.,* 1995). In general, *Trichoderma* spp. are favored by acid soil conditions (Papavizas, 1985), but a few fungal isolates of *Trichoderma koningii* (Tk) and *Trichoderma harzianum* (Th) were also highly effective in the alkaline black soil. The moist soil conditions appeared to be more favorable for the activity of Tk and a greater percentage of the antagonist was recovered from the straw that had been incubated in the moist soil. The lower recovery of *Trichoderma koningii* Tk in the wet soil compared to the moist soil could be due to greater antagonism by bacteria that flourished under the wet conditions (Wong *et al.,* 2002). *Fusarium pseudograminearum* (Fp) in wheat straw was reduced significantly ($P < 0.05$) when it was sprayed with BM1 isolate of *Trichoderma koningii* (Tk) in acid and red soil, when incubated for 4 months at two temperatures (15°C and 25°C) and at three water potentials (–0.03 MPa. –0.3 MPa and <

Author's Address
Department of Agricultural Microbiology, College of Agriculture, Kerala Agricultural University, Thrissur
E-mail.: *ks.gopal@kau.in*

–50 MPa) (Papavizas, 1985). The high reduction of the pathogen in the moist soil (–0.3 MPa) compared with the wet soil (–0.03 MPa) at both temperatures might be due to greater colonization of the straw by *Trichoderma koningii* Tk. At 25°C in the moist soil, the pathogen was eliminated from the straw pieces after 6 months and replaced by Tk. In air-dry soil (< –50 MPa), Fp survived in 100% of the straw pieces even after 6 months at either temperature.

Trichoderma sp. is a popular biofungicide in Kerala. Change in the weather parameters affect the growth and yield of black pepper and also the rhizosphere microflora of black pepper. On perusal of literature, it was observed that there are no studies conducted in Kerala on correlation between climatic variables and the population of *Trichoderma* sp. Hence, the present study was undertaken to determine the impact of climate variables on the population of *Trichoderma* sp. in the rhizosphere of black pepper.

Materials and Methods

Twelve healthy black pepper plants were randomly selected, and the rhizosphere soil samples were collected at monthly intervals from Panniyur-1 variety black pepper garden maintained at Kerala Agricultural University,Thrissur, Kerala. The *Trichoderma* sp. were isolated from each soil samples for a period of one year at monthly intervals by serial dilution and plate count method using TSM Agar medium (Kale *et al.,*2018). The plates were incubated at 28±2^{0}C for 5-7 days. The samples were enumerated for *Trichoderma* sp at monthly interval. Temperature, rainfall, relative humidity, soil temperature and soil moisture content were determined at monthly intervals for 12 months period.

The Population of *Trichoderma* for each month were analysed using WASP.2 software. The population of *Trichoderma* sp. obtained during twelve months were correlated with the recorded weather parameter.

Results and Discussion

During the study period, a total of three isolates of *Trichoderma* sp. were obtained. The population of *Trichoderma* sp. was less during the twelve months period. The highest population of *Trichoderma* was recorded in July 2015 (table 1), when ambient temperature was 26.9 ^{o}C. It is apparently clear that 27 to 30 ^{o}C was the favourable temperature for the growth of *Trichoderma* sp. In an earlier study, Singh *et al*. (2014) reported that *Trichoderma* sp. showed best growth at a temperature range of 25°C to 30°C which is in agreement with the present studies. Moreover, Gupta and Sharma (2013) also reported that the optimum temperature for *Trichoderma harzianum* was between 25 to 30 ^{o}C. As there was less rainfall during July, 2015 (510.1 mm) leading to less soil moisture content, the growth of *Trichoderma* sp. was good which might be due to its tolerant nature to drought conditions .

Table 1: Population of *Trichoderma* sp. in the rhizosphere soil of black pepper from July, 2015 to June, 2016

Months	*Trichoderma* sp. (x10^1 Cfu g^{-1})
July, 2015	36.6 (2.534^a)**
August, 2015	26.6 (2.360^a)
September, 2015	a
October, 2015	a
November, 2015	a
December, 2015	a
January, 2016	a
February, 2016	a
March, 2016	a
April, 2016	a
May, 2016	a
June, 2016	6.3 (1.778^b)

****Logarithmic transformed values are given in the parentheses**
a: absent

In an earlier study,the population growth rate of *Trichoderma* reached its highest level in the presence of plants under conditions of water deficit. The mutualistic interaction under water deficit condition between wheat and *T. harzianum* (Donoso *et al.,* 2008) facilitated in mitigation of the effect of drought on plant. In the present study, the *Trichoderma* sp. was able to tolerate water stress which might be due to either mutualistic association with plant or water uptake through extensive mycelial network. Saprophytic growth of *Trichoderma* sp. increased with soil moisture content in sterile soil, with a growth optimum at 70% soil water holding capacity (WHC). The lesser saprophytic growth was obtained at soil moisture contents below 20% WHC (Wakelin *et al.,*1999).

Table 2: Weather parameters in the rhizosphere of black pepper at monthly interval

Month	Soil temperature (^{o}C)	Rainfall (mm)	Relative humidity (%)
July, 2015	26.90	510.1	86.16
August, 2015	27.35	320.8	85.14
September, 2015	27.80	248.2	84.11
October, 2015	28.30	203.8	82.35
November, 2015	27.70	151.2	77.32
December, 2015	27.80	88.3	67.40
January, 2016	28.10	23.8	58.80
February, 2016	29.40	11.4	61.10
March, 2016	30.75	9.8	69.40
April, 2016	31.00	25.8	73.20
May, 2016	29.10	270.7	86.90
June, 2016	25.75	654.7	92.80

The least population was found in June 2016 (table 2). The population of *Trichoderma* was obtained only in July (2015), August (2015) and June (2016).The weather parameters in the rhizosphere region of the host plant were recorded at 30 days interval for one year from July 2015 to June 2016. Temperature was found to be maximum in April 2016 and minimum in June 2016. The relative humidity was found to be increasing with the increase in rainfall during the study period. In a similar study, Umoh *et al.* (2013) reported a positive correlation of relative humidity with the rainfall in their studies.

The weather variables were subjected to correlation co-efficient with the number of *Trichoderma* sp. to determine the impact of weather variables on the *Trichoderma* sp. population in the rhizosphere. The investigations revealed that the number of *Trichoderma* sp. was high with increase in rainfall and relative humidity but the population decreased with an increase in ambient temperature (table 3). Earlier study has reported that majority of the *Trichoderma* strains are mesophilic and the competitive colonization of strains such as *T. harzianum* was highest when the temperature was lower than the optimum temperature for growth *in vitro* and its saprophytic ability was more between 15°C to 21°C (Eastburn and Butler, 1991). In the present study, as the temperature increased, there was a decrease in the population which is in agreement with the results. However, the population of *Trichoderma* increased with increase in rainfall and humidity which have the ability to tolerate both biotic and abiotic stresses by multiple beneficial effects on plant growth and stress tolerance (Chepsergon *et al.,* 2014)

Table 3: Correlation of population of *Trichoderma* sp. with the weather parameters

Parameters	Correlation coefficient of population of *Trichoderma* sp.
Rainfall	0.594*
Relative humidity	0.434*
Air temperature	-0.458*

***Correlation significant at 1% level**

Conclusion

The population of *Trichoderma* sp. (366.0 cfu/g) increased with more rainfall and relative humidity, but the population was severely affected due to increase in ambient temperature. The studies demonstrated that the changes in weather variables around the black pepper affect the population of *Trichoderma* sp. significantly.

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References

Anandaraj, M. 2000. Diseased of black pepper. In P.N. Ravindram (Ed.). *Black Pepper-Piper nigrum. Medicinal and Aromatic Plants-Industrial Profiles*. Harwood Academic Publishers, Netherlands. p. 239-267

Chepsergon, J., Mwamburi, L., Kassim, M.K., 2014. Mechanism of drought tolerance in plants using *Trichoderma* spp. ***International Journal of Scientific Research***, 3:1592–1595.

Donoso, E. P., Bustamante, R. O., Caru, M. and Niemeyer, H. M., 2008. Water deficit as a driver of the mutualistic relationship between the fungus *Trichoderma harzianum* and two wheat genotype. ***Applied and Environmental Microbiology,*** 74(5):1412-1417.

Eastburn, D.M., and Butler, E.E., 1991. Effect of soil moisture and temperature on the saprophytic ability of *Trichoderma harzianum*. ***Mycologia***, 83(3):257–263.

Griffiths, B. S., Ritz, K., Bardgett, R. D., Cook, R., Christensen, S., Ekelund, F., Sorensen, S. J., Baath, E., Bloem, J., DeRuiter, P. C., Dolfing, J. and Nicolardot, B., 2000. Ecosystem response of pasture soil communities to fumigation- induced microbial diversity reductions: an examination of the biodiversity-ecosystem function relationship. ***Oikos*** , 90: 279-294.

Gupta, V. and Sharma, A. K., 2013. Assessment of optimum temperature of *Trichoderma harzianum* by monitoring radial growth and population dynamics in different compost manures under different temperature**. *Octa journal of biosciences*,** 1(2): 151-157.

Kale, G.J., Rewale, K.A., Sahane, S.P. and Magar, S.J., 2018. Isolation of *Trichoderma* spp. from the rhizospheric soils of tomato crop grown in Marathwada region. ***Journal of Pharmacology and Phytochemistry***, 7(3): 3360-3362

Lumsden, R.D., Lewis, J.A., Fravel, D.R., 1995. *Formulation and delivery of biocontrol agents for use against soil borne plant pathogens*. In 'Biorational Pest Control Agents'. (Eds FR Hall, JW Barry) pp. 166–182. (American Chemical Society: Washington, DC, USA

Papavizas, G.C., 1985. *Trichoderma* and *Gliocladium*: biology, ecology and potential for biocontrol. ***Annual Review of Phytopathology***, 23: 23–54.

Rao, G. S. L. H. V. P. (ed.) 2003. *Agricultural Meteorology*. Kerala Agricultural University, Thrissur, Kerala, India, p. 326.

Rao, G. S. L. H. V. P.(ed.) 2011. *Climate Change Adaptation Strategies in Agriculture and Allied Sectors*. Scientific Publishers (India).Jodhpur-342 001. p. 103.

Rita Noverizaa, and Tricita, H. and Quimiob, 2004. Soil mycoflora of black pepper rhizosphere in the Philippines and their in vitro antagonism against *Phytophthora capsici* L. ***Indonesian Journal of Agricultural Science***, 5(1):1-10

Singh,A., Mohammad Shahid, Mukesh Srivastava, Sonika Pandey, Antima Sharma and Vipul Kumar,2014. Optimal physical parameters for growth of *Trichoderma* species at varying pH, temperature and agitation. ***Virology and Mycology***, 3:1

Umoh, A, A, Akpan A O, and Jacob, B B. 2013. Rainfall and relative humidity occurrence patterns in Uyo Metropolis, Akwa Ibom State, South- South Nigeria. ***IOSR journal of engineering***, 3 (8): 27-31.

Wakelin, S.A., Sivasithamparam, K., cole, A. L. J and Skipp, R. A ., 1999. Saprophytic growth in soil of a strain of *Trichoderma koningii*. ***New Zealand Journal of Agricultural Research***, 42:3, 337-345 DOI: 10.1080/00288233.1999.9513383

Wong, P. T. W., Mead, B. A. J. A. and CroftC. M. C., 2002. Effect of temperature, moisture, soil type and *Trichoderma* species on the survival of *Fusarium pseudograminearum* in wheat straw. ***Australasian Plant Pathology***, 31: 253–257.