



International Journal of Nutrition and Agriculture Research

Journal home page: www.ijnar.com



EFFECT OF CLIMATE ON THE PRODUCTION OF BANANA

Ajoy Kumar Sinha^{*1}, Ravindra Kumar¹, Ruchi Kumari¹

^{1*}Department of Botany, Samastipur College, Samastipur-848134, India.

ABSTRACT

The wilt disease of banana pose a severe thread to global banana production. It is also known as Panama disease, or also known as *Fusarium* wilt of banana, putting economic development and food security in danger for many countries worldwide, while no solutions are present. Soil management provides a promising alternative to a solution, but it is not clear which environmental variables are important for decreased disease incidence. A field experiment is executed where landscape, climate, land management, soil chemistry, microbial populations and disease incidence are assessed in order to find relations between environmental variables and disease incidence of panama. It is also find out the suitable measures for production of banana.

KEYWORDS

Climate, Food commodity, Panama disease, Environmental hazards, Landscape, Slope, Cavendish cultivars, *Fusarium* wilt, Soil management, Crop rotation and Nutrient efficiency.

Author for Correspondence:

Ajoy Kumar Sinha,
Department of Botany,
Samastipur College,
Samastipur-848134, India.

Email: sinhaajoy14@gmail.com

INTRODUCTION

The role of climatic changes affect the production of banana plant. Banana production is large parts of tropic and sub tropic important for both food security and economic security. Banana has the highest global gross value production and is thus a large food commodity worldwide. (Zhang *et al*, 2013)¹.

Environmental degradation affects plants, animals, microorganisms and everything on the earth. The changes in temperature, humidity, rainfall, nature of soil and environmental pollution affect very badly to yield of banana plant. Air is a rich source of bioparticulate matter which mainly include pollen

grains, fungal spores and other microbes etc. Moisture, nutrient availability and temperature are some important factors that determines fungal growth. *Fusarium* wilt of banana also known as panama disease is a major threat to global banana production potting economic development.

For solving food security, it is important for management practices for a solution due to environmental variables, which are important for disease incidence. So it is necessary to develop suitable bio control agents for disease management (Huang *et al*, 2012)² reported that the crop rotation of banana is an efficient way for controlling banana crop, which are affected by *Fusarium* wilt disease. But it is not suitable due to the environmental conditions such as high temperature, thick fog, heavy rainfall, soil erosion etc. *Fusarium* wilt is a typical soil borne disease. The fungus causing problems in vascular units of the plant (Beckman and Ploetz, 1990)³. So it is difficult to control the disease in these unnatural environmental hazards. Once *Fusarium* wilt in filtrates' the banana plant it restricts water going up in the vascular units causing water shortage and eventually plant wilts. (Cook and Papendick, 1972)⁴.

Fusarium wilt can be recognized by the yellowing of the leaves or the collapse of the petiole and the subsequent falling of the leaves. In later phages of the disease also the pseudo stem of the plant can split and eventually the plant will die (Perez-vicente, 2004)⁵.

In the 80's a new strain of *Fusarium* wilt, Race 4, was discovered which affects the Cavendish cultivars and many other banana cultivars (Pegg and Langdon, 1986)⁶. By now Race 4 is spreading in the Asian tropics causing important losses in Malaysia, Indonesia and India (Perez-Vicente, 2004)⁵. Because Race 4 effects Cavendish and many other local cultivars (Ploetz, 2006)⁷, not only the exports but also local and regional food provision is threatened.

The research is going on how to minimize the damage *Fusarium* wilt can cause low production. However, the incidence of the disease is very variables and it is not well known which factors are important for a low disease incidence. The use of resistant cultivars was the only known effective

method to overcome panama disease (Ghag *et al*, 2015)⁸.

To optimize both the plant health and suppress the soil, soil management is introduced as a way to minimize the effect of *Fusarium* wilt of bananas (Ghorbani, *et al*, 2008)⁹. Soil management that includes the application of fertilizers tillage, managing nutrient efficiency and crop rotation and also can reduce susceptibility of a banana plant to *Fusarium* wilt includes pH, water contents and temperature are of importance (Peng *et al*, 1999)¹⁰.

Many factors on different scale influence the incidence of *Fusarium* wilt in the plant such as chemical soil properties, pH, acidity, organic matter, Nitrogen, Magnesium and Manganese are suspected to be of importance (Alabouvette, 1999¹¹, Navajothy *et al*, 2011¹², Segura *et al*, 2015)¹³. Microbial populations are also important for the suppression in the soil, while many chemical and physical environmental factors affect the microbial population.

On a farm scale, land management appears to have a dominant role on the disease incidence (Stover 1962¹⁴, Zhang *et al*, 2013¹, Pattison *et al*, 2014)¹⁵. Landscape and climate vary on an even larger scale than land management and is also expected to be related to disease incidence. Temperature has shown to be important (Pegg and Langdon, 1986)⁶.

Hence land management, soil chemistry and microbial populations can be used for improving soil management practices both within and outside area.

MATERIAL AND METHODS

The selected banana plants was divided in five different categories viz. landscape, climate, land management, soil management and microbial populations for the variability of banana plant access the landscape and climate variable was used.

The study area is located in the north Bihar region of India especially in Vaishali region where main crop is banana. Due to heavy flood and higher rainfall, the spatial variations in climatic variables such as temperature and precipitations are high (6°-48°C).

The climate in the study area is humid tropical especially in the rainy season from June to September months. The dominant soil in the areas

are Nitosols. Nitosols are deep well drained tropical soils with a high clay percentage which are suitable for the cultivation of a large variety of crop.

The disease incidence via combination of different variables in low elevated areas where temperature is moderate, low precipitation pattern and more slopes are found. In the gentle slopes sediments often accumulate and soil erosion during rainy season also contributed to the distribution of *Fusarium* wilt i.e. transported with the sediments. High steepness influence the water availability in the soil and the amount of water going down resulted the washing of *Fusarium* wilt to the root system. Sunshine is very important for banana plants and is an important variable influencing the amount of sun received by plants. The erosion patterns of soil depends on convex and concave slopes. Due to high erosion rates on convex slopes, important nutrients and organic material exude resulting low soil fertility. Distance to river is also importance for disease incidence. The regular floods of the rivers can influence biotic and abiotic components of the soil and also pose serious threats to plants (Risbeth, 1957)¹⁶.

Climate is known to be of importance for the incidence for the incidence of *Fusarium* wilt of banana. Variability in precipitation and temperature is assessed and selected to cover the average climatic condition and total precipitation in the driest month (May) and the mean temperature in the coldest month (December-January) are selected to cover the yearly climatic extremes in the area.

During the field observation the soil samples are also collected and analyzed for soil chemical variables and microbial populations. Plant density is also selected as a variable because it is expected to be important for disease incidence. Soil chemical variables are measured and can be controlled in the soil via fertilization and through macro- and micronutrients. The chemical composition in the soil is important for disease suppression (Segura *et al*, 2015¹³, Shen *et al*, 2015)¹⁷. However the interaction between nutrients and other chemical components are very complex. Certain nutrients have shown to be significant for explaining disease incidence.

The microbial activity is very important for soil suppression of *Fusarium* wilt. Microbial populations are also measured to see which variables might be enhancing or reducing the microbial activity in the soil.

RESULTS AND DISCUSSION

The result indicates that the variability in landscape, temperature, humidity, soil texture, pH effects the disease incidence. The disease incidence depends upon the combination of different variables in low elevated areas where the temperature is moderate and the low to high precipitation pattern. The slope is also important for the disease incidence. The gentle slope and soil erosion during rainy season contribute to the distribution of *Fusarium* wilt which were transported with the sediments. Sunshine is also one of the factors for banana plants and variability in sunrays influence the plant. The erosion pattern depends upon the convex and concave slopes. Slopes are important for banana cultivation. Distance to rivers is also influence for disease incidence. The higher concentration of the fungus in the soils depends upon distance of river (Stover, 1962)¹⁴. The regular floods of the river which influence the biotic and abiotic components of the soil. Flood can cause great damage to banana plant and decrease plant health (Rishbeth, 1962). The soil samples containing organic and inorganic elements influence the plant growth depending upon the concentration of macro- and micronutrients. Fewer containing elements shows poor response for the growth of banana plants. Plant density is also one of the important factors for disease incidence. A higher plant density can cause competition between the plants which results the effect of the growth of the plants and consequently brings high disease incidence. The chemical composition in the soil is important for disease suppression (Segura *et al*, 2015¹³, Shen *et al*, 2015)¹⁷. Certain nutrient has shown significant results for explaining disease incidence. The microbial activity is very important for soil suppression of *Fusarium* wilt. The variables might be enhancing or reducing microbial activity in the soil.

There are two main routes to reduce the effects of *Fusarium* wilt. One way is by minimizing the damage *Fusarium* wilt bring to a plant by making sure the plant is healthy and has sufficient resources. The other way is by suppressing *Fusarium* wilt in the soil, which cause minimizing the fungal concentration in the soil. Consequently this minimizes the invasion of *Fusarium* wilt in the plant. Hence the disease incidence of *Fusarium* wilt disease in the banana plant depends upon landscape, climate, land management, soil textures and microbial populations.

CONCLUSION

The climate, suitable temperature, moderate rainfall, gentle slope, landscape are the important factors for the production of banana crop. Crop rotation and soil texture are also important for production of banana plant which also minimizes disease incidence. The frequent climatic changes, variation in temperature, high precipitation and microbial population has significant result of disease incidence of *Fusarium* wilt.

ACKNOWLEDGEMENT

The authors wish to express their sincere gratitude to Department of Botany, Samastipur College, Samastipur-848134, India for providing necessary facilities to carry out this research work.

CONFLICT OF INTEREST

We declare that we have no conflict of interest.

BIBLIOGRAPHY

1. Zhang H, Mallik A and Zeng R S. Control of Panama disease of banana by rotating and intercropping with Chinese chive. (*Allium tuberosum*. Rottler.): role of Plant volatiles, *Journal of Chemical Ecology*, 39(2), 2013, 243-252.
2. Huang Y H, Wang R C, Li C H, Zuo C W, Wei Y R, Zhang L and Yi G J. Control of *Fusarium* wilt in banana with Chinese leek, *Eur. J. Plant Pathol*, 134(1), 2012, 87-95.
3. Beckman C H and Ploetz R C. Host responses to the pathogen. In *Fusarium wilt of banana*, APS Press, 1990, 93-105.
4. Cook R J and Papendick R I. Influence of water potential of soils and plants on root disease, *Annual Review of Phytopathology*, 10(1), 1972, 349-374.
5. Perez-Vicente L. *Fusarium* wilt (Panama disease) of banana: an updating review of the current knowledge on the disease and its causal agents, Orozco-Santos, M; Orozco-Romero, J; Velazquez-Monreal, J, 2004, 1-16.
6. Pegg K G and Langman P W. *Fusarium* wilt (Panama disease): a review. In *Banana and Plantain Breeding Strategies: Proceedings of an International Workshop*, Cairns, Australia, 1986, 119-123.
7. Ploetz R C. Panama disease, an old nemesis rears its ugly head: Part 2, the Cavendish era and beyond, *Plant Health Progress*, 7(1), 2006, 1-17.
8. Ghag S B, Shekhawat U K and Ganapathi T R. *Fusarium* wilt of banana: biology, epidemiology and management, *International Journal of Pest Management*, 61(3), 2015, 250-263.
9. Ghorbani R, Wilcockson S, Koocheki A and Leifert C. Soil management for sustainable crop disease control: a review, *Environmental Chemistry Letters*, 6(3), 2008, 149-162.
10. Peng H X, Sivasithamparan K and Turner D W. Chlamydospores germination and *Fusarium* wilt of banana plantlets in suppressive and conducive soils are affected by physical and chemical factors, *Soil Biology and Biochemistry*, 31(10), 1999, 1363-1374.
11. Alabouvette C. *Fusarium* wilt suppressive soils: an example of disease suppressive soils, *Australasian Plant pathology*, 28(1), 1999, 57-64.
12. Navajothy F. Spectroscopical differences among soil samples of selected susceptible and resistant varieties of banana in relation to

- wilt disease, *International Multidisciplinary Res. Journal*, 1(3), 2011, 20-28.
13. Segura R, Stoorvogel J J, Garcia-Bastidas F, Salacinas-Niez M, Sandoval J A and Kema G. Soil management as an effective strategy for crop disease management: the case of banana disease in banana. In Book of Abstract of the Wageningen Soil Conference: Soil Science in a changing world, 2015, 48.
 14. Stover R H. Fusarial wilt (Panama disease) of bananas and other *Musa* species, *Commonwealth Mycological Inst., Kew., U.K.* 1962.
 15. Pattison A B, Wright C L, Kukulies T L and Molina A B. Ground cover management alters development of *Fusarium* wilt symptoms in Ducasse bananas, *Australasian Plant Pathology*, 43(4), 2014, 465-476.
 16. Rishbeth J. *Fusarium* wilt of bananas in Jamaica II. Some Aspects of Host-Parasite Relationships, *Annals of Botany*, 21(2), 1957, 215-245.
 17. Shen Z, Ruan Y, Wang B, Zhong S, Su L, Li R and Shen Q. Effect of biofertilizer for suppressing *Fusarium* wilt disease of banana as well as enhancing microbial and chemical properties of soil under green house trial, *Applied Soil Ecology*, 93, 2015, 111-119.

Please cite this article in press as: Ajoy Kumar Sinha *et al.* Effect of climate on the production of banana, *International Journal of Nutrition and Agriculture Research*, 6(2), 2019, 64-68.