Int. J. Sci. R. Tech., 2025 2(12)
A Multidisciplinary peer-reviewed Journal
www.ijsrtjournal.com [ISSN: 2394-7063]

Original Article

Georeferenced Plant Pathology Digital Herbarium – An Alternate Approach

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ABSTRACT

Preservation and conservation of pant specimens in the form of herbarium is difficult challenges to plant biologists. In this digital era pictorial representation of plant specimens is gaining more values than the very old herbarium method of plant preservation. We have adopted an innovative method of pictorial representation of plant pathological specimen in the form of a digital storage. This method was followed by doing a pathological survey of an endangered, endemic, rare, threatened and vulnerable species of plant specimens which were highly infected by plant pathogens. For the survey purpose we have selected Alagar hills of Madurai, some selected areas in Madurai and Kodaikanal hills of Dindigul districts of Tamil Nadu, India. Usage of digital camera and high resolution mobile devices 25 specimens from Alagar hills and 15 plant pathological specimens from selected areas of Kodaikanal were picturized. These photos were stored in digital database of our department. The Along with plant pathological photos, we have a data of geographical positioning system (GPS) which clearly indicates the latitude and longitude of collected specimens. The GPS information were also updated in the digital plant pathological herbarium.

Keywords: GPS, Resolution, Pathogens

INTRODUCTION

Plants were under continuous threat to changing environment, human, animals and by plant pathogens. The plants ecosystem decreasing rapidly because of global warming and climate change. (Katy Wilkinson et al., 2011). The environmentalist plant biologists were all working and reporting about the serious damages of plant biosphere. Though there are many environmental factors affecting the plant system the plant pathogens (Bacteria, fungi and virus) causes serious damages to the plant in both vegetative and reproductive stage (Arthur Kelman et al., 2019). In the forest ecosystem the plants which comes under the criteria of endangered, endemic, threatened, rare and vulnerable were unknowingly devastated by unknown pathogens. The plant pathologist trying to control the disease by various means like chemical, physical and biological control. But for the primary understanding of plant pathogens is symptametoloigcal studies. This approach is done by collecting and preservation by traditional herbaria method. The foremost lacuna of herbaria method of plant preservation is every year students, scholars teachers and scientists were keep on collecting and preserving the plant specimens in the form of herbaria this will definitely increases the plant loss. If this proposition increases in the same ratio the total plant population may decrease radically. So, there is serious search of alternative form of studies. So here we have proposes an innovative approach called digital herbaria for plant symptomatological studies and plant conservation purposes. Recently the American Phytopathological Society introduced a APS image database which contains more than one thousand images showing disease symptoms. APS welcomes the submission of new disease images to load more on database. So our present aim is also to coincidence with modern APS technology. Nearing a decade ago Fran MacGillivray et al., 2010 proposed a methodology photographic images of herbarium collection as alternative sources for phenological studies. So, there were a serious demand over the scientific community for alternate search for herbarium method. Even though the old herbarium method of plant preservation is widely used there

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

were certain limitations in the old herbarium especially

1. The symptoms of the disease will change due to prolonged storage

eg. The red rust of sugarcane leaf symptom will change to black colour this may leads to the misconception for fore coming researchers.

The digital images of the plants were very clear to symptoms studies and it will not change.

Digital photographies do not fully replace herbaria, since they do not preserve genetic material for scientists. Our aim is propose a alternate technique for effective use of plant pathogenic photos and let the genetic material be left on their own environment instead of preserving and killing it in the form of herbaria

2. During the storage the plant pathogens may tend to liberate spores to other parts of the herbarium or it may be released to nearing environment either by air or by pest (Thomos B. croat,1978). This might may increase the inoculum load in the laboratory or in herbarium storage house.

The dissemination of pathogen spores is completely eliminated

3. There were certain pathogens may release mycotoxins to the environment during the storage. This will increase the mycotoxin problem in the storage house

The problem of mycotoxin is also eradicated.

Mycotoxin comparison studies were done with fresh and herbarium thalli of *Cladonia stellaris, C. rangiferina, Allocetraria nivalis, Cretraria islandica and Nephroma articum* lichens showed no major difference in mycotoxin content. It proved that the specimes preserved for many decades showed that the plant has effective system of conserving metabolic exchange products like mycotoxins (Deoxyvalenol, zeralenone, Alternariol Citrinin, Sterigmatocuctin, Cyclopiazoinic acid mycophenolic acid, emodin etc.,) Burkin et al., 2012.

4. Large no of labour, space and intensive care were needed for the old herbarium maintenance.

Every individual can handle the herbarium effortlessly.

5. On plant conservation aspect large population of plants were collected by many plant biologist for the purpose of herbarium.

The major aspect of our study is to conserve the plant this was ably fulfilled by this innovative attempt.

6. The usage of herbarium is restricted to one place. It is very hard for plant biologist to access the herbarium which was located far away from them.

Our digital database enable the world wide access of plant pathological herbarium

7. The GPS details were not followed in the longstanding herbarium methods.

Our present GPS details ensures the correct and exact location of the plant species.

MATERIALS AND METHODS

1. Study area Selection

For the study and survey purpose Alagar hill mountains and in and around area of Madurai District and Kodaikanal hills of Dindigul district were chosen. Prior permission from forest authorities were obtained. Care was taken not to disturb the forest ecosystem. Detached leafs were taken for study purpose. Periodical visits were made to the same location to study the existence of plant disease on the same place.

2.2. Digitization of Plant specimens

Nikon D3400 24.2 MP SLR camera were used to take picture of plant symptoms. The complete plant habit picture and zoomed vision of plant symptoms were taken with proper light exposure. The Geographical Positioning System (GPS) details were obtained using GPS device or with mobile APP device. These GPS details were tabulated along with plant picture.

2.3. Digital Herbarium Database

All the images were stored in the form of JEPG file along with GPS details in the Department computer. Repeated survey trips were conducted at different times of intervals and seasons.

RESULTS AND DISCUSSION

3.1. Study area Selection and its importance

The Algar hills range reserved forest, Dindigul District of Tamil Nadu State. It is situated from North latitudes 10° 5' 30" to 10° 9' 40" and East longitudes 78°10' 20" to 78°17'7", cover an area about 70 sq.km. well known for its medicinal plants and existence of rage, endangered, endemic plant species. Like *Syzygium cumini*, *Dioscorea oppositifolia* and *Memecylon captitellatum*. were found to be infected by plant pathogens like *Alternaria* and *Curvularia*. In Kodaikanal the most endangered Kurinji plant (*Strobilanthus kunthianus*) was found to be affected by *Alternaria* pathogen. (Fig.1,2,3,4)

3. 2. Digitization of Plant specimens

The images were tabulated along with GPS details (Table 1). This illustrative table shows the images taken in periodical survey.

3.2. Digital Herbarium Database

The plant images were stored in department domain database. In future these domain will be made to access worldwide with updation enabled. This database updating is still now in progress. We observed the propionate increase of database. So far we have more than 224 plant images with GPS detail collected from Alagar hills, Kodaikanal hills and in and around Madurai districts. This database will be released in public domain in future. (Table 1,2) There were many works on Alagar hills regarding the plants survey and documentation was already done by many workers (Sriganasan, 1984, Anand, 2015, Kottai Muthu and Ganesan, Karuppusamy, 2009). Starting from Francis 1906, the Alagar hills study area of many plant biologists all over Tamil Nadu. Since the Alagar kovil hills comes under the control colonial government as a Reserved forest in 1882, the entry was restricted by forest authorities. Our study on plant pathological aspect is a new one where there are no reports available. We attempted this study with an at most care of not to disturb the forest ecosystem and not violating the forest rules and regulation act. The Alagar hills (Bison valley) and selected areas of Kodaikanal Hills, in and around Madurai area were well known site for temple worship. Peoples were keep on travelling to this sites regularly for worship and recreational purpose. Due to the human intervention the plant ecosystem of that area are in serious threat. So, our present aim to disease diagnosis and alarming issues. Digitalization of plant pathological symptoms is a novel approach the major benefits of this attempt is to conserve the plant species. We started this project in the year 2016 and till now we documented more than 300 digital pictures. And the GPS details of the plant specimens helps to locate the plants at an appropriate place even in forest areas. This will be very useful to future biologists. In Bangabandhu Sheikh Mujibur Rahman Agricultural University, the department of crop botany has worked on digital herbarium of crop plants and in FRLHT Bangalore Scanned herbarium work were also done but our approach on plant pathology digital herbarium is a pioneer approach. There were some reports on plant disease recognition based on image processing technology reported from China in 2017 by Guiling Sun et al., using MAT-LAB technologies. But our present conclusion illustrate all the possible fungi symptoms that we encounter during the study time. In 2017 Vijai Sing and Misra described algorithm for plant disease image segmentation. This algorithm can be used or our further studies approach. Our recent approach also coincides with the parallel research aspect on machine vision image-based analysis reported by Dhaygude Sanjay and Kumbhar Nitin, 2013; Arivazhagan et al., 2013; Kulkarni Anand and Ashwin Patil, 2012. The plant disease detection by simply observing naked eye normally leads to misconception. For second confirmation the isolation, purification and PCR based sequence studies is the only option for clear cut identification. Nowadays the modern farmers are in search of rapid detection of disease and its control measures. So the recent tools which assists the early detection is gaining more importance. There were always importance were given to crops on plains, endangered, endemic rare and threatened plants in forest cover were under serious to many pathogens. Earlier reports on image processing for affected area of disease based on color (Ghaiwat Savita and Arora

Parul, 2014; Dhaygude Sanjay and Kumbhar Nitin, 2013; Bashir Sabah and Sharma Navdeep, 2012) is hard to determine where the color change is due to disease or nutrition deficiency. Using artificial intelligence in recognition of crop disease reported by Mrunalini et al., in 2011. These reports only on crop disease of plains. Our present study focus on forest plants ecosystem which were long time ignored due to various reasons like unreachability, animals attack and limitations in entry formalities. Artificial neural network technique is employed by Kulkarni et al., 2012 for early and accurate disease detection. Followed by histogram matching by Naikwadi Smita and Amoda Niket, 2013; leaf disease severity measurement by Patil Sanjay, 2011; Soft computing methods artificial neural networks (ANN) by Vijayragavan Venkatesh 2013; Multi gene genetic programming (MGGP) method by Garg Akhil et al., 2014. Though there were many attempts were made on studying the plant disease using computing technology certain limitation like lacks in accuracy, only very few disease have been covered, misconception of disease because the symptoms of disease various from one plant to another, varies from season and stress response (Vijay Sing and Misra, 2017) hinders the complete conclusion. The all above said phenomenon would be attended only with experts of plant pathology. The right culmination of plant pathologist with computer professionals only leads to a greater success like building a large database which contains plant disease images with GPS details, developing mobile app for future plant pathologists. The present conclusion of the project is aimed for a pathological survey on two hill regions of Madurai. Our study projected the results of major threats to forest plants due to plant pathogens. The serious plant pathogens many leads to a drastic devastation of forest ecosystem. So, there must be integrated approach between forest department and plant pathologist to minimize the plant disease problem. Though there were forest pathologist also working on this aspect as we are plant pathologist we are also working on this aspect. So our request is to the forest department for allocating the permission for botanist to visit the forest for study purpose. The digital herbarium approach leads to minimize the loss of plants for preservation in the form of herbarium. This approach can be speeded to all botanist to have more success on this. The bio control approach is widely used in all fields of plant pathology. Our results also supports the previous data. Human life will not exist if there is no plant on earth, so protect plants and protect humans.

ACKNOWLEDGEMENT

We acknowledge the forest department for their assistance during our survey work. And all authors deeply acknowledge our PG students for their timely participation in the work.

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HOW TO CITE: R. D. Vijaya Lakshmi, Velusamy Karthikeyan*, Aparna Mahaedevan, Sathiyapriya kamatchi, Muthurakku Senthilkumar, Madheswaran Madhavan, Georeferenced Plant Pathology Digital Herbarium – An Alternate Approach, Int. J. Sci. R. Tech., 2025, 2 (12), 14-18. https://doi.org/10.5281/zenodo.18125360