

Foldscope as a research tool in the diagnosis of fungal leaf spot diseases

A foldscope is a one-dollar microscope which is creating ripples in the education sector and research institutes across the country due to its portability and cost. This microscope was developed by the team led by Manu Prakash, at the Stanford School of Medicine, Stanford University, in 2014. It is origami-based ultra-affordable, paper microscope, designed to be extremely portable, durable, and to give optical quality similar to conventional research which can magnify up to 2000× (ref. 1), it can be attached with mobiles to capture images. In India, this microscope was endorsed by the Department of Biotechnology, Government of India and was introduced on a large scale for student and scientific community across the country to carry out research in different domains of science like biodiversity, food and nutrition, human health, environment, pollution, animal health, agriculture, etc. Application of this low-cost microscopy technology to a different domain of microscopic study would help people better understand the microscopic world around us including microorganisms and bring hands-on microscopy to the fields further enhancing scientific temperament among the masses.

In the present study, an attempt has been made to isolate, identify and study the morphological characterization of fungal pathogens of tea leaf using foldscope as a research tool. The study area is the Temi Tea Garden (27.24°N 88.42°) which is located in Temi, South district of Sikkim. Tea (*Camellia sinensis* (L.) O. Kuntze), belongs to the family Theaceae and is prone to many diseases during its long life span which extends over 60 years. Worldwide there are 380 fungal pathogens which attack roots, leaves and branches of tea plants^{2,3}. High yield in tea has been mainly achieved with reduction of losses due to diseases and pests. Therefore the survey, reporting and identification of the diseases is important to achieve the target of disease-free tea. The prevalence of different leaf spot diseases was detected from the Temi Tea Garden. Altogether 25 fungal cultures were isolated⁴ and 8 plant pathogenic fungi have been characterized and identified so far⁵⁻⁷. The identified fungal species are *Cladosporium cladosporioides* (Fresen) G.A. de Vries, using the foldscope *Xylaria* sp./*Colletotrichum* sp. aff. *C. musae* (Berk. & M. A. Curtis) *Arx/Rhizosphaera oudemansii*, *Colleto-*

trichum sp. aff. *C. musae*, *Alternaria alternata* (Fr.) Keissl./*Fusarium* sp. aff. *F. fusarioides* (Gonz. Frag. & Cif.) C. Booth. (Figure 1). *Exobasidium vexans*, an obligate fungal pathogen, was identified with the help of sign and symptoms along with section observation of diseased leaf tissue under the foldscope.

This cost effective easily accessible foldscope microscope was found to be a great scientific tool to study microbial diversity. Indeed, in the true sense, foldscope is a hands-on microscopy for the masses; it provides a beneficial research tool for visualization of vegetative and reproductive structures of fungi and other microorganisms.

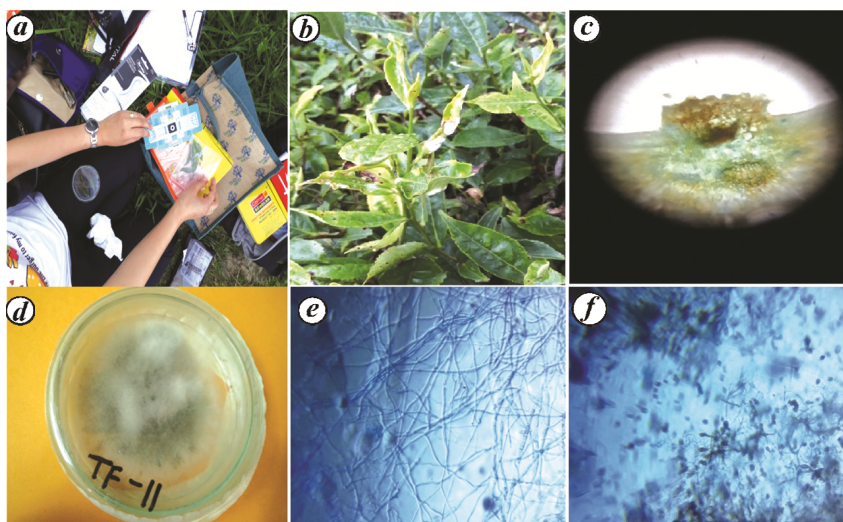


Figure 1. *a*, Use of foldscope in the field; *b*, Infected tea bush with blister blight; *c*, Section through blight; *d*, Fungal isolate (*Colletotrichum* sp.) on petri plate; *e*, *Fusarium* sp.; *f*, *Alternaria alternata*.

1. Cybulski, J. S., Clements, J. and Prakash, M., *PLoS ONE*, 2014, **9**(6), e98781; <https://doi.org/10.1371/journal.pone.009-8781>.
2. Watt, G., *Cal.*, 1898, 443–459.
3. Heinrich, L. D., *J. Agric. Rural Develop. Tropic Subtropic*, 2000, **101**, 13–38.
4. Schuck, S., Weinhold, A., Luu, V. T. and Baldwin, I. T., *PLoS ONE*, 2014, **9**(7).
5. Dugan, F. M., *The Identification of Fungi: An Illustrated Introduction with Keys Glossary and Guide to Literature*, The American Phytopathological Society, Press, St Paul, Minnesota, 2006.
6. Thind, K. S. and Dargan, J. S., *Indian Phytopathol.*, 1978, **31**, 490–496.
7. Nelson, P. E., Toussoun, T. A. and Marasas, W. F. O., *Fusarium Species: An Illustrated Manual for Identification*, The Pennsylvania State University Press, University Park and London, UK, 1983.

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