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SHORT COMMUNICATION

A low cost method for early detection of airborne *Puccinia* rust spores using glass slides and foldscope in the sugarcane field

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Abstract

The rust pathogens (*Puccinia* spp.) affect many cereals, pulses and sugar crops causing a major threat to crop production and productivity throughout the world. The sugarcane crop is being affected by *Puccinia melanocephala* and *P. kuehnii* causing brown and orange rust respectively. Sugarcane rust is an important constraint in popularizing the new and high potential varieties due to its appearance on the foliage. Under the changing climatic conditions many popular cultivars are showing rust infection from mild to severe form depending on the weather conditions during the crop seasons. Being an obligate pathogen, the rust is present on sugarcane throughout the year but the appearance and severity is highly influenced by the weather parameters such as temperature, relative humidity and the physiological maturity of the crop. Trapping the uredospores using Vaseline coated microscopic glass slides helped to determine the inoculum load at various time intervals in the air. The uredospores can be observed with the help of Foldscope, which broadens the scope of detection of uredospores without depending on the compound microscope in remote areas. By connecting with the mobile phone, the spores can be photographed and digital pictures can be shared for further confirmation. The frequency and quantity of the uredospores trapped will help in quantifying the spores in the field for management of sugarcane rust well in advance before the appearance of the symptoms in hot spot areas. This simple tool will be a boon for detection of rust spores in the field during the latent period before the appearance of the symptoms thus enabling management of rust in time.

Keywords Detection · Foldscope · *Puccinia* · Rust · Spore trap · Sugarcane · Uredospores

Sugarcane crop is the important source material for sugar industries in India and is grown in subtropical and tropical regions throughout the country. Apart from stalk diseases like red rot, wilt and smut, the foliar diseases are very important under the changing climate conditions and their severity changes with monsoon (Selvakumar and Viswanathan 2019). The rust pathogens *Puccinia melanocephala* and *P. kuehnii* infect sugarcane crop causing brown and orange rusts, respectively. The rusts are obligate pathogens and need the viable sugarcane crop in the field and are present on leaves throughout the year. The presence of rust inocula, severity of the disease, the stage of crop and favourable environment need to be assessed before going for chemical management during crisis period. The spread of rust is highly dependent on weather parameters like temperature, wind and rainfall. The symptoms appear 10–15 days after rust infection and the detection during the latent period help in timing and frequency of the fungicidal sprayings. The rapid methods available for detection of *Puccinia* spp. require sophisticated equipments and costly chemicals. The air samples can be collected using spore samplers and spores are observed in the laboratory using compound microscopes. Unfortunately, the samplers are very costly and may not be available easily and observing the inoculums load in the air at various time intervals under microscope is not possible at all locations. In this simplest technique, glass microscopic slides coated with Vaseline petroleum jelly were integrated with the Foldscope, an origami-based print-and-fold optical microscope. This simple combination helped in detection of orange /brown coloured uredospores of rust in the field itself without the need of compound microscope.

In the present study, the aerobiology of sugarcane rust was studied using spore traps in the field during 2016–19 crop seasons. The rust susceptible variety Co 0403 was grown in 40 rows each in a block during 2nd week of

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February. The microscopic slides were smeared with the Vaseline gel as a thin transparent layer. Transparent adhesive tape was used to fix the glass slides on sides of container facing the adhesive coating outside. Likewise, five more traps were prepared and the set up was fixed with a wooden pole at different locations in the field (Fig. 1). The height of the trap pole was adjusted in accordance with the height of crop growth in field once in a month. The slides were taken out from the traps once in 15 days and observed using compound microscope under 400X magnification from March to February till harvest (Fig. 2).

The observations of spores from the sticky slides indicated the trapping of uredospores which were responsible for secondary infection in sugarcane crop. The uredospores were not observed in the months from March to August on slides though the symptoms were present on leaves indicating the non-significant quantity of uredospores present in air to be intercepted by the glass slides (Fig. 2). The spores were trapped from all the directions using the thermo-cool structure and the same results were observed when slides were mounted on empty cylindrical plastic bottles.

To overcome the hurdles in carrying the slides to the lab for observing the spores under compound microscope, a low cost portable paper-folding microscope was used (Fig. 3a). The 'Foldscope', was developed with 140 × magnification and 2 µm resolution working on par with conventional research microscopes (Cybulski et al. 2014). The uredospores of *P. melanocephala* are small cinnamon to dark brown uredospores in the range of 25–39 × 17–28 µm in size, whereas, uredospores of *P. kuehnii* are orange to reddish brown colored and larger with size of 33–53 × 21–31 µm were very easy to be observed with the help of Foldscope. With this portable, handheld paper microscope, the spores trapped on a slide were observed in the field itself without any help of compound microscope (Fig. 3a). Once the spores were focused clearly, the Foldscope was attached to mobile phone camera lens with an adopter provided with the kit. Then the photos were taken by clicking the camera button

Fig. 1 Vaseline coated sticky slides for capturing uredospores in sugarcane field

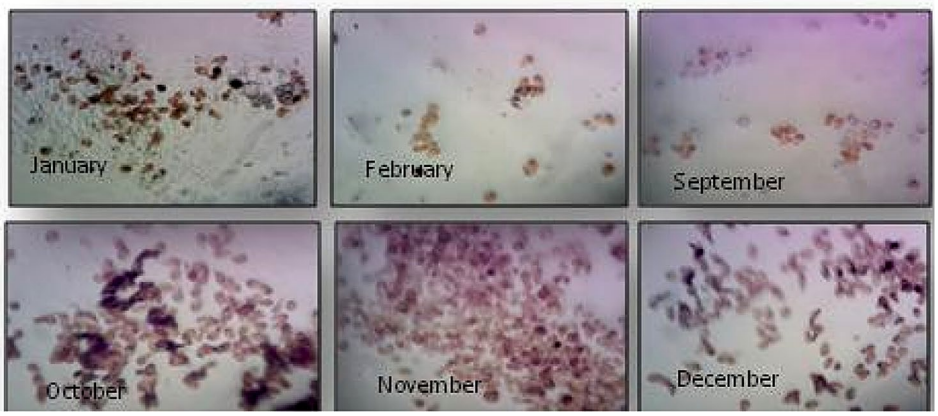

Fig. 2 Presence of uredospores on sticky slides at different months under compound microscope (400X)

Fig. 3 Observation of uredospores using mobile phone integrated with Foldscope. **a** Foldscope. **b** Foldscope attached with mobile phone. **c** Uredospores on sticky slides photographed through mobile phone attached with Foldscope

in the phone and the digital pictures were stored (Fig. 3b, c). Earlier, the Foldscope was used to create awareness among school children about micro organisms and to observe the presence of fungal spores very easily (Wangdi et al. 2019) .

Monitoring the movement of rust spores in the field is essential for management of sugarcane rust. The combination of sticky trap and Foldscope is an effective tool for detection of uredospores in the field. As the Foldscope is available at low price (~₹500) there is a scope in early detection of spores and prediction of rust appearance in many cereal crops viz., wheat, barley, maize and sorghum etc.

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