Whither now for jute wither?

Emergence of a new pathogen

Being sessile, plants face a number of threats, in the form of changing climate and microbes that cause disease. Plant diseases can wipe out entire fields of crops, leading to huge economic losses. In the jute fields in Bangladesh, there have been incidences of wilting of the plants, leading to their ultimate death. Scientists at the Bangladesh Jute Research Institute have been studying these symptoms in detail. This has led to the isolation of a new pathogen of jute, a fungus called Fusarium oxysporum. The pathogen has been confirmed as the cause of Fusarium wilt and infection of the transport systems inside the plant.

Jute is a plant belonging to the *Malvaceae* family that includes cotton, cacao, and okra. It is the second most widely cultivated fibre crop, after cotton. Jute provides a fibre that has versatile uses in various manufacturing industries. Cultivation of jute is predominant in tropical countries like Bangladesh, where the warm, wet and humid climate suits the growth of this plant. Jute is affected by several pathogens, resulting in diseases that cause devastation of the crop. Sometimes, however, new diseases occur which manifest as symptoms that can be confused for previously known diseases. Identification of the cause of the disease, i.e. the pathogen, is critical to determine the presence of existing or new pathogens. Recently, researchers at the Basic and Applied Research on Jute (BARJ) Project under the leadership of Professor Maqsudul Alam team at the Bangladesh Jute Research Institute have identified the cause of a new disease that results in vascular wilting of jute. This was identified as a fungal species, *Fusarium oxysporum*, a pathogen of jute that has not been identified and characterised previously.

BATTLE OF THE SPECIES

Plants co-exist with numerous other organisms on this planet. Some organisms such as humans and other large animals, take advantage of plants by consuming them for food. Other organisms such as microbes (such as bacteria and fungi), that are invisible to the naked eye, either collaborate with plants, or sometimes attack them to their own advantage. Microbes that collaborate with plants have special relationships, whereby they mutually benefit from each other's existence – the plant provides the nutrients and the fungus/bacteria help absorb minerals from the soil. This is true for many fungi living in the soil, including mushrooms, as well as bacteria that help fix atmospheric nitrogen, thereby enabling some plants to absorb nitrogen better.

On the other hand, microbes that take advantage of nutrients from plants result in disease. In this situation, the microbe is a pathogen that colonises the host plant, obtains its nutrients, and as a result, sometimes kills the plant cells. However in nature, disease is an exception rather than a rule. The plant has an army of defences that can sometimes evade the pathogen – this includes physical and chemical barriers, as well as chemicals that can kill the invading organism. However, the pathogen also evolves to mount its own arsenal of weapons to attack the plant. This can occur when the plant does not recognise the pathogen, or is weak because of other environmental constraints that affect plant function. When the strength of the pathogen supersedes the defences of the plant, disease occurs. In the field, to avoid spread of the disease, identification of the pathogen before it causes crop devastation is key, as is good agricultural practice.

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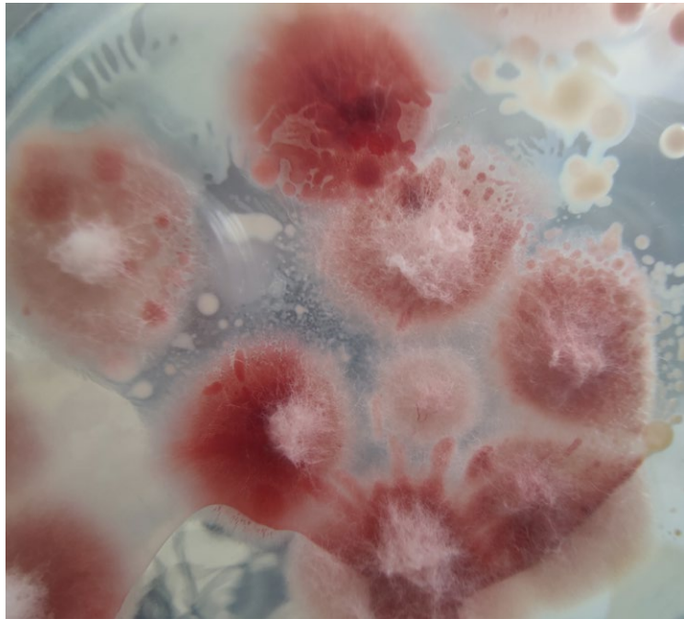

Scientists at the Bangladesh Jute Research Institute have isolated a new pathogen of jute, a fungus called Fusarium oxysporum.

Accurate diagnosis of plant disease is essential to control the pathogen from spreading.

WITHERING PLANTS

When the pathogenic fungus *Fusarium* infects a plant and colonises it, the plant wilts, meaning the plant cells face water stress, resulting in loss of rigidity to the tissue. The fungal species causing this withering is *Fusarium oxysporum*, a common soil-borne fungus. This fungus is a saprophyte, i.e. it feeds on dead organic matter. The fungus enters the plant through its roots and enters the cells through the xylem vessels. Xylem is part of the vascular tissue of the plant, which transports water and minerals from the roots to above-ground parts. So when the fungus enters the xylem tissue, it clogs up the transport of water and minerals. This leads to a severe water shortage in the plant and therefore, withering of the plant. The plant ultimately dies, and the fungus survives by thriving on the dead tissues. However, this wilting phenomenon also results from infection by other pathogens, leading to some confusion about the cause of disease. Therefore accurate diagnosis of a plant disease is essential to control the pathogen from spreading.

CURBING THE SPREAD

Fusarium oxysporum persists in soil environments over a long period of time. Crop rotation with Fusarium oxysporum non-host plants is one strategy to reduce *F. oxysporum* population in soil. In any plant-pathogen situation, the environment plays an important role to either encourage or curb the spread of the pathogen. For example, warm, humid environments, and water splash encourage the growth and spread of *Fusarium oxysporum*. In addition, the fungus would spread with farming equipment used in the soil. Good hygiene practices, such as burning of the crops when the disease is detected, is vital to avoid

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The research team at the Bangladesh Jute Research Institute have performed extensive studies to characterise this new pathogen.

its spread. Other practices such as using fungicides, is common, but not only is this damaging to the environment, it can also encourage evolution of resistance in the pathogen. *Fusarium oxysporum* infects a wide variety of plants, including banana, tomato, cotton, lentil, blackberry and kenaf. In some cases, plants resistant to the fungus have been identified, and the growth of these varieties is favoured when there is a potential threat of this pathogen. However, when the plant in question has not been previously identified as a target of this pathogen, using resistant varieties is not an option. This is a situation now being faced in jute fields in Bangladesh, where scientists have identified wilt disease in jute.

A NEW THREAT FOR JUTE

In recent years, farmers in Bangladesh have observed characteristic wilting of jute plants growing in the field. Symptoms appear as leaf wilting, distortion of twig leaves, and falling of leaves. A closer examination revealed that the vascular part of the stems had blackened; ultimately within two weeks of these symptoms the plant dies. Within one year, almost 10-30% of the jute crop was devastated due to this disease. Investigations were therefore initiated to identify the cause of these symptoms – whether it was a known pathogen or a new one. The research team of Basic and Applied Research on Jute Project at Bangladesh Jute Research Institute have performed extensive studies to characterise this pathogen. The infected tissues were isolated and cultured in the laboratory using artificial nutrients. In this way, the fungus could be studied in detail without the need for the plant. The morphology of the fungus was compared with previously identified pathogens. In addition, DNA from the fungus was isolated and sequenced, i.e. the information in the arrangement of the chemicals in DNA was unravelled. Given that every organism has its own DNA fingerprint, the scientists revealed that the pathogen was indeed *Fusarium oxysporum*, a previously unidentified pathogen of jute. Once isolated, these isolates of the fungus were used to infect jute plants, and tissue examination revealed characteristic wilting symptoms and blackening of the vascular tissues.

The researchers have therefore identified *Fusarium* wilt as a new threat to jute crops in Bangladesh. This opens up new avenues to explore the genome of this pathogen, as well as its interaction with different jute cultivars. Detailed studies on this plant-pathogen system will identify new targets for crop manipulation to breed resistant jute plants, and help develop efficient ways to curb the spread of this pathogen. This is important to produce jute plants of high quality for fibre development.

Research Objectives

In recent years, characteristic wilting symptoms have been observed in several regional and sub-regional experimental fields at the Bangladesh Jute Research Institute. This type of disease is also seen regularly in the fields of many jute producing farmers. To mitigate this problem, we are conducting this research to enable farmers to produce quality jute.

References

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Personal Response

What is the first priority to tackle in this plant-pathogen system?

" Phytosanitary practices are important, i.e. inoculum reduction, eliminating infected plants and delimitation of infected areas are important to control Fusarium wilt disease in Jute. In addition, crop rotation with *Fusarium oxysporum* non-host plants has been used to reduce *F. oxysporum* population in soil. An another important measure in *F. oxysporum* management is the control of root nematode. It was observed that Fusarium wilt disease is more prevalent in fields where nematodes are abundant. So, nematodes may also play an important role on Fusarium wilt of jute. Therefore, nematode control should be also taken into account.

The most efficient method of any management system of Fusarium wilt disease control is the use of resistant varieties. However, disease resistance is not always complete and can be overcome by conditions very favourable to disease development or by the appearance of new races of the pathogen. Nevertheless, needs continuous research programme to develop sustainable disease management. "

Is it possible that you can design an easy early diagnostic system for farmers to detect this pathogen?

" Yes, it is possible. The genome regions more useful to develop specific markers such as the sequences of the Internal Transcribed Spacer (ITS) and Inter-Genic Spacer (IGS) of ribosomal operon, the elongation translation factor-1α (*TEF-1α*) and mitochondrial β-tubulin genes (*tub-2*). Therefore, knowing the sequences of *ITS, IGS, TEF-1α, tub-2* and comparing those with the *F. oxysporum* species complex we can develop a specific marker for the identification of the jute fusarium wilt disease pathogen, *F. oxysporum*. However, it is a newly identified pathogen of jute. So, we need to carry out multiphasic experiments to sufficiently understand the pathogen as well as the jute. Early and fast identification procedures are a top priority to delimiting spread of disease and to establish appropriate quarantine and disease management. Although symptomless period is one of the constraints an accurate and quick diagnostic protocol for *Fusarium oxysporum* is essential. A rapid and reliable diagnostic can avoid the propagation of infected materials and initiate proper action to control the disease. "

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