



Ug99— Threat to Agriculture

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Ug99 is a virulent strain of old crop disease "Black Stem Rust" that has evolved to overcome the resistance prevalent in wheat varieties during the Green Revolution of the 1960s. Black Stem Rust is a disease caused by a fungi *Puccinia graminis* in wheat. *Puccinia* is a fungus that belongs to the class Basidiomycetes. This rust fungus of wheat resembling rusted iron rods in wheat stem, plugs the vascular system such that nutrients can not travel from the leaves to the grain resulting in plants producing fewer tillers and seeds, and in cases of severe infection the plants may even die.

Like most rust fungi it requires two hosts to complete its life cycle—Wheat (*Triticum aestivum* L.) and Barberry (*Berberis vulgaris*). The urediniospores (fungal spore) spread over long distances through wind currents rapidly and can affect fields of distant countries within a short time period. Huge crop loss due to this infection can lead to severe famines in countries where wheat is the major staple crop.

Nobel prize-winner Norman E. Borlaug, who helped India and many other countries to avoid the food crisis in the

1960s by developing high yielding crop strains said: "Ug99 has immense potential for social and human destruction. It is capable of severely damaging virtually all of the world's commercial bread wheat. It is a problem that goes far beyond wheat production in developing countries."

Threat to World Wheat Crops

Ug99 was first observed in Uganda in 1999. It has overcome many wheat-resistant genes like Sr24, Sr25, Sr26, Sr27, Sr31, and Sr38 that the other races could not. After Uganda, the spores of Ug99 spread to Kenya through wind current, followed by Ethiopia, Yemen, Iran, southern Sudan thereby threatening regions of the near east, eastern Africa, central and southern Asia. It not only spreads rapidly but also generates new variants able to break the resistance of the wheat varieties grown in these regions.

The deleterious effect of Ug99 is more pronounced (upto 100%) with respect to the stem rust that too may reduce crop yield. About 80% yield losses were recently recorded in Kenya and Uganda, though fortunately neither of these countries depends totally on wheat as a staple crop. But for countries like India, where wheat is the major staple crop, Ug99 is a big threat that can lead to a serious food crisis.

Predicted Pathway

The FAO has already alerted Afghanistan, India, Pakistan, Turkmenistan, Uzbekistan and Kazakhstan about the dangerous wheat fungus that may cause a huge loss to wheat production by destroying entire fields.

Stem rust outbreak caused by Ug99 depends on the following key factors: area and distribution of susceptible material; degree of susceptibility; optimum temperatures and moisture; amount of initial inoculum, and air movement. An additional sub-factor that might be added to this list is the historical precedence of the movement of spores through known regions.

The Ug99 spores can attack India following either of the two routes:

Route A: East Africa directly to southern Pakistan/western India (has no known precedent and of much lower probability).

Route B: East Africa—Middle East—West Asia—South Asia (has higher probability). Conditions favourable for outbreaks of epidemics currently exist in the migration path of highest probability.

Indian Approach

The Indian Council of Agricultural Research (ICAR) scientists, engaged in wheat



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improvement programme, are trying to protect the crop from Ug99 as wheat directly impacts the country's food security. The country has not faced any epidemic since the last four decades because regular countrywide surveys have been carried out to safeguard the wheat crop against destructive pathogens like Ug99.

WHEAT VARIETIES RESISTANT TO UG99

1. GW 273
2. GW 322
3. HI 1500
4. HD 2781
5. MP 4010
6. HUW 510
7. MACS 2846 (durum)
8. HI 8498 (durum)
9. UP 2338
10. DL 153-2
11. HW 1085
12. Raj 4120
13. PBW 343

The ICAR, in collaboration with the International Wheat and Maize Research Centre (CIMMYT), Mexico started a testing programme of wheat at Njoro in Kenya since 2005. The tests have shown that there are 13 Indian wheat varieties with resistance to Ug99 and its variants. This diverse resistance in wheat varieties will help them fight against the deadly pathogen and other future threats of this magnitude. The resistant wheat varieties are being multiplied.

It takes a few seasons for the race to build up and appear on a large scale to cause economic losses. Thus, by the time Ug99 reaches India, the already identified resistant varieties should be multiplied rapidly, bred and then aggressively distributed to cultivators to avoid any loss in the farmer's field. As an immediate relief measure, chemical control technology is also available to ensure that this race does not spread and cause damage.

Some fungicides have been identified that can be effective against stem rust. Stem rust can be effectively controlled by some azole fungicides such as tebuconazole, cyproconazole, fluquinconazole, prothioconazole and triadimenol. Strobilurins such as

trifloxystrobin and fluoxastrobin are effective for controlling cereal rust diseases.

There is a need to study the molecular mechanism of wheat and pathogen interaction of susceptible as well as resistant varieties in order to elucidate the biochemical or signaling pathway of the defense mechanism. Analysis of this study can help in the development of broad-spectrum disease-resistant transgenic plants. This will render a cost effective and environmentally friendly approach to combat the threat of Ug99 unlike the chemical treatment that is costly and might have deleterious effect on plants.

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