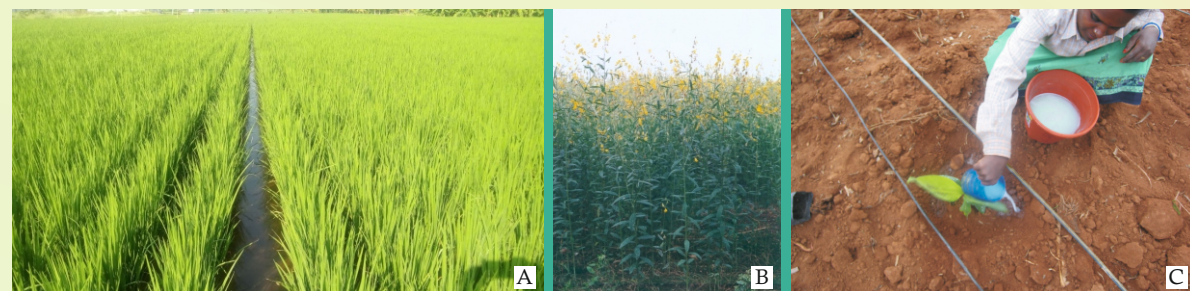


- F Intercropping with onion/growing cover crops.
- F Follow the good agricultural practices (GAP) so as to improve the soil health by applying recommended dose of fertilizers (apply less of N and more of K₂O, prefer only nitrate form of nitrogen), apply 1 kg of wood ash, more amount of organic manures such as vermicompost, Neem cake, well decomposed farm yard manure (for this banana waste recycling may be followed), application of effective microbes etc.
- F Soil application of rice chaffy grain formulation of endophytic *Penicillium pinophilum* + rhizospheric *Trichoderma asperellum* @ 100g/plant or jaggery based liquid formulation of *Trichoderma* sp. + *Bacillus cereus* @ 2 litres/plant for 3 times (at the time of planting, 2nd and 4th month after planting. This practice has been found effective for the Fusarium wilt strain present in Theni district of Tamil Nadu).



Management of Fusarium wilt TR4 - A. Crop rotation with paddy, B. Growing green manure before banana planting, C. Drip irrigation and drenching with carbendazim solution



Management of Fusarium wilt TR4 A & B. Demarcation and burning affected plants, C. Killing the affected plants by herbicide injection

Don't's for the management of Fusarium wilt disease

- F Do not use the same tractor which was used for ploughing in the Fusarium infested field without disinfestations.
- F Do not grow banana continuously in the same field, without crop rotation.
- F Do not extract suckers from the diseased plant/Fusarium wilt infested field for planting.
- F Do not apply excess nitrogenous fertilizers like urea.
- F Do not apply inorganic fertilizers alone but, combine with organic manures.
- F Do not follow flood irrigation.

- F Do not use the tools used in Fusarium wilt infected field without disinfestations.
- F Do not allow the irrigation water to pass through the Fusarium wilt infested area or plants.
- F Do not drain out water from the infested field to other fields.
- F Do not allow weeds to grow more in the field.
- F Do not pull out the Fusarium wilt infected plants and put it in the field or in the irrigation channel.
- F Do not follow the practice of mattocking (leaving the pseudostem in the field after bunch harvest).
- F Do not keep/heap all types of banana plant wastes in the field even after the harvest of the banana bunches.
- F Do not transport bunch as such for marketing.
- F Do not import any seed material, organic manures or TC plants etc. from other countries without proper quarantine procedures.
- F Do not allow others of foreign origin to perform any pest and disease management practices (consult the scientists of ICAR-NRCB, state agricultural universities or departments or KVKs or any other competent officials from the state or central governments).
- F Do not allow any unauthorised persons unnecessarily to enter inside your fields to perform any activity.
- F Do not throw any Fusarium wilt infected plants or soil in to the river water.

For your kind attention

If you see any banana plants showing the symptoms of Fusarium wilt disease, kindly contact the scientists of ICAR-NRC for Banana immediately. The mobile number is 9443589882/9080862453/0431-2618125 and e- mail id is directornrcb@gmail.com or rtbanana@gmail.com



Director
ICAR-National Research Centre for Banana

(Indian Council of Agricultural Research)
Thayanur Post, Thogamalai Road,
Tiruchirapalli - 620 102, Tamil Nadu, India
Ph : 0431 - 2618125

E-mail : directornrcb@gmail.com; www.nrcb.res.in



ICAR - NATIONAL RESEARCH CENTRE FOR BANANA

Thayanur Post, Thogamalai Road
Tiruchirappalli - 620 102, Tamil Nadu, India



Extension Folder No. : 25

Fusarium Wilt (Tropical Race 4) – An Emerging Threat To Banana Cultivation In India

R. Thangavelu and S. Uma



Fusarium Wilt (Tropical Race 4) - An Emerging Threat To Banana Cultivation In India

What is the importance of Fusarium wilt?

F Of late, severe incidence (10-50%) of Fusarium wilt in Grand Naine banana has been observed in the northern states of Bihar (Katihar and Purnea districts), and Uttar Pradesh (Faizabad and Barabanki districts).

F This is caused by a virulent strain called Tropical race 4 (TR4) which can attack all the banana varieties grown in India including Grand Naine and is regarded as most devastating.

F The Fusarium wilt affected plants mostly die or fail to yield bunch.

F The pathogen once introduced can survive in the soil for more than 40 years even in the absence of the host.



Banana field (Grand Naine) devastated by Fusarium wilt disease TR4

How to identify the disease?

External symptoms

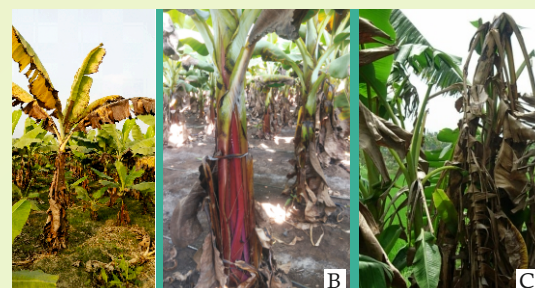
F Initially, yellowing of older leaves and later younger leaves also turn yellow.

F The leaves break at the petiole and hang down around the pseudostem and this gives 'skirt' like appearance to the plant.

F The newly emerging leaves will be pale with reduced leaf size.

F Longitudinal splitting of the pseudostem.

F No bunch is produced and if produced, the fruits are small with few developed fingers.



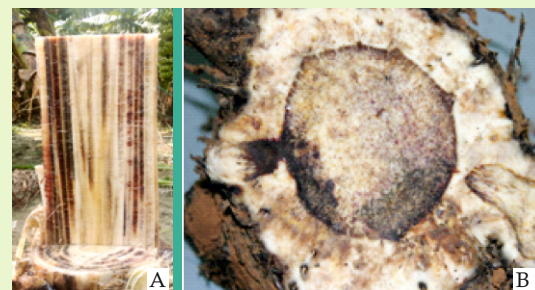
External symptoms - A. Yellowing of leaves; B. Longitudinal splitting of the pseudostem; C. Death of the plant

Internal symptoms

F When the corm is cut cross wise/horizontally, presence of yellow, red or brown strands can be seen.

F This vascular discoloration can also be seen in the pseudostem and extended up to the bunch stalk.

F The disease also spreads to the suckers and similar internal symptoms can be seen in the suckers as well.



Internal symptoms - Discoloured vascular tissues (xylem) in A.- Pseudostem, B.- Rhizome

How does the pathogen survive and spread?

Survival

F The Fusarium pathogen survives in soil as hardy chlamyospores for more than 40 years.

F The pathogen also infects and survives on more than 20 different weed hosts present in the banana field.

The pathogen spreads through

F Planting material including corm/rhizome.

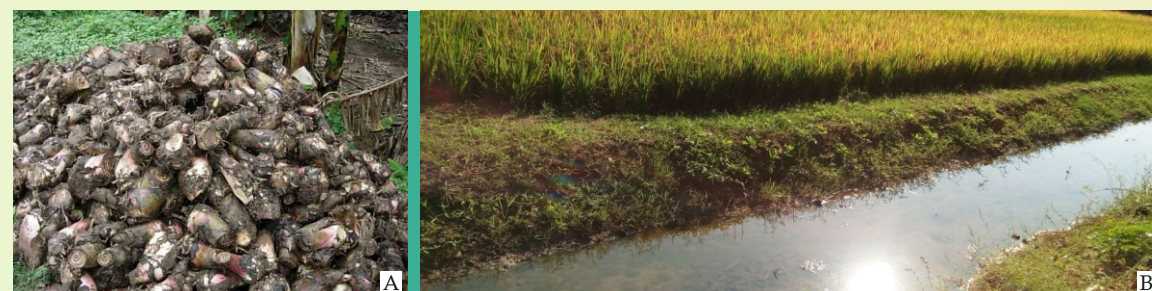
F Soils (soil adhering to the implements, tractor tyres, tools, feet of human and animals, other crops etc).

F Water (irrigation water, surface drainage waters after rainfall, flood water, hurricane river streams between disease-infested and disease-free areas etc.).

F Contaminated plant parts such as pseudostem tissues and leaves of infected plants.

F Root to root contact between the plants in a field.

F Banana weevils such as corm borer (*Cosmopolites sordidus*) and pseudostem borer (*Odoiporus longicollis*).



Spread of Fusarium wilt TR4 through A. Planting material (Suckers), B. Irrigation water

Do's and don'ts for the management of Tropical race 4 of Fusarium wilt disease in banana

Do's for the management of Fusarium wilt disease

F Keep the sign board (indicating beware of TR4 with danger sign and restricted entry) at the entry of reach field affected with Fusarium wilt tropical race 4.



Spread of Fusarium wilt TR4 through soils adhering to A. Tyres, B. Implements, C. Pseudostem borer

F Demarcate the wilt infected plants with rope/ coloured ribbon for restricted entry inside the field.

F Inject the wilt infected plants with Glyphosate 2-5 ml/ plant in two different places (preferably one at just above the ground and second, two feet away from the ground).

F After the death of the herbicide injected plants, burn them immediately or wait till the completion of the harvest of all other plants without disturbing.

F As soon as the sign of wilt infection is noticed, drenching of carbendazim (0.1 to 0. 3%) @ 3 -5 litres per plant for 3-5 times at 15 days interval and pseudostem injection of 3 ml of carbendazim 0.1% solution at 3rd 5th and 7th month after planting for all the plants (both infected and uninfected).

F Follow "come clean and go clean" approaches (wear polythene shoe or foot cover while entering in to the field and the same may be removed before the exit of the field. The same may be preserved for next use). Also 2 plastic drums with tap connection at the bottom of the drum may be kept at the entrance of the field. One for keeping water and another one for storing disinfectant (1% poly dimethyl ammonium chloride ie 10 g in 1 litre of water). All the tools used including hand and feet may be washed first in water and latter in disinfectant.

F Keep the plant and field very clean without weeds and banana plant wastes.

F Protect the plant from the attack of weevils (swab the pseudostem using brush/spray with neem oil -3 ml + chlorpyrifos -3ml in one litre of water or give pseudostem injection with Triazophos @ 2 ml (150 ml of chemical in 350 ml of water) in two places over the pseudostem or keeping the pseudostem trap swapped with *Beauveria bassiana* @ 20 numbers / acre. For corm weevil either soil application of carbofuron @ 40 g/plant / cartap hydrochloride @ 10 g/ plant around the plant at 3rd and 5th month after planting. This practice will protect the plants from nematode infection as well).

F Harvest and transportation as hands and not as bunches.

F After the harvest is over, entire plants may be uprooted and burnt *in situ* completely.

F Follow crop rotation including paddy /sugarcane/tapioca/ onion/ pineapple once or twice followed by banana for 2-3 cycles.

F Before the next crop, i) the field must be inundated/flooded with water for a period of 1 to 3 months or ii) biological disinfection method may be followed ie spreading 500 to 1000kg/acre of paddy or maize straw and flooding the field for about 20 to 30 days and iv) Sunn hemp seeds may be broadcasted, grown for 45 days and *in situ* ploughing may be carried out.

F The tractor tyres, ploughs and tools must be disinfected immediately before the exit from the field and also once before the entry into the field.

F As far as possible use bio-primed tissue cultured plants.

F When suckers are used as planting material, they should be extracted from disease free fields/plants and after the extraction, they should be pared (removal of outer skin with sharp knife) and immediately dipped in carbendazim (0.2%) for 30-45 minutes and planted.

F Tissue culture plants should be used instead of suckers.