

Fusarium Wilt (Tropical Race 4) – A Destructive Disease of Banana in India

- t River streams between disease-infested and disease-free areas
- t Root to root contact between the plants in a field
- t Insect vectors, especially the banana weevils such as corm borer, *Cosmopolites sordidus* and stem borer, *Odoiporus longicollis*

How to manage the disease effectively?

The disease can be managed effectively only by following integrated disease management (IDM) practices. They are

1. Keep the sign board (indicating beware of TR4 with danger sign and restricted entry) at the entry of each field affected with Fusarium wilt Tropical race 4.
2. Demarcate the wilt infected plants with rope/ coloured ribbon for restricted entry inside the field.
3. Inject the wilt infected plants with Glyphosate 2-5 ml/ plant in two different places (preferably one at the bottom and second 2 feet above from the ground).
4. After the death of the herbicide injected plants, burn them immediately or wait till the completion of the harvest of all other plants.
5. The affected plants should not be pulled out and put them in the field or in the irrigation channel.
6. 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 0.1% carbendazim solution at 3rd, 5th and 7th month after planting for all the plants (both infected and uninfected) may be carried out.
7. Follow “come clean and go clean” approaches (wear polythene shoe or foot cover while entering into 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 @ 10 g in 1 litre of water). All the tools used including hand and foot may be washed first in water and latter in disinfectant.
8. Keep the plant and field very clean without weeds and banana plants wastes.
9. Protect the plant from the attack of weevils (swab using brush/spray the pseudostem with Neem oil 3 ml + chlopyriphos 3ml in one litre of water or give pseudostem injection with Triazophos @ 2 ml (Triazophos solution can be prepared by mixing 150 ml of chemical in 350 ml of water) in two places over the pseudostem or keeping the pseudostem traps swapped with *Beauveria bassiana* @ 20 numbers/acre. For corm weevil either soil application of Carbofuran @ 40g / plant or 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.
10. During the harvest, in planta dehanding may be carried out so as to avoid the spread of the disease through peduncle while marketing to other un-infested areas.

11. After the harvest is over, entire plants may be up-rooted and burnt in situ completely.
12. Follow crop rotation including paddy/ sugarcane/ tapioca/ onion/ pineapple once or twice followed by banana for 2-3 cycles.
13. 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. A minimum of field capacity should be maintained for at least 20 days and iv) Sow the field with sunn hemp seeds and allow it to grow for 45 days and in situ ploughing may be carried out.
14. The tractor tyres and ploughs and tools must be disinfected immediately before the exit of the field and also once before the entry of the field.
15. Tissue cultured plants should be used instead of suckers.
16. Use the bio-primed tissue cultured plants especially in TR4 infested areas.
17. When suckers are used as planting material, they should be extracted from disease free fields/plants and after the extraction they should be pared and dipped immediately in carbendazim (0.2%) for 30-45 minutes and planted.
18. Intercropping with onion/growing cover crops.
19. Follow the good agricultural practices so as to improvement of soil health by applying recommended dose of fertilizers (apply less of N and more of K₂O, prefer only nitrate nitrogen), apply 1 kg of wood ash, more amount of organic manures such as vermicompost, neem cake, well decomposed farm yard manure etc, (for this banana waste recycling may be followed) application of effective microbes etc.
20. Soil application of rice chaffy grain formulation of endophytic *Penicillium pinophilum* + rhizospheric *Trichoderma asperellum* @ 100 g/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).
21. Follow drip irrigation/fertigation.
22. Do not drain out water from the infested field to other fields to avoid further spread.



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FUSARIUM WILT (TROPICAL RACE 4) –A DESTRUCTIVE DISEASE OF BANANA IN INDIA

What is the importance of the Fusarium wilt?

- Fusarium wilt or Panama disease caused by a soil borne fungus *Fusarium oxysporum* f. sp. *cubense* is most devastating worldwide including India.
- It can infect almost all the commercial banana varieties of India. Once the pathogen is introduced into the field, it can survive in soil for more than 40 years and can cause total death of the plants.
- Fusarium wilt is becoming a major constraint of banana production and is rampant in Tamil Nadu, Karnataka, Andhra Pradesh, Kerala, Uttar Pradesh, Madhya Pradesh, Bihar, Odhissa, West Bengal and North Eastern states.
- The disease has caused extinction of a famous local cv. Nanjangod Rasabale (an eco type of cv. Rasthali) in Mysore district of Karnataka. Similarly, in Andhra Pradesh, the Fusarium wilt disease has forced the farmers to abandon the cultivation of famous Amritapani (Silk-AAB) for more than 15 years.
- Due to the heavy losses incurred, farmers have shifted to growing other crops such as jasmine, grapes, turmeric, maize, sugarcane etc. in many parts of the country.
- As the Fusarium strain can also attack Cavendish group of bananas, there is a possibility of incurring a heavy loss to Indian banana industry as it mainly depends on Cavendish clones (Syn: Basrai, Robusta, Harichal, Grand Naine, Shrimanthi, Bhusaval and Pedda Pacha Arati) which occupy 52% of the total area under banana cultivation and contributes to 64% of the total banana production.

What is a Tropical race 4?

Tropical race 4 (TR4) is one of the strains of the fungus *Fusarium oxysporum* f. sp. *cubense* (Foc) that causes Fusarium wilt including Cavendish group of banana. This particular strain which belongs to a particular vegetative compatibility group called VCG 01213/16 can attack almost all the cultivars of banana grown in India both at tropical and subtropical conditions.



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

Which are the countries affected by Foc TR4?

The virulent strain Tropical race 4 has been reported and to cause major damage in countries like Taiwan, Malaysia, Indonesia (Java, Sumatra, Sulawesi, Halmahera, Kalimantan on the island of Borneo and Papua Province on the island of New Guinea), mainland China (Guangdong, Hainan, Guangxi, Fujian and Yunnan), the Philippines' island of Mindanao, Australia, Oman, Jordan, Mozambique, Lebanon, Pakistan, Laos and Vietnam and India.

Which are the states of India affected by the virulent strain Tropical race 4?

- The Survey conducted so far by ICAR-NRC for Banana indicated the presence of virulent strain TR4 in

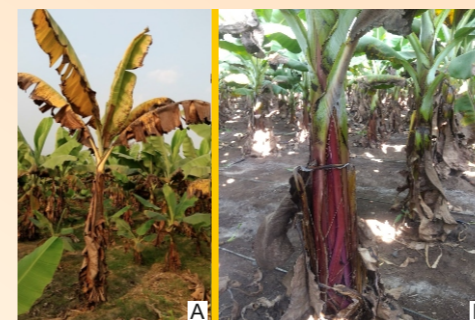
Katihar and Purnea districts of Bihar and Faizabad and Barabanki districts of Uttar Pradesh.

How to identify the disease?

The disease can be identified by both external and internal symptoms.

External symptoms

- The external symptoms are expressed only 4-5 months after planting. However, if the diseased suckers are planted, the symptoms of the disease can be seen even 2 months after planting.
- At initial stage, yellowing of leaf margins of older leaves and later the yellowing progresses towards the midrib and finally the whole leaf become yellowish. Then the yellowing of leaves spreads to upper leaves as well.
- The infected leaves gradually collapse at the petiole or towards the base of the midrib and hang down around the pseudostem and this gives 'skirt' like appearance to the plant.
- The youngest leaves are the last to show the symptom and often stand erect giving 'spiky' appearance to the plant.
- The newly emerging leaves will be pale with reduced leaf lamina and finally emergence of the leaf will be stopped.
- Longitudinal splitting of the pseudostem and emergence of large number of side suckers before the death of infected plants.
- Normally bunches are not produced and if produced, the fruits are small with few developed fingers.



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



Death of TR 4 infected plants

Internal symptoms

- Presence of yellow, red or brown strands on the corm and continuous black or brown or yellow coloured strands in the pseudostem and sometimes also in the bunch stalk due to the discoloration of vascular tissues caused by the fungus.



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

Which are all the varieties susceptible to Fusarium wilt disease?

- Cavendish group – AAA (syn: Basrai, Robusta, Harichal, Grand Naine, Shrimanthi, Bhusaval and Pedda Pacha Arati), Rasthali (Silk-AAB) (syn: Amritapani, Mortaman, Malbhog, Sabri, Patkapura, Nanjangod Rasabale); Ney poovan (AB),

Pacha Nadan (Pome-AAB), Monthan and Bluggoe (ABB), Poovan (Mysore-AAB) (syn: Chenichampa), Hill banana (Pome-AAB) (syn: Sirumalai, Virupakshi), Karpuravalli (Pisang Awak -ABB) (syn: Kanthali, Udayam, Manohar, Chinia) Pisang Mas (AA), Gros Michel (AAA) and Tella Chakrakeli (AAA).

Which are the resistant sources/cultivars available to this virulent strain TR4 at global level?

- The diploids – Pisang Jari Buaya (AA) and cv. Rose (AA),
- Bred hybrids (from FHIA, Honduras)- FHAI-01 (AAAB), FHIA -02 (AAAA), FHIA -03 (AAAB), FHIA-18 (AAB), FHIA 21(AAAB), FHIA -25 (AAB)
- Bred hybrids (from CRBP, Cameroon) - CRBP -39 (AAAB)
- Tissue culture Somaclonal variants (TBRI, Taiwan) – GCTCV-119 (AAA), GCTCV-218 (AAA) and GCTCV-219 (AAA) and
- Cultivars (plantains) – Obubit Ntanga and few East African highland bananas (EAHB) and ZJ 9 and 4 (AAA) from GDAAS, China are reported to be moderately resistant to resistant to TR 4 of Fusarium wilt pathogen.

What is mode of entry and survival of this pathogen?

- The pathogen present in the soil infects banana plants through the roots, then moves through the corm into the vascular system within the pseudostem and eventually blocks the transportation of water and nutrients in the stem. These results in yellowing of the leaves followed by plant death.
- Once the Fusarium pathogen introduced in to a field, the fungus can survive as chlamydozoospores for more than 40 years and cannot be totally eradicated.
- The pathogen also infect and survive on some of the weed hosts such as *Chloris inflata*, *Chloris barbata* (purple top chloris), *Commelina diffusa*, *Ensete ventricosum*, *Euphorbia heterophylla*, *Tridax procumbens* and *Panicum purpurescens*.

How does the pathogen spread from one field to another or from one region to another region?

The pathogen spreads by the

- Movement and planting of Fusarium pathogen infected suckers
- Movement of contaminated plant parts such as pseudostem tissues and leaves of infected plants
- Soil adhering to agricultural implements, containers, tools, animals, footwear, clothes, use of soil as a substrate
- Hurricanes
- Strong winds
- Heavy rains causing flooding
- Irrigation water
- Surface drainage waters after rainfall