


"Role of the VeA system in *Aspergillus* and *Fusarium* pathogenesis



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Plants offer a nutrient-rich environment to microbial pathogens and symbionts as well as herbivorous insect grazers.

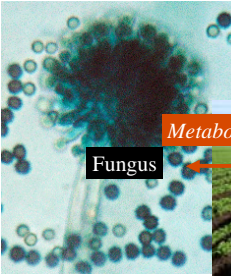


FUSARIUM HEAD BLIGHT (FHB, SCAB) OF WHEAT




FUSARIUM EAR ROT

As a result, plants must either **reduce the damage** caused by the inevitable infection of **fungal**, bacterial and viral pathogens, as well as members from other kingdoms such as nematodes and insects, or **provide and receive beneficial metabolites with a symbiotic organism**.



Fungus

Metabolic dialog



Plants

HPODEs

Mimicry

CCCCC/C=C\C/C=C\C/C=C\C/C=C\C/C=C\C/C=C\CCCC(=O)O

•Sporulation
•Toxin production

Biotic stress → Increase in mycotoxin biosynthesis

ROS (reactive oxygen species)

“-OMIC” TECHNOLOGY

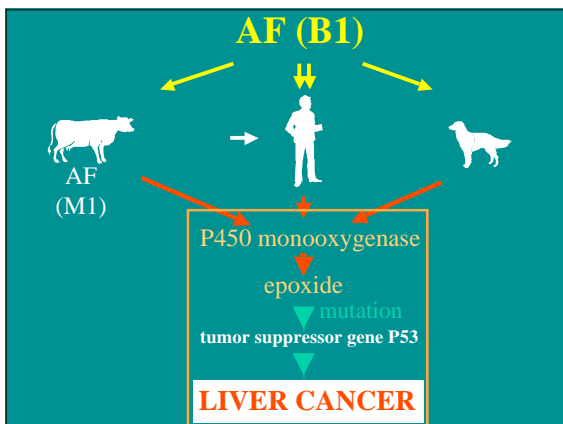
DETRIMENTAL IMPACT of FUNGI on HEALTH

- Opportunistic infection
- Allergic reaction
- Mycotoxin Contamination of Food**

Calvo A.M. 2004. Mycotoxins. In: Toxins in Food. Dabrowsky W. and Sikorski Z. (Eds.) CRC Press. Boca Raton, Florida, pg 215-237.







“In April 2004, one of the largest aflatoxicosis outbreaks occurred in rural Kenya, resulting in 317 cases and 125 deaths”

Lauren Lewis *et al.*, 2005. *Environ Health Perspect* 113: 1763-1767

May 2006

The United Nations and the Kenyan government Tuesday appealed to the world to quickly raise nearly \$US97 million to get food and basic supplies to starving Kenyans.




- Aflatoxin contamination
- Late rains

Cronique on Line , Cornell University Jan. 6, 2006 (Updated Jan. 17, 2006)

“...dog foods have been recalled for containing **highly toxic aflatoxins**, they have caused an **estimated 100 dog deaths** in recent weeks, say Cornell University veterinarians, who are growing increasingly alarmed...”

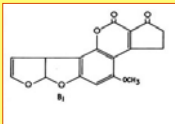


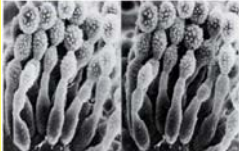


“We suspect that dogs have been dying since November, perhaps even October, but it took the perfect storm of circumstances to get the diagnosis,” said Karyn Bischoff, the veterinary toxicologist at Cornell who first identified aflatoxin as the culprit in the recent wave of deaths.”



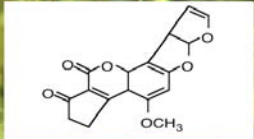
AFLATOXIN

Aspergillus flavus, *Aspergillus parasiticus*,
Aspergillus nomius, *Aspergillus pseudotamarii*,
Aspergillus bombycis



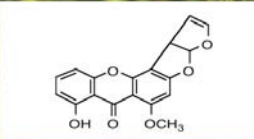


aflatoxin B₁

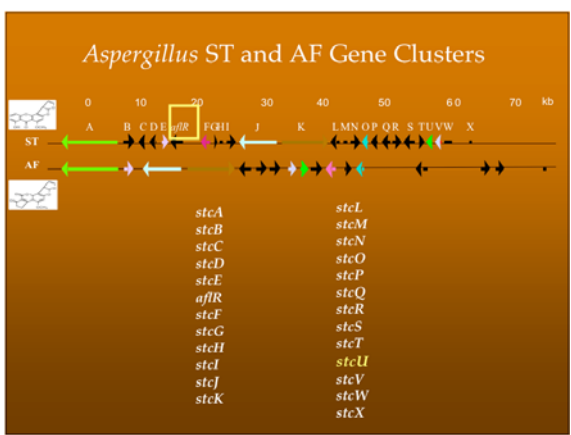


- Produced by *Aspergillus flavus* and *Aspergillus parasiticus*.
- Highly toxic, hepatotoxic, cirrhotogenic, and carcinogenic. Ld_{50} : 0.56 mg/kg rat.

sterigmatocystin





- Produced by *Aspergillus nidulans* and various other fungi.
- A precursor of aflatoxin in its pathway.
- Similar toxic properties to aflatoxin.


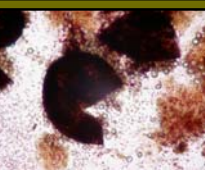


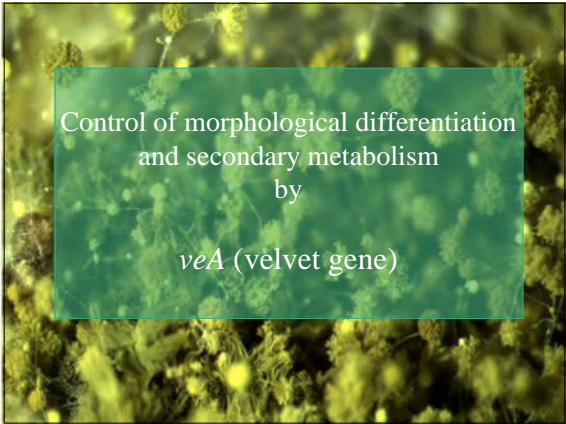
Model organism: *Aspergillus nidulans*

Asexual

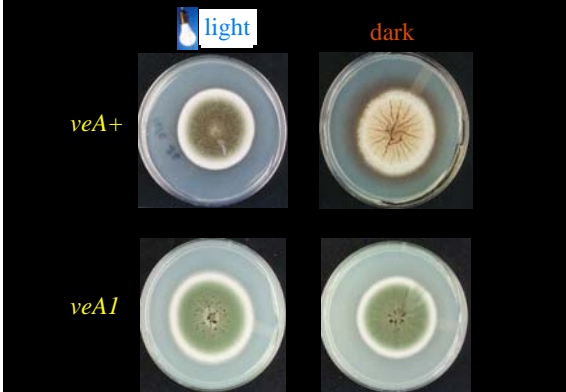



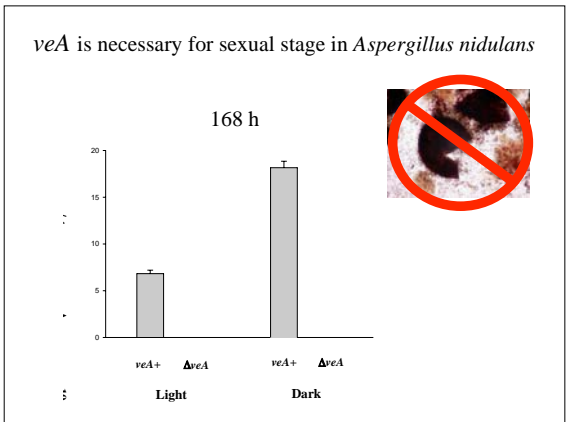
Sexual

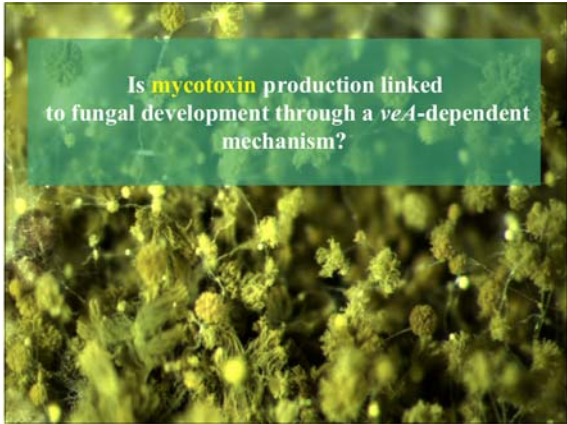



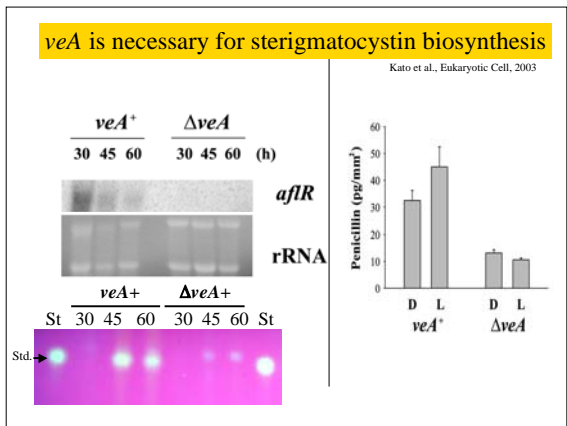


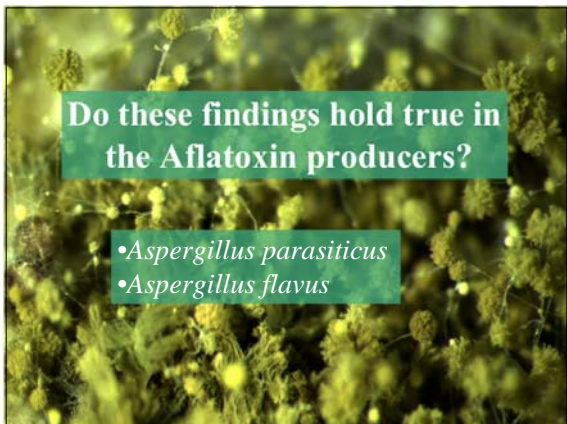
Aspergillus nidulans has a **light-dependent** developmental response

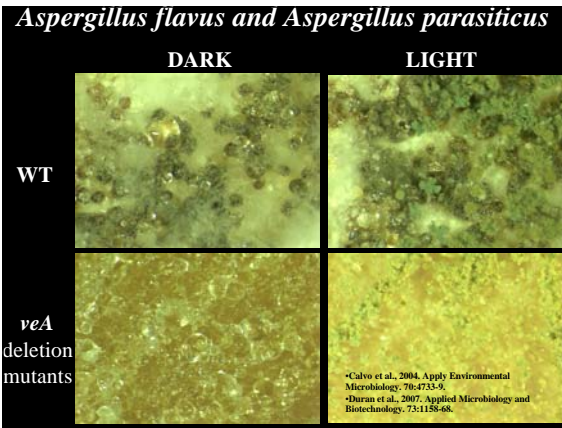


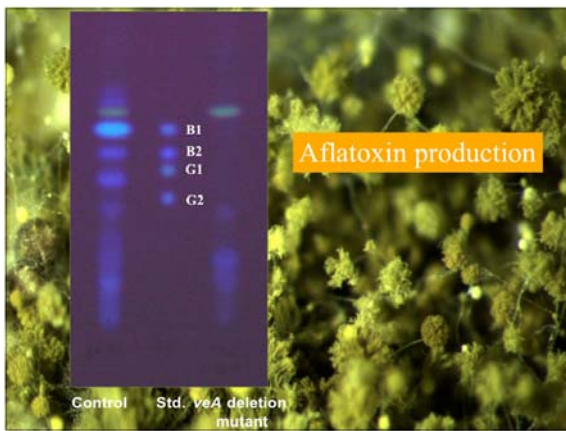


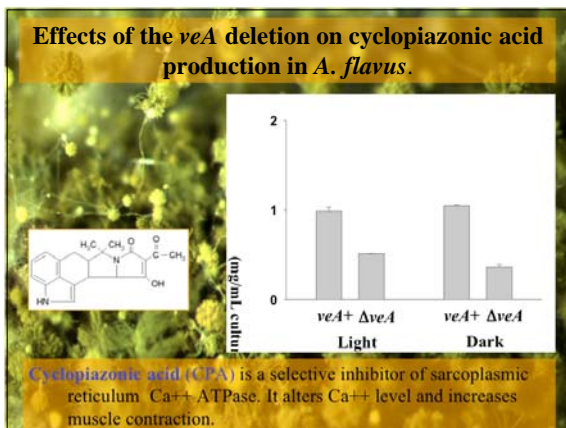


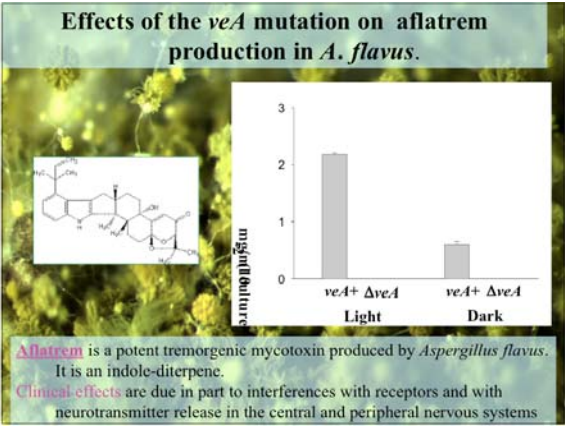


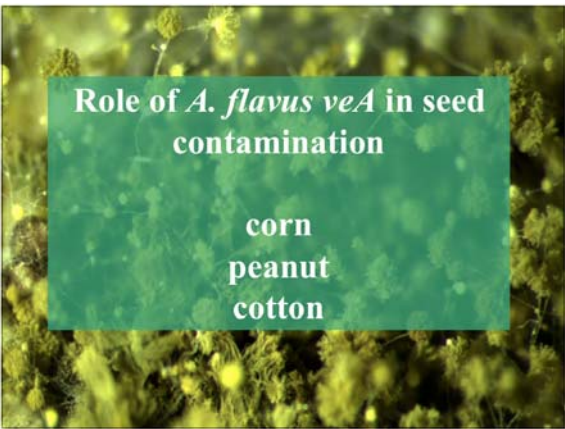


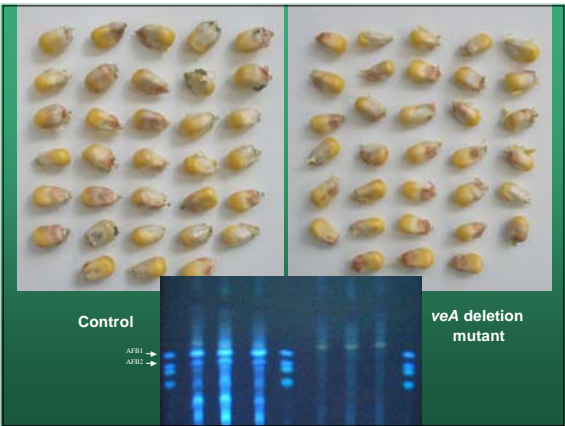


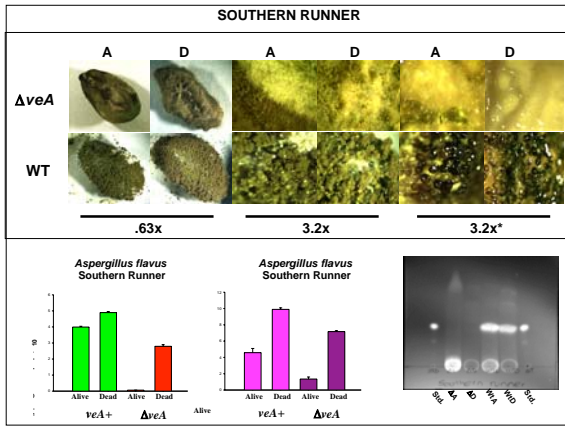


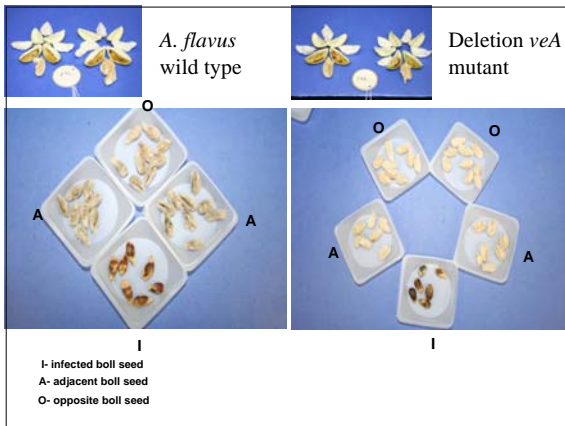




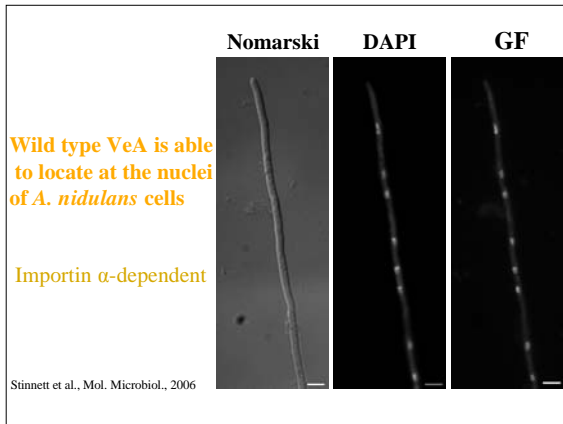


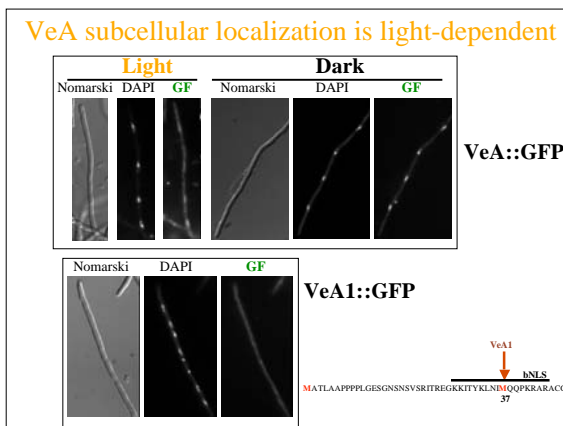


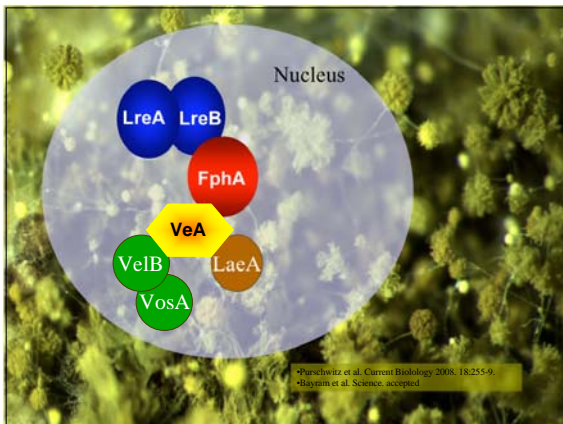


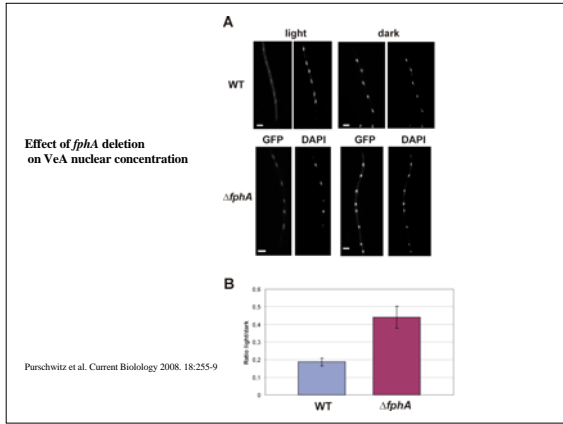






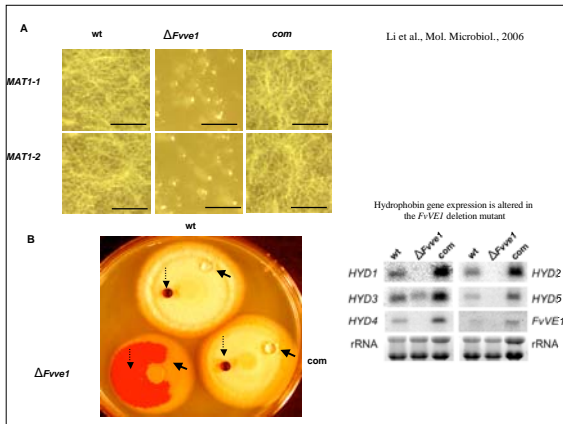


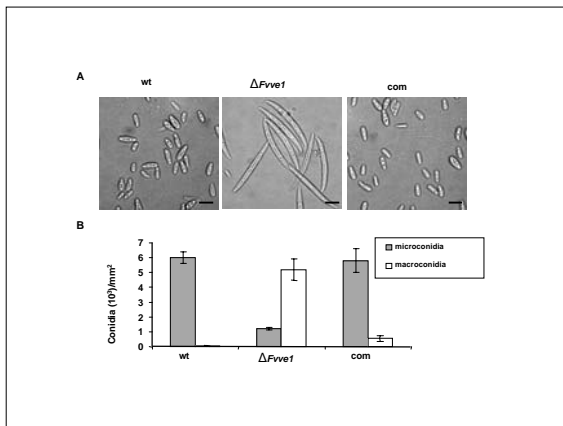


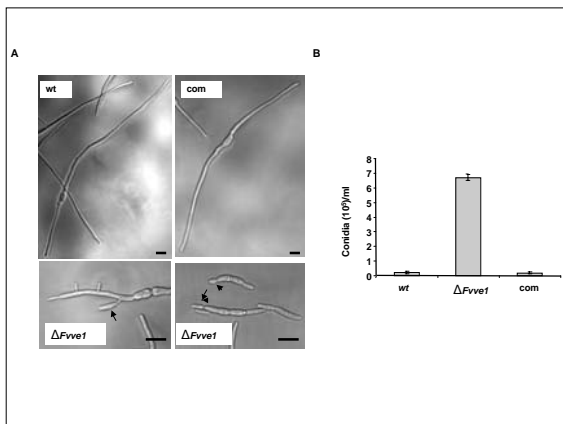




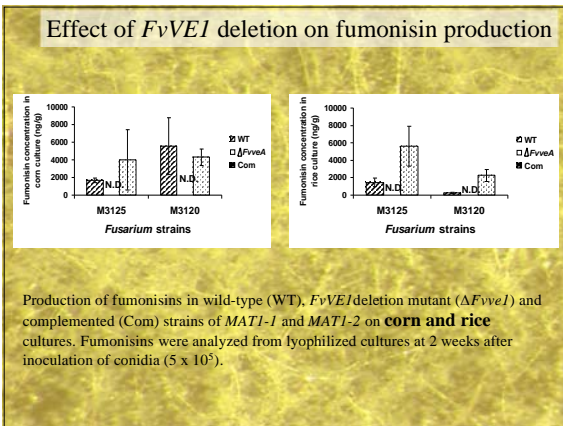


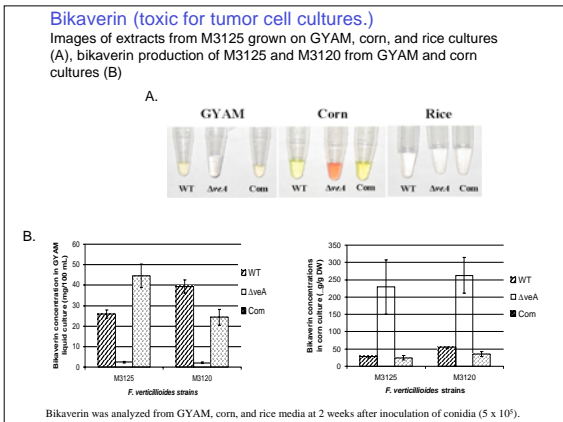












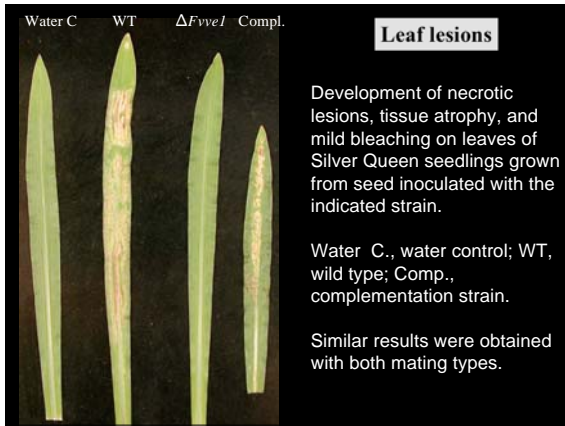
Role of *FvVE1* in pathogenicity on corn plants

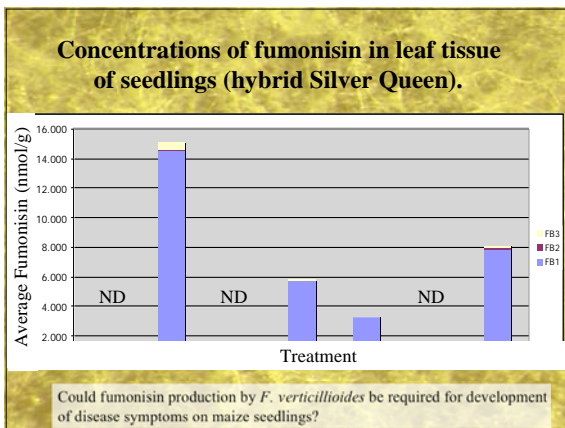
| Treatment | Rep1 | Rep2 | Rep3 |
|---------------------------|--------|--------|---------|
| Water Control | 0 (10) | 0 (10) | 0 (10) |
| M3125 (WT) | 9 (10) | 9 (9) | 10 (10) |
| M312501($\Delta Fvve1$) | 0 (9) | 0 (9) | 0 (10) |
| M312501C1 (Com.) | 8 (10) | 6 (9) | 8 (10) |
| M3120 (WT) | 8 (10) | 6 (10) | 7 (10) |
| M31206 ($\Delta Fvve1$) | 0 (10) | 0 (10) | 0 (10) |
| M31206C5 (Com.) | 7 (9) | 6 (10) | 7 (10) |

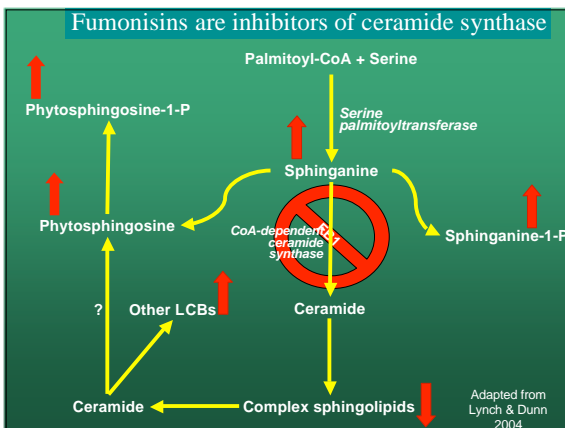
Silver Queen corn were inoculated with spore suspensions and placed at 27°C overnight. For each treatment there were 3 replicates. Each replicate consisted of one pot in which 10 seeds were planted and incubated at 30°C day for 14 hours; 20°C night for 10 hours.

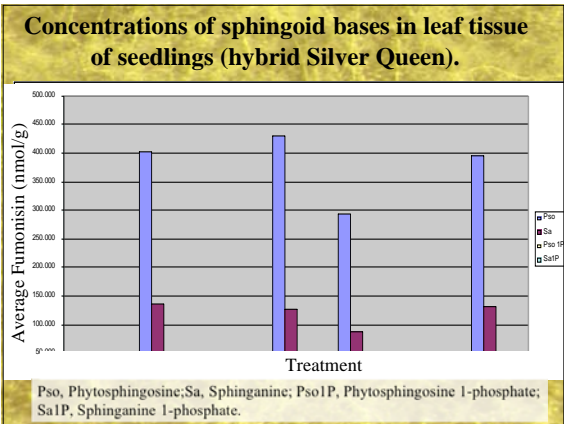


| Treatment | Leaf | Stem | Mesocotyl |
|---------------------------|------|------|-----------|
| Water Control | 0 | 0 | 0 |
| M3125 (WT) | 11 | 100 | 100 |
| M312501($\Delta Fvve1$) | 22 | 67 | 100 |
| M312501C1 (Com.) | 56 | 100 | 100 |
| M3120 (WT) | 67 | 100 | 100 |
| M31206 ($\Delta Fvve1$) | 22 | 67 | 89 |
| M31206C5 (Com.) | 67 | 78 | 100 |









Conclusions

- *veA* is required for normal morphological development and secondary metabolism in several *Aspergillus* spp.
- *Aspergillus nidulans* VeA protein has a functional bipartite NLS and its transport to the nucleus is dependent on the importin KapA.
- VeA concentration in the nuclei is light-dependent.
- VeA forms a nuclear protein complex including light-sensing proteins such as FphA, LreA, LreB. Other VeA-interacting proteins are LaeA and VelB-VosA.
- FphA affects VeA accumulation in the nucleus (in light).
- Pathogenicity of *A. flavus* on seeds is mediated by *veA*.
- VeA is conserved across fungal genera

Conclusions

Study of *veA* across fungal genera: *Fusarium verticillioides* *FvVE1*

- Differences in VeA regulatory output across fungal genera: Deletion of *FvVE1* suppressed aerial hyphal growth, reduced colony surface hydrophobicity, caused loss of hyphal polarity, marked activation of conidiation, and yeast-like budding growth. *FvVE1* deletion also markedly increased the ratio of macroconidia to microconidia.
- Supplementation of osmotic stabilizers restored wild-type phenotype to the deletion mutants, suggesting cell wall defects, (hypersensitivity to the cell wall assembly disrupting agent SDS and reduction in the mannoprotein content).
- Deletion of *FvVE1* suppressed fumonisin production on natural substrates (corn, rice) in both mating types. *FvVE1* also regulates other secondary metabolites in *F. verticillioides* (bikaverin)
- Deletion of *FvVE1* strains were unable to cause the disease symptoms on corn and were unable to produce fumonisins in plant tissue. Leaf lesion incidence and severity were correlated with fumonisin and disruption of sphingolipid metabolism.