KUTSAGA™
For Productivity. For Sustainability

(+263-242) 575 289-94
VOIP:- 0868 800 2604

kutsaga@kutsaga.co.zw

Tobacco Research Board
Kutsaga Research Station
Airport Ring Road, P. O. Box 1909, Harare, Zimbabwe

www.kutsaga.co.zw

Please address all correspondence to the Chief Executive Officer

11 January 2024

Dear Grower

INCIDENCES OF FUSARIUM WILT-BLACK SHANK DISEASE COMPLEX: AN EMERGING PROBLEM IN TOBACCO PRODUCTION

1.0 Introduction

In this 2023-24 farming season, the Kutsaga Plant Clinic has recorded increased incidences of wilts in tobacco crops. Disease diagnoses on plants submitted for testing have shown that most of the wilts are being caused by co-infections of *Fusarium* spp and *Phytophthora* spp resulting in a fusarium wilt/black shank (FW/BS) disease complex. This phenomenon has been widely observed in the 2023-24 farming season but isolated cases have been reported since the 2018-19 season. For example, in the 2019-20 farming season, there were 15 recorded cases; then in 2021-22, there were 5 recorded cases. The number of recorded and reported cases has risen astronomically to more than 40 this season. While the FW/BS disease complex is a recent phenomenon in Zimbabwe, it is one of several disease complexes (like bacterial wilt/black shank and black shank/root knot nematodes) threatening tobacco production in other tobacco growing countries such as the USA and China. It was anticipated that climate change would pose certain challenges in agriculture, including a change in the status of pests and diseases. Indeed, following the extremely hot and dry conditions experienced in Zimbabwe this agricultural season, certain pests and diseases, previously considered not economically important on tobacco have become prominent.

2.0 Fusarium wilt occurrence and symptoms

Fusarium wilt of tobacco is a widespread disease that occurs in many countries. It was first reported in the USA in 1916. By the 1990s, it had become the most important and damaging disease of cigar wrapper tobacco in Connecticut and Massachusetts, affecting approximately 20% of tobacco

production fields and causing severe yield losses. It is present in all countries of the American continent and is widespread in Asia and Oceania. In Africa, fusarium wilt is particularly severe in Malawi, and until recently, was of minor importance in Zimbabwe.

Fusarium wilt symptoms start as vein-clearing on the younger leaves with simultaneous drooping of the older lower leaves. This is followed by stunting, yellowing of the lower leaves, defoliation, marginal necrosis and plant death (Fig 1). Sometimes, the wilting and yellowing symptoms appear on one side of the plant. The disease can cause significant damage under high temperature and humid conditions. Several *Fusarium spp* cause wilting and root rots in tobacco. Previously, *Fusarium oxysporum* f.sp. *nicotianae* was the predominant species on tobacco. However, in recent studies done at Kutsaga, the highly virulent generalist pathogen *Fusarium falciforme,* and *Fusarium foetens* were also detected in samples collected countrywide and are now amongst the pathogens causing Fusarium wilt in Zimbabwe. Both *F. falciforme* and *F. foetens* have also been detected on potatoes in the country. Thus, there is high likelihood that these fusarium wilt pathogens could spread and infect other key food and cash crops thereby threatening the profitability and sustainability of the agricultural sector in the country.

Figure 1: Typical fusarium wilt symptoms on K M10 tobacco.

Notice the wilting and yellowing on one side of the plants in the middle row. This picture was taken at the Banket Research Station in 2015 where K RK66 (outer rows in the picture) was being evaluated for resistance to fusarium wilt.

3.0 Black shank occurrence and symptoms

Black shank is a potentially devastating disease of tobacco, with losses in individual fields potentially reaching 100%. In North Carolina (USA), black shank-induced losses of up to US$30 million dollars have been reported in some seasons. In China, black shank is also reported to be a major problem on flue-cured tobacco with losses of up to US$1 billion reported. Losses of up to 30% were reported in Zimbabwe in the 1990s. This disease is caused by the oomycete *Phytophthora nicotianae*. It affects tobacco at any stage of growth, but mostly plants that are at 6-8 weeks after transplanting. Disease development is rapid under high temperatures and dry conditions. In periods of prolonged drought, disease severity also becomes more intense, and subsequently plant death.

Depending on seedling size, an infected plant may wilt and die within a few days or a few weeks. Above-ground symptoms of the stem and root rot phases of the disease begin as a temporary wilt that progresses into leaf chlorosis and permanent wilting (Fig 2). Also noticeable are stem lesions that continue up the stem 30 cm or more above the soil surface. A longitudinal cut through the stem reveals necrotic pith that is often separated into disks (ladders) that do not extend beyond the necrosis observed on the outside of the stem (Fig 2).

Figure 2: Common diagnosis symptoms of black shank.

Brown or black lesions on the tobacco stem (left). If the stem if cut longitudinally, blackening and laddering or disking that does not extend beyond the necrosis observed on the outside of the stem is observed (right). Pictures courtesy of Kutsaga Research Station

4.0 Fusarium wilt/Black shank disease complex

The prevalence of *Fusarium spp* and *Phytophthora nicotianae* co-infecting tobacco plants has become a common phenomenon since the 2018-19 farming season. This has been observed in all tobacco varieties, including those varieties that have resistance to *Fusarium* and *P. nicotianae*, across all tobacco growing districts of the country. Disease severity is high under hot and dry weather conditions.

While we have detected some new *Fusarium spp* that are infecting tobacco in the country, we are still investigating the race structure of *Phytophthora nicotianae*. The emergence of the FW/BS disease complex is driven by several factors that include climate change and global trade in agricultural commodities. As seasons get hotter and drier, both *Fusarium* and *P. nicotianae* become more prevalent and severely infect crops. Global trade in plants and plant products has also contributed to the introduction of new pathogens and pathogen races in Zimbabwe. For example, the now widespread *Fusarium falciforme* was probably introduced via infected potato tubers imported into the country, after which it then jumped hosts to infect tobacco. Kutsaga is also aware that recently the National Plant Protection Organization of South Africa has notified the International Plant Protection Convention (IPPC) of the detection of Pepper ringspot virus (PepRSV) in its territory in potato cultivars and host jumping into tobacco is possible.

5.0 What should farmers do in the face of this FW/BS disease?

Research is underway at Kutsaga to understand the dynamics of this new disease complex. The FW/BS disease complex was reported a few years ago and the Cooperation Centre for Scientific Research Related to Tobacco (CORESTA) has a taskforce that is spearheading research on this menace. We are collaborating with partners in CORESTA from the USA, France and Brazil to unravel and understand the dynamics of the diseases. For now, we encourage farmers to pursue an integrated disease management strategy that encompass the use of resistant varieties (to black shank and fusarium wilt as separate diseases), chemical control, cultural control (suitable rotations) and legislative control. Thus, growers should make all efforts to reduce individual pathogen populations in the soil that initiate epidemics of the Fusarium wilt/Black shank complex.

5.1 Cultural practices

Cultural practices are vital to the long-term management of any disease. Effective cultural practices include:

(1) Planting on raised beds or ridges, which prevents or reduces duration of soil saturation required for zoospore movement in the root zone;

(2) Crop rotation, which removes potential sources of nutrition for reproductive growth of the pathogens. The duration of the rotation should be at least two years, but even longer rotations will not totally eliminate the pathogens from the soil.

(3) Stalk and root destruction after harvest, which effectively removes the infected root system from the soil and suppresses inoculum buildup. Root and stalk destruction also reduces populations of other pests and pathogens, especially root knot nematodes, that can greatly exacerbate disease severity.

(4) Soil chemistry greatly affects black shank development. The disease is favored by pH values greater than 6.2 and is suppressed at lower pH values. Soil pH values between 5.5 and 6.0 provide favorable growing conditions for tobacco without providing highly conducive conditions for *P. nicotianae*.

5.2 Host Plant Resistance

One of the major breeding objectives at Kutsaga has been to develop varieties with multiple disease resistances to the major bacterial, fungal and viral diseases including Black shank and Fusarium wilt.

5.2.1 Black Shank

The most widely used method of control for black shank is host plant resistance. Resistance to Black shank is governed by several genes (polygenic) and the level of resistance in tobacco varieties varies from high to low. All active Kutsaga-bred tobacco varieties have moderate to high levels of resistance to Black Shank. It is important to note that there are four known races of black shank that include, race 0, 1, 2 and 3 and Kutsaga cultivars only have resistance to race 0 and 1. Globally, resistance to race 2 and 3 has been elusive, hence a CORESTA work group was established to work on this objective. However, when the disease comes in a combination with other diseases, genetic resistance to black shank breaks down.

Research is on-going at Kutsaga to identify the pathogen race responsible for the current challenges and to establish if new virulent races of the pathogen have emerged. This project is not only being undertaken at Kutsaga but in other tobacco growing countries where black shank diseases have reemerged. A worldwide collaborative study initiated by CORESTA is currently underway to establish the current black shank pathogen races in the various tobacco growing countries, and to evaluate the relative resistances of available tobacco varieties.

5.2.2 Fusarium Wilt

Fusarium wilt has not been a major threat to tobacco production in Zimbabwe in the past hence the disease was not tested during variety development and evaluation of the current varieties. It is known however, that incidences of the diseases were sporadically encountered in tobacco farming communities although they appeared endemic at certain farms. It is known that genetic resistance is multigenic and additive gene effects are accumulated for efficacious resistance. Ongoing research efforts to develop genotypes with resistance to fusarium wilt are underway while stratagem endeavors to identify sources of resistances and introgress into all the elite varieties has been done.

5.3 Variety selection

Growers in disease hotspots may consider choosing K RK26R, K RK73, K RK28, K RK29, K RK61, K RK64, K RK66, K RK71, K RK72 and K RK74. These varieties carry medium to high resistances. Please take note that when Black Shank comes in combination with other diseases such as fusarium (the case with most cases experienced in the 2023-24 season), genetic resistance will break down. Research has been initiated to develop varieties with resistance to the disease complex targeting the fusarium wilt/blank shank combination. Plant breeders at Kutsaga, are constantly dedicated to exploring new approaches for resistance breeding in tobacco through exploring and investigating genetic diversity on an unprecedented scale in tobacco genome, and the discovery of new resistant genes.

5.4 Chemical control

Fungicides are available for the control of *Fusarium spp* and *Phytophthora nicotianae* as individual pathogens. For *Fusarium spp*, any of the following chemicals can be used: azoxystrobin+tebuconazole 320 SC (Custodia); azoxystrobin+difenoconazole 325 SC (Amistar Top); azoxystrobin+tebuconazole (Inhibit); fluoxastrobin+tebuconazole (Evito T). All these products are applied at 0.8 mL product per 4 L of water per m^2. The products may not completely remedy the situation but will reduce the spread of *Fusarium* and enable plants to recover.

There are no registered fungicides for the control of black shank once the disease has established in the field. However, in future, a preventative application of metalaxyl+mancozeb is recommended as below:

(+263-242) 575 289-94
VOIP 0868 800 2604
E-mail: kutsaga@kutsaga.co.zw
Tobacco Research Board
Airport Ring Road, P.O. Box 1909, Harare, Zimbabwe
www.kutsaga.co.zw
Please address all correspondence to the Chief Executive Officer

Compound	**Application Rate**	**Method of Application**	**Soils**
Metalaxyl-m + mancozeb (68-72% WP)	200 g/litre water	10 ml of mix/plant within 4 days* of transplanting, as drench around stem base, immediately followed by 5 mm irrigation if soil is not moist.	Heavy textured soils only

Trichoderma-based biological fungicides have also been shown to be effective in reducing the severity of both *Fusarium* and *P. nicotianae* induced diseases. Trichoderma employs mechanisms such as antibiosis, mycoparasitism, and competition to suppress or eliminate pathogens. In addition to disease control, *Trichoderma* also has growth enhancing effects and also plays a vital role in enhancing plant development under challenging abiotic stress conditions such as drought. Its ability to improve drought resilience becomes particularly valuable during periods of below-average rainfall. The *Trichoderma* can be applied in the seedbed or in the field. Trichoderma is readily available at Kutsaga.

6.0 Conclusions

With the inclement weather being experienced and ongoing climate change, growers should expect and be on the lookout for changes in disease and pest profiles on the various crops in their fields, and how they can impact their tobacco. Growers are encouraged to report any atypical behavior in pests, diseases or varieties on the various communication platforms offered by the Kutsaga so that appropriate advice can be given.

WhatsApp (0714980980), telephone (263 - 24) 2575 289/94, VOIP (0868 800 2604) and Email (kutsaga@kutsaga.co.zw)

Yours faithfully

Dr. Charles Karavina, Dr. Cleopas Chinheya and Francis Mukoyi

Plant Pathologist Plant Breeder