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Review

An overview of the fungal diseases of vegetables in Sokoto State, Nigeria

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Fungi constitute a major problem in the production, storage and processing of agricultural products especially Vegetable crops. Vegetables belonging to the families' cucurbitaceae, brassicaceae and solanaceae are important due to their nutritional as well as economical values. However, the farmers face heavy yield losses both in quality and quantity of these crops due to damage as a result of various diseases caused by fungal pathogens. Different pathogens were found to be associated with the various angiospermic diseases of vegetables. Diseases develop through soil-borne, above-ground infections and in some instances are transmitted through insect feeding. Although some general review on the fungal diseases of vegetables have been compiled by different workers. However, no comprehensive review is available on the fungal disease of vegetables in Sokoto north-western Nigeria. The present review gives inclusive information regarding various pathological aspects of the fungal disease, causes and management strategies opted for pre and post harvest diseases of vegetables in Sokoto.

Keywords: Review, Fungi, Vegetables, Disease.

INTRODUCTION

The population of the world is increasing at an alarming rate. It has been projected to grow to 8.2 billion by the year 2025 and is likely to approach 9.3 billion in 2050 (DESA, 2000). Feeding such rapidly projected growing population is becoming a big problem. Nigeria has advantage in the production of a variety of fresh crops especially vegetables during dry season in the low lands (Tsoho, 2004; NFDO, 2005; Salau, 2012). Estimates of production losses in developing countries are hard to evaluate. Post harvest losses of fruit and vegetables in some African countries have been estimated to reach 50% (Tsoho, 2004; FAO, 2008; FAO, 2012) hence minimizing post harvest losses of already produced food is more sustainable than increasing production (Kader and Rolle, 2004). Post-harvest diseases of fruits and vegetables caused by fungal and bacterial pathogens result in significant economic losses. Diseases caused by Microbial pathogens have been a major challenge to agriculture, health as well as national economy (Shehu et al., 2014[a]). In Nigeria, vegetables are commonly displayed on benches, sacks and in baskets for prospective buyers. While stored in the open markets the produce are susceptible to microbial invasion and colonization leading to contamination (Muhammad *et al.,* 2004; Shehu et al., 2014[b]). Vegetable contamination with fungal pathogens leading to diseases development on the produce can also occur due to pre-harvest practices such

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as plant fertilization with manure, sewage sludge and from irrigated water. Other aspects which contribute to disease of vegetables include injuries, high temperature and storage in previously contaminated bins (Shehu *et al.,* 2014[c]).The study area is Sokoto which lies between latitude 13° 3' 49^0N, longitude 5° 14' 89^0E and at an altitude of 272 m above the sea level. It is located in the extreme North Western part of Nigeria. It was estimated to have a population of 427,760 people (NPC/FRN, 2007). The soil is predominantly ferruginous tropical type, texturally sandy and pH of the soil ranges between 6 and 7. Rainfall starts late from June and ends early, in September. The highest temperatures of 45°C during the hot season are experienced in the months of March and April. Harmattan, a dry cold and dusty condition is experienced between the months of November and February (Abdullahi *et al*., 2009; MOI, 2008; Udo and Mamman, 1993). Production of vegetable is a major occupation of people of Sokoto and neighboring states in north western Nigeria, especially in the dry season when rainy season cultivation is over. This activity is both an income earner as well as a source of employment to a large proportion or otherwise underemployed labour force (Ibrahim, 2005; Salau, 2012; Shehu and Aliero*,* 2011). Sokoto state is among the northern area endowed with low lands where substantial quantities of vegetable are grown under irrigation during the dry season (Dogondaji, 2005). Salau, (2012) observed that the low land although quite small in area is one of the most valuable agricultural resources in the state. In vegetable production, farmers adopt different cropping practices. These practices determine the quality and quantum of gross agricultural production and the crop-mix grown in an agricultural year.

In current paper a review on the fungal disease of vegetables is described with reference to production, occurrence, symptomology, incidence, pathogenicity, losses and disease management.

Vegetable Production

Our dependence on healthy vegetable crops as reliable source of food traced all barriers of nation and culture. Consumers in Nigeria now demand excellent quality vegetable from the farmers and vendors that produce or sale large volumes of high quality vegetables (Shehu *et al.,* 2014[d]). Amaranth (*Amaranthus caudatus*), roselle (*Hibiscus sabdariffa*), kenaf (*Hibiscus cannabinus*) Onion (*Allium cepa*) and tomato (*Lycopersico esculentum*) are among the most common vegetables cultivated by farmers in Sokoto State, Nigeria both in the rainy and dry seasons (Salau *et al.,* 2012; Shehu and Aliero 2010). The vegetables grow in varied types of soil – sandy loam to clay and also tolerate moderate acidic and saline soils. The optimum temperature for its cultivation vegetables is 15 to 27^0C. Amaranth is a quick – growing green leafy vegetable and is often uprooted when it is 8 to 10 cm tall (3 to 4 weeks after sowing). Its flowers mature in 90 to 95 days. Roselle is an annual herb of the malvaceae family, it bears leaves, calyces and seeds which are edible and have versatile uses. The plant has an overall growing period of 4 to 6 months. The young plant is often uprooted when it is 3 to 4 weeks old for sale and consumption (Salau*,* 2012).

Diseases of Vegetables

Fungal disease constitutes a menace in vegetable production, and many pathogens have been associated with vegetable plant in the field as well in the storage and processing stage.

The principal fungal fruit rots reported all over the world with varying intensities on vegetables includes *Alternaria* rot caused by *A. solani* and *A. tenuis, Phytophthora* rot caused by *Phytophthora infestans, Phytophthora nicotianae* var*. parasitica,* Anthracnose ripe rot caused by *Colletotrichum phomoides*, *Phoma* rot *Phoma destructiva* and *Fusarium* rot caused by *Fusarium* spp. (Ibrahim, 2002; Iqbal *et al*., 2003; Patel *et al*., 2005; Ali *et al.,* 2005; Salau *et al.,* 2012). Purple blotch disease of onion caused by *Alternaria porri* was found to be endemic in sokoto state. Is an important disease of onion worldwide and is more prevalent in warm, humid environment. The disease is a major constraint to onion production in Nigeria with a yield loss ranging from 25 – 40% annually ('Yar'adua, 2003; Shehu and Muhammad 2011). The pathogen is soil borne and its inoculum can remain viable in the soil for many years. (Shehu *et al.,* 2014[d]). Early blight, caused by the fungus *Alternaria solani*, appears first on the lower leaves, usually after a heavy fruit set. It normally forms a few large (up to 1/2 inch) spots on a leaf. The spots are dark brown to black and roughly circular. Concentric rings develop in the spot forming a "target spot". The leaf area around each target spot turns yellow, and soon the entire leaf turns yellow and drops. *Alternaria* rot has been considered as the most common disease of tomato fruits and causes heavy losses in quality of the fruits, thus rendering large quantity of tomato fruits unfit for consumption. The disease was reported by Ibrahim (2002), Salau (2012) Shehu *et al.,* (2014[c]) from the Sokoto. The causal organism was isolated from the dead leaves of leafy vegetables and afterward it was reported from the decaying tomato fruits. Salau *et al.,* (2012) reported that *A. solani* was mainly responsible for the tomato decay and typical symptoms occurred on stem were brown to black, depressed and usually with distinct rings. Ibrahim (2002) reported that the spot range in size from minute pin-heads to areas extending completely across the surface of the fruit giving it a flattened appearance. Fusarium rot is considered most destructive on vegetables has been reported from (Ibrahim *et al.,*

2011). Number of different Fusarium species has been found associated with this rot. Fungal species of *Acremonium*, *Alternaria*, *Fusarium*, and *Plectosporium* were also detected in surveyed sites (Salau *et al.,* 2012) *Alternaria tenuissima*–like species are both endophytes and latent pathogens of *Amaranthus hybridus*. The group consists of the most common fungi isolated from asymptomatic; surface disinfested leaves of *Amaranthus hybridus* collected from the field in Sokoto.

Sources of Inoculums

Microbial organisms defend on different factors including soil condition that could be the reservoir of food borne pathogens or water for irrigation (Ibeyessie, 2007). Water may be source of different pathogens; they could be transferred from water to the vegetables (Shehu *et al.,* 2014[a] ; Shehu *et al,* 2014[b]) organic fertilizers (sewage sludge, animal manure, compost) may also be potential risk for contamination of vegetables. Vegetables may also be contaminated during harvest (due to lack of sanitary facilities to workers or dirty storage facility) or post harvest treatment (handling, storage and transportation). Therefore, to minimize the risk of infection or intoxication associated with vegetables, potential source of contamination should be identified and specific measures and intervention to prevent and minimize the risk of contamination should be considered and correctly implemented (Aliero and Ibrahim 2014).

Factors that Influence vegetable Disease

Vegetable losses vary each year, prevailing weather while the crops are growing and at harvest contribute greatly to the possibility of decay certain cultivars are more prone to decay than are others to specific pathogens. In a recent study, it was found that resistance of major vegetable cultivars to the fungi that cause blue mold, gray mold, bull's-eye rot, and Mucor rot was dependent on cultivar. Condition of the crop, as determined by fertilizer and soil factors, are very important in susceptibility of the crop to disease. Maturity of the crop at harvest, handling and type of storage has a great deal of influence on how long the crop can be stored without decay. Weather affects many factors related to plant diseases, from the amount of inoculum that overwinters successfully to the amount of pesticide residue that remains on the crop at harvest (Shehu and Muhammad, 2011).

Packing Sanitation it is important to maintain sanitary conditions in all areas where produce is packed. Organic matter (culls, extraneous plant parts, soil) can act as substrates for decay-causing pathogens. For example, in vegetables and pear packinghouses, the flumes and dump tank accumulate spores and may act as sources of contamination if steps are not taken to destroy or remove them.

Pathogenicity

Literature revealed that several methods of inoculation have been adopted by different workers for confirming the Pathogenicity of the causal fungi isolated from collected vegetables in Sokoto. According to Shehu and Muhammad (2011) who studied Fungi associated with storage rots of onion bulbs in Sokoto revealed that *Aspergillus niger*, A. *flavus* A. *fumigatus, Alternaria porri, Fusarium ox-ysporum*, *Rhizopus stolonifer* and *Penicellium citrinum* were found to be pathogenic to the onion bulbs, these fungi leading to rapid disintegration of the infected bulbs within 21 days of inoculation. The finding from this investigation indicates that the aforementioned fungi were associated with deterioration of onion bulbs. This agrees with the reports of other researchers (Muhammad *et al*., 2004; Dimka and Onuegbu, 2010) that fungi constitute a menace in the storage of many agricultural commodities including fruits, vegetables and nuts.

Similarly Salau *et al.* (2012) implicate that *Aspergillus* spp., *Alternaria* spp, *Penicillium* spp., *Rhizophus* spp. and *Saccharomyces* spp from there finding on Studies of fungi associated with vegetable plant diseases in Sokoto Metropolis revealed that within a week (7 days), a soft rotten area developed around the inoculation point of tomato, the same species were isolated from the rotten part, while all smearing inoculated leaves of vegetables remained green and symptomatic in all smearing, and un-smeared controls also remained green and asymptomatic in both places. However symptoms were the same as those previously observed in the field in which species of the *Aspergillus* group were identified as the causal agent of disease in these (Spinach, Lettuce, tomato and Cabbage) vegetable crops. The result obtained is in consonant with the finding of Kutama *et al*., (2007) who reported several species of Fungal Pathogens found associated with Tomatoes and his storage vessel (*Aspergillus* spp., *Alternaria* spp, *Penicillium* spp., *Rhizophus* spp. and *Saccharomyces* spp). This could be associated with hygienic conditions of the cultivation site of tomatoes.

Economic Implication

Losses from post harvest deterioration of vegetables have been substantial during storage, wholesale, retail, and consumer levels. The total losses are very difficult to establish because research has generally considered only one or two levels, and little work has been done to determine losses at different levels of storage, wholesale, retail and consumer level. Nevertheless in Sokoto state, losses of vegetables are estimated to range from 5% to as

much as 43% of the harvested vegetables (Shehu *et al.,* 2014[b]), most of the vegetable decay results from microbial infection (through wounds made during harvest) and postharvest handling. However, infection may takes place in the orchard during the growing season and remain latent. And in storage, the pathogens become active again and invade the vegetable tissues.

Management strategies

A variety of techniques have been used to reduce the decay and other forms of vegetable losses in the area, these include heaping of onion on the floor of straw hurt, sanitation to reduce pathogens inoculums from all types of vegetables, careful handling to reduce wounding, staring vegetables at low temperature, treatment of vegetables with fungal inhibitor among others.

CONCLUSION

It was concluded from the above review that fungal disease of vegetables is caused by several pathogenic fungi under different conditions. Many studies have been carried out with respect to occurrence, causal organisms, severity, losses, Pathogenicity and disease management. This review may help the future researchers to devise a concrete strategy for evaluating different pathological aspects and management of the post harvest fungal diseases of vegetables. However, further study is needed to reveal all the other recent reports about various pathological aspects on the fungal diseases of vegetables and management strategies opted for diseases**.**

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