DOWNLOAD PDF SMUT IN WHEAT AND THE MEANS TO BE USED FOR ITS PREVENTION

Chapter 1 : 4 Major Diseases of Wheat | Plant Diseases

At head of title: Government of the Province of Saskatchewan. Department of Agriculture.

The following points highlight the four major diseases of wheat. Rusts of Wheat 2. Hollyhock Rust of Wheat 3. Loose Smut of Wheat 4. Wheat is attacked by three different rusts: Rusts of various crops are mentioned in ancient history. The writings of the Romans bear evidence that their cereal crops were attacked with rusts. During subsequent years rusts were reported from different countries of the world, but without realizing the actual reason behind the incidence. It was Persoon in , who recognized that the stem rust was due to the attack of a fungus Puccinia graminis. But the true life history of P. Black rust or stem rust or black stem rust. This disease is present in greater or less amount practically in every country throughout the world, where wheat is grown, and epiphytotics have been recorded in many countries. The disease is most damaging in moderately moist areas and in moist seasons in areas with low average rainfall. With the onset of the disease, elongated brown or reddish-brown pustules or sori burst through the epidermis of the host tissue Fig. These pustules or uredia or uredosori split open in an irregular manner having an elongated crater-like opening with ruptured host epidermis clinging to one or both sides of the opening. The uredosori may develop without any surrounding chlorotic or dead cells or they may be seated in chlorotic areas which soon become dead. They may be few in number, or they may be very numerous and may coalesce to form more or less elongated brown or rusty powdery streaks. Within these sori are masses of reddish or rust-coloured powder consisting of thousands of minute dust-like uredospores. Later in the season the black rust stage or winter stage or telial stage appears. This consists of elongated pustules or telia or teleutosori similar in shape to the uredosori but black in colour. The black colour is due to the presence of masses of dark teleutospores they bear. The teleutosori are dark-brown to black and are smooth rather than powdery, although the epidermis of the host tissue is broken and the teleutospores are exposed. The dark teleutospores are more firmly attached in their beds than the uredospores, and their stalks are more rigid and thicker. They are essentially resting spores adapted for perennating on straw or stubble. On the barberry, small circular yellowish spots appear on the upper surface of the leaf. At more or less opposite places towards the lower surface of the leaf, yellowish or orange-coloured spots appear. Close examination of these spots on the lower surface of the leaf shows a cluster of small cups with saw-toothed edgesâ€"the aecia or cluster cups. Similar hypertrophied cluster-cup lesions may appear on the fruits and petioles. Black stem rust is caused by Puccinia graminis Pers. This is a heteroecious fungus. A transverse section of an uredosorus shows that the mycelium is intercellular, the hyphae produce small-rounded or branched haustoria which penetrate in the host cells. The uredospores are stalked single-celled, dikaryotic and golden-brown. The cell of the uredospore is oblong or ellipsoid with four equatorially arranged germ pores, and strongly echinulate. These spores must have a film of water in the host surface before they can germinate. The uredospores can infect graminaceous hosts repeatedly. Two kinds of spores may frequently be found together in the same sorus. A teleutospore is stalked consisting of two thick-walled, smooth, superimposed cells, the top cell being rounded or blunted and thickened at the apex. Each spore is dark- brown, bur-black in mass. Each cell during development possesses a pair of nuclei contributed by the dikaryotic mycelium. When the teleutospore turns brown and matures in the teleutosorus, the paired nuclei in each cell fuse. The mature teleutospore thus represents the diploid phase in the life history of P. Like the uredospores, the teleutospores also germinate in presences of a film of water. The sporidia germinate on the barberry leaf in the presence of moisture. The spermogonia are flask-shaped structures embedded in the host tissue and opening out into a small ostiole at the epidermis. They bear spermatia and flex- uous receptive hyphae. Ultimately the protoaecium develops into an aecium. The aecium when young is covered by a peridium which breaks with the maturity of the aecium. The aecium bears aeciospores in chains. The aeciospores are dikaryotic, single-celled and hexagonal in shape. The aecispores are readily dispersed by wind. They have about six germ pores in the wall. These spores serve to return the rust to the cereal or other graminaceous host. The aeciospores germinate on the graminaceous host in the same manner as the uredospores. The spores being dikaryotic are responsible for the establishment of a dikaryotic mycelium which ultimately gives rise to uredosori on the graminaceous host. This is due to the fact that P. Any particular form, race or variety can attack certain species or varieties of host plants but not all of the susceptible graminaceous hosts. The mighty Rust investigation began in Australia following the epidemic in The classical researches of Anton de Bary and the Tulasne brothers had long since established the parasitism of the rust fungi. The attempt failedâ€"the spores from the rust on the oats would not infect wheat, barley or rye. And with the exception of the rust on the wheat, which did infect the barley, he found that the rust on one cereal would not infect the others. There was not one Puccinia graminis but several, to be distinguished from one another only by the kinds of wild or cultivated grasses on which they would grow. Eriksson of Sweden had already sorted the single Puccinia graminis of his botanical forefathers into six special forms: Puccinia graminis special form avenae, to be found on oats and some half-a-dozen wild grasses; Puccinia graminis special form tritici, to be found on wheat and barley and a few others of the grasses; Puccinia graminis special form secalis, on rye, and so forth. These special forms of the fungus which differed so widely in their ability to parasitize the different cereals could perhaps be regarded as species in the making. Were these special forms of Puccinia graminis really species in an early stage of differentiation? Ward encountered a similar type of specialization toward species of Bromus. He was of opinion that the host substrate influenced the pathogenicity of a given race. Stakman and his associates made intensive study of the physiologic races of Puccinia graminis and indicated that the physiologic races are best defined by the effect upon different hosts. The physiologic races may or may not be stable. Physiologic races in so far as barberry is concerned are unknown. All physiologic races of graminaceous hosts, in so far as is known, infect barberry. When this host is infected, the pathogenic difference between races no longer exists. As such, it appears that the monokaryotic mycelium of rusts has as a rule pathogenic properties distinct from those of the dikaryotic mycelium. They are known to be viable for at least 18 months. Teleutospores serve, indirectly, to convey the disease to the alternate host, the barberry. The sporidia are dispersed by air currents and fall on the barberry host and infect young stems, petioles and leaves by direct penetration of the cuticle. Infection may take place during the day or night but is favoured mostly by daylight. The function of spermogonia was established by Craigie in The aeciospores dropping from the aecia are caught up by air currents and are carried to the graminaceous hosts. The uredospores formed in uredosori germinate on graminaceous hosts to spread infection. These spores germinate by a germ tube in a film of water. The tip of the germ tube swells to produce an appressorium from which a narrow hypha arises which passes through stomata and invades the substomatal space where it soon expands into a vesicle. From such an initial infection an uredosorus with mature spores becomes established in eight to fourteen days. With the dissemination of the uredospores throughout the crops, fresh uredosori continue to be formed, but they usually cease to develop before the wheat begins to change colour and ripen. The development of teleutosori follows along with the slowdown of the formation uredosori as the host plant approaches maturity. Disease cycle of Black stem rust of wheat is presented in Figure The pathogen perennates as teleutospores in the stubbles and straw of graminaceous host. When the seeds from rust infected wheat plants bearing mycoplasm are sown, the mycoplasm splits up into the host protoplasm and fungus protoplasm. The fungus protoplasm then becomes organized into fungal hyphae and thus the infection is re-established. In areas where both wheat and barberry hosts are present, the infection of the former may be initiated by aeciospores. But this ideal condition does not prevail all over India. For example, in the plains of India where barberry plants do not grow for hundreds of miles but the wheat rust appears year after year. Since the barberries are absent, aecial stage does not come into picture at all. The summer heat in the plains is so intense that the survival of rust on weeds or on any other substrate is not possible. It is obvious then that the rust does not spend summer in plains. Therefore, the first appearance of rust on wheat crop during next winter is due to the dissemination of inoculum which is most likely from uredospores from some source other than plains. The possibility of air-borne dissemination from other countries is rather nil due to natural barriers like, Indian Ocean and the Himalayas. Mehta working in the

Nilgiri Hills conclusively proved that the uredospores and teleutospores cannot survive in the plains during summer, but the uredospores can do so in the hills at an elevation of 3, to 5, ft. When regular wheat crop is sown in hills it is infected by the inoculum uredospores from Briza minor.

Chapter 2 : Smut | plant disease | blog.quintoapp.com

Smut in wheat and the means to be used for its prevention [electronic resource] / By T. N. Willing, G. A. Charlton and Saskatchewan. Dept. of Agriculture.

Host resistance[edit] Plant breeders have tried to improve yield quantities in crops like wheat from the earliest times. In recent years, breeding for the resistance against disease proved to be as important for total wheat production as breeding for increase in yield. The use of a single resistance gene against various pests and diseases plays a major role in resistance breeding for cultivated crops. The earliest single resistance gene was identified as effective against yellow rust. Numerous single genes for leaf rust resistance have since been identified, the 47th genes prevent crop losses due to Puccinia recondite Rob. Leaf rust resistance gene is an effective adult-plant resistance gene that increases resistance of plants against P. The line RL, developed in Canada for Lr37 resistance, showed seedling and adult-plant resistance to leaf, yellow and stem rust. Crosses between the French cultivars will therefore introduce this gene into local germplasm. Not only will the gene be introduced, but the genetic variation of South African cultivars will also increase. Molecular techniques have been used to estimate genetic distances among different wheat cultivars. With the genetic distances known predictions can be made for the best combinations concerning the two foreign genotypes carrying gene Lr37, VPMI and RL and local South African cultivars. This is especially important in wheat with its low genetic variation. The gene will also be transferred with the least amount of backcrosses to cultivars genetically closest to each other, generation similar genetic offspring to the recurrent parent, but with gene Lr37, Genetic distances between near isogenic lines NILs for a particular gene will also give an indication of how many loci, amplified with molecular techniques, need to be compared in order to locate putative markers linked to the gene. Nomenclatural history[edit] Fungal names are important. These are the keys to all information behind them. Then, an appropriate name can lead users to the right information. In the case of plant pathogenic fungi using an appropriate name is more important because of practical reasons. There are several examples among rust fungi of one species called with different names during different eras. This species has been called by at least six different names since , when G. Winter described the Puccinia rubigo-vera. Later, Eriksoon and Henning put it under the P. In and after some experiments Eriksson concluded that the rust should be considered as a separate authentic species. For this reason he described P. This name was used by Gaeumann [2] in his comprehensive book about rust fungi of middle Europe. Mains was among the first scientists who used a species name with broad species concept for WLR. They considered the same broad species concept and also discussed the validity of P. Finally, they introduced P. Wilson and Henderson [4] also used a broad species concept for P. The accepted name for WLR in their flora was P. Cummins in his rust monograph for Poaceae introduced an ultra-broad species concept for P. There was another stream opposite to broad morphologically-based concept among uredinologists. In the case of graminicolous rust fungi this stream was started by Urban who introduced P. Savile was also among the uredinologists believing in narrowing the species concept and considered P. Finally he considered WLR as a part of Puccinia persistens species with aecial stage on Ranunculaceae members, totally different from P. His final name for this rust was P. Wheat leaf rust spreads via airborne spores. Five types of spores are formed in the life cycle: Urediniospores , teliospores , and basidiospores develop on wheat plants and pycniospores and aeciospores develop on the alternate hosts. Before sporulation, wheat plants appear completely asymptomatic. Thalictrum flavum[edit] P. In order to complete its sexual life cycle P. In places where Thalictrum does not grow, such as Australia, the pathogen will only undergo its asexual life cycle and will overwinter as mycelium or uredinia. After around 10â€"14 days of infection, the fungi will begin to sporulate and the symptoms will become visible on the wheat leaves. Some places wheat rust can easily flourish and spread. In other areas, the environment is marginally suited for the disease. Urediniospores of the wheat rusts initiate germination within one to three hours of contact with free moisture over a range of temperatures depending on the rust. Urediniospores are produced in large numbers and can be blown considerable distances by the wind, but most urediniospores are deposited close to their source under the influence of gravity. Urediniospores are relatively resilient and can survive in the field away from host plants for periods of several weeks. They can withstand freezing if their moisture content is lowered to 20 to 30 percent. Viability rapidly decreases at moisture contents of more than 50 percent. Long-distance spread of urediniospores is influenced by wind patterns and the orientation of the spore to latitude. In general, spores move west to east due to the winds resulting from the rotation of the earth. At progressively higher latitudes, winds tend to take a more southerly component in the Northern Hemisphere and a northerly component in the Southern Hemisphere. Puccinia triticina can survive the same environmental conditions as the wheat leaf, provided infection but no sporulation has occurred. Stubbs, [10] Chester [11] Symptoms[edit] Symptoms: Small brown pustules develop on the leaf blades in a random scatter distribution. They may group into patches in serious cases. Symptoms can range in severity from barely aesthetic to completely overrun on the leaf surface. On barberry leaf the disease appears as powdery yellow spots with aecia being dispersed from the underside of the leaf. Control[edit] Varietal resistance is important. Chemical control with triazole fungicides may be useful for control of infections up to ear emergence but is difficult to justify economically in attacks after this stage. Control often is not as common as prevention through the creation of genetically resilient varieties and the removal of common barberry. Cultivars are the best method of controlling the disease and have been utilized for over years. However, resistance linked to single genes have been out maneuvered by the pathogen adapting to new cultures. This is why the destruction of the alternate hosts are key to control. Early-maturing cultivars as well as spring wheat should be sown as early as possible to avoid peak rust periods. Self-sown wheat volunteers should be destroyed as not to further spread urediniospores at the end of harvest. J, [13] Yehuda [14].

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Chapter 3 : Full text of "Stinking smut (bunt) in wheat and how to prevent it"

The Federal standards (grades) for wheat specify that â€" Smutty wheat shall be all wheat which has an unmistakable odor of smut, or which contains spores, balls, or portions of balls of smut in excess of a quantity equal to two balls of average size in 50 grams [approximately 2 ounces] of wheat.*

Ballantyne Wheat is a very important source of carbohydrates, proteins, vitamins and minerals. It occupies 27 percent of the total cereal production worldwide. Among the biotic constraints, smut diseases of wheat are important because they affect yield, quality of the wheat grain and subproducts and are subject to domestic and international phytosanitary regulations. Although most of these diseases can be controlled with chemical treatments, in many wheat-producing areas farmers do not follow this practice due to economics and the effect that these chemicals may have on the environment. Breeding for resistance has been a successful research activity and certainly is the best control method in the long term. However, variation in the pathogen may sometimes pose a threat to wheat production. In most cases, the use of clean seed will help to avoid dissemination of the fungal propagules, a practice recommended. Common bunt has also been reported on numerous grasses, but most are considered hosts only in exceptional circumstances Hardison et al. The disease is called stinking smut and hill bunt in some areas. Other than differences in teliospore morphology, the two fungi that cause common bunt are essentially identical. Tilletia tritici teliospores have a reticulate exospore, whereas those of T. Teliospores typically are viable for only two years in soil under field conditions but can remain viable for many years on stored seed. The disease is initiated when soil-borne, or in particular seed-borne, teliospores germinate and eventually produce hyphae that infect germinating seeds by penetrating the coleoptile before plants emerge. The intercellular hyphae become established in the apical meristem and are maintained systemically within the plant. Symptoms of common bunt usually are not apparent until after heading when sporulation begins in the young ovary, but infected plants are often slightly stunted. After initial infection, hyphae are sparse in plants but proliferate in the spikes when ovaries begin to form. Sporulation occurs in endosperm tissue until usually the entire kernel is converted into a sorus consisting of a dark brown to black mass of teliospores covered by a modified periderm, which is thin and papery. The sorus is light to dark brown and is called a bunt ball Plate The spikes are somewhat normal in appearance at maturity except that the kernels are converted into sori. Compact-type spikes tend to become more lax when infected, and infected spikes of most genotypes become at least slightly lighter in colour at maturity Plate Disease spikes have a conspicuous odour similar to rotting fish. Sori often rupture during harvest and handling, which spreads teliospores on seed and soil, but intact sori can also be found among harvested grain. When left unchecked, considerable yield losses can occur when the inoculum concentrations are high and the disease conducive conditions are ideal. In addition to yield losses, grain quality is also reduced due to the poor palatability of products made from highly contaminated grain, which causes an off colour and odour in the finished product. Well-defined pathogenic races have been found among the bunt population, and the classic gene-for-gene relationship is present between the fungus and host Hoffmann and Metzger, ; Goates, Although in some parts of the world breeding for resistance is an important part of common bunt management, most areas rely on seed treatments for control. Several systemic seed treatment chemicals, such as carboxin, difenoconazole, triadimenol and others, are highly effective for controlling the disease and have eliminated losses where they are commonly utilized Hoffmann and Waldher, ; Gaudet et al. These chemicals adequately control disease that can result from both seed-borne and soil-borne teliospore inoculum. Even where seed treatments are commonly used, a residual amount of inoculum is often still present that can cause disease outbreaks when seed treatments are not used regularly. Hoffmann and Goates have presented comprehensive reviews of this disease. Additional information on common bunt is presented in section "Dwarf bunt". The disease has never been reported on spring-planted wheat. Teliospores of the fungus have a reticulate exospore and are similar in appearance to those of T. Tilletia controversa is of quarantine significance to several countries, so differentiation of these two pathogens can be important. In addition to these morphological differences, teliospores of T. Infection occurs during the winter when, after several weeks of continuous cool, humid conditions, the teliospores at or near the soil surface germinate and eventually produce hyphae that infect seedlings. Continuous snow cover best produces these climatic conditions. Most infection occurs during late December to February Purdy et al. Dwarf bunt is a soil-borne disease; however, a small amount of infection has been induced in experiments with extremely high levels of seed-borne inoculum Grey et al. The distribution and incidence of dwarf bunt is highly correlated with snow conditions. Significant yield losses occur only after a winter with an extended period of snow cover in areas where relatively high levels of teliospores are present in the soil. The disease has its greatest potential when persistent snow covers unfrozen ground. Dwarf bunt occurs sporadically in several areas of the world, and its geographic distribution and year to year incidence is limited by the special climatic conditions required for infection and establishment in particular areas. Losses in yield and quality caused by dwarf bunt are the same as those described in section "Common bunt". Disease symptoms can be evident after early spring growth. As plants grow, the culms that produce diseased spikes are shortened in height by about 50 percent Plate These symptoms are more pronounced when infection is severe. After heading, sori similar to those described for common bunt form instead of kernels. Sori of dwarf bunt are usually more rounded than those of common bunt and tend to flare the glumes, giving the spike a ragged appearance Plate Other than this, the infected spikes appear some-what normal. It is common for infection to occur in only a few spikes per plant and also in only a portion of the kernels of individual spikes, particularly in resistant genotypes or under marginal climatic conditions. Usually kernels are completely transformed into teliospores, but partially diseased kernels can occur, which appear similar to Karnal bunt disease caused by T. This symptom can also occur in kernels infected with common bunt. Like common bunt, diseased spikes have a conspicuous fishy odour. Sori of dwarf bunt can swell and rupture during a period of wetting, which releases teliospores to the soil. In addition, sori are fragile and can rupture during harvest. Numerous pathogenic races of the fungus have been identified that follow the classic gene-for-gene system in the host-pathogen relationship Hoffmann and Metzger, The closely related common bunt pathogens are regulated in wheat by the same resistance genes. Thus, resistance to dwarf bunt can also confer resistance to common bunt. A very high level of resistance has been incorporated into several commercial cultivars in the United States that are commonly grown where the disease has the greatest potential Goates, These resistant cultivars have eliminated yield and quality losses in areas of the United States that historically had the worst disease incidence. The primary source of this resistance has continued to be effective for about 25 years. In addition, new high-yielding cultivars are available in the United States, which have additional sources of resistance that are highly effective Souza et al. In the United States, there is no known virulence to any of these sources of resistance; however virulence against these sources has been detected in some isolates from Eastern Europe. Goates has presented a comprehensive review of host resistance to dwarf bunt. Most of the common seed treatment chemicals that control other smuts and bunts are ineffective at controlling dwarf bunt because infection occurs months after seeds germinate when the chemical has become too dilute. However, the registered seed treatment chemical difenoconazole is extremely effective at low application rates Goates, ; Sitton et al. Informative reviews of dwarf bunt are included in Hoffmann and Goates It has also been detected in Nepal Singh et al. Karnal bunt occurs naturally on bread wheat T. Moderate temperatures, high relative humidity or free moisture, cloudiness and rainfall during anthesis favour disease development Mundkur, a; Bedi et al. Not all spikes of a plant are affected Mitra, ; Bedi et al. Infection of individual kernels varies from small points to complete infection. Affected kernels are usually partially infected Plate 28 , and completely infected ones are rare. The embryo is largely undamaged except when infection is severe. In infected spikelets, the glumes may be flared to expose bunted kernels Plate 29 , which reek of an odour similar to rotten fish caused by trimethylamine Mitra, Despite the fact that an increase in disease severity results in proportional decrease in seed weight Singh, ; Bedi et al. Although Karnal bunt affects flour quality colour, odour and palatability , levels of 1 to 4 percent infected grains could be used for human consumption Mehdi et al. If grains are washed and steeped, wheat lots with 7 to 10 percent infected grains are acceptable for consumption Sekhon et al. They occasionally have an apiculus Roberson and Luttrell, , papilla Mitra, or a vestige of attached mycelium Duran and Fischer, Variation in the enlargement of promycelial tips may occur. Primary sporidia are filiform, Primary sporidia germinate terminally or laterally to produce hyphae or sterigmata from which secondary falcate sporidia, Falcate secondary sporidia produce hyphae or other sporidia by repetition. H-bodies are not formed by T. After one or two mitoses, most sporidia become septate, forming two to four monokaryotic cells. Most secondary sporidia are mononucleate. Mycelial cells that originate from either type of sporidia are also mononucleate. After anastomosis, the dikaryotic sporogenous mycelium bears intercalated Y-shaped septa formed at the base of the probasidial initials. Solopathogenic lines have not been found. Although the site of dikaryotization in T. Most freshly collected teliospores are dormant, as indicated by the failure of fresh teliospores to germinate Mitra, ; Bansal et al. The highest germination occurs with one-year old teliospores Mathur and Ram, ; Kiryukhina and Shcherbakova, Teliospores germinate between pH 4 and 11, the optimum being between pH 6 and 9. Teliospores also germinate after ingestion by livestock and grasshoppers, providing another means of dissemination Smilanick et al. Teliospores are viable in the laboratory for five to seven years Mathur and Ram, ; Kiryukhina and Shcherbakova, Teliospores in unbroken sori and buried 8 or 15 cm in field soil or left on the soil surface can remain viable for 27 to 45 months Krishna and Singh, b. During harvest, sori may brake, and teliospores may contaminate healthy seed, soil, machinery or vehicles and may be blown by the wind for long distances. Viable teliospores were found up to 3 m over burning wheat fields Bonde et al.

Chapter 4 : Wheat seed production - A.J.G. van Gastel, Zewdie Bishaw, B.R. Gregg

This smut is very similar in general appearance to the loose smut of wheat, and like that si)ecies it ripens Avhen the grain is in flower, and is blown about by the wind.

Figure 5 Wheat kernels The earliest evidence of infection occurs shortly after ovaries would normally be pollinated. Infected ovaries appear greasy with a dark green cast. When squeezed, such ovaries reveal a mass of black spores that smell like rotting fish. This odor is actually that of trimethylamine, which is produced by the smut fungus. As the heads and kernels mature, the bunt balls develop into a hardened mass that looks like miniature footballs. The spores inside the mature bunt balls are released when the heads go through the combine harvester to produce the cloud of dust Figure 5. This dust also smells of rotting fish. Occasionally, both healthy seeds and bunt balls are found in the same head. Pathogen Biology Tilletia tritici, T. Tillet who in worked with this pathogen in wheat. Since then two species of Tilletia have been shown to be involved in this diseaseâ€"T. The two species are distinguished based on the morphology of the bunt spores Figures 6a and 6b or by modern molecular techniques, i. Tilletia tritici is found in the drier western areas of the United States whereas T. Figures 6a Figures 7 Reproduction The two Tilletia species have the same life cycle. Dark-colored teliospores form in bunted kernels and are the overwintering structures. They are released from infected plants see Disease Cycle and Epidemiology and land on healthy seeds or on the soil surface. Karyogamy and meiosis occur in the teliospore. When environmental conditions are favorable, each teliospore germinates by producing a short germ tube, technically called a basidium. Shortly after the basidium is formed, long thread-like, light-colored, haploid spores are produced, four or more per basidium Figure 7. These are called primary sporidia or basidiospores. Genetically compatible sporidia anastomose fuse very quickly to form an H-shaped structure Figure 7 , which allows the haploid nuclei in the two sporidia to come together as a dikaryon. The two nuclei do not fuse together, but function as a pair. An infectious hypha develops from the H-structure. This dikaryotic hypha penetrates into the tissue of a germinating seedling and establishes itself just behind the growing point or apical meristem of the wheat plant. Infection of wheat by the common bunt pathogen represents a race in which the fungus attempts to reach and establish itself in the developing apical meristem of each tiller before internode extension rapidly moves the apex upwards beyond the reach of the fungus. If environmental conditions favor the pathogen, infection and a consequential bunting of the majority of spikes of a susceptible cultivar will occur; conversely, if conditions are not optimal or if plant defense responses impede or stop pathogen ingress, infection will fail resulting in few or no spikes being infected. Just when the wheat head is formed, the hyphae of the smut fungus invade the newly developed seed and begin proliferating rapidly. The hyphae replace the cells of the seed, so that finally only the seed coat remains. The two nuclei eventually fuse to form a diploid nucleus in the teliospore. Disease Cycle and Epidemiology Disease Cycle These two smut fungi survive between growing seasons as teliospores on the surface of healthy seed or in the soil Figure 4. They can remain viable in either location for a number of years, perhaps ten years or more, particularly if the spores remain dry on the seed surface. When environmental conditions are favorable, each teliospore germinates, producing sporidia basidiospores Figure 7. After compatible sporidia anastomose fuse to form the H-shaped structure, the resulting dikaryotic, infectious hypha penetrates a seedling. As the plant grows, the fungal hyphae also grow, keeping pace with the apical meristerm. Eventually, the hyphae replace the cells of the seed, and the individual cells of the smut fungus become teliospores. During harvest, the smut spores are released from infected heads as the heads pass through the combine Figure 5 used to harvest the grain. They contaminate other seed being harvested or are spread by the wind to the soil surface, later to be incorporated into the soil mass during cultivation. Usually the soil moisture, which favors seed germination, also favors spore germination. Therefore, for winter wheat which is planted in the fall, infection is favored when the seed is planted later when soil temperatures are cooler. In contrast, early seeding of spring wheat when soil temperatures are cool favors infection. Disease Management

Seed Treatment Perhaps one of the greatest success stories in plant disease control is found in the use of chemical seed treatments for control of stinking smut. Early in the history of seed treatment, compounds containing copper were used, e. Later, mercury compounds were found to be even more effective, particularly in killing the seedborne teliospores. However, even the mercury compounds on the seed surface were not effective in eliminating infection from soilborne teliospores. In recent years, however, even more effective compounds for seed treatment have been developed Figure 8. Most of these are called "systemic" fungicides because they actually move systemically into and inside of the developing seedling to provide internal protection against the smut fungi. The first such compound was carboxin, which was sold initially in the early s and is still used today. Other systemic fungicides have since been discovered, including difenoconazole and tebuconazole, which are even more effective in small doses than carboxin. To date, no significant problems have occurred with the development of fungicide resistance in the smut fungi. This is probably due to the fact that there is only one cycle of reproduction of the smut fungus each year, rather than multiple cycles as occurs in many of the foliar infecting fungal pathogens where fungicide resistance has been well documented. Figure 8 Seed treatment is relatively inexpensive, very effective, and environmentally safe since very little of the active ingredient is applied per unit of land Figure 9. For growers who do not want to use chemical seed treatments, the use of organic seed treatment does offer some control, i. Figure 9 Resistant Cultivars of Wheat Stinking smut also can be controlled by the use of disease resistance. In the early part of the 20th Century when highly effective seed treatments were unavailable, a great effort was made by wheat breeders to produce smut-resistant cultivars. Today, that effort is almost nonexistent for two reasons. First, the smut fungus often mutated to form new strains, which could attack the new resistant cultivars. While most planted cultivars are susceptible to stinking smut, some are resistant, especially those developed with resistance to dwarf bunt See Signficance section. Seeding Date The severity of stinking smut can also be manipulated to a certain extent by choosing a planting date when the soil temperature is above that for optimal teliospore germination, e. This usually means either early fall seeding for winter wheat, or late spring seeding for spring wheat. While this practice can reduce the incidence of smut, it rarely eliminates the disease altogether. Although this practice can reduce the incidence of smut, it rarely eliminates the disease altogether. Generally, stinking smut is more of a problem in winter wheat than in spring wheat due to the longer period of more favorable temperatures for teliospore germination in the autumn when winter wheat is planted. Significance Historical Significance Stinking smut is a disease that was recognized early in agricultural development because of its prominent symptoms and signs, e. As such, it caught the attention of early botanists and agriculturists. Tillet, a French biologist became intrigued with the black spore masses in and actually experimented with them to determine if they could cause the disease. Even though this was prior to the time when the "germ theory of disease" was accepted, he did show that the spores were associated with the disease. However, he believed that it was a "poisonous entity" associated with the black spore masses that actually caused the disease, not the fungus itself. From the late s until the s, stinking smut was a devastating disease of wheat, particularly in winter wheat grown in the Pacific Northwest. Because of the dusty spore masses released during harvest, many "thresher" explosions occurred. Static electricity that developed around the combine machinery ignited the teliospore dust released by the combine. In , such explosions were reported in Washington. One can visualize the panic that must have developed when a "thresher-combine" pulled by a horse team caught fire in the middle of a wheat field from such a smut dust-induced explosion! Figure 10 Only when the organic mercury and HCB seed treatments became available after did losses from smut drop to much lower levels. Today, losses from smut rarely occur unless a grower chooses not to plant treated seed. This is a disease exclusively of winter wheat since the teliospores only germinate when the soil temperature hovers around freezing for long periods of time, usually 90 days or longer. This condition is usually found under snow cover so dwarf bunt is restricted to areas where winter wheat is grown and that have long periods of snow. Currently, this disease is of economic importance from the standpoint that certain countries have an embargo on the importation of wheat carrying dwarf bunt teliospores. For some time, the United States was not able to sell wheat to China because we could not guarantee to the Chinese that U. In , China relaxed its embargo and now accepts wheat shipments with low levels of dwarf bunt teliospores. Another bunt of economic importance because of its impact on trade is karnal bunt, caused by Tilletia indica. This fungus has a similar biology to that of the other smuts. However its disease cycle is somewhat different in that sporidia are blown up to open flowers, germinate on the stigma, and invade the developing seed. This smut was originally discovered in Karnal, India in the s, but recently was found in Mexico, and now in a few wheat fields in the southwestern portion of the United States, particularly Arizona and neighboring areas of California. Many countries of the world restrict importation of wheat carrying teliospores of karnal bunt. Although the disease causes little yield loss, its greatest impact is because of its effect on wheat trade Selected References El-Naimi, M. Organic seed treatment as a substitute for chemical seed treatment to control common bunt of wheat. Chemical seed treatments for controlling seedborne and soilborne common bunt of wheat. Bunts and smuts revisited: Has the air been cleared? Plant Health Progress Differentiation of Tilletia species by rep-PCR genomic fingerprinting. Compendium of Wheat Diseases.

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Chapter 5 : Wheat allergy - Wikipedia

Flag smut of wheat has ceased to be a problem in the regions where seed treatment with systemics is a routine practice for the control of this disease and for loose smut (Ustilago tritici).

The Rusts and Smuts Introduction The rusts and smuts are perhaps the most economically important fungal plant pathogens. The rusts and smuts may be recognized by the bright orange pustules and the black powdery appearance of the host plant, respectively. Stem rust Puccinia graminis on wheat stem and leaves. Bermuda grass smut Ustilago cynodotis on flowers. The observation of plant diseases have probably been observed by mankind since the time of hunter gatherer society Agrios, However, such observations cannot be ascertain due to lack of documentation. Although during historical time the observation of plant pathogens is certain, there is still controversy as to what plant diseases are being referred to. Cereals are considered to be the first cultivated crops Simpson and Conner-Ogorzaly, and the earliest records of plant diseases referred to, in The Bible, are thought by some to be the rusts and smuts Agrios, ; Carefoot and Sprott, ; Hudler, ; Large, An example that has been cited is of the first famine, as told in the Bible Genesis Hudler names three species of rusts, Puccinia graminis, P. In this story, Joseph has interpreted the dream of Pharaoh to mean that God has revealed to him that there would be seven good years where the wheat crops would flourish, followed by seven years in which the wheat would be "blighted" causing famine. However, there appears to be more evidence that would question the conclusive identification of rust and smut as causes of diseases in the Bible. The reference to diseases such as Blast, Blight, Mildew and Brand, in the Bible and even in later historical times, have been used interchangeably, referable to other diseases Fischer and Holton, ; Littlefield, or possibly not a disease at all Littlefield, An example of the latter is the hot sirocco wind off the Arabian desert may have been the cause of "blasting" rather than rust, and even as recently as the 19th. Century, the term "mildews" was applied to rust diseases in Great Britain. While ancient Greeks and Romans may not have had names for rust and smut diseases, there seems to be little doubt that these diseases were observed. Aristotle, Theophrastus and Roman writers such as Vergil, Pliny and Ovid gave enough details in their writings that there is little doubt that they were referring to these groups of fungi Littlefield, ; Fischer and Holton, Carefoot and Sprott , specifically described how famine came about during the declining years of the Roman Empire that could, in part, be attributed to rust. The higher incidence of wheat rust was said to be due to the increase in rainfall during the three centuries following the birth of Christ Littlefield, Ovid also described an entire ceremony for rust that also began during this period. It was believed that the origin of rust began as a punishment for mankind for the burning of a red fox caught in a chicken yard. The reenactment of this story became an annual ritual on April 19 as a sacrifice for averting rusts disease. The ritual later became an annual, sacred festival, the Robigalia, on April 25, with elaborate ceremonies and sacrifices made to the rust god, either Robigus, a male diety, or his female counter part Robigo. Sacrifices to Robigus or Robigo were made frequently made during the famine. Kavaler tells a similar story as that of Carefoot and Sprott , but instead of rust being the lone pathogen, she tells of smuts, as well as other fungi that were not named. The latter occurring would seem to be within the realm of possibility given the increase rainfall during this period of time. Today, we will discuss these two groups of diseases and the impact they have had on western cultures. We will begin with the rusts fungi since they have had the most impact, historically and economically, and continue to have significant impact. The species that we will discuss is Puccinia graminis, one of three species that cause Wheat Rust, which is probably the earliest recorded pathogen. We will also discuss Hemileia vastatrix, the cause of Coffee Rusts, a pathogen that changed the drinking habit of England and gave rise to an English stereotype and discuss the smuts in a more general matter. The Rust Fungi Before describing some of the impact that this group of diseases has had and continues to have on the world, let us look into the uniqueness of the life history of this fungus. Unlike most parasitic fungi, or fungi in general, the rusts do not have only one spore or two spore stages one sexual and the other asexual , and a single host, they may have as many as five spore stages and may have two hosts. The spore stages for this species is as follows: Urediospores in uredia sing. Teliospores in telia sing. Basidiospores on basidia sing. Aeciospores in aecia sing. The basidiospores are not borne on either hosts, and is the transitional stage that initially infects the barberry host. During the early spring, the aeciospores will infect the wheat plant. Infection of the wheat occurs in both the stem and leaves. Entry into the host occurs when the spores germinates and enters the plant through openings called stomata. Stomata are pores on the surface of the herbaceous parts of plants that allow for gas exchange to occur. However, these openings also provide an avenue for pathogens such as the rust fungi to enter. Once entry into the wheat plant has been accomplished, mycelium will grow and begin to absorb nutrient from the plant. The mycelium in the host plant will give rise to clusters of urediospores, with each cluster being produced in a uredium. As the urediospores develop, they will burst the epidermis, exposing the characteristic, rusty-colored urediospores on the surface of the plant. This stage is a "repeater stage" and is the most damaging stage to the wheat. The urediospore can infect other wheat plants throughout the spring and early summer. During late summer, just before fall, the uredium gradually converts into the telium and begin to produce the two-celled, thick-walled teliospores. The conversion is readily observed as the rusty-brown uredium becomes black as the teliospores are borne. Rusty pustules of uredia on leaf from: Urediospores as seen through microscope from http: Black pustules of telia on stem. Teliospores as seen through microscope. The following spring, each cell is capable of germinating to produce basidia and basidiospores. What happens next is unique among the fungi. Instead of infecting the wheat plant, again, the basidiospores, instead, must infect the alternate host, the barberry and produces spermogonia on the upper surface of the barberry leaves. Each spermogonium consists of what is interpreted as female receptive hyphae and male spermatia. These structures may be thought of as "eggs" and "sperms", respectively. Thus, this is the site where the "sexual act" takes place. In order to get the spermatia and receptive hyphae to "meet", the spermogonium exude a sweet, nectar that attract flies. As a fly goes from spermogonium to spermogonium, drinking the sweet liquid, spermatia become attached to the fly and becomes deposited on the receptive hyphae and begins to go through its sexual cycle. Unless this event takes place, the aeciospores, the next spore stage, will not form. The aeciospore is the stage that will then reinfect the Wheat plant and the cycle then starts again. Teliospore germinating to produce basidium from http: Spermogonium on upper surface of Barberry leaf and Right Image: Spermogonium section with receptive hyphae and spermatia from http: Aecium on lower surface of Barberry leaf and Right Image: Aecium section with aeciospores from http: Given the complexity of the life cycle of wheat rust, it would be safe to assume that the complete life cycle of this pathogen was not known when it was first observed during. Also, since the urediospore stage of wheat rust was the most recognizable stage of the life cycle, it will be seen that it would be the only known stage for centuries. Following the Fall of the Roman Empire, the growing of wheat expanded to Northern Europe where it was free of wheat rust until the 8th-9th Century when the barberry was also introduced and established as more travel between Europe and Middle East, where wheat rust is thought to have first became established with wheat as an agricultural plant. Over time, farmers began to realize that there was an association between barberry and wheat rust. However, it would be several centuries before this knowledge would be acted upon Barberry and Wheat Rust: An Answer to Eradication of Wheat Rusts? At some point in time farmers observed that wheat rust was often worst when there were barberry bushes were nearby. By , in France, the first law was enacted to control wheat rust by eliminating the barberry, even though there was not any tangible evidence connecting the two Littlefield, ; Schumann, This was followed later by other European countries and this practice was also followed as America was being colonized. While this practice was maintained the Europeans settled in the New World also did bring barberry plants with them since its wood was used a source of tool handles and yellow dyes, and its fruits for jellies and sauces Schumann, However, even if they did not, Wheat Rust would still be a problem since there are two native species of Barberry, in North America. Despite this discovery, it would be a long and difficult path to discover the five spore stages in the life cycle of the wheat and would require literally the efforts of thousands of researchers, starting in the 18th Century before this great mystery would become unraveled. Microscopic examination of the rust pustules, in , by the Italian naturalist, Felice Fontana, revealed to him that the pustule was composed of what he called "small parasitical plants". He also noted that the pustule was actually composed of two kinds of "bodies". One was the rusty orange color that was expected and the other was black. Fontana concluded that this represented two species of fungi that were named by Persoon as Uredo linearis and Puccinia graminis, respectively. Because the two "species" always were together, even in the same pustule, eventually led to the hypothesis that the two spores were derived from the same fungus. Anton de Bary would later observe that this hypothesis was correct in his observation that the uredia stage would eventually become the telia stage. It was finally the Tulasne brothers who turned their attention to the rust fungi in and concluded that there were five and only five spore stages and that different numbers of these spore stages could be found in different species of rust fungi. But what was the connection between the wheat host and the barberry? However, he was unable to reinfect the wheat with the basidiospore stage. After numerous attempts to reinfect the wheat, de Bary believed, though he thought it was rather far fetched, that perhaps another plant was required. Even though there was a history of the wheat plant with barberry in this disease, the connection was not made immediately. However, it was made, and soon after discovered that it was the aeciospores of aecia stage that reinfects the wheat host. With that de Bary had solved all but but the function of spermogonium, which would remain a mystery until when when a Canadian plant pathologist, John Craigie, determined the function of this part of the life cycle. The discovery that Barberry is the alternate host for Wheat Rust was a rather important discovery in trying to control the disease. If we remove the Barberry plant, the teliospores may be produced and survive the winter, but the basidiospores will not have an alternate host to infect. The urediospore cannot survive a harsh winter and will also die. Thus, the Wheat Rust disease is ended. There was a program that was developed, in the United States, in , and continued for decades, to eradicate the Barberry. This program was started to destroy Wheat Rust, but also was used as a means of employing large number of people during the Great Depression, in the s.

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Chapter 6 : Smut and bunt diseases of cereal - biology, identification and management | Agriculture and Fo

Stinking smut is a disease that was recognized early in agricultural development because of its prominent symptoms and signs, e.g., black smelly masses of spores in the heads of wheat. As such, it caught the attention of early botanists and agriculturists.

JPG The major Western Australian cereal crops, wheat, barley and oats, are susceptible to a range of smut and bunt diseases. Generally, smut diseases are host specific, meaning that smut of one cereal crop will not infect others for example, loose smut of wheat does not infect barley or oats. Smut diseases have one of two distinct life cycles: It is important to know the type of smut and its life cycle in order to determine effective control options. Internally seed-borne smut diseases Loose smut of barley and wheat are internally seed-borne and carried as a small colony of fungus inside the seed embryo rather than as spores on the seed coat. These are the only internally seed-borne smuts that occur in Australian cereal crops. Contaminated machinery and soil do not transmit these diseases. Loose smut of wheat and barley Loose smut of barley Ustilago nuda and wheat Ustilago tritici are caused by different fungal species specific to the crop they infect, however they have similar life cycles. Infected seed shows no symptoms and appears normal. When infected seed germinates, the fungus becomes active and grows slowly in the growing point of the plant. Diseased plants appear to grow normally but may be slightly taller and earlier maturing than surrounding healthy plants. At heading, the fungus forms a compact spore mass to replace all florets within the cereal head Figure 1. Figure 1 Loose smut of barley. Close up view of barley heads affected with loose smut All tillers on an infected plant can produce smutted heads and infected plants produce little or no grain. The black powdery spores blow away to leave a bare stalk or rachis Figure 2. The spores are released as the rest of the crop is flowering. They infect the developing grains of healthy plants and remain dormant until sown the next season. Frequent rain showers and high humidity at flowering favour infection. The higher rainfall southern areas of Western Australia are traditionally the worst areas for loose smut of wheat and barley. Further information is available on the my crop pages: Diagnosing loose smut in wheat and Diagnosing loose smut in barley. Figure 2 Only the rachis stalk remains after the spores of loose smut blow away A DAFWA nursery trial reflected field observations that Hindmarsh and its sister line La Trobe are both more likely to be affected by loose smut than the majority of other varieties tested including Bass, Commander, Flinders, Gairdner, Granger, Scope CL, Skipper or Wimmera. Yield loss is directly related to the level of infection in sown seed. Grain receival points accept small quantities of loose smut contamination in wheat and barley before applying dockages. How to avoid or manage it The disease is controlled by pickling seed with a systemic fungicide which penetrates the developing seedling to kill the internal infection. Cereal seed dressing fungicides differ in their efficacy for smut management with trial research demonstrating that some seed dressings can reduce the incidence of loose smut in heavily infected seed to nearly zero. The correct application of seed dressings is critical to ensuring adequate control. In-furrow and foliar fungicide applications are not effective. The factsheet - Controlling loose smut of barley , which compares seed dressings, is available from this page.

Chapter 7 : Smut diseases - G. Fuentes-DÃ¡vila, B.J. Goates, P. Thomas, J. Nielsen, B. Ballantyne

used for the prevention of stinking smut or bunt of wheat is an example of such treatment. Wheat and rye are subject to infection by several smuts, as are most.

Prolamin allergies[edit] Prolamins and the closely related glutelins, a recent[when? Albumin and globulin allergy[edit] At present many of the allergens of wheat have not been characterized; however, the early studies found many to be in the albumin class. Other allergies[edit] Wheat pollen and grass allergies[edit] Respiratory allergies are an occupational disease that develop in food service workers. Previous studies detected 40 allergens from wheat; some cross-reacted with rye proteins and a few cross-reacted with grass pollens. When enzymes cut proteins into pieces they add water back to the site at which they cut, called enzymatic hydrolysis, for proteins it is called proteolysis. The initial products of this hydrolysis are polypeptides, and smaller products are called simply peptides; these are called wheat protein hydrolysates. These hydrolysates can create allergens out of wheat proteins that previously did not exist by the exposure of buried antigenic sites in the proteins. When proteins are cut into polypeptides, buried regions are exposed to the surface, and these buried regions may possibly be antigenic. Such hydrolyzed wheat protein is used as an additive in foods and cosmetics. The peptides are often 1 kD in size 9 amino acid residues in length and may increase the allergic response. Common symptoms of a wheat allergy include sacroiliitis , eczema atopic dermatitis , hives urticaria , asthma , "hay fever" allergic rhinitis , angioedema tissue swelling due to fluid leakage from blood vessels , abdominal cramps, nausea , and vomiting. Reactions may become more severe with repeated exposure. Asthma, anaphylaxis, nasal allergies[edit] Main article: The Gli-B1 gene in wheat, Triticum aestivum comes from one of three progenitor species, Aegilops speltoides , indicating that nascent mutations on the B genome of wheat or from a small number of cultivated triticeae species. Allergic urticaria on the shin Urticaria, atopy, eczema[edit] Contact sensitivity , [23] atopic dermatitis , [24] eczema , and urticaria appear to be related phenomena, the cause of which is generally believed to be the hydrophobic prolamin components of certain Triticeae, Aveneae cultivars. A study of mothers and infants on an allergen-free diet demonstrated that these conditions can be avoided if wheat sensitive cohort in the population avoid wheat in the first year of life. Some individuals may be so sensitive that low dose aspirin therapy can increase risk for both atopy and WDEIA. Wheat allergies were also common with contact dermatitis. A primary cause was the donning agent used for latex gloves prior to the s, however most gloves now use protein free starch as donning agents. Rheumatoid arthritis[edit] There appears to be an association of rheumatoid arthritis RA both with gluten sensitive enteropathy GSE and gluten allergies. In patients with wheat allergies, rye was effectively substituted. In addition, cross-reactive anti-beef-collagen antibodies IgG may explain some rheumatoid arthritis RA incidences. When 10 foods causing the most reactions were removed migraines fell precipitously, hypertension declined. The published data on this approach are sparse, with the only double-blind study reporting negative results. Omega-5 gliadin, the most potent wheat allergen, cannot be detected in whole wheat preparations; it must be extracted and partially digested similar to how it degrades in the intestine to reach full activity. Other studies show that digestion of wheat proteins to about 10 amino acids can increase the allergic response 10 fold. Certain allergy tests may not be suitable to detect all wheat allergies, resulting in cryptic allergies. Because many of the symptoms associated with wheat allergies, such as sacroiliitis , eczema and asthma , may be related or unrelated to a wheat allergy, medical deduction can be an effective way of determining the cause. If symptoms are alleviated by immunosuppressant drugs, such as Prednisone, an allergy-related cause is likely. If multiple symptoms associated with wheat allergies are present in the absence of immunosuppressants then a wheat allergy is probable. Gluten-free diet Management of wheat allergy consists of complete withdrawal of any food containing wheat and other gluten-containing cereals gluten-free diet. Less obvious sources of wheat could be gelatinized starch , hydrolyzed vegetable protein , modified food starch, modified starch , natural flavoring, soy sauce , soy bean paste, hoisin sauce, starch, vegetable gum , specifically beta-glucan , vegetable starch. Alternative cereals[edit] Triticeae gluten -free oats free of wheat, rye or barley may be a useful source of cereal fiber. Some wheat allergies allow the use of rye bread as a substitute. Rice flour is a commonly used alternative for those allergic to wheat. Wheat-free millet flour, buckwheat , flax seed meal, corn meal , quinoa flour, chia seed flour, tapioca starch or flour, and others can be used as substitutes. Allergy has diagrams showing involvement of different types of white blood cells Food allergy has images of hives, skin prick test and patch test.

Chapter 8 : Stinking smut of wheat

The major Western Australian cereal crops, wheat, barley and oats, are susceptible to a range of smut and bunt diseases. Generally, smut diseases are host specific, meaning that smut of one cereal crop will not infect others (for example, loose smut of wheat does not infect barley or oats).

Early generations, such as breeder seed, can be located in the middle of a field with the same variety, which is a common practice in some North African countries. Breeder seed G1 grown in the middle of a pre-basic G2 field and G2 in the middle of a basic G3 field Plate 75 of the same variety to reduce risk of genetic and mechanical contamination for names of generations refer to Table For wheat, isolation distances are more important when dealing with smut-susceptible varieties. In India, Agarwal reported that basic and certified seed fields of susceptible wheat varieties should be isolated by m from fields infected with loose smut in excess of 0. In Morocco, a m isolation distance is required from other wheat fields if infection with loose smut is beyond 0. Restricting the number of varieties grown for seed multiplication per farm will reduce the chances of contamination. For example, in Tunisia only one wheat variety can be multiplied on a farm. Crop management Agronomic management should be optimal and is similar to that for a grain crop. Small differences do, however, exist: Roguing Roguing, removing undesirable plants, is another fundamental aspect of seed production. Undesirable plants, commonly known as rogues, are: Roguing is carried out to maintain the variety and species purity of the crop and to keep the seed crop free from seed-transmitted diseases. The best periods for roguing a wheat seed crop are at heading and at maturity because off-types and other varieties of the same species are most easily identified. In wheat, all off-types, including those that appear due to residual segregation, should be removed. For example, the inherent problem of tall off-types in semidwarf wheat varieties due to aneuploidy, arising from chromosome pairing failures at meiosis, has been discussed by Storlie and Talbert and Worland and Law Similarly, other crop species whose seed is difficult to separate during processing barley, oats, triticale, rye , noxious weeds wild oats, lolium and infected plants with seed-borne diseases i. Fusarium, Helminthosporium, Tilletia are usually easily distinguished at these stages. It may be necessary to rogue the field several times, and all tillers and roots should be removed pulled to prevent regrowth. Rogues should be removed from the field and disposed of far away from the field or burned. Roguing loose smut Ustilago tritici infected plants has no effect except in reducing the disease inoculum because the spores have already been spread and infection of the seed crop has taken place by the time the symptoms become visible. Therefore, certification schemes often do not allow the removal of smut-infected plants. However, reports from India indicated that loose smut-infected plants do head earlier and that flag leaves of smutted tillers exhibit yellow chlorotic streaks, yellow patches or yellowing at tips, even before ear emergence, and can thus be rogued before flowering. However, plants without streaks were also smutted Agrawal and Gupta, Seed certification schemes set minimum standards for each class of contaminants that are permitted in a seed crop. Roguing aims at ensuring that these standards are met. Roguing should be carried out only when the seed fields do not meet these standards; roguing fields that meet the standards is not economical. While roguing, no selection should be carried out to ensure that the genetic make-up of the variety remains the same. Roguing in early generations can be most effective. Breeder and pre-basic seed are harvested by plot combine and do not constitute many problems. Basic and certified seed, however, have to be harvested with commercial combine harvesters. The most critical factors to be considered are seed moisture content, mechanical damage and cleanliness of equipment. For seed crops, dry weather during ripening and harvesting is essential. Moisture Cereal seed reaches physiological maturity between 35 to 45 percent moisture content, but it needs to dry down to a safer moisture content for harvesting and storage Boyd et al. The seed moisture content can be used as an indicator of when the crop is ready for harvest. Electric moisture meters or the crop characteristics can be used to decide when to harvest. For wheat, threshing or combine harvesting at 16 to 19 percent moisture content reduces mechanical damage Thompson, Mechanical damage Proper adjustment of the concave clearance and drum speed of a combine is essential to avoid damage to the seed crop. Mechanical damage becomes a serious problem for durum wheat seed production in Algeria Lakhdar et al. In Algeria, seed harvested by a single ear thresher or combine showed low germination and increased fungal attack Lakhdar et al. Cleanliness Combine harvesters are often difficult to clean and may still harbour contaminating seed even after thorough cleaning. The availability of compressed air is important. The combine should be thoroughly cleaned before harvesting, as well as between different varieties. When harvesting the next variety, the first few hundred kilograms of seed may be discarded because contamination may still be present in the combine. For larger plots of certified seed, it is also possible to harvest and discard the outlying rows of the field. After harvesting, the seed should be packaged in new and clean bags to avoid contamination. Cleaning can be done because wheat seeds differ in length, width, thickness, density, weight and shape. For wheat seed cleaning, mainly screens, indented cylinders and air are used. Screens separate based on the width and thickness; a width or diameter separation is obtained by round screens, while for thickness separation oblong screens are used Plate Indented cylinders carry out length separation; the indents cells or pockets in the cylinder will, depending on their size, lift the seeds, which fit in the indents. Air separates seeds according to their behaviour in an air stream. The most important characteristic is the weight; light particles dust, chaff, glumes or empty or partly filled seeds will be lifted, whereas the heavier seed will fall down through the air stream. Each crop requires a different set of machines. The raw unprocessed wheat seed is received from growers in bags or bulk and sampled to evaluate the need for fumigation, drying and cleaning, as well as to guide and monitor processing operations. If seed moisture is too high, the seed is first pre-cleaned and dried. If insects are present, the seed should be fumigated. After the raw seed has been received and where necessary fumigated, processing operations and sequence are as outlined below Figure A typical pre-cleaner is similar to an air-screen cleaner, except that it has only one air channel to remove light material, one top scalping screen to remove large particles and one bottom grading screen to remove small particles. Dryer If wheat seed is above 11 to 12 percent moisture, it is dried before it goes into bulk storage or processing. Air-screen cleaner This is the basic cleaner, usually with two air channels and, preferably, four screens. The first air channel head aspiration removes dust and light materials as the seed falls from the feed hopper. The second air channel tail aspiration removes light seed and materials after the seed passes through the last screen. Although screen configurations vary considerably, one or two top or scalping screens remove particles larger than the good seed, and one or two bottom or grading screens remove particles smaller than the good seed. Because the average size of wheat seed varies according to the growing conditions, standard screen sizes cannot be recommended. Hand testing screens should be used to determine the exact screen perforations. Length separator A length separator is almost always used to clean wheat seed. By using the proper machine configuration, shorter or longer undesirable materials such as broken grains, weed seeds, oat, barley, etc. Broken grains and weed seeds, which are shorter than the good seed, are removed by using cylinders with smaller indents. Larger impurities can be removed by using a cylinder with indents that lift all good seed, but contaminants wild oats, oats or barley grains and unthreshed glumes remain in the cylinder. Gravity separator After the seed is cleaned by the air-screen cleaner and indented cylinder, it may be necessary to use a gravity separator. The gravity separator classifies a seed mixture mainly according to density or specific gravity. It can be used to remove unthreshed glumes and soil particles, which have similar sizes to wheat but different weights. Another application is the removal of weevil-infested grains from the seed lot and upgrading seed in order to improve germination. Furthermore, wild oats and some barley may be removed from the wheat seed lots, but at the expense of substantial amounts of good seed and only after recycling the material a number of times on the gravity separator. Treater Wheat seed should, if necessary, be treated with the appropriate fungicide to protect the seed and seedling after planting. Insecticides are sometimes applied to protect seed in storage and in the soil. Treatments may be applied to protect the seedlings or adult plants against pathogens carried on or in the seed. Dryer In humid and hot climates, seeds may be sealed in vapourtight plastic bags to maintain viability over longer periods. In such cases, wheat seed moisture content must be below 9 percent, preferably not over 8. Usually, a dehumidified, closed-circuit dryer is used after the seed treatment is applied. Bagger-weigher The final step is to weigh the proper amount of seed into the proper kind of bag. Wheat seed bags should be of a size that fits local farmer needs seed rates and field size. During processing, strict attention should be paid to the cleanliness of the processing machines and any admixture should be avoided. Every processing plant should have a complete set of hand screens, a small air-screen cleaner and an indented cylinder to help determine the proper processing requirements. It is also essential to have an internal quality control laboratory attached to each seed plant with a small seed testing facility. This laboratory unit should constantly monitor the quality of the seed and the efficiency of processing operations. Seed infection may lead to low germination, reduced field establishment, severe yield loss or a total crop failure. For example, severely infected wheat grains with Karnal bunt either fail to germinate or produce a greater percentage of abnormal seedlings Singh and Krishna, ; Singh, In wheat, fungi Fusarium spp. Chemical seed treatment is one of the efficient and economic plant protection practices and can be used to control both external and internal seed infection. It protects young seedlings or adult plants against attack from seed-borne, soil-borne or airborne pests. It disinfects seed from pathogen, checks spread of harmful organisms, promotes seedling establishment, maintains and improves seed quality or minimizes yield losses. Selection of the proper chemical depends on the target organisms. A wide range of chemicals Diekmann, and equipment Jeffs and Tuppen, are now available for such purposes. Some recent literature gives detailed information on the management of bunts and smuts Wilcoxson and Saari, and bacterial Duveiller et al. Moreover, pre-harvest foliar application of chemicals can also reduce the internally seed-borne fungi and can be combined with seed treatment to produce healthy seed. Sinclair cited that foliar spraying of wheat with benomyl, methyl benzimidazole carbamate or benomyl plus mancozeb reduced F. Apart from disease control, seed treatment also has a positive effect on crop growth and yield. Ahmed reported that wheat seed treatment with systemic fungicides, such as Baytan, Raxil and Vitavax, significantly increased crop stand, grain yield and yield attributes. Seed production in disease-free areas or under effective disease control and field inspection schemes is very important to obtain disease-free seed.

DOWNLOAD PDF SMUT IN WHEAT AND THE MEANS TO BE USED FOR ITS PREVENTION

Chapter 9 : Loose smut - Wikipedia

Covered smut of barley, however, is not so easily controlled as is stinking smut of wheat, because the barley smut spores apparently are borne on the inside, as well as on the surface of the glumes.

One of the easiest and most promising ways of making the crop more profitable is by controlling stinking smut bunt. It was estimated 1 that in stinking smut caused a reduction in yield of wheat in the United States amounting to 28,, bushels, or an average of about one-half bushel per acre harvested. Added to this were the discounts for smutty wheat on the market, which undoubtedly amounted to several millions of dollars. These losses could have been prevented by seed treatment at a cost of from 5 to 10 cents an acre. Stinking smut is one of the most common and most important wheat diseases. Being closely associated with the seed, and having the same climatic requirements as wheat itself, it has spread and established itself practically everywhere the crop is grown. It occurs generally throughout the United States except possibly in a few communities or local areas where united efforts have been put forth to eradicate it. Weather conditions, time of planting, amount and kind of seed treatment, and possibly other factors influence its prevalence. For several years it may be of only moderate importance in a State or area, and then for a year or a period of years it may become out- standingly important. In Pennsylvania and other Eastern States there was a very marked increase in severity in , , and In the spring-wheat States there has been a decided increase in severity since about Previous to that year the percentage of carloads of hard red spring and durum wheat grading smutty at Minneapolis had been averaging only from 1 to 2 per cent. Commencing in , however, and continuing in , , , , and , the receipts averaged Coincident with this was an increase of smut in durum wheat, which until that time had been, on the whole, rather free from smut. Investigations have pointed to the possibility that this increase may have been due to the introduction and spread in durum wheats of one or more new physiological forms or races of stinking smut. In spite of the fact that stinking smut is readily suppressed by proper and well-known seed-treatment methods, and theoretically should be on the decline as these methods become more generally adopted, the disease continues as a cause of heavy annual losses, and, in some areas at least, is on the increase rather than on the decrease. This necessitates an additional cost and is reflected in a lower price of wheat to the farmer. A smutted head is a total loss. Experiments 3 have shown that the percentage of smutted heads in the field is approximately the same as the actual loss in yield to the farmer. A field with 25 per cent of the heads smutty will show a reduction in yield of about one- fourth on account of smut. During the summer of counts to determine the amount of stinking smut were made in spring- wheat fields in 16 counties in Minnesota, the Dakotas, and Montana. The average amount of smut found in all fields was 2. If this is considered as the aver- age for all four States â€” and probably it is not far from correct â€” it represents a reduction in yield of 5,, bushels of spring wheat. During the period to the Bureau of Plant Industry issued annual estimates 4 of the reduction in yield of certain crops from plant diseases. The average annual loss from stinking smut of wheat over that year period was 2 per cent, and the average annual reduction in yield was 18,, bushels. Smutty wheat can not command as high a price as clean wheat when sold on the market. Many mills refuse to buy it. Others that are equipped with washing and scouring apparatus can use smutty wheat, but naturally will not pay as high a price for it as if it were 2 Percentages are for crop years, July 1 to June The grain trade on the Pacific coast designates the degree of smut in grain in terms of one-half per cent by weight. A large pro- portion of these losses are passed back to the grower either directly in the form of a discount or indirectly through a correspondingly lower price paid at the elevators to producers of clean and smutty wheat alike. The average discount for smutty spring wheat of the crop at country elevators was about 5 cents a bushel. During the crop year a total of , cars of wheat were received at markets at which Federal supervised grain inspection service is performed. Of these cars, 68,, or Immediately after blooming the yellow pollen sacs or anthers emerge and dangle from the healthy heads but are en- tirely absent in the totally infected heads. About the time the wheat is in the dough stage the infected heads assume a bluish-green color in contrast to the lighter green of the healthy ones. They also re- main green longer than the sound heads. In varieties in which the normal heads bend over slightly with the weight of the kernels the smutty heads are noticeably erect. In some varieties, especially club wheat, the smutty heads are more slender and often longer than the sound heads. Infected culms on the average are shorter than the healthy ones. As the grain ripens the smutty heads can be distinguished by the spreading of the chaff glumes and the appearance of the dark smut balls protruding from between them. In bearded varieties the beards awns are often deformed and brittle. When the grain is fully ripe the glumes of the diseased heads assume a pale, ashen color instead of the slightly golden yellow of the healthy heads. This applies especially to the durum wheats. The smut balls may be easily crushed between the fingers into an oily black mass which gives off a disagreeable fishy odor. In a single plant all or only part of the heads may be smutty. In a single head all the kernels may be diseased or only part of them and the rest may be sound. Smutty and healthy heads are shown in Figures 1 and 2. Stinking s m u t is easily distinguished from the loose smut of wheat, which appears at the time of flower- ing as a naked, fluffy, black mass. Loose - smut heads have no covering and the smut is soon blown or washed a w a y, leaving a bare stalk. This disease can be controlled only by the h o t-water treatment. In general it is of less importance than stinking smut. If wheat is stored in a well-ventilated place the odor becomes less pronounced after a period of weeks or months, so that the presence of smut may not always be detected by this means. But the presence of smut balls in the grain is always a positive indica- tion of infestation. These smut balls are shaped somewhat like wheat kernels but as a rule are shorter and proportionately more plump. They vary in color from silvery gray to light brown. The smut balls are creased like wheat kernels, but are without the hairy " brush " found on wheat kernels. A single smut ball contains from 2,, to 4,, spores. Each spore is capable of infecting a wheat plant unless it is removed from the seed or its viability is destroyed by treatment. In heavily smutted wheat the kernels have smut spores adhering to all parts of their surfaces, giving the grain a dark color. In more lightly smutted grain the spores are most abundant at the hairy brush end of the kernel and in the crease. If all the balls have been removed from rather lightly smutted wheat, the presence of the spores on the kernels is not always readily detected. A, Head affected with stinking smut ; arrow points to spikelet with glumes removed to show smut ball ; B, healthy head of same variety ; C, loose smut, same variety, mature stage ; D, loose smut, same variety, late stage wheat may even be judged smut free and yet may carry enough spores to produce a heavily infected crop if the soil and climatic conditions are favorable. An examination of such kernels under the microscope will reveal the presence of smut spores. When wheat is sold on the market it is always examined for smut. Smutty wheat is discounted in price. Seed wheat, however, would be considered to be heavily infested with smut if it contained as much as two balls of smut or its equivalent in spores and pieces of balls in 50 grams of wheat. Some of the smut X about 5 Stinking smut usually can be prevented by sowing smut-free seed, or by carefully cleaning and treating seed before sowing. It can be reduced by selecting a date of seeding which experience has shown gives the least smut and at the same time is best adapted for the locality, or by sowing varieties resistant to stinking smut. The threshed grain from such fields should also be carefully examined to determine that the grain is entirely free of smut balls and smut spores. Care should then be taken that the smut-free seed will not be contaminated by smutty harvesting or threshing machinery or by being placed in smutty sacks, wagons, bins, or other containers. Certified seed bought from reliable seedsmen should be but is not always smut free. Owing to the difficulty of detecting slight traces of smut in a lot of seed, and on account of the fact that under certain weather con- ditions a very slight seed infestation may result in a Jbadly smutted crop, it is usually best to treat the seed and thus insure its freedom from smut. Furthermore, recent research has brought out evidence that yields may be increased by some of the seed treatments even in the absence of stinking smut. This has been proved by numerous experiments carried out by the United States Department of Agriculture and by State experiment stations. Results obtained in experiments in and with three spring- wheat varieties are shown in Table 2. The wheat used in these experi- ments was thoroughly cleaned so that all smut balls were removed. Powdered smut was then added to the seed so that it was dark with spores and undoubtedly more heavily smutted than seed commonly used in farm practice. Portions of this lot of seed were then treated with Ceresan, 5 copper carbonate 50 per cent brand , copper carbonate 18 per cent brand , and formaldehyde, and sown in plots on the experiment station farms at St. Dak; and Bozeman, Mont. Copper carbonate, 18 per cent brand. Copper carbonate, IS per cent brand.. Formaldehyde Ounces 2 2 2 3 a Num- ber 3, 21 37 Per cent Per Xum- cent ber The 50 per cent brand of copper carbonate applied at the rate of 2 ounces per bushel reduced the percentage of smut in every case to less than one half of 1 per cent. The diluted brand of copper carbonate, containing only 18 per cent copper, when used at the rate of 2 ounces per bushel, was not as effective as the 50 per cent brand, but at 3 ounces per bushel it was as good as, and in some cases better than, the 50 per cent brand applied at the 2-ounce rate. In these experi- ments Ceresan, on the whole, was less satisfactory in the control of smut than the other treatments. Xumerous other experiments could be described to demonstrate the fact that, where soil infestation does not occur, stinking smut can be prevented by properly cleaning and treating the seed. Unsatis- factory results obtained on farms usually can be traced to improper cleaning or treating. Therefore the two most important factors in smut prevention are properly cleaning and treating the seed. Practically all wheat as it comes from the threshing machine contains more or less weed seeds, other grains, and foreign material. When the wheat is smutty it also usually contains a considerable number of whole and broken pieces of smut balls as well as smut spores. The wheat also frequently contains a considerable percentage of diseased kernels that are shrunken in size and of light weight. The crop of wheat produced and delivered to country ele- vators in the spring-wheat States contained readily separable weed seeds, other grains, and foreign material dockage , in the following- average percentages by weight: The wheat also contained a certain quantity of foreign seeds and smut balls which were not sep- arated from the grain with the testing equipment used at the ele- vators, and in addition to this, much of the wheat had been rid of other material by being cleaned on the farms before it was delivered to the country elevators. From this it will be seen that the wheat delivered from the threshing machines in that area contained con- siderable quantities of foreign seeds and smut balls. Wheat produced in other areas also contains varying but usually smaller amounts of foreign seed. Weed seeds planted with the wheat will produce weeds in the fields. Weeds materially reduce the wheat yield, and the weed seeds that are harvested with the wheat cause a reduction in the price that is paid for the wheat when it is sold on the market. All but a fraction of the weed seeds and other foreign material and smut balls can readily be removed from the seed wheat by means of the modern grain-cleaning machinery that is available.