CAZRI
DEN NEWS
Volume 14 (1) January - June, 2012

Abnormal symptoms of smut disease on *Panicum antidotale* grass in desert environment

Smut Fungi

The smuts are multicellular fungi that are characterized by their large numbers of dark coloured teliospores. The smuts get their name from a German word for dirt because of their dark, thick-walled and dust-like spores. The common name smut derives from words meaning to besmirch or smudge and refers to the presence of sooty, dirty, black, or brownish masses on the affected plants. Smut fungi are the second largest group of plant parasitic Basidiomycota. In contrast to rust fungi, their life cycle includes only one host plant and a yeast stage in most species of smut fungi. They are plant parasitic microfungi living on host plants belonging to grasses, sedges, and numerous other families of plants. Therefore they are graminicolous genera and species. More than 40 % of the known species of smut fungi infect species of Poaceae and 15 % infect species of sedges (Cyperaceae). Most other host plants are herbaceous, including species of many different host relationships of dicotyledons and monocotyledons. Economically important hosts include maize, barley, wheat, oats, sugarcane, sorghum and pearl millet. Bunt of wheat ('covered smut', 'ball smut' or 'stinking smut') caused by *Tilletia laevis* and/or *T. tritici* is most striking disease causing significant losses. Similarly, Karnal bunt is caused by the smut fungus *Tilletia indica* (also known as *Neovossia indica*) and is spread by spores. Seed smuts or bunt (*Tilletia species*) are used to designate the smuts of grasses in which the normal seeds are replaced by smut "balls." The balls retain somewhat the shape of the normal seed but encased by the seed wall.

Smut of *Panicum antidotale*

Smut fungi occur throughout the world in all agri-ecosystems including their host plants, in grasslands as well as in agriculture fields. In arid zone, smut disease occasionally attack on grasses due to acute abiotic stresses and desert environment. But, during moderate rainfall period in arid areas of Rajasthan, smut fungus attacks sewan grass (*Lasiurus scindicus*) and blue panicgrass (*Panicum antidotale*) (Fig. 1 & 2). *P. antidotale* (Hindi: *Gramna*, English: Blue panicgrass) is a tall (up to 3 metres), coarse, woody perennial grass throughout the Himalaya, the Upper Gangetic Plain and even in arid areas of Rajasthan. The plant is multi-stemmed, fibrous and having strong spreading rhizomes.

P. antidotale is native to India, now introduced to many countries as a pasture grass. It grows on sand dunes, undulating plains and dry river beds in north-west Pakistan, Afghanistan and Iran. It is tufted perennial up to 150 cm high, glabrous but with woolly bud scales at the base. Panicles are up to 30 cm long, dense, with 3 mm-long acute spikelets, the lower glume half as long as the spikelet. Glumes with broad, membranous margins are common features of the grass. It has short, thick, bulbous rhizomes and deep roots and blue-green leaves. It has a very deep root system and helps in sand dune stablization. In Gujarat, 4 733 kg green matter per hectare can be harvested. It is adapted to areas of summer rainfall (500-750 mm) and also to irrigated land. It can grow even in areas with less than 130 mm rain in Rajasthan. It has a high degree of drought tolerance. It has also some tolerance to salinity but more to alkalinity caused by

Fig. 1 & 2. Smut disease on *Panicum antidotale* and *Lasiurus sindicus*

sodium and magnesium than to the chlorides. The institute has developed variety CAZRI 347, which is ideally suited to the arid conditions and easily digestible to the livestock. It is also fairly resistant to the smut disease. As the stems rapidly get hard and woody, therefore they should be grazed or cut before flowering. Blue panicgrass is ready to graze when well established and intermittent grazing keeps its nutritious stage. Seeds are used as famine food with *Bajra* (pearl millet).

Abnormal Symptoms

The *Panicum* grass has various diseases such as malformation of flowers and smut sori on vegetative buds. Smut (*Tilletia tumefaciens*) produces gall or tumor on vegetative parts, shoots and axillary buds. Meristematic tissues of nodal buds are highly susceptible to infection. Smut galls consist of fungal and host tissues. Young galls are white, firm and covered with a semiglossy periderm. As galls begin to mature, interior tissue becomes semi fleshy and streaks of black tissues occur as teliospores begin to form. The surfaces of the galls are rapidly blackened by the large numbers of powdery ustilospores shed on them. The galls have a strong odour similar to that of wheat bunt and presumably due to the presence of trimethylamine. The main culm usually develops beyond the infected axillary buds and a normal inflorescence forms. Geographical distribution of *T. tumefaciens* is India and Pakistan. Smut sori develop in axillary buds at the base of the plant and, less frequently on upper parts of culms (Fig. 3 & 4). The infected buds become hypertrophied and swollen forming globose or finger-like galls which can be 9-10 cm long and 2-3 cm broad (Fig 5). Several smutted axillary buds are formed on infection in the nodal bud. Infected buds multiplies (1-45) into smutted nodal buds from the single nodal bud. They vary in shapes and sizes with full of brown powdery mass of teliospores (Fig. 6-8). Therefore number of galls is formed at a single node, covered with a complex arrangement of elongated, hairy and swollen scale leaves. Spore mass is powdery, brownish-black, composed of teliospores intermixed with sterile cells. Sterile cells are globose to subglobose or ovoid, hyaline, usually yellowish, 15-36 µm diam., their walls smooth, variable in thickness (1.5-7 µm thick), often distinctly laminated. Teliospores are globose to subglobose, dark brown, 17-25 µm diam.,

Fig. 3. Nodal bud infected with smut at lower region of *P. antidotale* with profuse spores

Fig. 4. Smut sori at upper nodal bud of Blue panicgrass

walls reticulate; reticulations 5-6.5 µm wide, 1.5-3 µm deep; sheath present, usually inconspicuous, rarely extending beyond the wall sculpturing (Fig. 9).

Fig. 5. Development of multiple nodal buds infected with smut giving finger like structures

Fig. 6-8. Various abnormal structures formed on axillary buds of *P. antidotale* stem during smut pathogenesis

Unusual Symptoms of other Smut Diseases

By the presence of smut fungi, many host plants show abnormal growth of certain organs or tissues, i.e. they develop galls. The entire plant can be stunted, tillering, or show giant growth. Specific organs can enlarge forming hypertrophic galls, others can be aborted or transformed. Some smuts destroy the flowering structure. Others are restricted only to certain parts of it. Some are confined almost exclusively to the stems of grasses. Others produce galls or tumor like structures in various parts of their host plants.

Fig 9. Reticulated smut spores of *T. tumefaciens*

These developments of the plant can form part of the sorus, the area where the smut develops its teliospores, and contribute to exposal and dispersal of the spores. For the development of teliospores, dikaryotic fungal hyphae in the host tissue are septated and numerous portions of cytoplasm are transformed to teliospore. This is the typical way of teliospore development for species of Ustilaginales, the largest order of smut fungi. In members of Tilletiales, teliospore initials are differentiated at the tips of sporogenous hyphae or lateral ramifications of hyphae. In these species, the gelatinous matrix is not as evident as in Ustilaginales. In mature teliospores of species of Tilletiales, endosporium and exosporium are separated by a thin middle layer.

Mode of Infection

Spores of smut fungi are found as more or less enormous powdery masses in different organs of the plant, often visible to the naked eye in flowers, inflorescences, seeds or leaves. They form smut sori, which are often accompanied by abortion of plant organs or abnormal growth of host tissue (galls). Spores are exposed by rupture of envelopes formed by fungal or plant cells, dispersed by wind, water, or animals, and germinate forming sporidia, sexual cells carrying small spores. Teliospores can also be carried in soil and on a variety plant parts. Infection occurs after heading when sporidia produced from teliospores at the soil surface are dispersed to the lower nodal buds of grass. These spores contribute to further dispersal and multiply as yeast. After infect a new host plant. Meristematic host tissues are most vulnerable plant part for the infection of smut dikaryotic cells. Depending on the different species of smut fungi, the hyphae are restricted to intercellular spaces or form hyphae or haustoria inside the cells. By interacting with living host cells, the fungus obtains nutrients for its development. The smut fungi are not entirely obligate parasites as are the rust fungi. In fact, some smuts can easily complete their entire life cycle on an artificial medium if it contains the nutrients essential for growth. Some smuts apparently persist indefinitely in the soil or in old manure piles. They are fully capable, however, of attacking their host plants when the plants are available under the requisite conditions for infection.

Tilletia tumefaciens	
Taxonomy	
KIngdom	Fungi
Phylum	Basidiomycota
Class	Exobasidiomycetes
Order	Tilletiales
Family	Tilletiaceae
Genus	*Tilletia*
Species	*T. tumefaciens*
Binomial Name	*Tilletia tumefaciens* Syd. & P. Syd.
Vernacular Name	Smut gall

Panicum antidotale	
Taxonomy	
Kingdom	Plantae
	Angiosperms
	Monocots
	Commelinids
Order	Poales
Family	Poaceae
Genus	*Panicum*
Species	*P. antidotale*
Binomial name	*Panicum antidotale* Retz.
Vernacular name	*Gramna*

Transmission

Many of the grass smuts are seed-borne and air-borne. The wind carries millions of smut spores, which are lodged in or on the developing seeds of healthy plants. When the seeds germinate, the smut spores also germinate and infect the young seedlings. Then the plants that arise from the seedlings are smutted. But smut of blue panicgrass is air as well as soil borne as it attacks only vegetative parts of the grass, that too nodal lower bud. Perennial nature of *P. antidotale* further aggravates disease severity due continuous availability of host and pathogen.

Conclusion

As the grasses have greater role in livestock productivity in arid and semi arid areas of Rajasthan due to the dominance of livestock based farming system. Blue panic grass is not only a livestock feed but also helps in soil conservation by building as well as binding the soil. Moreover, this grass is highly nutritive at pre-flowering stage and palatable to all kinds of livestock. Though the grass is fairly resistant against pest and diseases under dry is a matter of serious concern. Among the diseases, smuts are more prominent in all types of the grasses grown in Rajasthan. Thus in present scenario, the disease has assumes importance for the development of management strategies through the development of resistant strains of promising grasses or through reducing inoculum potentials of *T. tumefaciens*. Consequently detailed study of life cycle of smut disease is the need of the time prior to development of resistant germplasm/control measures. By this way intelligent control measures can be devised or resistant germplasm can be screened. As the information in this areas is meager efforts should be made in this direction utilizing the concept of networking among the NARS partners.

R. Raj Bhansali

FORTHCOMING CONFERENCES AND EVENTS

5th International Conference on Water Resources and Sustainable Development from 24 to 25 February 2013 at Algiers, Algeria. Contact: http://ciredd.ensh.dz/

First International Controlled Traffic Farming Conference from 25 to 27 February 2013 at Australia. Contact: http://ctfeurope.com/2012/ctf13/

17th Biennial Southern Silvicultural Research Conference from 5 to 7 March 2013 at Shreveport, Louisiana. Contact: http://www.bssrc.org/17thbssrc/Welcome.html

International Conference on Soils, Sediments and Water from 26 to 28 March 2013 at Lyon, France. Contact: http://www.intersol.fr/

3rd Conference on Range, Watershed and Desert from 28 to 29 March 2013 at Karaj, Iran. Contact: http://www.3rwdconf.persianblog.ir

Climate Extremes and Biogeochemical Cycles from 2 to 5 April 2013 at Seefeld, Austria Contact : http://www.bgc-extremes2013.org

The Institute of Foresters of Australia National Conference, Managing our Forests into the 21st Century from 7 to 11 April 2013 at Canberra, Australia. Contact: http://www.forestryconference.org.au/about about-the-conference

Cost Effective Tools for Soil Organic Carbon Monitoring from 7 to 12 April 2013 at Vienna, Austria. Contact: http://meetingorganizer.copernicus.org/EGU2013/session/11933

First International Conference on Remote Sensing and Geo-information of Environment from 8 to 10 April 2013 at Pafos, Cyprus. Contact: http://www.cyprusremotesensing.com/rscy2013/

35th International Symposium on Remote Sensing of Environment from 22 to 26 April 2013 at Beijing, China. Contact: http://www.isrse35.org/

8th Annual International Symposium on Environment from 13 to 16 May 2013 at Athens, Greece. Contact: http://www.atiner.gr/environment.htm

3rd Climate Change Technology Conference from 27 to 29 May 2013 at Montréal, Québec, Canada. Contact: http://www.cctc2013.ca/

Conference on Desertification and Land Degradation from 17 to 18 June 2013 at Ghent, Belgium. Contact: http://www.desertland.eu/

2nd International Conference - Energy & Meteorology from 25 to 28 June 2013 at Toulouse, France. Contact : http://www.icem2013.org/

Visit Abroad

Dr. M.M. Roy, Bangladesh from 22.1.2012 to 26.1.2012 to attend the Second Regional Committee of South Asia and China.

Dr. M.M. Azam, USA from 9.1.2012 to 8.5. 2012 to attend the USIEF Full Bright Nehru Environmental Leadership Programme 2011-12.

Sh. Pradeep Kumar, went to Viterbo, Italy for three years on 30.4. 2012 to pursue Ph.D. at University of Tuscia under ICAR International Fellowship award 2011-12.

31.5.2012 for participation in International conference on Climate Change Adaptation: Adaptation Futures-2012, at University of Arizona, Tucson

Dr. R.K. Bhatt, Dr. T.K. Bhati, and Dr. B.K. Mathur, Dubai (UAE), from 25.6.2012 to 28.6.2012 to attend the workshop for CGIAR research programme on Dryland Systems (CRP.1.1) "Integrated Agricultural Production Systems for the Poor Vulnerable in Dry Areas".

Dr. Dheraj Singh, Manila, Phillipine, from 24.9.2012 to 28 .9.2012 to participate in the 3rd Annual Meeting of the Global forum for Rural Advisory Services (GFRAS).

Dr. P.C. Moharana, Bloomington, USA, from 1.10.2012 to 31.1.2013 to participate in training course under Full Bright Nehru Environmental Leadership Programme 2012-13 on the subject titled GIS based Arid Land livelihood at the Department of geography, Indiana University, Bloomington.

Dr. J.C. Tewari, La Paz, Bolivia, from 12.11.12 to 14.11. 2012 for participate in the 10th International Workshop of "Sustainable Management of Marginal Dryland- Phase-2 (SUMAMAD-2).

Central Arid Zone Research Institute, Jodhpur 342 003, INDIA

ENVIS : Desert Environment Newsletter, Volume 14, Issue 1 (January-June, 2012)

***Editors* : Tirth Das and Dr. R.K. Dave; *Advisor* : Dr. Uday Burman**

Web: www.cazri.res.in E-mail: tdas@cazri.res.in Fax: 0291-2788706 Phone: 0291-2786931

Evergreen # 0291-2747767