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Ergot Disease Management and Production of Quality Seeds of Pearl Millet

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nary

Ergot, incited by *Claviceps fusiformis*, is an important and widespread dise- of pealr millet (*Pennisetum glaucum*). In India ergot is economically important veral states, and generally hybrids are more susceptible than open-pollinated Ergot reduces grain yield and presents health hazards to humans and : when sclerotia-contaminated grains are used for consumption. Infection pearl millet florets occurs by airborne ascospores and conidia of *C. fusifor-*, and sclerotia are formed in place of grains in the infected florets. Conta- ition of pearl millet seeds with sclerotia at harvest serves as a source of ary inoculum for the next season crop. The disease development is favou- by wet and cool weather at flowering time. The disease management prac- reported to reduce ergot in pearl millet include cultural, chemical, bio- al, biocultural, separation of sclerotia from seeds, host resistance, and tegrated disease control measures. To produce ergot-free seeds it is sugges- d to remove sclerotia from the seeds, grow the crop during the dry season in field that had no ergot incidence in pearl millet during the previous season, row seed parents of a hybrid that have proper nicking of flowering, and use got-resistant cultivars.

ntroduction

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is a staple cereal crop and is grown annually on about 11 million ha in India. The crop thus occupies 11% of the area under cereals and contributes about 5% of the total cereal production of the country (Harinarayana, 1987). The major pearl millet growing states in India are Rajasthan, Maharashtra, Gujarat, Uttar Pradesh, Haryana, Andhra Pradesh, and Tamil Nadu.

Ergot caused by *Claviceps fusiformis* Loveless, is one of the few important diseases of pearl millet, which causes significant yield loss in certain years in some parts of the country. The estimated yield loss under high ergot pressure ranges from 55% in varieties to 65% in hybrids (Thakur, 1987). In addition, ergot adversely affects grain quality by contaminating grains with toxic sclerotia of the pathogen and thus making the grain unfit for consumption. The sclerotia contain neurotoxic alkaloids of clavine group mainly agroclavine,elymoclavine chanoclavine, setoclavine and penniclavine (Banks *et al.*, 1974; Bhat, 1977; Bhat *et al.*, 1975, 1976). Ergot toxicity is manifested in humans in the form of gastrointestinal disturbances, like nausea, vomiting, giddiness, and diarrhea and in extreme cases death (Bhat *et al.*, 1975; Bajpai, 1976), in monkeys, restlessness, ataxicness, muscle twitching, redness of face, ground biting and loss of response to thermal and tactile stimuli (Bhat and Roy, 1967), and in chicks, gasping, dropping of wings, leg wickness, and occasional vomiting (Bhat *et al.*, 1976). Feeding of ergot sclerotia is known to cause agalactia of sows (Loveless, 1967) inhibition of lactation and interruption of pregnancy in mice (Mantle, 1968, 1969). Generally humans are more sensitive to alkaloids than animals. The Central Committee of Food Standards of the Directorate General of Health Services has fixed a safe limit of 0.05% of sclerotia contaminated grain (Bhat *et al.*, 1975) and 28 μg. alkaloid/kg body weight (Krishnamachari and Bhat, 1976). Ergot is generally more serious in the homogeneous, uniform F_1 hybrids than in the heterogeneous, variable open-pollinated varieties and land-race cultivars (Andrews, 1987; Thakur *et al.*, 1983b). Screenings of more than 7,300 breeding lines of All India Coordinated Pearl Millet Improvement Project (AICPMIP) and ICRISAT including F_1 hybrids, their parental lines, and varieties have shown high susceptibility to ergot (Thakur *et al.*, 1985, 1989). In recent studies Thakur *et al.* (1989) have shown strong positive association of cytoplasmic male sterility with ergot susceptibility in F_1 hybrids. Under environmental conditions congenial for ergot infection, ergot can become a serious problem in seed production plots if nicking of flowering in seed parents is not proper. Because of increasing cultivation of F_1 hybrids in India, ergot deserves a major attention and it should start from the seeds.

Ergot is not seed-borne, but it is seed and soil contaminant. Sclerotia mixed with seeds or deposited on the soil from the previous crop serve as a source of primary inoculum. In this paper, I will consider various methods of ergot management and suggest ways to produce ergot-free seeds of pearl millet.

Control Measures

The various control measures available for ergot of pearl millet can be described under chemical, cultural, biological, biocultural, host plant resistance and integrated management.

Chemical

Between 1920 and 1987, 26 research and review papers have been pub shed and 23 chemical fungicides have been tried to control ergot of pearl r let (Chahal *et al.*, 1988). The common fungicides were Aureofungin, Cuman-L Ziram, Zineb, Difolatan and Benlate, and these were used as spray du flowering of pearl millet. However, no chemical has been recommended by the AICPMIP for use by the farmers. Chemical control of ergot is neither (

mical nor feasible because of several reasons including the high cost of fungicide and its application, appearance of ergot during rainy weather resulting in washing of fungicide, and the need for repeated sprays to protect the tillers.

Cultural

A number of cultural practices have been recommended to reduce ergot incidence. Manipulation of planting dates to avoid coincidence of flowering with rainy weather, deep ploughing to bury sclerotia deep in the soil to prevent their germination, judicious application of chemical fertilizers, intercropping with legumes, particularly mungbean—the leaf canopy of which can prevent ascospores produced from germinating sclerotia in soil from reaching to pearl millet flowers (Thakur, 1983 ; Thakur, 1987 ; Thakur and Chahal, 1987). These measures are highly location and time specific and cannot be recommended as a general practice.

Biocultural

Control of ergot in pearl millet through pollen management is a novel idea of utilizing pollination-induced resistance that operates under natural conditions (Thakur and Williams, 1980). Ergot infection in F_1 hybrids was effectively reduced (80% reduction) by strategically planting a less susceptible, early maturing pollen donor to the hybrid at ICRISAT Center (Thakur *et al.*, 1983b) This method of ergot control needs wider testing using recently released F_1 hybrids before it can be recommended for use by farmers.

Biological

Mycoparasitism is an important mechanism for biological control of diseases. *Cerebella andropogonis* (Kulkarni and Moniz, 1974), *Fusarium sambucinum* and *Dactylium fusarioides* (Tripathi *et al.*, 1981), and *F. semitectum* var. *majus* (Rao and Thakur, 1988) and *F. chlamydosporium* (Chahal *et. al.* 1987) have been reported to parasitize honeydew and sclerotia of ergot. Rao and Thakur (1988) obtained a significant reduction in sclerotia formation and increased sclerotia disintegration by using *F. semitectum* var. *majus* a biocontrol agent in field and greenhouse experiments. More detailed studies are needed to explore possibilities of an effective control schedule with mycoparasites.

Host plant resistance

Growing disease-resistant cultivars is the most effective and economical means of disease control. Genetics of resistance appears complex, resistance being recessive and under polygenic control (Thakur *et al.*, 1983a). Resistance to ergot has, however been developed (Thakur *et al.*, 1982) and many lines with high resistance to ergot, and lines with combined resistance to ergot, smut, and downy mildew are now available (Thakur *et al.*, 1985 ; Thakur and King, 1988) Efforts are being made at ICRISAT Center to transfer ergot resistance in parental lines of hybrids (Rai and Singh, 1987).

Integrated control

Integrated control for ergot should include using sclerotia-free seed, well ploughed field, intercropping with legumes where possible, and ergot-resistant cultivar.

Production of quality (ergot-free) seed

Availability of quality seeds of improved varieties is the key to increased agricultural production. Farmers are gradually becoming conscious and are willing to pay higher price for improved quality seed. Seed quality includes purity, germination, health, weed seed content, moisture content etc. Seed production is affected by various factors including diseases, insects, improved cultivar, seed price, seed regulations etc. It is amply clear therefore that seed health or disease is one of the most important factor for both seed quantity and quality.

For ergot disease of pearl millet, contamination of seed with sclerotia is the major problem. These sclerotia can be separated by treating the seed with brine solution, by mechanical separator or manually, depending on the quantity of seed to be handled. Various concentrations (5-20%) of brine solutions have been suggested (Nene and Singh, 1976: Pathak *et al.*, 1984), but 10% brine solution has been found most effective and economical (Nene and Singh, 1976). This method, however, will be useful only for a small quantity of seed. Various kinds of mechanical separators have been used i.e. screen air separator, specific gravity separator, brand grader (Nicholas, 1975; Pathak *et al.*, 1984) and draper belt separator (Modi *et al.*, 1979). These separators are effective in cleaning up to 80-90% of sclerotia from the seed lots. It is suggested that for small quantity of seed 10% brine solution and for large quantity mechanical separator would be useful.

Ergot is a serious problem in those parts of the country, where rainfall is high and flowering in pearl millet coincides with rainy weather. In a preliminary study based on rainfall data, flowering time of pearl millet hybrids and their ergot severity scores at seven locations in India, Huda and Thakur (1989) classified these locations into low, medium and high risk area for ergot development. They classified Hisar and Jalna as low risk areas, Ludhiana, Delhi, and Jamnagar as medium risk areas and Aurangabad as high risk area. Since ergot is a problem of the rainy season crop, in some states where the seed crop can be grown during the postrainy season with irrigation, ergot incidence can be avoided. States, such as Gujarat, Andhra Pradesh, Tamil Nadu, and Karnataka can be the areas of seed production during the postrainy season. In the low risk area or during the relatively dry rainy season seed production can also be taken in other states.

Since there is no ergot-resistant cultivar available at present, the major efforts have to be on producing ergot-free seeds of pearl millet. The steps involved are: 1. Selection of field not having ergot infected pearl millet crop in the previous season to eliminate soil-borne ergot inoculum ; 2. Use of good quality sclerotia-free seeds ; 3. Growing the seed crop during the post-rainy season ; 4. Using parental lines of hybrid with better nicking of flowering for quick pollination of female lines ; and 5. Isolation of seed production plot from other pearl millet fields, at least 200 m, to avoid air-borne ergot inoculum and pollen contamination.

References

Andrews, D.J. 1987. Breeding pearl millet hybrids. In *Hybrid Seed Production of Selected Cereal Oil and Vegetable Crops* (eds. W.P. Felstritzer and A.F. Kelley), pp. 83-109. FAO Plant Prod. Prot. Pap. 82. FAO Rome

Bajpai, N. 1976. Bajra causes ergot poisoning. Sci Reptr. 13 : 494-495

Banks G.T. Mantle, P.G and Szczybak, C.A. 1974. Large scale production of clavine alkaloids by *Claviceps fusiformis*. J. General Microbiol. 82 : 345-361

Bhat, R.V. 1977. Identity of pathogen causing ergot of pearl millet in India. Curr. Sci. 46 : 184-185

Bhat, R.V. and Roy, D.N. 1976. Toxicity study of ergoty *bajra*(pearl millet)in rhesus monkeys Indian J. Medical Res. 64 : 1629-1633

Bhat, R.V., Roy, D N. and Tulpule, P.G. 1975. Ergot contamination of *bajra*. Proc. Nutrition Soc. India 19 : 7-11

Bhat, R.V., Roy, D.N, and Tulpule, P.G. 1976. The nature of alkaloids of ergoty pearl millet or *bajra* and its comparison with alkaloids of ergoty rye and ergoty wheat. Toxic. Appl. Pharmac. 36 : 11-17

Chahal, S.S., Gill S.S. and Sharma, S B 1987. Effect of culture filtrate of *Fusarium chlamydosporum* on growth of *Claviceps fusiformis* and ergot development in pearl millet. Plant Dis. Res. 2 : 32-36

Chahal, S S., Thakur, R. P. and King, S.B. 1988. An annotated bibliography on ergot of pearl millet, 1920-1987. Patancheru, A.P. 502 324, India : International Crops Research Institute for the Semi-Arid Tropics

Harinarayana, G. 1987. Pearl millet in Indian agriculture. In Proceedings of the International Pearl Millet Workshop 1986 pp. 5-17. ICRISAT, Patancheru, A.P. India

Huda, A.K.S. and Thakur, R.P. 1989. Characterization of environments for ergot disease development in pearl millet. In Agrometeorological Information for Planning and Operation in Agriculture with Special Reference to Plant Protection (eds V. Krishnamurthy and G. Mathys), pp. 197-221. Lectures presented at the workshop, 22-26 August 1988 Calcutta India. World Meteorological Organization (WMO), Geneva, Switzerland

Krishnamachari, K.V.S.R. and Bhat, R.V. 1976. Poisoning of ergoty *bajra* (pearl millet) in man. Indian J. Medi Res. 64 : 1624-1628

Kulkarni, C S. and Moniz, L. 1974. Occurrence of hyperparasite *Cerebella* on ergot of bajra [*Pennisetum typhoides* (Burm. F.) Stapf and Hubb.]. Curr. Sci. 43 : 803

Loveless, A. R. 1967. *Claviceps fusiformis* sp. nov., the causal agent of an agalactica of sows. Trans. Brit. Mycol. Soc. 50 : 15-18

Mantle, P.G. 1968. Inhibition of lactation in mice following feeding with ergot sclerotia (*Claviceps fusiformis* Loveless) from the bulrush millet (*Pennisetum typhoides* Stapf. and Hubbard) and an alkaloid component. Proc. Royal Soc. B. 170 : 423-434

Mantle, P.G. 1969. Interruption of early pregnancy in mice by oral administration of agroclavine and sclerotia of *Claviceps fusiformis* Loveless. J. of Reproduction and Fertility, 18 : 81-88