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Original Article

Fusarium Species Associated with Foxtail Millet (Setaria Italica) in Iran

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ABSTRACT

Objective: *Fusarium* diseases that cause grain mold and stalk rot of millet are the most important diseases, of these crops in Iran. *Fusarium* can cause stalk rots, ear rots, and grain mold, resulting in serious production losses in millet, and produce mycotoxins that are harmful to both humans and domesticated animals. **Methods:** A total of 23 *Fusarium* isolates were recovered from Foxtail millet collected from different geographic regions of Southern Khorasan provinces in Iran during 2012 - 2014. *Fusarium* isolates were identified based on the morphological characters. **Results:** According to morphological features, 9 out of 23 isolates were identified as *F. solani,* one as *F. fujikuroi,* three as *F. diversisporum.,* one as *F. verticillioides,* three as *F. semitectum*, two as *F. equiseti*, one as *F. crookwellense* and three as *F. acuminatum*. Based on the available references, all *Fusarium* species that were recovered in this study, are reported from millet for the first time from Iran.

1. INTRODUCTION

Foxtail millet (*Setaria italica*) is the second-most widely planted species of millet, in temperate, subtropical, and tropical Asia and in parts of southern Europe, and is grown for forage in North America, South America, Australia, and North Africa(Belton and Taylor, 2004). Foxtail millet was included in the original treatment of Flora Iranica(Bor, 1970) citing a few localities. In his additions, Scholz (1981)refers to this species, based on a herbarium specimen of Gauba: ‘‘In valle fluvii Calus, 500 m, 8.10.1937, Cult’’. Foxtail millet, formerly a famous crop of Persia, and for a long time a traditional cereal in Iran, has become a very rare and underutilized crop as defined by Hammer et al. (2001). The species, locally named ‘‘Gavras italiaei; Gours’’ was formerly used in a wide range of local cuisines. The grains were boiled like rice, cooked into porridge, or after grinding baked into flat bread(Hammer and Khoshbakht, 2007).

Fusarium diseases that cause grain mold and stalk rot of millet are the most important diseases, of these crops in Iran. *Fusarium* can cause stalk rots, ear rots, and grain mold, resulting in serious production losses in millet, and produce mycotoxins that are harmful to both humans and domesticated animals(Onyike et al., 1991). The purpose of this study was to determine the distribution of *Fusarium* 'species associated with Foxtail millet collected in the east of Iran.

2. MATERIALS AND METHODS

Foxtail millet samples were obtained from main millet growing areas throughout Southern Khorasan province. All the samples were surface sterilized with 10% Clorox® and rinsed in several changes of sterile water.

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The samples were placed on semi-selective medium for *Fusarium*, peptone pentachloronitrobenzene agar (PPA) as described by Nash and Snyder (1962), and incubated for 7 days under standard growth conditions. The cultures were single-spored following a standard protocol by Leslie and Summerell (2006) . After 7 days of incubation, the cultures were transferred onto potato dextrose agar (PDA) and carnation leaf agar (CLA); for species identification. The cultures on PDA were used for observing the macroscopic characteristics such as colony features, growth rate and pigmentation. For microscopic characterization, pure cultures were transferred onto CLA and soil extract agar(Leslie and Summerell, 2006; Burgess and Gardens, 1994; Fisher et al., 1982). The microscopic characteristics such as conidia ontogeny, as well as the presence of chlamydospores and types of conidiophores were examined following the procedure by Leslie and Summerell (2006). The observations were done using a light microscope. The *Fusarium* isolates were identified based on the morphological characteristics into the species level (Nelson et al., 1982; Nelson et al., 1983; Burgess et al., 1988).

3. RESULTS AND DISCUSSION

A total of 23 isolates of *Fusarium* were obtained from the millet plant samples showing typical symptoms of *Fusarium* disease in four locations throughout the main millet growing areas in Southern Khorasan Province. The *Fusarium* isolates were single-spored and tentatively identified into 8 species. According to morphological features, 9 out of 32 isolates were identified as *F. solani (Mart.) Sacc,* one as *F. fujikuroi* , three as *F. diversisporum* Sherb*.,* one as *F. verticillioides,* three as *F. semitectum* Berk. and Ravenel, two as *F. equiseti* , one as *F. crookwellense* L.W. Burgess, P.E. Nelson and Toussoun, and three as *F. acuminatum*. *F. solani* has worldwide distribution and has multiple hosts(Gerlach and Nirenberg, 1982). This is widely found in soil and constitutes one of the most important phytopatogen in agriculture. In Iran, this species is introdused as one of the wheat, barley, oat, aegilops, barley, rice and maize stalk and root rots pathogens(Darvishnia et al., 2010; Vafaei et al., 2001; Ershad, 2009). Nine isolates of *F. solani* were recovered from Amirabad, Mazhan, Taghab and Mohammadie during this survey.

F. fujikuroi Nirenberg, is the causal agent of Bakanae disease of rice(Sun and Snyder, 1981). These species previously have been isolated from rice in gilan provinces in the north of Iran(Padasht et al., 1995). During this survey, this spices was isolated in one sample of millet root from Mazhan. *F. diversisporum* has been isolated from barley in various geographical areas, such as Ahwaz in the South(Vafaei et al., 2001) and Gorgan in the north of Iran(Darvishnia et al., 2010; Ershad, 2009). Three isolates of *F. diversisporum* were isolated from millet stalks in Mazhan and Mohammadie in this resarch.

F. verticillioides were isolated from finger millet grown by subsistence farmers in Uganda(Saleh et al., 2012). This species is potential for fumonisin associated problems especially when this grain is used as a weaning food (Leslie and Summerell, 2006). *F. verticillioides* has been reported to be the cause of root and stalk rots and ear rot in maize, barley, wheat, sugarcane, rice and sorghum in Iran.(Darvishnia et al., 2010; Mohammadi et al., 2012; Mohammadi and Mofrad, 2010) In this research only one isolate of *F. verticillioides* was isolated from millet root from Taghab. *F. semitectum* is a common soil saprophyte usually found associated with decaying plant tissues in the warmer regions of Africa, Asia, and North and South America (Leslie and Summerell, 2006). This spices was reported from the roots of barley, corn, wheat in Iran(Ershad, 2009; Darvishnia et al., 2010). In this research, three isolates from this spicese were recovered from Mazan and mohammadie.

F. equiseti is associated with seed of many crops including maize, peanuts, sorghum, and millet and occurs mainly as a saprophyte on the seed surface(Adejumo et al., 2007; Onyike et al., 1991; Leslie and Summerell, 2006). *F. equiseti* was also reported to produce zearalenone, beauvericin and trichothecene (Desjardins, 2006). *F. equiseti* was isolated from root of millet at Mazhan during this survey. *F. equiseti* has been reported from maize, barley, wheat and rice in Iran(Ershad, 2009; Darvishnia et al., 2010; Chehri et al., 2010). *F. crookwellense* was isolated from the roots of millet in Mohammadie. *F. crookwellense* was first isolated from dimple-like lesions on potato tubers from the rural area of Crookwell in New South Wales, (Burgess et al., 1982). Since then representative isolates have been recovered from a variety of plant species (mainly crown or root tissues) and from debris from grassland and cultivated soils(Leslie and Summerell, 2006). This species has also been recovered from wheat and barley in Iran(Darvishnia et al., 2010).

F. acuminatum has been recovered from root and stalk of millet in mazhan. *F. acuminatum* which was first described by Elis and Everhart (Ellis and Everhart, 1895)from potato stems in Geneva, is more common in temperate areas, often in grassland and cultivated soils; it is less common in tropical areas(Leslie and Summerell, 2006). In Iran this spices was reported from barley and wheat(Darvishnia et al., 2010; Ershad, 2009)t. *F. moniliforme* was reported to cause head mold of millet in West Africa (Leslie, 2003), and the cultivation of millet in southern Nigeria was limited by *F. graminearum* (Onyike et al., 1991). *F. napiforme* was isolated from pearl millet (*Pennisetum typhoides*) grain from Namibia(Marasas et al., 1987). A *Fusarium* species with characters that are very close to those of *F. nygamai(*Burgess and Trimboli, 1986*)*, was isolated from pearl millet in Nigeria(Nirenberg and O'Donnell, 1998). Onyike *et al.* (1991) reported various *Fusarium* species associated with pearl millet, proso millet and fox tail millet in

Nigeria, Lesotho and Zimbabwe. Species isolated from pearl millet in Zimbabwe included *F. equiseti, F. moniliforme, F. semitectum, F. nygamai, F. chlamydosporum, F. oxysporum* and *F. napiforme.* Those isolated from pearl millet grain in Nigeria included *F. moniliforme, F. nygamai, F. equiseti, F. chlamydosporum, F. semitectum, F. subglutinans* and *F. napiforme. F. equiseti* was the only species recovered from fox tail, proso and pearl millet and was the only species recovered in all three countries.

Generally, the *Fusarium* species exhibited varying level of pathogenic effects on the millet varieties. *F. subglutinans, F. fujikuroi, F. dlamini, F. beomiforme, F. anthophilum, F. verticillioides,F. oxysporum, F. scirpi* and *F. nygamai* expresses pathogenic effects. The most virulent *Fusarium* on the millet varieties are *F. verticillioides, F. oxysporum* and *F. scirpi* (Akanmu et al., 2013). Based our knowledge, this is the first report of *F. equiseti*, *F. solani*, *F. verticillioides*, *F. diversisporum*, *F. fujikuroi*, *F. semitectum*, *F. acuminatum*, *F. crookwellens* from millet in Iran. Thus, this study provides the prerequisite knowledge required in the control of the pathogenic *Fusarium* species on millet varieties in Iran.

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REFERENCES

Adejumo TO, Hettwer U, Karlovsky P (2007). Occurrence of *Fusarium* species and trichothecenes in Nigerian maize. International journal of food microbiology 116 (3):350-357. doi:10.1016/j.ijfoodmicro.2007.02.009

Akanmu A, Abiala M, Odebode A (2013). Pathogenic effect of soilborne *Fusarium* species on the growth of millet seedlings. World Journal of Agricultural Sciences 9 (1):60-68.

Belton PS, Taylor J (2004). Sorghum and millets: protein sources for Africa. Trends in Food Science & Technology 15 (2):94-98.

Bor N (1970). Gramineae.– In: Rechinger, KH. Flora iranica 70573.

Burgess L, Nelson P, Toussoun T (1982). Characterization, geographic distribution and ecology of *Fusarium crookwellense* sp. nov. Transactions of the British Mycological Society 79 (3):497-505.

Burgess LW, Gardens RB (1994). Laboratory manual for *Fusarium* research. Fusarium Research Laboratory, Department of Crop Sciences, University of Sydney.133 pp.

Burgess LW, Liddell CM, Summerell BA (1988). Laboratory manual for *Fusarium* research: incorporating a key and descriptions of common species found in Australasia.156 pp.

Burgess LW, Trimboli D (1986). Characterization and distribution of *Fusarium nygamai*, sp. nov Mycologia 78223-229.

Chehri K, Darvishnia M, Zafari D (2010). Six new *Fusarium* species isolated from maize in Iran. Rostaniha 1169-81.

Darvishnia M, Alizadeh A, Zare R (2010). Three new *Fusarium* taxa isolated from gramineous plants in Iran. Rostaniha 1155-67.

Desjardins AE (2006). *Fusarium* mycotoxins : chemistry, genetics and biology. APS Press, St. Paul, Minn.260 pp.

Ellis JB, Everhart BM (1895). New species of fungi from various localities. Paper presented at the the Academy of Natural Sciences of Philadelphia,

Ershad D (2009). Fungi of Iran. Fungi of Iran. Iranian Research Institute of Plant Protection, Iran.531 pp.

Fisher N, Burgess L, Toussoun T, Nelson P (1982). Carnation leaves as a substrate and for preserving cultures of *Fusarium* species [*Dianthus caryophyllus*]. Phytopathology 72-151.

Gerlach W, Nirenberg H (1982). The genus *Fusarium*--a pictorial atlas(Mitteilungen aus der Biologischen Bundesanstalt fur Land-und Forstwirtschaft Berlin-Dahlem). Vol 209. Kommissionsverlag P. Parey, Germany.406 pp.

Hammer K, Heller J, Engels J (2001). Monographs on underutilized and neglected crops. Genetic Resources and Crop Evolution 48 (1):3-5. doi:10.1023/a:1011253924058

Hammer K, Khoshbakht K (2007). Foxtail millet (*Setaria italica* (L.) P. Beauv.) in Mazandaran/Northern Iran. Genet Resour Crop Evol 54 (4). doi:10.1007/s10722-007-9211-z

Leslie JF (2003). Sorghum and millets diseases. Wiley-Blackwell.504 pp.

Leslie JF, Summerell BA (2006). The *Fusarium* laboratory manual. 1st edn. Blackwell Pub., Ames, Iowa.388 pp.

Marasas W, Rabie C, Lübben A, Nelson PE, Toussoun T, Van Wyk P (1987). *Fusarium napiforme*, a new species from millet and sorghum in southern Africa. Mycologia 79 (6):910-914.

Mohammadi A, Mofrad N (2010). Investigation on genetic diversity of *Fusarium verticillioides* isolated from corn using vegetative compatibility groups and relation of VCGs to the pathogenicity. Journal of Agricultural Technology 6 (3):497-502.

Mohammadi A, Nejad RF, Mofrad NN (2012). *Fusarium verticillioides* from sugarcane, vegetative compatibility groups and pathogenicity. Plant Protection Science 48 (3):80-84.

Nash SM, Snyder WC (1962). Quantitative estimations by plate counts of propagules of the bean root rot *Fusarium* in field soils. Phytopathology 52 (6):567-572.

Nelson PE, Toussoun TA, Cook RJ (1982). *Fusarium* : diseases, biology, and taxonomy. Pennsylvania State University Press, University Park.560 pp.

Nelson PE, Toussoun TA, Marasas WFO (1983). *Fusarium* species : an illustrated manual for identification. Pennsylvania State University Press, University Park.226 pp.

Nirenberg HI, O'Donnell K (1998). New *Fusarium* species and combinations within the *Gibberella fujikuroi* species complex. Mycologia 90434-458.

Onyike NB, Nelson PE, Marasas W (1991). *Fusarium* species associated with millet grain from Nigeria, Lesotho, and Zimbabwe. Mycologia 83708-712.

Padasht F, Hedjarud GA, Elahinia SA (eds) (1995) Introduction of fungal agents of rice sheath rot disease in Guilan. Karaj,Iran

Saleh AA, Esele J, Logrieco A, Ritieni A, Leslie JF (2012). *Fusarium verticillioides* from finger millet in Uganda. Food Additives and Contaminants: Part A 29 (11):1762-1769.

Scholz H (1981). Erga¨nzungen und Verbesserungen zur''Flora iranica'': Gramineae. Willdenowia 11259-265.

Sun S, Snyder W (1981). The bakanae disease of the rice plant. In:Nelson PE, Dignani MC, Anaissie EJ (eds) *Fusarium*: diseases, biology and taxonomy. The Pennsylvania State University Press, University Park, 104-113

Vafaei S, Farokhinejad R, Darvishnia M (2001). *Fusarium* species isolated from root and crown of wheat & barley in khuzestan province. The Scientific Journal of Agriculture 24101-126.