Crown rot disease on wheat caused by the new species, Fusarium Pseudograminearum in the northwest of Iran.

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Abstract

The crown rot disease of wheat was studied during in four provinces including Qazvin, Zanjan, east Azarbyjan and Ardabil in northwest of Iran. Different wheat fields in studied areas were visited and samples of the suspected plants showing symptoms such as withering, whitening of spikes, growth reduction and white heads collected and transferred to laboratory. Samples were cultured in media and isolated fungi belongings to five genera were identified. Generally, the most frequently isolated pathogen was \textit{Fusarium pseuograminearum} as a soil borne fungus. This species normally caused crown rot resulting in severe damage in several locations under dry conditions in spring season. The disease caused losses from 18 - 45.5\% in the fields where the season and crop rotation allowed the disease to build up. Environmental conditions and genetic susceptibility of cultivars were the two main factors affecting the incidence of diseases.

Keywords: Wheat, Crown rot, \textit{Fusarium pseuograminearum}, Iran

Introduction

Wheat (\textit{Triticum aestivum L.}) covers about 30\% of the world’s cultivated land and is the most important agricultural commodity in international trade (karimi 1992). The most important agricultural crop of Iran is wheat and is cultivated approximately in 4.5 million hectares. Its production was 8.7 million tons in 1999. Crown rot is a significant disease of small grain cereals, caused mostly by \textit{Fusarium} species and is the main disease limiting yield of wheat in northwest Iran (Froutan et al. 1995). Since the plant is adapted to different climatic areas from cool to warm conditions, many soil borne fungi can cause seedling blight and common root rot on wheat and result in yield losses (Wise, 1998). However, crown rot of wheat in Iran is caused mostly by the new species named \textit{Fusarium pseuograminearum} (Aoki & Donnell, 1999) formerly known as \textit{F. graminarum} (Group 1). Generally the increased incidence and economic importance of the disease has been linked to environmental conditions such as dry weather and use of susceptible varieties.

Generally, crown rot is the most common diseases of wheat in northwest Iran and usually appears after flowering when white heads can be seen scattered in the crop. It usually occurs in large patches and is more common on the lower sides of paddocks. The disease acquires economic proportions in the northwest of Iran, especially in East Azarbyjan, Ardabil and Zanjan provinces. It is also a serious problem in Australia (Burgess and Patterson, 1996) and USA (Smiley et al. 1996). In addition the disease has been reported from the wheat tracts of South Africa (Klaasen et al. 1991) as well as Syria, Egypt and Italy (Balmas, 1994).

Commonly, it is known that several soil- borne fungi are involved in causing crown rot of wheat in Iran. For example, Mansoury (1995) isolated different species of \textit{Fusarium}, \textit{Drechclera} and \textit{Sclerotium} from the affected wheat fields in the Fars province. On the other hand, \textit{F. culmorum}, \textit{F. avenaceum} and \textit{F. acuminatum} infections were correlated with yield...
losses (Ravanloo and Banihashemi 1999). Other fungi, including Rhizoctonia solani, R. cerealis, F. graminearum and Gaeumannomyces graminis have also been associated with seedling blight and common root rot of wheat in north Iran (Froutan, et al. 1995). Crown rot disease usually causes yield losses under dry conditions in spring when infection of the crown or stem tissue occurs near the soil surface. Initial infections of plants are facilitated by wet conditions but the fungus grows rapidly through the plant tissues when the plants are moisture stress (Wallwork 1996). The present study has been carried out to assess the incidence of crown rot disease of wheat by *F. pseudograminearum* and the contribution of environmental conditions and susceptible varieties on the increase of its incidence in northwest Iran.

**Materials and methods**

The study covered wheat fields in the Qazvin, Zanjan, East Azarbyjan and Ardabil provinces from 1999 to 2001. All these areas were visited and plants with symptoms of chlorosis withering, growth reduction, crown necrosis, white heads and blighting of spikelets were collected and transferred to the laboratory of plant pathology in Zanjan University. Six samples infected with crown rot were collected from each province each year and totally 72 complete samples were used to isolate and identify the causal agents. Various fractions of the samples i.e. root crowns, and soils around the roots were cultured in different media. Potato Dextrose Agar (PDA) as common rich medium, Peptone PCNB Agar (PPA) as selective medium and Carnation Leaf Agar (CLA) used as a natural substrate.

Isolated cultures were incubated in a room lighted with near-ultraviolet wave lengths (black light tube, Philips TL 36 w/80 RS F40 BLB) and fluctuating temperatures regime, 25°C during day and 20°C at night under 12 h photoperiod. Sporulation and pigmentation of *Fusarium* species are favored by this situation (Burgess et al., 1994). Soil dilution technique (Saremi, 1998) was also used to isolate inoculums from soil in the root zone, infected with crown rot disease.

Normally, the causal agent of crown rot disease was cultured on PPA medium for inoculum preparation and then a plug of mycelium was put into chaff-grain medium. This medium was prepared from a mixture of cereal chaff and ground cereal grain (ratio 5:1) used together. The chaff-grain mixture was first soaked in water overnight at 5°C to leach phenolic compounds, then drained before distributing in polyester oven bags. The containers were sealed with a large cotton wool plug and autoclaved for 15 min each on two days. The containers were inoculated with mycelia suspension and incubated under standard conditions, then was air dried after colonization with mycelium, crushed and sieved to the required mesh size for addition to soil for pathogenicity test.

Yield Loss of wheat was assessed at one location of infected fields from each province. Grain yield from 1m² area in each infected field was compared with the plot of same size in a non-infected field. Yield of four wheat fields infected where mostly crown rot disease was assessed in the areas under study. Annual infection rate with percentage of damage for each province was also determined.

**Results**

*Symptom of the disease in wheat*

The main symptoms of common root rot and crown rot caused by *F. pseudograminearum* in the areas studied were yellowing, growth reduction and white head (Fig.1a). The diseased plants were mostly stunted and the symptoms were most striking near or below the surface.
They include brown spots, blotches and rotting on the crown, roots and subcrown internodes (Fig. 1b). The infected plants were stunted, necrotic or rot on rootlets and engulfed in a mass of white fungal growth. Some infected plants showed pink coloration around the crown in studied areas (Fig. 1c). The disease appeared when the fungus was able to build up sufficient inoculum in the soil over two or more years on susceptible varieties.

Isolation of causal agents and other fungi

Generally, 160 fungal isolates were identified during the 3-years study in different wheat fields. Most of the soil-borne fungi that caused common root rot and crown rot were isolated from the fields under studied. Fungi such as *Rhizoctonia solani* and *Drechslera sp.* were also found in rare situations. But the major fungal pathogen, isolated with high population, was *Fusarium pseudograminearum*. Cultures of the fungus formed uniform dense mycelium in PDA medium and microconidia were absence (Fig. 2a). The mycelium was predominantly light yellow, grayish rose at the periphery and white at apex of the colony. There was significant difference in the frequency of isolations of *F. pseudograminearum* and other isolated species at either studied site in any year. The incidence of crown rot was more in the relatively drier provinces of Ardabil, East Azarbyjan, Zanjan and Qazvin, which had lower rainfall than other northern provinces, such as, Golestan and Mazenderan. These two humid provinces are close to the Caspian Sea and receive heavy rainfall in the crop season (April and May), conditions suitable for the development of head blight disease. In this situation, *Fusarium graminearum* (Group 2) was isolated from the head blight affected wheat samples collected only at some locations. This population produced perithecium with ascospores.

Total eight species were isolated from all the regions but *F. graminearum* G2 was isolated in rare cases in the humid regions only. The infected plants had immature heads and some spikes appeared prematurely bleached. Crown rot caused severe damage in the Ardabil province when dry condition followed infection of plants under wet weather in spring.

Frequency of isolated fungi

The population of *F. pseudograminearum* was mostly recovered from the sub-crown internodes and roots of the plants suspected to be diseased. Its frequency was 51% among the soil-borne fungi isolated in the areas under study. The frequency of the other fungi was 21% *Rhizolania solani*, 3% *R. cerealis*, 7% *F. culmorum*, 10% *Drechsera* sp., 3% for *Sclerotium rolfsii*, and 5% *Bipolaris* sp.

Rate of yield losses

Crown rot disease caused white heads and resulted in poor seed filling, leading to significant yield losses. Plants of infected fields were compared with noninfected plants in each province. Investigation showed that there were differences in the extent of yield loss in different areas (Tab. 1).

Discussion

The incidence of crown rot and head blight of wheat were significantly affected by environmental factors, mainly rainfall and susceptible varieties. The effect of climate, especially rainfall and temperature, on the abundance of *Fusarium* species has been reported by various investigators (Burgess et al. 1988; Marasas, et al., 1988; Sangalang et al. 1995). The incidence of *Fusarium graminearum* (Group 2) in humid areas supported the contention that *F. compactum* was isolated only from warmer sites and *F. sambucium* was recovered only from temperate to cold areas (Saremi et al. 1999).
It is important to develop resistant cultivars through breeding effort by applying recurrent selection. It was obvious that using susceptible cultivar such as “Flat” and "Golestan" (local name) resulted in high epidemic of head blight disease in north Iran (Golestan Province). Some cultivars were less infected due to physical barriers. There was difference in the incidence of head blight among cultivars growing in adjacent fields in north Iran (Etebrian and Torabi 1996). Different methods to find sources of resistance to head blight in Iran were reviewed by Allizadeh et al. (2001). Some physiological and morphological characters in wheat were associated with disease resistance. Some varieties with partial resistance showed less reduction in grain yield due to light blight infection. Cultivars also differ in resistance to the crown rot disease, and the more resistant ones should be cultivated over large areas. However the incidence of crown rot disease was mostly correlated with stubble management as the fungus survives in the infected residues (Wearing and Burgess 1977). Burgess et al. (1993) determined the consistency of the effects of stubble management on crown rot disease over longer periods of continuous wheat cultivation and on the increase of disease incidence. The experience showed that stubble retained in some plots enhanced infection of crown rot disease. It was observed that in the Zanjan province the development of crown rot disease was more in poor soils than in soils rich in organic matter content. It has been reported that the soil-borne pathogens are generally less than fungal saprophytes in the soil with high organic matter content (Van Bruggen, 1995). However, crown rot was more on deep heavy clay soils with continuous wheat cultivation. Since crown rot and head blight have become major diseases in the areas of continuous wheat cultivation in Iran, particularly in the northern wheat belt, it is important to control them through management practices and use of tolerant cultivars. Crop rotation, stubble burnt in autumn and careful selection of nitrogen dose can help to minimize the incidence of disease. We have to stop the practice of stubble retention, which leads to significant increase in the incidence of crown rot caused by *F. pseudograminearum*.

**Acknowledgments**

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**References:**

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Tables

<table>
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<th>Province</th>
<th>Yield, g/1 m²</th>
<th>Yield loss (%)</th>
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<tr>
<td></td>
<td>healthy crop</td>
<td>Diseased corp.</td>
</tr>
<tr>
<td>Ardabil</td>
<td>227</td>
<td>124</td>
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<tr>
<td>East Azarbyjan</td>
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<td>Zanjan</td>
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<td>115</td>
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<td>Qazvin</td>
<td>145</td>
<td>119</td>
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Table 1: Yield losses in wheat in four provinces in northwest Iran caused by *Fusarium pseudo*

Figure Legends

Figure 1: Symptom of crown roon wheat caused by *Fusarium pseudograminearum*, white head (a), crown rot (b) and discoloration of crown (c) on infected plant.

Figure 2: Colony morphology (a) and macroconidia (b) of *Fusarium Pseudograminearum* isolated from infected wheat.