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Symptom based indexing of barley yellow dwarf disease infecting wheat in Pakistan

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Abstract

Wheat (*Triticum aestivum* L.) is the major staple grain food of Pakistan and is prone to many pathological diseases especially viral diseases are among the biotic factors inflicting huge economic losses. Every year *Barley yellow dwarf virus* (BYDV) causes substantial losses to wheat crop. In this study, during survey 2013-14, a total of 210 samples examined from different wheat growing areas of Pakistan, 180 samples showing typical barley yellow dwarf viral symptoms following (90) yellowing tip Yt, (45) stunted growth St, (32) reddening Rd and (13) showed curling Cr. The symptom based indexing study can play an important role in the identification of BYDV and further epidemiological studies.

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Introduction

Wheat is an important cereal crop in Pakistan having annual production of 24.2 million tons. Burgeoning population of the country demands increase in its production that is hindered by a number of pests, pathogens and environmental stresses. Among the yield limiting constraints, Barley Yellow Dwarf Virus (BYDV) is important, inflicting approximately 75% wheat production losses in diseased crop nationally (Bux, 2012). The disease was first identified in Pakistan in 1964 (Aslam and Ahmad, 1987). From 1985 onwards, the disease became more pronounced in wheat, barley, and oats (Khalid *et al*., 1992). Barley yellow dwarf is a significant small grain viral disease and was first recognized by Oswald in the United States in 1951 (Oswald and Houston, 1951). In several areas of cereal production in the world, Barley Yellow Dwarf Virus is recognized globally as one of the most prevalent and harmful diseases of cereal grain crops such as barley, wheat, oat and rye (Ohm *et al*., 2005). The virus spreads by nature through various strains of aphid vector (Wang *et al*., 2001).

Weeds and voluntary cereal are the primary inoculum of the virus. BYDV manifests foliage coloration, slowed development owing to space decrease, inhibits plant development, decreased tiller ability, suppress heading and increases the sterility of the flower (Haber, 1995). These symptoms lead to significant loss of yield of up to 80%. Typically, these infections cause plant growth to stop and less until tillage when the development begins again in spring. The most prominent symptom of the early season plant is generally discoloration of the leaves. The leaves may be red to purple and pinkish to brown in different shades. As the diseased plant continues to grow, old leaves typically start to die from their tip and may appear leathery while new leaves start to discoloration (Hammond *et al*., 2008). The BYDV infects a variety of plants throughout the *Poaceae* family including major crops weed, barley, oats, sometimes rice and maize causing considerable losses worldwide every year (Lister and Ranier, 1995). However, the yield may decrease between 10 and 20 percent in early infection (Simon and Roger, 2005). Keeping in all the view present study was to investigate the symptoms based observation of Barley yellow dwarf disease causing infection on wheat crops in Pakistan which can helpful for further epidemiological studies.

Materials and methods

Survey and sample collection

Samples were collected randomly from 7 districts (Chakwal, Muzaffargarh, Islamabad (ICT), Hyderabad, D.I. Khan, Peshawar and Quetta) of four provinces (Punjab, Sindh, Khyber Pakhtunkhwa, and Baluchistan) located in Pakistan showing the typical symptoms of BYDV on wheat at the end of February. There were a total of 210 samples collected from the seven districts including 5 different locations of each district along with 6 samples from each location. For sampling, smart sampling technique with Bragard method (Ssekyewa, 2006) was used. Infected leaves were harvested from wheat crop, put into the sterile ELISA sampling bags and brought to nearest district research stations for further studies. Detailed field notes were produced by easy observation on virus symptoms and vector presence.

Symptoms codes

Symptoms coded for Yellow Tip as (Yt), For stunted plant growth (St), leaves curling as Cr and reddening as Rd.

Collection of Aphids from infected fields

The presence of aphids was taken into account during sample collection by using formula =

$$\frac{\text{no. of aphids in infected samples}}{\text{total no. of infected samples}}$$

Results

During survey 2013-14, four types of *Barley yellow dwarf viral* symptoms on leaves following yellowing tip (Yt), Stunted growth (St), Reddening (Rd) and curling (Cr) were observed in wheat fields from seven different districts of Pakistan shown in Fig 01. Among all districts a maximum of 90 samples showing typical yellowing tips (Yt) due to *Barley yellow dwarf virus*. Maximum infected samples of Yt (22) were noted on Muzaffargarh

district while minimum five were found from Islamabad and Quetta respectively. Similarly, 45 samples were observed stunted growth (St) moreover, maximum (13) samples from Muzaffargarh and minimum (3) samples from Islamabad were noted. In case of Reddening (Rd) were observed in 32 samples and maximum eight from Muzaffargarh while one from Hyderabad were noted. The curling of leaves rarely found from wheat crop fields, in (13) samples curling (Cr) symptoms were observed, maximum five samples from Muzaffargarh were found while from Islamabad and Quetta no samples were found with curling shown in Fig 02. Among infected samples aphids were also present as a vector responsible to spread the infection followed by 20 samples in Chakwal, (31) in Muzaffargarh, (8) in Islamabad, (24) in Hyderabad, (18) in D.I. Khan, (11) in Peshawar and (5) samples in Quetta Aphids were found shown in Fig 03.

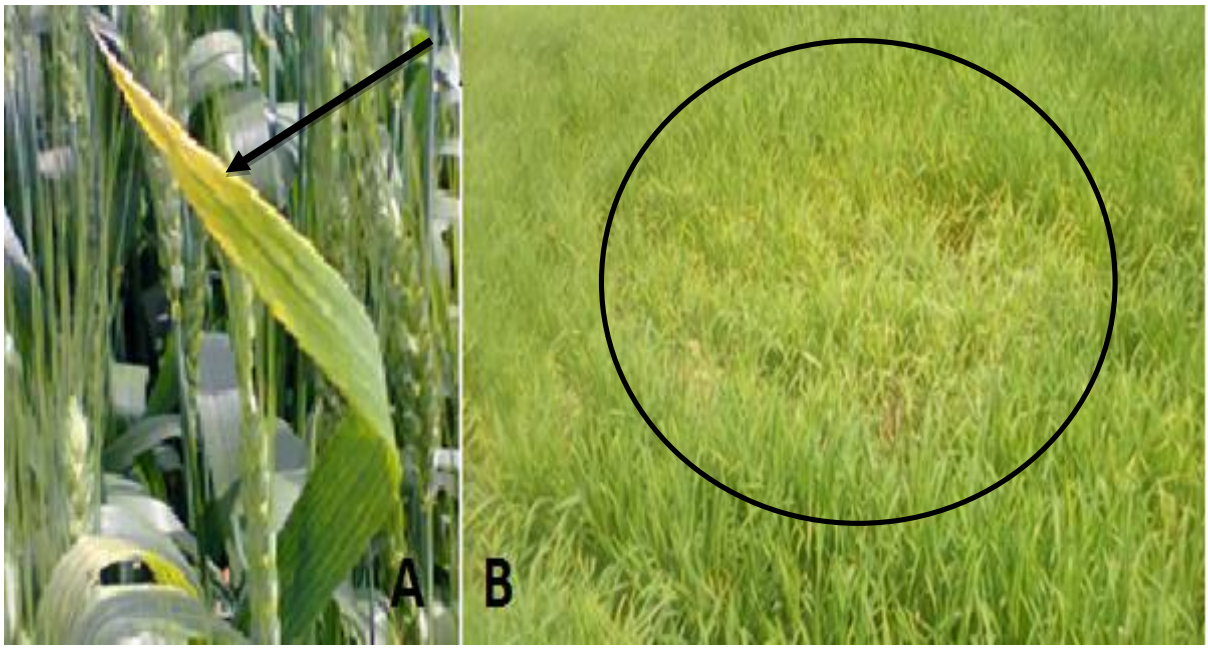

Fig. 1. (A) is showing Yellow tip (Yt) symptoms on wheat causing Barley Yellow Dwarf Disease (B) is showing infected field including Stunted growth (St) , Curling (Cr) of leaves and Reddening (Rd).

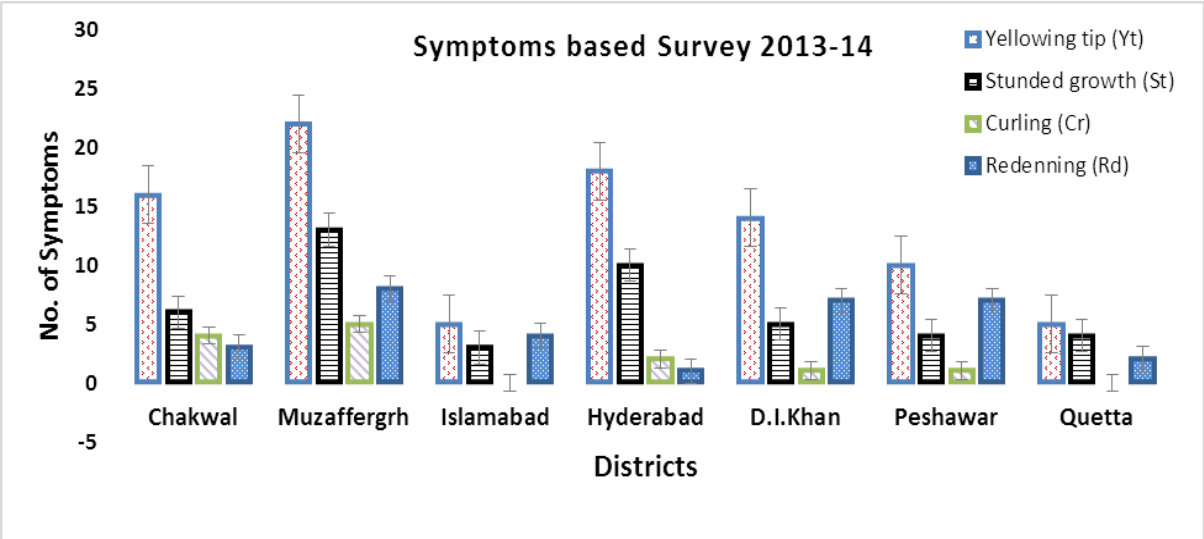

Fig. 2. Symptom based indexing of Barley Yellow Dwarf Virus infected wheat samples, ± Standard deviation taken from reading n=5.

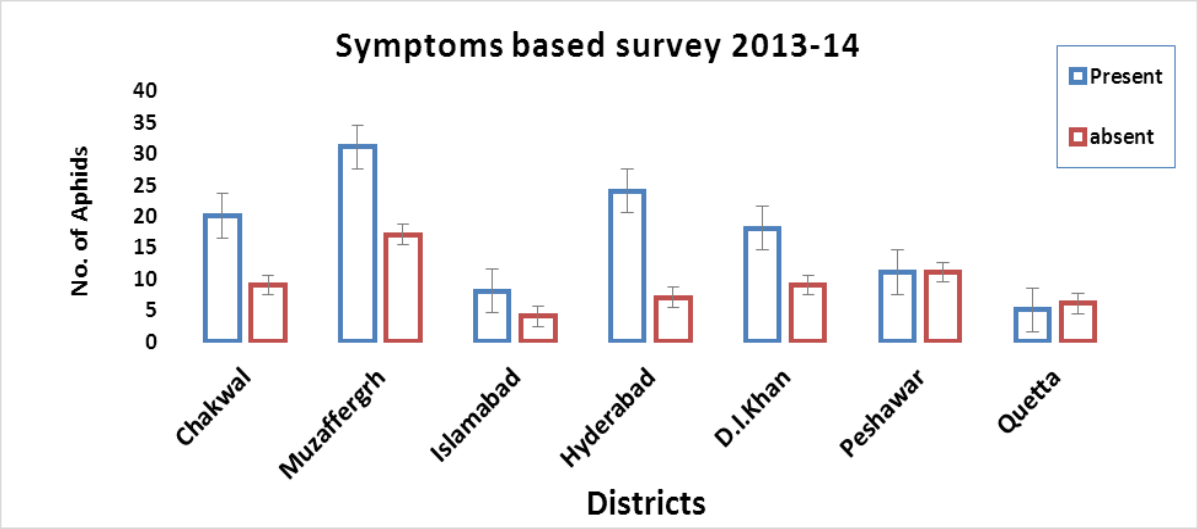

Fig. 3. No. of Aphids counted on infected wheat samples, ± represents Standard deviation taken from reading n=5.

Discussion

The Symptoms of BYDV is characterized by stunting, yellowing, decreased tillering, inhibited head development and grain fill in wheat (Wiese, 1977). The virus-infected plants also become weak and prone to winter injury. Environmental factors such as higher light intensity and lower temperature (15-18ºC) favors disease development (Miller *et al.*, 1987). Previously, preliminary studies on barley yellow dwarf disease in cereal in Pakistan suggested that PAV-like isolate was most prevalent with 64.4% incidence, followed by MAV-like isolate (40%) but SGV was least detected (4.4%) (Bashir *et al.*, 1997). Similar work related to sample collection of wheat having particular BYDV symptoms (Yellowing tips, Stunted growth, Reddening, curling), presence of Aphid vector was experimentally proved after BYDV inoculation on wheat noted a yellow tip, stunting as well as curling of some plant leaf and concluded that such conditions can lead to a serious epidémic growth (Comeau and Haber, 2002). The stunted growth and yellowing on the BYDV-infected wheat has been discovered by Pocsai *et al.* (2002). Rajaram *et al.* (1996) observed that the viral symptoms can make confusion with a biotic factor like environmental conditions and nutritional deficiencies. Rakib *et al.* (2012) reported that the main factors involved in the transmission include aphid species, test plant species and age of the plant used for studies. It's obvious that the method of identifying variants of virus is the specificity between virus and vector. Gray and Gildow (2003) investigated that virus–vector relationship has been an important aspect to cause serious infection of BYDV. Such investigations have revealed that around 25 aphid species are involved in specific, non-mechanical, circulative and non-propagative transmission of BYDVs. Bukvayova *et al.* (2006) found that the BYDV is most prevalent viral disease in wheat crop. The *Barley yellow dwarf virus* mostly infect Poaceae family which include more than 200 sp. of the grasses and cereal crops. It is transmitted by aphids sp. and is non-transmissible by seed and mechanical means. The symptoms based samples were collected for differentiations. The grasses act as a source of BYDV spread and produce reddening and yellowing of leaves Overwintered winged aphids spread virus from perennial grasses to newly germinating cereal fields and aphids spread viral infection on different sites in patches (Miller and Rosachova, 1997).

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