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PERFORMANCE OF SOME WHEAT CULTIVARS AGAINST APHID AND ITS DAMAGE ON YIELD AND PHOTOSYNTHESIS

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The aim of the study was to check the population dynamics on different wheat cultivars and to check the aphid damage on yield and photosynthetic activities on wheat crop. Aphid (*Shizaphis graminum* R.) herbivory results in significant loss yield in many crops. Planting resistant cultivars is a simple and effective method to reduce its damage. The experiment was conducted in agricultural farm of Multan, Pakistan. Four wheat varieties i.e. Galaxy 2013, Faisalabad 2008, Punjab 2011and AARI 2011 were sown on November 14, 2015. The study was conducted in Randomized Complete Block Design with three replications. The results revealed that aphids' population was increased during last week of February to the 3rd week of March. Peak populations were recorded in 3rd week of March in all cultivars. But Galaxy 2013 showed significant difference in aphid abundance as compared to other cultivars. Also, Galaxy 2013 was significantly different for thousands grain weight, yield, photosynthetic rate and chlorophyll contents as compared to other cultivars. It was proved that Galaxy 2013 can withstand/tolerate aphid damage and give higher yield.
Keywords: Wheat cultivars, aphid, yield, photosynthesis.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important cereal crop with the vast area under cultivation in Pakistan (Anwar *et al*., 2009). To feed increasing population, increase in productivity is necessary (Khakwani *et al*., 2012). Various abiotic and biotic stresses are responsible for low yield, like unfavorable weather conditions, traditional style of cultivation, lack of high yielding varieties, drought, improper use of fertilizers, soil fertility levels and occurrence of diseases and insect pests (Akhtar *et al*., 2010).

Among insect pests, aphids are the serious pest possessing an extensive range of 60 plant species including barley, sorghum, vegetables and maize (Bowling *et al*., 1998). In Pakistan, *Schizaphis graminum* (Green-bug), *Rhopalosiphum padi* (Bird cherry-oat aphid), *Diuraphis noxia* (Russian wheat aphid) and *Sitobion avenae* (English grain aphid) are commonly known species reported on wheat (Shahid *et al*., 2012; John *et al*., 2017). But, the specie *S. graminum* is found the most abundant and dangerous for wheat crop in our country (Wains *et al*., 2014). Yield losses are positively correlated with aphid populations (Riazuddin *et al*., 2004). Aphids suck the sap of plants which results in leaf curling, discoloring and distortion, shorten growth and molds are develop on their honey dews (Akhtar and Khaliq, 2003). It also injects toxin into the plant that interrupts grain formation, reduce photosynthetic rate, decrease carbon assimilation, transpiration and total chlorophyll (Ryan *et al*., 1987; Burd and Elliott, 1996; Kannan, 1999). In addition, these are the vectors which transmit many fungal and viral diseases in plants (Bukvayova *et al*., 2006). So, yield losses may reach up to 7.9 to 34.2% with aphid damage in wheat (Akhtar *et al*., 2010). It has been reported that combination of feeding infestation and honeydew secretion can result in yield losses of 72% (Rabbinge *et al*., 1981). Reduction in shoot biomass, number of grains per spike, thousand grain weight and yield has also been recorded (Shahzad *et al*., 2013).

To manage aphids, various integrated pest management (IPM) strategies have been employed i.e. cultural, physical, mechanical, biological and chemical, the host plant resistance has been proved the best tool to inhibit losses by aphids worldwide (Junaid *et al*., 2016). In IPM, plant resistance to insects recommends the utilization of resistant varieties to restrict insect pest damage. Lowe (1987) reported that host plant resistance can check aphid population below the economic threshold level (ETL). Leszczynski *et al*. (1995) revealed that allelochemicals released by resistant varieties restrict aphid abundance, reduce fecundity and their development. Also, the aphid incidence has been recorded significantly variable in different wheat cultivars (Parvez and Ali, 1999; Ahmad and Nasir, 2001). Aphids pre-reproductive, reproductive and post-reproductive growth, development and fecundity is significantly influenced by crop varieties (Saikia *et al*., 1998). Plant resistance could be used in conjunction with other direct control tactics (Akhtar *et al*., 1991).

As stated earlier and is well admitted that aphid infestation reduces crop productivity. Crop yield is mainly decided by plant photosynthetic activity. Aphid infestations are responsible in altering physiological and biochemical processes in plants like photosynthesis. For instance, feeding of *S. graminum* causes damages to cell walls and chloroplasts because these contain a degrading enzyme present in their saliva (Al-Mousawi *et al*., 1983). While Russian wheat aphid, *Diuraphis noxia* (Mordvilko) feeding is responsible for reduced chlorophyll contents (Miller *et al.*, 1994).

Earlier research depicted that aphid abundance started increasing from 1990s and attained the position of pest in Pakistan (Aheer *et al*., 1994). But there are no principles or ETL to manage aphids in wheat. Furthermore, the impacts of aphid herbivory on plant photosynthesis rate and chlorophyll contents are limited. Hence, the present study was carried out to evaluate the host plant resistance in some wheat varieties against *S. graminum* and to check the effect of aphid infestation on thousand grain weight, yield, photosynthesis rate and chlorophyll contents.

MATERIALS AND METHODS

Four wheat varieties i.e. Galaxy 2013, Faisalabad 2008, Punjab 2011and AARI 2011 were sown on November 14, 2015. The study was conducted in Randomized Complete Block Design with three replications. The wheat seeds were sown by the hand drill on recommended rate. The plot size was 5×5 m^2. Distance between treatments was 1m. Standard agronomic practices were applied uniformly on each treatment till crop maturity.

***Aphid population*:** The aphid counts were made on weekly basis starting from end of February. Twenty spikes were selected randomly, and aphids' counts were recorded.

***Measurement of photosynthesis capacity and chlorophyll contents*:** Photosynthetic rate was recorded by selecting flag leaf of twenty randomly selected plants from each treatment. The photosynthetic rate was recorded by using a battery operated open system LCA-4 ADC portable infrared gas analyzer (Analytical Development Company, Hoddeson, England). Flag leaf was put under the machine sensor until the constant value was obtained. These measurements were recorded from 11:00 AM to 15:00 PM when photosynthetic rate was on its maximum. The chlorophyll contents were recorded by using chlorophyll meter (SPAD-502, Minolta Japan). It measures the greenness or relative chlorophyll content of leaves. SPAD values were measured at the midpoint of the leaf next to the main leaf vein.

***Yield data*:** After crop maturity each treatment was harvested and threshed to record the thousands grain weight and yield per hectare.

***Statistical analysis*:** The data were analyzed statistically (analysis of variance ANOVA) by using the software Statistix 8.1 software (Analytical software, Statistix; Tallahassee, Florida, USA, 2005) and means were compared by using LSD test.

RESULTS AND DISCUSSION

***Aphid population on different wheat cultivars*:** The mean aphid population on wheat is shown in Table 1. Aphid incidence was seen in month of February but their abundance was too low. Significant differences were recorded for *S. graminum* abundance on different cultivars in all sampling dates. Cultivar galaxy 2013 had significantly less attack as compared to other cultivars. Faisalabad 2008 also suffered less attack as compared to cultivar AARI 2011 and Punjab 2011. The higher *S. graminum* population was recorded during 3rd week of March on cultivar AARI 2011 and Punjab 2011 i.e. 58.57 and 60.20 aphids/tiller, respectively. Whereas minimum population was recorded on cultivar galaxy 2013 i.e. 41.20 aphids/tiller on the 3rd week. Aphid abundance on wheat crop was increased from last week of February to 3rd week of March. Their number decreased from the last week of March as temperature started to rise and crop was being matured.

Earlier, it has been reported that peak population were recorded in month of March. Ahmed *et al.* (2015) demonstrated that aphids were increased from 1st week of March to the 3rd week of March on wheat. Similarly, peak aphid populations were recorded on 3rd week of March (Aslam *et al*., 2004; Zeb *et al*., 2011; Ashfaq *et al*., 2007; Aheer *et al*., 2006; Iqbal *et al*., 2008; Jan *et al*., 2018). In the beginning of March, peak aphid population started on wheat. It is because of crop milking stage which is favorable for the reproduction, fecundity and growth of aphids (Shrivastava *et al*., 2011). In our study, an abrupt fall in the *S. graminum* abundance was observed at last week of March. Likewise, Ali *et al*. (2015) described that aphids population decreased in the last week of March. Aphid abundance was diminished in start of April. This is because of rise in temperature and crop maturity.

Table 1 also reveals that cultivar Galaxy 2013 had significantly lower aphid's incidence as compared to

Table 1. Mean week wise per plant aphid population on the different wheat cultivars.

	27-Feb-15	6-Mar-15	13-Mar-15	20-Mar-15	27-Mar-15
Galaxy 2013	6.67±0.88b	8.50±0.76c	27.80±0.80c	41.20±0.61c	13.33±1.76c
Faisalabad 2008	8.33±0.33b	11.33±0.67b	33.13±0.38b	45.97±1.56b	17.00±0.58b
AARI 2011	11.67±0.88a	15.26±0.64a	40.63±0.63a	58.57±0.99a	24.77±0.82a
Punjab 2011	9.33±0.88ab	17.10±1.1a	43.13±1.04a	60.20±0.87a	26.07±0.61a

Means followed by different letters are significantly different (α=0.05); a, b, and c indicate differences within the columns.

Faisalabad 2008, AARI 2011 and Punjab 2011. Ahmad *et al*. (2016) justified that maximum aphids' abundance was recorded on Punjab 2011 and Lasani 2008. Aphid population was found maximum on Faisalabad 2008 than on other cultivars (Ahmad *et al*., 2016). It is proved that Galaxy 2013 exhibited resistance against aphids and is unfavorable for the pest. Galaxy 2013 was found to be resistant variety against aphids (Shafique *et al.*, 2016; Yahya *et al*., 2017). Host plant resistance directly interferes with insect populations, fecundity, growth, development, its infestation and injury (Ahmed and Nasir, 2001; Akhtar *et al.*, 2006; Ahmed *et al*., 2015). Resistant cultivars can be integrated to other IPM methods to manage wheat aphid below ETL.

***Effect of aphid feeding on thousand grain weight and yield on wheat*:** The impact of *S. graminum* herbivory in thousand grain weight is shown in the Figure 1. Statistically significant results were recorded. Cultivar Galaxy 2013 gave higher weight than those of Faisalabad 2008, AARI 2011 and Punjab 2011. This proved that *S. graminum* feeding caused reduction in thousand grain weight significantly on cultivars AARI 2011 and Punjab 2011. Similarly, *S. graminum* feeding also caused reduction in yield of cultivars AARI 2011 and Punjab 2011. Significantly higher yield was recorded in Galaxy 2013 as compared to other cultivars as shown in Figure 2. Galaxy 2013 has resistance against wheat aphids with maximum grain yield as compared to other cultivars (Shafique *et al*., 2016). Another study revealed that cultivars with heavy attack of aphid gave poorer grain weight and therefore, yield elements and aphid damage level have inverse relationship. In the same study, higher yield was recorded in Galaxy 2013 in comparison with other cultivars (Yahya *et al*., 2017). Aphids had positive correlation with loss of grain yield (Wains *et al*., 2010).

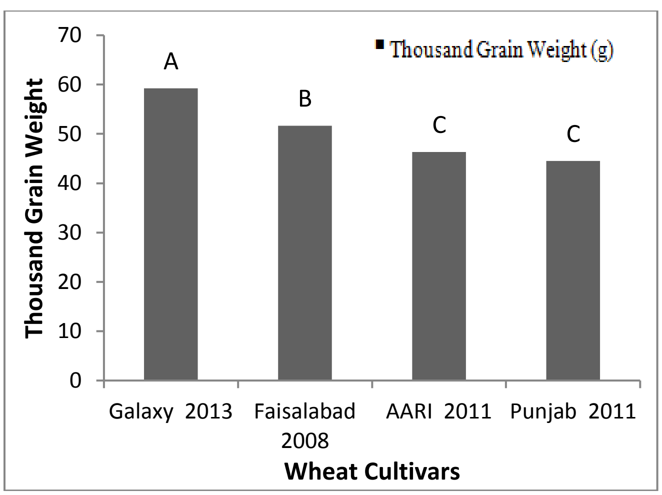

Figure 1. Effect of aphid feeding on thousand grain weight of wheat

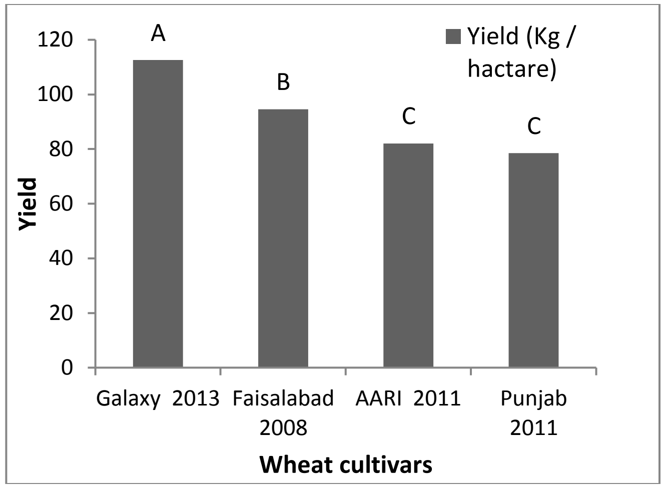

Figure 2. Effect of aphid feeding on yield of wheat.

Highly significant differences were observed for thousand grain weight and yield in wheat (Shahzad *et al*., 2013). Cultivars infested by aphids exhibited poorer thousand grain weight (Ahmad *et al*., 2015). Aphids inject toxic saliva into the plants that finally stops grain formation (Ciepiela, 1993).

***Effect of aphid feeding on photosynthetic rate and chlorophyll contents on wheat*:** The impact of *S. graminum* herbivory in photosynthetic rate is shown in the Figure 3. Cultivar Galaxy 2013 showed significantly higher photosynthetic rate than those of Faisalabad 2008, AARI 2011 and Punjab 2011. This proved that *S. graminum* feeding caused reduction in photosynthetic rate significantly in cultivars AARI 2011 and Punjab 2011. Similarly, *S. graminum* feeding also caused reduction in chlorophyll contents of cultivars AARI 2011 and Punjab 2011. Significantly higher chlorophyll contents were recorded in Galaxy 2013 as compared to other cultivars as shown in Figure 4. Photosynthetic rate and chlorophyll contents were significantly higher in Galaxy 2013 as compared to other cultivars. Macedo *et al*. (2009) conducted research on wheat and clarified that *D. noxia* and *R. padi* negatively affected photosynthesis rate. Similarly, Yahya *et al*. (2017) revealed that aphid damage resulted in reduced photosynthetic rate and less chlorophyll content on wheat crop. Aphid feeding alters physiological and biochemical processes in plants including photosynthesis. For instance, feeding of *S. graminum* caused damages to cell walls and chloroplasts which are attributed to degrading enzymes present in saliva (Al-Mousawi *et al*., 1983). Earlier, Gerloff and Ortman (1971) suggested that injections of toxin by pests are the reasons of reduced photosynthetic rate and chlorophyll contents. Besides toxins, secreted honeydew by aphids covering 33% of stomata of wheat leaves resulted in reduced photosynthetic rate (Rabbinge *et al*., 1981). Reduced photosynthetic rate and chlorophyll contents also reported in canola crop (Hussain *et al*., 2014; Razaq *et al*., 2014).

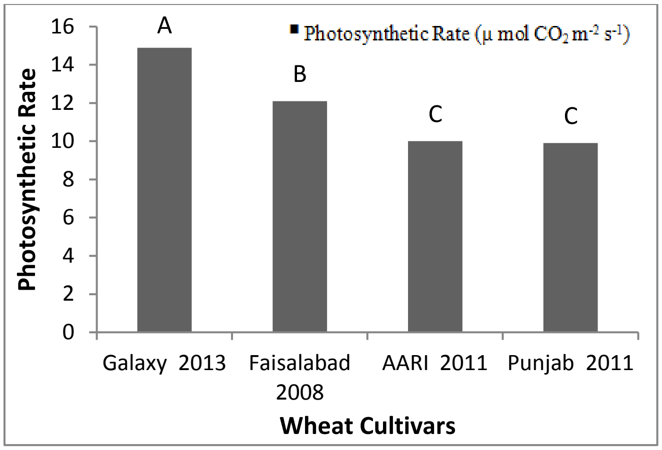

Figure 3. Effect of aphid feeding on photosynthesis rate of wheat.

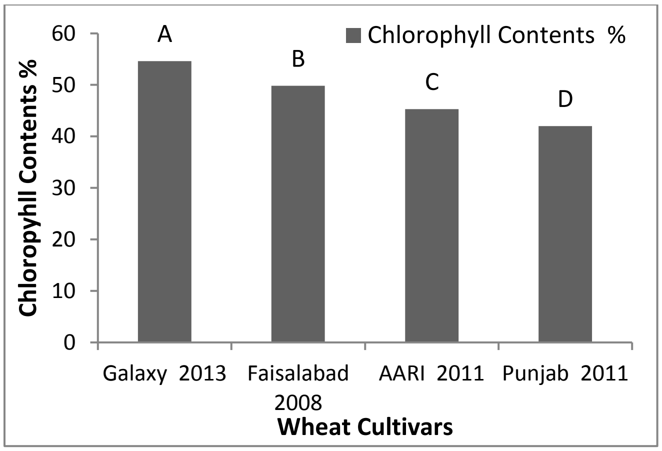

Figure 4. Effect of aphid feeding on Chlorophyll contents of wheat.

***Conclusion*:** It is concluded that aphid feeding reduced both yield and photosynthetic rate in all varieties of wheat crop. But cultivar Galaxy 2013 gave significantly higher yield and increased photosynthetic rate. It has the ability to tolerate and withstand the aphid damage. Since, our major target is to achieve higher yield of wheat, so it isdeclared that Galaxy 2013 have resistance against aphids. In IPM, sowing of resistant variety is a cultural practice and it is environmentally safe as compared to chemical control with advantage of no resistance to insect pests. In the light of this research, we recommend the sowing of cultivar Galaxy 2013 to prevent aphid damage and to obtain higher yield.

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