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INFLUENCE OF FOLIAR APPLICATION OF MICRONUTRIENTS ON POPULATION DYNAMICS OF APHIDS ON WHEAT

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Abstract

Wheat is considered as the major staple food world widely and is the best human diet. The wheat aphids *Rhopalosiphum padi* and *Diuraphis noxia* (Hemiptera: Aphididae) are the most hazardous pests of cereal crops especially wheat. An experiment was carried out during spring season of 2020 to assess the effect of foliar applications of five micronutrients (Fe, Mn, B, Cu and Zn) on population dynamics of aphids on wheat in Lahore, Pakistan. There were six treatments *viz.* T_1 (control), T_2 (1.5 g $CuSO_4$ L^{-1}), T_3 (4 g $ZnSO_4$ L^{-1}), T_4 (3 g $MnSO_4$ L^{-1}), T_5 (10 g $FeSO_4$ L^{-1}), and T_6 (1 g boric acid L^{-1}) in a randomized complete block design. Foliar application was done once after 12-week sowing when the crop was at booting stage. Population of aphids was significantly reduced in all the micronutrient application treatments as compared to control. In T_2 where $CuSO_4$ was sprayed, population of aphids was the lowest. The foliar application of Zn, Mn and B also declined the aphid population during the whole experimental period. Resultantly, foliar application of micronutrients could be applied to reduce the aphid population on wheat.

Key Words: Foliar spray, Micronutrients, Non-chemical control, Wheat aphids.

Introduction

Wheat is the staple food with 35% population of the world dependent on this crop for food (IDRC, 2010). It is a well source of nutrition with array of benefits. Wheat demand in the country is increasing continuously due to rising population. Low yield per acre area is also a significant constraint in meeting the demand. It was estimated that the yield potential in Pakistan is 2.5 times less than advanced wheat-producing nations (Nadim *et al*., 2012). Wheat production ranks first in Pakistan among all the cereals (Asad and Rafique, 2000), and acts as income generating crop for economy of the country (Abbas *et al*., 2015).

Aphids, being sucking pests cause a significant decline in wheat production (Singh and Singh, 2013). Aphids belongs to the family Aphididae and order Homoptera, sometimes referred as plant lice. They have a wide host range *i.e.* feed on cereals, vegetables and ornamental plants. They have sucking proboscis and insert toxic saliva in plant tissues (Zeb *et al.*, 2011). In recent years, they have become problematic for wheat cultivation. They are commonly found attacking on various wheat varieties. The estimated yield loss of 35 to 40% is associated with aphid attack in wheat crop (Gogi *et al.*, 2015). The aphid species namely *Diuraphis noxia*, *Rhopalosiphum padi*, *Sitobion avenae* and *Schizaphis graminum* are known to attack on wheat crop. A few plant viruses are considered to be transmitted by aphid attack (Aziz *et al.*, 2015).

Micronutrients have specific functions in plant tissues (Asad and Rafique, 2000). Iron boosts up plant growth and development. It is a building block in proteins and enzymes, and directly influence the chloroplast development, thylakoid membrane, and chlorophyll synthesis. Nitrogen fixation involves iron (Rawashdeh and Sala, 2013). Similarly, Zn is an integral part of some important enzymes, and is also helpful in various biological processes and growth of plant tissues. It strengthens the plant's defensive system. It activates various metallo-enzymes to protect plant from pathogens (Cabot *et al.,* 2019). Mn plays a role in processes such as photosynthesis, metabolism of nitrogen and protein formation. It also enhances defensive mechanism of plants (Alejandro *et al.,* 2020). Cu is important for being a cofactor of various plant proteins. Like others, small amount of it is required but if it exceeds from recommended dose, it may be injurious to plant tissues (Printz *et al.,* 2016). Even in traces, Cu is significant for pollen viability along with the redox reactions. Boron is important for cell formation and carbohydrate utilization (Nadim *et al.,* 2011).

Foliar application of nutrients maintains the quality and quantity of crop plants (Salih, 2013). Additionally, foliar application lowers the chances of pollution as they are not added to the soil. Foliar sprays of micro-nutrients not only increase crop yield but also reduce amount of fertilizer used. Various studies confirm, nutrient's application has a positive effect on yield through reduced insect attack. In the present study, the effect of foliar applications of micronutrients on wheat against wheat aphids was studied.

Materials and Methods

Experimental site and soil analysis: A field experiment was conducted in Lahore, Pakistan to analyse foliar applications of micronutrients *viz.* Fe, B, Mn, Zn and Cu on wheat and wheat-aphids during cropping year 2019-2020. Composite soil samples were taken from field at 18 cm depth with the help of a spade from different points. The soil analysis was done for pH, organic matter, soil phosphorous, electrical conductivity and potash content (Table 1).

Table1: Properties of experimental soil

Texture	Clay loamy
PH	8.24
Organic matter (%)	0.69
Phosphorous (mg kg^{-1})	2.28
Potassium (mg kg^{-1})	56
Electrical conductivity dS m^{-1}	1.6

Sowing of seeds: The soil was characterized as clay loamy with well drained properties. Ploughing was carried out in the month of November and it was given irrigation after 2 days to maintain the moisture content. Thereafter, the field was given a levelling operation with manual equipment. Wheat seeds were sown on 27th of November, the planting method was manual (line sowing) and row to row distance was 6 cm apart. First irrigation was given on 02/12/2019 and 4 irrigations were given during the whole cropping period. Manual weeding operation was also carried out meanwhile to keep the field free of weeds. 1st half of nitrogen split and recommended dose of phosphorous was given to the soil at the time of preparatory operations while the 2nd split of nitrogen fertilizer was given with first irrigation after three weeks. All the practices were followed recommended for wheat cultivation in Pakistan. No pesticide application was done at any stage.

Treatments: Seeds of wheat var. Galaxy 2013 were sown in the field plots. Foliar treatments of 5 micronutrients *viz.* Fe, Cu, B, Mn and Zn was carried out. The allocation of treatments was randomized complete block design with 3 replicates. Weighed amount of each salt was dissolved in 1.0 L of H_2O and applied using a hand showering apparatus. Treatments included T_1 = Control with water spray, T_2 = 1.5 g $CuSO_4$ L^{-1}, T_3 = 4 g $ZnSO_4$ L^{-1}, T_4 = 3 g $MnSO_4$ L^{-1}, T_5 = 10 g $FeSO_4$ L^{-1}, T_6 = 1 g boric acid L^{-1}.

Spray and data collection: Foliar spray was carried out once at tillering stage during early morning hours with a hand sprayer. Initial data (pre-treatment data) were noted on 24th of February 2020. From each of the three replicates of each treatment, 5 random spots were designated from each row. After 2 days of nutrients application, first data regarding aphids count was collected followed by a 2nd and 3rd data recorded after 5 and 7 days of the spray. Thereafter, data were recorded on weekly basis.

Aphid population on wheat: In the cropping area, aphid's population appeared towards the closing of January and reached to its climax at the end of next month. For data collection, 5 random spots were selected in each row. By using camel hairbrush 00, numbers of wheat aphids were counted during morning hours. Aphid's count was done from leaves, stems as well as spikes.

Data analysis: The data regarding number of aphids on wheat plants was converted into mean values for each replicate of all the treatments and analysis of variance was applied. Their means were compared using Tukey HSD Test at $P \leq 0.05$.

Results and Discussion

Effect of Cu spray on aphid population: At different time periods after foliar spray, the effect of Cu was variable on population of aphids. However, at most of the intervals, the aphid population was significantly lower on Cu sprayed wheat plants as compared to corresponding control treatment. After two days of Cu spray, aphid population was 31 as compared to 47 in control. The difference between the two treatments was significant ($P \leq 0.05$). After 5 and 7 days of foliar application of Cu, aphid population was 45 and 42 on the sprayed plants as compared to 59 and 45 on control plants, respectively, showing

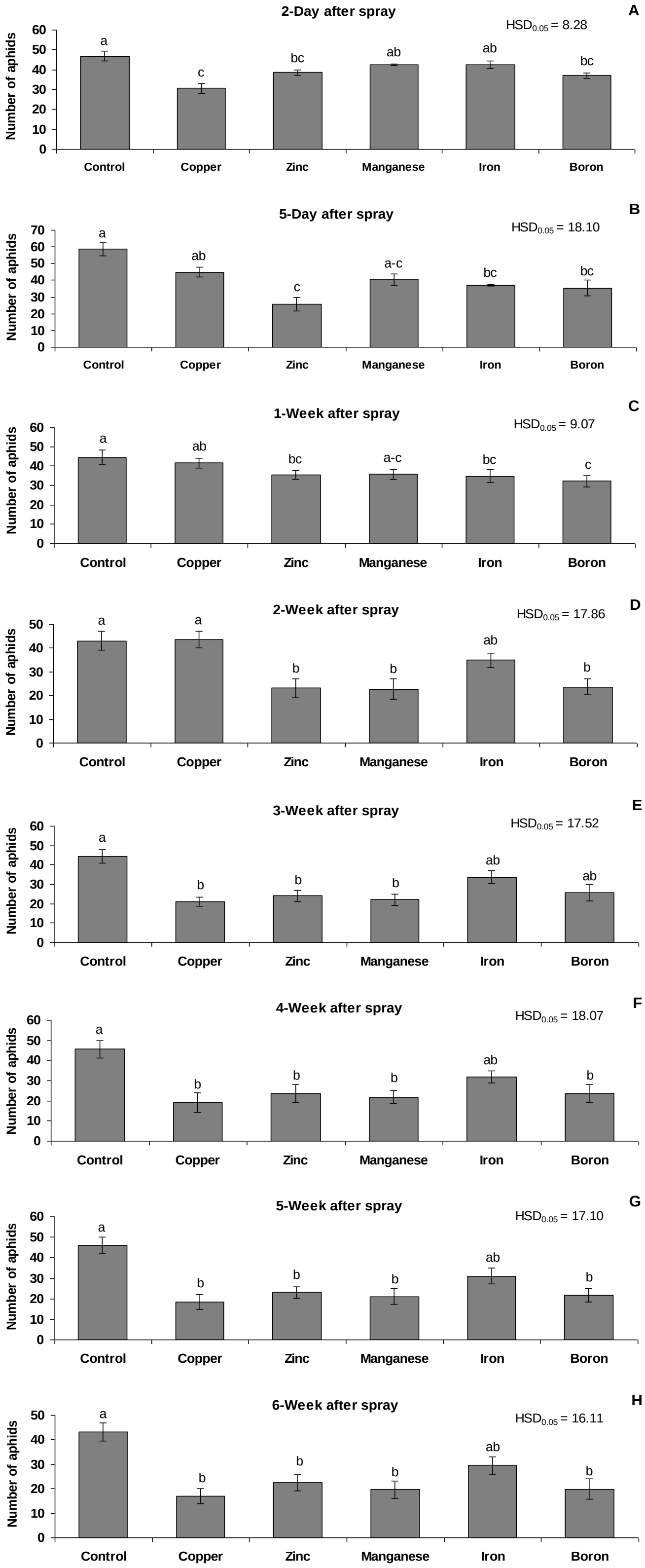

Fig. 1. Effect of foliar spray of micronutrients on population of wheat aphid at different time intervals after spray. Vertical bars show standard errors of means of four replicates. Values with different letters at their top show significant difference ($P \leq 0.05$) as determined by Tukey's HSD test.

insignificant difference between the control and treated plants. Similarly, there were 44, 21, 19, 18 and 17 aphids on Cu sprayed plants than 43, 44, 46, 46 and 43 aphids on control plants after 2nd, 3rd, 4th, 5th and 6th week of foliar spray, respectively (Fig. 1). Average number of aphids were 29 and 46 on sprayed and control plants throughout the experimental period with significant difference between the two treatments (Fig. 2).

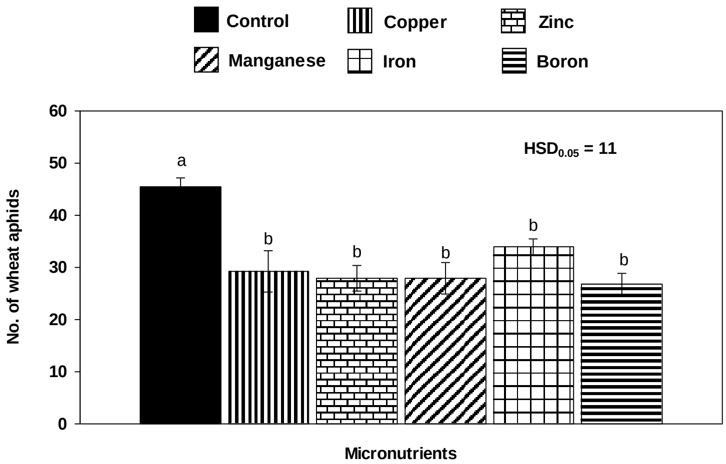

Fig. 2. Effect of foliar spray of micronutrients on mean population of wheat aphid over the entire period of study. Vertical bars show standard errors of means of four replicates. Values with different letters at their top show significant difference (*P*≤0.05) as determined by LSD Test.

Effect of Zn spray on aphid population: In case of Zn sprayed wheat plants, the number of aphids was significantly (P≤0.05) lower on treated as compared to control plants. There were 39, 26, 35, 23, 24, 24, 23 and 23 aphids on Zn sprayed plants as compared to 47, 59, 45, 43, 44, 46, 46 and 43 aphids on control plants, respectively, at various intervals (Fig. 1). Overall, the average number of aphids on Zn applied and control plants was 28 and 46, respectively (Fig. 2). Earlier, zinc sulphate spray on cotton significantly reduced population of white fly that lowered the incidence of cotton leaf curl viral disease (Kalsoom *et al.,* 2019). Zinc is likely to be a key player in immune responses in plants (Gupta *et al.,* 2012). It is a structural as well as catalytic protein cofactor in a large number of enzymes (Hambidge *et al.,* 2000). It affects interactions between plants and pathogens through activation of metalloenzymes as reported by Fones and Preston (2012). In addition, Noman *et al.* (2019) reported that zinc finger proteins are responsible for regulating plant responses to various biotic stresses.

Effect of Mn spray on aphid population: Foliar application of Mn showed a pronounced inhibitory effect on aphid population throughout the experimental period. The inhibitory effect was insignificant during the first week after foliar spray while it was significant (P≤0.05) thereafter. Aphid population was 43, 41, 36, 23, 22, 22, 22 and 20 on Mn applied wheat plants than 47, 59, 45, 43, 44, 46, 46 and 43 on corresponding control treatment, respectively, at various time intervals after foliar spray (Fig. 1). The overall effect of the Mn spray was significant ($P \leq 0.05$) with average number of 28 aphid on Mn than 46 on control plants (Fig. 2). Similarly, foliar application of Mn reduced the population of Citrus red mite, *Panonychus citri* (Chávez-Dulanto *et al.,* 2018). Mn contributes in the synthesis of phenolic compounds and various other mechanisms involved in plant defense against pests (Fernando *et al.,* 2009).

Effect of Fe spray on aphid population: Although the number of aphids was continuously lower on Fe sprayed plants than on control plants but the difference between the two treatments was generally insignificant at various intervals after foliar spray (Fig. 1). However, the overall effect of Fe spray was significant with 34 and 46 average number of aphids on Fe applied and control plants, respectively (Fig. 2). Earlier, Chávez-Dulanto *et al.* (2018) reported that foliar application of Fe lowered the population of Citrus rust mite (*Phyllocoptruta oleivora*) on mandarin orange in Peru.

Effect of B spray on aphid population: The inhibitory effect of B application (in the form of boric acid) on aphid population was consistently significant ($P \leq 0.05$) throughout the experimental period. There were 37, 35, 32, 24, 26, 24, 22 and 20 aphids on Fe applied than 47, 59, 45, 43, 44, 46, 46 and 43 on control plants at different time intervals (Fig. 1). Average number of aphids on B treated and control wheat plants was 27 and 46, respectively (Fig. 2). Boric acid has been applied as an effective chemical for the control of an extensive variety of sucking insects in diverse plantations (Bicho *et al.,* 2015). In order to keep citrus mites below economic levels, Citrus farmers of Chancay valley, Peru use spraying of fertilizers such as Cu and B (Chávez-Dulanto *et al.,* 2018). Kalsoom *et al.* (2019) carried out a field experiment to compare the effect of foliar application of boric acid with commercial pesticides for the control of white fly (*Bemisia tabaci*) in cotton. They found that a 2 g L^{-1} aqueous solution of boric acid showed 65% control of white fly. Javaid *et al.* (2018) 81% mortality of sucking insects due to boric acid application. Boric acid produces toxin in the neuron of insects and also destroys the inner portion of foregut of insects (Habes *et al.,* 2006).

Conclusion

This study concludes that foliar application of micronutrients Mn, Zn, Cu, Fe and B can significantly reduce aphid attack on wheat under agro-ecological conditions of Lahore, Pakistan.

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