Original Article **Asian J Agri Biol, 2015, 3(1): 34-40.**

EFFECT OF DIFFERENT DOSES OF FERTILIZERS ON WHEAT APHIDS AND THEIR NATURAL ENEMIES IN POTHWAR, PUNJAB

Muhammad Asif Aziz*, Hira Zameer, Imran Bodlah, Muhammad Naeem and Ghulam Shabbir
Biological Control Laboratory, Department of Entomology, PMAS-Arid Agriculture University Rawalpindi, Pakistan

ABSTRACT

Present study was conducted to evaluate the effect of different application levels of Nitrogen, Phosphorus and Potash (NPK) on the population of aphids and their natural enemies on wheat crop at research farm of Department of Entomology, PMAS-Arid Agriculture University Rawalpindi, Pakistan during 2013. Population of *Rhopalosiphum padi* was the maximum in N: P: K=75:60:60 (kg/ha) while it was the minimum in 90:60:75 treated plots. Population density of *Sitobeon avenae* was the maximum in 0:0:0 and the minimum in 105:60:60 and 90:60:60. Population of *Schiazphis graminum* was the maximum in 75:60:60 and the minimum in 90:60:75 and 90:60:45. Population of mummified aphids remained the maximum in 75:60:60 and 0:0:0. *Chrysoperla carnea* larvae were the most abundant in 75:60:60. Population of lady bird beetles was the maximum in 75:60:60 and the minimum in 105:60:60. The maximum *C. carnea to* aphids, lady bird beetle to aphids and parasitoid to aphids ratios were recorded in 75:60:60, 0:0:0 and 90:60:45, respectively. Since the population of *S. avenae* was very low as compared to *R. padi*, the treatment 90:60:45 seems to be more suited for the farmers to manage the aphids and get healthy wheat crop. Therefore the treatment 90:60:45 seems to be more suited for the farmers to manage the aphids and get healthy wheat crop. It is evident from the current study that use of balanced fertilizer is very important to manage the population of aphids in arid zone. Over application of fertilizer should also be avoided because it do not help in pest control, conversely it may cause stress on plants particularly in case of delay in rains. The treatment 90:60:45 is almost comparable with the recommended dose in arid zones and present studies confirms its usefulness on wheat in Pothwar region of Punjab.

Keywords: Wheat, aphid, parasitoid, predators, NPK

INTRODUCTION

Wheat crop is grown throughout the world and acts as a basic edible food in Pakistan while aphids are the most troublesome pests of wheat (Aziz et al., 2013). A number of aphids attack on wheat crop like bird cherry oat aphid (*Rhopalosiphum padi*), Russian wheat aphid (*Diuraphis noxia*), english grain aphid (*Sitobion avenae*), rice root aphid, (*Rhopalosiphum rufiabdominalis*), corn leaf aphid (*Rhopalosiph ummaidis*) *and* green bug (*Schizaphis graminum*) (Hashmi et al., 1983). Direct feeding of aphids act as a source for the significant losses in the yield of crop (Keickhefer and Kantack, 1980). Aphids feed on plant tissues and block the regular transportation of phloem, nitrogen particles move slowly to the cells and in terrupt the movement of photosynthates (Peterson and Higley, 1993). Aphids are also responsible for the transmission of many plant viruses (Aheer et al., 2008).

In Pakistan, most of the land is deficient in major plant nutrients and require regular application of NPK to get healthy crops. These fertilizers exert great impact on the growth and nutritional value of plants by changing the essential minor metabolites, which also influence the aphid population in the treated field (Bado et al., 2002). In wheat, the application of fertilizers affects the host inclination and host selection of aphid, because their landing is determined by the volatiles of the plants (Powell et al., 2006). Weibull (1987) reported that application of nitrogen on barley increased the phloem cell sap, which proved more favorable for *R. padi*. According to Awmack and Leather (2002), the nitrogen level in the diet of herbivores insects is the most important factor affecting their performance. The population of *R. padi* is reported to be decreased on nitrogen deficient plants (Dixon, 1987; Ponder et al., 2000). Application of potassium increases the yield of

**Corresponding author:* e-mail: asifaziz@ uaar.edu.pk

wheat crop and is also reported to have negative effect on aphid population (Sweeney et al., 2000). *Rhopalosiphum padi* prefers the barley crop with less applications of K in soil than that of with more potassium availability (Havlickova and Smetankova, 1998).

Predators and parasitoids are competent source of biological control of wheat aphids (Iqbal et al., 2008). Availability of nitrogen affects the interaction between the prey and its predators. The predator (*Harmonia axyridis*) consumed more aphids from plants treated with low amount of nitrogen because the aphids on high nitrogen treated plants gained more body weight and were recorded non preferred by the predator (Aqueel and Leather, 2012). Many people have conducted different experiments to investigate the effect of nitrogen fertilizer on the parasitoid of aphids, but the results do not show the clear picture. (Karungiet al., 2006; Pontiet al., 2007). Keeping in view all these studies, a systematic study was conducted to find out the effect of different levels of NPK on the population of wheat aphids as well as their predators and parasitoids and to explore the best combination of NPK which can give better yield of wheat crop and help to manage the aphid population.

MATERIALS AND METHODS

The study was designed to evaluate the effect of different application levels of NPK on the population of aphids and their natural enemies on wheat crop at research farm of Department of Entomology, PMAS-Arid Agriculture University Rawalpindi, Pakistan. For this study wheat (AUR-0809) crop was sown during November, 2012 in the field. Area of each plot was 2.5 × 0.5 meter having 0.3 meter row to row distance. The experiment was comprised of six treatments and four replications in Randomized Complete Block Design. All the agronomic practices were uniformly applied on all test plots except application of fertilizer. There were six treatments of NPK with four replicates viz. $T_{1=}$ 0:0:0, $T_{2=}$ 75:60:60, $T_{3=}$ 90:60:60, $T_{4=}$ 105:60:60, $T_{5=}$ 90:60:45, $T_{6=}$ 90:60:75, NPK (kg/ha) respectively.

Effect of different doses of NPK on aphid population

All the experimental plots were examined carefully for any aphid attack and the data were recorded as the aphid infestation started on wheat plants (05.03.2013). In each plot, ten wheat tillers were selected randomly and aphids were counted over the whole tiller. Data were recorded with weekly intervals. All the stages of aphids were counted and recorded as aphid population (per tiller).

Effect of different doses of NPK on the population of natural enemies

To check the effect of different levels of NPK on natural enemies of aphids on wheat crop, experimental plots were examined regularly. Data regarding predators were recorded by randomly selecting 10 wheat tillers from each plot. Data regarding parasitoids were taken separately on the basis of mummified aphids per leaf, stem and spikes in order to see the preference of parasitoids for parts of wheat plant. To record the ratio of aphids to natural enemies (predators and parasitoids), their population (per 100 tillers) were recorded in peak activity timings (Cai et al., 2009).

Statistical Analysis

The data on population of aphids and their natural enemies were analyzed statistically by using one way ANOVA. Comparison of mean values was made by using the Duncan's multiple range test (DMRT) at 0.05% probability (Steel et al., 1997).

RESULTS

Population density of *R. padi*

Population of *R. padi* nymphs was the maximum in NPK=75:60:60 treated plots; significantly different from all other treatments. Apterous adults of *R. padi* were the maximum in 105:60:60 and comparatively minimum in 90:60:45 which was statistically similar with 90:60:75 and 0:0:0. Alate population of *R. padi* was the maximum in 90:60:60 and the lowest in 90:60:45 and 0:0:0. Overall population of R. *padi* was the maximum in 75:60:60 while comparatively minimum in 90:60:45 which was statistically similar with 0:0:0, 90:60:75 (Table 1).

Population density of *S. avenae*

The lowest population of *S. avenae* was recorded in NPK=105:60:60 which was statistically similar with 90:60:60, while the maximum population was observed in 90:60:45 which was statistically similar with 75:60:60, 90:60:75 and 0:0:0 treated plots. The least apterous population of *S. avenae* was observed

in 90:60:75 and 105:60:60, while it was the maximum in 105:60:60 treated plots. Alates of *S. avenae* were the most abundant in 0:0:0 and comparatively minimum in 105:60:60 treated plots. Total population of all morphs of *S. avenae* was the maximum in 0:0:0 and the lowest in 105:60:60 which was statistically similar with 105:60:60 (Table 1).

Population density of *S. graminum*

Population of *S. graminum* nymphs was the maximum in 75:60:60 treated plots followed by all other treatments with were statistically similar with each other. Apterous adults of *S. graminum* were found to be the maximum in 0:0:0 and the lowest in 90:60:45 which was statistically similar with 90:60:75 and 90:60:75. Maximum alates of *S. graminum* were found in 75:60:60 treated plots and minimum in 90:60:75 which was statistically similar with 90:60:45. Overall population of *S. graminum* was the maximum in 75:60:60 and the lowest in 90:60:75 which was statistically similar with 90:60:45 (Table 1).

Parasitoids and Predators population Density

Population of mummified aphids per leaf, stem, spike and complete plant remained maximum in 75:60:60 and in 0:0:0 treated plots. *Chrysoperla carnea* larvae were most abundant in 75:60:60 and comparatively less in numbers in 105:60:60 treated plots. Population of lady bird beetle larvae, adults and their total population was the maximum in 75:60:60 and comparatively minimum in 105:60:60

Effect of NPK fertilizers doses on aphids to parasitoid/predator ratio

Percentage of aphid parasitized by its parasitoid was the maximum in 90:60:45 which was statistically different from other treatments and minimum in 105:60:60 treated plots. Maximum *C. carnea to* aphid ratio was observed in 75:60:60 and the minimum on 105:60:60 which was statistically similar with 90:60:45 and 90:60:75. Lady bird beetle to aphid ratio was the maximum numbers in 0:0:0 which was statistically similar with 75:60:60 and minimum in 90:60:45 treated plots (Table 3).

DISCUSSION

The population of *R. padi* is reported to decrease on nitrogen deficient plants (Ponder *et al*., 2000) and more supply of nitrogen increased the population of cereal aphids (Dixon, 1987). This trend was observed in case of 0:0:0 and 75:60:60 for both *R. padi* and *S. graminum.* But their population started decreasing onwards with the increase in nitrogen level. According to Southwood (1973) more aphids were attracted to those plants which have nitrogen in high amount, but in the present studies, when nitrogen application was increased from 75:60:60 to 105:60:60, the aphid species did not show increasing trend. This observation is supported by the findings of Gash (2012), who declared that fecundity of the aphids decreased with the increase in application rate of nitrogen, as high amount of nitrogen in the plant affects the performance of aphids. Comparatively less population of *R. padi* and *S. graminum* was observed in 90:60:45 treated plots which is comparable with the dose of fertilizers recommended in arid zone. The population of *S. avenae* was comparatively lower in 90:60:60 and 105:60:60 treated plots than the rest ones including control treatment, which advocates lack of effect of nitrogen application on its population. Application of potassium reported to have negative effect on aphid population (Sweeney *et al*., 2000), but in the current study the data did not support this phenomenon. Comparatively less population of R. padi and S. graminum was recorded in 90:60:45 than in 90:60:75 treated plots. In case of S. avenae comparatively less population was observed in 90:60:60 than in 90:60:75 treated plots. Number of parasitoid on leaves, stem and spike were more in 75:60:60, but population of aphids was also more on this treatment. It has been found that *Aphidius colomani* preferred 1st and 2ndinstars of *A. gossiypi* for parasitism (Perdikis et al., 2004) because aphids in 1st and 2nd instars are less defensive against parasitoid and it is easy for parasitoid to attack on these instars (Losey and Denno, 1998). Population of predators was more in NPK=75:60:60 treated plots as compared to the plots having higher applications of nitrogen. This may be due to the fact that high amount of nitrogen results in increase in the weight of aphids, so they are not preferred by the predators (Garatt et al., 2010; Aqueel and Leather, 2011). Non availability of preys in plots with high nitrogen application may be another cause of less population of predators in these plots. Percentage of aphid to parasitoid ratio was the maximum in NPK=90:60:45; also harbored the lowest population of *R. padi* and *S. graminum*,

comprising the major portion of aphid population on the wheat. Therefore the treatment NPK=90:60:45 seems to be more suited for the farmers to manage the aphids and get healthy wheat crop. It is evident from the current study that use of balanced fertilizer is very important to manage the population of aphids in arid zone. Over application of fertilizer should also be avoided because it do not help in pest control, conversely it may cause stress on plants particularly in case of delay in rains. The treatment 90:60:45 is almost comparable with the recommended dose in arid zones and present studies confirms its usefulness on wheat Pothwar region of Punjab.

Table 1. Means comparison of aphids at various NPK fertilizer treatments on wheat during 2013

Treatments	*Rhopalosiphum padi*				*Sitobean avenae*				*Shizaphous graminum*			
	Nymphs/ Plant	Apterous/ plants	Alates/ plant	Total R. padi/ plant	Nymphs/ plant	Apterous/ plants	Alates/ plant	Total*S. avenae*/ plant	Nymphs /plant	Apterous/plants	Alates/plant	Total *S. graminum*/ plant
NPK= 0:0:0	7.98b	1.02c	0.81c	**9.61c**	1.410a	0.14ab	1.06a	**2.61a**	1.00b	0.76a	0.15ab	**1.92ab**
NPK=75:60:60	12.96a	2.25ab	1.42ab	**16.20a**	1.48a	0.17ab	0.29d	**1.94b**	1.43a	0.42bc	0.20a	**2.05a**
NPK=90:60:60	9.23b	1.60bc	1.54a	**12.00b**	0.50b	0.20a	0.21d	**0.91c**	1.05b	0.30c	0.13abc	**1.48bc**
NPK=105:60:60	9.20b	2.35a	0.99bc	**12.06b**	0.29b	0.08b	0.72b	**1.09c**	0.93b	0.58ab	0.09abc	**1.61abc**
NPK=90:60:45	7.98b	0.80c	0.82c	**9.43c**	1.56a	0.12ab	0.55bc	**2.23ab**	0.95b	0.22c	0.03bc	**1.19c**
NPK=90:60:75	8.19b	0.90c	1.04bc	**9.91c**	1.44a	0.08b	0.37cd	**1.86b**	1.05b	0.28c	0.01c	**1.34c**
DMRT at 0.05	2.40	0.71	0.42	**2.80**	0.03	0.09	0.20	**0.40**	0.40	0.20	0.12	**0.5**

Means sharing similar letters are not signigicantly different at 0.05 probability at DMR test

Table 2. Mean comparison of mummified aphids and predator population on wheat at NPK different application ratio during 2013

Treatments	Mummies/ leaf	Mummies/ stem	Mummies/ spike	Mummies/ plant	*Chrysoperrla carnea* larvae/plant	Ladybird beetle larvae/plant	Adult ladybird beetle/plant	Total ladybird beetles/plant
NPK= 0:0:0	0.22c	0.125c	0.042c	0.38c	0.10b	0.13bc	0.13c	0.24bc
NPK=75:60:60	0.44a	0.346a	0.15a	0.93a	0.23a	0.32a	0.28a	0.61a
NPK=90:60:60	0.24c	0.208b	0.03c	0.48b	0.04c	0.15b	0.15b	0.30b
NPK=105:60:60	0.31b	0.146c	0.03c	0.49b	0.01d	0.05e	0.07e	0.12d
NPK=90:60:45	0.23c	0.246b	0.05c	0.51b	0.02d	0.08de	0.10d	0.18cd
NPK=90:60:75	0.3bc	0.125c	0.07b	0.45bc	0.09b	0.10cd	0.11cd	0.2cd
DMRT at 0.05	0.10	0.04	0.02	0.08	0.02	0.03	0.02	0.08

Means sharing similar letters are not significantly different at 0.05 probability at DMR test

Table 3. Percent ratio of aphids with parasitoid and predators on wheat crop at various level of NPK during 2013

Treatments	Parasitoids	*C.carnea*	Lady bird beetles
NPK= 0:0:0	2.85±0.67 ab	0.47±0.15ab	1.67±0.13 a
NPK=75:60:60	2.54±0.36 abc	0.60±0.03 a	1.50±0.25 a
NPK=90:60:60	1.69±0.62 bc	0.28±0.06 bc	1.11±0.35 ab
NPK=105:60:60	1.46±0.24 c	0.06±0.07 c	0.58±0.16 bc
NPK=90:60:45	3.19±0.54 a	0.15±0.09 c	0.40±0.18 c
NPK=90:60:75	1.7±0.46 bc	0.11±0.07 c	0.70±0.21 bc

Means sharing similar letters are not signigicantly different at 0.05 probability at DMR test

ACKNOWLEDGEMENTS

Authors are thankful to the Department of Entomology, PMAS-Arid Agriculture University Rawalpindi for providing a study plot at research farm and laboratory facilities to conduct this study.

REFERENCES

Aheer GM, Ali A and Munir M, 2008. Abiotic factors effect on population fluctuation of a late aphids in wheat. J. Agric. Res. 46: 367-371.

Aqueel MA and Leather SR, 2011. Effect of nitrogen fertilizer on the growth and survival of *Rhophalosiphumpadi* (L) and *Sitobionavenae* (F) (Homoptera: Aphididae) on different wheat cultivars. Crop Prot., 30: 216-221.

Aqueel MA and Leather SR, 2012. Nitrogen fertilizer affects the functional response and prey consumption of *Harmonia axyridis* (coleoptera: coccinellidae) feeding on cereal aphids. Ann. Appl. Biol. 160: 6-15.

Awmack CS and Leather SR, 2002. Host plant quality and fecundity in herbivorous insects.Annu. Rev. Entomol., 47: 817-844.

Aziz MA, Ahmad M, Nasir MF and Naeem M, 2013. Efficacy of different neem (*Azadirachtaindica*) products in comparison with imidacloprid against English grain aphid (*Sitobionav*enae) on Wheat. Int. J. Agric. Biol.15: 279–284.

Bado SG Rodriquez SMand Folcia AM, 2002. Aphids (Homoptera: Aphididae) and predatory ladybeetles (Coleoptera: Coccinellidae) abundance variation in a barley crop with different fertilization practices. IDESIA. 20: 31-42.

Cai QN, Ma XM, Zhao X, Cao YZ and Yang XQ, 2009. Effects of host plant resistance on insect pests and its parasitoid: A case study of wheat-aphid–parasitoid system. Biol. Control. 49(2):134-138.

Dixon, AFG, 1987. Cereal aphids as an applied problem. Agr. Zool. Rev. 2: 1-57.

Garratt MPD, Wright DJ and Leather SR, 2010. The effects of organic and conventional fertilizers on cereal aphids and their natural enemies. Agric. Forest. Entomol. 12: 307-318.

Garratt MPD, Leather SR and Wright DJ, 2010. Tritrophic effects of organic and conventional fertilizers on a cereal-aphid-parasitoid system. J. Entomol. Exp. Applic. 134: 211-219.

Gash AFJ, 2012. Wheat Nitrogen Fertilization Effects on the Performance of the Cereal Aphid *Metopolophiumdirhodum.* Agron. 2: 1-13.

Hashmi AA, Hussain MM and Ulfat M, 1983. Insect pest complex of wheat crop. Pak. J. Zool. 15 (2): 169- 176.

Havlickova H and Smetankova M. 1998. Effect of potassium and magnesium fertilization on barley preference by the bird cherry-oat aphid(*Rhopalosiphumpadi*). RostlinnaVyra. 44: 379-383.

Iqbal J, Ashfaq M and Ali A, 2008. Management of aphids by augmentation of Coccinellids and *Chrysoperlacarnea*under field conditions on wheat. Pakistan J. Agric. Sci. 45(1): 57-59.

Karungi J, Ekbom B and Kyamanywa S.,2006. Effects of organic versus conventional fertilizers on insect pests, natural enemies and yield of *Phaseolus vulgaris*. Agric. Ecosyst. Environ. 115: 51-55.

Keickhefer RW and Kantack BH, 1980. Losses in yield in spring wheat in South Dakota. J. Econ. Entomol. 69: 421-422.

Leather SR, 1994. Life history traits of insect herbivores in relation to host quality. Insect. Plant. Interac. 5: 175-207.

Losey JE and Denno RF, 1998. Positive predator-predator interactions: enhanced predation rates and synergistic suppression of aphid populations.Ecology. 79(6): 2143-2152.

Perdikis DC, Lykouressis DP, Garantonakis NG andIatrou SA, 2004. Instar preference and parasitization of *Aphis gossypii* and *Myzus persicae* (Hemiptera: Aphididae) by the parasitoid *Aphidiuscolemani* (Hymenoptera: Aphidiidae). Eur J Entomol. 101: 333-336.

Peterson, RK and Higley LG, 1993. Arthropod injury and plant gas exchange: current understandings and approaches for synthesis. Trends. Agric. Sci. 1: 93-100.

Ponder KL, Pritchard J, Harrington R and Bale JS, 2000. Difficulties in location and acceptance of phloem sap combined with reduced concentration of phloem amino acids explain lowered performance of the aphid *Rhopalosiphumpadi* on nitrogen deficient barley (*Hordeumvulgare*) seedlings. EntomolExp Appl. 97(2):203-210.

Ponti L, Altieri MAand Guitierrez AP, 2007. Effect of crop diversification levels and fertilization regimes on abundance of *Brevicoryne brassicae* (L) and its parasitisation by *Diaeretiellarapae* (M'Intosh) in broccoli. Agric. Forest. Entomol. 9: 209-214.

Powell G, Tosh CRand Hardie J, 2006. Host plant selection by aphids: behavioral, evolutionary, and applied perspectives. Ann. Rev. Entomol. 51: 309-330.

Southwood TRE, 1973. The insect plant relationship- an evolutionary perspective. Symp. R. Entomol. Soc. Lond. 6: 3-30.

Steel RGD and Torrie JH and Dickey DA, 1997. Principles and procedures of statistics. A biometrical approach.McGraw-Hill Book Company, New York: 666.

Sweeney DW, Granade GV, Eversmeyer MGand Whitney DA, 2000. Phosphorus, potassium, chloride, and fungicide effects on wheat yield and leaf rust severity. J. Plant Nutr. 23(9): 1267-1281

Weibull J, 1987. Seasonal changes in the free amino acids of oats and barley phloem sap in relation to plant growth stage and growth of *Rhopalosiphumpadi*. Annu. Appl. Biol. 111: 729-737.