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AN ECOFRIENDLY APPROACH TO CONTROL WHEAT APHID (*SCHIZAPHIS GRAMINUM* (RONDANI) BY USING BIO RATIONAL INSECTICIDES AS SEED TREATMENT AND FOLIAR APPLICATIONS

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ABSTRACT

The present research was carried out at the research field of Department of Agriculture and Agribusiness Management, University of Karachi. Seed treatment of Imidacloprid + Tebuconazole mixture and foliar applications of Pymetrozine, Matrine and Dinotefuran were evaluated to determine their effectiveness against aphid on wheat crop. The experiment was conducted in a randomized complete block design (RCBD) with three replicates, each replicate consisting of five treatment including control. Aphid's counts were made 24 hours before spray and post application data was recorded after 24, 48, and 72 hours and at weekly intervals. An overall performance of all the insecticides revealed that seed treatment (Imidacloprid +Tebuconazole) gave significant results with 88% reduction in aphid population followed by foliar applications of Pymetrozine (83%), Dinotefuran (78%) and Matrine (74%). In addition, it was also observed that Imidacloprid + Tebuconazole seed treatments increased average yield as compared to other insecticides including control. It can be concluded that seed treatment has the potential to provide significant whole plant protection against wheat aphids to prevent yield losses. The systemic activity of Imidacloprid + Tebuconazole mixture with relatively low rate of application makes it an effective and environment friendly option for seed dressing

Keywords: Neonicotinoid, bio rational insecticides, Seed treatment, *Schizaphis graminum* (Rondani).

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops and staple food of many countries including Pakistan. It is extensively grown both in irrigated and rainfed areas around the world. Cereal grains are vital source of calories and proteins (Alonso-Amelot and Avila-Nunez, 2011). Due to higher nutrition contents, wheat (*Triticum aestivum* L.) a high calorie food has important role to ensure food security in current climate change patterns worldwide (Aheer *et al.,* 2008). It is also main food crop of Pakistan occupying largest area under single crop 9.3 million hectares with an average production of 25.482 million tons and contributes 2.0 percent to GDP of Pakistan (Anonymous, 2016). Aphids (Homoptera: Aphididae) are the important pests of different crops, cause severe yield losses worldwide by damaging the crops (Blackman and Eastop, 2000). Cereal crops damage by aphids are much alarming especially in case of wheat crop. Even though aphids stay for limited time in the field, but they have ability to multiply rapidly and damage the whole crop within few days (Jarosik *et al*., 2003). They are most destructive sucking pests of agricultural and horticultural crops, distributed worldwide with recorded 4000 species, infesting over 250 host plants (Ali and Rizvi, 2007).

In Pakistan wheat yield adversely affected by aphids (Steffey *et al.*, 2009; Hamid, 1983; Carter *et al.*, 1980), as they cause severe damage by sucking the cell sap of the host plant. Its population is dramatically increases and found responsible for as high as 50% reduction in grain weight per year (Van-Emden and Harrington 2007; Capinera, 2008). Aphids are known as the highest damaging pest on wheat crop in Pakistan (Khan *et al*., 2012).

In cereal crops, several aphid species have been reported worldwide, among them *Schizaphis graminum* is the most destructive one, because this affects the spikes, which are direct bearer of grains. The literature reveals that aphid

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population on wheat crop started increasing from 1990 and got a pest status in Pakistan (Aheer *et al*., 1994). Pesticides application on wheat crop is common practice in Pakistan due to which spray area is increasing day-by-day (Anonymous, 2011). Due to severe infestation by aphids at initial crop growth stage the young plants destroy, however normal aphid feeding results in poor root growth and ultimately decrease in tillers and grains (Russell, 2013). An estimated 35-40% yield losses are caused directly by sucking cell sap, while indirectly 20-80% yield losses are reported by transmitting fungal and viral infections (Kieckhefer and Gellner, 1992; Girma *et al.*, 1993; Trdan and Milevoj, 1999). Plant vitality reduced by sap sucking and apparently infested leaves wilts, giving silky appearance and turns pale. Wheat aphid exude honeydew due to which sooty fungi growth occurs on foliage (Patrick and Knutson, 2006).

Insecticides have become commonly used in numerous agricultural settings to control sucking pest. They have potential for mitigation of harmful bugs, but unfortunately, injudicious use have surpassed their beneficial effects. Nonselective use of pesticides kills the non-targeted organisms along with the targeted ones. In addition to that, with the passage of time, some pests also develop genetic resistance to pesticides. A key feature of neonicotinoids that distinguish them from currently available pesticide classes is their systemic nature. These are relatively smaller molecules and highly water soluble, when plants uptake these compounds and their metabolites circulates primarily via xylem transport via plant tissues and gives longer period of protection against a number of sap-feeding insects/arthropods (Nauen *et al*., 2008; Magalhaes *et al*., 2008, 2009). Dinotefuran, a third generation chemistry acts as an agonist of insect nicotinic acetylcholine receptors, by binding in a mode that vary from other neonicotinoid insecticides. Its mode of action involves disruption of the insect's nervous system by inhibiting nicotinic acetylcholine receptors. It has high efficiency, low toxicity, and a wide range of control of leafhoppers, aphids and whiteflies, and it is safe for human beings and animals. (Wu *et al*., 2013; Ghosh *et al*., 2014).

Pymetrozine insecticide, a newly introduced chemistry of class known as the pyridine azomethines. It is mostly effective against sap sucking insect pests in the field. It has systemic action and good selectivity, particularly effective against sucking insects such as aphids, whiteflies and plant hoppers (Kristinsson, 1994; Wyss and Bolsinger, 1997; Foster *et al*., 2002). Pymetrozine is both systemic and translaminar, making it highly mobile within plants (Acheampong and Stark, 2004). When it applied by injection or ingestion, it irreversibly inhibits aphid feeding by blocking stylet penetration into the plant tissues, quickly inhibits the feeding (Harrewijn and Kayser, 1997), and causes death by starvation (Kayser *et al*., 1994). Pymetrozine and flonicamide are favourable to control aphid population due to highly selective for a range of beneficial arthropods (Jansen *et al*., 2011).

Matrine, a natural plant agent derived from wild medical plant *Sophora Flavescens (*Ait.). It plies its function mainly by direct contact. When the pests get in touch, their nervous system paralyzed immediately, then protein of their bodies denaturalizes and finally death occurs. It is highly efficient, broad spectrum with no residual effect, hence a green protection to environment. Considering the environmental contamination issues due to haphazard use of pesticides, in this study we used two neonicotinoids, Dinotefuran as foliar treatment and a mixture of Imidacloprid and Tebuconazole as seed treatment in comparison with foliar applications against wheat aphid.

Keeping in view the importance of pesticides' application methodology and wheat crop yield losses caused by aphids' present study was planned to evaluate the efficacy of seed treatment Imidacloprid+Tebuconzole and foliar applications of three different insecticides against wheat aphid to avoid wheat losses and environmental contamination. Moreover, the effect of pesticide on wheat crop yield also analyzed.

MATERIALSANDMETHODS

The present study was carried out in the research field of Department of Agriculture and Agribusiness Management University of Karachi. The experiment was conducted in a randomized complete block design (RCBD) with three replicates, each replicate consisting of five treatment plots of 5 m ×3 m including control plot. Wheat crop was sown in the month of December; routine agronomic practices were made through the growing season. For aphid count, 10 plants were randomly selected and tagged from each treatment. Pre application/seed treatment data was observed after 63 days of sowing. The Insecticides (Table 1.) were applied when average infestation of aphids reached at 10 or more aphids per tiller (Aziz *et al.*, 2013; Zeb, Qamar, *et al*., 2015). Data were recorded on the basis of average population of survival aphids. Pretreatment counts (Plate 5) were made 24 hours before spray and post-treatment data were recorded after 24, 48 and 72 hours and further at weekly intervals. After crop harvesting the yield was calculated in treated and untreated plots. The percentage of the reduction of the insect population was calculated according to the

Abbott's formula

$$\text{Corrected \%} = \left(1 - \frac{\text{n in T after treatment}}{\text{n in Co after treatment}}\right) * 100$$

Where: n = Insect population, T = treated, Co = control

The obtain data were analyzed by statistical tool analysis of variance (ANOVA) by using SPSS version 16.0. Significant differences among treatment means were tested with least significant difference (Tukey's) test using 5% significant level. The pest population in various treatments was used as an indicator of insecticide efficacy.

Table 1.
Pesticides used in efficacy trials against *Schizaphis graminum* (Rondani).

Trade Name	Common Nmae	Source/Procured from	Dose (ml/gm)/Acre
Hombre Excel 37.25% FS	Imidacloprid + Tebuconazole	Bayer CropScience	2ml/kg seed
Plenum 50 WG	Pymetrozine	Syngenta	80ml/acre
Legend 0.5% AS	Matrine	Kanzo Ag	500ml/acre
Oshian 20SG	Dinotefuran	Arysta Life Science	100gm/acre

Table 2.
Efficacy of seed treatment and foliar application of insecticides against wheat aphid.

Treatment	24 Hr	48Hr	72Hr
Mean ± S.E			
Imidacloprid+ Tebuconazole	90.0267±1.07934[a]	88.8433±.81516[a]	88.2167±.66939[a]
Pymetrozine	86.7867±1.73561[ab]	87.2100±.65987[a]	84.7633±2.70380[ab]
Matrine	74.4700±3.94108[b]	78.5133±2.00217[b]	76.4000±.80258c
Dinotefuran	81.4367±3.39922[ab]	84.5167±2.44121[ab]	80.3533±.96326[bc]

Values sharing the same letter (s) in a column are not significantly different at P<0.05

Treatment	1st week	2nd week	3rd week
Imidacloprid+ Tebuconazole	87.7600±.81733[a]	86.3400±1.38385[a]	85.9800±1.61150[a]
Pymetrozine	84.4567±1.11291[ab]	80.0900±1.50088[a]	73.6100±3.95672[ab]
Matrine	75.4700±2.42315[c]	76.1100±4.45188[a]	60.0533±3.72402[b]
Dinotefuran	77.1900±2.11363[bc]	75.8700±2.07693[a]	65.9367±2.64528[b]

Values sharing the same letter (s) in a column are not significantly different at P<0.05

Overall Percent Efficacy	
Imidacloprid+ Tebuconazole	87.8604±.62292[a]
Pymetrozine	82.8197±2.11122[ab]
Matrine	73.5027±2.7450[c]
Dinotefuran	77.5506±2.64160[bc]

Values sharing the same letter (s) in a column are not significantly different at P<0.05

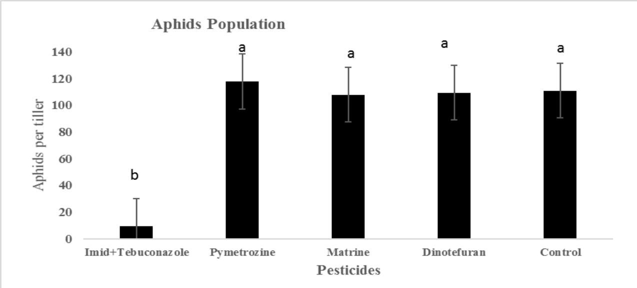

Fig. 1
Aphid's population before 24 hours of spray and after seed treatment.

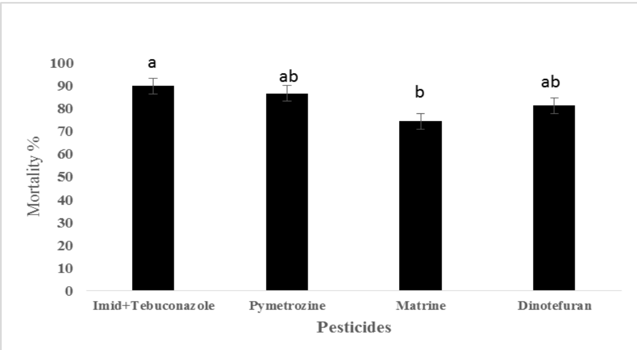

Fig. 2
Efficacy of different insecticides against wheat aphid after 24 hours of spray.

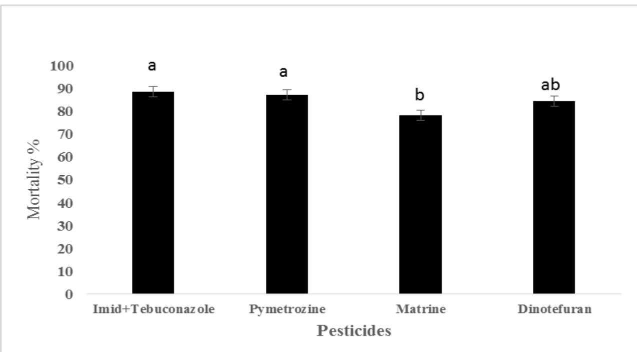

Fig. 3
Efficacy of different insecticides against wheat aphid after 48 hours of spray.

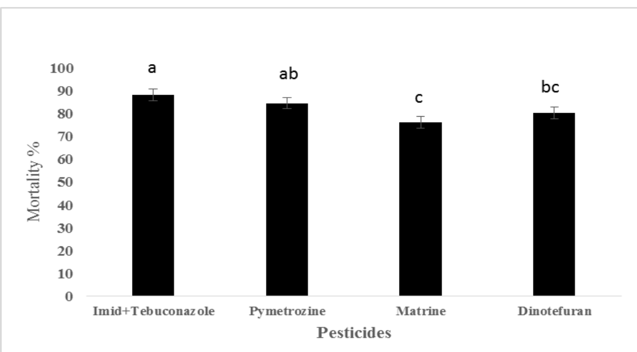

Fig. 4
Efficacy of different insecticides against wheat aphid after 72 hours of spray

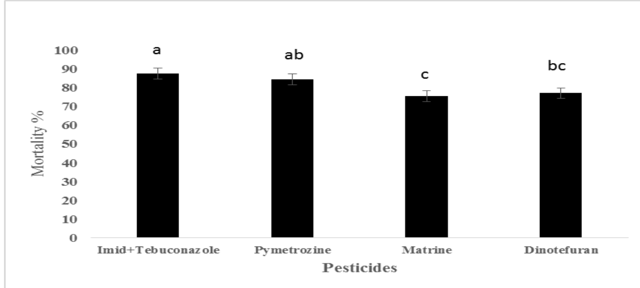

Fig. 5
Efficacy of different insecticides against wheat aphid after one week of spray.

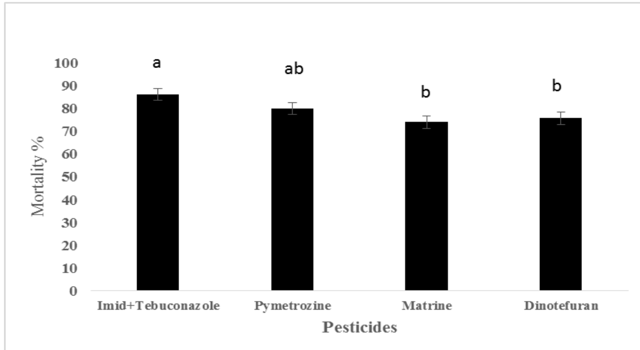

Fig. 6
Efficacy of different insecticides against wheat aphid after second week of spray.

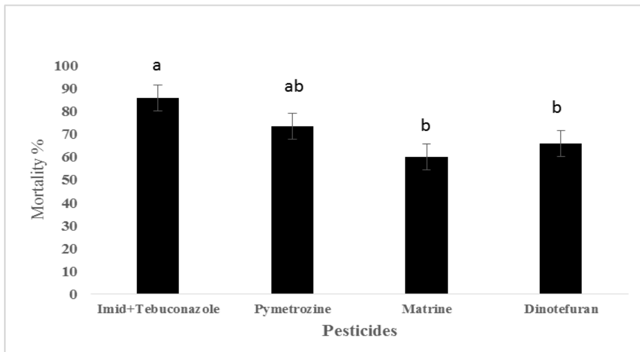

Fig. 7
Efficacy of different insecticides against wheat aphid after third week of spray.

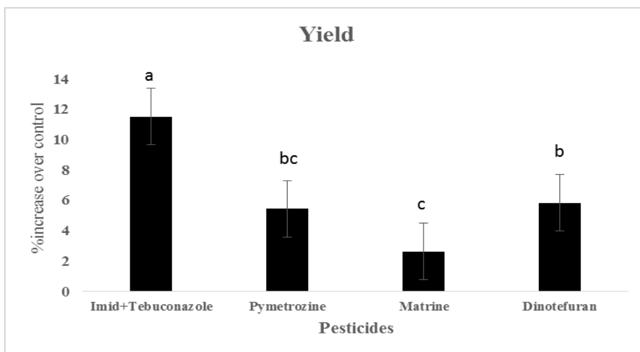

Fig. 8
Percent increase in wheat yield over control plot

RESULTS AND DISCUSSIONS

The aphid infestation on wheat crop started in the first week of January, 63 days after sowing (DAS). A gradual increase in aphid population was observed during vegetative stage and continued up to last week of February. Similar results were observed by (Aheer *et al*., 2006; Aslam *et al*., 2004; Khan *et al*., 2012; Zeb *et al*., 2011). Minimum aphid population was observed after 63 DAS in the plots treated with Imidacloprid + Tebuconazole as seed dressing as compared to Pymetrozine followed by Dinotefuran and Matrine respectively (Figure 1). In present study more emergence of seeds was observed in plots treated with mixture of Imidacloprid + Tebuconazole in comparison to foliar application of insecticides. Similar observation was reported by (Ahmed *et al*., 2001) that emergence of seeds were more fast in plots treated with Imidacloprid + Tebuconazole mixtures than in control. Another study reveals that, seedlings' disease caused by soil borne fungi in wheat crop was prevented by seed treatment with fungicides. Additionally, it increases plant population and mergence percentage. Our observation coincide with findings (Pike *et al*., 1993) that fungicides stimulates emergence characteristics of seeds planted at shallow depth in irrigated fields. On the other hand, (Kaspers *et al*., 1987; Holderness, 1990) also reported that a little dose of seed treatment may stimulate shoot growth.

Pymetrozine foliar application ranked 2nd throughout the experiment. However, seed treatment Imidacloprid +Tebuconazole were found better than all foliar sprays against wheat aphid. Shafique *et al*. (2014) applied Pymetrozine, Imidacloprid and Lambda-cyhalothrin against *S. graminum,* at recommended dose rates and found that Imidacloprid was most effective with maximum mortality 97% followed by lambda-cyhalothrin (93%) and pymetrozine (87%) respectively after 14 days of application. Our results of pymetrozine match with the results of (Jansen *et al*., 2011) who reported that pymetrozine seems to be very favourable insecticide to control sucking insects such as aphid because it is highly selective for a range of beneficial arthropods related to aphid control.The aphid infestation on wheat crop started in the first week of January, 63 days after sowing (DAS). A gradual increase in aphid population was observed during vegetative stage and continued up to last week of February. Similar results were observed by(Aslam et al., 2004; Aheer et al., 2006; Zeb et al., 2011; Khan et al., 2012). Minimum aphid population was observed after 63 DAS in the plots treated with Imidacloprid + Tebuconazole as seed dressing (Figure.1) as compared to Pymetrozine followed by Dinotefuran and Matrine respectively. Mixture of Imidacloprid and Tebuconazole accelerated seedling emergence.(Ahmed et al., 2001) observed that emergence of seeds was more rapid in treated plot with fungicide/insecticide mixtures than in untreated control. Our observation coincide with previous findings (Pike et al., 1993) that fungicides modify emergence characteristics of seeds planted at shallow depth in irrigated fields. On the other hand, a little dose of seed treatment may stimulate shoot growth (Kaspers et al., 1987; Holderness, 1990). Pymetrozine ranked 2nd throughout the experiment. However, seed treatment Imidacloprid +Tebuconazole were found better than all foliar sprays against wheat aphid. Similar study was conducted by (Shafique et al., 2016) against *S. graminum,* they applied , Pymetrozine, Imidacloprid and Lambda-cyhalothrin at recommended dose rates and found that Imidacloprid was most effective with maximum mortality 97% followed by lambda-cyhalothrin (93%) and pymetrozine (87%) respectively after 14 days of application.

Aphid population 24 hours after spray

The percentage reduction after 24 hours of foliar applications over control was higher in Pymetrozine 86.79% followed by Dinotefuran (81.44%) and Matrine (74.47%) respectively however, Imidacloprid+tebuconazole after 64 days of seed dressing in comparison with foliar applications gave highly effective results with 90.52% less infestation in aphid population. Similarly, (Ahmed *et al*., 1996) found Imidacloprid very effective against various resistant species of aphids. Vostrel. (1998) found 100% mortality in resistant population of wheat aphids when treated with Imidacloprid. Gray *et al*. (1996) reported that wheat and oat plants treated with Imidacloprid reduced adult longevity and fecundity of three cereal aphid species as compared to untreated plants.

In this study untreated plots appeared to be most susceptible with highest population of aphids per tiller, however among conventional insecticides, Dinotefuran was less effective than Imidacloprid +Tebuconazole and Pymetrozine, but it was more effective than Matrine against wheat aphid. Our results are in the lines of (Abd-Ella, 2016), who concluded that Imidacloprid and thiamethoxam mixture had a better efficiency against wheat aphids than acetamiprid and dinotefuran. Similarly (Wu *et al*., 2013 and Ghosh *et al*., 2014) revealed that dinotefuran has high efficiency, low toxicity, and a wide range of control and it is safe for crops, human beings, and animals. In particular, it has an excellent ability to control plant hoppers, aphids, whiteflies and other typical piercing-sucking insects.

Aphid population 48 hours after spray

After 48 hours of spray similar trends were observed, in case of foliar applications with 85.95% reduction by Pymetrozine followed by Dinotefuran (83.47%) and Matrine (80.99%) respectively, while Seed treatment by Imidacloprid+tebuconazole found highly effective with 90.91% less infestation after 65 DAS. Similar study was conducted by (Ahmed *et al*., 1994) who reported that seed treatment with fungicides prevented wheat seedling diseases caused by soil borne fungi and also an increase in plant population. Suhail *et al*. (2013) used imidacloprid+tebuconazole @ 4ml /kg wheat seed as seed treatment and found very effective against aphid population. Imidacloprid seed treatment has important advantages over conventional sprays and being bio rational (low risk) insecticide it reduces hazards and has a longer period of protection on crops (Munkvold *et al*., 1996) and (Sloderbeck et al., 1996). Joshi and Sharma (2009) conducted experiment to evaluate the effectiveness of different treatment concentrations of Imidacloprid against wheat aphids at 24 hrs, 2 days, 7 days and 14 days post spray interval and found that Imidacloprid treatment at the rate of 400 ml ha^{-1} was most effective against wheat aphids.

Aphid population 72 hours after spray

After 72 hours seed treatment with Imidacloprid+tebuconazole maintained its excellent performance with 88.89% efficacy followed by foliar application Pymetrozine (84.59%), Dinotefuran (80.10%) and Matrine (70.06%) respectively. Singh and Venkateswarlu (2000) studied the effects of Imidacloprid as seed treatment alone or in mixture with different fungicides on various wheat aphid species, and found no contrary effect on seed germination, plant health and grain yield. Consequently, application of Imidacloprid seed treatment, the crops remained free of aphid populations for a longer period. In present study Matrine a natural plant agent, derived from wild plant *Sophora flavescens (*Ait.) showed less effectiveness in comparison to other insecticides, however, being bio pesticide it is safe to human beings, livestock and environment in comparison to conventional insecticides.

Aphid population one week after spray

The results of this study (Table 2) clearly reveal that treatment with Imidacloprid+tebuconazole was most effective against aphid with 87.76% efficacy followed by Pymetrozine (84.45%), Dinotefuran (75.47%) and Matrine (77.19%) respectively. After second week of spray similar results were observed; mean aphid population after second week of spray indicated significant variation among treatments. However, maximum aphid population was recorded in untreated plots.

After third week of spray, suddenly decline in aphid population was observed at the end of February till the first week of March, while the population almost diminished at last week of March. These results are similar to those reported earlier(Keickhefer et al., 1992; Parvez Ali, 1999; Ahmad and Nasir, 2001). The sudden decline in aphid population might be due to maturity of crop, grain hardness, unavailability of sap due to senescence of the crop and high temperature. After mid-March, rise in temperature and humidity causes flora reduction or elimination of aphid infestation (Tabasum et al., 2012).

Similar results were observed (Kieckhefer and Gellner, 1988; Ahmad and Nasir, 2001) in their studies, aphid population was increased gradually from 17th February and remained low, because wheat plant produces tillers in initial stage and aphid does not reproduce fastly on the early growth stages of wheat. This may be due to the lower quality of food (sap) available in the early stages of the wheat. Qualitative and quantitative changes in the food occur with life of the plant and its growth stages, which eventually affect the survival, longevity, distribution, reproduction and speed of development of insects (Yazdani and Agarwal, 1997). Our results are also in the lines of (Khan et al., 2012; Muhammad et al., 2013) who reported that aphid population decline started after mid-March due to the rise in temperature, ripening of crop and the attack of coccinellid beetles.

Figure 8 shows the comparative yield data of all treatments including untreated plot. Eventually it endorses the performance of insecticides. Higher yield was observed in plot treated with Imidacloprid+tebuconazole followed by Dinotefuran, Matrine and Pymetrozine respectively. In a similar study, (Marie et al., 1997) reported that the imidacloprid seed treatment enhanced the grain yield when used against Russian wheat aphid.

CONCLUSION

The results of the present study clearly showed that Imidacloprid+tebuconazole seed treatment has the potential to provide significant whole plant protection against wheat aphids and prevent wheat yield losses. Foliar applications of Pymetrozine, Dinotefuran and Matrine also showed moderate results, however, seed treatment is more economical and environment friendly with excellent control. The systemic activity and the relatively low rate of application make it user friendly for seed dressing and provide protection from sucking insect pests, thus eliminating the need of repeated sprays. However, the methodology for application of seed treatments should be carefully considered because of the higher selection pressure of the pests, which can be followed by a faster development of resistance to insecticides.

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