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# Population trend of corn leaf aphid (*Rhopalosiphum maidis.*) with different chemical doses in three maize varieties

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**Abstract**

Field experiment was conducted to find out the comparative efficacy of different commercial insecticides for the control of aphids, *Rhopalosiphum maidis* Fitch (Homoptera: Aphididae) and to study the resistance level of the newly released maize variety (Jalal) to the farmers for general cultivation in comparison with the two commonly grown corn cultivars (Azam and Sarhad white). Experiment was laid down in a randomized complete block design with three replications. The treatments included; seed dresser (*Imidacloprid*$^{TM}$), granular application (*Carbofuran*$^{TM}$) and foliar spray (*Methamidophos*$^{TM}$), each in recommended and half of the recommended doses. Aphid's population data were recorded on weekly intervals for each treatment upon the varieties. Seed dresser, granules application and foliar spray significantly reduced aphid infestation from 1$^{st}$ week to 4$^{th}$ week as compared to control. Recommended dose of all of the insecticides significantly minimized the aphid's population as compared to half doses. The newly released cultivar 'Jalal' showed comparatively more resistance to the aphid's infestation as compared to 'Azam' and 'Sarhad White' suggested that the old cultivars have almost lost their resistance against the available strains of aphids. Similarly recommended dose of seed dressing resulted in maximum grain yield (2841 kg ha$^{-1}$) followed by the recommended dose of foliar spray, whereas; minimum grain yield (2678 kg ha$^{-1}$) was recorded in control plots. Maize variety 'Jalal' produced higher grain yield (2857 kg ha$^{-1}$) followed by 'Azam' (2818 kg ha$^{-1}$). Outcome of the experiment suggested that 'Jalal' is not only a productive variety but also proven tolerant to aphids compared to the existing two corn varieties (Azam and Sarhad White). Thus these findings provided a tool to focus on the use of recommended doses of *Imidacloprid*$^{TM}$ as seed dresser with low toxicity and environmental safety for early protection, good plant vigor and greater yield. The same variety can be used in the development of potential hybrid or varieties breeding.

**Key words:** Aphids infestation, Pesticide application, Corn cultivars

## 1. Introduction

Corn (*Zea mays* L.) is vulnerable to the attack of a number of insect pests including aphid, which is a known serious pest. The corn leaf aphid, (*Rhopalosiphum maidis.* Fitch) (Aphididae: Homoptera) is a cosmopolitan specie that has been recorded on many species of graminae of which corn is a preferred host (Bing *et al*., 1990). The specie is parthinogenic and entirely viviparous. *R. maidis* damage occurs when large population builds up in corn whorl before anthesis. Large *R. maidis* population have been associated with the yield loss, particularly in drought stressed corn (Everly, 1960). Resistance to *R. maidis* in corn was first reported in the $F_1$, of a cross between yellow dent corn and teosinte (Gerner, 1971). Since then resistance in corn has often been documented (Diske & Guthire, 1998). Resistance to corn leaf aphid's resulting from several factors including plant morphology, soil structure, climatic aberrations and physio-chemical characteristics of the host pest (Coon *et al.*, 1948). The factors involved in conditioning resistant to the corn leaf aphid, however the mechanism is still poorly understood (Bing et al., 1990). *R. maidis* is found in corn, barley and occasionally in wheat. However, it has been reported that the most common host for this particular strain is Jhonson grass; a wild cereal specie (Stray *et al*., 1994; Apablaza & Tiska, 1973). Both Jhonson grass and *R. maidis* are mainly

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associated to orchards and cereal fields in northern and central Chile, showing quite similarity for distribution pattern (Mattheri, 1950; Artigas, 1994).

Corn leaf aphids are very common in whorl stage, but rarely cause economic losses. Infestation becomes apparent when tassels begin to emerge revealing colonies of aphids. Infestations are even more severe in late-planted corn. If the population is beyond the threshold level, especially three-weeks prior tasselling, a physiological damage correlating with yield loss may be observed. However, infestation usually occurs close to the tassel emergence, and despite large numbers, the aphids, do not cause economic losses (Bessin, 2004). This infestation and losses due to the attack of corn leaf aphid is also a known major problem for the maize industry of Pakistan. The *R. maidis* is often kept in check naturally by the predator *M. sexmaculata* in the absence of pesticide application (Pirzada *et al*., 1996). *R. maidis* has a wide host range in the Graminae, including more than 30 genera and most of the cereal crops, especially barley, corn and sorghum. *R. maidis* feeding on cereal may cause direct yield loss (Kieckhefer & Kantack, 1980). It is also a vector of several other plant viruses affecting cereal crops and soybean for mosaic disease (Blackman & Eastop, 1984). Population of *R. maidis* has been reported in barley during spring in the Northern planes of USA. Flight activity to other crop is probably related to population increase in barley and subsequent dispersal (Kieckhefer & Lytle, 1976). Earlier studies addressed many other factors including temperature influencing *R. maidis* biology (El-Ibrashy *et al*., 1972; Singh & Painter, 1964; Carter, 1957). Population density of aphid plant$^{-1}$ on corn has variable values ranging from 3.42 to 42.17 depending on the weather conditions (Fareed, 1991). In areas with mild summer, the pest could be a threat to the early as well as late corn plantation (Mashwani & Kareemullah, 1990). Khalil et al., (2010) applied the powder inoculum for the control of maize leaf diseases.

Keeping in view the importance of corn industry for the production of poultry feeds, this study was initiated to: (i) work on the population trend of aphid association with *R. maidis* in the summer corn crop, (ii) evaluate the resistance level of 'Jalal' variety in comparison with two other cultivars (Azam and Srahad white) for yield loss, and (iii) address recommendations for these pesticides.

## 2. Materials and methods

Field Experiment was conducted to find out the comparative efficacy of different insecticides for the management of *R. maidis* in maize crop and to study the performance in terms of resistance of the newly released variety (Jalal) in comparison with the two commonly cultivated corn varieties (Azam & Sarhad white). The experiment was started on 6$^{th}$ July 2010, continued up to 3$^{rd}$ week of October at the Agricultural farm of The Agricultural University, Peshawar Pakistan. Experiment was designed in a randomized manner to assess the performance of the three insecticides (*Imidacloprid*, *Carbofuron* & *Methamidophos*) on the three corn cultivars viz. Jalal, Azam and Sarhad white (Table 1). Plot size was 5×3m$^2$ with three replications of each treatment along with control. There were six treatments along with a check plot with four rows plot$^{-1}$ having row-to-row distance of 75cm and plant-to-plant distance of 30cm. The treatments included seed dressing, granular application and foliar spray, each in recommended and half of the recommended doses. Seeds were treated with *Imidacloprid* prior sowing at two levels. Treatments were assigned as $T_2$ recommended dose (5 gmkg$^{-1}$ of seed) and $T_3$ half of the recommended dose (2.5 gmkg$^{-1}$ of seed). As granular application, '*Carbofuron*' was applied on 12$^{th}$ August @ 20 kgha$^{-1}$ as a recommended dose ($T_4$) and 10 kgha$^{-1}$ as half of recommended dose ($T_5$). '*Methamidophos*' was applied as foliar spray on 16$^{th}$ September @ 1000 mlha$^{-1}$ as a recommended dose ($T_6$) and 500 mlha$^{-1}$ as half of recommended dose ($T_7$). Agronomic practices were kept constant for all treatments of the corn. The relative performance of corn varieties/cultivars and insecticides efficacy were studied to find out the population density of *R. maidis* on each cultivar upon weekly interval, starting from two-leaf stage till the crop maturity. Data were collected on yield and its components viz., number of cobs plant$^{-1}$, number of grains cob$^{-1}$, 1000-grain weight and grain yield plant$^{-1}$ converted to hectare. Aphid's density was determined by visual counting and collecting total number of aphids available on the newly unfolded randomly selected 3$^{rd}$ leaf in each replication. Their means were determined following data analyses using M-STAT C package. ANOVA was performed for data analysis and means were separated through LSD test as proposed by (Steel & Torrie, 1980).

Table 1. List of pesticides used in the study to count aphid's population with recommended and half of the recommended dose.

| S.No | Common name | Trade name | Dose applied |
|---|---|---|---|
| 1. | Imidacloprid 70WS | Confidor | 5 gmkg$^{-1}$ seed (Full) |
| 2. | Imidacloprid 70WS | Confidor | 2.5 gmkg$^{-1}$ seed (Half) |
| 3. | Carbofuran 3G | Carbofuran 3G | 20 kgha$^{-1}$ (Full) |
| 4. | Carbofuran 3G | Carbofuran 3G | 10 kgha$^{-1}$ (Half) |
| 5. | Methamidophos | Methamidophos | 1000 mlha$^{-1}$ (Full) |
| 6. | Methamidophos | Methamidophos | 500 mlha$^{-1}$ (Half) |

## 3. Results and discussion

### *3.1 Effect of seed dresser on aphid's population*

Analysis of variance showed that the three maize cultivars were affected by the aphid's population significantly using different application of the pesticides through different ways on weekly interval basis (Table 2). Mean aphid's population was significantly lower on the newly released maize cultivar 'Jalal' during all weeks. Similarly, the full dose of *Imidacloprid* was found effective for the control of aphid's population in maize cultivars. Maximum mean aphid's population (22.96 aphids plant$^{-1}$) were observed in Sarhad white (SW), followed by Azam (18.14 aphids plant$^{-1}$), whereas minimum aphids population (12.83 aphids plant$^{-1}$) was recorded in corn cultivar Jalal (Table 2). An increase was observed in all the cultivars for aphid's population from 1$^{st}$ to 7$^{th}$ week, which drastically reduced in the 9$^{th}$ week. Interaction between weeks and cultivar's exhibited that aphid's population differed at different weeks for all the three cultivars, with maximum variation in 'Azam'. Seed dressing with recommended dose of *'Imidacloprid 70WS'* either in full or half significantly reduced aphid's population compared to the control (Table 2).

Using *Carbofuran* both in full and half dose to measure the population density of aphid it was observed from the mean data (Table 3) that all the three maize cultivars responded differently to the application of *Carbofuran*. As stated earlier, the infestation raised in the subsequent weeks with the passage of time until 7$^{th}$ week of data recorded. Interaction among variety, week and seed dressing indicated that higher number of aphid's infestation (43.81) was recorded by SW followed by 'Jalal' in 6$^{th}$ week. However, the mean data reveled that the minimum infestation of 11.29 was recorded in 'Jalal' followed by 'Azam' (17.03). The response of *Carbofuran* was also significant on the mean basis.

Table 4. The effect of *Methamidophos* also had significant effect on the aphid's population responsible for the cause of blights in maize cultivars. The minimum population density for aphid's (22.16) was recorded in 'Jalal' followed by 'Azam' (29.14), however, the rate of infestation was much higher in SW (35.28). Similarly, the use of *Methamidophos* was found effective with full dose as recommended, however the control made was also enough through half dose application of *Methamidophos* (Table 4). Interaction of varieties with weekly infestation revealed that the aphid's population drastically fell down in the 3$^{rd}$ week.

Table 2. Interaction effect of varieties and treatments with time intervals on the mean number of corn leaf aphid's plant$^{-1}$ of maize with Imidacloprid

| Time intervals (weeks) | Varieties | | | | Treatments | | | |
|---|---|---|---|---|---|---|---|---|
| | Jalal | S. white | Azam | Mean | Imidacloprid $_{(Full\ dose)}$ | Imidacloprid $_{(Half\ dose)}$ | Control | Mean |
| $W_1$ | 0.59 | 2.48 | 0.92 | **1.33** | 0.00 | 0.07 | 3.92 | **1.33** |
| $W_2$ | 1.15 | 4.59 | 3.00 | **2.9** | 0.22 | 0.18 | 8.33 | **2.91** |
| $W_3$ | 2.11 | 12.07 | 7.55 | **7.25** | 1.26 | 1.77 | 18.70 | **7.25** |
| $W_4$ | 6.11 | 18.00 | 11.70 | **11.93** | 4.18 | 5.66 | 25.96 | **11.93** |
| $W_5$ | 13.52 | 26.00 | 17.85 | **19.12** | 5.07 | 10.48 | 41.81 | **19.12** |
| $W_6$ | 26.03 | 43.74 | 35.03 | **34.94** | 23.29 | 28.44 | 53.07 | **34.94** |
| $W_7$ | 36.00 | 58.07 | 50.78 | **48.28** | 31.62 | 37.96 | 75.26 | **48.28** |
| $W_8$ | 26.18 | 31.48 | 28.81 | **28.82** | 26.85 | 28.81 | 30.81 | **28.82** |
| $W_9$ | 3.81 | 10.22 | 7.63 | **7.22** | 7.22 | 7.78 | 6.66 | **7.22** |
| Mean | **12.83** | **22.96** | **18.14** | -- | **11.08** | **13.46** | **29.39** | -- |
| $LSD_{(0.005)}$ for varieties | | | | 0.745 | $LSD_{(0.005)}$ for treatments | | | 0.745 |
| $LSD_{(0.005)}$ for weeks | | | | 0.745 | $LSD_{(0.005)}$ for interaction effect | | | 2.236 |
| $LSD_{(0.005)}$ for interaction | | | | 2.236 | | | | |

Table 3. Interaction effect of varieties and treatments with time intervals on the mean number of corn leaf aphid's plant$^{-1}$ of maize with granular pesticide (carbofuran)

| Time intervals (weeks) | Varieties | | | | Treatments | | | |
|---|---|---|---|---|---|---|---|---|
| | Jalal | S. white | Azam | Mean | Carbofuran $_{(Full\ dose)}$ | Carbofuran $_{(Half\ dose)}$ | Control | Mean |
| $W_1$ | 4.48 | 14.07 | 9.70 | **9.42** | 9.07 | 9.14 | 10.03 | **9.42** |
| $W_2$ | 2.48 | 11.48 | 8.15 | **7.37** | 0.29 | 1.85 | 19.96 | **7.37** |
| $W_3$ | 4.66 | 16.74 | 11.37 | **10.92** | 0.89 | 3.85 | 28.04 | **10.92** |
| $W_4$ | 11.14 | 25.29 | 17.04 | **17.82** | 2.55 | 5.03 | 45.89 | **17.82** |
| $W_5$ | 21.11 | 35.63 | 30.85 | **29.19** | 12.29 | 16.26 | 59.04 | **29.19** |
| $W_6$ | 31.44 | 43.81 | 26.37 | **33.87** | 21.59 | 27.15 | 52.89 | **33.87** |
| $W_7$ | 3.74 | 8.70 | 6.63 | **6.35** | 5.26 | 4.29 | 9.51 | **6.35** |
| Mean | **11.29** | **22.24** | **17.03** | -- | 7.42 | 9.65 | 32.19 | -- |
| $LSD_{(0.005)}$ for varieties | | | | 0.806 | $LSD_{(0.005)}$ for treatments | | | 0.806 |
| $LSD_{(0.005)}$ for weeks | | | | 1.232 | $LSD_{(0.005)}$ for weeks | | | 1.232 |
| $LSD_{(0.005)}$ for interaction | | | | 2.134 | $LSD_{(0.005)}$ for interaction effect | | | 2.134 |

Table 4. Interaction effect of varieties × time interval on the mean number of leaf aphid's plant$^{-1}$ in maize with methamidophos

| Time intervals (weeks) | Varieties | | | | Treatments | | | |
|---|---|---|---|---|---|---|---|---|
| | Jalal | S. white | Azam | Mean | Methamidophos (Full dose) | Methamidophos (Half dose) | Control | Mean |
| $W_1$ | 53.56 | 88.00 | 72.11 | **71.22** | 62.67 | 68.33 | 82.67 | **71.22** |
| $W_2$ | 11.07 | 13.63 | 12.37 | **12.36** | 0.48 | 1.26 | 35.33 | **12.36** |
| $W_3$ | 1.78 | 4.22 | 2.93 | **2.93** | 0.33 | 1.15 | 7.44 | **2.98** |
| Mean | **22.16** | **35.28** | **29.14** | -- | 21.16 | 23.58 | 41.81 | -- |
| $LSD_{(0.005)}$ for varieties | | | | 2.102 | $LSD_{(0.005)}$ for treatments | | | 2.102 |
| $LSD_{(0.005)}$ for weeks | | | | 1.214 | $LSD_{(0.005)}$ for weeks | | | 1.214 |
| $LSD_{(0.005)}$ for interaction | | | | 1.214 | $LSD_{(0.005)}$ for interaction effect | | | 1.214 |

Corn or maize leaf aphid (*R. maidis*) is a serious pest of wheat in many countries including Pakistan (Bing *et al.,* 1990). 'Jalal' cultivar was developed by Cereal Crops Research Institute, Pakistan and was released for general cultivation in 2003. Granular application for the control of insect pest of corn is a common practice among the corn growers in Pakistan. Usually extension services of entomologists of Pakistan are recommending *Imidaclopridclopard* against the entire pest complex of maize. Seed dressing is one of the effective mean to protect the crop from early pests including shoot fly, cutworm, jassid and early attack of borer. So *Imidacloprid* was proven effective than the foliar application of *Methamidophos.* 'Jalal' proved to be comparatively resistant to the infestation of the corn leaf aphid. Low infestation of aphid's have been reported in 'Jalal' (Kiramat, 2003). Controlling the aphid's population in different cultivars through seed dressing of *Imidacloprid* has been reported by many scientists (Gray *et al*., 1996; Fareed, 1991; Mashwani & Kareemullah, 1990). Instead of controlling aphid's population through chemical way its better to change the sowing time (Straub & Boothrod, 1980). Aphid's infestation is a serious problem and by evaluating plant resistance it can be easily overcome at 4-5 leaf stage with the combined strategy of antibiosis and antixenosis (Rabichuk, 1985).

*3.2. Response of maize cultivars to different treatments based on aphid's population and their interaction effect with weeks*

Data concerning aphid's population as affected by different treatments of pesticides (full & half dose) varied significantly for all the three cultivars (Table 5). Using half dose of *Imidacloprid* the interaction effect (T×V) was significantly low for all the three cultivars, however it was acceptable for 'Jalal' than the other two cultivars. Using *Carbofuran* as pesticide for studying the aphid's population with full dose as recommended was found significant than the half dose of the said pesticide for controlling the aphid's population in all three maize cultivars. However, the interaction effect was much more effective in 'Jalal' than the rest of the two cultivars (Table 5). As stated for *Imidacloprid* and *Carbofuran* the control was also good using *Methamidophos* granules. On the basis of mean aphid's population *Imidaclopridclopard* was found effective in 'Jalal' in the 1$^{st}$ week followed by *Carbofuran* in 6$^{th}$ week and *Methamidophos* in 3$^{rd}$ week. Infestation of aphid's was high (107.4) in the 4$^{th}$ week using *Imidacloprid,* low (33.87) in 6$^{th}$ week using *Carbofuran* and moderate (71.22) using *Methamidophos* in 1$^{st}$ week (Table 5).

Though *Imidacloprid* was proven effective however, the half dose had prolonged results with yield loss. Foliar spray of *Methamidophos* proved ineffective to provide any protection against the pest. The reason for the low performance of the foliar spray may be attributed to the fact that the insecticide was applied late in season when the pest was already established. Aphid's population directly had least significant effect on the yield traits (Wilde & Ohiagu, 1976). Fereres (2000) concluded that use of barrier crops could be an effective crop management strategy to protect against vectors that are the causing agents for virus infection, but only under specific circumstances.

*3.3. Effect of seed dressing, granular and foliar spray on the yield & yield components of maize cultivars*

Data pertaining to treatments application of seed dressing (full & half), granules (full & half) and foliar spray (full & half) revealed that the mean number of cobs plant$^{-1}$ were significantly higher (1.00) using pesticide as seed dressing (full dose). On mean basis 'Jalal' had more number of cobs plant$^{-1}$ (0.90) followed by 'Azam' (0.87). Number of grains cob$^{-1}$ was also significantly affected with different treatments (Table 6). Maximum combine mean grains cob$^{-1}$ of all the three maize cultivars (283.81) was recorded using pesticide as seed dressing (full dose). Of the three maize cultivars, 'Jalal' excelled in performance than the other maize cultivars with 285.8 grains cob$^{-1}$. 1000-grain weight in maize is a direct primary yield component. Data regarding 100-grain weight as influenced by different treatments was also significant on the mean basis. Maximum 1000-grain weight of 211.41 g for all the genotypes was recorded using seed dressing as full dose. Similarly, 'Jalal' produced more 1000-grain weight of 213.3 g under all treatment applications. Aphid's population reduces yield directly as they are the responsible vector for dissemination of blight disease. Mean grain yield was high (2841.07 kg ha$^{-1}$) in all the three genotypes using pesticide as seed dressing in full-recommended dose.

Table 5. Interaction effect of varieties with treatments and time interval on the mean number of corn leaf aphid's plant$^{-1}$ of three maize cultivars

| **Varieties** | **Time intervals (weeks)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Treatments** | $W_1$ | $W_2$ | $W_3$ | $W_4$ | $W_5$ | $W_6$ | $W_7$ | $W_8$ | $W_9$ | T×V |
| Jalal | $Imidacloprid_{(F)}$ | 0.00 | 0.33 | 0.45 | 2.55 | 5.00 | 18.89 | 28.99 | 25.11 | 3.88 | 9.46 |
| | $Imidacloprid_{(H)}$ | 0.00 | 0.11 | 0.55 | 5.00 | 7.78 | 23.88 | 32.55 | 26.88 | 4.66 | 11.26 |
| | Control | 1.77 | 3.00 | 5.33 | 10.77 | 27.78 | 35.33 | 46.44 | 26.55 | 2.88 | 17.76 |
| S. white | $Imidacloprid_{(F)}$ | 0.00 | 0.22 | 1.67 | 5.66 | 5.55 | 25.66 | 33.77 | 28.99 | 10.66 | 12.46 |
| | $Imidacloprid_{(H)}$ | 0.11 | 0.22 | 2.55 | 6.55 | 13.00 | 32.22 | 42.44 | 31.33 | 9.78 | 15.35 |
| | Control | 7.33 | 13.33 | 32.00 | 41.77 | 59.44 | 73.33 | 98.00 | 34.11 | 10.22 | 41.05 |
| Azam | $Imidacloprid_{(F)}$ | 0.00 | 0.11 | 1.66 | 4.33 | 4.66 | 25.33 | 32.11 | 26.44 | 7.11 | 11.30 |
| | $Imidacloprid_{(H)}$ | 0.11 | 0.22 | 2.22 | 5.44 | 10.66 | 29.22 | 38.89 | 28.22 | 8.89 | 13.76 |
| | Control | 2.66 | 8.67 | 18.78 | 25.33 | 38.22 | 50.55 | 81.33 | 31.78 | 6.89 | 29.35 |
| Mean | | **1.33** | **2.91** | **7.24** | **107.4** | **19.12** | **34.93** | **48.28** | **28.82** | **7.21** | -- |
| $LSD_{(0.05)}$ LSD for interaction | | | | | | | | | | | 3.873 |
| $LSD_{(0.05)}$ LSD for T×V | | | | | | | | | | | 0.745 |
| $LSD_{(0.05)}$ LSD for weeks | | | | | | | | | | | 1.29 |
| Jalal | $Carbofuran_{(F)}$ | 4.22 | 0.00 | 0.67 | 1.67 | 8.22 | 23.00 | 4.00 | -- | -- | **5.96** |
| | $Carbofuran_{(H)}$ | 4.22 | 1.11 | 2.11 | 3.44 | 12.00 | 23.00 | 3.88 | -- | -- | **7.10** |
| | Control | 5.00 | 6.33 | 11.22 | 28.33 | 43.11 | 48.33 | 3.33 | -- | -- | **20.80** |
| S. white | $Carbofuran_{(F)}$ | 13.00 | 0.66 | 1.33 | 4.33 | 15.55 | 23.11 | 6.44 | -- | -- | **9.20** |
| | $Carbofuran_{(H)}$ | 13.77 | 2.55 | 6.55 | 7.88 | 20.00 | 36.33 | 4.00 | -- | -- | **13.01** |
| | Control | 15.44 | 31.22 | 42.33 | 63.67 | 71.33 | 72.00 | 15.66 | -- | -- | **44.52** |
| Azam | $Carbofuran_{(F)}$ | 10.00 | 0.22 | 0.67 | 1.67 | 13.11 | 28.66 | 5.33 | -- | -- | **8.52** |
| | $Carbofuran_{(H)}$ | 9.44 | 1.89 | 2.88 | 3.77 | 16.77 | 22.11 | 5.00 | -- | -- | **8.83** |
| | Control | 9.66 | 22.33 | 30.55 | 45.67 | 62.67 | 38.33 | 9.55 | -- | -- | **31.25** |
| Mean | | **9.42** | **7.37** | **10.92** | **17.82** | **29.19** | **33.87** | **6.35** | -- | -- | -- |
| $LSD_{(0.05)}$ LSD for interaction | | | | | | | | | | | 3.696 |
| $LSD_{(0.05)}$ LSD for T×V | | | | | | | | | | | 1.397 |
| $LSD_{(0.05)}$ LSD for weeks | | | | | | | | | | | 1.232 |
| Jalal | $Methamidophos_{(F)}$ | 45.67 | 0.33 | 0.33 | -- | -- | -- | -- | -- | -- | **15.44** |
| | $Methamidophos_{(H)}$ | 60.00 | 0.55 | 1.00 | -- | -- | -- | -- | -- | -- | **20.51** |
| | Control | 55.00 | 32.33 | 4.00 | -- | -- | -- | -- | -- | -- | **30.44** |
| S. white | $Methamidophos_{(F)}$ | 80.00 | 0.78 | 0.00 | -- | -- | -- | -- | -- | -- | **26.92** |
| | $Methamidophos_{(H)}$ | 81.33 | 1.77 | 1.33 | -- | -- | -- | -- | -- | -- | **28.14** |
| | Control | 102.67 | 38.33 | 11.33 | -- | -- | -- | -- | -- | -- | **50.77** |
| Azam | $Methamidophos_{(F)}$ | 62.33 | 0.33 | 0.67 | -- | -- | -- | -- | -- | -- | **21.11** |
| | $Methamidophos_{(H)}$ | 63.67 | 1.44 | 1.11 | -- | -- | -- | -- | -- | -- | **22.07** |
| | Control | 90.33 | 35.33 | 7.00 | -- | -- | -- | -- | -- | -- | **44.22** |
| Mean | | **71.22** | **12.35** | **2.97** | -- | -- | -- | -- | -- | -- | -- |
| $LSD_{(0.05)}$ LSD for interaction | | | | | | | | | | | 3.642 |
| $LSD_{(0.05)}$ LSD for T×V | | | | | | | | | | | 1.214 |
| $LSD_{(0.05)}$ LSD for weeks | | | | | | | | | | | 1.214 |

Of the three maize cultivars, 'Jalal' gave maximum grain yield of 2857.9 kg ha$^{-1}$ under different methods of pesticide applications (Table 6). The use of *Methamidophos* as foliar spray for the control of aphid's population and their interaction with yield and yield components was found ineffective for number of cobs plant$^{-1}$, grains cob$^{-1}$ and 1000-grain weight. Minimum number of cobs plant$^{-1}$, grains, weight and grain yield was recorded for all the three cultivars in control. Thus, the newly developed maize cultivar was proven resistant to the attack of aphid's infestation. Our findings are fully supported by Kiramat (2003) who reported moderate insect resistant in Jalal to the insect attack and recorded 6.97 tons of yield as compared to the 3.56 tons ha$^{-1}$ yield of Azam. Similarly, Ullah et al (2005) obtained a maximum grain yield of 6.83 t ha$^{-1}$ from different sets of maize cultivars with the application granular pesticide. To get maximum yield through pesticide control is effective and safe for environment with low $LD_{50}$ to be used for aphid's count and eradication (Gray *et al.*, 1996). Yield loss in maize due to the infestation of aphids can be controlled if proper management of the crop is done through aphids survey and studying environmental factors (Everly, 1960). Oil extracts with optimum rate reduced the aphids infestation and enhanced grain yield, however the diluted and low concentration of oil were ineffective to control the aphid's colonies (Ferro *et al*., 1980).

Table 6. Effect of different treatments over the yield and associated traits of three maize cultivars

| Treatments | Cobs plant$^{-1}$ | | | | Grains cob$^{-1}$ | | | | 1000-grain weight | | | | Grain yield | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jalal | SW | Azam | Mean | Jalal | SW | Azam | Mean | Jalal | SW | Azam | Mean | Jalal | SW | Azam | Mean |
| Seed Dressing (F) | 1.11 | 0.89 | 1.00 | 1.00a | 296.11 | 273.33 | 282.00 | 283.81a | 215.89 | 187.67 | 230.67 | 211.41a | 2919.44 | 2745.7 | 2807.11 | 2841.07a |
| Seed Dressing (H) | 1.00 | 0.78 | 0.89 | 0.89c | 291.67 | 270.67 | 279.67 | 280.67 b | 223.89 | 185.00 | 201.78 | 203.56b | 2867.22 | 2784.9 | 2871.11 | 2824.07 d |
| Granules (F) | 0.89 | 0.89 | 1.00 | 0.92b | 288.22 | 273.67 | 277.33 | 279.74c | 213.56 | 180.33 | 203.22 | 199.04b c | 2822.00 | 2713.6 | 2873.33 | 2802.96 g |
| Granules (H) | 0.89 | 0.78 | 0.89 | 0.85d | 287.00 | 270.00 | 276.11 | 277.70 d | 212.44 | 176.67 | 200.11 | 196.41c | 2867.78 | 2701.8 | 2872.44 | 2814.00e |
| Foliar Spray (F) | 1.00 | 0.78 | 0.89 | 0.89c | 283.33 | 267.22 | 273.22 | 274.59e | 211.11 | 183.00 | 197.56 | 197.22c | 2898.22 | 2775.6 | 2839.11 | 2837.63 b |
| Foliar Spray (H) | 0.77 | 0.78 | 0.89 | 0.81e | 281.33 | 266.44 | 274.22 | 274.00e | 209.22 | 179.00 | 194.56 | 194.26c | 2861.00 | 2745.0 | 2870.00 | 2825.33c |
| Control | 0.67 | 0.89 | 0.55 | 0.70f | 273.00 | 265.33 | 266.33 | 268.22f | 206.67 | 179.67 | 202.00 | 196.11c | 2769.67 | 2669.8 | 2596.00 | 2678.48f |
| Mean | 0.90a | 0.83 c | 0.87b | -- | 285.8a | 269.52 c | 275.56 b | -- | 213.3a | 181.6c | 204.3 b | -- | 2857.9a | 2733.7 c | 2818.44 b | -- |
| LSD for treatments | | | | 0.071 | LSD for treatments | | | 1.49 | LSD for treatments | | | 6.074 | LSD for treatments | | | 1.187 |
| LSD for (cobs plant$^{-1}$) | | | | 0.003 | LSD for (grains cobs$^{-1}$) | | | 3.04 | LSD for 1000-grain weight | | | 3.214 | LSD for grain yield | | | 4.786 |

## 4. Conclusions

'Jalal' maize cultivar had proven to be more productive as well as found resistant to the attack of aphid's and could be incorporated in the breeding program to develop pesticide resistant genotypes and ensure the food safety in the future. Moreover, The full dose of *Imidacloprid* as seed treatment is recommended as it provided early protection and good plant vigor with greater yield.

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