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EFFICACY OF NEWLY SYNTHESIZED PESTICIDAL CHEMICAL '4-[3-(4-BIPHENYL)-1, 6-DIHYDRO-6-IMINOPYRIDAZIN-1-Yl] BUTYRONITRILE HYDRO BROMIDE' ON BEAN APHID, *APHIS CRACCIVORA* KOCH (HOMOPTERA: APHIDIDAE)

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Abstract: A study was carried out to determine the effectiveness of newly synthesized chemical '4-[3-(4-biphenylyl)-1, 6-dihydro-6-iminopyridazin-1-yl] butyronitrile hydro bromide against beanaphid, *Aphis craccivora,* under six treatments: T1 (20 ppm), T2 (40 ppm), T3 (60 ppm), T4 (80 ppm), T5 (100 ppm), and untreated control T6. Aphid numbers was peaked in January and it was zero in February. The best efficacy of administered doses was found in the T3 and followed by T5, T4, and T2, respectively. The aphid abundance in different weeks (F= 1.89; p<0.05) and the treated doses (F= 3.19; p< 0.02) were significantly varied among the plants. The aphid population showed a positive correlation with temperature in the T3 (r = 0.48) and T5 (r = 0.33) and a negative correlation in T1 (r = -0.32), T2 (-0.24), and T4 (-0.20), and untreated control T6 (- 0.24). Whereas, aphids were positively correlated with humidity in T3 (r = 0.46), T4 (r = 0.40), and T5 (r = 0.18) and negatively correlated in T1 (r = -0.32), T2 (r = -0.53), T4 (r = -0.40), and untreated control T6 (r = -0.52). The treated doses T4 and T3 produced the most vigorous fruits, while T1 produced the lowest.

Key words: *Aphis carccivora,* Infestration*, Dolichos labla,* 4-[3-(4-biphenylyl)-1, 6-dihydro-6-iminopyridazin-1-yl] butyronitrile hydro bromide.

INTRODUCTION

Aphis craccivora (Hemiptera: Aphididae) is a well-known insect pest throughout the world (Blackman and Eastop 2006). As sucking pests, aphids have a significant adverse impact on a variety of field crops, fruits, and vegetables (Aheer *et al.* 2008). Their growth rate is influenced by the quality of the host plant (species and cultivars), environmental factors, especially soil fertility, and crop stand density (Brabec *et al.* 2014). In Bangladesh, *Aphis craccivora* widely infests the hyacinth bean or country bean (*Dolichos labla*).

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which is a major vegetable of the Leguminosae family. It contains high protein, folic acid, dietary fiber, starch, phytochemicals, vitamins, and complex carbohydrates (Filella and Penuelas 1994). The production of *Dolichos labla* is threatened greatly by the attack of aphids, leaf miners, beetles, caterpillars, and hooded hoopers (Karel and Rweyemamu 1984) and may cause 20–40% yield loss in the case of vegetable cowpea, bean, and other pulses (Srinivasa *et al.* 2014). Aphids damage flowers, buds, and tender shoots reducing the seed viability and reducing the market value of fruits (Srivastava and Singh 1986). Chemicals should be utilized for quick suppression of aphid populations when they are high and causing significant yield loss (Riazuddin *et al.* 2004). In Bangladesh, for controlling aphid infestation, approximately 15 kinds of insecticides are applied (Kabir *et al.* 1996), such as Cypermethion, Carbany, Karate Malathion, and Diazinon (Scaife and Turner 1983, Alam 1969). Synthetic pesticides are quick and effective at controlling insects, but they are also expensive and leave lingering residues on crops' exposed surfaces, in soil, and in water (Hussain 1989). In our country, the random use of chemicals is a common practice to control aphids by farmers (Ahmed *et al.* 2004). With different degrees of success, many researchers have tried to manage this damaging pest by repeatedly applying insecticides (Chowdhury and Roy 1975). Therefore, there is a need to introduce other new alternative chemicals, such as '4-[3-(4-biphenylyl)-1, 6-dihydro-6-iminopyridazin-1-yl] butyronitrile hydro bromide' to control aphid bean in our country. It is a new synthetic chemical that contains a special compound called iminopyridazine (Rahman *et al.* 2012) that inhibits the nervous system and peripheral tissues of animals and insects. Climate factors that affect aphid booming include temperature, relative humidity, precipitation, wind speed, and the number of hours of daylight (Campbell *et al.* 1974). Their development and mortality are influenced by temperature, and the range of temperatures and relative humidity that promote the growth of aphid populations is 13.7°C to 30.3°C and 45.3% (Ahmed 2001). The goal of this study was to evaluate the efficacy of various doses of the newly synthesized chemicals against *Aphis craccivora* in relation to temperature and humidity as well as to examine the fruit quality after application of different doses.

MATERIAL AND METHODS

Study site: The study was conducted at the rooftop garden in the Department of Zoology, Jagannath University from November 2015 to February 2016 covering one Rabi season (winter season).

Preparation of 4-[3-(4-biphenylyl)-1, 6-dihydro-6-iminopyridazin-1-yl] butyronitrile hydro bromide: 4-[3-(4-biphenylyl)-1, 6-dihydro-6-iminopyridazin-1-yl] butyronitrile hydro bromide is a mixture of phenyl, hydrogen, ammonia, bromine compounds, and cyanide (Fig. 1). It was first reported in Japan in 2014 with the aim of being used as an insecticide (Rahman *et al.* 2014). In the study, 20 ppm, 40 ppm, 60 ppm, 80 ppm, and 100 ppm doses were used in different treatments: T1, T2, T3, T4 and T5, respectively. The untreated control T6 was devoid of the experimented chemicals; it was only a mixture of water and 1% CH_3OH. In each treated dose 100 ml water was mixed with chemicals.

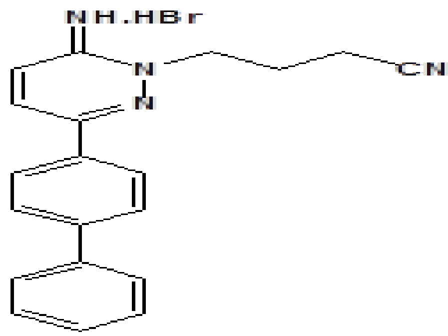

Fig 1. Chemical structure of 4-[3-(4-biphenylyl)-1, 6-dihydro-6-iminopyridazin-1-yl] butyronitrile hydro bromide.

*Dolichos labla (*Country bean)*:* The plant seeds used for our experiment were obtained from the local market. Seeds were soaked in water for 48 hours and then germinated. After one week, seedlings were transplanted into plastic tubs. During the study, 18 tubs were used and arranged in six rows, each having three plants (*Dolichos labla*).

Experimental design: The experiment was laid out in a Randomized Complete Block Design (RCBD) with six treatments having three replications followed by Rashid *et al.* (2004). Treatment 1 (T1): 1mg Prepared insecticide (20 ppm) + 100 ml water, Treatment 2 (T2): 5mg Prepared insecticide (40 ppm) + 100 ml water, Treatment 3 (T3): 10 mg Prepared insecticide (60 ppm) + 100 ml water, Treatment 4 (T4): 15mg Prepared insecticide (80 ppm) + 100 ml water, Treatment 5 (T5): 20 mg Prepared insecticide (100 ppm) + 100 ml water, followed by Treatment 6 (T6) (control: untreated): 1% CH_3OH + water.

Application procedure of insecticide: The chemical doses were applied to the bean plants at an interval of one week by knapsack sprayer from 1 November 2015 to 31 January 2016. The spraying was done in the afternoon to avoid sunlight in the assigned plots in tubs. Precautionary measures were taken during the spray time.

Aphid sampling: The aphid population in the plants was observed in every week on every Sunday from 8 am to10 am and counted directly. Number of aphid populations was recorded from a treated set just 24 hours after the spray, at seven days intervals. Aphids were counted by dropping them on a white paper with the help of a camel hair brush, except for one newly born aphid by using microscope.

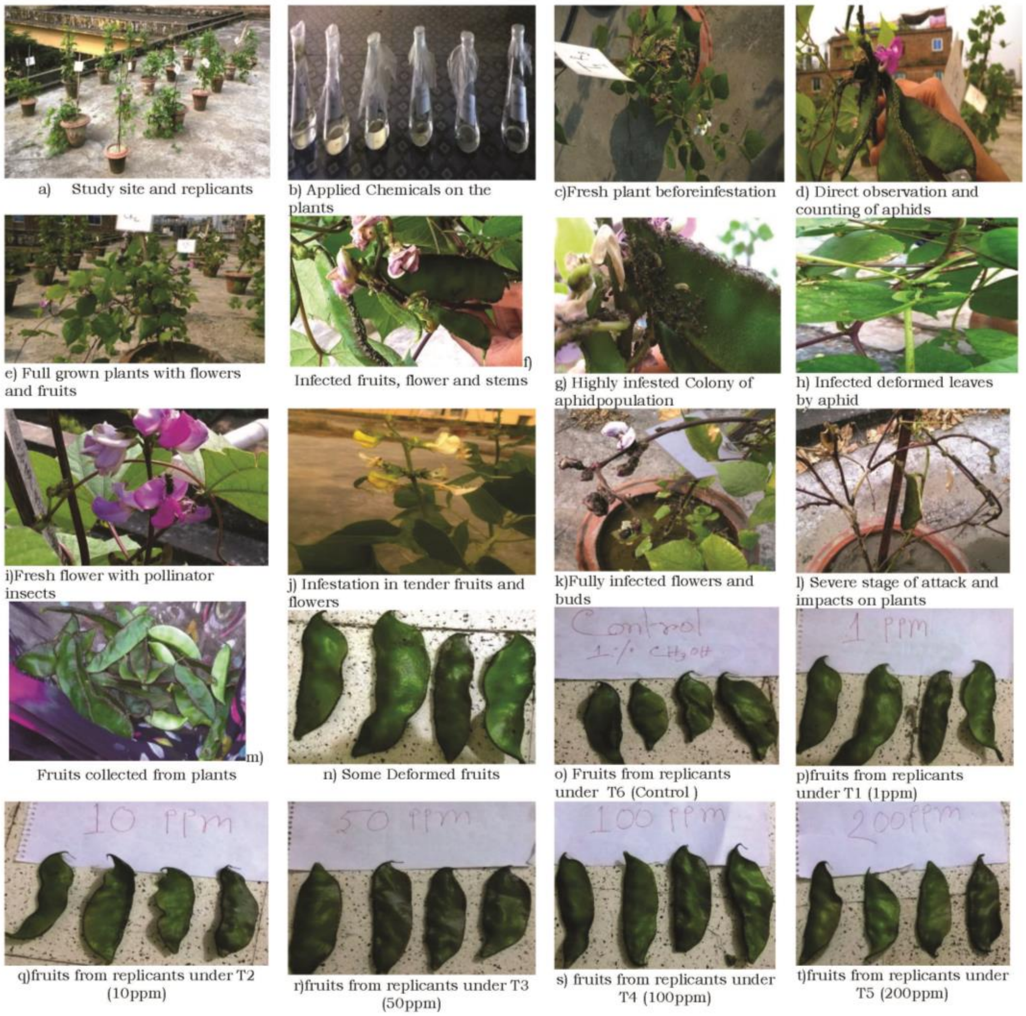

Plate 1. Materials and Different stages of this investigation.

Fruit yield: The total number of fresh and infested fruits was collected and recorded.

Climatic factors: Weekly records of air temperature along with relative humidity were obtained from the Department of Geography, Jagannath University during the sampling period. The relationship between weekly numbers of *Aphis craccivora* and corresponding temperature and relative humidity was calculated.

Data analysis: Least Significant Difference (LSD) test was used to separate the treated and untreated means. An analysis of variance (ANOVA) test was done with SPSS software version 20 to check the significant value.

RESULTS AND DISCUSSION

The aphid population was fluctuating throughout the fourteen weeks of the study period. The number of *Aphis craccivora*, cowpea aphid infestation on bean plants in 6 treatments with 3 replications during the sampling period is shown in Table 1. Among the observed months, the highest population (204.7 ± 194.7) was recorded in the month of January and the minimum was zero in December (T2, T3, and T4), January (T3 and T4), and February (T4 and T5). In November, the highest number was observed (31 ± 33.78) in the second week of November under treatment T5 and the lowest number (0.7±1.82) was observed in the same week under treatment T4. In the second week of December, the highest population abundance (57.6 ± 80.15) under T1 and no population were observed at first week in T2, T3, and T4 and also at second week in T2. Similarly, the maximum population was reported by El-Nagar *et al.* (1982). During the current study in January, the maximum population (124 ± 99.03) was observed in the first week under T1, and under T3 and T4, no population was seen during the second and third weeks. A similar trend was reported by Selim *et al.* (1987) and Shopna *et al.* (2015), who stated the highest incidence of *A. craccivora* was peaked in January. Aphid population started to decline from February (Selim *et al.* 1987) and no population was observed at first week under T4 and T5. The opposite trend of the study mentioned by Hassan *et al.* (2004), who observed the highest population in the 4th week of February. El-Defrawi *et al.* (2000) showed that the *A. craccivora* was available in December and February. The untreated control T6 also showed the maximum abundance of aphids (80±65.6) in January, and the minimum in February. ANOVA results showed that the period of a week ($F= 1.89$; $p<0.05$) and the treated doses ($F = 3.19$; $p < 0.02$) were significantly varied across the aphid population.

Aphid populations were inclined by different treatments such as 20 ppm, 40 ppm, 60 ppm, 80 ppm and 100 ppm. The result showed that among the treated plants, the highest mean abundance (377.661) of aphids was observed under treatment T1 and the lowest (89.661) under treatment T3 (Fig. 1). The effectiveness of treatments against cowpea aphids on bean plants was T1 > T6 > T2 > T4 > T5 > T3. It was revealed that applying treatment T3 was the highly effective dose for cow aphid control on bean plants. In the case of T1, the highest number of aphid infestations was found on 3 in January, 2016 (124 ± 99.03) and the lowest number of aphid (3.33 ± 5.57) was found on 7 February, 2016. Figure 2 shows that there was a gradual decrease in the aphid numbers from 1st to 5th week. But in 6th week it suddenly started to increase and in 9th week it reached to the highest number. After 10th week, it showed a gradual decrease in the aphid population. In T2 the maximum number (67.33 ± 114.89) of aphids was found on 3rd January 2016 and the minimum number (2.33 ± 4.04) was found in 15 November 2015 (Fig. 2).

Table 1: Abundance of *Aphis craccivora* on bean plants under 3 replications in 6 treatments during the study period

Date& no. of Inspection		Aphid Population						Avg. Temp(°C)	Avg. RH(%)
		T1	T2	T3	T4	T5	T6(Control)		
8.11.2015	1st	11.3± 10.6	12±4.3	17±14.7	5.7±14.3	12.7±5.8	8±5.6	24	83
15.11.2015	2nd	3.6±3.2	2.3±4.0	19.7±27.1	0.7±1.8	31±33.7	15±2	24	83
22.11.2015	3rd	5.6±9.8	16.7±21.5	13.7±19.5	1±3.4	1.3±2.3	31.3±22.1	23	84
30.11.2015	4th	9±8.5	25.3±21.8	10.7±12.9	6.7±23.2	8.3±14.4	34±15.7	24	81
	Total	**29.67± 32.1**	**56.33±51.7**	**61±74.2**	**14±42.8**	**53.3±56.3**	**88.3±45.4**		
6.12.2015	5th	8.3±14.4	0	0	0	6.7±11.5	12.66±2.5	24	83
13.12.2015	6th	57.6±80.1	18.3±2.3	0	15.7±28.3	18.3±7.0	11.33±12.7	24	83
20.12.2015	7th	30.6±41.1	12.3±3.6	2.3±4.0	20.3±62.6	21.7±20.2	35.66±30.4	21	78
27.12.2015	8th	7.3±6.4	6.7±11.5	3.3±5.8	10±17.3	10±17.3	45±18.02	20	78
	Total	**104 ±144.1**	**37.33±17.4**	**5.67±9.8**	**46±108.2**	**56.8±48.8**	**104.7±63.6**		
3.1.2016	9th	124±99.0	67.3±114.9	4±6.93	13.3±23.0	10±17.3	80±65.6	20	75
10.1.2016	10th	63.3±55.0	30±51.9	5±9.01	0	6.7±11.5	30±13.2	19	75
17.1.2016	11th	16.6±15.2	10±17.3	0	8.3±7.6	1.7±2.9	9±7.9	20	77
24.1.2016	12th	21±19.3	10.3±13.0	4±6.9	50±86.6	1.7±2.9	12.7±2.5	21	77
31.1.2016	13th	15.6±6.0	9±7.9	2.7±4.6	8.3±7.6	4±6.92	9±6.1	17	81
	Total	**240.7 ±194.7**	**126.7±205.2**	**15.7±27.7**	**80±124.5**	**24±41.5**	**140.7±95.3**		
7.2.2016	14th	3.3±5.8	5.3±5.03	7.3±6.4	0	0	17.66±3.05	23	82
	Total	**3.3±5.8**	**5.3±5.03**	**7.3±6.4**	**0**	**0**	**17.66±3.05**		

While on 6 December 2015, the number of aphids under this treatment reached to zero. But after this week, the figure is showing a moderate (18.33 ± 2.30) infestation of aphids in the 6th week leading to a gradual decrease up to 27 December 2012. But then in the next week it became the highest number leading to the 10th week (30 ± 51.96). Then the aphid population was found in a nearly stable number after 10th week. In the case of T3, the highest number of the aphid populations was found from 8 November 2015 to 30 November 2015. Among this 4 week, the highest number (19.66 ± 27.15) was found on 15 November 2015. In the 5th week which was in December 2015, the aphid number turned into zero leading to the next week too. But again in 20 December 2015 infestation of the aphid was recorded following a gradual increase up to 10 January 2016. But again in 17 January 2016, the number became zero. In the last 3 weeks, it showed a moderate up and down in the infestation of the aphids population.

In the case of T4, the highest number (50 ± 86.06) of aphids was found on 24 January, 2016 attacking the plants and the lowest number (0.66 ± 1.82) was found on 15 November, 2015 leading to 22 November, 2015 (1 ± 3.48). The aphid population was eradicated entirely after this treatment in 3 weeks, on the 6th of December 2015, the 10th of January, and the 7th of February 2016. From 13 December 2015 to 3 January 2016, the aphid population showed a relative up and down. In treatment 5, the largest aphid population (31 ± 33.77) was found to attack the bean plants on 15 November 2015. The number leading to the lowest number (1.33 ± 2.30) the next week which is 22 November 2015. In the final week of the experiment, February 7, 2016, the number of aphid populations under this treatment dropped to zero. For treatment 6 (control), the highest incidence of aphid infestation (240 ± 65.574) was found in 3 January 2016. The lowest number of aphid infestations (8 ± 5.567) was found on 08 November 2015. It was found that the aphid infestation increased in 3rd (31.33 ± 22.188), 4th (34 ± 15.71) and 8th (45 ± 18.02) weeks (Fig. 2). There was a gradual decrease in aphid number in 6 December 2015 (12.66 ± 2.51) and 13 December 2015 (11.33 ± 12.66). Hasan *et al.* (2009) also observed that its population correlated with the variation in weather. In the current research, the temperature range was 17°C -24°C. The temperatures ranging between 20°C and 25°C (Rondon *et al.* 2005) as well as 30.3°C (Nasir and Ahmad 2001) have been reported as suitable for aphid growth and reproduction. Aphid density variation was significantly and positively influenced by temperature recorded by Nasir and Ahmad (2001), Aheer *et al.* (2007, 2008) and Campbell *et al.* (1974). The result exhibited that under treatments T3 and T5, there was a positive correlation between temperature and the aphid population ($r = 0.478$ and $r = 0.327$, respectively). Similar results were reported by Nasir and Ahmad (2001) and Aheer *et al.* (2007 and 2008).

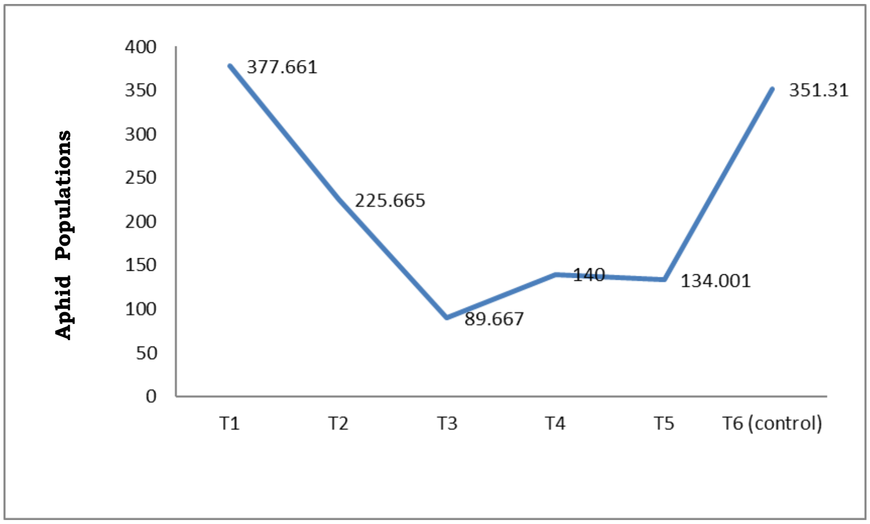

Fig. 2. Infestation of aphids during the use of new synthesized insecticide of various doses and control on bean plants.

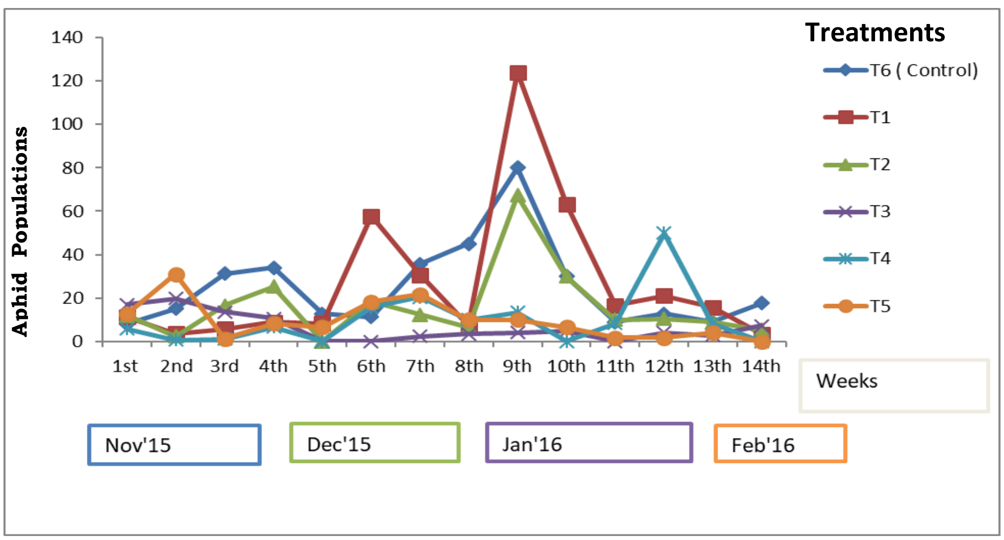

Fig. 3. Week-wise aphid population under each treatment.

However, negative relationship of aphid was observed under treatment T1 (r = -0.316), T2 (r = -0.244), T4 (r = -0.195) as well as untreated control T6 (r = -0.236) (Fig. 3). The highest incidence of aphid population was observed in January under 20°C. Nasir and Ahmad (2001) suggested that temperature 13.7°C to 30.3°C were the best for aphid growth. Aheer *et al.* (2007) and Wains *et al.* (2008) noted that in March, when the air temperature ranged from 7.7°C to 25.02°C, the aphid population had peaked.

In this study, the most favorable climatic conditions for increasing the aphid population were relative humidity levels between 75% and 84%. A similar trend in the study was also noticed by Rondon *et al.* (2005) that humidity 50-72% is convenient for the proliferation of aphids. The positive effects of humidity on aphid were observed under T3 (r = 0.464), T4 (r = 0.395) and T5 (r = 0.181). On the contrary, negative correlations were observed under treatment T1(r = -0.316), T2 (r = -0.533), T4 (r = -0.395) and T6 (r =- 0.521) (Fig. 4). Relative humidity on aphids showed a very clear opposing tendency (Wains *et al.* 2008). The current results contrasted with those of Aslam *et al.* (2005) who discovered that abiotic factors had an impact on the aphid population.

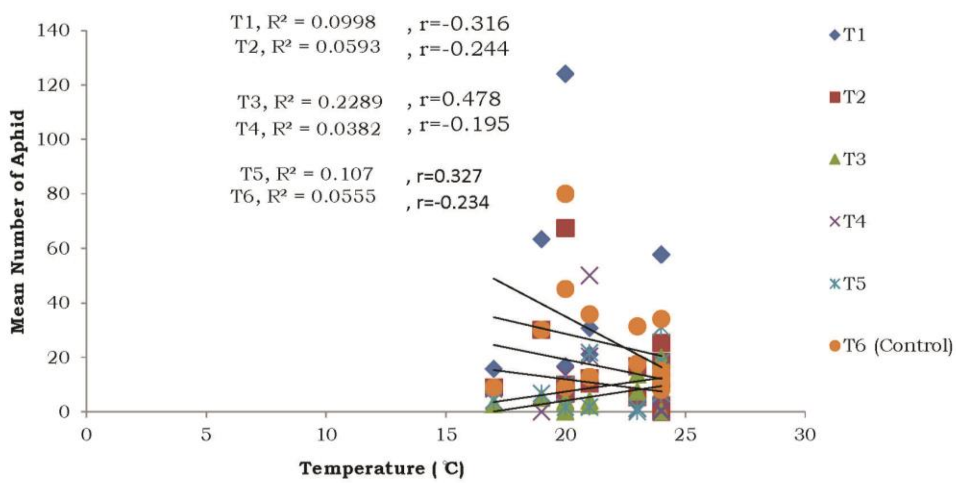

Fig. 4. Correlation of aphid population with temperature under various treatments .

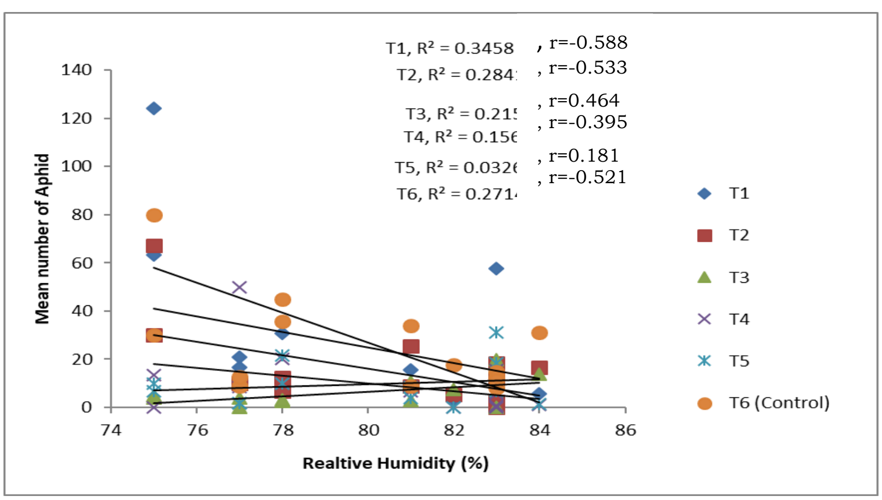

Fig 5 .Correlation of aphid population with relative humidity under various treatments.

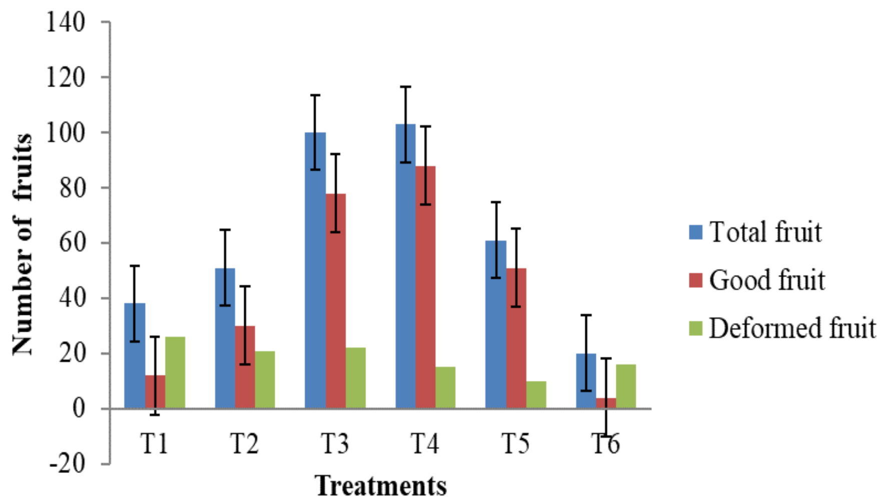

Fig. 6. The quality of bean fruits after treatments of various doses and control.

The bean production was influenced by the chemical in various treatments (Fig. 5). According to the results, T4 produced the healthiest beans (103) while T1 produced the least (38). Among the treated doses the production rate and good quality fruits were found from T3, T4 and T5. However, very less production and deformed fruits were yielded from treatment T6 (control), followed by T1. It might be revealed that the treated doses in T3 and T4 were economically beneficial against *Aphis craccivora*.

CONCLUSION

The number of aphids peaked in January and fell to its lowest level in February. Among the treated doses number of aphid population were highly affected by T3. The relative humidity and temperature have an impact on aphid dynamics. The number of aphid abundance was positively related to temperature under treatment T3 and T5, and negatively with T1, T2, T4, and untreated control T6. The positive influence of humidity on aphid was observed under treatments T3, T4 and T5, and negatively influence under treatments T1, T2, T4, and T6. The maximum amount of fruits were collected from the treated plant of T3 and T4. The results suggested that T3 (60ppm; 10mg+ 100 ml of water) dose might be used for controlling aphid prevalence and the quality bean was achieved from the doses T3 and T4. This newly synthesized chemical might be effective in controlling aphids alongside the biological and botanicals.

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