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Study on the Effects of Acetamiprid and Lambda-Cyhalothrin Application on Some Biochemical Parameters of Onion and Tomato

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ABSTRACT

Pesticides were introduced some decades ago with the aim of enhancing crop yield by protecting crops from pests. Due to adaptations and resistance that has been developed by pests against these chemicals, higher amounts and new chemical compounds are used to protect crops; this ultimately leads to undesired side effects in the crops. The aim of this study was to investigate the effect of acetamiprid and lambda-cyhalothrin application on reducing sugar, total protein, ascorbic acid, total phenolics and chlorophyll content in onion and tomato. This study was conducted by applying different concentrations (recommended, under-dose and over-dose) of these pesticides to onion and tomato and measuring the content of the aforementioned biochemical parameters after harvest using spectrophotometric methods. It was observed that both acetamiprid and lambda-cyhalotrhin application caused decreases in the reducing sugar content of onion and tomato. Similar trend was observed for ascorbic acid and chlorophyll content, except acetamiprid treated onion which recorded higher ascorbic acid content as compared to the control. Lambda-cyhalothrin and acetamiprid application caused increases in the total protein content of all the treated onion and tomato samples as compared to their controls. All the acetamiprid and lambda-cyhalothrin treated onions and tomatoes recorded lower total phenolic contents as compared to their respective controls. Most of the effects of acetamiprid and lambda-cyhalothrin on the parameters studied were observed in the recommended and/or the over-dose treated samples. Vegetable growers should be educated on the correct application of pesticides so that the nutrients in vegetables will be safeguarded and retained.

Key words: Pesticides, over-dose, under-dose, acetamiprid and lambda-cyhalothrin

INTRODUCTION

Farming has been part of human society since time immemorial, providing a wide variety of crop and animal produce to meet the food demands of humans and animals as well. Chief amongst the crops cultivated for food are vegetables, cereals, legumes and tubers. In the past, vegetable cultivation in Ghana and Africa as a whole was on subsistence basis where families cultivated vegetables for their own consumption. However, rapid population growth together with rapid growth in civilization demanded large scale cultivation of vegetables in Africa and other continents to meet the demand of society[1]. Large scale vegetable cultivation therefore emerged as a necessity to satisfy the increasing and varied needs of society. Vegetables are very prominent amongst the crops cultivated on large scale currently, because they provide important sources of nutrients for the Ghanaian population and also serve as a source of income for most families involved its cultivation[1]. Most vegetables are rich in health-promoting phytochemicals (carotenoids, flavonoids, polyphenols and minerals). Mounting evidence suggests that the consumption of fresh and minimally processed vegetables help reduce the risks of several diseases like cancer, hypertension, skin infections[2] and heart diseases[3].Vegetable production in Ghana is an all-year-round agricultural activity of small-scale farmers and has a great potential to increase the income level and standard of living of growers[4].

Large scale vegetable cultivation demanded the application of agrochemicals to prevent crop destruction by pests in order to increase the yield of vegetables cultivated. It is estimated that as much as 45% of crops are destroyed annually by pests and diseases worldwide[5]. Potent agrochemicals are therefore used irrespective of whether they have been approved for vegetable production or not. Danso *et al.*[6] pointed out that farmers mix cocktails of agrochemicals to increase their potency. The commonest agro-chemicals that farmers have embraced are pesticides. Since the introduction of pesticides into farming, pesticides have undergone extensive chemical modifications to generate compounds that are very toxic to pests; these very potent chemicals can also become dangerous to the crops they are applied on, since some are less rapidly degraded[7]. Even though pesticides have proven to be highly effective in protecting vegetable crops under extreme pressure from insect pests[8], the indiscriminate and widespread use of synthetic pesticide in vegetable cultivation usually has resulted in pesticides resistance development[9]. Many of these pesticides applications do not only lead to development of resistance but also affects the quality of the crops applied on[10]. Local farmers that normally use these pesticides have little or no idea about the dangers these chemicals pose when misused. There is evidence of pesticide residues in water sediments, crops, meat and human fluids[11,12]. Acetamiprid, [(E)-N-[(6-chloro-3-pyridyl)-methyl]-N-cyano-N-methyl acetamidine] is a contact insecticide for sucking-type insects and has translaminar action. It is a synthetic organic compound of the family of chemicals that acts as neonicotinoid insecticides. Acetamiprid can be applied as a foliar spray or a soil treatment. It acts on its target organisms by antagonizing the nicotine acetylcholine receptor of neural pathways of the insects, affects synapse transmission and causes paralysis or death of the insect[13]. Acetamiprid acts on a broad spectrum of insects, including *Hemiptera*, especially Aphids, *Thysanoptera* and *Lepidoptera*. It is approved for use on apples, aubergines, cherries, house plants, lettuce, ornamental garden plants, pears, peppers, plums, potatoes and tomatoes. Lambda-cyhalothrin is a pyrethroid insecticide registered by the U.S. Environmental Protection Agency[14]. Pyrethroids are synthetic chemicals that are structurally similar to the natural insecticides called pyrethrins. Scientists developed pyrethroid insecticides to have enhanced biological activity and desired physical and chemical properties relative to pyrethrins[15]. Pyrethroids act by disrupting the gating mechanism of sodium channels that are involved in the generation and conduction of nerve impulses[15]. Pyrethroids disrupt the sodium channel activation gate by keeping it opened longer than necessary. The delayed closing of the gate results in prolonged excitation of nerve fibers leading to rapid paralysis and death of an insect.

The low cost and high efficacy of these pesticides make them attractive to farmers, who apply them indiscriminately. This indiscriminate application, i.e., wrong concentration and frequency of application lead to the deposition of chemical residues in the treated crops. These trace amounts of the pesticide or its metabolites can cause some disturbances in the biochemical reactions in the crops and can also cause health problems for the consumers of such crops[16]. Data are available on the dangers indiscriminate pesticides application have on the environment and the consumers in most vegetable cultivating communities[17]. However, very little information is available on the effect these pesticides and their residues have on the food qualities of the treated crops. This research therefore sought to provide information on the effects that indiscriminate pesticides application (wrong concentration and frequency of application) have on some biochemical parameters like total phenolic content, reducing sugars, ascorbic acid, total protein and chlorophyll content of onion and tomato. To achieve these goals, different concentrations of the pesticides acetamiprid and lambda-cyhalothrin were applied on onion and tomato at different stages of growth. The vegetables were harvested upon maturity and the various biochemical parameters determined.

MATERIALS AND METHODS

Insecticide acquisition and preparation: Acetamiprid and lambda-cyhalothrin insecticides were purchased from certified agrochemical shops in the Abura Market in Cape Coast Metropolitan Assembly (CCMA) of the Central Region of Ghana. Three different final solutions (recommended, overdose and under dose) were prepared for each insectide.Lambda-cyhalothrin and acetamiprid pesticides were prepared as follows; 10 mL of each pesticide in 15 L of water for the recommended, 5 mL in 15 L of water for under-dose and finally 20 mL in 15 L of water for overdose.

Soil preparation: A total of sixty four rubber buckets of the same size were filled with "black soil" to the brim at the School of Biological Science Botanical Garden, University of Cape Coast and labeled. For acetamiprid treatment of tomato, the control consisted of a set of four buckets with no pesticide applied (only water), another set of four buckets were labeled as recommended (recommended dosage of pesticide), a third set four buckets were labeled as overdose (higher than prescribed dosage) and a final category also comprising of four buckets were labeled as under dose (less than recommended dosage). Similar labeling was done for acetamiprid treated onion, lambda-cyhalothrin treated tomato and onion.

Seed sowing and insecticide application: The viable tomato and onion seeds were purchased from certified agrochemical shops in the Abura Market of the Cape Coast Metropolitan Assembly in the Central Region of Ghana. Each bucket in each treatment category was treated with 1 L of the corresponding acetamiprid or lambda-cyhalothrin solution respectively, whereas, each bucket labeled as control was treated with 1 L of water. The treated soil in each bucket was allowed to sit for a period of three days, after which five seeds of tomato or onion were sown in each bucket. Another 1 L of each pesticide was applied to each respective treatment bucket one and half months after the seeds have germinated. A last round of 1 L of each pesticide was applied to each bucket labeled with each treatment seven days before the vegetables were harvested. Each bucket either labeled as control or treatment was watered every other day until harvest.

Sample harvest and preparation: The matured tomato fruits and onion bulbs were harvested and cleaned thoroughly. A total of 100 g of each sample was ground using 200 mL of distilled water in a mortar on ice using a pestle. Each macerate was then filtered through muslin cloth and then centrifuged at 3500 rpm for 30 min. The supernatant of each sample was filtered through Whatman No.1 paper and stored at 4°C for further analyses.

Estimation of reducing sugar: The reducing sugar in each sample was estimated using the Folin and Wu[18] method with slight modification using glucose as a standard. A volume of 0.5 mL of each extract was transferred into different test tubes after which 0.2 mL of alkaline copper tartarate was added and placed in a water bath for 10 min. After cooling, 0.2 mL of phosphomolybdic acid was added and the final volume made up to 5.0 mL by the addition of distilled water. The absorbance of each sample was measured by a spectrophotometer at a wavelength of 580 nm. The amount of reducing sugar in each extract was extrapolated from a standard curve obtained from the absorbance and concentration of the standard glucose.

Estimation of protein content: The protein content of each sample was estimated using the Bradford method[19] with some minor modifications and Bovine Serum Albumin (BSA) as a standard. Briefly, a volume of 0.5 mL of each sample was placed in separate test tubes. Phosphate buffer (pH 7) was added to each test tube to make a final volume of 3 mL. A total volume of 3 mL of Bradford dye was added to each tube. The reaction mixture was incubated in water bath for 15 min at a temperature of 60°C in the dark. The absorbance of each sample was read at 595 nm after samples were cooled. Absorbance recorded for each sample was used to extrapolate the content of protein using the standard curve generated from the standard BSA.

Total Phenolic Content (TPC): The total phenolic content in each sample was measured using the method described by Singleton and Rossi[20]. A volume of 0.5 mL of each extract was transferred into separate test tubes and each mixed with 0.2 mL of 50% (v/v) Folin-Ciocalteu reagent. After 3 min, 0.5 mL of saturated sodium carbonate (Na_2CO_3) was added to each reaction mixture and the volume was made up to 10 mL by the addition of distilled water. The absorbance of each solution was read at 765 nm. A standard curve was prepared using gallic acid as the standard and total phenolic content of samples were extrapolated from the standard curve. TPC values were expressed as mg of gallic acid per 100 g of sample on Dried Weight (DW) basis.

Ascorbic acid (Vitamin C) estimation: The ascorbic acid content was determined using the method described by Niewiadomski[21] with some minor modifications using ascorbic acid as a standard. A volume of 1 mL of each extract was pipetted into separate test tube after which 0.1 mL of bromine water was added to each test tube and mixed until the color of the solution changed from orange to yellow. Excess bromine was removed by the addition of three drops of thiourea after which the volume was made up to 5 mL by the addition of 4% oxalic acid. A volume of 0.5 mL of each of the brominated samples was transferred into separate test tubes and the volume of each test tube made up to 1.5 mL by the addition of distilled water. A volume of 0.5 mL of 2, 4-dinitrophenylhydrazine (DNPH) was added to each test tube followed by two drops of thiourea. The content of each test tube was thoroughly mixed and incubated in a water bath at 60°C for 30 min, after which 3 mL of 80% sulphuric acid was added to each solution and allowed to cool. The absorbance of each solution was measured at a wavelength of 540 nm. The content of ascorbic acid in each extract was then extrapolated from the standard curve generated from the standard ascorbic acid.

Chlorophyll content estimation: The method employed was one described by Wellburn[22] with slight modifications. A mass of 3 g of shredded leaves of each sample was weighed into Waring mortar and pestle and homogenized using 20 mL of 80% acetone. The macerate was centrifuged at 4000 rpm for 10 min. The supernatant was decanted into different test tubes and centrifuged again. The centrifugation procedure was repeated until there was no further separation. Absorbance for each sample was read at two different wavelengths 645 nm for chlorophyll a and 663 nm for chlorophyll b. The total chlorophyll content (a + b) in each sample was calculated using the formula below:

$$\text{Chlorophyll content} = (0.00802\times\text{Abs 645 nm}) + (0.002\times\text{Abs 663 nm}) \quad (1)$$

Where:
Abs 645 nm = Absorbance at 645 nm
Abs 663 nm = Absorbance at 663 nm

Data analysis: Statistical analysis of the data obtained from the study was done using Statistical Package for the Social Scientist (SPSS) version 21. The data obtained were subjected to one-way analysis of variance (ONE-WAY ANOVA). This was used to distinguish between means that were statistically significant at p-value of 0.05.

RESULTS

At the recommended and over-dose levels, acetamiprid caused significant decrease in the chlorophyll content in onion as compared to the control (Table 1). On the other hand, the under-dose, recommended and over-dose acetamiprid dosages caused decreases in the reducing sugar content as compared to the control, with the highest decrease observed at the under-dose level. The total protein content increased at the under-dose level, but decreased at both the recommended and over-dose levels (Table 1). Ascorbic acid content increased in all the treatment regimes, with the highest increment observed in the over-dose treated onion. Total phenolic content decreased in all the treatment regimes, however, the highest decrease was observed in the over-dose treated onion; this decrease was statistically significant as compared to the control ($p<0.05$) (Table 1).

At the recommended dosage, lambda-cyhalothrin application caused a significant decrease in the reducing sugar content of the treated onions as compared to the control ($p<0.05$) (Table 2). The total protein content increased in all the treated onions, with the highest increment occurring in the over-dose treated onion as compared to the control. Ascorbic acid content decreased in all the lambda-cyhalothrin treated onions as compared to the control, however, the highest

Table 1: Effect of the application of different concentrations of acetamiprid on the reducing sugar, protein, ascorbic acid, flavonoid and chlorophyll content in onion

	Dosage of pesticide			
Biochemical parameter	Control	Under dose	Recommended	Over dose
Reducing sugar (g/100 g)	8.91±2.617	2.89±2.206	5.83±2.868	3.85±1.165
Total proteins (g/100 g)	2.65±1.134	3.68±2.287	1.07±0.586	1.13±0.098
Ascorbic acid (mg/100 g)	87.27±0.559^{a}	92.11±0.161^{a}	96.14±2.656	96.47±3.013
Total phenolic (mg/100 g)	94.42±2.164^{ab}	47.56±4.987^{a}	76.94±4.987	19.99±1.201^{b}
Chlorophyll (mg mL^{-1})	0.059±0.001^{ab}	0.055±0.002	0.052±0.001^{b}	0.049±0.002^{a}

Values are mean±standard deviations of three measurements. Values with the same superscript as that of the control within the same row are significantly different as compared to the control (p<0.05)

Table 2: Effect of the application of different concentrations of lambda-cyhalothrin on the reducing sugar, protein, ascorbic acid, flavonoids and chlorophyll content in onion

	Dosage of pesticide			
Biochemical parameter	Control	Under-dose	Recommended	Over-dose
Reducing sugar (g/100 g)	8.58±1.458^{a}	4.96±1.673	3.09±1.130^{a}	3.35±1.224
Total proteins (g/100 g)	4.36±0.079^{a}	4.56±0.236	4.42±0.375	5.69±0.166^{a}
Ascorbic acid (mg/100 g)	91.52±3.978	71.74±0.739	65.27±7.785	56.20±14.668
Total phenolic (mg/100 g)	96.93±2.377^{ab}	90.27±6.620	51.91±6.529^{a}	58.55±5.599^{b}
Chlorophyll (mg mL^{-1})	0.053±0.002^{ab}	0.048±0.001	0.043±0.001^{a}	0.034±0.003^{b}

Values are mean±standard deviations of three measurements. Values with the same superscript as that of the control within the same row are significantly different as compared to the control (p<0.05)

Table 3: Effect of the application of different concentrations of acetamiprid on the reducing sugar, protein, ascorbic acid, flavonoids and chlorophyll content in tomato

	Dosage of pesticide			
Biochemical parameter	Control	Under-dose	Recommended	Over-dose
Reducing sugar (g/100 g)	7.85±0.09[ab]	6.35±0.551	5.64±0.085[a]	5.32±0.195[b]
Total proteins (g/100 g)	2.83±0.096[ab]	3.04±0.076	3.50±0.019[a]	3.83±0.075[b]
Ascorbic acid (mg/100 g)	54.76±1.186[ab]	52.01±0.412	49.06±0.516[a]	44.89±0.586[b]
Total phenolic (mg/100 g)	81.15±0.223[abc]	76.05±0.399[a]	74.06±0.849[b]	72.22±0.424[c]
Chlorophyll (mg mL^{-1})	0.066±0.008[ab]	0.039±0.002	0.029±0.003[a]	0.027±0.006[b]

Values are mean±standard deviations of three measurements. Values with the same superscript as that of the control within the same row are significantly different as compared to the control (p<0.05)

Table 4: Effect of the application of different concentrations of lamba-cyhalothrin on the reducing sugar, protein, ascorbic acid, flavonoids and chlorophyll content in tomato

	Dosage of pesticide			
Biochemical parameter	Control	Under-dose	Recommended	Over-dose
Reducing sugar (g/100 g)	7.36±0.166[abc]	6.37±0.122[a]	5.84±0.056[b]	5.28±0.031[c]
Total proteins (g/100 g)	3.82±0.100[ab]	4.16±0.058	4.92±0.088[a]	5.23±0.100[b]
Ascorbic acid (mg/100 g)	56.44±0.489[abc]	54.24±0.409[a]	51.79±0.722[b]	48.29±1.138[c]
Total phenolic (mg/100 g)	77.29±0.968[ab]	73.74±0.310	69.68±0.417[a]	64.56±1.344[b]
Chlorophyll (mg mL^{-1})	0.067±0.005[ab]	0.051±0.003	0.044±0.002[a]	0.034±0.002[b]

Values are mean±standard deviations of three measurements. Values with the same superscript as that of the control within the same row are significantly different as compared to the control (p<0.05)

decrease was observed in the over-dose treatment (Table 2). The lowest phenolic content was observed in the onions treated with recommended dosage of lambda-cyhalothrin; this decrease was statistically significant as compared to the control (p<0.05). Chlorophyll content in both recommended and over-dose lambda-cyhalothrin treated onions were significantly lower than that of the control (p<0.05) (Table 2). The recommended and over-dose acetamiprid treated tomatoes recorded significantly lower reducing sugar contents as compared to the control (p<0.05) (Table 3). On the other hand, the recommended and over-dose acetamiprid treated tomatoes had significantly higher protein contents as compared to the control (p<0.05). Ascorbic acid content decreased in all the acetamiprid treated tomatoes, however, the highest significant decrease was observed in the over-dose treated tomatoes (p<0.05) (Table 3). The total phenolic content was significantly lower in all the acetamiprid treated tomatoes, with the lowest total phenolic content observed in the over-dose tomatoes (p<0.05). Chlorophyll content was also significantly reduced in all the acetamiprid treated tomatoes as compared to the control. However, the highest significant decrease was observed in the over-dose acetamiprid treated tomatoes (Table 3).

The reducing sugar content decreased significantly in all the lambda-cyhalothrin treated tomatoes as compared to the control (p<0.05) (Table 4). However, the highest significant decrease was observed in the over-dose treatment. On the contrary, total protein content increased in all the lambda-cyhalothrin treated tomatoes. However, the highest significant increase in protein content was observed in the over-dose treated tomatoes (p<0.05) (Table 4). Ascorbic acid content decreased significantly in all the lambda-cyhalothrin treated tomatoes (p<0.05). However, the highest decrease was recorded in the over-dose treated tomatoes. Significant decreases were observed in both total phenolic and chlorophyll contents in lambda-cyhalothrin treated tomatoes as compared to the control. However, the highest decrease in each case was observed in the over-dose treatment (Table 4).

DISCUSSION

Pesticides are used to control pests on animals and/or plants, however, in the latter; these pesticides can sometimes affect their biochemical reactions and functions. Plants were affected by pesticides in a number of ways; these include inhibition of photosynthesis, mitosis and cell division[23]. Pesticides can also interfere with the activities/functions of plant enzymes, root growth, synthesis of chlorophylls and proteins and the destruction of cell membranes[23]. Different mechanisms have been suggested by Taiz and Zeiger[24], on how the higher concentrations of pesticides could retard the physiological and biochemical processes in plants which could provide further insights into retardation in growth. For instance, the presence of pesticide deposits in soil destabilizes the thermodynamic activity of water along with micro and macro nutrients in the surrounding soil[25]. The presence of pesticide deposits in soil also tends to decrease the uptake of water along with nutrients as pesticides deposits get attached with the soil particles affecting the nutrient uptake from the soil to the root[25]. The results of these interferences end up either lowering or enhancing the quality of food crops depending on the dosage used in the treatment[26].

Both acetamiprid and lambda-cyhalotrhin application caused decreases in the reducing sugar content of onion and tomato. Similar trend was observed for ascorbic acid and chlorophyll; however, all the acetamiprid treated onions recorded higher ascorbic acid content as compared to the control. Talat *et al.*[23] observed that the fungicide antrakol inhibited photosynthetic electron transport and disrupted photosystem II reaction centre in *Nicotiana tabacum* (tobacco). The decrease in photosynthetic pigments (chrolophylls) might cause a decline in the reducing sugar and vitamin C considering the fact that vitamin C is a hexose compound. Similarly Chauhan *et al.*[26] observed a 13.13% decrease in the ascorbic acid content in pesticide treated potato samples as compared to the untreated ones. Ismail *et al.*[27] in a similar investigation recorded a 20% decrease in the ascorbic acid content in treated tomato samples. Ismail *et al.*[27] recorded a 4% reduction in glucose content in profenofos treated potato and tomato as compared to the untreated samples at higher concentrations of profenofos. Chauhan *et al.*[26] also observed a 13% decrease in the reducing sugar of imidacloprid treated potato samples compared to the untreated samples. On the contrary, Radwan *et al.*[28] observed a rise in the reducing sugar content after the application of pirimiphos-methyl insecticide on green pepper.

Hexaconazole also increased the total sugar content at lower concentrations suggesting that the pesticide positively affected the metabolic enzymes and enhanced the functioning of the enzymes of the Photosynthetic Carbon Reduction (PCR) cycle, such as Ribulose-5-bisphosphate carboxylase (RUBISCO), 3-Phosphoglyceric acid kinase, NAD-Glyceraldehyde-3-phosphate-dehydrogenase and aldolase[28]. A study by Kengar *et al.*[29] on triazophos at lower concentrations demonstrated an upsurge in the reducing sugar content in spinach. An increased level of reducing sugar may be due to its non-conversion to non-reducing sugar. This might be a mechanism adopted by the plant to reduce the effect of triazophos stress.

Lambda-cyhalothrin and acetamiprid application caused increases in the total protein content of all the treated onion and tomato samples as compared to their controls. Chauhan *et al.*[26] also observed that imidacloprid treated potato samples contained 18.26% higher amount of protein than the untreated potato sample. According to Chauhan *et al.*[26] increases in protein content may be due to the nitrogen-containing groups in the chemical structure of imidacloprid; this was chemically similar to the acetamiprid used in this study. They speculated that the nitrogen element induce efficient synthesis of amino acids resulting in the buildup of 18.26% more proteins in imidacloprid treated potato samples than the untreated potato samples. In a related investigation, Sankar *et al.*[30] reported triadimefon fungicide treatment in *Catharantus roseus* increased the protein, amino acid, glycine and proline contents in the leaves, stem and roots. The accumulation of these metabolites might result from the oxidative stress induced by the fungicide application as a defense mechanism. Plants respond to a variety of stress by accumulating certain specific metabolites like amino acids[30]. It might provide extra protection to plants against the damaging effect of oxygen radical arising from oxidative stress[30].

Also, malathion insecticide at lower concentrations have been shown to increase protein synthesis in pepper[25]. Zamin and Soaliha[25], reported that the increase in protein content could be due to an increase in Nicotinamide Adenine Dinucleotide (NAD) and NAD phosphate (NADP) ratios which triggered electron transport system and increased adenosine triphosphate (ATP) levels by inducing changes in enzyme systems. Similarly, Ismail *et al.*[27] observed that profenofos insecticide deposits also caused a rise in the protein content of potatoes. In the same vein, Radwan *et al.*[28] observed that profenofos and primifos-methyl pesticide application significantly amplified the total proteins in potatoes and green pepper. Likewise at the recommended concentration of 5 g L^{-1}, Captan fungicide showed higher protein content in pepper leaves at lower concentrations than at higher concentrations and the control as well[31].

All the acetamiprid and lambda-cyhalothrin treated onions and tomatoes recorded lower total phenolic contents as compared to their respective controls. The decrease in the total phenolic content can be attributed to the decomposition of phenols which are responsible for the non-enzymatic anti-oxidative properties[26]. Hesam *et al.*[32] also reported a decrease in phenolic content in potatoes after pesticide application in Iran. There was also a significant decrease in the total dihydroxy phenols in imidacloprid residue containing potato samples by 49.93% as compared to untreated samples[26]. On the contrary, it had been observed by Sofy *et al.*[33] that phenolic content of quinoa plants treated with gibberelic acid (GA3) were significantly elevated as compared to the untreated samples. It seemed that the pesticide deposits which served as foreign substances in the plant triggered the formation of more phenolic compounds like iso-flavones (Genistein, diadzein), phenolic acid (elagic, tannic and vanilic acid) and hydroxycinnamic acid derivatives (ferulic acid, ρ-hydroxy benzoic acids and ρ-caumeric acid)[25].

CONCLUSION

It was concluded that both acetamiprid and lambda-cyhalotrhin treatment caused decreases in the reducing sugar content, ascorbic acid content and chlorophyll content in tomato and onion except the acetamiprid treated onions, which recorded a higher ascorbic acid content as compared to the control. Most of the effects of acetamiprid and lambda-cyhalothrin on the parameters studied were observed in the recommended or the over-dose treated samples.

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