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Research Paper

HUMAN URINE AS A FERTILIZER- A COMPARATIVE STUDY USING *SOLANUM LYCOPERISCUM* AND *CAPSICUM SP.*

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Abstract

Fertilizer is any organic or inorganic material of natural or synthetic origin (other than liming materials) that is added to soil to supply one or more plant nutrients essential to the growth of plants. Urea fertilizer production has developed during the last decades so that urea is one of the most important industrial nitrogen fertilizers and new urea–ammonia fertilizer plants have been built recently, for instance in India. Human urine is a natural resource, which is available in all human societies even in the poorest ones which can be used as a natural fertilizer. Urine contain rich plant nutrients, since the human kidney is the main excretory organ and thus urine contains most of the nutrients present in human food which have not been utilized for new cell growth or energy consumption. In the present study two plant materials were selected- *Solanum lycopersicum and Capsicum sp.* In this study, soil analysis as well as estimation of protein, ascorbic acid, proline and Ascorbate Peroxidase enzyme (APX) for the two study materials grown with different concentrations of human urine fertilizer was done. Plant growth and morphological studies of the plants under investigation were observed. The soil analysis for Nitrogen, Phosphorous, Potassium, Electrical Conductivity and pH were also carried out before and after the fertilizer treatment. After the fertilizer treatment the N P K content in soil showed some changes. It was observed that available potash concentration was increased, at the same time there was a slight decrease in the nitrogen and phosphorus content. The results also showed the relation between APX and Ascorbate and the stress amino acid proline was also estimated.

Key words: Fertilizer, Protein, *Capsicum sp.*, Proline, Ascorbate, APX, Urea, Soil NPK, Human urine.

INTRODUCTION

Human urine is a natural resource, which is available in all human societies even in the poorest ones. Urine contain rich plant nutrients, since the human kidney is the main excretory organ and thus urine contains most of the nutrients present in human food which have not been utilized for new cell growth or energy consumption. The chemical composition of human urine depends on time of day, diet, climate, physical activity and body size [29]. Urea is the main nitrogen component present in human urine. Urea fertilizer production has developed during the last decades so that urea is one of the most important industrial nitrogen fertilizers [8] and new urea–ammonia fertilizer plants have been built recently, for instance in India [6]

Undiluted urine can chemically burn the roots of some plants, but it can be used safely as a source of complementary nitrogen in carbon-rich compost. These by-products are eventually expelled from the body during urination, the primary method for excreting water-soluble chemicals from the body. Human urine contains considerable amounts of primary crop nutrients, i.e., nitrogen (N), phosphorous (P) and potassium (K), and secondary nutrients, including sulphur (S), calcium (Ca) and Magnesium (Mg). Urine has a fertilizer value of N/P/K 18:2:5 [15], and for urine mixed with flush water, the ratio can be N/P/K/S 15:1:3:1 [21] Urine is produced after filtration of the blood in the kidneys, and therefore, it contains low-molecular-weight compounds, since proteins are not filtered. About 75–90% of N is excreted as urea, the remainder being in the form of either ammonium or creatinine [14].

Urea fertilizer production has developed during the last decades so that urea is one of the most important industrial nitrogen fertilizers [8] and new urea–ammonia fertiliser plants have been built recently, for instance in India [6]. The phosphorous and potassium contents in urine are almost totally (95–100%) in an inorganic form [14].

Urea is rapidly degraded by urease to ammonium and water, which may elevate pH values up to a pH of 9; this can also reduce the bacterial population, although ammonia evaporation is also higher at higher pH values. The urea/ammonium in urine and urea/ammonium in artificial fertilizers are similar; that is, 90–100% of urine nitrogen is in the form of either urea or ammonium, as has been verified in fertilizing experiments [12, 28]. However, it is important to study the use of urine fertilizer with different crop plants because of their different nutrients requirements and the variation in the nutrient content in urine. In particular, the high amount of chlorine and the relatively low amount of phosphorous in urine might evoke different responses in different plants [26]. Urine has been and is currently used in agriculture as fertilizer for a diverse range of fruits and vegetables in many regions of the World [22].

Urine applications resulted in similar plant growth characteristics as compared to those using mineral fertilizers [23] or led to enhanced plant height and leaf length in maize [9]. Likewise, tests on tomatoes [1], red beet [24], pumpkin [25], maize [17] and okra crops [11] showed very similar results, all reporting an increased plant biomass as compared to no fertilization, and a yield comparable to or higher than that from mineral fertilizers.

MATERIALS AND METHODS

In the present study two plant materials were selected- *Solanum lycopersicum and Capsicum spp.* In the present study, soil analyses as well as estimation of protein [16], ascorbic acid [10], proline [3] and Ascorbate Peroxidase enzyme (APX) [19] were done.

Properly collected urine samples were mixed with water in different concentrations from 40 % to 70 %. A control was also kept in which only normal water was added. The tomato plants were named as A1 (control), A2, A3, A4 and A5 (40% to 70% fertilizer). The capsicum plants were given names, B1 (control), B2, B3, B4 and B5 (40% to 70%). The prepared fertilizer was added at one week intervals and observed for the morphological changes daily.

RESULTS AND DISCUSSION

The morphological studies of the plants under investigation were observed (Table 1). The stem height in both the tomato and capsicum plants was found to be increasing with different concentrations of urine. The leaves also showed a slight increase in their number. This is due to the presence of nitrogen, phosphorous, potassium and other trace elements in urine. Compared to capsicum, tomato plants showed pronounced morphological changes with urine treatment. [27, 18]. A study on the morphology of two *Capsicum species* in relation to urine treatment observed that various concentrations of diluted urine can be an excellent fertilizer [31].

The soil analysis for Nitrogen, Phosphorous, Potassium, Electrical Conductivity and pH were also carried out (Table 2 and b). Before adding the fertilizer, soil gave pH value 4.7 which showed that the selected soil sample was strongly acidic. The electrical conductivity was 0.09dS/m which was a normal. The result showed a nitrogen content of 3.1% and phosphorus

50.1Kg/ha and potassium content 88Kg/ha. From the result it was clear that the nitrogen and phosphorus were in sufficient amounts in the soil, but the available potash was comparatively low. After the fertilizer treatment the N P K also showed some changes (Table 2b). It was observed that available potash concentration was increased, at the same time there was a slight decrease in the nitrogen and phosphorus content. This might be due to the urine fertilizer treatment, which need more investigation so that we could get better conclusion. After the fertilizer use, the result showed pH values as 6.0(A1), 5.8(A2), 5.7(A3), 5.7(A4), 6.2(A5), 5.7(B1), 5.6(B2), 5.5(B3), 5.7(B4) and 5.8(B5). The electrical conductivity also showed considerable change in almost all the samples (Table 2b).

The results of protein analysis for various samples were given in the Figure 1 a and b. The results showed that human urine is an excellent fertilizer for plant growth as it contributes to the high concentration of protein in the studied species. Similar studies in *Solanum lycopersicum* and *Capsicum sp.*regarding protein content are there in some early works [7, 5, 2 and 13].

Proline content of Tomato (*Solanum lycopersicum*) and *Capsicum spp* slightly increases with different urine concentrations (Figure 2a and b). Proline was found 0.2178 mg/g of tissue in control *Solanum lycopersicum* (A1), highest value found to be 0.3812 mg/g of tissue in *Solanum lycopersicum (*A5), least value found was 0.3138 mg/g of tissue in *Solanum lycopersicum* (A2). Proline was found to be 0.1665 mg/g of tissue in control *Capsicum sp* (B1), highest value was 0.3840 mg/g of tissue in *Capsicum sp* (B5), least value 0.1793 mg/g of tissue in *Capsicum sp* (B2). Treatment of urine provides a small, harmless stress to the plant, which leads to the production of the stress aminoacid, proline [7, 13].

When plants are exposed to certain stressful conditions, the production of Reactive Oxygen Species (ROS) increases and can cause significant damage to the cells. Antioxidant defenses, which can detoxify ROS, are present in plants. A major hydrogen peroxide detoxifying system in plant cells is the Ascorbate-glutathione cycle, in which, Ascorbate Peroxidase (APX) enzymes play a key role catalyzing the conversion of H_2O_2 into H_2O, using ascorbate as a specific electron donor. In this study, the treatment of plants with different concentrations of urine results in the increased concentration of Ascorbate and Ascorbate peroxidase activity. Ascorbate is a major metabolite in plants. It is an antioxidant and, in association with other components of the antioxidant system, protects plants against oxidative damage resulting from aerobic metabolism, photosynthesis and a range of stress [30, 7].

Ascorbate peroxidase (APX) total activity was found to be 1 moles/min in *Solanum lycopersicum*(A1) and then increased to 2.3 moles/min in *Solanum lycopersicum*(A5). Similarly, 1.1 moles/min in *Capsicum sp* (B1) and 3.2 moles/min in *Capsicum sp* (B5) were observed (Figure 3a, 3b, 4a and 4b) [20, 4].

Table 1: Morphological studies of Tomato and *Capsicum sp*. A1 to A5-Tomato B1 to B5-*Capsicum sp*.

Plants	Stem height(cm)	No. of leaves /branches
A1 control	2.8	8
A2	3	9
A3	3.2	10
A4	3.6	11
A5	3.9	13
B1 control	40	15
B2	52	13
B3	56	14
B4	59	16
B5	61	18

Table 2a: Soil Parameters before fertilizer application

Parameters	Values
pH	4.7
Electrical conductivity (d S/m)	0.09
Nitrogen content (%)	3.1
Available Phosphorus (Kg/ha)	50.1
Available Potassium(Kg/ha)	88

Table 2b: Soil Parameters after fertilizer application

Samples	pH	EC (d S/m)	Nitrogen Content (%)	Available Phosphorus (Kg/ha)	Available Phosphorus (Kg/ha)
A1(control)	6.0	0.04	2.0	22.4	110
A2	5.8	0.06	2.0	14.7	110
A3	5.7	0.03	1.7	12.1	88
A4	5.7	0.04	1.9	22.7	77
A5	6.2	0.05	1.6	13.2	187
B1(control)	5.7	0.05	2.0	16.9	110
B2	5.6	0.05	2.5	19.6	187
B3	5.5	0.05	1.7	18.7	187
B4	5.7	0.08	1.9	14.7	143
B5	5.8	0.07	1.7	19.4	88

Figure 1a: Amount of protein in samples A1 to A5-Tomato

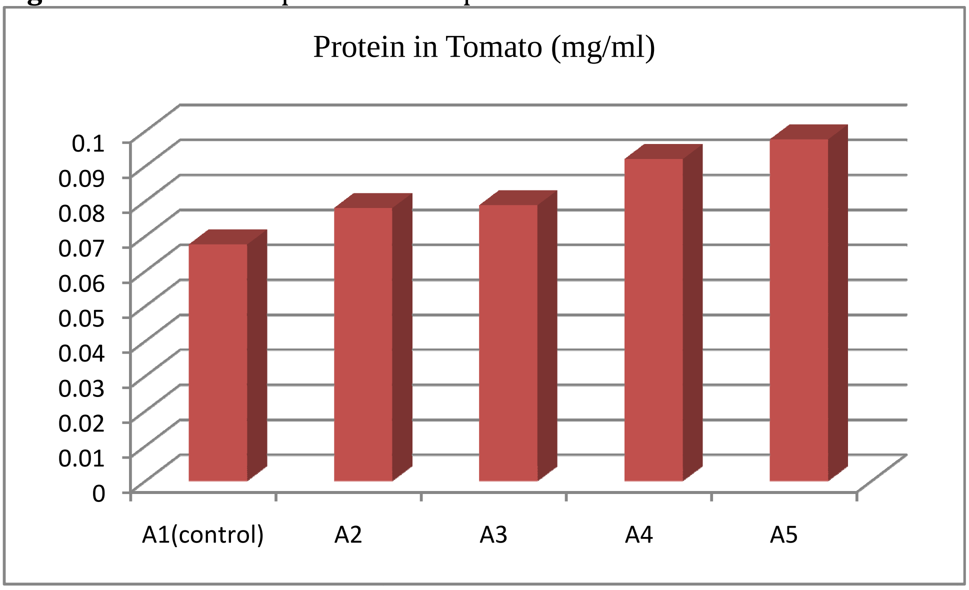


Figure 1b: Amount of protein in samples B1to B5- *Capsicum sp.*

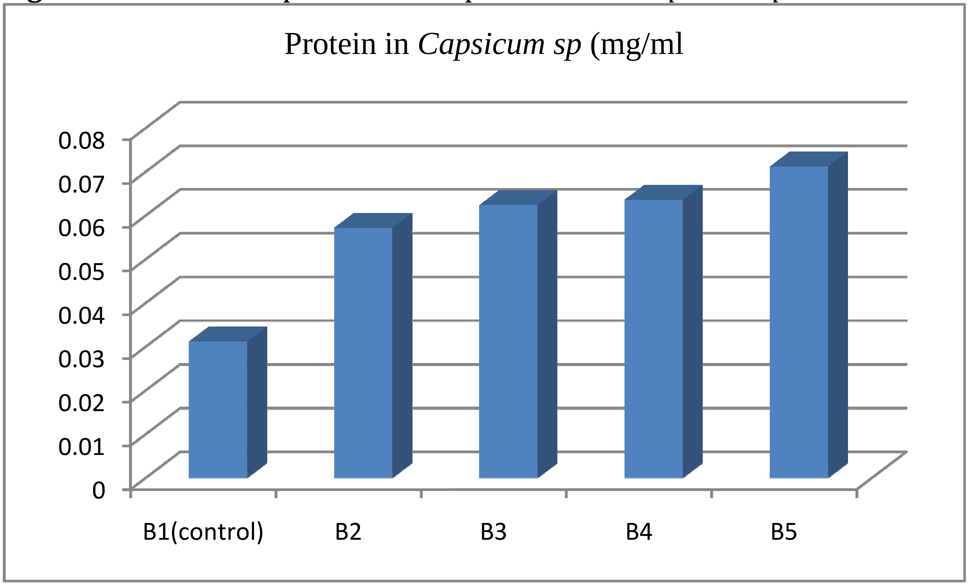


Figure 2a: Estimation of Proline A1 to A5-Tomato

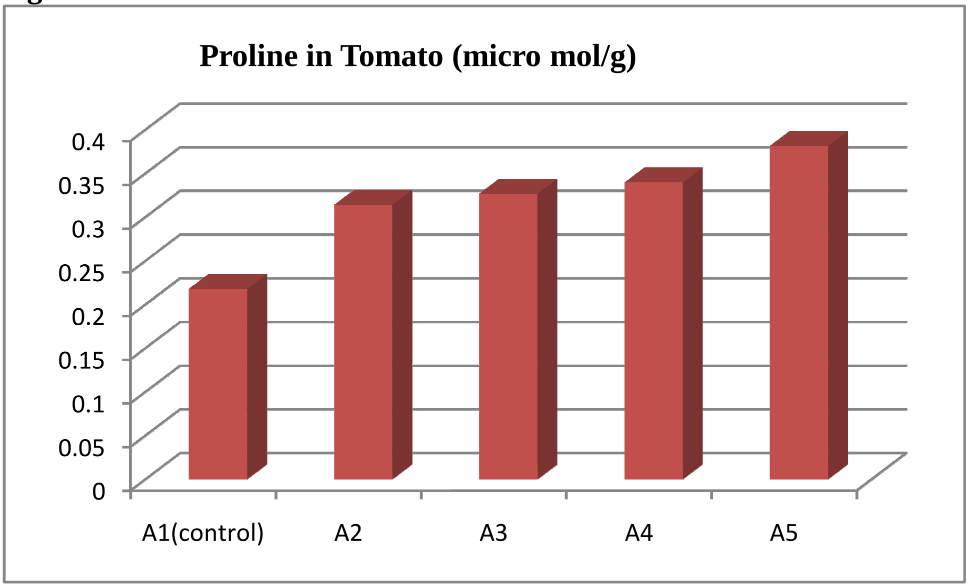


Figure 2b: Estimation of Proline B1to B5- *Capsicum sp*

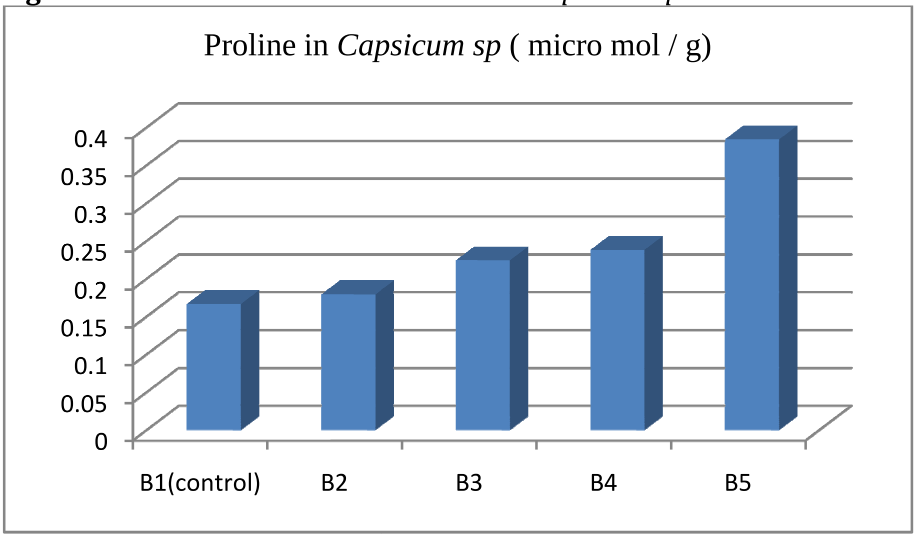


Figure 3a: Estimation of Ascorbic Acid A1 to A5- Tomato

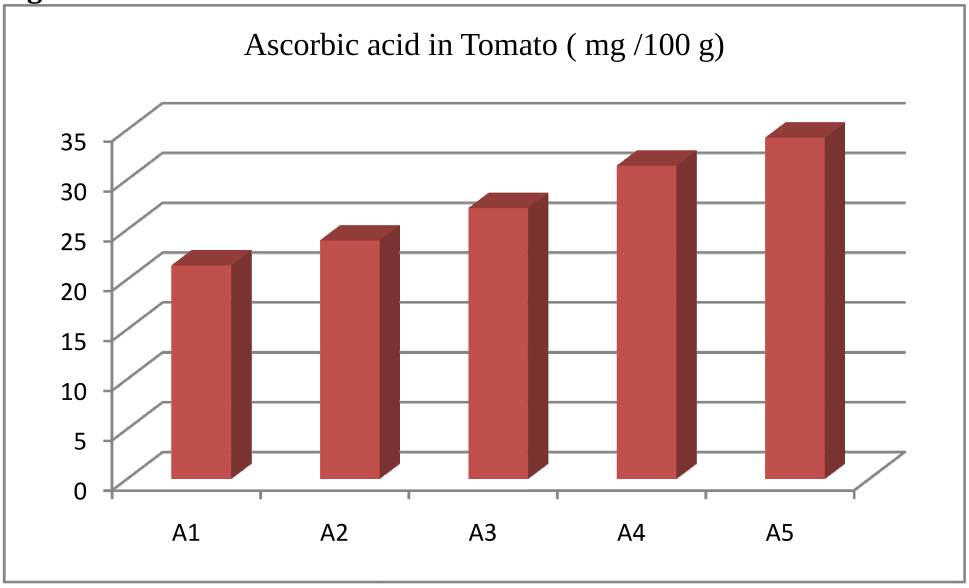


Figure 3b : Estimation of Ascorbic Acid B1to B5- *Capsicum sp.*

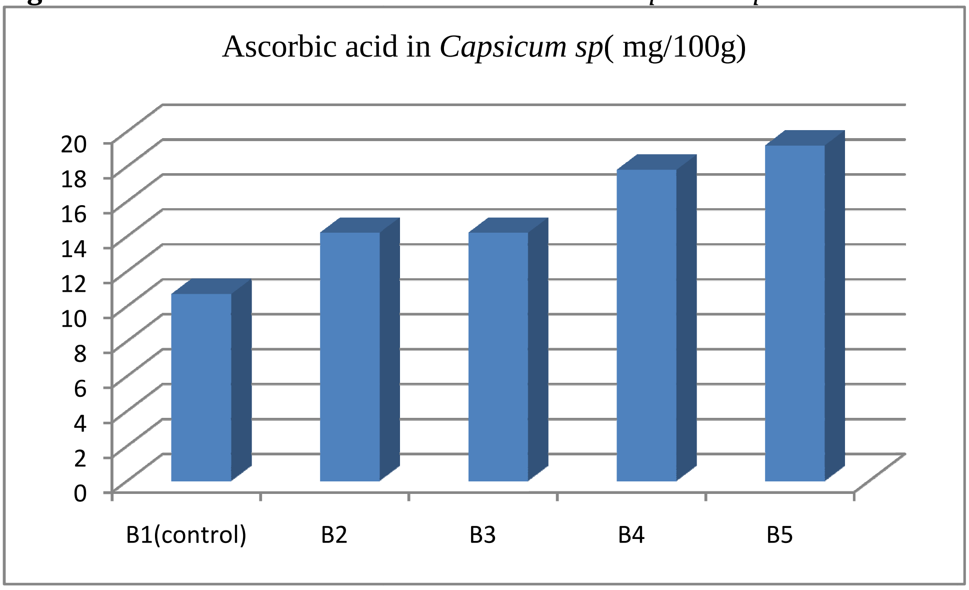


Figure 4 a: Estimation of APX A1 to A5- Tomato

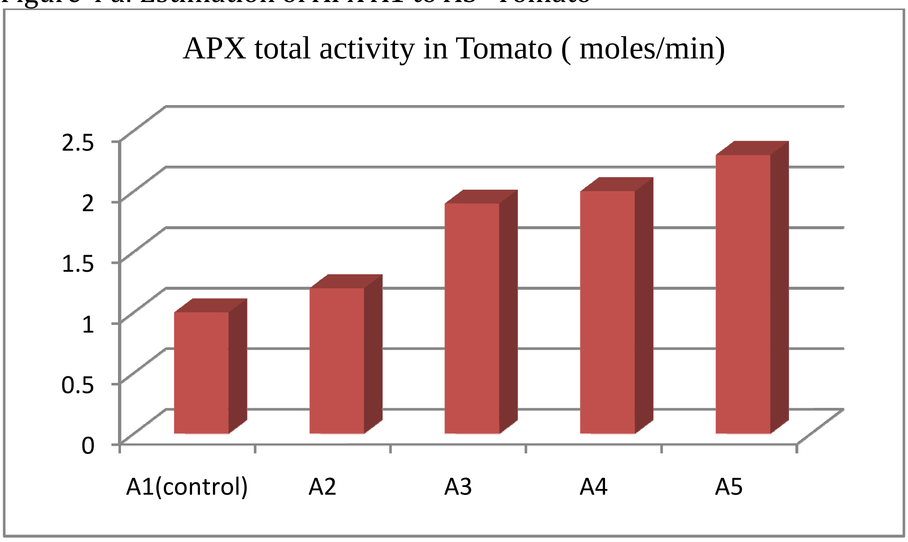
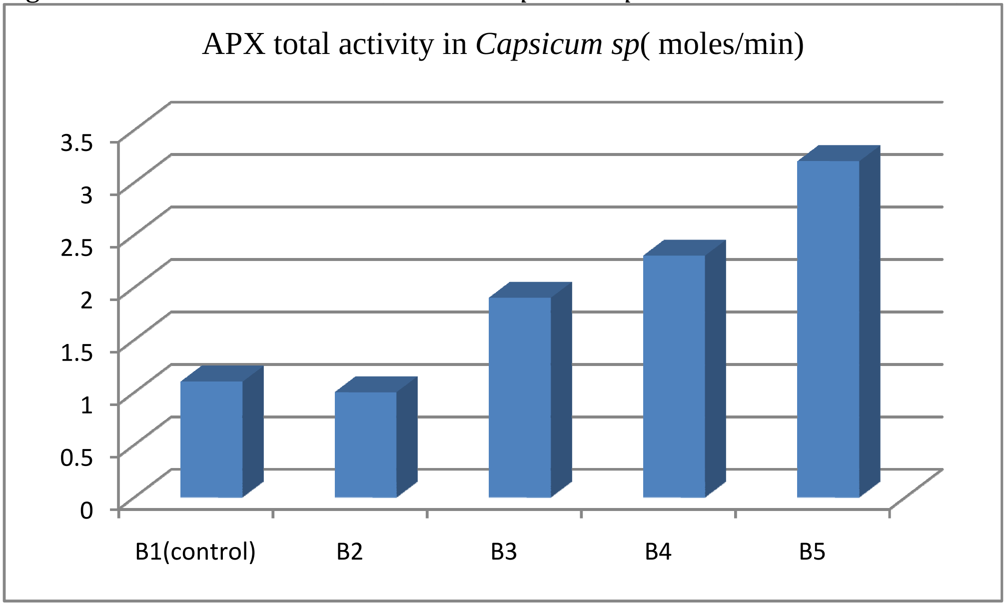


Figure 4 b: Estimation of APX B1to B5- *Capsicum sp*



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