Effects of aspirin on aquaponics tomato (Solanum lycopersicum) production in laboratory condition

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Abstract: The experiment was conducted to visualize the effect of exogenous aspirin on tomato production in aquaponic system. Aspirin, a derivative of salicylic acid, acts as a potential non-enzymatic antioxidant and plant growth promoter, hence regulates plant physiology. The experiment employed three treatments (T) with three replications (R) each where, 60 ppm and 120 ppm aspirin were used in T1 and T2, respectively and Tcon was control with no aspirin. Media filled plastic containers (0.29m×0.30m×0.21m) as growbeds and plastic tanks of 120 liter capacity as fish tank were installed to construct each aquaponic systems indicating each replication. Tilapia, was stocked at 111 fish/m³ in the fish tank and fed commercial floating feed containing 30% protein at the rate of 3% body weight twice daily. In each replication, two tomato saplings were planted. Fish tank water was oxygenated with a 10 watt air pump, then waste water from tank was pumped to grow bed with a 12 watt submersible pump. Survival rates were 70, 85 and 50% in T1, T2 and Tcon respectively. While fish productions were 0.42, 0.34 and 40.49 (kg/m²/60 days) in T1, T2 and Tcon respectively. The water quality parameters were within the suitable ranges for tilapia as well as tomato in the aquaponic system. Foliar spray of aspirin was applied fortnightly. Tomato production was hampered with various diseases in all the treatments although the aspirin treated plant (T1 and T2) were free from few diseases. The highest tomato production was found 0.44 kg/m²/60 days in T2 followed by T1 (0.42 kg/m²/60 days) and Tcon (0.34 kg/m²/60 days). Noticeably, Plant growth and tomato production were higher in T2 and T1 with less disease prevalence than Tcon, suggesting positive impacts of aspirin on tomato. However, further research is needed to justify the aspirin doses at user level.

Keywords: aquaponics; aspirin; foliar application; tomato

1. Introduction
Tomato as one of the most widely produced and consumed vegetable in the world (Heuvelink, 2005), contains high levels of antioxidant active compounds such as vitamin C, polyphenols and carotenoids (Tonnimonaro et al., 2012). Tomato is known as the nutritional powerhouse for human being, containing low-calorie (just 18 calories per 100 g), and low in fat contents and have zero cholesterol levels. However, tomato in aquaponic system or in conventional systems sometimes get affected by diseases due to lack of hormones and reduce the production. Salicylic acid (SA) act as a potential non-enzymatic antioxidant as much as plant growth regulator, playing an important role in regulating a number of plant physiological processes (Fariduddin et al., 2003; Raskin, 1992). Aspirin or Acetylsalicylic Acid (ASA) is one of the derivatives of Salicylic acid (SA), is a medicine properties normally used to treat human diseases. It triggers plant’s defenses against disease, protect the plants from fungal, bacterial and viral infections. ASA behaves like a hormone and acts as a growth promoter in plants. Salicylic acid, acetylsalicylic acid or other analogues of SA can function as a plant hormones (Pallag et al., 2014). SA is an important mediator of the plant defense response to pathogens (White, 1979). Exogenously supplied SA was shown to affect a large variety of processes in plants, including stomatal closure, seed
germination, fruit yield and glycolysis (Cutt and Klessing, 1992). The first indication for a physiological effect of SA was the discovery of flower-inducing action and bud formation in tobacco cell cultures (Eberhard et al., 1989). The stimulatory effect of SA on flowering was later demonstrated in other plant species and this was ground for suggesting that SA functions as an endogenous regulator of flowering (Cleland and Ajami, 1974). Singh and Kaur (1981) stated that foliar application of SA (100 ppm) on baby corn increased the plant height, leaf area, crop growth rate and total dry matter production. On the other hand, aquaponics, as a closed loop system consisting of hydroponics and aquaculture elements, is increasingly practiced in many parts of the world (Goddek et al., 2015). It is the perfect engineering of ecology, is the combination of aquaculture (fish or crustaceans) and hydroponic cultivation of plants (hydroponic vegetables, flower, and/or herb) in a re-circulating system, utilizing the nutrients present in the aquaculture effluents to produce plants with commercial value (Gollardo-Colli et al., 2014; Yildiz et al., 2017). Intensive re-circulating aquaponic systems reused relatively small volumes of water by circulating through bio-filters to remove toxic waste products before returning the water to production tanks. The system allowed production of fish much higher than in extensive pond culture with carrying capacity $k g m^{-3}$ and 0.6 $k g m^{-3}$ respectively (Losordo et al., 1998). Therefore, the present experiment was conducted to increase the tomato production, reduce the prevalence of diseases and improve the nutritional quality of tomato by using foliar application of aspirin.

2. Materials and Methods
2.1. Site selection
The experiment was carried out at the aquaponics laboratory of the faculty of Fisheries in the Bangladesh Agricultural University (BAU), Mymensingh. The laboratory was well protected and had good locked door system. Besides, it is a clean and dry place. The experimental set up was in well exposed to sunlight.

2.2. Experimental design
The duration of the experiment was 60 days from 19th March to 18th May, 2018. Among different types of aquaponic system, media based system was selected to conduct the experiment. The experimental design was comprised of nine fish holding tanks, each containing 90 liter of water and nine plastic containers for vegetable growing bed. Those were cut longitudinally 0.5 inch below the upper surface to make it a bed. These containers were randomly allocated as treatments $T_1$, $T_2$ and control. Each treatment and control were have three replications ($R_1$, $R_2$ and $R_3$) and these were denoted as $T_1R_1$, $T_1R_2$, $T_1R_3$, $T_2R_1$, $T_2R_2$, $T_2R_3$, $T_{Con}R_1$, $T_{Con}R_2$, $T_{Con}R_3$ (Figure 1). For oxygenation, an air pump of 18 watt with one air stone was added in each fish tank. The water from the fish tank was irrigated to the tomato bed by a 12 watt submersible pump.

![Figure 1. Experimental layout of aquaponic systems.](image)

2.3. Stocking and rearing the fish
Monosex tilapia fingerlings were bought from the local renowned hatchery. After acclimatization they were stocked in the tank at the density of 10 fingerlings/90 liter tank. A 12 watt submersible water pump was added in each tank to lift up waste water from fish tank to vegetable bed from 9:00 am to 5:00 pm. One aerator along with one air stone was set in each tank to facilitate dissolve oxygen to prevent oxygen deficiency in the tank.
water. The fish was fed with commercial floating feed containing 30% protein twice (10.00 am and 4:00 pm) daily at the rate of 3% body weight.

2.4. Bed preparation for tomato cultivation
Locally available, cheap, good quality plastic container was used as tomato culture bed. Nine plastic container were bought from local market. The size of each container was 0.29m×0.30m×0.21m. Those were cleaned with detergent, rinsed with clean water for 3 to 4 times and sun dried before use. Those were cut longitudinally 0.5 inch below from the upper surface with a sharp knife to make it a bed. One pore was made above 0.5 inch from the bottom of each container to connect outlet pipe with m-seal to facilitate clean water from the tomato bed to the fish tank after filtering. A PVC plastic pipe (length 0.27 m and diameter 0.12 m) was used as siphon in each bed by making pores in it. Plastic containers were set on wooden structure.

2.5. Fish and vegetable sampling
Fish and vegetable were sampled fortnightly. The number of bunches, flowers and fruits were counted and plant height was measured fortnightly during the study period. The ripe tomato was weighed and recorded during harvesting. During each sampling, all fishes were caught from each replication with scoop net and individual length-weight was measured with an electronic compact balance (EK-600i) and wooden fish length measuring scale.

2.6. Fish and vegetable harvesting
After 90 days all the fish were harvested and their growth Performance was measured such as length gain (cm), weight gain (g), percent weight gain, food conversion ratio (FCR), survival rate (%) and fish production (kg/m²). Ripen tomato was harvested and weighed up to the experiment completion. After final harvesting roots were picked up from the beds and washed carefully with tap water. Both the roots and plants were weighed by using electric balance.

2.7. Physico chemical parameter of fish tank water measurement
Physico chemical parameters of tank water were measured to know the suitability of fish culture. Temperature and pH were measured every 7 days interval. Electric conductivity (EC), Carbonate (CO₃), Hydrogen carbonate (HCO₃), Potassium (K), Total nitrogen (N), Sulphur (S) and Sodium (Na) were measured three times interval during experiments. The tests were done in the Humboldt Soil Testing Laboratory, Soil Science department, Bangladesh Agricultural University.

2.8. Data processing and analysis
The collected data were entered in MS Excel 2010 and significant differences between treatments were tested employing ANOVA (one-way analysis of variance) using statistical software SPSS-20 and Duncan’s New Multiple Range Test (DMRT).

3. Results and Discussion
3.1. Plant growth performance
The highest mean leaf number, flower number and bunch number of tomato plant were found 48.5±12.5, 19.00±3.60, 5.33±0.57 in T₁. Whereas the lowest mean leaf number, flower number and bunch number were 34.5±1, 0.76±0.5 and 5±5 recorded in T_con. The highest mean leaf area was 21.61±2.6 cm² in T₁ followed by T₂ (15.83 ±2.69 cm²) and T_con (14.79±0.32 cm²) (Figure 2). These might be due to the presence of aspirin (a derivative of SA) in the treatments that function as an endogenous regulator of flowering (Cleland and Ajami, 1974). According to Singh and Kaur (1981), foliar application of SA (100 ppm) on baby corn increased the plant height, leaf area, crop growth rate and total dry matter production that conform to the present findings. Plant heights were measured fortnightly. The highest mean height of the plant was 286.0±64.00 cm in T₁ at the end of experiment which was higher than the findings of Cole et al. (2016). At the same time the plant height in T₂ was 231.75±36.75 cm whereas, the lowest mean height of the plant was 167.50±23.00 cm in T_con. There was significant difference in mean height of plant among the three treatments on different dates (Figure 3). Total plant weight, Root length and weight were calculated after harvesting on 18th May 2018. The highest mean weight of plant was 178.75±100.23 g in T₁ whereas 147.92±96.17 g was found in T₁ and 136.34±43.18 g in T_con (Table 1). The highest mean length and weight of root 42.50±5.13 cm and 94.47 ±134.49 g was obtained from T₁. In contrast, the length and weight of T₂ and T_con were 39.52±4.87 cm, 12.89±0.40 g and 29.83±8.04 cm, 11.29±4.57 g, respectively. There was no significant difference in mean length and weight among the treatments
The highest fruit numbers were counted 15.33±0.57 in T₁ and the lowest number were found in T₂. Though the fruit numbers were little bit higher in T₁ but the total fruits weight were significantly higher in T₂ than T₁ and Tcon. All these ascertained the positive attributes of aspirin in the treatments although most suitable concentration of aspirin was ambiguous.

Table 1. Growth parameters of plant in different treatments at harvesting date.

<table>
<thead>
<tr>
<th>Sampling date</th>
<th>Parameter</th>
<th>T₁ Mean (±SD)</th>
<th>T₂ Mean (±SD)</th>
<th>Tcon Mean (±SD)</th>
<th>Level of significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>18/5/2018</td>
<td>Plant wt. (g)</td>
<td>147.92±96.17</td>
<td>178.75±100.23</td>
<td>136.34±43.18</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Root length (cm)</td>
<td>42.50±5.1</td>
<td>39.52±4.8</td>
<td>29.83±8.04</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Root wt. (g)</td>
<td>94.47±134.48</td>
<td>12.89±0.40</td>
<td>11.29±4.57</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Fruits number</td>
<td>15.33±0.58</td>
<td>9.0±1.0</td>
<td>9.33±0.58</td>
<td>**</td>
</tr>
<tr>
<td></td>
<td>Total fruits wt. (g)</td>
<td>46.35±6.8</td>
<td>48.6±4.24</td>
<td>37.26±0.86</td>
<td>*</td>
</tr>
</tbody>
</table>

Note: Values are mean ±Standard deviation from triplicate group. T₁= Treatment 1 (60 ppm aspirin), T₂=Treatment 2 (120 ppm aspirin), Tcon=Control (No aspirin). Values in a row having similar letters (s) or without letters do not differ significantly whereas values bearing the dissimilar letter (s) differ significantly as per DMRT (Duncan’s New Multiple Range Test).

** Significant at P≤0.01; * significant at P≤ 0.05; NS non-significant at P˃ 0.05

Figure 2. Mean leaf number, Bunch number, Flower number and leaf area (cm ±SD) of salicylic acid treated (T₁ and T₂) and non-treated (Tcon) tomato plants during experimental period in aquaponic system. Vertical bar of each treatment represents standard deviation (±SD).

Figure 3. Height (cm ±SD) of salicylic acid treated (T₁ and T₂) and non-treated (Tcon) tomato plants at different sampling dates in aquaponic system. Vertical bar of each treatment represents standard deviation (±SD).

3.2. Tomato production
The highest production was 0.44kg/m²/90 days in T₂ where tomato plants were treated with 60ppm aspirin (Figure 4). In the other treatments, these were 0.42kg/m²/90 days (T₁) and 0.34kg/m²/90 days (Tcon). According
to USDA (2019), the proximate composition of tomato was estimated as moisture 94.52%, ash 0.53%, crude fiber 1.2%, crude protein 0.88%, crude fat 0.20% and carbohydrate 3.89%. Amount of protein and crude fiber content were higher but the carbohydrate content was lower than the aforementioned reference. Although, other nutrients’ contents were nearly similar. The highest amount of lipid and fiber were found 0.87±0.01% and 3.20±0.1% in T\textsubscript{1}. The highest moisture content was 94.35±1.0% in T\textsubscript{2} and the highest mean protein, ash and carbohydrate were 1.25± 0.01%, 0.567±0.001% and 1.09±0.001% in T\textsubscript{con} (Table 2). Therefore, the use of aspirin increased the moisture content but decreased the nutritional value of experimental tomato.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Protein Mean ±SD</th>
<th>Lipid Mean ±SD</th>
<th>Ash Mean ±SD</th>
<th>Crude fiber Mean ±SD</th>
<th>NFE Mean ±SD</th>
<th>Moisture Mean ±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>T\textsubscript{1}</td>
<td>0.99±0.001\textsuperscript{c}</td>
<td>0.87±0.01\textsuperscript{a}</td>
<td>0.517±0.001\textsuperscript{a}</td>
<td>3.20±0.1\textsuperscript{a}</td>
<td>0.16±0.001\textsuperscript{b}</td>
<td>94.24±0.99</td>
</tr>
<tr>
<td>T\textsubscript{2}</td>
<td>1.05±0.01\textsuperscript{b}</td>
<td>0.84±0.01\textsuperscript{b}</td>
<td>0.511±0.001\textsuperscript{c}</td>
<td>2.94±0.01\textsuperscript{b}</td>
<td>0.308±0.001\textsuperscript{a}</td>
<td>94.35±1.0</td>
</tr>
<tr>
<td>T\textsubscript{con}</td>
<td>1.25± 0.01\textsuperscript{a}</td>
<td>0.76±0.01\textsuperscript{c}</td>
<td>0.567±0.001\textsuperscript{a}</td>
<td>2.60±0.1\textsuperscript{c}</td>
<td>1.09±0.001\textsuperscript{c}</td>
<td>93.72±0.99</td>
</tr>
</tbody>
</table>

** Level of significance

Note: Values are given with (±Standard deviation). T\textsubscript{1}= Treatment 1 (60 ppm aspirin), T\textsubscript{2}=Treatment 2 (120 ppm aspirin), T\textsubscript{con}=Control (No aspirin). Values in a column having similar letters (s) or without letters do not differ significantly whereas values bearing the dissimilar letter (s) differ significantly as per DMRT (Duncan’s New Multiple Range Test).

** Significant at P≤ 0.01; * significant at P≤ 0.05; NS non-significant at P˃ 0.01

Figure 4. Total production of tomato (kg/m\textsuperscript{2}/60 days) from aspirin treated (T\textsubscript{1} and T\textsubscript{2}) and non-treated (T\textsubscript{con}) tomato plants after final harvesting. Vertical bar of each treatment represents standard deviation (±SD).

3.3. Plant health

Leaf miners, blossom-end rot, cracking diseases and cutworms were found in T\textsubscript{1}, T\textsubscript{2} and T\textsubscript{con}. In addition TMV (Tobacco Mosaic Virus) and bacterial spot diseases were also found in T\textsubscript{con}. According to Fuentes \textit{et al.} (2016) symptoms of leaf miners producing pest are shown in a specific way on the leaf surface. The damage is visualize as a tubular leaf puncture or a fan-shaped leaf puncture with irregular mines. Several leaf miners can be found even in the same leaf or plant. Blossom-end rot disease occur due to calcium deficiency. Tomato cracking diseases may occur due to excessive moisture, fluctuations in temperature, and an overabundance of nitrogen. According to Vlot \textit{et al.} (2009) the plant hormone SA plays a major role in disease resistance signaling. Glazebrook (2005) reported that the SA response pathway is typically (but not exclusively) effective against microbial biotrophic pathogens. In previous experiment it is found that SAs ability to induce acquired resistance is not restricted to tobacco and TMV, but is effective in many plants against various necrotizing and systemic viral, fungal, and bacterial pathogens. However, it should be noted that not all plant-pathogen systems respond to SA (Pennazio \textit{et al.}, 1985; Roggero and Pennazio, 1988). SA also induces various PR proteins in a broad range of both dicotyledonous and monocotyledonous plants including tomato (White \textit{et al.}, 1987), potato (White \textit{et al.}, 1983), bean (Hooft \textit{et al.}, 1986). Losanka \textit{et al.} (1997) reported that salicylic acid (SA) influence on different physiological processes. It has role on plant growth and development, flowering, ion uptake,
stomatal regulation and photosynthesis. SA also act as a natural inducer of thermogenesis and disease resistance in plants.

3.4. Fish growth performance

Tilapia was reared for 90 days from 19th March to 18th May. The initial mean length of the fish were 13.62±0.05, 12.03±0.20 and 12.8±1.46 cm which were increased to 16.56 ±0.001, and 15.51±3.6 and 15.93±1.08cm in T1, T2 and Tcon respectively and the mean initial weight were 53.16±2.05, 34.34±2.69 and 41.05±1.46g that increased to 83.27±1.24, 65.35±5.0 and 76.56±3.27g in T1, T2 and Tcon respectively. After a certain stage, tilapia length gain was slower compared to the weight increment (Figure 5). There was no significant difference among fish length and weight in different sampling dates. That might be due to small experimental unit. The length and weight gain, percent length gain, percent weight gain and Specific growth rate (%/day) were lower but the survival rates were higher than the previous observation (Zahan et al., 2018). The FCR for tilapia in the present experiment was bit higher 3.05, 3.38 and 3.19 in T1, T2 and Tcon respectively than the findings of Rahmatullah et al. (2010) and Quagrainie et al. (2011) which were 2.69 and 3.1, respectively. The productions of tilapia were 0.42, 0.34 and 0.49 kg/m²/90 days in T1, T2 and Tcon respectively. There was no significant difference among the treatments (Table 3) although the productions were comparatively lower, which might be attributed to high stocking density. Notably, there was no impact of aspirin on fish growth. As before spraying aspirin to the tomato leaves water pumps were kept stopped, tomato beds were covered with polythene bags so that the aspirin solution could not mix to the water of fish tank.

Table 3. Growth performances of tilapia observed in different treatments during the study period.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>T1</th>
<th>T2</th>
<th>Tcon</th>
<th>Level of significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Initial Length (cm)</td>
<td>13.62±0.05</td>
<td>12.03±0.20</td>
<td>12.8±1.46</td>
<td>NS</td>
</tr>
<tr>
<td>Mean Final Length (cm)</td>
<td>16.56±0.001</td>
<td>15.51±3.6</td>
<td>15.93±1.08</td>
<td>NS</td>
</tr>
<tr>
<td>Mean Length Gain (cm)</td>
<td>2.94±0.05</td>
<td>3.48±0.56</td>
<td>3.12±1.18</td>
<td>NS</td>
</tr>
<tr>
<td>Percent Length Gain (%)</td>
<td>21.56±0.45</td>
<td>28.98±5.112</td>
<td>25.18±12.22</td>
<td>NS</td>
</tr>
<tr>
<td>Mean Initial Weight (g)</td>
<td>53.16±2.05</td>
<td>34.34±2.69b</td>
<td>41.05±1.46b</td>
<td>*</td>
</tr>
<tr>
<td>Mean Final Weight (g)</td>
<td>83.27±1.24a</td>
<td>65.35±5.00b</td>
<td>76.56±3.27a</td>
<td>**</td>
</tr>
<tr>
<td>Mean Weight Gain (g)</td>
<td>30.11±0.88</td>
<td>31.02±7.69</td>
<td>35.50±9.88</td>
<td>NS</td>
</tr>
<tr>
<td>Percent Weight Gain (%)</td>
<td>56.74±3.73</td>
<td>91.89±29.61</td>
<td>95.85±53.65</td>
<td>NS</td>
</tr>
<tr>
<td>Specific growth rate (%)</td>
<td>0.749±0.04</td>
<td>1.0729±0.26</td>
<td>1.08±0.44</td>
<td>NS</td>
</tr>
<tr>
<td>Survival Rate (%)</td>
<td>70%</td>
<td>85%</td>
<td>50%</td>
<td>-</td>
</tr>
<tr>
<td>Feed Conversion Ratio</td>
<td>3.05</td>
<td>3.38</td>
<td>3.19</td>
<td>-</td>
</tr>
<tr>
<td>Production (kg/m²/60 days)</td>
<td>0.42</td>
<td>0.34</td>
<td>0.49</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: Values are given with ±Standard deviation. T1= Treatment T1 (60 ppm aspirin), T2=Treatment T2 (120 ppm aspirin), Tcon=Control (No aspirin). Values in a row having similar letters (s) or without letters do not differ significantly whereas values bearing the dissimilar letter (s) differ significantly (P<0.05) as per DMRT.

** Significant at P≤ 0.01; * significant at P≤ 0.05; NS non-significant at P> 0.01
3.5. Water quality parameters

The water quality parameters of the fish tanks were within the suitable range for aquaculture. As observed, the mean temperatures and pH values in fish tank water were (26.1±0.75)ºC and 6.92±0.13;(26.5±0.83)ºC and 7.1±0.18; and (25.9±0.75)ºC and 7.0±0.18; and (25.9±0.75)ºC and 7.1±0.01 in T₁, T₂ and T_con respectively that was suitable for tilapia and tomato. In aquaponic system optimum temperature and pH for tilapia ranges from 28-32ºC and 6.0-8.5 respectively and for nitrifying bacteria ranges from 25-30ºC and 7.0-8.0, respectively (Tyson and Simonne, 2014). The reported mean dissolved oxygen content (DO) of the tank water over the study period were 7.97±0.7, 7.91±0.91 and 7.92±0.7 in T₁, T₂ and T_con respectively (Figure 6). The highest electric conductivity (EC), hydrogen carbonate (HCO₃⁻) and total Nitrogen (N) were counted at 1388.5 ±26.27μs/cm, 292.8±45.78 and 11.45±1.76mg/l, respectively in T₁ and the highest phosphorus (P), Sulphur (S) and Sodium (Na) were found at 11.22 ±1.32, 7.68±0.52 and 163.88 ±8.6mg/l, respectively in T₂ at the end of the experiment (Table 4). The highest carbonate (CO₃⁻) value was 24.0±13.86mg/l in T₁ at the middle of the study which was totally absent in the source water. The highest potassium (K) value was 13.12±2.33mg/l in T_con at the end of the experiment (Table 4). There was no impact of aspirin on water quality parameter also.

Table 4. The water quality parameters of lab test results in different treatments during the experimental period.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Initial data</th>
<th>17/4/18</th>
<th>18/5/18</th>
<th>17/4/18</th>
<th>18/5/18</th>
<th>17/4/18</th>
<th>18/5/18</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC (µs/cm)</td>
<td>747</td>
<td>999.0±8.08</td>
<td>1388.5±26.27</td>
<td>990.0±8.37</td>
<td>1352.0±72.75</td>
<td>972.5±9.53</td>
<td>1331.0±36.95</td>
</tr>
<tr>
<td>CO₂ (mg/l)</td>
<td>0</td>
<td>24.0±13.86</td>
<td>0.00±0.00b</td>
<td>33.0±5.19</td>
<td>0.00±0.00b</td>
<td>30.0±3.46</td>
<td>9.00±3.0a</td>
</tr>
<tr>
<td>HCO₃⁻ (mg/l)</td>
<td>286.7</td>
<td>207.40±14.09</td>
<td>292.8±45.78</td>
<td>231.80±10.56</td>
<td>265.55±8.80</td>
<td>209.60±0.00</td>
<td>240.95±12.33</td>
</tr>
<tr>
<td>Total N (mg/l)</td>
<td>2.8</td>
<td>2.1±0.40</td>
<td>11.45±1.76c</td>
<td>0.7±0.40</td>
<td>6.3±0.40b</td>
<td>2.1±0.40</td>
<td>6.3±0.40b</td>
</tr>
<tr>
<td>P (mg/l)</td>
<td>0.294</td>
<td>3.89±0.49b</td>
<td>10.98±0.18</td>
<td>4.87±0.26a</td>
<td>11.22±1.32</td>
<td>4.18±0.28ab</td>
<td>9.05±0.31</td>
</tr>
<tr>
<td>K (mg/l)</td>
<td>1.21</td>
<td>1.31±0.05</td>
<td>5.55±0.40</td>
<td>2.21±0.46</td>
<td>12.51±3.85</td>
<td>3.62±0.23</td>
<td>13.12±2.33</td>
</tr>
<tr>
<td>S (mg/l)</td>
<td>3.47</td>
<td>5.77±0.60</td>
<td>6.82±0.15</td>
<td>5.74±0.36</td>
<td>7.68±0.52</td>
<td>5.21±0.22</td>
<td>6.56±0.13</td>
</tr>
<tr>
<td>Na (mg/l)</td>
<td>109.25</td>
<td>94.35±2.87a</td>
<td>99.32±11.47b</td>
<td>114.21±2.87b</td>
<td>163.88±8.6c</td>
<td>114.21±2.87b</td>
<td>124.15±14.34ab</td>
</tr>
</tbody>
</table>

Note: Values are given with (±Standard error). T₁= Treatment 1 (60 ppm aspirin), T₂=Treatment 2 (120 ppm aspirin), T_con=Control (No aspirin). Values in a column having similar letters (s) or without letters do not differ significantly whereas values bearing the dissimilar letter (s) differ significantly (P<0.05) as per DMRT.
Figure 6. Mean values of temperature, DO and pH in different treatments during the study period. Vertical bar of each treatment represents standard deviation (±SD).

4. Conclusions

The present study was conducted with a view to find out a feasible way of producing organic vegetable (tomato) using foliar spray of aspirin from aquaponic system. Firstly it was observed that plant growth and tomato production were higher in T$_2$ (120 ppm aspirin) than T$_1$ (60 ppm aspirin) and T$_{con}$ (Control). Secondly, higher aspirin level (120 ppm) in foliar spray reduced the prevalence of disease in tomato plants. This indicates that aspirin has positive impact on tomato production in aquaponic system. Therefore, further research is needed to verify and optimize the aspirin doses at the user level to get representative results.

Conflict of interest

None to declare.

References


Cole JC, MW Smith, CJ Penn, BS Cheary and KJ Conaghan, 2016. Nitrogen, phosphorus, calcium, and magnesium applied individually or as a slow release or controlled release fertilizer increase growth and yield and affect macronutrient and micronutrient concentration and content of field-grown tomato plants. Scientia. Hort., 211:420-430.


