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Fruit Set and Development in Potted Tomato, Lycopersicon Lycopersicum (L.) Karsten, Treated with Gibberellic Acid (Ga_3)

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Abstract

The study was conducted to determine the most effective concentration of Gibberellic Acid (GA_3) that promotes fruit setting and fruit development as well as the flower development that is most responsive to GA_3 The cost and benefit analysis of the treatments was also done. Seven concentrations (O, 5, 10, 20, 40, 80, and 160 ppm) were sprayed to the flower clusters during pre-anthesis and post-anthesis. The study was laid in a 2x7 factorial experiment replicated three times, each with five hills per replicate. Fruit setting was highest in tomato plants sprayed with 10 ppm GA_3 during post-anthesis. Applying five ppm GA_3 during pre-anthesis or post-anthesis significantly improved tomato production among other treatments based on yield and return on investment (ROI) The cost and benefit analysis showed that applying GA_3 was not costly and gave more than 200 % ROI in treated tomatoes.

Keywords: fruit setting, fruit development, treatments

Introduction

Vegetable production is limited by genetic and environmental factors. Soil being a heterogeneous environmental factor provides a suitable or unsuitable environment for the crop with respect to nutrient availability and thereby affecting its growth and development.

Tomato (Lycopersicon lycopersicum (L.) Karsten, a vegetable known for its red berry-like fruits, is a part of our daily diet. It is often prepared as salad, spice for common dishes and sauce for pasta and pizza. Tomato is one of the most important vegetables in the world particularly that of the low-income group. Since 1989, the supply of tomato is increasing but because of continuous growing population, there is still shortage of it. (Malena, 1994).

Marginal soil is a common problem especially along coastal areas and even in lowlands that are experiencing severe erosion problems. Ideally, tomato requires a relatively cool, dry climate for high yield and premium quality harvest. However; it is adapted to a wide range of climatic conditions (Siemansma and Piluke, 1994).

Fruit development is a result of favorable environmental factors such as low temperature that promotes fruit setting. Temperature dictates the productivity of most vegetables such as tomato, which flowers are very sensitive to extremities in day and night temperature.

GA3 is a naturally occurring plant growth regulator which causes a variety of effects. This hormone was first discovered in Japan by Kurosawa (1926) while studying "Bakanae," a rice disease caused by the fungus, Gibberela fujikoroi. It is from this fungus which GA3 was extracted, purified, and eventually commercialized. GA3 can also be found in seeds of many species.

One of the striking effects of gibberellin in plants is in flowering and fruit development. Rath and Rajput (1993) noted that increased application rate of gibberellin increased flowering. Fruit setting and fruit development were also improved in grapes after application of GA3 at full bloom (Griggs and Iwakiri, 1961).

Sustainable agriculture is a concept and practice that could provide sufficient food to a population over a long period of time. Hence, technique to augment, not only crop productivity but also areas with unfavorable soil, temperature and rainfall, is necessary if food sufficiency is to be attained.

Hence, this study was conducted to evaluate the effects of the different levels of GA3 applied before and after anthesis or flower opening, on the yield of potted tomatoes. The profitability of the treatments was also determined.

Materials and Methods

The study was conducted at the DOSCST main campus in Mati, Davao Oriental.

Good quality seeds of tomato variety Improved Pope were sown in a seed box with sterilized soil media having 1:1:1 sand, garden soil and compost ratio. Seedlings were grown under shade condition and sufficient moisture was maintained to avoid stress. Ten days before transplanting, the seedlings were hardened by gradually reducing the amount and frequency of watering and by exposing them to full sunlight. This was done to ensure transplant survival by acclimatizing them to actual field conditions. At four weeks old, seedlings were transplanted late in the afternoon to minimize stress and provide transplants longer time to recover during the night.

Fertigation was done using starter solution with the rate of 1tbsp. per 4 liters

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water just before transplanting.

The growing media of garden soil were set to half of empty cement sacks two weeks before transplanting. Added to the soil were 0.25 kg chicken dung and 2 tbsp. muriate of potash (0-0-60) per sack.

The study was laid out in a 2 X 7 factorial experiment replicated three times. There were 5 hills per replication having a total experimental population of two hundred ten tomato plants.

Basal application of fertilizer was done at transplanting using Urea (46-0-0) at the rate of 2 tbsp. per hill. Side dressing was done in 3 split applications using 2 parts of urea and one part muriate of potash on the following schedule:

2 weeks after transplanting 1 tbsp
1 month after transplanting 1 tbsp
2 months after transplanting 1 tbsp

Foliar fertilization was done twice during flowering stage with 10 days interval using complete fertilizer (19-19-19) at the rate of five tbsp per 16 liters spray tank load.

Uniform amount of irrigation was applied daily except during rainy days. The amount and frequency were increased as the crop reached the reproductive stage.

Kakawate posts and nylon twine were used as trellis to support the growing plant from lodging. A post was erected on each end of a row with nylon twine tied between ends as a horizontal trellis. Then nylon twine was tied on each branch to the vertical trellis to support the tomato plant. This was started four weeks after transplanting and continued as the plant developed more branches and fruits.

Periodic ocular inspection was done to detect pest incidence. Dithane was used to control fungal diseases at the rate of 2 tbsp per 16-liter spray tank load. Lamdacyhalotrin was used to control aphids and hoppers at the rate of 3 tbsp per 16 liters of water.

Data were taken from three clusters per hills per treatment per replication. Number of fruits aborted was obtained by computing the difference between number of fruits set and the number of fruits developed Means of different treatments were subjected to analysis of variance (ANOVA) using Duncan's New Multiple Range Test (DNMRT), 5% level of significance. Mean yield was based on the average weight of harvested fruits taken from the first 3 clusters developed per plant. Tomato juice from different treatments was extracted and blended, Total soluble solids were determined using a digital refractometer. Potential yield was computed based on the average weight of fruit per cluster and the average number of clusters per treatment per plant. Average number of clusters was limited to the number of clusters developed at time of data gathering at approximately three weeks from first harvest.

Because the available GA_3 was only 90%, a corrected value was first derived to come up with 100% purity as follows:

$$90\%\ X = 100\%$$

$$X = \frac{100\%}{90\%}$$

$$X = 1.11$$

Thus, to express in parts per million (ppm) concentration a 1.11 mg GA_3 was added to a liter of water.

Concentrations were prepared using the following formula:

5 ppm = 5 x1.11mg GA_3 in 1 liter water
10 ppm = 10 x1.11mg GA_3 in 1 liter water
20 ppm = 20 x1.11mg GA_3 in 1 liter water
40 ppm = 40 x1.11mg GA_3 in 1 liter water
80 ppm = 80 x1.11mg GA_3 in 1 liter water
160 ppm = 160x1.11mg GA_3 in 1 liter water

Table 1. Treatment combinations

Factor A Stage of Flower Development	Factor B GA_3 Concentration
Pre Anthesis (A_1)	T_1 0 ppm
	T_2 5 ppm
	T_3 10 ppm
	T_4 20 ppm
	T_5 40 ppm
	T_6 80 ppm
	T_7 160 ppm
Post Anthesis (A_2)	T_1 0 ppm
	T_2 5 ppm
	T_3 10 ppm
	T_4 20 ppm
	T_5 40 ppm
	T_6 80 ppm
	T_7 160 ppm

Two liters of solution were prepared for every treatment. Spraying was done late in the afternoon using an atomizer at the rate of 2 sprays per flower cluster done at different flowering stages. The treatment combinations are as follows:

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	T_4 20 ppm
	T_5 40 ppm
	T_6 80 ppm
	T_7 160 ppm

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Harvesting

Harvesting was done at green stage or more or less 90 days after planting, Subsequent harvesting was done every three days.

Results and Discussion

GA_3 on Flowering

Flowering tomato plants exhibited variability in their number of produced flowers (Table 2). The mean number of flowers per cluster ranged from 5.26 to

6.55, whereA_2T_4 is having the lowest and A_2T_4, having the highest.

Table 2. Mean number of flowers of tomato plants treated with GA_3 during pre and post antheses.

	Treatment	R_1	R_2	R_3	Mean*
Pre Anthesis (A_1)	T_1 0 ppm	6.26	6.80	6.13	6.40 ab
	T_2 5 ppm	6.00	6.13	5.60	5.91 abc
	T_3 10 ppm	7.20	6.33	5.46	6.33 ab
	T_4 20 ppm	5.66	6.33	5.66	5.88 abcd
	T_5 40 ppm	6.26	5.66	6.33	6.08 abc
	T_6 80 ppm	5.73	5.06	6.26	5.6 bcd
	T_7 160 ppm	5.73	5.73	6.26	5.91 abcd
Post Anthesis (A_2)	T_1 0 ppm	5.73	6.00	6.00	5.91 abcd
	T_2 5 ppm	6.26	5.53	5.53	5.77 bcd
	T_3 10 ppm	6.86	6.40	6.40	6.55 a
	T_4 20 ppm	5.33	5.20	5.26	5.26 d
	T_5 40 ppm	5.40	5.53	6.26	5.73 bcd
	T_6 80 ppm	5.33	7.00	5.90	6.08 abc
	T_7 160 ppm	5.73	5.73	5.33	5.60 cd

*Means with same letters do not differ significantly at 5% level of significance DMRT.

GA3 on Flower Abscission

Flower abscission refers to the separation of flowers from the mother plant. In tomato, this phenomenon is highly affected by the atmospheric temperature. High incidence of flower abortion can be observed at higher temperature.

Lowest incidence of flower abscission was observed in tomato treated with 5 ppm of GA applied at post anthesis followed by those treated with 5ppm applied during pre-anthesis with means of 0.04 and 0.08 respectively (Table 3). However, these plants did not differ significantly from those that were treated with 20 ppm to 160 ppm applied either in the post anthesis. Highest flower abscission was observed in untreated plants during pre-anthesis.

Table 3. Mean number of flower abscission of tomato plants treated with GA_3 during pre- and post-antheses.

	Treatment	R_1	R_2	R_3	Mean*
Pre Anthesis (A_1)	T_1 0 ppm	1.20	1.73	1.93	1.62 a
	T_2 5 ppm	0.02	0.00	0.60	0.08 b
	T_3 10 ppm	0.73	0.53	0.33	0.53 c
	T_4 20 ppm	0.13	0.20	0.20	0.18 cd
	T_5 40 ppm	0.00	0.20	0.20	0.13 d
	T_6 80 ppm	0.20	0.20	0.20	0.20 d
	T_7 160 ppm	0.13	0.13	0.66	0.31 cd
Post Anthesis (A_2)	T_1 0 ppm	1.13	0.86	0.66	0.88 b
	T_2 5 ppm	0.60	0.06	0.00	0.04 d
	T_3 10 ppm	0.40	0.26	0.33	0.33 cd
	T_4 20 ppm	0.26	0.33	0.00	0.20 cd
	T_5 40 ppm	0.33	0.06	0.13	0.17 cd
	T_6 80 ppm	0.20	0.20	0.13	0.18 cd
	T_7 160 ppm	0.13	0.46	0.33	0.31 cd

*Means with same letters do not differ significantly at 5% level of significance DMRT

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On Fruit Set

Marked differences were observed between the control and A_2T_4 and the other treatments (Table 4). The said control A_2T_4 was the lowest among the experimental plants, because of the significant number of flowers abscised in these plants as shown in Table 3. Highest average fruit set of 6.22 was obtained by the treatment using 10 ppm applied at post anthesis (A_2T_3). However, this treatment did not vary significantly from other treatments except in A_1T_1, A_2T_1 and A_2T_4.

On Fruit Abortion

The lowest incidence of fruit abortion was in plants treated with 5 ppm and 40 ppm GA_3 both at post-anthesis (Table 5). Untreated plants at pre- and post-anthesis obtained the highest number of fruits aborted. These results suggest that GA_3 application significantly enhanced fruit development in tomato by decreasing the incidence of fruit abortion.

On Fruit Development

Number of developed fruits was least in plants that were not treated with GA_3. This could be due to the significant number of aborted flowers in these plants (Table 3). Highest number of fruits developed was observed in plants treated with 40 ppm applied during pre-anthesis (A_1T_5) and in plants treated with 1 0 ppm at post-anthesis (A_2T_3). However, these two treatments did not vary significantly from other treatments except in A_2T_4, A_2T_1 and A_1T_1 (Table 6). The number of fruits developed was inversely related to the number of fruits aborted.

On Marketable Fruits

Lowest number of marketable fruits was obtained from plants that were not treated with GA, both at pre- and post-anthesis (A_1T_1 and A_2T_1). High number of marketable fruits was obtained in plants treated with 5 ppm GA_3 applied during post-anthesis (A_2T_2) followed by plants treated with 80 ppm at post-anthesis (Table 7).

Table 4. Mean number of set-fruit of tomato plants treated with GA_3 during pre- and post-antheses.

	Treatment	R_1	R_2	R_3	Mean*
Pre Anthesis (A_1)	T_1 0 ppm	5.20	5.06	4.20	4.82^{d}
	T_2 5 ppm	5.80	6.13	5.53	5.82^{ab}
	T_3 10 ppm	6.46	5.80	5.13	5.80^{ab}
	T_4 20 ppm	5.53	6.13	5.46	5.71^{abc}
	T_5 40 ppm	6.26	5.46	6.13	5.95^{ab}
	T_6 80 ppm	5.53	4.86	6.06	5.48^{abc}
	T_7 160 ppm	5.60	5.66	5.60	5.62^{abc}
Post Anthesis (A_2)	T_1 0 ppm	4.60	5.13	5.33	5.02^{cd}
	T_2 5 ppm	6.20	5.46	5.53	5.73^{abc}
	T_3 10 ppm	6.46	6.13	6.06	6.22^{a}
	T_4 20 ppm	5.06	4.86	5.26	5.06^{cd}
	T_5 40 ppm	5.33	5.46	6.13	5.64^{abc}
	T_6 80 ppm	5.13	5.73	5.80	5.55^{ab}
	T_7 160 ppm	5.60	5.26	5.00	5.29^{bcd}

*Means with same letters do not differ significantly at 5% level of significance, DMRT.

Table 5. Mean number of aborted fruit of tomato plants treated with GA_3 during pre-and post-antheses.

	Treatment	R_1	R_2	R_3	Mean*
Pre Anthesis (A_1)	T_1 0 ppm	1.20	0.93	0.74	0.95[a]
	T_2 5 ppm	0.47	0.47	0.27	0.40[bc]
	T_3 10 ppm	0.40	0.27	0.20	0.29[c]
	T_4 20 ppm	0.93	0.20	0.46	0.53[bc]
	T_5 40 ppm	0.33	0.26	0.13	0.24[c]
	T_6 80 ppm	0.40	0.20	0.33	0.31[bc]
	T_7 160 ppm	0.40	0.26	0.27	0.31[bc]
Post Anthesis (A_2)	T_1 0 ppm	0.27	0.67	1.20	0.71[ab]
	T_2 5 ppm	0.20	0.06	0.27	0.18[c]
	T_3 10 ppm	0.53	0.67	0.33	0.51[bc]
	T_4 20 ppm	0.26	0.06	0.66	0.32[bc]
	T_5 40 ppm	0.20	0.13	0.22	0.18[c]
	T_6 80 ppm	0.27	0.40	0.07	0.27[c]
	T_7 160 ppm	0.34	0.26	0.14	0.24[c]

*Means with same letters do not differ significantly at 5% level of significance DMRT.

Table 6. Mean number of developed fruits of tomato plants treated with GA_3 during pre- and post-antheses.

	Treatment	R_1	R_2	R_3	Mean*
Pre Anthesis (A_1)	T_1 0 ppm	4.00	4.13	3.46	3.86[e]
	T_2 5 ppm	5.33	5.66	5.26	5.42[ab]
	T_3 10 ppm	6.06	5.53	4.93	5.51[ab]
	T_4 20 ppm	4.6	5.93	5.00	5.18[abc]
	T_5 40 ppm	5.93	5.20	6.00	5.71[a]
	T_6 80 ppm	5.13	4.66	5.93	5.17[abc]
	T_7 160 ppm	5.13	5.40	5.33	5.28[abc]
Post Anthesis (A_2)	T_1 0 ppm	4.33	4.46	4.13	4.31[de]
	T_2 5 ppm	6.00	5.40	5.26	5.55[ab]
	T_3 10 ppm	5.93	5.46	5.73	5.71[a]
	T_4 20 ppm	4.80	5.80	4.66	4.75[cd]
	T_5 40 ppm	5.13	5.33	5.93	5.46[ab]
	T_6 80 ppm	4.86	6.40	5.73	5.66[ab]
	T_7 160 ppm	5.26	5.00	4.86	5.04[bc]

*Means with same letters do not differ significantly at 5% level of significance, DMRT.

Table 7. Mean number of marketable fruits of tomato plants treated with GA_3 during pre- and post-antheses.

	Treatment	R_1	R_2	R_3	Mean*
Pre Anthesis (A_1)	T_1 0 ppm	2.93	3.20	2.93	3.02[g]
	T_2 5 ppm	4.40	4.46	4.13	4.33[bcdef]
	T_3 10 ppm	4.20	4.40	4.13	4.24[cdef]
	T_4 20 ppm	3.40	4.73	4.33	4.15[def]
	T_5 40 ppm	4.60	4.53	4.93	4.69[abcde]
	T_6 80 ppm	4.66	4.06	4.66	4.46[cdef]
	T_7 160 ppm	4.46	4.66	4.40	4.51[cdef]
Post Anthesis (A_2)	T_1 0 ppm	3.13	3.06	3.06	3.08[g]
	T_2 5 ppm	5.66	5.13	5.06	5.28[a]
	T_3 10 ppm	5.06	4.40	5.13	4.86[abc]
	T_4 20 ppm	3.80	4.13	3.93	3.95[f]
	T_5 40 ppm	3.90	4.80	5.40	4.71[abcd]
	T_6 80 ppm	4.40	5.40	5.06	4.95[ab]
	T_7 160 ppm	4.13	4.00	4.06	4.06[e]

*Means with same letters do not differ significantly at 5% level of significance, DMRT.

On Weight per 10 tomato fruits

The mean weight often pieces sample fruits from the various treatments did not differ significantly. The different concentrations effected a mean yield ranging from 217g to almost 300g for every ten fruits (Table 8).

On Yield

GA_3 applied as floral spray significantly increased yield (Table 9). Highest fruit yield of 408 g from the first three clusters was obtained from plants treated with 5 ppm applied during post anthesis (A_2T_2). This was remarkably higher by about 218.67 g more than the control, which weighed only 189.33 g (API). However, the yield of plants applied with GA_3 at 80 ppm both during pre- and post-anthesis (A_1T_6 and A_2T_6) did not differ significantly with those applied with 5 ppm GA_3 (A_1T_2 and A_2T_2) both during pre- and post-anthesis. But the yield differs significantly between plants with applied with GA_3 at 20 ppm and 180 ppm including the control (A_1T_1 and A_2T_1) both pre and post anthesis.

Table 8. Mean Weight (g) of 10 pieces of tomato fruits from plants treated with GA_3 during pre- and post-antheses.

	Treatment	R_1	R_2	R_3	Mean*
Pre Anthesis (A_1)	T_1 0 ppm	282.00	246.20	188.30	217.50 ^{a}
	T_2 5 ppm	248.25	299.80	310.45	286.17 ^{a}
	T_3 10 ppm	249.30	181.80	249.80	226.97 ^{a}
	T_4 20 ppm	229.60	257.00	172.90	219.83 ^{a}
	T_5 40 ppm	263.45	299.30	176.20	246.32 ^{a}
	T_6 80 ppm	212.15	288.10	282.80	261.02 ^{a}
	T_7 160 ppm	233.50	215.27	216.60	221.79 ^{a}
Post Anthesis (A_2)	T_1 0 ppm	192.65	285.65	178.25	218.85 ^{a}
	T_2 5 ppm	299.65	321.45	276.48	299.19 ^{a}
	T_3 10 ppm	211.88	281.11	313.14	268.71 ^{a}
	T_4 20 ppm	216.22	315.00	263.00	264.74 ^{a}
	T_5 40 ppm	311.26	226.00	196.55	244.60 ^{a}
	T_6 80 ppm	252.00	302.85	189.70	248.18 ^{a}
	T_7 160 ppm	175.34	261.40	295.22	243.99 ^{a}

*Means with same letters do not differ significantly at 5% level of significance, DMRT.

Table 9. Mean fruit yield of tomato plants applied with GA_3 during pre- and post-antheses.

	Treatment	R_1	R_2	R_3	Mean*
Pre Anthesis (A_1)	T_1 0 ppm	160	162	139	153.66 ^{f}
	T_2 5 ppm	292	291	272	285.00 ^{bc}
	T_3 10 ppm	275	291	273	279.66 ^{bc}
	T_4 20 ppm	200	279	250	243.00 ^{cd}
	T_5 40 ppm	251	253	282	262.00 ^{bc}
	T_6 80 ppm	269	237	269	258.33 ^{bcd}
	T_7 160 ppm	256	249	251	238.66 ^{cd}
Post Anthesis (A_2)	T_1 0 ppm	212	174	182	171.74 ^{ef}
	T_2 5 ppm	416	416	392	408.00 ^{a}
	T_3 10 ppm	300	265	292	285.66 ^{bc}
	T_4 20 ppm	238	261	249	249.33 ^{cd}
	T_5 40 ppm	251	297	304	283.00 ^{bc}
	T_6 80 ppm	274	329	306	303.00 ^{b}
	T_7 160 ppm	209	202	201	210.66 ^{de}

*Means with same letters do not differ significantly at 5% level of significance, DMRT.

Table 10. Mean fruit diameter (mm) of tomato plants applied with GA_3 during pre- and post-antheses.

	Treatment	R_1	R_2	R_3	Mean*
Pre Anthesis (A_1)	T_1 0 ppm	29.86	30.22	29.30	30.50^c
	T_2 5 ppm	31.36	32.21	32.20	32.44^b
	T_3 10 ppm	31.48	31.83	30.29	31.28^{bc}
	T_4 20 ppm	31.95	29.80	29.43	30.65^{bc}
	T_5 40 ppm	30.12	30.56	31.68	30.94^{bc}
	T_6 80 ppm	29.78	31.55	31.22	30.778^{bc}
	T_7 160 ppm	30.38	30.96	30.13	30.54^c
Post Anthesis (A_2)	T_1 0 ppm	31.78	31.56	31.53	31.46^{bc}
	T_2 5 ppm	36.36	35.52	35.13	35.73^a
	T_3 10 ppm	31.52	32.16	32.42	32.73^{bc}
	T_4 20 ppm	32.35	33.48	31.45	32.48^b
	T_5 40 ppm	31.08	33.05	31.18	31.70^{bc}
	T_6 80 ppm	31.53	28.48	32.20	30.86^{bc}
	T_7 160 ppm	30.85	30.05	29.42	30.20^c

*Means with some letters do not differ significantly at 5% level of significance, DMRT.

Parthenocarpy

Parthenocarpic (seedless) fruits were observed in some treatments except in control. Some fruits were observed to have underdeveloped seeds at maturity. Generally, it was observed that most of the sample fruits coming from treatments applied with high levels of GA_3 concentrations ranging from 40 to 160 ppm were seedless or had underdeveloped seeds.

Same observations were observed in studies conducted using GA_3 induced parthenocarpy in emasculated clusters of both seedless and seeded varieties of grapes, although the final berry size was smaller than that of open-pollinated clusters (Weaver and Sachs, 1968). Thompson (1967) also successfully induced parthenocarpic development in strawberry varieties using GA_3.

Cost and Benefit Analysis

Tomatoes treated with GA_3 at pre anthesis gave higher average net income of P98.03 than those under post anthesis with an average net income of P92.48. Average ROI was 422.99% and 401.78% for pre- and post-anthesis, respectively. Among all treatments, 5ppm gibberellic acid (AlT2) gave the highest net income of PI31.39. Tomatoes under AlT2 also gave the highest return of investment (ROI) of 613.68 % (Table 12).

Table 11. Mean total soluble solids (% Brix) of tomato fruits from plants sprayed with GA_3 during pre- and post-antheses.

	Treatment		R_1	R_2	R_3	Mean
Pre Anthesis (A_1)	T_1	0 ppm	8.5	7.3	8.1	7.97 ab
	T_2	5 ppm	7.7	8.2	8.0	7.97 ab
	T_3	10 ppm	7.3	6.7	8.5	7.50 ab
	T_4	20 ppm	7.4	8.2	6.9	7.50 ab
	T_5	40 ppm	6.8	8.5	8.0	7.77 ab
	T_6	80 ppm	8.1	7.7	8.4	8.07 ab
	T_7	160 ppm	8.7	8.3	8.4	8.47 a
Post Anthesis (A_2)	T_1	0 ppm	7.8	7.2	6.2	7.07 b
	T_2	5 ppm	6.5	8.3	7.5	7.43 ab
	T_3	10 ppm	7.8	8.1	8.3	8.07 ab
	T_4	20 ppm	8.2	7.5	7.6	7.77 ab
	T_5	40 ppm	8.0	8.2	8.0	8.07 ab
	T_6	80 ppm	8.5	8.5	8.3	8.43 a
	T_7	160 ppm	8.1	8.4	7.4	7.97 ab

*Data were taken from 10 pieces per treatment per replication. Means with same letters do not differ significantly at 5% level of significance, DMRT.

Table 12. Cost and benefit analysis of the different treatments of tomato plants applied with GA_3 during pre-and post-antheses.

Pre-Anthesis							
Treatment	0 ppm	5 ppm	10 ppm	20 ppm	40 ppm	80 ppm	160
Seed	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Fertilizer	15.48	15.48	15.48	15.48	15.48	15.48	15.48
Pesticide	17.06	17.06	17.06	17.06	17.06	17.06	17.06
Labor	47.00	47.00	47.00	47.00	47.00	47.00	47.00
GA_3	0.00	1.36	2.72	5.44	10.88	21.76	43.52
Sack	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Trellis	5.35	5.35	5.35	5.35	5.35	5.35	5.35
Irrigation	10.56	10.56	10.56	10.56	10.56	10.56	10.56
Atomizer	2.75	2.75	2.75	2.75	2.75	2.75	2.75
Total Cost/	105.70	107.06	108.42	111.14	116.58	127.46	149.22
Cost/ Hill	21.14	21.41	21.68	22.23	23.32	25.48	29.84
Potential yield/	7.16	15.28	12.97	11.51	10.64	12.43	11.54
Market Price	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Gross Income /	71.60	152.80	129.70	151.10	106.40	124.30	115.40
Net Income /	50.46	131.39	108.02	128.87	83.08	98.81	85.56
ROI (%)	238.69	613.68	498.25	579.71	356.26	387.64	286.73

Post Anthesis							
Treatment	1	2	3	4	5	6	7
Seed	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Fertilizer	15.48	15.48	15.48	15.48	15.48	15.48	15.48
Pesticide	17.06	17.06	17.06	17.06	17.06	17.06	17.06
Labor	47.00	47.00	47.00	47.00	47.00	47.00	47.00
GA_3	0.00	1.36	2.72	5.44	10.88	21.76	43.52
Sack	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Trellis	5.35	5.35	5.35	5.35	5.35	5.35	5.35
Irrigation	10.56	10.56	10.56	10.56	10.56	10.56	10.56
Atomizer	2.75	2.75	2.75	2.75	2.75	2.75	2.75
Total Cost/ Trmnt	105.70	107.06	108.42	111.14	116.58	127.46	149.22
Cost/ Hill	21.14	21.41	21.68	22.23	23.32	25.48	29.84
Potential yield/	8.36	14.69	12.93	10.92	12.91	12.44	9.00
Market Price	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Gross Income /	83.60	146.90	129.30	109.20	129.10	124.40	90.00
Net Income/ Trmnt	62.46	125.49	107.62	86.97	105.78	98.91	60.16
ROI (%)	295.46	586.13	496.40	391.23	453.60	388.03	201.61

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Return on Investment (ROI) gives a sound basis in determining which among the treatments will give the highest income at the least cost. In agriculture, producing crops with high net income and low cost of production is an important consideration. Some technologies are relatively costly but can be compensated by its resulting yield. Others may be cheap but gave lower yield. Gibberellic Acid application in agriculture is not costly as perceived by many. In this study, increasing operating cost per treatment is observed due to increasing Gibberellic Acid concentration.

Summary, Conclusion and Recommendations

The study was conducted at the DOSCST main campus in Mati, Davao Oriental to determine the most effective concentration of Gibberrellic Acid (GA3 that promotes fruit setting and fruit development as well as the flower development that is most responsive to GA3 The cost and benefit analysis of the treatments was also done. A total of 210 plants were used in the experiment and was laid in 2 x 7 factorial design replicated three times with 5 hills per replicate.

Highest average fruit set of 6.22 was obtained by applying 10 ppm GA3 at post-anthesis. Lowest incidence of fruit abortion was in plants treated with 5 ppm and 40 ppm both at post-anthesis. While those not treated with GA3 at pre and post anthesis yielded the highest number of fruits aborted. Among all treatments, 5ppm concentration GA3 gave the highest net income of PI 31.39. Tomatoes treated with 5ppm at pre-antheses gave the highest return of investment (ROI) of 613.68 %.

Tomato production in Mati, Davao Oriental was significantly improved by GA_3 application.

The use of the GA_3 at the rate of 5 ppm both at pre- and post-anthesis gave best results. Higher concentrations gave inferior results and higher cost of production. Consequently, this resulted in lower return on investment.

Based on the results, the following recommended:

1.GA3 can be applied both during pre- or post-anthesis.

2.GA3 can be used at rate of 5 ppm concentration. The 5-ppm rate was effective as observed during the experiment.

3.Replication of this study may be done at farmer's level.

4.Further study is recommended using other solanaceous crops.

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