BIBLIOGRAPHY

SOPOSOP, JACQUELINE G. APRIL 2012. Acceleration of Flowering of Aerial Grown Strawberry 'Sweet Charlie' as Affected by Gibberellic Acid (GA_3) Application under Glasshouse Condition. Benguet State University, La Trinidad, Benguet.

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ABSTRACT

The study was conducted at the Pomology Project Glasshouse, Benguet State University, La Trinidad, Benguet from November 2011 to February 2012 to determine the effect of gibberellic acid (GA_3) on the flowering of strawberry, determine the best concentrations and frequency of GA_3 application that accelerated flowering of strawberry and to compare bench and aerial techniques in planting strawberry to increase production without utilizing wide land areas.

The Strawberry plants were applied once, two times, and three times with Gibberellic Acid (GA_3) at the concentrations of 0, 50, 100, 150, 200, and 250 ppm GA_3 at 10 days interval 20 days from plating in a black polyethylene plastic bags with garden soil and BSU compost (2:1) as growing media.

Results showed that the earliest plants to initiate flower buds were the plants treated with 50 ppm GA_3 and those plants applied once with the same GA_3 concentration were the first to attain red ripe stage from fruit set and had the earliest fruits that were harvested (75% ripe) from planting.

On the number of days from flower bud formation to fruit set, the plants that were not treated with GA_3 were the earliest to show fruit set and also had the earliest fruits harvested from flower bud formation compared to the treated plants. The plants also produced the highest total yield.

Among the plants treated with GA_3, plants treated with 50 ppm GA_3 applied two (2) and three (3) times produced the highest yield followed by the plants treated with 100 ppm and 150 ppm GA_3 applied three (3) times respectively.

Based on the preceding results and discussions, it is recommended not to use gibberellic acid (GA_3) in aerial planting of strawberry plants for higher production.

However, gibberellic acid (GA_3) could be used for off-season production and application of 50 ppm GA_3 sprayed once 20 days from planting, is recommended to improve and to enhance the flowering and fruiting of strawberry for earlier harvest.

RESULTS AND DISCUSSION

Initial Height (cm)

Results showed that there were no significant differences obtained on the initial height of strawberry plants 20 days from planting.

Number of Days from Planting to Flower Bud Formation

Effect of GA_3 concentration. Highly significant differences were observed on the number of days from planting to flower bud formation as affected by the different GA_3 concentrations. Table 1 showed that plants treated with 50 ppm GA_3 were the earliest to initiate flower buds among the treatments with a mean of 38.44 days from planting but were statistically comparable with the rest of the treatments applied with GA_3. The plants which were not applied with GA_3 (control) took longer days to attain flower bud formation from planting with a mean of 57.00 days.

Effect of frequency of application. Results showed that there were no significant statistical differences observed on the number of days from planting to flower bud formation as affected by the frequency of application. However, numerical figures showed that the earliest to form flower buds were those plants applied with GA_3 three (3) times with a mean of 41.83 days followed by two (2) times application which had a mean of 42.67 days.

Interaction effect. There were highly significant interaction effects observed between different GA_3 concentrations and the frequency of application with regards to the number of days from planting to flower bud formation.

Figure 1 showed that plants treated with 200 ppm GA_3 applied once were the

earliest to initiate flower buds with a mean of 27.33 days compared to those plants treated with the other concentrations applied two (2) and three (3) times. While those plants that were not treated with GA_3 but were applied with distilled water two (2) times (control) had the longest number of days to initial flower bud formation with an average of 72.67 days from planting.

Table 1. Number of days from planting to flower bud formation (0.5 cm bud size)

TREATMENT	MEAN (days)
GA_3 Concentration (ppm)	
0 (Control)	57.00a
50	38.44b
100	41.89b
150	45.22b
200	42.56b
250	39.22b
Frequency of Application	
1x	42.67a
2x	47.67a
3x	41.83a

Means with the same letter are not significantly different at 5% level by DMRT

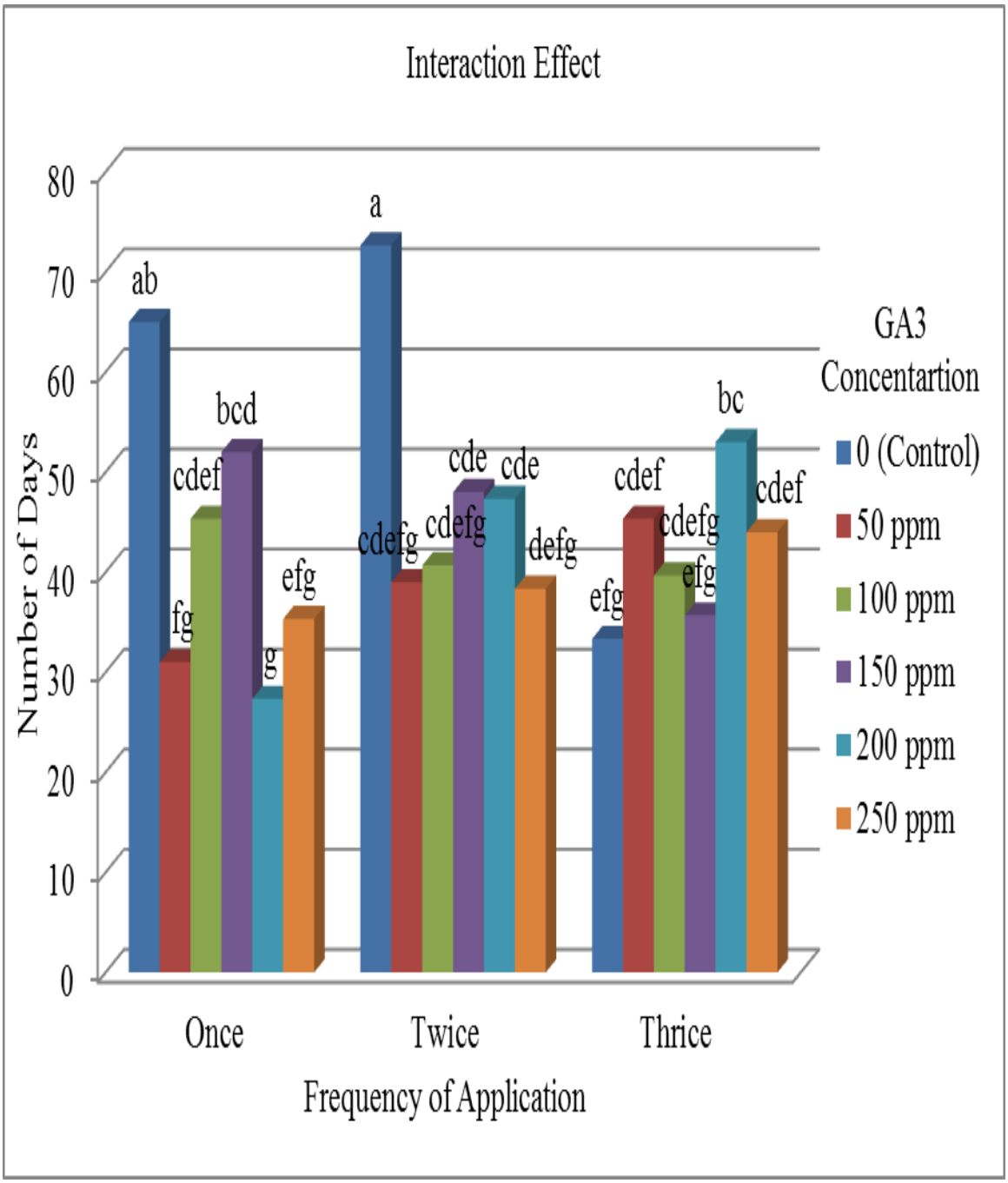

Figure 2. Number of days from planting to flower bud formation (0.5 cm bud size) of strawberry as affected by concentration and frequency of GA_3 application.

Number of Days from Flower Bud Formation to Fruit Set

Effect of GA_3 concentration. Highly significant differences were observed on the number of days from flower bud formation to fruit set. Table 2 showed that the earliest to initiate fruit set among the plants treated with GA_3 were those applied with 200 ppm with a mean of 19.11 days while those plants applied with 250 ppm GA_3 showed the highest number of days with a mean of 23.56. Earlier fruit set were observed on plants which were not applied with GA_3 (control) with an average of 13.56 days compared to the plants treated with different GA_3 concentrations.

Effect of frequency of application. Results showed that there were no significant differences on the number of days from flower bud formation to fruit set as affected by frequency of application.

Interaction effect. There were no significant interaction effects observed between the different GA_3 concentrations and the frequency of application with regards to the number of days from flower bud formation to fruit set.

Numerically, results showed that the plants treated with 200 ppm GA_3 applied once were the earliest to initiate fruit set with an average of 17.00 days from flower bud formation followed by the plants treated with 50 ppm GA_3 applied once and 200 ppm GA_3 applied twice (2) with a mean of 18.00 and 19.00 days respectively. However, the plants that were not treated with GA_3 (control) were the earliest to initiate fruit set with a mean of 9.67, 14.00 and 17.00 days from flower bud formation compared to those plants treated with GA_3 applied once, two (2) and three (3) times.

Table 2. Number of days from flower bud formation to fruit set

TREATMENT	MEAN (days)
GA_3 Concentration (ppm)	
0 (Control)	13.56c
50	21.56ab
100	22.67ab
150	20.00ab
200	19.11b
250	23.56a
Frequency of Application	
1x	19.56a
2x	20.17a
3x	20.50a

Means with the same letter are not significantly different at 5% DMRT

Number of Days from Fruit Set to Red Ripe Stage

Effect of GA_3 concentration. No significant differences were observed on the number of days from fruit set to red ripe stage as affected by different GA_3 concentrations. Numerically, results in table 3 showed that plants treated with 50 ppm were the earliest to reach red ripe stage with an average of 20.67 days from fruit set compared to the other treatments. While the plants treated with 100 ppm GA_3 had the highest number of days to attain red ripe stage with a mean of 32.22 days from fruit set.

Effect of frequency of application. Results showed that there were no significant differences on the number of days from fruit to red ripe stage as affected by frequency of

application.

Interaction effect. There were no significant interaction effects observed between the different GA_3 concentrations and the frequency of application with regards to number of days from fruit set to red ripe stage.

However, numerical results showed that plants treated with 50 ppm applied once were the earliest to attain red ripe stage with a mean of 13.33 days from fruit set compared to those plants treated with other concentration of GA_3 applied two (2) and three (3) times.

Table 3. Number of days from fruit set to red ripe stage

TREATMENT	MEAN (days)
GA_3 Concentration (ppm)	
0 (Control)	24.11a
50	20.67a
100	32.22a
150	24.67a
200	28.11a
250	30.11a
Frequency of Application	
1x	25.06a
2x	28.39a
3x	26.50a

Means with the same letter are not significantly different at 5% level by DMRT

Number of Days from Flower Bud Formation to First Fruit Harvest (red ripe stage)

Effect of GA_3 concentration. Significant differences were observed on the number of days from flower bud formation to first fruit harvest as affected by the different GA_3 concentrations. Table 4 showed that plants treated with 50 ppm produced fruits that were harvested earlier at red ripe stage with a mean of 45.11 days from flower bud formation compared to the other plants treated with GA_3. However, results revealed that the plants without GA_3 application (control) had the earliest fruits that were harvested at red ripe stage with an average of 38.11 days from flower bud formation compared to the plants treated with GA_3.

Effect of frequency of application. Results showed that there were no significant differences on the number of days from flower bud formation to first fruit harvest as affected by frequency of application.

Interaction effect. There were no significant interaction effects observed between the GA_3 concentrations and the frequency of application with regards to number of days from flower bud formation to first fruit harvest.

Numerically, results showed that plants treated with 150 ppm GA_3 applied once had the earliest fruits harvested at red ripe stage with an average of 41.33 days from flower bud formation followed by plants treated with 50 ppm GA_3 applied once with a mean of 41.67. However, earlier fruit harvested at red ripe stage were observed from the plants that were not applied with GA_3 (control) with a mean of 36.33, 36.33 and 41.67 days from flower bud formation compared to the plants treated with GA_3.

Table 4. Number of days from flower bud formation to first fruit harvest (red ripe stage)

TREATMENT	MEAN (days)
GA_3 Concentration (ppm)	
0 (Control)	38.11b
50	45.11ab
100	59.33a
150	54.33ab
200	62.67a
250	60.78a
Frequency of Application	
1x	56.39a
2x	51.44a
3x	52.33a

Means with the same letters are not significantly different at 5% DMRT

Number of Days from Planting to First Fruit Harvest (75% red)

Effect of GA_3 concentration. Table 5 shows that there were no significant differences were observed on the number of days from planting to first fruit harvest as affected by different GA_3 concentrations. Numerically, results revealed that plants applied with 50 ppm GA_3 had the earliest fruits that were harvested at 75% red skin color with a mean of 81.78 days from planting compared to the other treatments.

Effect of frequency of application. Results showed that there were no significant differences recorded on the number of days from planting to first fruit harvest as affected by frequency of application. However, results in table 5 showed that fruits of plants applied

once with GA_3 were harvested earlier with a mean of 90.17 days from planting compared to the plants applied with GA_3 two (2) and three (3) times.

Interaction effect. There were no significant interaction effects noted between the different GA_3 concentrations and the frequency of application with regards to the number of days from planting to first fruit harvest.

However, the results showed that plants treated with 50 ppm GA_3 applied once, produced the earliest fruits harvested at 75% red skin color from planting with a mean of 59.33 days compared to those plants treated with other GA_3 concentrations applied two (2) and three (3) times.

Table 5. Number of days from planting to first fruit harvest (75% red)

TREATMENT	MEAN (days)
GA_3 Concentration (ppm)	
0 (Control)	100.78a
50	81.78a
100	102.44a
150	89.89a
200	104.00a
250	87.78a
Frequency of Application	
1x	90.17a
2x	97.22a
3x	95.94a

Means with the same letter are not significantly different at 5% level by DMRT

Total Yield (g)

Effect of GA_3 concentration. Highly significant differences were observed on the total yield of fruits harvested (g) from January to February. Plants applied with 50 ppm GA_3 had the highest average weight of fruits with a mean of 10.10 grams compared to the other plants treated with different GA_3 concentrations. However, plants that were not treated with GA_3 (control) had the highest average weight of fruits harvested with a mean of 24.14 grams compared to the plants treated with different GA_3 concentrations.

Effect of frequency of application. Results showed that there were no significant differences on the total yield produced as affected by frequency of application.

Interaction effect. There were no significant interaction effect between the different GA_3 concentrations and the frequency of application with regards to total yield produced.

Numerically, results showed that plants treated with 50 ppm GA_3 applied three (3) and two (2) times have the highest total weight of fruits harvested with an average weight of 11.08 and 11.49 grams respectively followed by the plants treated with 150 ppm GA_3 applied three (3) times with a mean of 11.66 grams and the plants treated with 100 ppm GA_3 applied three (3) times with a mean of 11.84 grams compared to the other plants treated with GA_3. However, the plants that were not treated with GA_3 (control) had the highest total yield produced compared to the plants treated with different GA_3 concentrations with an average weight of 26.19, 23.66 and 22.56 grams.

Table 6. Total yield (g)

TREATMENT	MEAN
GA_3 Concentration (ppm)	
0 (Control)	24.14a
50	10.10b
100	8.85b
150	6.98b
200	6.46b
250	0.84c
Frequency of Application	
1x	8.84a
2x	9.22a
3x	10.63a

Means with the same letter are not significantly different at 5% level by DMRT

Marketable Yield (g)

Effect of GA_3 concentration. Highly significant differences were observed on the total marketable fruits as affected by different GA_3 concentrations. Table 7 showed that the plants treated with 50 ppm GA_3 had the highest average weight of total marketable fruits with a mean of 8.64 grams compared to those plants treated with different GA_3 concentrations. However, plants that were not treated with GA_3 (control) generally produced higher total marketable yield with a mean of 19.24 grams while the plants treated with 25 ppm GA_3 produced the lowest average weight of total marketable fruits with a mean of 0.22 grams.

Effect of frequency of application. Results showed that there were no significant differences on total marketable fruits as affected by frequency of application.

Interaction effect. There were no significant interaction effects between different GA_3 concentrations and the frequency of application with regards to total marketable fruits.

Numerically, results showed that the plants treated with 150 ppm GA_3 applied three (3) times and the plants treated with 50 ppm GA_3 applied two (2) times had the highest weight of total marketable fruits compared to the other plants treated different GA_3 concentrations applied once with a mean of 10.79 and 10.19 grams respectively. However, the plants that were not treated with GA_3 (control) generally had the highest weight of total marketable fruits with a mean of 20.58, 18.85 and 18.29 grams compared to the plants treated with GA_3 as affected by different GA_3 concentration and frequency of application. Moreover, the plants treated with 250 ppm GA_3 applied once and two (2) times did not produce marketable fruits.

Table 7. Marketable yield (g)

TREATMENT	MEAN
GA_3 Concentration (ppm)	
0 (Control)	19.24a
50	8.69b
100	7.73b
150	5.45b
200	5.27b
250	0.22c
Frequency of Application	
1x	6.98a
2x	7.49a
3x	8.81a

Means of the same letter are not significantly different at 5% level by DMRT

Non-marketable Yield (g)

Effect of GA_3 concentration. Significant differences were observed on the total non-marketable fruits as affected by different GA_3 concentrations. Table 8 showed that the plants treated with 150 ppm, 50 ppm, 200 ppm and 100 ppm GA_3 had the highest weight of non-marketable fruits with means of 1.53, 1.46, 1.18, and 1.12 grams compared to the plants treated with 250 ppm GA_3 with a mean of 0.62 grams. However, the plants that were not treated with GA_3 (control) produced the highest weight of total non-marketable fruits with a mean of 4.896 grams.

Effect of frequency of application. Results showed that there were no significant

differences on total non-marketable fruits as affected by frequency of application.

Interaction effect. There were no significant interaction effects between the different GA_3 concentrations and the frequency of application with regards to the total non-marketable fruits.

Numerically, results showed that the plants treated with 150 ppm GA_3 applied three (3) times and the plants treated with 200 ppm GA_3 applied once had the highest total of non-marketable fruits compared to the other plants treated with different GA_3 concentrations with a mean of 2.54 and 2.15 grams respectively. However, the plants that were not treated with GA_3 have the highest weight of total non-marketable fruits with a mean of 5.61, 5.37 and 3.71 grams compared to the plants treated with GA_3.

Table 8. Non-marketable yield (g)

TREATMENT	MEAN
GA_3 Concentration (ppm)	
0 (Control)	4.89a
50	1.46b
100	1.12b
150	1.53b
200	1.18b
250	0.62b
Frequency of Application	
1x	1.86a
2x	1.73a
3x	1.82a

Means of the same letter are not significantly different at 5% level by DMRT

Occurrence of Insect Pest and Diseases

Vegetative Stage. Moderate infestations and infection of insect pest and diseases were observed on the plants planted at the bench and those plants that were hanged during the vegetative stage.

Moreover, severe infestations of mites were observed on the plants planted on the bench while moderate infestations were observed on the plants that were hanged during the vegetative stage.

Reproductive Stage. There were moderate infestations of insects and there were no disease infection observed on the plants planted on bench and those plants that were hanged

during the reproductive stage.

Moreover, moderate infestation of mites was observed on the plants planted on the bench while there was no infestation noted on the plants that were hanged during the reproductive stage.

Maturity Stage. There were no insect pests, mites infestation and disease infection recorded on the fruits planted on the bench as well as those plants that were hanged during the maturity stage.

Table 9. Occurrence of insect pest and diseases

INSECT PEST AND DISEASES	VEGETATIVE STAGE		REPRODUCTIVE STAGE		MATURITY STAGE	
	BENCH PLANT-ING	AERIAL PLANT-ING	BENCH PLANT-ING	AERIAL PLANT-ING	BENCH PLANT-ING	AERIAL PLANT-ING
Insects	2	2	2	2	1	1
Diseases	3	3	1	1	1	1
Mites Infestation	3	2	2	1	1	1
Insect pest infestation and disease infection rating: 1 – no infestation/ infection 2 – moderate infestation/ infection 3- severe infestation/ infection						

Sugar Content (% Brix)

Effect of GA_3 concentration. Significant differences were observed on the percent sugar contents of fruits as affected by different GA_3 concentrations. Table 10 showed that the plants treated with 150 ppm GA_3 had sweeter fruits compared to the other treatments with a mean of 7.88% followed by those plants that were not treated with GA_3 (control) with a mean of 7.09%.

Effect of frequency of application. Results showed that there were no significant differences on the percent sugar content of fruits as affected by different frequency of application.

Interaction effect. There were no significant interaction effects between the different GA_3 concentrations and the frequency of application with regards to percent sugar content.

However, results showed that the plants treated with 150 ppm GA_3 applied two (2) and three (3) times were generally sweeter with a mean of 8.93% and 8.03% including the plants treated with 100 ppm GA_3 applied two (2) times with a mean of 8.37% compared to the other treatments. Moreover, the plants treated with 250 ppm GA_3 applied once and twice have no percent sugar content because the fruits harvested have no juice extracted due to small fruits.

Table 10. Sugar content (% Brix)

TREATMENT	MEAN
GA_3 Concentration (ppm)	
0 (Control)	7.09a
50	6.98a
100	6.53a
150	7.88a
200	6.28a
250	1.11b
Frequency of Application	
1x	5.68a
2x	6.24a
3x	6.00a

Means of the same letter are not significantly different at 5% level by DMRT

Temperature Data (°C)

Table 11 presents the maximum temperature data recorded inside the glasshouse from plating until harvesting.

There was a lower average temperature during the month of November and February compared to the month of December and January however there were no big differences regarding temperature during the 4 months duration of the experiment.

Table 11. Temperature data of the glasshouse

MONTH	AVERAGE TEMPERATURE (°C)
November	20.79
December	21.98
January	21.39
February	20.88

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The study was conducted at the Pomology Project Glasshouse, Benguet State University, La Trinidad, Benguet from November 2011 to February 2012 to determine the effect of gibberellic acid (GA_3) on the flowering of strawberry, determine the best concentrations and frequency of GA_3 application that accelerated flowering of strawberry and to compare bench and aerial techniques in planting strawberry to increase production without utilizing wide land areas.

The earliest plants to initiate flower buds were the plants treated with 50 ppm GA_3 and those plants applied once with the same GA_3 concentration were the first to attain red ripe stage from fruit set and had the earliest fruits that were harvested (75% ripe) from planting. This was followed by the plants treated with 200 ppm GA_3 applied once and those were also the earliest to show fruit set among the treated plants.

On the number of days from flower bud formation to fruit set, the plants that were not treated with GA_3 (control) were the earliest to show fruit set and also had the earliest fruits harvested from flower bud formation compared to the treated plants. The plants also produced the highest total weight of fruits with the highest marketable and non-marketable yield.

Among the plants treated with GA_3, plants treated with 50 ppm GA_3 applied two (2) and three (3) times produced the highest yield followed by the plants treated with 100 ppm and 150 ppm GA_3 applied three (3) times respectively. Moreover, the plants treated with 150 ppm and 50 ppm GA_3 applied three (3) and two (2) times respectively had the highest marketable yield while the plants treated with 250 ppm GA_3 applied once and two

(2) times did not produce marketable fruits. With regards to non-marketable fruits, the plants treated with 150 ppm and 200 ppm GA_3 applied three (3) times and once were the highest in terms of weight.

As to percent sugar content, the plants treated with 150 ppm GA_3 applied two (2) and three (3) times, the plants treated with 100 ppm GA_3 applied two (2) times and those plants that were not treated with GA_3 were the sweetest among the other treatments.

With regards to occurrence of insect pest and diseases, both the plants planted on bench and plants that were hanged are comparable from vegetative stage until maturity stage. However, mites infestation was moderately observed on the plants planted on the bench while the plants that were hanged had no infestation during the reproductive stage.

On the temperature data, there was a lower average temperature during the month of November and February compared to the month of December and January; however there were no big differences during the four (4) months.

Conclusion

It is therefore concluded that the strawberry plants not treated with gibberellic acid (GA_3) were the first to fruit set from flower bud formation, the first to be harvested at red ripe stage and produced higher yield than those treated plants. It is also concluded that 50 ppm GA_3 application enhances flower bud formation, fruit development from fruit set to red ripe stage and first to be harvested from planting.

Recommendation

Based on the preceding results and discussions, it is recommended not to use gibberellic acid (GA_3) in aerial planting of strawberry plants for higher production during the usual cropping season.

However, gibberellic acid (GA_3) could be used for off-season production and application of 50 ppm GA_3 sprayed once 20 days from planting is recommended to improve and to enhance the flowering and fruiting of strawberry for earlier harvest.

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