



RESEARCH PAPER

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Growth and yield adaptability of selected varieties of strawberry (*Fragaria x ananassa*) under BPSU abucay bataan condition, Philippines

Chester Allan T. Mainem^{*1}, Rossel Q. Agustin², Gerald M. Duza³

¹Faculty Abucay Campus, Bataan Peninsula State University, Bataan, Philippines

²Bachelor of Science in Agriculture, Abucay Campus, Bataan Peninsula State University, Bataan, Philippines

³Faculty, Cagayan State University, Piat Campus, Baung Piat Cagayan, Philippines

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Abstract

This study aims to evaluate the growth adaptability, yield performance and Pest infestation on three introduced strawberry varieties at Bataan namely; Sweet Charlie, Festival and Summer Princess. Evaluation test was based on the Plant height, Number of Runners, Days to flower, Number of fruit bears, Weight of fruit per pot, Computed Yield and Pest degree infestation. This was conducted at the Greenhouse Nursery of BPSU, Abucay Campus. In terms of growth adaptability, Sweet Charlie obtained the most prominent character followed by Festival variety and Summer Princess. On the yield performance, all varietal tested are comparable to each other, However, Summer princess revealed as least in growth adaptability, study shows that, summer princess yielded better than the two remaining varieties tested under greenhouse condition. Thus, summer princess variety is a more noticeable and promising variety that can thrive in Bataan condition. On Insect and Disease assessment, most prevalent insects found are Cutworm and Aphids while on diseases, Anthracnose fruit rot and Angular leaf spot were observed these are caused by fungi. Further studies may focus on the cultural management practices, field test to find out more promising cultivars that will thrive best to Bataan, Sensory evaluation is also recommended.

***Corresponding Author:** Chester Allan T. Mainem ✉ ctmainem@up.edu.ph

Introduction

One of the most important fruit crops cultivated worldwide is the Strawberry (*Fragaria x ananassa* Duch.) Belong to the Rosaceae family and genus *Fragaria*, they are aggregate fruits, fleshy, juicy and red. It has a green leafy cap and the stem adorn its crown. Strawberry has enlarged receptacle and the seeds are on the outside skin. Ellagic acid is also found in strawberry which believed to be anticarcinogenic (Almorado, 2019). Strawberries are considered rich source of essential phytochemicals like ellagic acid, anthocyanins, quercetin, echin and essential vitamins ascorbic acid and folic acid. It was also highly classified among other dietary sources for polyphenols and antioxidants content (Basu, 2014). Strawberry is classified as temperate grown type of fruit but now it is already grown in other regions (Shahzad *et al*, 2018). The municipality of La Trinidad in the northern region of the Philippines was the top producer of this fruit. The strawberry produced in this municipality were eaten fresh or processed as preserves, candy, body products such as body soap, feminine wash and including cosmetic products (Ticbaen, 2017). It was in 1999 in the same municipality, the first and only breeding program for strawberry was conducted by Benguet State University. The aim were to develop new strawberry cultivars with high yielding potential, acceptable fruit quality, long shelf life and tolerant to pest like mites and botrytis disease. After three years of evaluation, from 30 varieties and four wild relatives used as parental a one single cross and backcross outperformed sweet Charlie strawberry which commonly planted up to this days. There were also three other single crosses and 2 backcrosses that shows potential having comparable yields on the check variety. These superior lines was calculated to give an estimated income of Php 72,000.00-105,000.00 per hectare at an average price of Php 60.00 perkg during that time (Padua & Kilakil, 2011).

Due to the increasing worldwide demand, strawberry fruit is an excellent product for export and can be a dollar earner for the local economy, provided that there is a constant large volume produced. A single

farmer may be unable to produce the necessary volume alone but if a cooperative unit of strawberry growers collaborates, they may be able to produce the required volume regularly demanded by consumers as well as the processors. La Trinidad and other parts of Baguio City produced high production of strawberry with an average yield of 15.8 tons/ha and is expected to continue to expand as growers take an increasing share of the local market, this may contribute on the topography of the area and cool climate they have (Almorado, 2019).

Paparozzi (2013), with the high price of inputs and demand for more foods to be produced. Vegetables, fruits and other plants are now moved in greenhouses. However, there are few common challenges that must be considered; like crop adaptability by moving a field-grown crop to an enclosed condition, providing the needed or recommended nutrients (Tellez *et al*, 2014) nutrient management plays a crucial role in the production, quality as with the pest and disease control, and greenhouse formulated pesticide. Considering the technique in planting and variety of strawberry growing in greenhouse is possible. (Castro *et al*, 2017) strawberry varieties Albion and San Andreas were adapted in greenhouse environment.

Growing crops under greenhouse shade nets have many advantages but nowadays it specifically gaining more importance for raising high-value cash crops with off seasonality and superior quality of the produce. It is used to protect crops and plants from adverse weather conditions, animals and pests, besides providing suitable conditions for plant growth. Also, the essential performance properties of greenhouse shade nets are the resistance to solar radiation and weathering. This study aims to evaluate the growth, yield, and adaptability of the three (3) varieties of strawberry that is being planted in La Trinidad, this was done under greenhouse condition.

Materials and methods

This research was conducted from January 2017 to July 2017. Experimental set up was conducted at the Experimental Station of the College of Agriculture,

Bataan Peninsula State University- Abucay Campus, Bangkal Abucay, Bataan, Philippines.

Acquisition and Varieties Used

The runners were acquired in a reliable agricultural supplier and farmers at La Trinidad Benguet. Strawberry Varieties used in the study has good adaptability and vigor. Following varieties were as follows; The Sweet Charlie these berries are medium in size, deliciously sweet. They are June-bearers, but an excellent choice for use as a short-day variety in warmer climates, height approximately 20.0cm.

The Festival variety have an average petiole length is 120mm. The average lengths and breadth of leaflets are 78 and 73mm for terminal leaflets, respectively, and 69 and 72mm, respectively, for secondary leaflets. Leaflet margins are crenate and average 21 serrations per terminal leaflet, and 26 per secondary leaflet, and lastly the Summer princess which is a winter type strawberry, color is light red, sugar content 8.28, Soft, Fragrance is strong, and fruit size a little small and cultivated from August to November.

Experimental Design

The experiment established under Greenhouse condition under wet season, with a temperature ranging to 22.5°C to 31.5°C. The experiment is laid out in Complete Randomized Design (CRD). Ten (10) runners were used for each variety and replicated five (5) times. Treatments Variable are: 1 (V1): Sweet Charlie; Variable 2 (V2): Festival; Variable 3 (V3): Summer princess.

Cultural Management and Practices

Proper care and management were done throughout the whole duration of the experiment. The following practices of proper care and management were as follows; (1) Planting Media and Polypropylene Pots Preparation a total of 150 pcs of 17.78cm diameter and 27.94cm height polypropylene pots were filled with 1.25kg of planting media composed of 100kg of garden soil and 25kg of vermicompost purchased at BPSU Abucay Campus Organic Fertilizer Project. (2) After land preparation hardening for 5 days was done before planting the strawberry runners. One runner

was planted in every pot and (BPI, 2017) the crown was at soil level. Planting was done late in the afternoon under greenhouse condition. (3) Watering was also employed whenever necessary to maintain favorable moisture of the soil.

The overhead sprinkler was used for irrigation to provide proper distribution of moisture to the strawberries. (4) on mulching rice straw was used as material on the potted strawberries, this is to retain soil moisture and to protect the strawberry fruits from direct contact on the soil. (5) In terms of fertilizer Application, 20 DAT, inorganic fertilizer (46-0-0) was applied through side dressing on each polypropylene pots. The same application mode was done after two weeks with a complete fertilizer (14-14-14) until the end of the study. And lastly (6) on Harvesting it was done in the morning twice a week this is the fully rippled strawberries. The harvested strawberries were sorted to marketable and non-marketable based on damages inflicted from insect pests or disease.

Pest and Diseases Management

Strictly daily monitoring was done to observed different occurring insects and diseases. Hand-picking was implemented on insect pests. Insect and Pathogens were recorded for the assessment of the degree of the infestation using the adapted rating scale of Montalban (2009).

Data Gathered

The data gathered in this study were categorized into growth and yield parameters. Both parameters are considered as the variable factors in this experiment. Five (5) data plants were taken randomly from the plot. The fruits were handpicked and gathered according to variety. Data collected were as follows:

Growth Parameters

On the Average plant height at harvest (cm) it was measured from the base of the crown to the tip of the leaf per strawberry plant. The average number of branch crowns were obtained by counting the branch crown occurred on the crown of the strawberry plant. On the average number of days to emergence of branch crown it was obtained by counting the number

of days from transplanting until branch crown emerges per strawberry plant. For the average number of runners this was done by counting the number of runners emerged per the strawberry plant. And lastly, on the average number of days to flower this was obtained by counting the number of days from transplanting to the setting of flowers.

Yield Parameters

For the average number of flowers per pot this was obtained by counting the number of flowers from the sample strawberry plant. On the average number of fruits per pot this was done by counting the number of fruit recorded during the harvest. For the average weight of fruits per pot (g) from the recorded weight of harvested strawberry fruits from the sample plant using a weighing scale.

Average total weight of fruit per pot (g) was obtained by dividing the harvested number of strawberry fruits to the weight of strawberry fruits, and lastly on the Computed Yield per net house was computed by using the given formula; Yield per net house (168m²) = kg per pot X no. of plants per net house.

Collection and Identification of Insects

Collection and Identification of Insect and other arthropods associated with strawberries were done every week. All collected insect pest was preserved and identified by Crop Protectionist of the College.

Disease Assessment

Disease assessment was done from transplanting to harvesting. The same method for disease assessment was employed using the same methodology used by Montalban (2009). Disease Severity.

Rating the leaf infection (%) using the numerical rating and rating scale; Rating 0 Healthy plant; Rating 1 (1%-10% Infected Leaves), Rating 2 (11%-25% Infected Leaves), Rating 3 (26%-40% Infected Leaves), Rating 4 (41%-60% Infected Leaves), and Rating 5 (60%- above Infected Leaves). This was obtained by using the given formula.

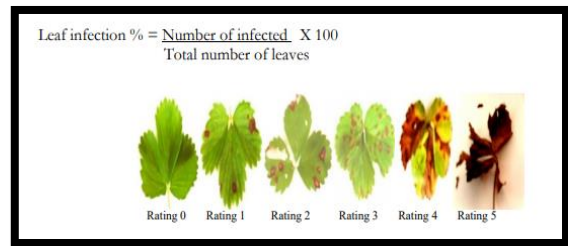


Fig. 1. Formula and Rating scale for Diseases Severity in Strawberry (Cited from Almorado, (2019), International Journal of Humanities and Social Science).

Statistical Analysis

All data to be gathered were tabulated and analyzed following the ANOVA for a single factor experiment in CRD of the Analysis of Variance (ANOVA) for Randomized Completely Block Design. Significant differences among treatment means were compared using Duncan's Multiple Range Test (DMRT).

Results and discussion

The performance of the strawberry varieties under greenhouse condition was determined by the by the following parameters: average plant height at harvest, the average number of branch crown, the average number of days to emergence of branch crown, the average number of days to flowering, the average number of runners, average number of shoots per runner, statistical analysis and cost and return analysis, the average number of flowers per pot, average weight of fruits per pot, average number of fruits per pot, average weight of fruit per variety, computed yield and Insect and Diseases infestation.

Table 1 present the summary of Growth adaptability and the Flowering of different varieties of strawberry under the greenhouse condition. As gleaned in the table. On the strawberry plant height at harvest. Strawberry Sweet Charlie (variety 1) obtained the tallest mean of 14.38cm, followed by Strawberry Summer princess, and Festival with a means 14.20cm and 13.50cm respectively. On the average number of branch crowns, Strawberry Sweet Charlie garnered the highest number of branch crowns with a mean of 2.00 followed by Strawberry Festival (variety 2) and Strawberry Summer princess (variety 3) with a means of 1.60 and 1.20 respectively.

On the number of days to emergence of the branch, the table shows that the Strawberry Summer princess has the shortest number of days in to emerge branch

crown with a mean of 7.04 days followed by the Strawberry Festival (9.32 days) and 11.92 days for Strawberry Sweet Charlie.

Growth Adaptability

Table 1. Summary data on Growth Adaptability of Selected Three Varieties of Strawberry under Greenhouse condition.

Varieties	Average Plant Height at Harvest (cm)	The average number of branch crown	The average number of days to emergence of branch crown	The average number of runners	The average number of days to flowering	The average number of flowers per pot (fully bloomed)
V ₁	14.38 ^a	2.00 ^a	11.92 ^a	47.40 ^a	15.80 ^a	12.28 ^a
V ₂	13.50 ^a	1.60 ^a	9.32 ^a	48.40 ^a	14.72 ^a	12.64 ^a
V ₃	14.20 ^a	1.20 ^a	7.04 ^a	46.80 ^a	16.64 ^a	12.52 ^a

Remarks: V₁ = Sweet Charli, V₂ = Festival and V₃ = Summer princess. In a column, all means with the same superscripts are not significantly different at 5% level of significance by DMRT.

On the other parameters, on the average number of runners Strawberry Festival obtained the most number of runners with a mean of 48.40, followed by Strawberry Sweet Charlie and Summer princess with a means of 47.40 and 46.80 respectively. Result on the average number of days to flowering, Strawberry Festival obtained the shortest day to flower with a mean day of 14.72 followed by Sweet Charlie with a mean of 15.80 days while the Summer princess obtained the longest days of flowering with a day means of 16.64 days. And for the average number of flowers per pot (fully bloomed) table show that the Strawberry Festival has the most number of flowers with a mean of 12.64, followed by Summer princess (variety 3) with a mean of 12.52 and Strawberry Sweet Charlie (variety 1) with a mean of 12.28.

Analysis of variance indicated no significant differences in the different parameters garnered on the different varieties tested. This means that varieties tested are comparable to each other in terms

of growth adaptability under greenhouse condition at Bataan. Moreover, for recommendation purposes, sweet Charlie showed the most prominent variety in terms of growth adaptability which shown on the result of the study, this coincides that this variety is known growing to a height of approximately 20.0cm which can be adaptable to the area of Bataan, while Festival has shown the most noticeable in terms of the number of flowering and number of runners, this variety is known to be short-day cultivar.

The vigorous plant tends to produce numerous runners if planted in early October in central Florida. 'Strawberry Festival' has a mean fruit weight similar to that of 'Sweet Charlie', currently one of the major cultivars grown in west-central Florida. The fruit is mostly conic in shape. The external color of the fully mature fruit is deep red and glossy; internal color is bright red. The calyx is large and showy. Fruit of the 'Strawberry Festival' has a very firm texture and excellent flavor. (Chandler *et al.*, 2000).

Yield Performance

Table 2. Summary data on the yield performance of Selected Three Varieties of Strawberry under Greenhouse condition.

Varieties	Average Number of Fruits	Average total weight of fruits per pot (g)	The average weight of fruit per pot (g)	Computed yield (kg)
V ₁	6.16 ^a	46.37 ^a	5.79 ^a	78.19 ^a
V ₂	5.44 ^a	49.93 ^a	6.34 ^a	87.45 ^a
V ₃	6.32 ^b	55.56 ^a	6.94 ^a	94.34 ^a

Remarks: V₁ = Sweet Charli, V₂ = Festival and V₃ = Summer princess. In a column, all means with the same superscripts are not significantly different at 5% level of significance by DMRT.

Table 2 shows the summary result of yield performance of the three varieties tested under greenhouse condition, as gleaned in the table on the

average number of fruit bears, Summer princess variety obtained the most number of fruit bears with a mean of 6.32 but this result may vary on the

agronomic characteristics of the variety in which one crown can bear multiple flowers compared to the other two varieties tested which bear one flower per stalk, this followed by Sweet Charlie and Festival Strawberry with a means of 6.16 and 5.44 respectively. Analysis of variance indicated significant differences among the variety in terms of the average number of fruits per pot, this means that the number of fruits obtained by summer princess varies on the number of fruits bears by Sweet Charlie and Festival variety. This result contradicts the performance of these varieties under open field condition where in, Festival strawberry have higher yield than the Sweet Charlie Strawberry (Chandler, 2000).

On the other hand, in terms of the average total weight of fruit per pot, Average weight of fruit per pot, and Computed Yield, Summer princess obtained the highest average means followed by Festival Variety and Sweet Charlie as the least but based on the analysis of variance, all varietal treatments are comparable to each other. This means that these three varieties tested showing a prominent good character in terms of adaptability under the Bataan condition; in terms of yield performance varietal tested princess strawberry is recommended.

A. Insect Pest And Other Arthropods

After collection and identification there were five (5) species of insect pest and one arachnid found associated with all the strawberry tested in Bataan, which included cutworm (*Spodoptera litura*) and semi-looper that feeds on leaves and stem resulting to irregular shape holes and contributes to the reduction of the strawberry crown (Burrack H. and Teonnisson A., 2014), aphids (*Aphis gossypii*) cause several forms of damage, including stunted shoots, curled and yellow leaves, distorted plants and the formation of galls. As they feed, aphids produce a sticky substance called honeydew. Sooty mold grows on honeydew, harming the appearance of your plants and fruits but not causing them serious damage (homeguides.sfgate.com/strawberry-plants-aphids). Ants (*Solenopsis* sp) and adult beetle-like snout beetle (*Trachycyrtus* sp). that caused stunted growth,

wilting, yellowing, and death of the seedlings (Alimurung *et al.* 2016) Arachnids like spider mites (*Tetranychus urticae*) were also identified that caused graying and yellowing of the leaves, browning, and withering of the flower (Fasulo T. and Denmark H. 2009) the Festival variety were identified as susceptible in spider mites.

B. Diseases In Strawberry

Pathogens like fungus, bacteria, virus, etc. can cause different diseases to strawberry and other crops. On the different varieties tested most prevalent diseases found are Anthracnose fruit rots (caused by *Colletotrichum acutatum* Simmond) and the Angular Leaf Spot disease (ALS) a bacterial disease caused by *Xanthomonas fragariae*, a pathogen highly specific to wild and cultivated strawberry (Legard *et al.*, 2003).

Degree of the severity of diseases on the identified diseases in strawberry shows no significant differences among the three varietal treatments used under Bataan condition, Infected leaves rating ranged from 1%-10% this means that the degree of the severity of infection was at a low level of infection this may be explained because of the study conducted were observed in a confined area (greenhouse) which limits most insects enter that can be a vector of some pathogens that caused diseases.

In addition to this, during the harvesting time, it was also observed that some of the fruits show lesion on the calyx of fruits that are being identical to foliar lesions that leads to the fruit unmarketable, therefore growers must choose carefully on their planting materials to lessen or avoid infections, study shown that Strawberry Festival appears more resistance to pest in insect infestation under Bataan condition compared to Summer Princess and Sweet Charlie, this is accordance to the study of Chandler, (2000), that variety Festival appears to be less susceptible than Sweet Charlie to botrytis fruit rot (caused by *Botrytis cinerea* Pers. ex Fr.) and less susceptible than 'Camarosa' to powdery mildew (caused by *Sphaerotheca macularis* [Wallr. ex Fr.] Jacz. f. sp. fragariae).

Conclusion

It was concluded that in terms of growth adaptability, Sweet Charlie obtained the most prominent character followed by Festival variety and Summer Princess. On the other hand, in terms of Yield performance, all of the varietal treatments tested are comparable to each other, in the study, given that Summer princess revealed as the least in Growth adaptability, study shown that in terms of yield performance summer princess yielded better than the two remaining varieties tested under greenhouse condition. Furthermore, most common insects and diseases identified belong to order Coleoptera, Homoptera, and Lepidoptera while pathogens identified mostly are fungi and bacteria. Further studies may be conducted at the field for a confirmatory test of all the varieties tested, cultural management practices are recommended to find out more promising cultivars that will best adapt to Bataan and Sensory evaluation is also recommended.

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