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Response of Mulching and Organic Fertilizers on the Growth Performance of Strawberry (*Fragaria ananassa* L.) in Southern Philippines

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Abstract

Strawberry is a hybrid species of the genus *Fragaria* that is widely grown worldwide, especially in cool climate areas and are widely cultivated for their fruit. It is one of the important horticultural crops grown in many parts of the world. Strawberries can be grown using organic fertilizers under different mulching technique. This study investigated the growth and yield performance of strawberries to various application of organic fertilizers (vermicast, vermicompost and vermitea) and mulching materials (rice hull and plastic mulch). Planting materials were taken from a healthy, disease-free strawberry (Shoga) and carried out in Split Plot Factorial Design replicated four times. Strawberry plants applied with vermicompost resulted in significantly high percentage survival (99.16%), plant height (21.61 cm) and number of runners (3.93) compared to plants applied with vermicast and vermitea. Moreover, strawberry plants under plastic mulch condition had the highest growth and yield performance in terms of plant height (21.07 cm), number of runners (4.19), number of leaves (6.57) and total number of marketable fruits (48.10). Based on these results, strawberry applied with vermicompost under plastic mulch condition are recommended. Moreover, results can serve as basis for strawberry growers to use effective yet less expensive fertilizer particularly in tropical Philippines.

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Growth Parameters;
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Introduction

In the regions of the Northern Hemisphere known to its temperate climate condition, strawberries are common and locally grown. Most of the cultivated large-fruited strawberry (*Fragaria x ananassa*) are originated in Europe in the 18th century. It was observed during the 19th century that most of the different countries had develop their own strawberry

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varieties given with favorable length of days, climate, altitude and the productivity performance based on its adaptation in particular area or region.[8] Based on the data of FAO statistics, it was reported in 2005, that this perishable crop is widely grown all over the world that includes 73 countries except the continent of Antartica.[14]

According to Milošević in 1997, the ideal pH range of strawberry production is on the range of 4.6-6.5, since this type of crop can be produced in all seasons and could quickly adapt its environment. The market demand and marketability of this crop is high due to expanded culture demand in the markets. Even though the global demand remains high in producing organic strawberries for consumption, consumer demand for these perishables is concentrated in Europe and America.[37] In the US, more than two thirds of the consumers occasionally buy organic products and around 28% buy weekly organic products.[13] Due to its potential demand, the important reasons for the consumers to consume and buy organic foods are the health benefits it provides. Aside from that, it can also help to reduce pesticides, produce safe food as sources of greater nutrition, taste and environmentally farm inputs and practices that enhances biodiversity and soil fertility that also promoted soil health.[24]

The demand for strawberries now exceeds the supply and prices continue to rise. In many locations, organically grown berries command a price premium and owing great local and global market demand to prevent health issues concerning the application of synthetics and chemicals. Moreover, it was also mentioned that organic inputs applied in plants produced higher soil nutrition that contains beneficial microorganisms enhancing production of strawberry in organic based farms resilience to stress with high quality fresh fruits produced.[32] These significant discoveries give grounds for additional explorations that aimed at validating and quantifying their interactions and outcomes. Certification for organic agriculture were continuously increasing in the world. Based on the data in 2000, there were around 10 million hectares (ha) that adopt farmed organically, but in 2006, figure had increased to more than 30 million hectares. Among these areas, there were ten countries that obtained the highest percentage that range from 5-25% of land covered and certified under organic management, led by the European country.

Furthermore, Yessefi 2006 reported that the vast development of organic management started in Europe during the 1990s slowed down, while in North America is going to an opposite trend. Thus, the market for organic products is reporting the highest growth globally.

The demand of strawberry fruits in the Philippines is high, most especially during the holiday season. This type of fruit commands a very high market price particularly in the highlands of Mindanao located in Southern Philippines where most of the areas had a wide potential for strawberry production. One of the gaps identified is the lack of planting materials and appropriate technology for strawberry production. With this identified problem, farmers have limited engagement in strawberry farming.[27]

On the other hand, Polish and Europe strategies considered organic farming as one of the important factors for agricultural sector development for growing and increasing organically fresh produced in the last years.[1] Nevertheless, scarce, and limited information on the availability of classical and new kinds of organic fertilizers like plant extracts[33] or microbial inocula[25] and its effects on plant production are serious tailback and threatening in the future of development sector.

Improving the soil fertility and soil structure by the use of organic amendments such as traditional thermophilic composts, has been acknowledged and become successful,[16] improving microbial populations and diversity,[5] microbial functions,[40] and enhancing the water holding capacity of soils and crop productivity. The influence and use of effective microorganisms have been associated with their ability to reduce soil-borne plant diseases[11] plant parasitic nematode population and crop productivity.[17]

On the other hand, the application of mulching has strong effects on the quality, productivity and harvesting that primarily influenced soil moisture conservation, regulates availability of nutrients in the soil, microbial activity, enhanced soil fertility, inhibits the growth of weeds and reduction of dirty

and diseased strawberries.[34] Productivity and yield of strawberry were affected by increasing of 68 to 33% when subjected to mulching condition.[4]

This paper investigated the growth and yield performance of strawberry (Shoga variety) using different mulching materials and organic fertilizers. Assessing the effects of organic fertilizers and mulching application is important to enhance the productivity of strawberries without too much extensive application of chemicals. The use of organic production excludes the use of chemical fertilizers and conventional pesticides that requires integrated post controls and soil building.

The objective of this study is to evaluate the effects on the growth and yield of strawberry using different mulching and organic fertilizers (vermitea, vermicompost and vermicast). Moreover, result can serve as basis for strawberry growers to use effective, eco-friendly yet less expensive fertilizers.

Methodology

Study Site

The study was conducted at Sitio Sayaban, Barangay Ilomavis, Kidapawan City Philippines (Latitude: 6.735009; Longitude: 124.818287) from December 2015- March 2016. The area has an elevation of 756.5 meters above sea level

Planting Materials

Strawberry (Shoga variety) runners of about 1 month old were obtained from Meperanum's farm at Barangay Kisante, Makilala North Cotabato, Philippines. The area was maintained as source of healthy and disease free planting materials ensuring uniformity in terms of the size, shape and age of sample plants.

Experimental Set-up

Mulching Materials Experiment

The growth and yield performance of strawberries using different mulching materials were investigated (Figure 1). Application of mulching materials were done three days before planting the strawberry runners. Ten sample plants/ plot with a total size of 0.5 x 3 m were used in data gathering. The following mulching materials used in the experiment are the following (without mulching (control), plastic mulch, and rice hulls).

Fig. 1: The actual experimental set-up of the study located at Barangay Ilomavis, Kidapawan City, North Cotabato, Philippines.

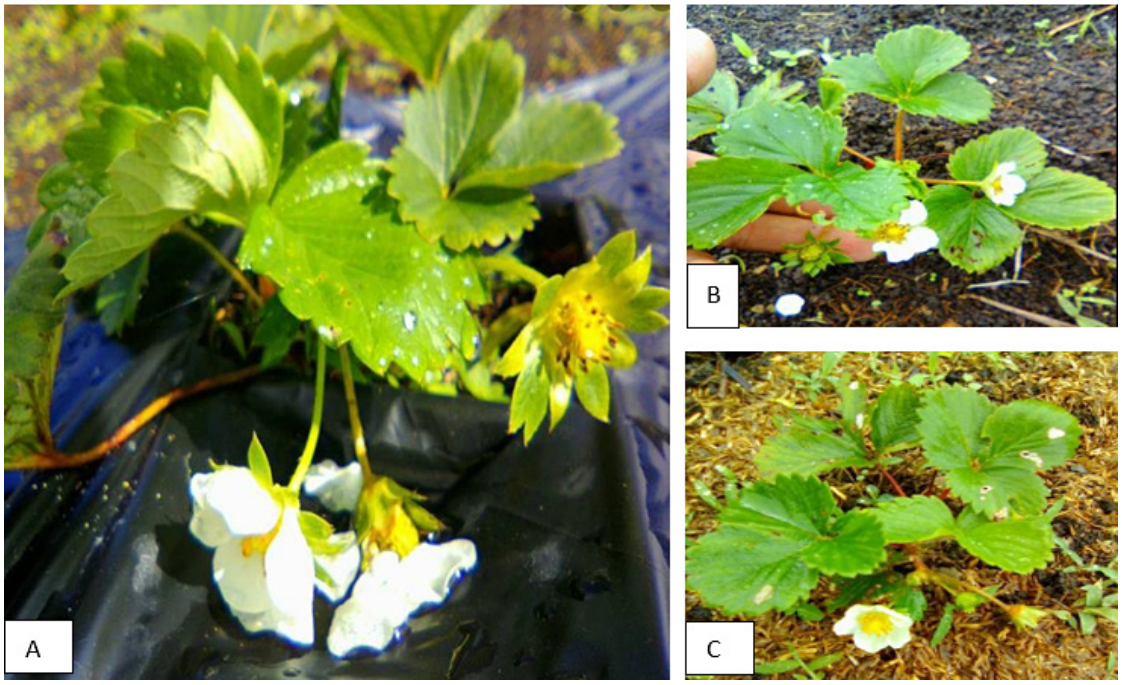

Fig: 2. Blooming stage of random sample strawberry plants subjected to different mulching conditions (a-Mulching, b-unmulch, c- rice hull) two months after transplanting.

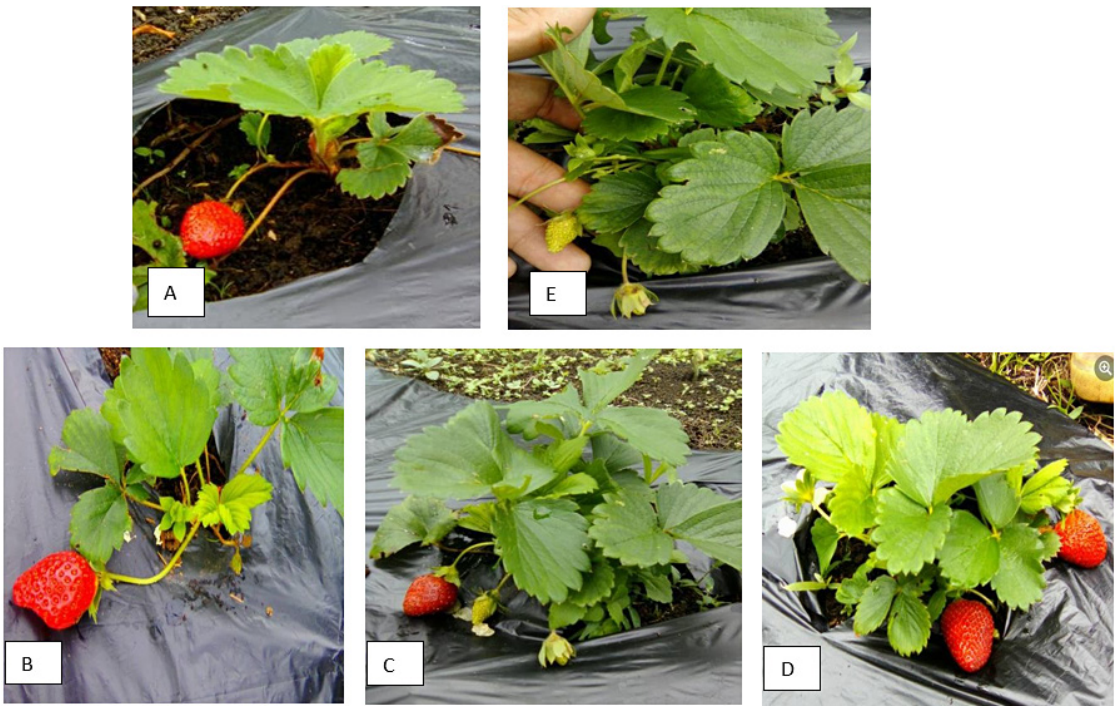

Fig: 3. Fruit stage of random sample strawberry plants applied with different organic fertilizers under mulching conditions (a-Control/ w/out application, b- vermitea, c-vermicompost, d-vermicast, e-complete fertilizer (14-14- 14)/standard check) three months after transplanting.

The area was maintained by manual weeding and cleaned thoroughly for planting of strawberry plants. The arrangement of the plants were set in a Split Plot Factorial Design with 4 replications per treatment. There were 12 treatment combinations with 10 sample plants used per replicate.

Organic Fertilizers Experiment

The growth and yield performance of strawberry applied with different organic fertilizers were investigated. The organic fertilizers used in strawberry plants are vermicompost and vermicast which were applied using the localized placement method at 100 g/plant and vermitea through drenching application method at 50 ml/plant. Inorganic fertilizer (14-14-14) as standard check were also applied at 10 g/plant, application of all treatments were done every 15 days for the next three months. Fertilizers were obtained from a local commercial market located within the locality.

Table 1 : Growth and yield parameters of strawberry plants as influenced by different organic fertilizers at 90 days after transplanting.

Treatments	Percentage** Survival (%)	Plant** Height (cm)	Number of** Runners	Number of^{ns} Leaves	Days to^{ns} Flowering	Marketable^{ns} Fruits/plot	Non-Marketable^{ns} Fruits/plot
Control	94.38^{c}	19.41^{c}	3.58^{b}	6.07	14.9	45.08	8.83
Vermitea	98.34^{ab}	19.87^{c}	3.89^{b}	6.14	13.7	46.83	8.33
Vermicompost	99.16^{b}	21.61^{a}	3.93^{a}	6.22	13.2	48	7.83
Vermicast	100^{a}	20.21^{ab}	3.81^{b}	6.56	13.4	46.92	8.25
Inorganic (14-14-14)	100^{a}	19.41^{ab}	3.81^{b}	6.6	12.9	46.33	7.75

** significant

^{ns} not significant

Means in a column having different superscripts are significantly different ($p<0.05$) (Tukey's test)

Mulching Application and Planting of Runners

For mulching application, plastic mulch with 4 feet width and 30 microns thickness and 5 kg of rice hulls/plot were applied and used before planting the strawberry seedlings. Sample plants were carefully planted at 10 x 10 cm distance of planting in previously prepared plots.

Care and Management

Watering of planted runners were immediately done after planting and as often as necessary depending on the moisture condition of the soil. Manual weeding was also done to maintain the cleanliness of the experimental area and weed- free condition of all plots during the conduct of the experiment.

Plant Growth and Yield Assessment

Growth and yield parameters such as percentage survival (%), number of runners, number of leaves, days to flowering, number of marketable fruits (g) and non-marketable fruits (g) produced were counted while plant height (cm) were measured using a measuring tape in centimeter reading at 90 days after transplanting.

The percentage survival (%) was computed using the formula

Number of survived strawberry plants / Total number of strawberries planted x 100%.

Data Analysis

Data gathered were subjected to appropriate statistical data analysis. F-test through the Analysis of Variance (ANOVA) was used. The level of significance was set at 5%, and significant differences were analyzed using Tukey's post-hoc test.

Results and Discussion

Organic Fertilizer Experiment

Table 1 shows the data on the percentage survival (%), plant height (cm), number of runners, length

of runners (cm), number of leaves, days to flowering, marketable fruits and non-marketable fruits of strawberry using different organic fertilizers (shoga) 90 days after transplanting. With growth parameters measured, significant differences were found only in percentage survival, plant height and number of runners. Strawberry applied with vermicast and inoganic fertilizer (standard check) produced the highest percentage survival (on average, 100%) while plants applied with vermicompost produced the tallest plant height (on average, 21.21 cm) and number of runners (on average, 3.93 cm).

No significant differences were observed on number of leaves, days to flowering, total number of marketable and non-marketable fruits.

The result indicates that the application of vermicast and vermicompost enhance the survival and growth of strawberry plants. Moreover, application of vermicompost produced more runners for strawberry plants which is essential to strawberry seedling production. The result agrees with the findings of Adhikary (2012) that vermicompost obtained great number of humic acids and plant growth hormones that act as growth regulators of the plant that enhances growth responses. Furthermore, it also contains enzymes that helps break down the organic matter in the soil to release available nutrients needed by plant available for root absorption for plant growth and development. Several studies have also been done which shows that vermicompost has an effective role in improving growth of different agricultural crops such as agronomic crops, fruit crops, ornamentals and various vegetables.[7,31,6,21,29,18,10] In addition, the application of vermicompost to plants provides supplementary dose that enhances crop productivity and soil fertility that makes macronutrients such as the nitrogen, phosphorus and potassium available to plant. Aside from that, soil application of vermicompost contains rich beneficial microorganisms, microbial populations and diversity that provides microsites for microbial functions that benefit plant growth.[3]

Moreover, finding of the study agree with Umar *et al.* (2009) who narrated highest runners per plant in strawberry was found in plants applied with vermicompost in combination with PM + Azotobacter + wood ash + oil cake application. The increase in terms of the number of runners per plant produced is basically due to the increased of plant growth in the form of number of leaves, height that accumulates photosynthates thereby increasing the runners of strawberry.

Table 2: Growth and yield parameters of strawberry plants as influenced by different mulching at 90 days after transplanting.

Treatments	Percentage** Survival (%)	Plant** Height (cm)	Number of** Runners	Number of^{ns} Leaves	Days to^{ns} Flowering	Marketable^{ns} Fruits/plot	Non-Marketable^{ns} Fruits/plot
Control	95.00	19.06^{c}	3.52^{c}	6.43^{b}	14.03	43.35^{b}	8.83
Rice hull	99.00	19.90^{b}	3.74^{b}	6.57^{a}	13.52	46.45^{b}	8.33
Plastic Mulch	99.00	21.07^{a}	4.19^{a}	6.57^{a}	13.32	48.10^{a}	7.83

** significant

^{ns} not significant

Means in a column having different superscripts are significantly different ($p<0.05$) (Tukey's test)

Mulching Application Experiment

Table 2 shows various data on the percentage survival, plant height, number of runners, length of runners, number of leaves, days to flowering, total number of marketable fruits and non-marketable fruits of strawberry applied with different mulching application (shoga) 90 days after transplanting. The only significant differences were found in plant height, number of runners, number of leaves and total number of marketable fruits. Each of

these parameters, strawberry applied with plastic mulch registered the tallest plant height (21.07 cm), most number of runners (4.19) leaves (6.57) and marketable fruits (48.10). Comparable result was also noted on the number of leaves (6.57) of strawberry plant applied with rice hull as mulching material.

Consequently, it was found that plastic mulch improves the yield of the crops and soil moisture condition.[9,20,28,30,35] Similar results were also found that used of plastic mulch technique enhance growth, emergence and maturity of several vegetables including the cucumber and tomato,[38] beet and Chinese cabbage.[12] It was also reported that there is an increased crop growth (3.2-4.0 cm), nitrogen fixing activity in plant, dry root mass, and the chlorophyll content of leaves and more active buds in polyethylene mulched plots than un mulched plots.[19] Furthermore, the application of plastic film mulching conserved soil moisture that promotes the growth of the roots for improved water uptake from the deep soil and increase yield productivity.[22]

In addition, mulching improved microbial activity, enhanced oxygen availability, soil environment, moderates soil temperature, increased soil porosity, reduced water loss through leaching, control weeds, increases the availability of nutrients, reduce soil compaction, runoff and soil erosion, and increased plant growth, yield of fruit quality.[23,15]

Conclusion and Recommendations

This study investigated the effect of various types of organic fertilizers and mulching on the growth and yield performance of strawberry. The best performance in terms of the percentage survival is the strawberry plants applied with vermicast while plants applied with vermicompost had the best performance in terms of the number of runners and plant height. The application of vermicompost significantly increased the growth of strawberry plants and production of runners.

Among the application of different mulching materials, strawberries in plastic mulch condition had the best performance in terms of the plant height, number of runners, number of leaves and total number of marketable fruits. Based on these results, growing strawberries applied with organic vermicompost under plastic mulch condition is recommended for production of strawberry seedlings and marketable strawberry fruits.

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Conflict of Interest

No potential conflict of interest was declared by the authors.

Author's Contribution

The author carried out the experimental design and treatments, developed the conceptual framework, verified the analytical methods, and performed the data gathering and monitoring of the study. The author discussed the results and contributed to the final manuscript.

Data Availability Statement

'Not applicable'

Ethics Approval Statement

'Not applicable', no humans and animals were involved throughout the conduct of the experiment

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