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Research Article

Productivity and Profitability of Tomato (*Lycopersicum esculentum* M.) Production in Masbate Under Improved Nutrient Management with and without Mulching

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ABSTRACT

Field trial on tomato production was conducted under two sources of fertilizer through integrated application with and without mulching material to measure the growth, productivity and profitability of the said crop in the province of Masbate. The study was laid in a two-factor factorial Randomized Complete Block Design. Fertilizer treatments were tested in treatment of mulching (rice straw and control). The factorial treatment combinations were as follows: A₁B₁ - no fertilizer and without mulching; A₂B₁ - complete fertilizer without mulching; A₃B₁ - goat manure without mulching; A₄B₁ - complete fertilizer + goat manure without mulching; A₁B₂ - no fertilizer and with mulching; A₂B₂ - complete fertilizer with mulching; A₃B₂ - goat manure with mulching; A₄B₂ - complete fertilizer + goat manure with mulching. The study revealed that the treatment that exhibits higher growth (plant height and number of branches) and yield (38.41 t/ha.) is in the treatment under complete fertilizer + goat manure. The same treatment also obtained higher number of fruits (543) and higher number of marketable fruits (424) per treatment with significant difference. In terms of the fruit size, length and diameter of the tomato, complete fertilizer + goat manure shows dominant effect. Profitability showed significant difference between treatments were the complete fertilizer + goat manure, complete fertilizer, goat manure, and control got 1,334, 1,265.15, 517.51 and 52.20 respectively. Therefore, the integration of organic (goat manure) and synthetic fertilizer (Triple 14) will enhance the yield of the tomato in Masbate and it is highly profitable.

Keywords: Complete fertilizer, Goat manure, Integrated fertilizer, Masbate, Tomato

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Introduction

Tomato (*Lycopersicon esculentum* Miller) is one of the most important fruit vegetables grown in the Philippines because of its utilization such as ingredient in many dishes, raw materials for sauces, drinks and a source of income to the farmers. Having its utilization and importance, another fascinating fact about tomato is it is a rich source of vitamin A and C and folic acid and contain a different beneficial nutrients and antioxidants (PSA-Cost and Return of Tomato, 2018). With this fact, it is therefore essential to include tomato in human diet. Tomato production in the Philippines is 214,573 metric tons in year 2014, most of it produced from Bukidnon, Ilocos, Pangasinan, Nueva Ecija and Quezon. In Masbate having a total volume of production of 71,000 kilograms for 890,000 people in 2014 is not enough making it to be supplied by other provinces which makes the product more expensive because of additional cost from transportation and make it unaffordable for the least fortunate Masbateños (PSA – Major Crops Statistics, 2015).

To produce tomato in the province, the concept of crop production is needed because it is the art and science of producing crops, having the goal of abundant productivity and quality in order to produce profit while protecting the degradation of natural resources (Lantican, 2001). Basically, in order to maximize the efficiency and productivity, the use of improve genetic variety, fertilizer application, pest management, mechanization, and other cultural practices must be fully understood for best productivity to supply the increasing demand of human population.

One of the limiting factors in crop production is the availability of nutrient elements present in the soil. To maximize the efficiency and productivity of tomato production, correct volume and timing of fertilizer application is necessary and it will only be achieved by synthetic fertilizer supplementation. However, while aiming for this goals, various problems such as soil degradation and soil microbial population reduction is the negative effect (Lin, et.al, 2019). On the other hand, according to Ye, et.al (2020), organic fertilizer has a good benefit to the soil properties and does help the crop

production but it is not the same with the benefits given by synthetic fertilizer.

With this concern, as the world's population is exponentially increasing and food production is increasing arithmetically, the problem in food sufficiency and the goal to end hunger will not be materialized. In fact, there are still so much people all over the world who experience starvation. Furthermore, with the current population and current tomato production in Masbate, it is therefore highly needed to produce tomato in the province to prevent the high price of this in demand vegetable and lower its prices and make it affordable for all. Therefore, the importance of this study on the productivity of tomato in Masbate is highly significant and the integration of these two fertilizers and mulching material with both advantage and disadvantage was under investigation to help in the sustainability of vegetable production in Masbate and to supply the necessary vegetable without compromising the integrity of the natural resource base.

The very objective of this study is to determine the productivity and profitability of tomato in Masbate under the influence of complete fertilizer (T₁₄), goat manure and complete fertilizer + goat manure under rice straw as mulching material. The specific objectives of the study are the following; (1) to evaluate the vegetative growth and yield of tomato under different types of fertilizer and mulching media; (2) to determine the profitability of tomato production in Masbate.

Methods

The field experiment was conducted at the experiment area of Dr. Emilio B. Espinosa Sr. Memorial State College of Agriculture and Technology (DEBESMSCAT) – Cawayan Campus at Barangay Poblacion, Cawayan, Masbate.

Research Materials

The materials used in the experiments were tomato seeds variety Diamante Maxx F1, goat manure, Triple 14 (NPK 14) fertilizer and rice straw.

Crop Establishment and experimental design

Tomato seedlings were planted in 348.75m² field at 28 days after sowing with a

planting distance of 0.70m x 0.60m. The experimental field were divided into 24 plots, each plot measured 2 x 5 meter in size with 0.5 meter in space between each plot. Goat manure and triple 14 fertilizer were used during fertilization as plant treatments. Goat manures were bought from goat farm within the locality and it was applied three days before transplanting. The study was laid in a two-factor factorial experiment in Randomize Complete Block Design (RCBD)

Treatment application

Two different sources of fertilizer were used as treatments, organic source was a goat manure and the synthetic fertilizer source was the triple 14 (NPK 14). Fertilization of goat manure was conducted three days before planting with a doses of 0, 8.5, 4.25 ton/hectare for control, pure goat manure and goat manure + triple 14 respectively. While for the triple 14 fertilization, it was applied in a weekly basis with 0, 10g, 5g per plant for control, pure synthetic and goat manure + triple 14 respectively.

Observed parameters and statistical analysis

Observed parameters were plant height, number of branches, number of fruits, yield per plot, yield per hectare and the cost and return analysis. The plant height and number of

branches were observed at 42 Days after transplanting (DAT) while the number of fruits, yield per plot, yield per hectare and the cost and return analysis were collected and computed at the end of the three-priming activity. The total sampling size per experimental unit is eight plants with 24 plants per experimental unit. The data were analyze and process according to Analysis of Variance (ANOVA) and Duncan's Multiple Range Tests (DMRT) using SAS on Demand for Academics, an online interface of SAS by N. Cary.

Results and Discussion

Plant Height of Tomato as Affected by Treatment

Plant height of tomato was collected at 42 DAT which is at the reproductive stage already of the tomato. Table 1 shows that in factor A (type of fertilizers), there was a significant effect on goat manure and complete fertilizer and complete fertilizer + goat manure. Complete fertilizer is 16.01 centimeter taller than goat manure treatment with plant height of 84.06cm and 100.07cm, respectively. However complete fertilizer is not significantly different to treatment of complete fertilizer + goat manure with very small plant height difference with each other, complete fertilizer + goat manure got a mean of 100.21cm.

Table 1. Plant height (cm) of tomato due to application of rice straw and different fertilizer at 42 days after transplanting (DAT)

Mulching Material	Type of Fertilizers				Mean
	Control	Complete Fertilizer	Goat Manure	Complete Fertilizer + Goat Manure	
Control	64.58	77.54	69.88	87.92	74.98 ^a
Rice Straw	35.33	83.08	74.96	81.00	68.59 ^a
Mean	49.96 ^a	80.31 ^b	72.42 ^{ab}	84.46 ^b	

c.v. = 13.63%

Mean values followed by same letter within column did not differ significantly according to Duncan's multiple range tests (P < 0.05).

In terms of factor B, with and without rice straw mulching, the data reveal that there was no significant effect observed between the two means. In addition, interaction between two factors has no significant effect as well. Furthermore, in terms of the means of the

treatment combination, it shows that tomato plants treated with complete fertilizer with mulching are slightly taller (105.88cm) compared with other treatments, except to those tomato plants treated without fertilizer and mulching.

The reason behind such difference is relative to the study conducted by Kumar, et.al (2019) which started that incorporation of farm yard manure and half dose of synthetic fertilizer can make a good plant development. Further, the result of experiment in Bangladesh Agricultural University reveals similar results with significant difference exhibited among treatment of different fertilizer used and the integrated fertilizer shows dominant plant height compare to the other fertilizers (Islam, et.al, 2017).

Thus, plant height of tomato increased by application of fertilizer treatments, but for more improved plant growth, application of goat manure + complete fertilizer is highly recommended. According to Lamp'1 (2018), organic fertilizer is bearing a large number of benefits. Organically derived fertilizer stimulates beneficial soil microorganisms and it improves soil structure for better nutrient absorption, organic fertilizer has numerous contents of micronutrients that is needed in plant growth and development and these micronutrients is not available in all synthetic fertilizer. While synthetic fertilizers bear good benefits such as fast-acting and water-soluble fertilizer that can be taken up by plants immediately thus making its effect instant. This kind of fertilizer

is the most used by the crop producers because it is readily available, available in large number and its analysis grade is greater as well and it is make cost effective according to the same author.

Number of Branches of Tomato as Affected by Treatment

The number of branches is the second growth parameter that was collected and analyzed in this study. Collecting the number of branches of tomato for this study is essential since this is a good indicator of a good plant growth development (Rimando, 2001). The data was collected at 42 DAT as well. The result show significant effect between control and other type fertilizer applied. But there is no significant difference between the three types of fertilizers against each other for the second data collection. This result is very good observation that will guide the beneficiaries of the result that applying organic fertilizer (goat manure) has no similarity with no application on a statistical basis, same with applying half of synthetic fertilizer to full or pure synthetic fertilizer. This is because of the fact that the organic fertilizer has low nutrient content than synthetic fertilizer as mentioned by Lin. W. et.al, (2019).

Table 2. Number of branches of tomato due to application of rice straw and different fertilizer at 42 days after transplanting (DAT)

Mulching Material	Type of Fertilizers				Mean
	Control	Complete Fertilizer	Goat Manure	Complete Fertilizer + Goat Manure	
Control	3.29	9.63	8.33	10.00	7.81 ^a
Rice Straw	4.04	9.88	8.38	9.42	7.93 ^a
Mean	3.67 ^a	9.76 ^b	8.36 ^b	9.71 ^b	

c.v. = 15.55%

Mean values followed by same letter within column did not differ significantly according to Duncan's multiple range tests ($P < 0.05$).

Days of Flowering of Tomato after transplanting.

Table 3 shows the data for the days to flowering. The data reveals that there was no significant difference between the types of fertilizers. However, significant difference was observed in tomato treated with complete fertilizer +

goat manure and goat manure alone with number of days of 23.04 and 25.09 respectively.

In terms of factor on mulching, the interaction of the two factors and the treatment combination, there was no significant differences that was observed on the days of flowering to tomato after transplanting.

Table 3. Number of days of flowering after transplanting

Mulching Material	Type of Fertilizers			Mean	
	Control	Complete Fertilizer	Goat Manure		Complete Fertilizer + Goat Manure
Control	28.00	26.25	25.96	23.33	25.89 ^a
Rice Straw	26.25	28.88	24.21	22.75	25.52 ^a
Mean	27.13 ^{ab}	27.57 ^{ab}	25.09 ^b	23.04 ^a	

c.v. = 11.91%

Mean values followed by same letter within column did not differ significantly according to Duncan's multiple range tests ($P < 0.05$).

Yield of Tomato per Treatment

Data on table 4 show that there is a significant difference on tomato treated with complete fertilizer + goat manure 38.41 in terms of yield with other treatments in terms of type of fertilizers. On the other hand, no significant difference observed for the mulching materials in terms of yield of tomato. In addition, the study reveals that there is no significant difference as well for the interaction of the two independent variable.

However, in terms of the difference on treatment mean, various significant differences was observed in the yield of tomato but treatment on complete fertilizer + goat manure with no mulching got the highest yield with 39.92 kilogram per plot, followed by complete fertilizer with mulching with 39.83 kilograms, 36.89 kilograms and 35.54 kilograms for complete fertilizer + goat manure without mulch and complete fertilizer without mulch respectively.

It indicates that the application of pure synthetic fertilizer is comparable to the yield of the complete fertilizer + goat manure which is just half of the recommended application of

synthetic fertilizer. Moreover, it was observed that even the application of organic (goat manure) is in highest application based on the nutrient content of the manure, it is still cannot yield much as pure synthetic fertilizer do.

The result on the yield of tomato is similar with the result of study like the study of Islam, et. al (2017), where in the highest yield of tomato was obtained from the treatment of complete fertilizer + manure. Furthermore, in the study conducted by Abera, et.al (2018), in combining organic and synthetic sources of fertilizer in a study reveals that the higher yield were obtained with the sole recommended nitrogen and phosphorus and the use of integrated 50 percent conventional compost and 50 percent vermicompost.

On the other hand, result of the seven years study conducted by Chand, et. al (2006) on the effect of combining organic and synthetic fertilizer on mustard production shows that with the combination of the two types of fertilizer there is a positive effect on the productivity of mint and mustard and there is good availability of N and P in the soil, thus making the production sustainable.

Table 4. Average yield of tomato per treatment (Kg) due to application of rice straw and different fertilizer

Mulching Material	Type of Fertilizers			Mean	
	Control	Complete Fertilizer	Goat Manure		Complete Fertilizer + Goat Manure
Control	9.26	35.54	21.55	39.92	26.57 ^a
Rice Straw	6.2	39.83	16.89	36.89	24.95 ^a
Mean	7.73 ^a	37.69 ^c	19.22 ^b	38.41 ^c	

c.v. = 20.80%

Mean values followed by same letter within column did not differ significantly according to Duncan's multiple range tests ($P < 0.05$).

In addition, the table below is just a conversion of the table on the yield of tomato per treatment. Data on integrated fertilizer shows dominant yield difference with other treatment. The yield is near to the national average yield per hectare of the variety diamante max

f1 which is 40 tons per hectare. This is a good reference for the Masbateño who want to engage in vegetable farming since it can compete with the other province in terms of productivity.

Table 5. Average Yield of tomato per treatment in tons per hectare due to application of rice straw and different fertilizer

Mulching Material	Type of Fertilizers				Mean
	Control	Complete Fertilizer	Goat Manure	Complete Fertilizer + Goat Manure	
Control	9.26	35.54	21.55	39.92	26.57 ^a
Rice Straw	6.20	39.83	16.89	36.89	24.95 ^a
Mean	7.73 ^a	37.69 ^c	19.22 ^b	38.41 ^c	

Number of Fruit per Plot

The table on table 6 shows the average number of harvested fruits of tomato for the three priming during the conduct of the study. The treatment with integrated fertilizer shows huge number of fruits compare to the other treatment which has a difference of 423 and 285 for control and organic respectively. It has also big difference with synthetic fertilizer but

it has no significant difference unlike with the later which has a significant difference. Number of fruits is related to the yield since the greater number of fruits you have the heavier yield you can get. Similar result was observed to the study of Purbajandi et al, (2019) where he stated that the higher number of fruits was obtain with the application of 2/3 organic and 1/3 synthetic.

Table 6. Average number of fruits per treatment due to application of rice straw and different fertilizer

Mulching Material	Type of Fertilizers				Mean
	Control	Complete Fertilizer	Goat Manure	Complete Fertilizer + Goat Manure	
Control	123.67	500.33	292.67	505.33	355.50 ^a
Rice Straw	117.00	495.33	224.33	580.67	354.33 ^a
Mean	120.33 ^a	497.83 ^c	258.50 ^b	543.00 ^c	

c.v. = 26.53%

Mean values followed by same letter within column did not differ significantly according to Duncan’s multiple range tests (P < 0.05).

Contrary, the yield of tomato treated with organic fertilizer in terms of number of fruits was lower because of the reason that organic fertilizer is sometimes more expensive than synthetic fertilizer, volume of fertilizer is larger than synthetic and because it is slow-release type of fertilizer, the effect on crops is not being seen right away and that might affect the growth and yield in the production according to Lamp’l, J. (2018). Moreover, according to Ye. L, et.al (2020) organic fertilizer is always

associated with lower yield of crops and thus a higher cost.

Number of Marketable fruits per plot

In terms of number of marketable fruits per plot, data reveal that there was significant difference observed in different fertilizer application. Similar to the result on the number of fruits, still tomato treated with complete fertilizer + goat manure and complete fertilizer has higher number of marketable fruits with 424

pieces compared to the goat manure applied to the tomato which as only 196.87 and 98.17 for control.

For factor B, no significant difference between the mulching treatment was observed same with the interaction with the two factors. Significant difference was observed but the treatment on complete fertilizer + goat manure

with rice straw has the greatest number of marketable fruits with 452.33 fruits.

For the comparison of treatment mean, 452.33 is the highest number of marketable fruits which is the treatment of tomato under complete fertilizer + goat manure with mulching material, this figure is significantly different with other treatment mean.

Table 7. Average number of marketable fruits per treatment due to application of rice straw and different fertilizer

Mulching Material	Type of Fertilizers				Mean
	Control	Complete Fertilizer	Goat Manure	Complete Fertilizer + Goat Manure	
Control	96.33	379.33	226.33	395.67	274.42 ^a
Rice Straw	100.00	354.33	167.00	452.33	268.42 ^a
Mean	98.17 ^a	366.83 ^c	196.67 ^b	424.00 ^c	

c.v. = 26.32%

Mean values followed by same letter within column did not differ significantly according to Duncan's multiple range tests (P < 0.05).

Number of Non-Marketable fruits per Plot

Table 8 presents the table for the non-marketable fruit which pertains to the fruits not suitable for market because of some deformities and damages. Data reveal that tomato with no treatment or control has the lowest number

of non-marketable with 22.17 and it was followed by the treatment applied with goat manure, complete fertilizer and the treatment applied with complete fertilizer got the highest number of non-marketable fruits equivalent to 131 fruits.

Table 8. Average number of non-marketable fruits per treatment due to application of rice straw and different fertilizer

Mulching Material	Type of Fertilizers				Mean
	Control	Complete Fertilizer	Goat Manure	Complete Fertilizer + Goat Manure	
Control	27.33	121.00	66.33	109.67	81.08 ^a
Rice Straw	17.00	141.00	57.33	128.33	85.92 ^a
Mean	22.17 ^a	131.00 ^c	61.83 ^b	119.00 ^c	

c.v. = 36.59%

Mean values followed by same letter within column did not differ significantly according to Duncan's multiple range tests (P < 0.05).

When it comes to the mulching, no significant difference was observed same as to the interaction of the two factors. However, based on treatment combination, significant difference was observed on tomato treated with complete fertilizer with mulching as it got the greatest number of non-marketable fruit with 141 fruits.

The statistical data also tell us that there is a significant difference among this figure. This means that the treatment with the highest number of fruits also exhibit highest number of non-marketable which should be corrected with further related studies for improvements because these fruits can still be possible income for the growers.

Fruit Size of Tomato in terms of length and diameter (cm)

Fruit size of tomato is one of the bases for the quality of the product - the bigger the size, the better. In this part of the study, fruit length and diameter were gathered and measured accordingly using a caliper for each sample fruits in each treatment. Data reveal that significant difference was observed between the type of fertilizer where in control treatment has the smallest fruit with 3.65 cm length while the complete fertilizer + goat manure got the biggest fruit with 4.37 cm length.

In terms of the diameter of the tomato fruit (figure 9.1), significant difference is still present among the treatments with 3.90 cm mean for complete fertilizer + goat manure, 3.89 cm mean for the complete fertilizer, 3.62 cm mean for the goat manure and 3.18 cm mean for the control.

As presented, the complete fertilizer + goat manure application got the top spot for the biggest fruit and it is similar to the data of Purba-jandi, et. al, (2019) wherein in terms of fruit length of tomato and its diameter, the combination of organic and synthetic fertilizer got the best fruit size.

Table 9. Average fruit size of tomato in terms of its length (cm) due to application of rice straw and different fertilizer

Mulching Material	Type of Fertilizers				Mean
	Control	Complete Fertilizer	Goat Manure	Complete Fertilizer + Goat Manure	
Control	3.93	4.30	4.20	4.35	4.20 ^a
Rice Straw	3.36	4.34	4.02	4.39	4.03 ^a
Mean	3.65 ^a	4.32 ^b	4.11 ^b	4.37 ^b	

c.v. = 5.0%

Mean values followed by same letter within column did not differ significantly according to Duncan's multiple range tests ($P < 0.05$).

In terms of the diameter of the fruit (table 10) significant difference still present among the treatments with 3.90cm mean for integrated, 3.89cm mean for the synthetic, 3.62cm mean for the organic and 3.18cm mean for the control.

As presented, the integrated fertilizer application got the top spot for the biggest fruit and it is similar to the data of Purba-jandi et al, (2019) where in in terms of fruit length of tomato and its diameter, the combination of organic and synthetic fertilizer got the best fruit size.

Table 10. Average fruit size of tomato in terms of its diameter (cm) due to application of rice straw and different fertilizer

Mulching Material	Type of Fertilizers				Mean
	Control	Complete Fertilizer	Goat Manure	Complete Fertilizer + Goat Manure	
Control	3.37	3.84	3.66	3.92	3.70 ^a
Rice Straw	2.98	3.93	3.57	3.89	3.59 ^a
Mean	3.18 ^a	3.89 ^c	3.62 ^b	3.90 ^c	

c.v. = 4.74%

Mean values followed by same letter within column did not differ significantly according to Duncan's multiple range tests ($P < 0.05$).

Profitability and Cost and Return Analysis

Profitability and return of investment are one of the motivations for the crop producers. Even Lantican (2001) defined crop production as the art and science of producing crops, aimed at increasing productivity and quality of

the product in order to maximize monetary return however, should minimize the negative environmental effects. The figure below (Table 11) is the summary of the net income of the study per treatment.

Table 11. Net income of tomato per treatment due to application of rice straw and different fertilizer

Mulching Material	Type of Fertilizers				Mean
	Control	Complete Fertilizer	Goat Manure	Complete Fertilizer + Goat Manure	
Control	355.79	3498.05	1859.37	4201.22	2478.61 ^b
Rice Straw	-42.58	4092.83	1245.72	3807.67	2275.91 ^a
Mean	156.61 ^a	3795.44 ^c	1552.55 ^b	4004.45 ^d	

c.v. = 0%

Mean values followed by same letter within column did not differ significantly according to Duncan's multiple range tests (P < 0.05).

Separately, mulching materials and type of fertilizer shows significant difference. However, significant difference was not observed between the interaction of the two factors. In addition, in terms of the net income among the type of fertilizers, all treatments are statistically significant to each other and the treatment with the highest return was the treatment with complete fertilizer + goat manure with 1,334.81 php, followed with 1,265.15 php for the complete fertilizer, goat manure with net income of 517.51 php and lastly with 52.20 php for the control.

Under the type of mulching, it was revealed that tomato with control treatment or the treatment with no mulching got the higher net income compared to the rice straw. Reason behind this is because of the additional cost incurred in applying rice straw without any return.

Furthermore, tomato treated with complete fertilizer + goat manure without mulching material shows greater net income with 1400, followed by complete fertilizer with rice straw with 1364.28 income, complete fertilizer without mulching with 1166.02, 1269.22 for complete fertilizer + goat manure with mulching, and these are all significantly different with control and goat manure with income of -14.19 and 118.60 pesos only.

The data showed is very promising if it will be tried in a hectare basis for the vegetable producers in the province of Masbate.

In terms of the return on investment (ROI), this was obtained by dividing the net income from the cost of investment the multiply by 100. Similar to the net income, still control got the highest ROI than the treatment with rice straw. While treatment with integrated fertilizer got the highest ROI, followed by synthetic fertilizer, organic and control.

Table 12. Return on investment (ROI) of tomato per treatment due to application of rice straw and different fertilizer

Mulching Material	Type of Fertilizers				Mean
	Control	Complete Fertilizer	Goat Manure	Complete Fertilizer + Goat Manure	
Control	39.78	269.22	177.18	353.66	209.96
Rice Straw	-4.84	318.68	120.42	324.63	189.72
Mean	17.47	293.95	148.80	339.15	

Conclusion

Based on the findings, the following conclusions were formulated:

1. Application of rice straw as mulching material did not significantly improve the growth and yield of tomato.
2. The application of the combination of complete fertilizer and goat manure significantly improve the growth parameters and yield of tomato.
3. The application of combined complete fertilizer and goat manure increase the profit from tomato.
4. There was no interaction effect between type of fertilizer and mulching materials.

Recommendation

Based on the conclusions arrived at the study, the following recommendations are given:

1. Utilization of integrated fertilizer management should be applied to tomato production for better growth, better yield and better profit.
2. Application of rice straw as mulching materials in tomato is not recommended.
3. It is also recommended to conduct similar study to other crops and in long term study for more reliable impact on the crop production.
4. Conduct of soil laboratory testing should be included for more holistic data.

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