

## **BIBLIOGRAPHY**

NAHAMA, JAKE L. APRIL 2013. Performance Trial of Eight Tomato(*Lycopersiconesculentum* Mill.) Cultivars Under Tadiangan, Tuba, Benguet Conditions. Benguet State University, La Trinidad, Benguet.

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## **ABSTRACT**

The study was conducted at Tadiangan, Tuba, Benguet from November to March 2012 to determine the growth and yield performance of the eight tomato cultivars and to determine the economics of growing the different varieties of tomato under Tadiangan, Tuba, Benguet condition.

Results of the study showed that all the eight tomato cultivars evaluated took 30 days from sowing to the transplanting stage of the seedlings. Avatar variety was the earliest to flowering from transplanting among the varieties tested and first fruit were harvested within 58 days from transplanting.

Avatar and Apollo produced significantly highest fruit number per plant and per plot among the tomato cultivars studied. Avatar variety gave the significantly highest marketable fruit yield per plot and per hectare. The Rocky variety produced the heaviest fruit. Malakas and Maganda varieties were moderately resistant to late blight infection and insect pests infestation. All the tomato cultivars evaluated were observed to be resistant to bacterial wilt infection. The Maganda variety recorded the highest sugar content. All the



cultivars were acceptable to the traders and consumers based on color, taste, flavor and aroma. Atlas variety was rated not acceptable in terms of its fruits size.



## RESULTS AND DISCUSSIONS

### Days from Sowing to Transplanting of Seedlings

Statistical analysis shows that the number of days from sowing to transplanting of seedlings among the eight tomato cultivars evaluated did not differ significantly.

The result shows that the eight different tomato cultivars had attained comparable period (30 days) from sowing upto the transplanting stage of the seedlings in both determinate and indeterminate type of tomatoes.

Table 1. Days from sowing to transplanting seedlings and number of days from transplanting to flowering

CULTIVAR	DAYS FROM SOWING TO TRANSPLANTING OF SEEDLINGS	NUMBER OF DAYS FROM TRANSPLANTING TO FLOWERING
Macapuno White	29 <sup>a</sup>	20.00 <sup>a</sup>
Apollo	30 <sup>a</sup>	21.50 <sup>ab</sup>
Atlas	30 <sup>a</sup>	20.25 <sup>bc</sup>
Maganda	30 <sup>a</sup>	22.75 <sup>a</sup>
Rocky	30 <sup>a</sup>	19.50 <sup>c</sup>
Malakas	30 <sup>a</sup>	22.50 <sup>a</sup>
Avatar	29 <sup>a</sup>	16.50 <sup>d</sup>
Antares	29 <sup>a</sup>	19.75 <sup>c</sup>

In a column, means with a common letter are not significantly different at 5 % by DMRT



### Number of Days from Transplanting to Flowering

Table 1 shows the number of days from transplanting to flowering of the various cultivars. Avatar variety were the first to produce flowers from transplanting followed by the varieties Rocky and Antares then Macapuno White, Apollo and Atlas while the varieties Malakas and Maganda attained the longest period of first flowering.



Figure2. Overview of the experimental area grown with different varieties of tomatoes at fruiting stage under Tadiangan, Tuba, Benguet condition

### Fruit Set (%)

There were highly significant statistical analysis as indicated by the percentage of fruit set among the eight tomato cultivars as shown in Table 2. Avatar variety attained the highest percentage of fruit set which was followed by the varieties, Apollo, Antares, Atlas, Malakas, and Maganda while Macapuno White and Rocky varieties attained the lowest percentage of fruit set.

### Days from Transplanting to First Harvest

Table 2 shows the number of days from transplanting to first harvest of the various entries. Avatar variety attained the earliest days to first fruit harvest from transplanting but not significantly different with the varieties Rocky, Apollo, Atlas, Antares and Macapuno White while Maganda and Malakas attained the longest period of first flowering.

The result shows that different cultivars have varied response to maturity periods which may be inherent characteristics of the varieties tested under Tuba, Benguet condition. This is consistent with the statement of Work and Carew (1955) that varietal trial is important to observe earliness and maturity of different varieties.

### Number of Fruits per Plant

Table 3 presents the number of fruits per plant. Apollo and Avatar varieties produced the most number of fruits per plant which is significantly different to the other varieties. This was followed by the varieties Atlas, Maganda, Malakas, Antares and Macapuno White while Rocky variety yielded the least number of fruits per plant.

The difference in the number of fruits per plant are an apparent expression of their varietal characteristics. The growth habit of Apollo and Avatar which is indeterminate with long trusses that produced smaller but more fruits might have contributed to the fruit count. However, other indeterminate type cultivars did not produced the same as Apollo and Avatar, a clear proof that a certain variety of a crop do well in the one district and be worthless in another (Knott, 1989). On the other hand, the determinate type of growth usually produces short trusses with lesser fruit count but bigger fruit size.

Table 2. Fruit set (%) and number of days from transplanting to first harvest



CULTIVAR	FRUIT SET (%)	DAYS FROM TRANSPLANTING TO FIRST HARVEST
Macapuno White	83.35 <sup>d</sup>	63.25 <sup>c</sup>
Apollo	91.18 <sup>ab</sup>	62.75 <sup>c</sup>
Atlas	89.38 <sup>bc</sup>	62.50 <sup>c</sup>
Maganda	85.75 <sup>cd</sup>	64.75 <sup>b</sup>
Rocky	82.80 <sup>d</sup>	61.25 <sup>d</sup>
Malakas	86.40 <sup>cd</sup>	67.50 <sup>a</sup>
Avatar	93.75 <sup>a</sup>	58.00 <sup>e</sup>
Antares	89.03 <sup>bc</sup>	63.25 <sup>c</sup>

In a column, means with a common letter are not significantly different at 5% by DMRT

#### Number of Fruits per Plot

Statistical analysis indicated that the varieties Apollo and Avatar have produced significantly more fruit harvested per plot (Table 3).

This was followed by the varieties Atlas, Antares, Malakas and Maganda having produced the second most number of fruits per plot while Rocky variety had the least number of fruits produced.

The plant height might have added some nodes that contributed to the production more fruits for Apollo and Avatar varieties as having produced the more number of fruits per plant. As observed in the study some tomato varieties produced more but smaller fruits per bunch allowing more fruits to be counted.



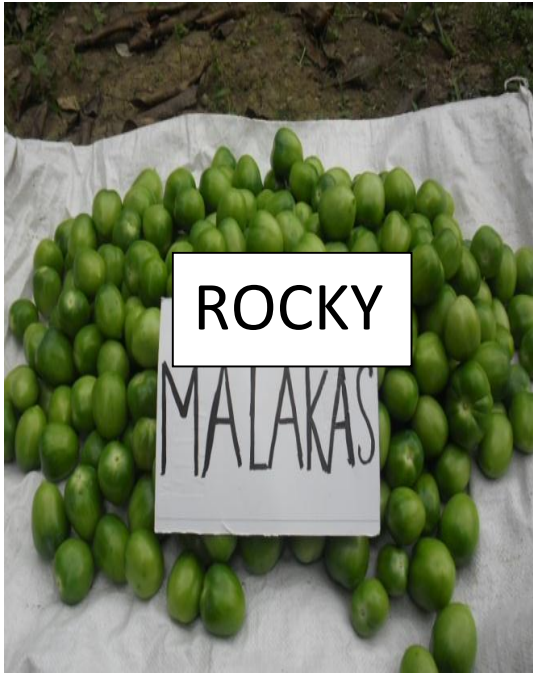


Figure 4. Malakas, Rocky, Maganda, and Macapuno White tomato cultivars harvested at green mature stage from November to March 2011

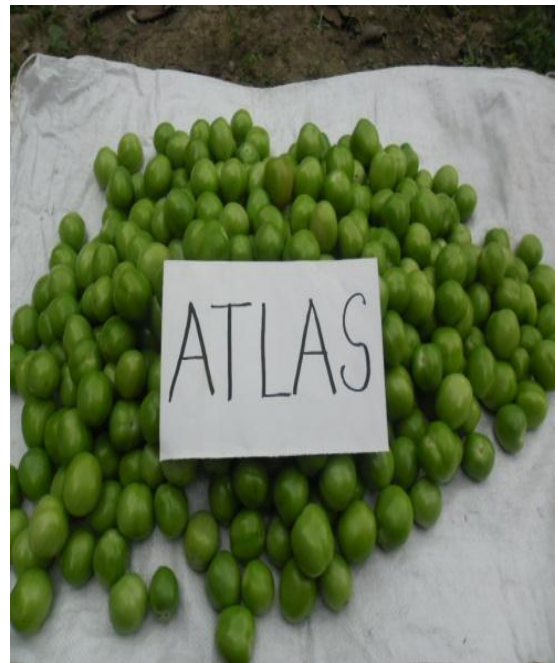


Figure 5. Antares, Atlas, Applo, and Avatar tomato cultivars harvested at green mature stage from November to March 2011



Table 3. Number of fruit per plant and number of plants per plot

CULTIVAR	NUMBER OF FRUITS PER PLANT	NUMBER OF FRUITS PER PLOT
Macapuno White	44.55 <sup>d</sup>	435.75 <sup>e</sup>
Apollo	75.85 <sup>a</sup>	747.00 <sup>a</sup>
Atlas	67.55 <sup>b</sup>	664.25 <sup>b</sup>
Maganda	61.95 <sup>c</sup>	492.50 <sup>d</sup>
Rocky	33.58 <sup>e</sup>	308.50 <sup>f</sup>
Malakas	58.93 <sup>c</sup>	513.25 <sup>d</sup>
Avatar	74.75 <sup>a</sup>	742.50 <sup>a</sup>
Antares	54.30 <sup>c</sup>	546.25 <sup>c</sup>

In a column, means with a common letter are not significantly different at 5% DMRT

#### Weight of Marketable and Non-Marketable Fruits

Statistical analysis in Table 4 shows that Avatar variety is significantly different with the other tested tomato cultivars by producing heavier marketable fruits. This was followed by Antares and Atlas varieties having similar marketable yield then followed further by the varieties Apollo, Malakas, Maganda and Macapuno White while the Rocky variety produced the least weight of marketable fruits.

The plant height and weight of individual fruit is the main contributor to high yield of tomatoes. There were significant differences noted on the non-marketable yield per plot of the eight tomato cultivars evaluated in Tuba, Benguet from October to April planting season. Atlas and Apollo varieties produced the highest weight of non-marketable fruit because it was observed to have produced fruits showing deformities such as malformed



appearance, small sizes, and poor skin appearance which is considered unfit in the market. This was followed by the varieties Avatar, Antares, Malkas, Maganda, and Rocky while Macapuno White variety produced the lowest weight of non-marketable fruits. This is consistent with the statement of Uichanco (1959) that higher yield is expected during dry season than rainy season. This is because sunlight provides the energy used in photosynthate production for utilization of the plant.

However, according to Villareal (1982) tomato production in the tropics tend to be more successful in the highlands than in the lowland which is primarily due to its mild temperature. Hence, cool season of the highlands are best for tomato production.

Table 4. Weight of Marketable and Non-Marketable Fruits

CULTIVAR	WEIGHT OF MARKETABLEFRUIT	WEIGHT OF NON-MARKETABLEFRUIT
Macapuno White	30.84 <sup>cd</sup>	0.42 <sup>d</sup>
Apollo	35.68 <sup>cb</sup>	1.07 <sup>ab</sup>
Atlas	38.25 <sup>b</sup>	1.14 <sup>a</sup>
Maganda	32.85 <sup>bcd</sup>	0.78 <sup>c</sup>
Rocky	28.63 <sup>d</sup>	0.48 <sup>d</sup>
Malakas	33.37 <sup>bcd</sup>	0.87 <sup>bc</sup>
Avatar	58.80 <sup>a</sup>	0.96 <sup>abc</sup>
Antares	38.63 <sup>b</sup>	0.96 <sup>abc</sup>

In a column, means with a common letter are not significantly different at 5% by DMRT



### Total Yield per Plot

As presented in Table 5, Avatar variety produced the heaviest total yield per plot which was significantly different over the rest of the cultivars studied. Statistical analysis indicated that Apollo, Antares and Atlas varieties have similar total yield per plot and significantly different from the total yield of the other cultivars. This was followed by varieties Malakas, Maganda and Macapuno White while Rocky variety produced the lowest total yield per plot.

### Computed Yield per Hectare

The computed yield per hectare followed the trend of total yield per plot where in Avatar variety had the highest computed yield. This was followed by the varieties Antares and Atlas having comparable means of computed yield which significantly differed from the varieties Apollo, Malakas, Maganda and Macapuno White. The Rocky variety had the lowest computed yield even though it produced bigger fruit size but had the least number of fruit harvested.

The results support the statement of Edmund and Andrews (1957) that varieties differ in productivity as an expression of the hereditary genes influenced by the environment. The variety best adapted to the environment reflects the high yield potential according Villareal (1969). The importance of varietal trial is to evaluate the yield of new tomato varieties in areas with specific climatic conditions. Each cultivar has its own characteristics and yield potential.



Table 5. Total yield per plot (kg) and computed yield (t/ha)

CULTIVAR	TOTAL YIELD (kg)	COMPUTED YIELD (t/ha)
Macapuno White	31.26 <sup>cd</sup>	62.52 <sup>cd</sup>
Apollo	36.76 <sup>b</sup>	73.50 <sup>bc</sup>
Atlas	39.35 <sup>b</sup>	80.14 <sup>b</sup>
Maganda	33.61 <sup>cd</sup>	67.22 <sup>cd</sup>
Rocky	29.11 <sup>d</sup>	58.22 <sup>d</sup>
Malakas	34.24 <sup>bcd</sup>	68.48 <sup>cd</sup>
Avatar	59.75 <sup>a</sup>	119.52 <sup>a</sup>
Antares	39.59 <sup>b</sup>	79.19 <sup>b</sup>

In a column, means with a common letter are not significantly different at 5% DMRT

#### Weight of Individual Fruit

The difference in the average weight per fruit among the entries is shown in Table 6. Statistical Analysis showed that the Rocky variety produced the heaviest weight per fruit due to their bigger size. This was followed by varieties Antares, Malakas and Maganda which did not significantly differ from each other. Avatar, Apollo and Macapuno White varieties had similar fruit weight while Atlas variety registered significantly the lowest fruit weight due to its small size. This observation is a characteristic among the tomato cultivars evaluated wherein those that produce the most number of fruits have smaller fruit size and lighter weight.



## Plant Height

The longest vine measured at the last harvest was on the variety Antares which was significantly different from the other varieties. This was followed by the variety Malakas, and then followed further by the varieties Avatar, Maganda, Atlas and Rocky which did not significantly differ with each other. Moreover, Apollo and Macapuno White varieties had also similar plant height measured producing the shortest vine.

This result reflects the genetic characteristics of the different cultivars. All cultivars except the variety Rocky having an indeterminate type of growth habit where the main axis continuously produced vegetative buds throughout its life cycle (Halfacre, 1979).

Table 6. Weight of individual fruit (g) and plant height (cm)

CULTIVAR	WEIGHT OF INDIVIDUAL FRUIT (g)	PLANT HEIGHT ( cm)
Macapuno White	40.41 <sup>ef</sup>	125.47 <sup>d</sup>
Apollo	41.65 <sup>de</sup>	129.69 <sup>d</sup>
Atlas	37.98 <sup>f</sup>	139.22 <sup>c</sup>
Maganda	44.17 <sup>cd</sup>	139.26 <sup>c</sup>
Rocky	59.34 <sup>a</sup>	117.68 <sup>e</sup>
Malakas	46.12 <sup>c</sup>	145.01 <sup>b</sup>
Avatar	42.48 <sup>de</sup>	140.08 <sup>c</sup>
Antares	50.27 <sup>b</sup>	175.72 <sup>a</sup>

In a column, means with common letters are not significantly different at 5% by DMRT

## Interval of Days to Harvest



Statistical Analysis shows that the number of fruit picking among the eight tomato cultivars evaluated did not differ significantly. The results indicate that the period of harvest were comparable in both determinate and indeterminate tomatoes (Table 7).

#### Resistance to Late Blight

As presented in Table 7, the varieties Avatar, Antares, Macapuno White, Atlas, Apollo and Rocky was observed to be resistant and had the same reaction to late blight. Maganda and Malakas varieties were rated to be moderate resistant because it was observed that 26 to 50 percent of the plants was infected by late blight.

Table 7. Number of fruit pickings and resistance to late blight

CULTIVAR	NUMBER OF FRUIT PICKINGS	RESISTANCE TO LATE BLIGHT
Macapuno White	8.00 <sup>a</sup>	Resistant
Apollo	8.00 <sup>a</sup>	Resistant
Atlas	8.00 <sup>a</sup>	Resistant
Maganda	8.00 <sup>a</sup>	Moderate Resistant
Rocky	9.00 <sup>a</sup>	Resistant
Malakas	8.00 <sup>a</sup>	Moderate Resistant
Avatar	8.00 <sup>a</sup>	Resistant
Antares	9.00 <sup>a</sup>	Resistant

In a column, means with a common letter are not significantly different at 5% by DMRT



### Resistance to Bacterial Wilt and Insect Pest Infestation

All of the cultivars are resistant to bacterial wilt as shown in Table 8. On the other hand Macapuno White, Apollo, Atlas, Avatar, Rocky and Antares varieties were resistant to fruit worm and leaf miner infestation while Maganda and Malakas varieties rated to be moderately resistant.

In terms of resistance to other pest and diseases, majority of the hybrid cultivar tested were observed to be resistant while some are moderately resistant. As explained by Kinoshita (1972), he stated that F1 hybrids grows vigorously and are resistant to some pest and diseases having good adaptability to hot and cold climates.

Table 8. Resistance to bacterial wilt and insect pest infestation

CULTIVAR	RESISTANCE TO BACTERIAL WILT	INSECT PESTINFESTATION (Fruit worm, Leaf miner, Aphids, White flies)
Macapuno White	Resistant	Resistant
Apollo	Resistant	Resistant
Atlas	Resistant	Resistant
Maganda	Resistant	Moderate Resistant
Rocky	Resistant	Resistant
Malakas	Resistant	Moderate Resistant
Avatar	Resistant	Resistant
Antares	Resistant	Resistant



### Sugar Content

The highest percentage of sugar content was noted on the Rocky variety with a mean of 4.55. All the other test varieties showing comparable sugar content response under Tadiangan Tuba Benguet condition ranging from 3.90 to 4.50 as shown in Table 9.

### Cost and Return Analysis

Table 10 shows that the highest return of investment was obtained from Avatar variety, 274.42 %. This was followed by the varieties Antares (196.58%), Apollo, Malakas, Maganda, Macapuno White and Atlas (100.03 %). All the tomato entries obtained net profit but at different levels.

Table 9. Sugar content (°Brix)

CULTIVAR	SUGAR CONTENT (°Brix)
Apollo	4.05 <sup>b</sup>
Atlas	3.90 <sup>b</sup>
Maganda	3.95 <sup>b</sup>
Rocky	4.55 <sup>a</sup>
Malakas	4.20 <sup>b</sup>
Avatar	3.90 <sup>b</sup>
Antares	4.15 <sup>b</sup>

In a column, means with a common letter are not significantly different at 5% by DMRT





## Market Acceptability

Table 11 shows the degree of acceptability of marketable fruits as evaluated by consumers and traders. All the cultivars are acceptable in terms of the color, taste and aroma/flavor. In terms of sizes, the variety Rocky and Antares was rated very acceptable followed by the varieties Avatar, Macapuno White, Maganda, Malakas and Apollo were rated acceptable while Atlas variety were not acceptable by the raters due to their small sizes.

Table 11. Acceptability ratings from consumers and traders

CULTIVAR	COLOR	SIZE	FLAVOR/AROMA	TASTE
Macapuno White	Acceptable	Acceptable	Acceptable	Very Acceptable
Apollo	Acceptable	Acceptable	Acceptable	Acceptable
Atlas	Acceptable	Not Acceptable	Acceptable	Acceptable
Maganda	Acceptable	Acceptable	Acceptable	Acceptable
Rocky	Acceptable	Very Acceptable	Acceptable	Acceptable
Malakas	Acceptable	Acceptable	Acceptable	Acceptable
Avatar	Acceptable	Acceptable	Acceptable	Acceptable
Antares	Acceptable	Very Acceptable	Acceptable	Very Acceptable



Table 10. Cost and return analysis of growing the different tomato cultivars

ITEMS	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>	C <sub>5</sub>	C <sub>6</sub>	C <sub>7</sub>	C <sub>8</sub>
Marketable Yield (kg)	123.37	142.72	152.82	131.4	114.5	133.48	235.18	154.52
A. Sales (Php)	792.03	917.68	764.1	848.84	916	864.95	1505.15	1177.44
B. Expenses (Php)								
1. Seeds	45	45	50	45	50	45	50	50
2. 16-16-16	65	65	65	65	65	65	65	65
3. Chicken Dung	30	30	30	30	30	30	30	30
4. Insecticide	62	62	62	62	62	62	62	62
5. Fungicide (Powder)	60	60	60	60	60	60	60	60
6. Fungicide (Liquid)	65	65	65	65	65	65	65	65
7. Harvesting	-	-	-	-	-	-	-	-
8. Transportation	50	60	50	60	60	60	70	65
Total Expenses	377	387	382	387	392	387	402	397
Net Profit	415.03	530.68	382.1	461.84	524	477.95	1103.15	780.44
ROE (%)	110.09	137.13	100.03	120.9	133.67	123.5	274.42	196.58
Rank	7	3	8	6	4	5	1	2

Note : The selling prices of the different tomato cultivars not higher than Php 9.



## Meteorological Data

As presented in Table 12, the minimum and maximum temperature during the study period ranged from 25.1 to 29.8°C and 11.3 to 15.00 °C, respectively and recorded from the month of November to March.

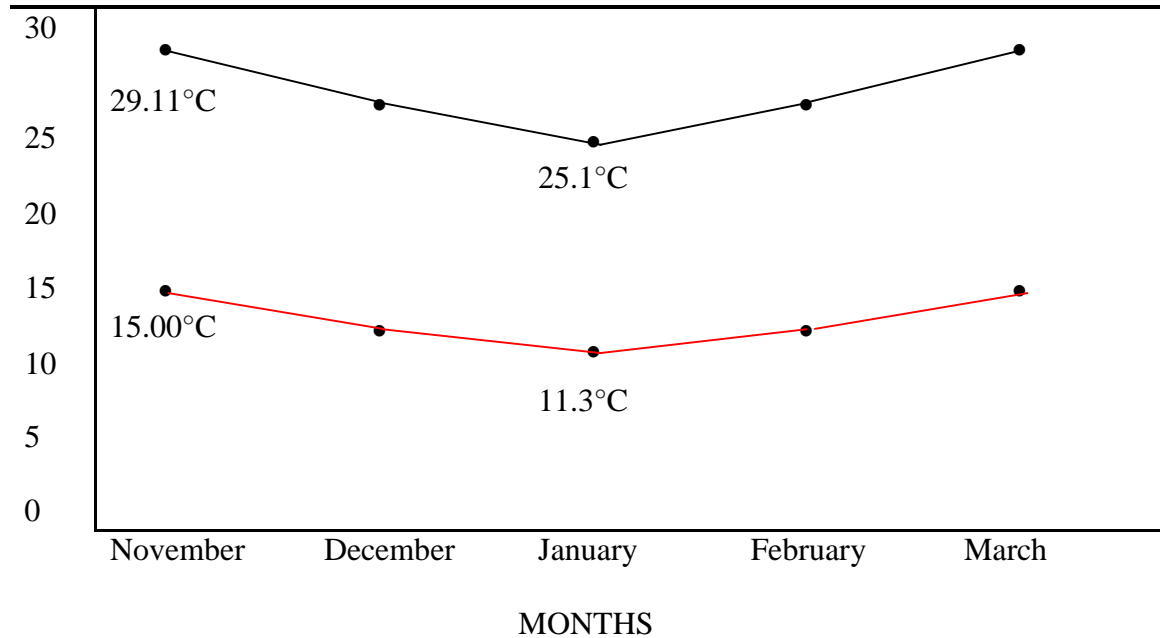


Figure 5. Monthly temperature under Tadiangan, Tuba, Benguet

### LEGEND:

- Maximum temperature
- Minimum temperature



### Other Observations

Summarized in Table 13 are other observations from eight tomato cultivars evaluated. All the cultivars studied appeared to grow well under local condition but they had different varietal characteristics.

Table 13. Other observations

CULTIVAR	FRUIT SHAPE	FRUIT SIZE	
		POLAR DIAMETER	EQUATORIAL DIAMETER
Macapuno White	Lengthened Cylindrical	5.50	3.10
Apollo	Plum shaped	5.40	4.30
Atlas	Round	4.00	3.80
Maganda	High Round	5.60	4.70
Rocky	Slightly Flattened	4.60	6.60
Malakas	High Round	5.80	4.30
Avatar	High Round	4.90	4.60
Antares	Lengthened Cylindrical	5.70	4.70

In a column, means with a common letter are not significantly different at 5% by DMRT



## SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

### Summary

This study was conducted at Tadiangan, Tuba, Benguet from November 2011 to March 2012 to determine the growth and yield performance of the eight tomato cultivars and to determine the economics of growing the different varieties of tomatoes under Tadiangan, Tuba, Benguet condition.

All the eight tomato cultivars evaluated attained similar period (30 days), from sowing up to the transplanting stage of the seedlings. Avatar variety attained the first flowering from transplanting followed by the varieties Rocky, Antares, Macapuno White, Atlas, and Apollo while Maganda and Malakas varieties attained the longest period of flowering. The Avatar variety attained the first fruit set and first fruit harvest 58 days from transplanting followed by the varieties, Apollo, Antares, Atlas, Maganda, Malakas and Macapuno white while Rocky variety attained the longest period of fruit set.

Avatar had produced significantly higher fruit number per plant and per plot over the other tomato cultivars studied. This was followed by the varieties Atlas, Maganda, Malakas, Macapuno white and Antares while Rocky variety produced the lowest in both fruit number per plant and per plot. The heaviest marketable fruit per plot was harvested from the variety Avatar (58.80 kg. ) while Atlas and Apollo variety produced the heaviest weight of non-marketable fruits because it was observed to have produced fruits showing deformities which is considered unfit for the market. The computed yield per hectare followed the trend of total yield per plot where in Avatar variety had the highest computed yield. This was followed by the varieties Antares and Atlas having comparable means of computed yield which significantly differed from the varieties Apollo, Malakas, Maganda,



and Macapuno White. The Rocky variety had the lowest computed yield even though it produced bigger fruit size but had the least fruit harvested.

The Rocky variety produced the heaviest weight of individual fruit due to their bigger size. This was followed by the varieties Antares, Malakas, Maganda, Avatar, Apollo, and Macapuno White while Atlas variety registered significantly the lowest fruit weight. The longest vine measured at the last harvest was Antares variety which has indeterminate growth habit. Rocky variety is the only one having determinate growth habit was measured as having the shortest vine. Fruit pickings among the eight tomato cultivars evaluated did not differ significantly having similar number of harvests.

As to insect pest and disease reaction, in terms of late blight Malakas and Maganda varieties were rated moderate resistant because 26 to 50 percent of the plants was infected while the rest were rated resistant. In terms of bacterial wilt all tomato cultivars evaluated was observed to be resistant while in insect pest infestation (fruitworms, leafminer, aphids, white flies) Malakas and Maganda varieties rated to be moderate resistant while the other varieties was observed to be resistant. The highest sugar content was recorded from the Maganda variety while the other tested varieties had similar sugar content response under the same condition. All the cultivars were rated acceptable by the traders and consumers based on color, taste, flavor and aroma. However, Atlas variety were rated not acceptable in terms of their fruit size.

In terms of profit, the highest return of Investment was obtained from the variety Avatar (274.42%). This was followed by the varieties Antares (196.58%), Apollo (137.13%), Rocky (133.67%), Malakas (123.50%), Maganda (120.90%), Macapuno White (110.09%) and Atlas (100.03%).



## Conclusions

Based on the results presented and discussed, all the tomato cultivars evaluated are adapted under Tadiangan, Tuba, Benguet condition with varying yield potentials as a genetic response to the environment during the conduct of the study. The tomato variety “Avatar” is the best cultivar in terms of yield that obtained the highest profit, percent of fruit set, number of fruits per plant and plot and weight of marketable fruits.

## Recommendations

Based from the preceding results and discussions, it is recommended that the variety “Avatar” is the best choice to be planted during the month of October to March under Tadiangan, Tuba, Benguet condition. However, it is further recommended that it is important that more studies will be done to verify the results of this study at different location and the use of other varieties of tomato.



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