*Research article*

# Utilization of Coconut Fronds for Weed and Insect Pest Management in Tomato Production

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**Abstract** The study assessed the effectiveness of coconut frond or cocofrond mulch in managing weed and insect pest population in tomato crops. Specifically, it aimed to determine if cocofrond mulch can reduce weed infestation in tomato; to evaluate its influence in minimizing insect pest population affecting the crop; and to find out the yield performance of tomato mulched with cocofronds. Randomized Complete Block Design with four treatments and four replicates was employed in a 139.50 $m^2$ experimental lot using the Diamante Max variety. The woven and unwoven cocofronds, polyethylene plastic mulches, and control plots with hand weeding were compared. Weed and insect pest species, its population counts, and yield data were taken and analyzed statistically through analysis of variance and Tukey's HSD Test. The findings revealed that either woven or unwoven coconut frond used as bed mulch was as effective as black plastic mulch in suppressing the dominant broadleaf, the Button weed (*Borreria laevis)* but had no effect on the populations of the other 17 minor weed species observed. Bed mulch reduced the numbers and damage caused by the 12-spotted ladybird beetle (*Epilachna philipinensis remota*) larvae but had no effect on its adult population nor on the damage caused by other pests like the green looper (*Chrysodeixis chalcites)* and fruitworm (*Helicoverpa armigera)* larvae. Neither coconut frond nor black plastic bed mulch had any significant effect on tomato crop's yield. These findings are ample basis for a wider exploration on the potential use of coconut fronds as a low-cost weed and pest management techniques for organic vegetable production.

**Keywords** coconut frond, weed management, insect pest management, mulch, broadleaf weed

## INTRODUCTION

In the Philippines context, tomato ranks second in the top horticultural crops being produced by a production industry, which dominated by small scale farmers. Although it is grown widely, the average yield in the Philippines is relatively low with 9.79 mt posted in 2005 (PCAARRD, 2007).

Low production in small scale farming is due to high incidence of diseases, insect pests, and high logistics costs. Other farmers encounter problems on nutrient deficiency diseases, insect pest infestation, and weed competition. Weeds reduce yields by competing for space, light, water, and nutrients, weakening crop stand, and by reducing harvest efficiency. Weed infestation throughout the crop life cycle results in about 40 to 60% reduction in potential tomato fruit yield (Adigun, 2005). Some weeds increase pest problems by serving as hosts for insects and pathogens. Weeds are most competitive if they emerge prior to or at planting until about 6 to 8 weeks after crop emergence (University of California, 2014). Despite the high costs in insect pest, disease and weed management measures, the problems result to low income due to low yield. Thus, farmers grope for a safe and economically productive technology to counter weed and insect pest problems in tomato culture, and mulching is believed to be one.

Studies on mulching frequently present straw mulch, plastic mulch and live-mulch cowpea. This is tested in pepper and shown that cowpea mulch is more effective in suppressing pest populations of pepper but straw mulch provide a better refuge for the natural enemies (Mochiah et al., 2012). Mulching trials on plant growth, yield, and pest control in organic yellow zucchini production reveal that paper, rye straw, black plastic, and rye straw plus paper greatly reduce weeds as compared with the bare soil control and are not significantly different in their weed suppression effect (Hulsey, 2013). Black plastic mulch results in significantly higher total yields as compared to all other treatments and the bare soil control. Black plastic also has significantly greater densities of squash bugs and stink bugs as compared to other treatments and the control. None has ever tried mulching coconut leaves and fronds in tomato or other vegetables but this experiment.

## OBJECTIVE

The main purpose of this study was to assess the usefulness and applicability of coconut fronds as mulch for weed and insect pest management in tomato production. Specifically, the purpose was to determine the influence of cocofrond mulch on weed population, pest incidence and yield of tomato.

## METHODOLOGY

The experiment was conducted at the Bohol Island State University, Zamora, Bilar, Bohol with a reddish soil that had 2.27% organic matter content, 3.5 ppm Phosphorus, 10 ppm K, and a pH of 4.88. The area had previously been abundantly occupied by Humidicula grass apart from *Paspalum conjugatum, Euphorbia hirta, Digitaria ciliaris, Dactyloctinium aegyptium, Ehinochloa colona* and *Panicum repens*. A randomized complete block design was used with four treatments and four replicates. All cultural practices in tomato production were followed, except on weed and insect pest management after transplanting. Diamante Max variety of tomato seedlings were transplanted on December 6, 2013. Vermicompost and carbonized rice hull combination at the rate of 5 tons per hectare was applied as basal fertilizer. The study compared coconut fronds and the commonly recommended black plastic mulch. Fig. 1 presents the treatments.

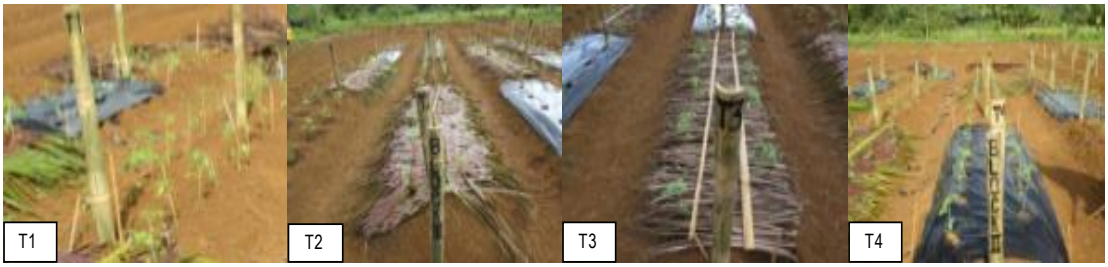


**Fig. 1 Treatments: T1- control-hand weeding, T2- woven cocofrond mulch, T3- unwoven cocofrond mulch, T4- plastic mulch**

Data collected were weed species, population per species at 30 and 60 days from transplanting; insect pest population per species taken fortnightly in ten sample plants per treatment per block; and yield of five harvests per treatment per block computed in tons/ha. Analysis of variance and Tukey's HSD Test were applied.

## RESULTS AND DISCUSSION

### Influence of Coconut Fronds and Plastic Mulches on Weed Infestation

Table 1 presents the 18 weed species found in the experimental plots where majority were broadleaf weeds, no grass weeds identified, and only one sedge species the *Cyperus kyllingia*. All were dominated by a broadleaf *Borreria laevis*.

**Table 1 Mean population weeds per species per treatment**

| Morphological Classification | Scientific Name | Mulch / Mean Population* | | | |
|---|---|---|---|---|---|
| | | Control | Parallel Cocofrond | Woven Cocofrond | Plastic Mulch |
| Broadleaf | *Calpogonium mucunoides* | 0.8 | 1.8 | 0.8 | 0.8 |
| Broadleaf | *Ageratum conyzoides* | 16.3 | 10.5 | 8.0 | 20.0 |
| Broadleaf | *Mimosa pudica* | 16.8 | 25.8 | 34.5 | 9.5 |
| Broadleaf | *Phyllanthus.amarus* | 9.3 | 1.3 | 9.3 | 2.5 |
| Broadleaf | *Cassia tora* | 0 | 0.8 | 0 | 1.0 |
| Broadleaf | *Ipomea triloba* | 6.8 | 5.3 | 7.8 | 1.5 |
| Broadleaf | *Borreria laevis* | 255.0 | 75.0 | 119.0 | 31.5 |
| Broadleaf | *Borreria ocymoides* | 2 | 0 | 0 | 0 |
| Broadleaf | *Commelina diffusa* | 1.8 | 0.3 | 0.3 | 1.5 |
| Broadleaf | *Phyllathus niruri* | 3.5 | 4.5 | 1.3 | 2.5 |
| Broadleaf | *Desmodium triflorum* | 1.3 | 1.8 | 0.8 | 0.5 |
| Broadleaf | *Chromolaena odorata* | 0 | 0 | 0 | 0.3 |
| Broadleaf | *Cleome rutidosperma* | 1.5 | 2.0 | 6.0 | 0.3 |
| Broadleaf | *Corchorus olitorious* | 8.5 | 7.3 | 11.3 | 0.5 |
| Broadleaf | *Euphobia hirta* | 0 | 0 | 0.3 | 0 |
| Broadleaf | *Stachytapheta jamaicensis* | 1.0 | 1.0 | 1.0 | 0 |
| Broadleaf | *Bidens pilosa* | 0 | 0 | 0.5 | 0 |
| Sedge | *Cyperus kyllingia* | 3.3 | 0.3 | 1.5 | 0 |

**means from 3 replicates*

Multivariate analysis showed that only the population of *Borreria laevis* significantly differed among treatments. Tukey's HSD Test in Table 2 reveals that all kinds of mulch significantly reduced the population of *B. laevis* compared to hand weeding. The test also illustrates that all mulches have similar suppressive effects on the *B. laevis*. This initial finding encourages further studies to prove its potential in weed management in tomato as well as in other vegetables.

**Table 2 Comparison of treatment means of *B. laevis* using Tukey's HSD test**

| Treatment | N | Subset* | |
|---|---|---|---|
| | | 1 | 2 |
| T4 - PE plastic mulch | 4 | 31.50 | |
| T3 - Parallel cocofrond | 4 | 75.00 | |
| T2 - Woven cocofrond | 4 | 119.00 | |
| T1 – Control/Hand Weeding | 4 | | 255.00 |
| | P-value | 0.149 | 1.00 |

**means in the same subset are not significantly different to each other*

**Effects of Coconut Fronds and Plastic Mulches on Insect Pest Incidence**

The population of the three insect pest species found the most damaging to the experimental tomato crops: 12-spotted ladybird beetle, *Epilachna philipinensis remota;* tomato fruitworm, *Helicoverpa armigera* and the green looper, *Chrysodeixis chalcites* differed in terms of time and the mulch used. Figure 2 reveals that plastic mulch reduced their population for a number of weeks. This was followed by cocofrond mulches while tomatoes with hand weeding had higher pest population in most of the time.

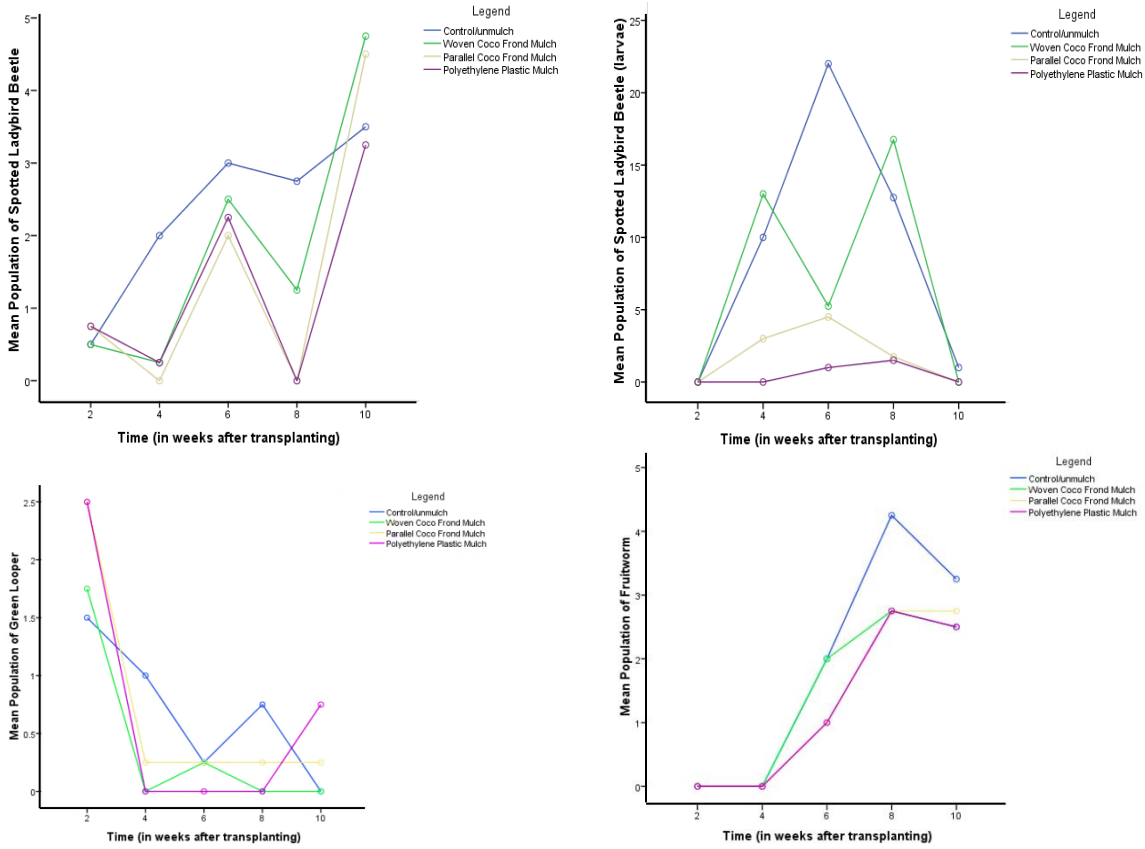


**Fig. 2 Population of 12-spotted ladybird beetle adults (above left), its larvae (above right); greenlooper larvae (lower left), and tomato fruitworm larvae (lower right) infesting tomato crops per time**

Analysis on the population of 12-spotted ladybird beetle adults, fruitworm larvae, and green looper larvae presented in Table 3 shows highly significant difference between time/weeks, while the beetle larvae had significant result. This implies a similar effectiveness of the mulches on the pest though time element or crop stage had significant effect on the pest irrespective of the mulching materials. However, pest population was not significantly affected by the treatments except for 12-spotted ladybirds beetle larvae which had been significantly affected by the mulches. Time and treatment interaction was not significantly denoting the independent influence of time and mulches on the pest population. The same analysis illustrated that *Epilachna* larvae was influenced by mulch while the adults were not affected. This suggests that there was a difference in egg lay and survival of the eggs or of the hatching larvae in mulched plots versus the control.

Tukey's HSD test results on the 12-spotted ladybird beetle larval population presented in Table 4 reveals that plastic mulch had a significantly lower number compared to the rests of the mulches. The unwoven and the woven cocofrond mulches had intermediate populations which were not significantly different from either the black plastic mulch or the control plots.

**Table 3 Analysis of variance on the insect pest population infesting the tomato crops**

| Pests | Source of Variations | | | | | |
|---|---|---|---|---|---|---|
| | Within-Subjects | | | | Between Subjects | |
| | Time | | Time x Treatment | | Treatment | |
| | F-Statistic | P value | F-Statistic | P value | F-Statistic | P-Value |
| Spotted ladybird beetle adults | 15.085** | 0.000 | 0.966ns | 0.494 | 1.745ns | 0.211 |
| Spotted l. beetle larvae | 3.988* | 0.043 | 1.438ns | 0.256 | 4.949* | 0.018 |
| Fruitworm larvae | 9.181** | 0.000 | 0.304ns | 0.986 | 0.165ns | 0.918 |
| Green looper | 17.878** | 0.000 | 1.070ns | 0.406 | 0.389ns | 0.763 |

*Note: Tested at 95% level of confidence*

**Table 4 Comparison of means on spotted ladybird beetle larval population using Tukey's HSD test**

| Treatment | | Subset* 1 | Subset* 2 |
|---|---|---|---|
| 4 – Plastic Mulch | 4 | 0.0415 | |
| 3 – Parallel/Unwoven Cocofrond | 4 | 0.1545 | 0.1545 |
| 2– Woven Cocofrond Mulch | 4 | 0.5810 | 0.5810 |
| 1– Control/Hand weeding | 4 | | 0.7605 |
| *P-value* | | 0.114 | 0.068 |

**means in the same subset are not significant to each other at 95% level of confidence*

The damage counts based on infested leaves by the 12-spotted ladybird beetles and the fruitworm bored tomato fruits are shown in Fig. 3. The figure illustrates that there was lesser damage on the crops that were mulched with cocofronds, compared to the ones that planted with hand weeding and with plastic mulch.

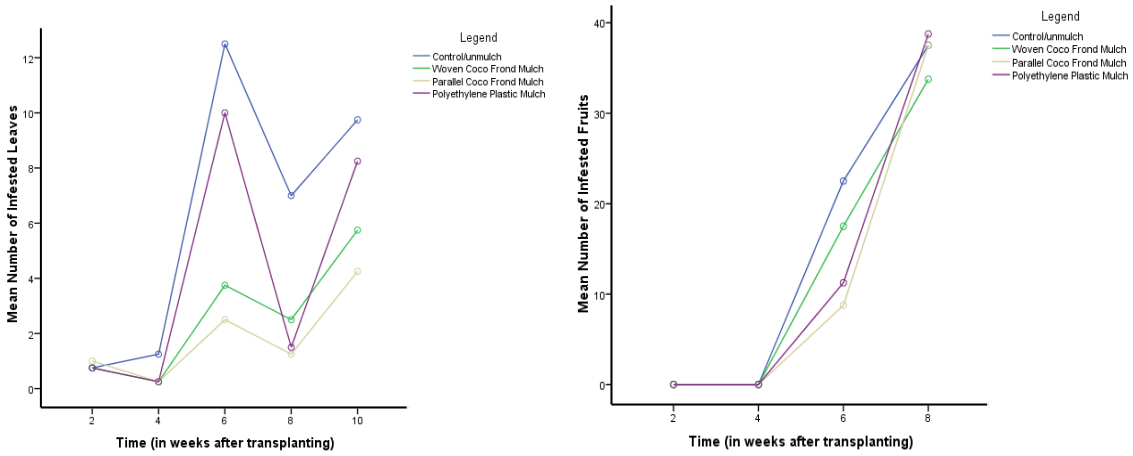


**Fig. 3 Number of *Epilachna* beetle-infested leaves (left) and the fruitworm-infested fruits tomato (right)**

**Table 5 Analysis of variance on the 12-spotted ladybird beetle and fruitworm infestation on tomato crops**

| Pests | Source of Variations | | | | | |
|---|---|---|---|---|---|---|
| | Within-Subject | | | | Between-Subjects | |
| | Time | | Time x Treatment | | Treatment | |
| | F-Statistic | P value | F-Statistic | P value | F-Statistic | P-Value |
| 12-spotted l. beetle infestation | 2.258ns | 0.130 | 0.385ns | 0.873 | 4.540* | 0.024 |
| Fruitworm infestation | 32.395** | 0.000 | 0.307ns | 0.968* | 0.254ns | 0.857 |

*Note: Tested at 95% level of confidence*

Analysis of the *Epilachna* beetle infested leaves in Table 5 indicates no significant interaction between time and treatments, but main effects between treatments differed significantly. This means that the beetle-infested tomato leaves were significantly reduced with the use of mulching materials. Tukey's HSD test on infested leaves showed that plants with hand weeding had significantly higher infested leaves compared to mulched plants, particularly to unwoven cocofronds. Analysis also showed that fruitworm damage was not significantly different among treatments indicating that mulching had no influence on the number of infested fruits. A significant difference between times indicated that fruitworm-infested fruits irrespectively increased with crop age applied with mulching materials.

### Influence of Coconut Fronds and Plastic Mulch on Yield of Tomato

Yield of tomato with and without mulch did not differ significantly from each other as shown in Table 6. This implies the lack of influence of the mulch on the crop's yield. There could have been a treatment difference if the control plots had not been hand weeded.

**Table 6 Yield analysis of tomato in tons/ha as influenced by cocofrond mulch**

| Source of Variation | Sum of Squares | df | Mean Square | F | P-value |
|---|---|---|---|---|---|
| Treatment | 0.183 | 3 | 0.061 | $1.086^{ns}$ | 0.392 |
| Error | 0.675 | 12 | 0.056 | | |
| Total | 0.858 | 15 | | | |

*Note: Tested at 95% level of confidence*

## CONCLUSION

Mulching is useful in suppressing the dominant weed, *B. laevis* in tomato production. The three bed mulches, woven and parallel arranged coconut fronds, and black plastic similarly suppressed the population of *B. laevis*. The black plastic mulch was highly effective in reducing spotted ladybird beetle [SLB] (*Epilachna* sp.) larval population, while both woven and unwoven/parallel arranged cocofronds had slightly suppressed the pest. The mulches reduced the SLB larval damage on tomato, although in this case the woven cocofronds was highly effective while, the non-woven/parallel cocofrond mulch and plastic mulch were slightly effective in minimizing the damage. Despite the effectiveness of the mulches on weeds and insect pest management, they did not influence crop yield, implying additional tests.

## ACKNOWLEDGEMENTS

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