Case study: Evaluation of the effects of mulch on operation costs and yield of hot pepper

By Glenn Takai, Mark Acosta, Joe Tuquero

Introduction

Hot peppers are very popular throughout the world. In markets, they are sold as a fresh vegetable, dried/roasted, pickled, and as an additive in many products. In Guam, hot peppers are commonly used in making local hot sauces and many spicy local dishes. Locally, fresh local hot peppers and by-products are in high demand throughout the year. The cost of fresh local hot peppers average $12/lb. directly from the farm. Local by-products of hot peppers like *fina'denne' dinanche* (Figure 1) average $1.25/oz. (Bamba, personal communication). Hot peppers also provide numerous health benefits. Particularly the mature fruits are a good source of Vitamin A and Vitamin C (University of Illinois Extension, 2017).

Sheet mulch

Sheet mulching is a layered method of mulching. Typical sheet mulching methods consist of initially laying single or multiple layers of cardboard over a targeted area. Cardboard layers can be topped with shredded/chipped organic waste material (Figure 2). It is a simple, low-maintenance conservation practice used for weed suppression, erosion control, and reducing soil moisture loss. It also works as a soil amendment (organic matter) that maintains and improves soil quality and quantity as mulch materials decompose. Common sheet mulching resources include organic waste materials, such as cardboard, shredded paper, grass clippings, chipped wood, and numerous types of green waste.

Figure 1. Local processed by-product of hot pepper, *fina'denne' dinanche*.

Figure 2. Sheet mulching with cardboard and shredded paper

Figure 3. Local Guåfi hot pepper growing with mulch or no mulch applied in Talo'fo'fo', Guam

Case study

Since Sept. 11, 2021, a local variety (Guåfi) of hot pepper has been growing in a commonly cultivated volcanic soil (Chacha Clay Variant) in Talo'fo'fo', a village located in southern Guam. An experiment was conducted on this field to evaluate the effects of mulch on operation costs and yield of hot pepper (Figure 3).

Materials and methods

In an open field, hot pepper plants received either mulch application or no mulch. Sheet mulch was applied at the base of each plant covering an area of approximately 1.5 sq.ft. The material consisted of a layer of cardboard topped with grass clippings and shredded paper, maintained at a thickness of 3 inches. Cardboard and shredded paper were obtained from a local credit union. Grass clippings were collected for mulch material at the farm site with a riding mower (John Deere D125) with a mulch bagger implement attached.

Randomly, 27 mulched and 27 non-mulched plants were selected for evaluation of operation costs and yield.

Two hand-weeding time intervals were experimented with during the duration of the study, which started on Sept. 11, 2021, and ended on Feb. 21, 2022. One hand-weeding time occurred at a 2.5-week interval, and the other hand-weeding time occurred at a one-month interval. Labor time and cost values for both hand-weeding time intervals were recorded. Other operational costs to obtain and install mulch were also accounted for.

Yield data was collected weekly from Dec. 26, 2021, to Jan. 21, 2022. Yield data recording was forced to halt after Jan. 21, 2022, due to missing plants from theft.

As plants grew, common pests (mites and aphids) and a fungal disease (anthracnose) were identified and controlled as needed. All plants were irrigated and fertilized evenly throughout the duration of the experiment.

Results and Discussion

Operational cost

There were no costs obtaining cardboard and shredded paper other than fuel for travel and labor for mulch installation. Because mowing the field is a routine practice at the farm site, there were also no costs of obtaining grass clippings other than labor cost for applying grass as mulch material. Obviously, there was no labor cost to leave plants bare without mulch application.

The average time taken to obtain cardboard and shredded paper was one hour per roundtrip. Although this type of travel was conducted five times for the entire field, only one roundtrip was accounted for to provide sufficient mulch for the 27 mulched plants for the experiment. Fuel cost derived from average fuel prices (approximately $5/gal) in Guam from 2021 to 2022. These operational costs along with the time and costs of the two different weeding time intervals are shown in Table 1.

Mulched plants

For mulched plants, there was little difference in

Table 1. Cost analysis of growing hot pepper plants (Oct. 2-Feb. 21, 2022) with or without mulch.

Mulch Treatment	Operation Activity (Hours worked per 1 person per 27 plants) and Total Costs at $9.25/hr. (Guam minimum wage)						
	Hand-weeding interval schedules	Obtaining mulch from off-site (hours)	Installation mulch material (hours)	Weeding (average hours/ hand-weeding interval)	Total hours projected to weed out plants (5 months)	Estimated total fuel cost of 28 miles roundtrip to obtain cardboard and shredded paper for mulch	Projected cost of weeding at 5 months
Mulched	2.5 weeks 1 month	1 1	1 1	0.08 0.16	0.75 0.8	$7.50 $7.50	$32.94 $33.40
No Mulch	2.5 weeks 1 month	0 0	0 0	0.5 2	4.5 10	0 0	$41.63 $92.50

total costs between the two different weeding time intervals. However, labor time spent for weeding at one-month intervals was two times longer than labor time spent for weeding at 2.5-week intervals.

Non-mulched plants
For non-mulched plants, there was a significant difference in total costs and labor time between the weeding time intervals. Labor time spent weeding at one-month intervals was four times longer than labor time spent weeding at 2.5-week intervals. Total cost of weeding at one-month intervals was almost three times higher than weeding at 2.5-week intervals.

Mulched vs. non-mulched plants
Labor time spent weeding mulched plants was significantly less than labor time spent weeding non-mulched plants, particularly when weeding at one-month intervals. Operational costs of mulching plants at both weeding time intervals were significantly reduced in comparison to operational cost of non-mulched plants weeded at one-month intervals.

Results indicate that weeding routinely at 2.5-week intervals reduced labor time and cost for both mulched and non-mulched plants. Table 1 depicts a projection of costs of time and labor for both weeding time intervals for the duration of the experiment. It is realized that climate may play a role in labor time during any weeding time interval. The experiment began in the rainy season and ended in the dry season for Guam.

Although total operational costs for routine weed maintenance (2.5-week intervals) showed little difference in cost between mulched and non-mulched plants, labor time is clearly reduced when weeding mulched plants. The slight difference in cost was likely due to fuel/travel cost to obtain off-site mulch materials.

Through this experiment, it is recommended that when outsourcing mulch material, one should seek a source as close in proximity to the field as possible to reduce fuel cost for travel.

Yield

Results indicate a significant difference in yield among treatments. Total yield was significantly higher from mulched plants as shown in Table 2. Other than an obvious reduction of weed competition, other benefits of mulch, such as soil moisture retention and possible increase in organic matter from mulch decomposition, may have also played a role in the increased yield of mulched plants.

Table 2. Yield data of mulched and non-mulched hot pepper (Guåfi) plants (Dec. 26, 2021 – Jan. 21, 2022)

Mulch Treatment	Average Weekly Yield (lbs.)	Total Yield (lbs.)
Mulched	2.5	24
No-Mulched	1.5	14

Conclusion

Results of the experiment show that using sheet mulch as a treatment is beneficial from more than one aspect. In this case, it is recommended to mulch hot pepper plants. There are cost-saving measures from labor as well as a reduction in intensive labor on the field. It is also shown that profits are increased through higher yields from mulching.

Future studies resulting from this experiment can be to research the quality and health of the soil from the addition of mulch as organic matter and the efficacy of mulching on irrigation.

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PUBLICATION CREDITS

REVIEWERS Cliff Kyota
Extension Agent II
UOG Cooperative Extension & Outreach

Rynette Perez
Extension Associate II
UOG Cooperative Extension & Outreach

EDITED BY Jackie Hanson

LAYOUT BY Conrad Calma

UNIVERSITY OF GUAM
COOPERATIVE EXTENSION & OUTREACH

Cooperative Extension & Outreach
University of Guam
303 University Dr.
Mangilao, GU 96923-9000
(671) 735-2000/2060
www.uog.edu/extension

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