

Increasing Productivity of Malabar Spinach (*Basella alba* L. and *Basella rubra* L.) Grown in the Marginal Upland Area of Inopacan, Leyte Through Different Mulching Materials

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ABSTRACT

Basella or malabar spinach, locally known as alugbati is a tropical leafy indigenous vegetable commonly grown for its succulent, nutritious, and tender stems. It has also a number of medicinal applications. Despite its many uses and potential value, its importance is under estimated. The study was conducted to evaluate the effects of different mulching materials on the growth and yield of two *Basella* species grown in a rolling soil in the marginal uplands of in Inopacan, Leyte. A factorial experiment was set-up with Alugbati species/varieties as the main plot factor and the different mulching materials as the sub-plot. Treatments were: T0- control, T1- rice hull, T2- rice straw and T3- plastic mulch.

Basella alba, the green-stemmed alugbati had significantly bigger stems, greater number and heavier shoots than the red-stemmed *Basella rubra*. Leaf spot disease caused by *Colletotrichum sp.* was more evident in *B. rubra*. Regardless of the mulching materials used, mulched plants yielded higher than the unmulched plants or those planted in bare soil. Moreover, the use of silver plastic mulch resulted to the highest total yield. The results indicate the high potential of mulching in increasing the yield and thus the profitability of alugbati production.

Keywords: Alugbati, *Basella alba*, *Basella rubra*, plastic mulch, rice hull, rice straw

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INTRODUCTION

Malabar spinach or ceylon spinach, commonly known as *alugbati* is a vegetable which belongs to Basellaceae family. It is a fast growing vegetable, native to tropical Asia (India or Indonesia) and extremely heat tolerant. It is commonly grown for its young shoots which make an excellent succulent, slightly mucilaginous vegetable. It is high in Vitamins A, B9 and C, iron and calcium (Grubben and Denton, 2004).

Alugbati is a very productive leafy vegetable, suitable for both home and market garden in the lowland tropics (Siemonsma and Piluek, 1994). Its thick, semi-succulent, heart-shaped leaves have a mild flavour and mucilaginous texture. Daily consumption of malabar spinach has been shown to provide vitamin A especially in populations that are at high risk of vitamin A deficiency (Haskell et al., 2004). A number of medicinal applications have been reported: young leaves as laxative, pulped leaves to poultice sores, red fruit juice as eye-drops to treat conjunctivitis. The red forms are likewise planted as ornamental. A need to increase its production is seen as a potential means of solving nutrition problem in a cheaper way as *alugbati* is very easy to grow without much inputs.

One cultural management practice employed to increase yield of vegetable is mulching. Mulches are natural (straw, sawdust, herbage and other materials) or synthetic (polyethylene in different colors) materials placed on the soil surface. These are well known for modifying the energy and water balance at the surface of soils creating more favorable conditions for plant growth. Direct effects include increased in soil temperature (Farias-Larios et al., 1994), decrease in moisture loss from the soil, prevention of weed development (Borosisic, et al., 1998), control of soil-borne pathogens, and reduced insect/pest populations (Farias-Larios and Orozco-Santos, 1997). Mulching is considered as an agrotechnical procedure which can significantly modify microclimate around plants (Siwek et al., 2007). Application of mulches beneficially influences soil structure, reduces negative effects of wind and water erosion, and decreases soil warming in summer months (Holderbaum et al., 1990) Favorable microclimatic conditions created by mulching can ensure, among other things, higher yields, products of better quality or/and earliness, as well as a more cost-effective production. The use of mulches is known to be worthwhile being an important reason for the crop's quality and productivity improvement (Fontanettiverdial et al., 2001).

Despite the potential value of *alugbati*, it received lesser attention which means it is under-estimated and under-exploited; hence no production data are available. Through the Philippine Higher Education Research Network (PHERNet) project, an attempt to increase production of *alugbati* has been conducted. Its importance to Filipino diets, the medicinal application and the interest of increasing its yield through improved cultural management practices constitute a challenge to researchers to come up with a technology to provide the crop with a favorable environment so as to increase its production. In view of the foregoing considerations, conducting research work on the use of mulching on *alugbati* production was deemed necessary. Specifically, the study was conducted to evaluate the influence of different mulching materials on the growth and yield of two *alugbati* species/varieties and to do a cost and return analysis of mulched and unmulched *alugbati* production.

MATERIALS AND METHODS

Soil Sampling and Land Preparation

This study was conducted in Sitio Batuan, Barangay Linao, Inopacan Leyte. The soil used is clay loam having a 5.0 pH, 2.55 % OC, 0.26 % total N, 2.94 mg/kg⁻¹ P and 153.78 mg/kg⁻¹ K. An area of 186 m² was plowed and harrowed two times to pulverize the soil and remove weeds. Beds measuring 0.8 m x 6.0 m were then constructed.

Preparation of Alugbati transplants

Fresh terminal shoots of *alugbati* were procured from the local market of Baybay City. These were trimmed to a uniform length of 20 cm and planted in polyethylene pots with a mixture of 2:1:1 garden soil, carbonized rice hull and aged chicken dung. Cuttings were then planted into pots measuring 7.5 cm x 10 cm with 7.5 cm portion of the stem buried into the medium and allowed to form roots.

Experimental Design and Treatments

The experimental area was laid out using Split-plot Design arranged in RCBD with three replications. Each treatment plot measured 0.8

m x 6.0 m. One row of plants was established in each plot with spacing of 0.5 m per hill and 0.5 m per rows. An alleyway of 0.5 m was provided between replications to facilitate farm operation and management as well as data gathering. The treatments were as follows:

Factor A: *Alugbati* species/varieties

V₁ – Red *Alugbati* (*Basella rubra* Linn.)

V₂ – Green *Alugbati* (*Basella alba* Linn.)

Factor B: Different mulches

T0 – control (no mulch)

T1 – Rice straw

T2 – Rice hull

T3 – Silver Plastic

Cultural Management

Rooted *alugbati* cuttings were transplanted unto plots measuring 6.0 m at 0.80 m at 0.5m distance between hills. Five hundred grams of rice hull charcoal and 10 g complete (14-14-14) fertilizers were applied upon transplanting in each hill. Two weeks after planting, 150 ml of 75 grams urea dissolved in 16 liter of water was drenched.

Two (2) centimeter thick of rice straw and rice hull were spread over the designated treatment plots right after planting. The plastic mulch on the other hand, was spread ahead of planting. Right after spreading the plastic mulch, it was fastened by clipping the sides with bamboo sticks formed like a staple wire. Holes about 10 cm diameter were made on the plastic using can containing burned charcoal, then transplanting of *Basella* was done.

Trellising was done one week after transplanting using 1.5 m long slated bamboos tied with plastic twines. Pests were controlled by pruning or removal of infected and infested shoots.

Harvesting was done weekly by cutting the terminal shoots which were then classified as marketable and non-marketable. Marketable shoots are free from diseases and insect damage while non-marketable shoots are diseased and damaged. Number and weight of each were then recorded.

Data Gathered

A. Horticultural Characteristics

1. *Stem Diameter (cm)* – This was obtained by measuring the diameter of the shoots one (1) cm from the cut portion of the cuttings at harvest which was 38 cm from the tip.
2. *Number of marketable and non-marketable terminal shoots per plot* – This was determined by counting the number of marketable and non-marketable cuttings from each sample plants after sorting.
3. *Weight of marketable and non-marketable terminal shoots (kg/plot)* – This was determined by weighing the marketable and non-marketable shoots after sorting in each harvest.
4. *Total yield (tons/ha).* - This was determined by getting the cumulative weight of the cuttings from the first to the last harvest.

B. Meteorological Data

Data on total weekly rainfall and average weekly soil temperature and moisture from each plot were gathered.

Statistical Analysis

The data obtained were analysed using Cropstat 7.2 and the means were compared using Duncan Multiple Range Test at 5% level of probability.

Cost and Return Analysis

This was determined by taking into account all the cost of production from land preparation to harvest and the income obtained. Gross income was calculated by determining the number of bunches generated from the total shoots harvested. Number of shoots per bunch was based on the one sold in the market which is 10 shoots on the average, the price of which is P5.00 per bunch. Net income was calculated by subtracting the production cost from gross income.

RESULTS AND DISCUSSION

Horticultural Characteristics

The two *Basella* species differed in their horticultural characteristics (Table 1). Green *alugbati* had bigger stems than the red *alugbati*. Number of marketable shoots and total yield were likewise significantly higher in the green stemmed *alugbati*. Results could be due to genetic differences of the two species. In terms of the effect of the different mulching materials showed that regardless of its kind, whether organic i.e. rice hull and rice straw or inorganic, the silver plastic mulch enhanced the production of greater number and heavier marketable shoots. Furthermore, in terms of total yield, plastic mulched *Basella* yielded the highest. The findings of Khazaei et al, (2013) also pointed out that mulching significantly increased the total yield of lettuce using silver plastic films.

The better performance of mulched plants over that of unmulched (Fig. 1) can also be ascribed to its contribution to weed management via reducing weed seed germination, blocking weed growth, repelling insect and favouring the crop by conserving soil moisture (Fig. 2) at the same time moderating soil temperature (Fig. 3). This is in consonance with the result of the study of Jenni et al. (2004) showed that polyethylene with at least one black side was effective in controlling weed growth, and that growing lettuce on polyethylene mulches increased marketable yield by 7% and resulted in significantly heavier heads of lettuce compared to those of the control. Zhang et al. (2005) also observed that mulching with straw reduced soil evaporation loss and increased water use efficiency of winter wheat in northern China. In addition, organic mulch, once decomposed adds organic matter to the soil. (Schonbeck, 2012). The better development of plants in the treatment with double-faced plastic covering could be explained by the higher light reflection caused by the silver side of this kind of mulch, which could have increased the accumulation of photosynthates by the leaves (Muller, 1991). This might have influenced the higher nitrogen absorption by the plants. The results obtained are in accordance with Walker, quoted by Muller (1991). According to the author, higher soil temperature, which was also observed in this study (Fig. 3) lead to higher absorption of nitrogen and greater vegetative growth. Pinto (1997) mentioned the loss of nitrogen in the soil profile by leaching of nitrate in bare soils. Furthermore, there was a decrease in the oxygen concentration in the rhizosphere for treatments of no mulch,

which promoted better aeration. Thus, the nitrate is used by microorganisms as an alternative electron receptor, increasing the risk of nitrogen loss by denitrification or partial nitrification of the ammoniacal nitrogen (Marschner, 1995).

Disease Incidence

Leaf spot disease caused by *Colletotrichum sp.* was more evident in *B. rubra* than in *B. alba* regardless of the mulching materials used (Fig. 4 and 5). The higher disease incidence could be due to the occurrence of the heavy rainfall throughout the experimental period (Fig. 6). It was noted that *B. rubra* is susceptible to the disease while *B. alba* is resistant. However with continuous rain, disease infection become unmanageable with the use of physical means in controlling the disease infection.

Table 1. Horticultural characteristics of two *Basella* species grown under different mulching materials

	Stem Diameter	Plot yield/4.8 m ²				Yield (t/ha)
		Number		Weight (kg)		
		Marketable	Non-marketable	Marketable	Non-marketable	
<i>Variety</i>						
Red (<i>B. rubra</i>)	0.63b	302.37b	39.94	4.27	0.46	9.29b
Green (<i>B. alba</i>)	0.72a	394.05a	43.42	4.35	0.34	9.82a
<i>Treatments</i>						
T0-Control	0.66	313.51b	40.49	3.77b	0.38	8.38b
T1-Rice hull	0.66	337.40a	44.66	4.23a	0.41	9.39b
T2-Rices traw	0.68	361.21a	39.40	4.43a	0.38	9.44b
T3- Silver Plastic	0.71	380.72a	42.16	4.81a	0.42	11.02 _a
CV a (%)	0.07	0.04	0.49	0.16	0.67	0.16
CV b (%)	0.54	0.05	0.23	0.03	1.03	0.04

Means within the same column having the same letter or without letter designation are not significantly different at 5% level of significance using Duncan's Multiple Range Test.

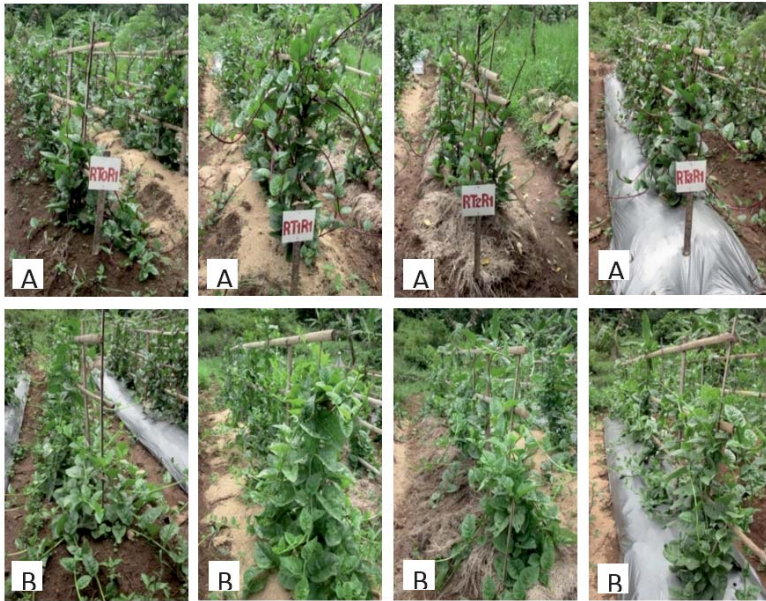


Figure 1. *Basella rubra* (A) and *Basella alba* (B) planted without mulch (1), rice hull (2), rice straw (3) and plastic (4).

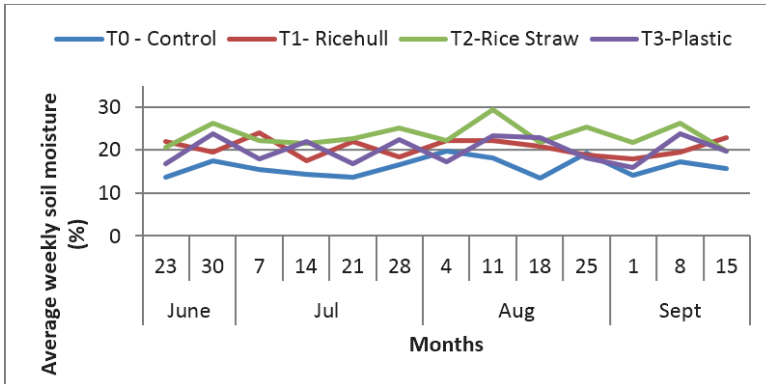


Figure 2. Average weekly soil moisture during the conduct of the study (June-Sept., 2013).

Increasing Productivity of Malabar Spinach Grown In The Marginal Uplands

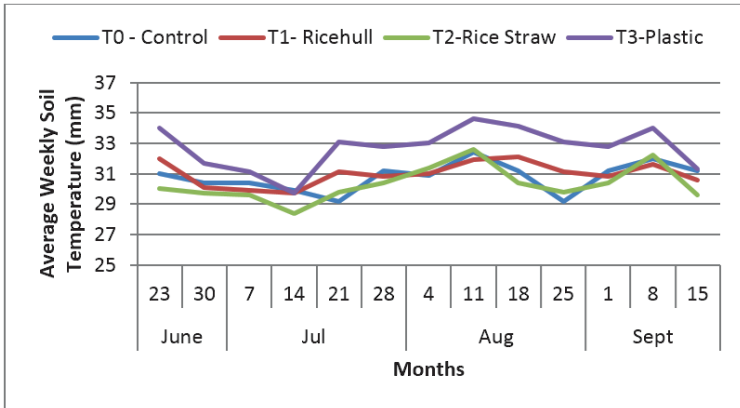


Figure 3. Average weekly soil temperature during the conduct of the study (June-Sept., 2013).

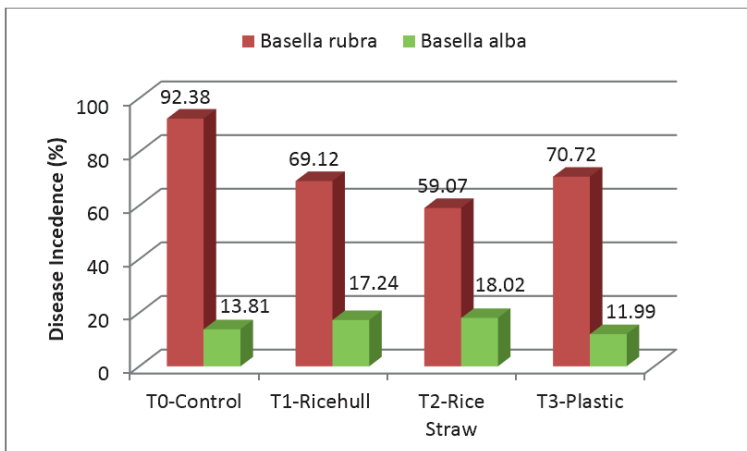


Figure 4. Percent disease incidence (*Colletotrichum* sp.) three and one half months from planting.



Figure 5. (A) *Basella rubra* infected by *Colletotrichum* sp., (B) *Basella alba* showing resistance to infection.

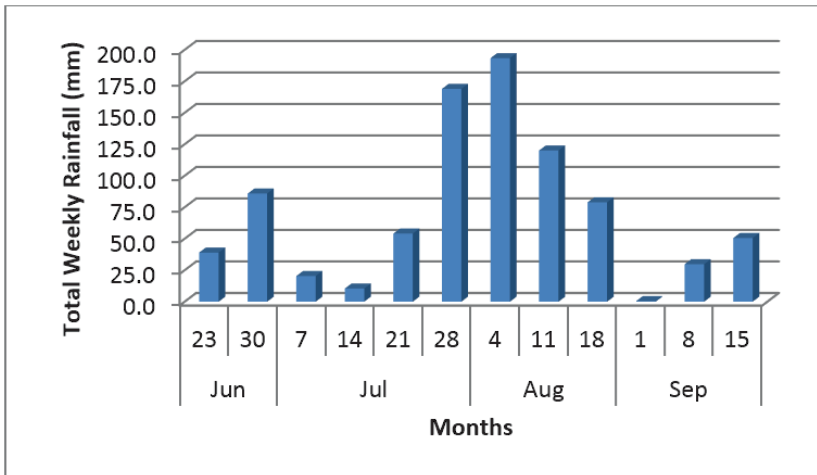


Figure 6. Total weekly rainfall (mm) during the conduct of the study (June-Sept., 2013)

Estimates on the cost and return of alugbati production

Cost and return analysis of *B. rubra* and *B. alba* grown with different mulching materials are presented in Table 2. It was noted that production of *B. alba* gave a higher net return. Production of *Basella* without mulch incurred the highest total production cost of PhP 3,018.25, followed by plastic mulch. The use of the two organic mulches had the same expenditures.

All the three mulching materials had higher net returns than the control or unmulched plants. This was due to the higher number of bunches produced in mulched plants. The plastic mulch, however, yielded the highest profit of PhP 1,587.05, followed by rice straw of PhP 1,470.45 and rice hull of PhP 1,399.80.

CONCLUSIONS

Based on the results obtained, the following conclusions were drawn:

1. Mulching with the use of straw, rice hull and plastic mulch enhanced growth and yield of *Basella*. Furthermore, these mulching materials had superior effect over that of unmulched treatment or bare soil in terms of number and weight of marketable shoots.

2. Plants mulched with silver plastic produced the highest yield and consequently gave the highest net returns.

Table 2. Estimates on the cost and return of *alugbati* production as affected by mulching per 182 m².

Treatments	Number of bunches*	Gross Income**	Total Expenses (PhP)	Net Income**
<i>Variety</i>				
Red (<i>B. rubra</i>)	725.69	3,628.45	2,981.45	647.00
Green (<i>B. alba</i>)	945.7	4,728.50	2,981.45	1,747.05
<i>Treatments</i>				
T0-Control	752.42	3,762.10	3,018.25	743.85
T1-Rice hull	795.61	3,978.05	2578.25	1,399.80
T2-Rice straw	809.74	4,048.70	2578.25	1,470.45
T3-Plastic	913.70	4,568.50	2981.45	1,587.05

* Number of bunches were computed by considering the average number of shoots per bunch in the market

** Obtained by multiplying the number of bunches with the current price of *Basella* at 5 PhP/bunch

RECOMMENDATIONS

1. Under the condition of the study where rainfall was abundant, mulching using plastic mulch is recommended.
2. Similar study should be conducted during one season to determine any differences in the response of *Basella* to the different mulching materials.

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