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Growth and yield of okra (*Abelmoschus esculentus* (L.) Moench) grown in the marginal upland area of Sta. Rita, Samar as influenced by different planting densities and mulching materials

Zenaida C. Gonzaga[1*], Warren L. Obeda[2], Ana Linda G. Gorme[3], Jessie C. Rom[4], Oscar F. Abrantes Jr.[5], and Othello B. Capuno[6]

ABSTRACT

Okra or Lady's finger, botanically known as *Abelmoschus esculentus* (L.) Moench, is a tropical and sub-tropical indigenous vegetable crop commonly grown for its fibrous, slimy, and nutritious fruits and consumed by all classes of population. It has also several medicinal and economic values. Despite its many uses and potential value, its importance is under estimated, under-utilized, and considered a minor crop and little attention was paid to its improvement. The study was conducted to evaluate the effects of different planting densities and mulching materials on the growth and yield of okra grown in slightly sloping area in the marginal uplands in Sta. Rita, Samar, Philippines. A split-plot experiment was set-up with planting density as main plot and the different mulching materials as the sub-plot which were: unmulched or bare soil, rice straw, rice hull, hagonoy and plastic mulch.

Planting density did not significantly affect the growth and yield of okra. Regardless of the mulching materials used, mulched plants were taller and yielded higher compared to unmulched plants. Moreover, the use of plastic mulch resulted to the highest total fruit yield. The results indicate the potential of mulching in increasing yield and thus profitability of okra production under marginal upland conditions.

Keywords: rice straw, rice hull, hagonoy, plastic mulch

INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench) or Lady's finger belongs to Malvaceae family and one of the most economically important vegetable crop

[1,2,3,4,5] Department of Horticulture, Visayas State University, Visca, Baybay City, Leyte 6521-A
[6]Office of the Vice President for Research & Extension, Visayas State University

***Corresponding Author.** Address: Department of Horticulture, Visayas State Unversity, Visca, Baybay City, Leyte 6521-A; Email: zcgonzaga@yahoo.com
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grown in tropical and sub -tropical parts of the world (Gemede et al 2015). Okra has been called "a perfect villager's vegetable" because of its robust nature, dietary fiber, and distinct seed protein balance of both lysine and tryptophan amino acids (It has a diverse array of nutritional quality and potential health benefits hence grown and consumed daily by all classes of the population. It is a good source of carbohydrates, vitamins A and C, minerals such as Ca, K, Na, Cu, Mn, Zn Mg, P and Fe (Makhadmed & Ereifej 2004, Osunde & Makama 2007), nutritional qualities like protein, fiber, ash, viscosity (Ade tuyiet Al 2011) and low fat content (Kouassi et al 2013). Compared to other fleshy fruit vegetables like tomato and eggplant, it is richer in Ca which is about 70-90mg per 100g (Siemonsma & Piluek 1994). It also provides the necessary energy to the body and important antioxidants that could boast immune body system and prevent diseases. In some countries, the young leaves are used in preparing yam soup which serves as the major source of energy (Nwachukwu et al 2014). Often the extract obtained from the fruit is added to different recipes like stews and sauces to increase the consistency. It has medicinal applications when used as a plasma replacement or blood volume expander, prevent cardiovascular disease, type 2 diabetes, digestive diseases and some cancers (Gemede et al 2015). However, okra has been considered an economically minor crop and little attention was paid to its improvement in the international research program (Duzyaman 2010, Kumar et al 2010).

MATERIALS AND METHODS

Land Preparation

This study was conducted in the marginal upland in Barangay Caticugan, Sta. Rita, Samar. An area of 322m^2 was plowed and harrowed two times to pulverize the soil and remove weeds. After the 2nd harrowing, plots measuring 1.0mx3.0m were constructed. A total of 45 treatment plots were raised.

Experimental Design and Treatments

The experimental area was laid out in Split-plot arranged in Randomized Complete Block Design (RCBD) and replicated three times. Each treatment plot measured 1.0mx3.0m and plant spacing of 0.5cm between hills x 0.5cm between rows. An alleyway of 0.5m was provided between replications and treatment plots to facilitate farm operation and management as well as
data gathering.

The treatments were designated as follows: Factor A (different planting densities); D_1–1plant per hill, D_2–2 plants per hill, and D_3–3 plants per hill and Factor B (different mulching materials); T_0–Control (unmulched), T_1–Rice straw, T_2–Rice hull, T_3–Hagonoy, and T_4–Plastic mulch.

Cultural Management

Basal fertilizer application was done at 5g complete per hill plus 2.1kg per plot chicken dung before sowing. The seeds were sown directly to the plots at a spacing of 0.5m between hills and rows. The number of seeds sown per hill depends on the number of plants to be grown in each hill which corresponds to factor A (planting

density). Watering the plants which made use of water catchment in 200L drum installed in the study site was done early in the morning depending on the soil conditions during the early stage of vegetative growth.

Two (2) centimeter thick of rice straw, rice hull and hagonoy leaves were spread over the designated treatment plots one week after seedling emergence while plastic mulch was installed before sowing the seeds to avoid seedling damage.

Harvesting was done twice a week using a pruning shear after which fruits were classified as marketable and non-marketable. Marketable fruits are free from deformities, diseases and insect damages while non-marketable fruits are those infected with diseases, deformed, and damaged.

Data Gathered

A. Horticultural characteristics and yield parameters

Plant height was obtained by measuring the height of the plants after the last harvest. The number of days to first flowering and fruiting were obtained by counting the number of days from transplanting up to the emergence of flowers in each sample plant and the formation of fruits when the wilted petal was being detached from a newly formed fruit. The fruit size (cm) was obtained by measuring the fruit diameter using vernier caliper and length using ruler. The number and weight (kg) of marketable and non-marketable fruits per plot was determined by counting and weighing those fruits from each treatment plot after sorting. Finally, the total yield (tons/ha) was determined by getting the cumulative weight of the marketable and non-marketable fruits from the first until the last harvest.

B. Other data gathered

Data on weeds were taken by weighing all the weeds in each treatment plot from
transplanting to the last harvest and data on total weekly rainfall was also obtained.

Statistical Analysis

The data obtained were analyzed using STAR program and treatment mean comparison was done using Duncan Multiple Range Test (DMRT) at 5% level of probability.

Cost and Return Analysis

This was determined by taking into account all the cost of production from land preparation until the harvest and the gross income obtained. Gross income was calculated by determining the total weight of the marketable fruits harvested multiplied by the current market price at PhP20.00 per kg. Then, net income was calculated by subtracting the production cost from the gross income.

RESULTS AND DISCUSSIONS

Horticultural and Yield Characteristics

Planting density did not significantly affect the height, number of days to first flowering, first fruiting and yield of okra. However, different mulching materials significantly enhanced the height of the crop. Early flowering was also observed in unmulched plants which then resulted to early fruiting (Table 1). Moreover, different mulching materials showed significant effect in increasing its yield regardless of the three planting densities used (Table 2). At the start, vigorous growth of plants was observed in all the treatments (Figure 1) but later on, better performance of mulched plants over than that of unmulched plants (T_0) were observed (Figure 2). The better performance and higher yield of mulched plants over than that of unmulched can be ascribed to its contribution to weed management via reducing weed seed germination, suppressing weed growth and favoring the crop by conserving soil moisture at the same time moderating soil temperature (Gonzaga et al 2014). This is also in consonance with the result of Jenni et al (2004) that mulching using polyethylene plastic on lettuce plants was effective in controlling weed growth and thus increased marketable yield to 7% compared to the control or unmulched plants. Furthermore, among all the different mulching materials used, plastic mulch (T_4) has the greatest number and heaviest marketable fruits produced, which was not significantly different from rice straw (T_1). This was followed by mulching with hagonoy weeds (T_3) which did not significantly differ with rice hull mulch (T_2) while the control had the lowest yield. On the other hand, bigger fruits measured in terms of length and width were produced in plants under plastic mulch (Table 2) because plastic mulch controls leaching of water and nutrients and rice straw mulch gave additional nutrients to the plants compared to unmulched plants. The rice straw mulch was effective in minimizing weeds (Devasinghe et al 2011), but the superior plastic mulch shows relevant fruit size, number and weight of marketable okra fruits, with lesser weeds, as Poffley (1997) stated that the plastic mulch is more efficient in water utilization due to the reduced evaporation in the soil and more efficient in fertilizer utilization since nutrient leaching is controlled. Weed population in the field significantly vary (Figure 3). The control/unmulched okra plots had the heaviest weeds, which was followed by those mulched with rice hull, hagonoy, and rice straw. Plots mulched with plastic had the lightest weight of weeds among the treatments. Plots mulched with hagonoy has lesser weeds compared to unmulched but should have been less effective in controlling weed growth than those material that did not easily decomposed like rice straw and rice hull that continually provide ground cover. This study lend support to the report of Sumalinog (2015), that organic material that decomposed easily such as kakawate and hagonoy leaves were less effective in controlling weed growth than those that do not readily decomposed like rice straw and rice hull under open field condition. However, despite the decomposition of hagonoy weeds, the dense foliage of okra plants still inhibits growth of weeds. In addition, rainfall (Figure 4) prominently affect the longevity of the mulching material in the field wherein heavy rain percolation caused rice hull and hagonoy leaves to be easily washed out because these mulches are lighter in weight compared to the other mulching materials which led to growth of weeds.

Table 1. Horticultural characteristics of okra grown under different planting densities and mulching materials

Treatments	Plant Height (cm)	Number of Days to First	
		Flowering	Fruiting
Planting densities			
One (1) plant per hill	83.44	42.51	47.22
Two (2) plants per hill	84.05	43.02	47.23
Three (3) plants per hill	84.76	42.42	47.94
Mulching materials			
T0 – Control	77.99c	41.19b	46.00b
T1 – Rice straw	88.47a	42.75a	47.50a
T2 – Rice hull	84.69b	42.81a	47.80a
T3 – Hagonoy weeds	84.09b	43.56a	49.09a
T4 – Plastic mulch	85.17b	42.94a	47.44a
CV a (%)	8.50	2.95	6.09
CV b (%)	3.53	3.18	3.48

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

Table 2. Yield of okra grown under different planting densities and mulching materials

Treatments	Fruit Size (cm)		Plot Yield/3m^2				Yield (t/ha)
			Number		Weight (kg)		
	Diameter	Length	Marketable	Non-marketable	Marketable	Non-marketable	
Planting densities							
One (1) plant per hill	1.53	12.53	237.34	50.40	5.10	1.01	20.38
Two (2) plants per hill	1.53	12.51	249.87	54.84	5.34	1.15	21.63
Three (3) plants per hill	1.51	12.27	256.37	50.20	5.49	1.04	21.77
Mulching materials							
T0 – Control	1.45b	11.65b	187.85d	48.34	4.04d	1.08	17.06c
T1 – Rice straw	1.60a	13.34a	269.48b	53.21	5.72b	1.16	22.95a
T2 – Rice hull	1.49b	12.62b	234.10c	49.57	5.03c	0.72	19.17b
T3 – Hagonoy weeds	1.48b	12.03b	224.98c	55.85	4.84c	1.23	20.23b
T4 – Plastic mulch	1.59a	13.54a	322.90a	52.10	6.91a	1.15	26.87a
CV a (%)	9.14	10.52	11.82	24.32	11.86	28.44	12.03
CV b (%)	3.32	4.70	11.64	22.29	11.65	34.32	12.48

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

Growth and yield of okra

Figure 1. Two-month old okra plants in the experimental set-up in Sta. Rita, Samar showing vigorous growth

Figure 2. Okra plants applied with different mulching materials

Figure 2 continued

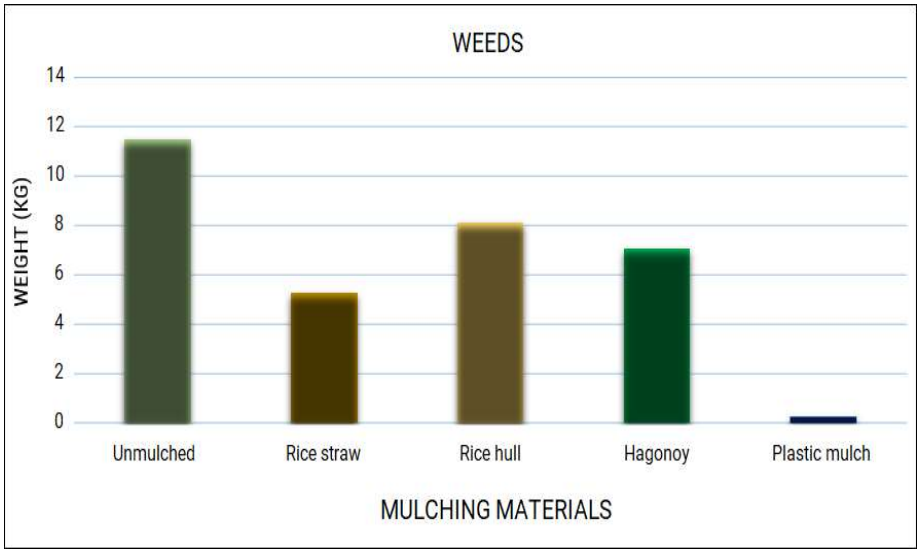

Figure 3. Total weight (kg) of weeds per 27m^2 in okra applied with different mulching materials

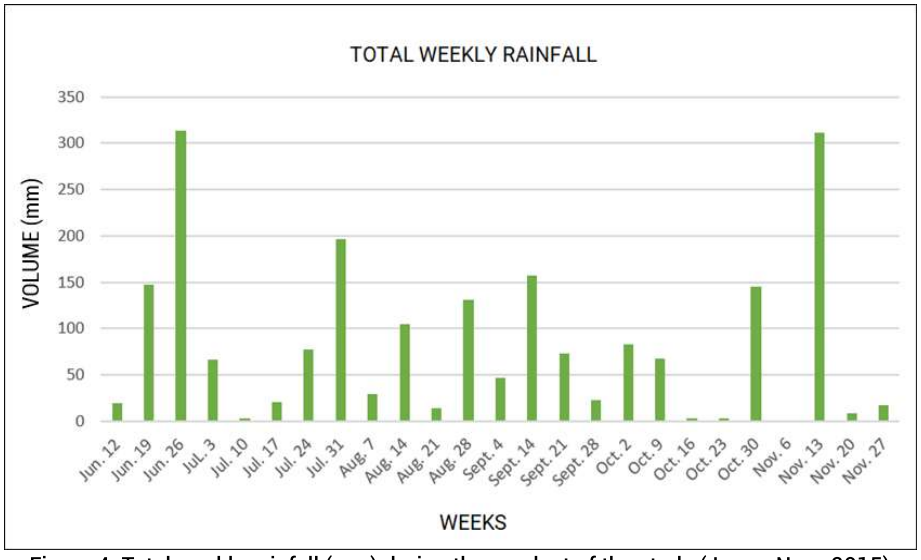

Figure 4. Total weekly rainfall (mm) during the conduct of the study (June - Nov., 2015)

Estimates on the Cost and Return of Okra Production

Cost and return analysis of okra as influenced by different planting densities and mulching materials are presented in Table 3. In general, plants mulched with plastic in all the three planting densities had the highest total cost of production, followed by plants mulched with Hagonoy and rice hull having the same expenditures, then by plants mulched with rice straw, and lastly by the unmulched plants which had least total production cost. Specifically, production of okra with three (3) plants per hill mulched with plastic incurred the highest total production cost of PhP3,972.30, followed by two (2) plants per hill of PhP3,867.30 and one (1) plant per hill of PhP3,762.30. The cost of production of okra with one (1) plant per hill without mulching material incurred lowest production cost of PhP3,209.80, followed by two (2) plants per hill of PhP3,314.80, and three (3) plants per hill of PhP3,419.80.

Table 3. Estimates on the cost and return of okra production as affected by mulching per 322m^2

Treatments	Weight (kg)	Gross Income* (PhP)	Total Expenses (PhP)	Net Income** (PhP)
Planting density				
One (1) plant per hill				
Mulching materials				
T_0 – Control	497.81	19,912.44	3,209.8	6,746.42
T_1 – Rice straw	749.10	29,964.12	3,569.8	11,412.26
T_2 – Rice hull	578.56	23,142.60	3,619.8	7,951.50
T_3 – Hagonoy weeds	654.55	26,181.84	3,619.8	9,471.12
T_4 – Plastic mulch	964.15	38,565.84	3,762.3	15,520.62

Table 3 continued

Treatments	Weight (kg)	Gross Income* (PhP)	Total Expenses (PhP)	Net Income** (PhP)
Planting density				
Two (2) plants per hill				
Mulching materials				
T_0 – Control	569.92	22,796.88	3,314.8	8,083.64
T_1 – Rice straw	769.87	30,794.88	3,674.8	11,722.64
T_2 – Rice hull	716.47	28,658.64	3,724.8	10,604.52
T_3 – Hagonoy weeds	637.52	25,500.72	3,724.8	9,025.56
T_4 – Plastic mulch	908.16	36,326.40	3,867.3	14,295.90
Planting density				
Three (3) plants per hill				
Mulching materials				
T_0 – Control	568.50	22,740.12	3,419.8	7,950.26
T_1 – Rice straw	799.03	31,961.04	3,779.8	12,200.72
T_2 – Rice hull	740.85	29,633.88	3,829.8	10,987.14
T_3 – Hagonoy weeds	668.87	26,754.60	3,829.8	9,547.50
T_4 – Plastic mulch	927.77	37,110.72	3,972.3	14,583.06

*Obtained by multiplying the weight of okra fruits with the current price at PhP20.00/kg
**Obtained by subtracting the gross income from the total expenses incurred in the study

Results also show that okra plants applied with the four different mulching materials gave higher net returns compared to the control (T_0) or unmulched plants. This was basically due to the higher yield obtained from those mulched plants which then resulted to higher gross income compared to unmulched plants regardless of the planting densities being used. However, among the three different planting densities used, one (1) plant per hill yielded the highest profit of PhP15,520.62, followed by three (3) plants per hill which is PhP14,583.06, and two (2) plants per hill which is PhP14,295.90 which were all mulched with black polyethylene plastic. On the other hand, regardless of the different planting densities, unmulched plants had the lowest profit of PhP6,746.42, PhP7,950.26, and PhP 8,083.64 in one, three and two plant(s) per hill, respectively.

CONCLUSION AND RECOMMENDATION

Based on the results obtained, it is concluded that different planting densities resulted to comparable yield in okra. However, mulching with the use of rice straw, rice hull, hagonoy and plastic mulch enhanced growth and yield of okra. Furthermore, these mulching materials had superior effect over that of unmulched treatment or bare soil in terms of number and weight of marketable fruits. Plants mulched with plastic produced the highest yield and consequently gave the highest net returns.

Under the condition of the study where rainfall is abundant, plastic mulching is highly recommended.

REFERENCES

Adetuyi FO, Osagie AU & Adekunle AT. 2011. Nutrient, anti-nutrient, mineral and zinc bioavailability of okra *Abelmoschus esculentus* (L) Moench Variety. *American Journal Food Nutrition* 1(2):49-54

Cregg BM and Schutzki R. 2009. Weed control and organic mulches affect physiology and growth of landscape shrubs. *HortScience* 44(5):1419–1424

Devasinghe DAUD, Premarathne KP & Sangakkara UR. 2011. Weed management by rice straw mulching in direct seeded lowland rice (*Oryza sativa* L.). *Tropical Agricultural Research* 22(3):263-272

Gemede HF, Ratta N, Haki GD, Woldegiorgis AZ & Beyene F. 2015. Nutritional quality and health benefits of "okra" (*Abelmoschus esculentus*): a review. *International Journal of Nutrition and Food Sciences* 4(2):208-215

Gonzaga ZC, Dimabuyu HB, Sumalinog RR & Capuno OB. 2014. Increasing productivity of Malabar spinach (*Basella alba* L. and *Basella rubra* L.) grown in the marginal upland area on Inopacan, Leyte through different mulching materials. Visayas State University. *Annals of Tropical Research* 36 (Supplement):166-178

Jamil M, Munir M, Qasim M, Baloch J & Rehman K. 2005. Effect of different types of mulches and their duration on the growth and yield of garlic (*Allium sativum* L.). *International Journal for Agricultural Biologist* 7(4):588-591

Jenni S, Brault D and Stewart KA. 2004. Degradable mulch as an alternative for weed control in lettuce produced on organic soils. *Acta Horticulturae 638*:111-118

Kołota E. 2013. Living mulches in vegetable crops production: perspectives and limitations (a review). Department of Horticulture, Wrocław University of Environmental and Life Sciences, Pl. Grunwaldzki 24a, 50-363 Wrocław, Poland. *Acta Science of Poland Hortorum.Cultus*12(6):127-142

Kouassi JB, Massara CC, Monde AA, Tiahou GG, Sess DE & Yama ET. 2013. Comparative study of proximate chemical composition of two varieties of okra dried by two methods: sun and electric drying. *American Journal of Biological Science* 1(4):74-79

Kumar S, Dagnoko S, Haougui A, Ratnadass A, Pasternak D & Kouame C. 2010. Okra (*Abelmoschus* spp.) in West and Central Africa: Potential and progress on its improvement. *African Journal of Agricultural Research* 5(25):3590-3598

Makhadmeh IM and Ereifej KI. 2004. Geometric characteristics and chemical composition of okra (*Hibiscus esculentus* L.) grown under semi-arid conditions. *International Journal of Food Properties* 7(1): 83-90

Mukherjee D, Mitra S & Das AC. 1991. Effect of organic matter cakes on the changes in carbon, nitrogen and microbial population in soil. *Journal of Indian Society soil Science* 39: 121-126

Nwachukwu EC, Nulit R & Go R. 2014. Nutritional and biochemical properties of Malaysian okra variety. *Advancement in Medicinal Plant Research* 2(1):16-19

Osunde ZD and Musa Makama AL. 2007. Assessment of changes in nutritional values of locally sun-dried vegetables. *Assumption University Journal of Technology* 10(4): 248-253.

Poffley M. 1997. Growing vegetables using black plastic mulch and trickle irrigation. ISSN No: 0157-8243. 367. No. B17. Agdex No: 250/16

Siemonsma JS and Piluek K. 1994. Vegetables. *PROSEA (Plant Resources of South-East Asia)* 8:57-59. Bogor. Indonesia

Sumalinog RR. 2015. Influence of different organic and colored plastic mulches on the growth and yield of tomato (*Solanum lycopersicum* L.) grown in the open field and protective structure (MS thesis). Visayas State University

Vander ZP, Degamante A, Acasio R, Domingo A & Hagerman H. 1986. Response of Solanum potatoes to mulching during different seasons in an isohyperthemic environment in the Philippines. *Tropical Agriculture (Trinidad)* 63:229-239

Wu J, Donnell AC & Syers JK. 1993. Microbial growth and sulphur immobilization following the incorporation of plant residues into soil. *Soil Biology and Biochemistry* 25:1567-1573

http://www.ehow.com/facts_7520978_planting-density.html Retrieved on February 15, 2017

https://superfoodbox.life/blogs/blog/okra.Retrieved on January 31, 2018