Effects of Intercropping Celosia, Amaranthus and Corchorus on the Growth and Yield of Cucumber (Cucumis Sativus L.).

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Chapter Seven

Effects of Intercropping Celosia, Amaranthus and Corchorus on the Growth and Yield of Cucumber (*Cucumis Sativus* L.).

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Abstract

Intercropping is the growing of two or more crops in close proximity to promote interaction between them. Intercropping has the advantage of increasing crop productivity. It could, however, lower the yield of one or more of the component crops. Two field experiments were conducted in IDO Local Government Area of Oyo State to evaluate effects of intercropping celosia, Amaranthus and Corchorus on the growth and yield of cucumber (Cucumis sativus L.). Cucumber seeds were sown at the rate of one seed per hole and spaced at 0.8 m x 1.0 m resulting in 12,500 plants per hectare while the seeds of celosia, Amaranthus and Corchorus were broadcast on the bed at the rate of 6 kg per hectare. Data were collected on vine length (cm), number of leaves between 2 and 6 weeks after sowing, number of fruits and fruit weight (kg) of cucumber at two major harvests, weed biomass, celosia, Amaranthus and Corchorus biomass yield at 7 Week After Sowing (WAS). The data were subjected to analysis of variance system while significant means were compared using the Least Significant Difference (LSD). The results showed that intercropping Celosia, Amaranthus and Corchorus with Cucumber did not have significant effects on the growth parameters such as the vine length and number of leaves but significantly affected the yield of cucumber in terms of the number of fruits and weight of fruits. The cumulative number and weight of fruits of cucumber intercropped with celosia were significantly lower than that of sole cucumber in the two croppings. The differences in yield among cucumber intercrops with the three vegetables were however not significant. Amaranthus, Corchorus, and Celosia caused 12, 18 and 30% reduction in the number of the fruit of cucumber respectively while the corresponding reduction in fruit yield were 18, 21 and 31%. Celosia appeared to have higher yield reduction effects on the cucumber than other leafy vegetables, thus care must be taken in choosing the associated crops.

Keywords: Cucumber; Amaranthus; Corchorus; Intercropping; Yield

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Introduction

Cucumber (*Cucumis sativus* L.) belongs to the Cucurbitaceae (gourd family). The cucumber is a thermophilic horticultural crop with a creeping vine that bears cucumiform fruits that are used as vegetables. It is a good source of vitamins and minerals (Ofosu, 2007).

There are three main genotypes of cucumber: slicing, pickling and seedless. Within these varieties, several cultivars have been created. The cucumber is originally from South Asia but now grows on most continents. Many different types of cucumber are traded on the global market. It is cultivated in almost all the agro-ecological zones of Nigeria ranging from coastal to savannah zones. The savannah zone of Nigeria has the greatest potential for its production due to moderate rainfall. However, research has proved that it can also grow in some southern parts of Nigeria (Ofosu, 2007).

Cucumber is commonly used for food, medicinal and industrial purposes. It is either eaten raw or prepared in various forms especially as components of the vegetable salad. Cucumber is commonly processed into fresh products like pickles, kimchi, and salad or as beverages like juice. In medicine, it is used to mitigate various cancers including (breast-ovarian, uterine and prostate); and for the treatment of diabetics, skin irritations as well as rehydrate the body. Cucumber can also be used for beauty purposes such as body scrub and cleansing cream. Its benefits concerning other health and medical conditions include the manufacture of soaps, lotions, shampoos fragrant and usage in the cosmetic industry.

Fruit and leafy vegetables are of great importance worldwide most especially in the human diet as they contain all the necessary minerals and vitamins needed for the proper functioning of the human system. Sadly, due to the problem of land scarcity and crop ranking, it has become difficult to cultivate them extensively (Harwood 1975). Vegetables are abundantly grown in Nigeria for their edible fruits and leaves (Ofosu, 2007). The term leafy vegetable is frequently used to refer to plants whose succulent stem portions, petioles, and leaves are mainly cooked and eaten in soups (Ofosu, 2007). Besides their aesthetic value in food presentation, vegetables enhance the nutritional quality of diets in terms of vitamins and minerals such as carotene, ascorbic acid, riboflavin, iron, iodine and calcium (Harwood 1975).

Intercropping was a common routine in the past but it has progressively been substituted by extensive cultivation (Andrew and Kassam 1976). Intercropping is the growing of two or more crops in close proximity to promote interaction between them. It is practiced with the aim of maximizing plant

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cooperation rather than plant competition for maximum crop yields per unit area (Theunissen 1997). It also provided a more competitive effect against weeds either in time or space than those of mono-cropping (Sullivan 2001). Arnon (1972) reported that for food crop production, intercropping is frequently used and the system varies with locality and resources available to the farmers (Arnon 1972). Intercropping of vegetables is experiencing a renaissance with the uptake of organic farming. Cultivation of several plant species simultaneously eliminates negative traits of homogenous cultivation, supports bio-diversity and remains compliant with the rule of balanced agriculture. Any system of cropping that can increase the rate of crop yield and or lower the cost of production will provide economic opportunity for farmers. Intercropping has been identified as a promising system that results in ineffective use of land and other resources, efficient utilization of water and soil nutrients and reduction in the cost of production. It also gained wide acceptability among farmers in tropical countries (Norman, 1970; Willey, 1979) because of its economic advantages (Baker, 1979).

Intercropping has an additional advantage of weed control. Weeds are naturally occurring plants that are injurious in agricultural systems. Most weeds are opportunistic, filling in voids on the farm and can only grow or exist if there is space for them. Weeds harbor insects and disease organisms, serve as alternate hosts to pests, compete with crops for nutrients, moisture, light, and space, they may increase insect and disease damage to crops, decrease the quality of crops, or cause harm to animal health that feeds on them (Weaver 1984). Weeds reduce crop yield and quality by competing with the crops (Anil 2000). Despite yield stability, the most important advantage of intercropping is the possibility of better control of weeds, pests or diseases. Other advantages of intercropping include; greater system resilience by the interplay of different crops, greater production at crop edges, deliver environmental benefits such as greater soil and water conservation potential (Akobundu 1987). Despite the advantages of mono- or soles cropping such as reducing input use, weed control with selective herbicide, ease of mechanization, etc., almost all smallholder farmers in the developing world still practice intercropping (Ijoyah 2011). Therefore, this experiment is aimed to investigate the effect of intercropping leafy vegetables on growth and yield of cucumber with a view of maximizing plant cooperation rather than plant competition for maximum crop yields per unit area.

Materials and Methods

Description of experimental site: The experiment was carried out at IDO in IDO Local Government area, Ibadan, Oyo State, located within the latitude of 7° 45′ 9.25′′ N and longitude of 3° 87′

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52.50'' E. The site has sandy-loam soils. The field was about 40 m × 28 m located in a FADAMA, near a stream which served as the main source of residual soil moisture for the trial established in February 2018. The second rain-fed experiment was established on the upland field on the same farm.

Land preparation, Cultural Practices, and Experimental Procedure

The land preparation was done manually with the use of hoes and cutlasses one week prior to planting. The farm site was ploughed and tilling was done with the use of native hoe to prepare smooth weed-free ridges. Plots were arranged in pairs with each treatment occupying two subplot. The size of each plot was 5 m × 3 m with a border of 1m between plots. Subsequent hand wedding was done as the need arose and as expected the leafy greens served as life mulch for the cucumber plant and major wedding was only carried out once at 4 Weeks After Sowing (WAS). Visual observation was carried out for determination of weed emergence and growth as relate to the density of vegetable in population.

Treatments and Experimental, Design and Plot Size

The treatments were cucumber (Variety Greengo 918 F_1) grown sole or in intercropping with three commonly grown leaf vegetables in south western Nigeria, *Corchorus olitorius* (Corchorus), *Amaranthus viridis* (Amaranthus) and *Celosia argentea* (Celosia). Plots were arranged in pairs with each treatment occupying two sub plot. The size of each plot was 5 m × 3 m with a border of 1m between plots. The trials were laid out in randomized complete block design (RCBD) consisting of four treatments including the control and replicated four times. The experiment was done twice with planting in a valley bottom which used residual soil moisture substituted with occasional watering as commonly practised by farmers and the second planting done on dryer upland field at the on-set of rains.

Cultural Management and Experimental Procedure

The treatments combinations are presented in Table 1, Planting was done on the 24th February and 13th April 2018 for the first and second trial respectively. Cucumber seeds were direct seeded at the rate of one seed per hole and spaced at 0.8 m x 1.0 m resulting in 12,500 plants/ha while the leaf vegetable seeds were broadcast on the bed between each cucumber plant at the rate of 6 g per 10 cm^2 equivalent to 6 kg/ha. The vegetables were planted simultaneously to the cucumber on the same day to evaluate their ability in controlling weeds with particular emphasis on their effect on growth and yield of cucumber. The cucumber plants were staked with bamboo poles and twine in a trellis pattern.

Data collection

Data were collected from three cucumber plants on growth and yield parameters including plant height by measuring

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with meter rule, numbers of leaves/plant, number of branches/plant and cumulative fruit weight/plant harvested at 4-day interval. The cumulative fruit weights were also recorded from which the fruit yield (t/ha) was estimated. The fruit yield was then calculated for the cumulative fruit weight/plant.

Data analysis

The data were subjected to analysis of variance system while significant means were compared using the Least Significant Difference (LSD).

Table 1: Treatments combination of the experiment

S/N	Treatment
1	Sole cucumber
2	Cucumber + amaranthus
3	Cucumber + celosia
4	Cucumber + corchorus

Results and Discussion

Soils of the experimental site: The results of the physical and chemical characteristics of the soil of the two fields before cropping cucumber are presented in Table 2. The soils of the experimental site were characterized as loam loamy-sand with 781, 134 and 85, and 801, 114 and 80 g/kg sand, silt and clay respectively for the valley bottom and the upland fields. The soils were slightly acidic with very high organic carbon content.

Effects of Celosia, Amaranthus and Corchorus intercropping on vine length and number of leaves in Cucumber

Table 3 and 4 contains the result on the effects of intercropped celosia, Amaranthus and Corchorus on the vine length of cucumber in the first and second cropping respectively. In both cases, the effects of intercropping were not significant ($P \leq 0.05$) on the vine length of the cucumber. However, the cucumber that was intercropped with celosia appeared to have longer vines compared to other intercropping. This could be due to the fact that celosia seeds germinated later than other leafy vegetables hence delay in onset of competition for light and another resource with cucumber plants. This might cause etiolation which might make the cucumber to grow longer. The non-significant effect of intercropping on growth characteristics of cucumber was reported by Yildirim and Guvenc (2004) and Ojeifo (2007).

The number of leaves in cucumber as influenced by intercropping with celosia, amaranthus and corchorus in first and second cropping of the crops are presented in Tables 5 and 6. There were no significant differences in the number of leaves at the various stages of growth as influenced by the intercropping with the different leaf vegetables (Ojeifo 2007).

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Table 2: Chemical and physical properties of the soil at experimental site

	First site	Second site
pH (H_2O)	6.2	6.3
Organic C (g Kg^{-1})	19.4	18.4
Total N (g Kg^{-1})	4.5	4.1
Available P (g Kg^{-1})	14.9	13.7
Exchangeable bases (cmol Kg^{-1})		
Ca	12.6	11.8
Mg	1.7	1.7
Na	0.9	0.8
K	1.7	1.5
Exchangeable Acidity (cmol Kg^{-1})	0.4	0.3
CEC (cmol Kg^{-1})	17.3	16.1
Base saturation (cmol Kg^{-1})	82.4	91.6
Particle size (g Kg^{-1})		
Sand	781	806
Silt	134	114
Clay	85	80
Textural class	Sandy loam	Loamy sand

Table 3: Vine length (cm) of Cucumber as affected by intercropping with three leafy vegetables (First Cropping)

	Weeks after sowing				
Treatment	2	3	4	5	6
Sole Cucumber	11.2	18.8	53.2	92.3	169.3
Cucumber + Amaranthus	11.4	20.3	51.7	90.8	166.8
Cucumber + Celosia	11.8	20.6	51.9	99.8	174.5
Cucumber + Corchorus	14.4	22.4	57.6	96.0	162.3
LSD	ns	ns	ns	ns	ns

Table 4: Vine length (cm) of Cucumber as affected by intercropping with three leafy vegetables (Second Cropping)

	Weeks after sowing				
Treatment	2	3	4	5	6
Sole Cucumber	14.5	21.4	56.9	95.9ab	171.0
Cucumber + Amaranthus	15.9	22.4	55.6	104.9a	165.3
Cucumber + Celosia	15.0	22.0	57.2	100.2ab	169.3
Cucumber + Corchorus	15.5	22.1	55.5	82.1b	160.0
LSD	ns	ns	ns	22.31	ns

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Table 5: Number of leaves of Cucumber as affected by intercropping with three leafy vegetables (First Cropping)

Treatment	Weeks after sowing				
	2	3	4	5	6
Sole Cucumber	4.4	5.7	11.4	22.2	29.2
Cucumber + Amaranthus	4.9	6.9	12.9	25.8	33.7
Cucumber + Celosia	5.0	6.8	12.6	23.3	30.9
Cucumber + Corchorus	5.0	6.3	11.9	23.7	31.2
LSD	ns	ns	ns	ns	ns

Table 6: Number of leaves of Cucumber as affected by intercropping with three leafy vegetables (Second Cropping)

Treatment	Weeks after sowing				
	2	3	4	5	6
Sole Cucumber	4.9	6.2	19.1	24.5	37.1
Cucumber + Amaranthus	5.2	7.2	17.7	26.9	36.3
Cucumber + Celosia	5.3	7.3	20.3	24.9	37.2
Cucumber + Corchorus	5.2	6.7	20.4	25.2	36.3
LSD	ns	ns	ns	ns	ns

Fruit yield of Cucumber as influenced by intercropping with Celosia, Amaranthus and Corchorus

The fruit yield of cucumber both in terms of number and weight per hectare after two major harvests in the first and second cropping as well as cumulative yields in both croppings as influenced by intercropping with celosia, amaranthus and corchorus are presented in Tables 7 and 8. Intercropping Cucumber with Celosia, Amaranthus, and Corchorus vegetable had significant effects ($P \leq 0.05$) on the number of fruits as well as the fruit weight of the crop at both harvesting points as well as the cumulative yields in the first cropping (Table 7).

Although the numbers of fruits at both harvests as well as the weight of fruits in the first harvest were not significantly influenced in the second cropping, the cumulative yields in both parameters were significantly different as influenced by the intercropping with the selected crops (Table 8).

The cucumber intercropped with Celosia had the lowest number of fruits at the first harvest and the cumulative harvests in the first cropping. This was significantly lower than those obtained from the plots that were intercropped with Amaranthus and those of the sole cropping but comparable to that of intercropping with Corchorus in both

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harvests. In the second harvest of the first cropping, a number of fruits of cucumber in the plots intercropped with celosia and that of Corchorus were significantly lower than that obtained in sole Cucumber cropping but comparable to that of amaranthus cucumber intercrop (Table 7).

The fruit weight of Cucumber intercropped with celosia in the first cropping was significantly lower than that obtained from sole cropping of Cucumber but comparable to those obtained from intercropping with the two other crops. The fruit weight of fruits from the intercrops with Amaranthus and Corchorus were not significantly lower than that obtained from the sole cucumber plot in this first harvest of the first cropping (Table 7).

In the second and cumulative harvests of fruits in the first cropping, all intercrop resulted in significantly lower fruit weight than that produced by the sole crop of cucumber (Table 7).

In the second cropping, numbers of fruits in the first and second harvests as well as fruit weights of Cucumber were not significantly influenced by intercropping with the selected leafy vegetables. However, a cursory look at the values indicates that these parameters followed a similar trend with that of the first cropping (Table 8). The Celosia intercrop caused about 12% reduction in a number of fruits in both first and second harvest and about 14% reduction in fruit weight compared to the sole crop of cucumber, though these were not significant. Ojeifo (2007) reported that on per unit area basis, the sole crops out-yielded the intercrops with regards to Cucumber.

The cumulative numbers of fruits and fruit weight of second and cumulative harvests in the second cropping were significantly influenced by intercropping with the selected vegetables. Intercropping with Celosia caused a lower cumulative number of fruits as well as the weight of fruits in the second harvest of the second cropping than the sole crop of cucumber. These yield parameters recorded in plots intercropped with Celosia was not however significantly lower than those from the other intercrops which were in turn comparable to that obtained in sole Cucumber plot. For the cumulative fruit weight, both Celosia and Amaranthus intercrops caused significant reduction in fruit weight compared to the sole cropping of cucumber. Intercropping with corchorus resulted in fruit weight that was not significantly lower or higher than that of the sole crop of Cucumber and intercrop with the other selected vegetables respectively (Table 8).

The weed biomass production as influenced by intercropping of Cucumber with the selected leaf vegetables is presented in Figure 1. The weed biomass was significantly influenced by the intercropping system. Sole cropping of cucumber resulted in highest weed biomass production of 3.2

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tonnes/ha (fresh weight) which was significantly higher than those produced in the other plots. Cucumber intercropped with Amaranthus caused weed biomass production of 0.91 t/ha which was comparable to 8.3 t/ha obtained from Cucumber-Celosia intercrop. These values were not significantly lower than 1.2 t/ha weed biomass production obtained from plots intercropped with Corchorus. The high weed biomass obtained from the sole crop of Cucumber was due to the absence of crop cover on the plots as the Cucumber plants were staked and thus the weed seeds were able to germinate and dominate the plots. It was observed in the field that the seeds of Corchorus germinated much later and also grew much slower than those of other vegetables thus allowing the weed to thrive earlier than the crops got established. Ofosu-Anim and Limbani (2007) reported that intercropping okra with Cucumber resulted in reduced weed infestation, especially of broadleaf weeds.

The total biomass production of vegetable crops and/or weeds in the cucumber and the selected leaf vegetables is presented in Figure 2. The biomass productions are significantly different under the different crop/plant combinations. Biomass productions in the plots that had Amaranthus or Celosia are comparable to one another but significantly higher than that obtained in plots that had Corchorus. Sole cropping had the least biomass production since only weeds which were removed at the early part of the lifecycle of the Cucumber crop were the companion plants.

Although it was observed that the total yield of cucumber and the vegetables could be advantageous (Yildirim and Guvenc, 2004), the effects of the intercropping with the selected vegetables caused reductions in cumulative number of fruits and weight of the fruits with a range of 12 to 30 and 18 to 31% respectively by the intercropped vegetables. Yildirim and Guvenc (2004) concluded that intercropping cucumber with lettuce, leaf lettuce, and French beans had some yield advantages and higher area-based productivity than when grown alone. The yield advantage in intercropping may also be due to the effects of intercropping on pest and diseases control or dynamics in the system (Pitan and Esan, 2014).

Table 7: Number and weight of Cucumber fruits at harvest as affected by intercropping with the selected leafy vegetables (First Cropping)

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Treatment	Number of fruits/ha			Weight of fruits (kg/ha)		
	1st harvest	2nd harvest	Cumulative	1st harvest	2nd harvest	Cumulative
Sole Cucumber	12750a	18318a	31068a	4788a	6880a	11668a
Cucumber + Amaranthus	11574a	15887ab	27460ab	4017ab	5522b	9539b
Cucumber + Celosia	7870b	13797b	21667c	2938b	5207b	8145b
Cucumber + Corchorus	11392ab	14233b	25625bc	4067ab	5182b	9248b
LSD	3523.8	2816.6	4680.3	1174.4	1330.3	1865.7

Table 8: Number and weight of Cucumber fruits at harvest as affected by intercropping with the selected leafy vegetables (Second Cropping)

Treatment	Number of fruits/ha			Weight of fruits (kg/ha)		
	1st harvest	2nd harvest	Cumulative	1st harvest	2nd harvest	Cumulative
Sole Cucumber	16304	17123	33427a	6119	6446a	12564a
Cucumber + Amaranthus	15957	15944	31901ab	5548	5534ab	11082b
Cucumber + Celosia	14355	15006	29361b	5238	5448b	10686b
Cucumber + Corchorus	15645	15945	31590ab	5867	5962ab	11829ab
LSD	ns	ns	3556.3	ns	986.2	1462.0

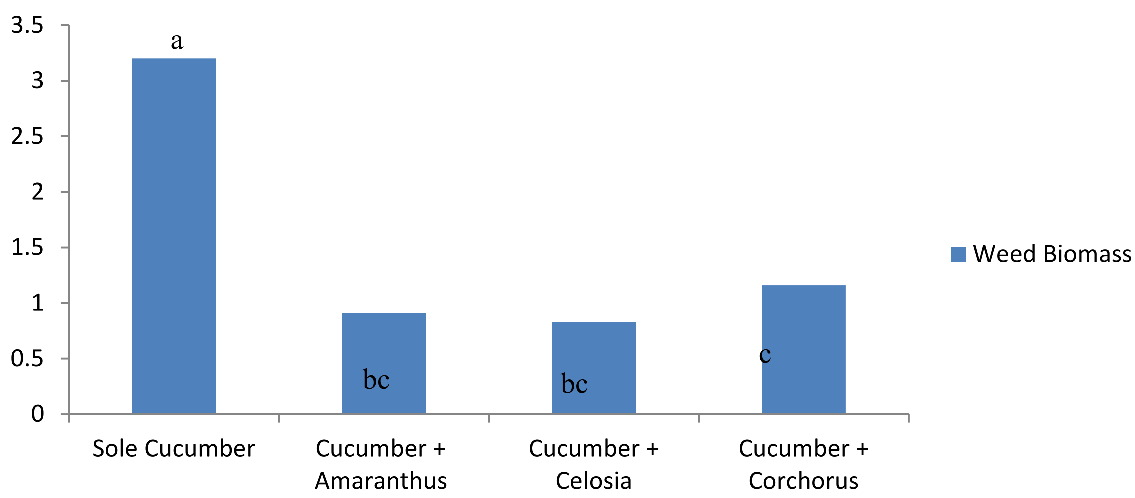

Figure 1: Weed biomass in Cucumber intercropped with selected leafy vegetables

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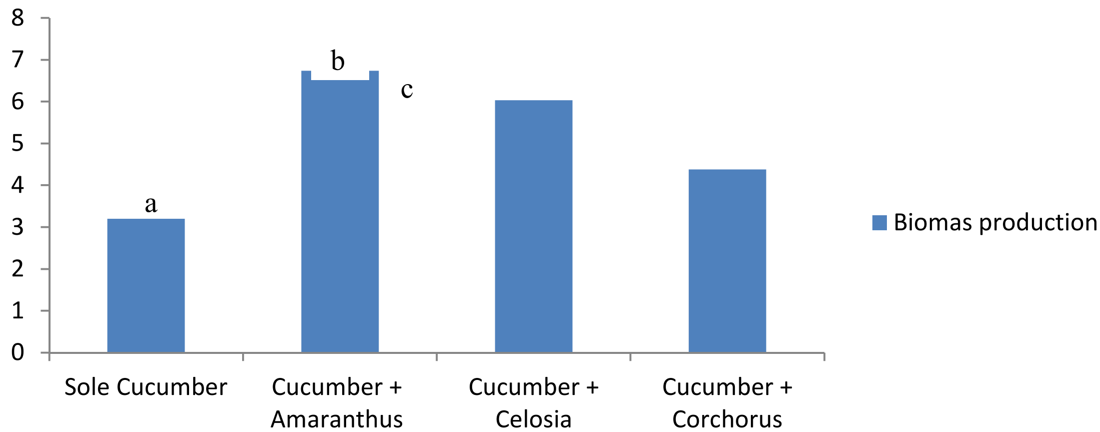

Figure 2: Total plant biomass in Cucumber intercropped with selected leafy vegetables

Summary and Conclusions

Two field experiments were conducted in IDO in February and April 2018 to evaluate the effects of intercropping Celosia, Amaranthus, and Corchorus on the growth and yield of cucumber (*Cucumis sativus* L.). Cucumber seeds were sown at the rate of one seed per hole and spaced at 0.8 m x 1.0 m resulting in 12,500 plants/ha while the leaf vegetable seeds were broadcast on the bed at the rate of 6 g per 10 cm^2 equivalent to 6 kg/ha. The cucumber plants were staked with bamboo poles and twine in a trellis pattern. Data were collected on growth and yield parameters of cucumber, weed biomass and Celosia, Amaranthus and Corchorus biomass yield at 7 WAS.

The results showed that intercropping Celosia, Amaranthus or Corchorus with Cucumber did not have significant effects on the growth parameters such as he vine length and a number of leaves but significantly affected the yield of Cucumber in terms of the number of fruits and the weight of fruits. Amaranthus, Corchorus, and Celosia caused 12, 18 and 30% and 18, 21 and 31% reduction in the number of fruits and in fruit weight respectively of cucumber. As could be seen, intercropping with celosia appeared to have higher yield reduction effects on the cucumber than other leaf vegetables, thus care must be taken in choosing the associated crops in Cucumber leaf vegetable intercrop. Although the selected vegetables had significant effects on the yield of cucumber, the economic analysis involving the total yields of the crops in the mixture may be required to determine the profitability of the intercropping system.

Celosia intercrop consistently reduced fruit number and yield of Cucumber at 2^{nd} harvest and cumulatively in the two

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croppings while Amaranthus and Corchorus similarly reduced the values in the first cropping only.

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