

INTERPLANTING COWPEA, SQUASH AND JEW'S MALLOW WITH TARO

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ABSTRACT

This work was carried out during two summer seasons, i.e., 2003 and 2004, to investigate the effect of interplanting cowpea, squash or Jew's mallow with taro on vegetative growth, chemical composition of taro corms, yield and its components, associated weeds, and land equivalent ratio. Significant decrease was observed in taro vegetative growth when interplanting with cowpea, squash and Jew's mallow. The vegetative growth of the companion crops were decreased by interplanting compared to sole crops. The highest values of chemical composition of taro corms (N, P, K, protein and starch) were obtained by solid taro. Interplanting cowpea with taro increased taro yield as compared to sole crop or with either squash or Jew's mallow. In addition, yield of cowpea, squash and Jew's mallow was higher when they were grown alone than when they were interplanted with taro. The results indicated that interplanting cowpea or squash with taro reduced significantly number of weeds, fresh and dry weight of weeds/ m² after 90 days from taro planting. However, interplanting Jew's mallow with taro had no effect on weed control. The highest yield was produced and land usage was increased due to interplanting cowpea with taro. The land usage was increased by 74%, 59% or 42 % when interplanting cowpea, squash or Jew's mallow with taro, respectively, than that obtained if the unit area was planted with sole crops.

Generally, it may be concluded that interplanting cowpea with taro being the most effective and favorable treatments in most cases.

Keywords: Taro, Interplanting, Squash, Cowpea, Jew's mallow, Vegetative growth, Nitrogen, Phosphorus, Potassium, Protein, Starch, Yield, Weed control, Land equivalent ratio.

INTRODUCTION

Taro (*Colocasia esculanta*) is a monocotyledonous plant belonging to the family *Araceae*. It is considered one of the most important vegetables grown in Egypt due to its high nutritional and economical values. There are some factors that limit the increment of taro cultivation area such as its high need for fertilization, high amounts for irrigation water and its long duration in land (7-9 months). In addition, in the early period of plant growth, i.e., up to 90 days from sowing, the growth rate is low which causes an increasing in growing weeds. Also, interplanting is a factor that limits the spread of the associated weeds, i.e., interplanting helps in controlling weed population compared to sole cropping. Therefore, the potential application of intercropping may be a way to increase the productivity of land and increase the yield of unit area. The intercrop components may differ in their use of environmental sources in a way they can complement each other in time and space and they may use environmental sources more efficiently than when

grown in monocrops, and perhaps produce a higher yield than monocropping (Willy, 1979). Legumes and non – legumes can complement each other in the use of nitrogen sources and legume N was transferred to non – legumes as reported by Jensen (1996), and this in turn decreases the pollution from N fertilizers. Concerning the effect of interplanting on vegetative growth of taro and other vegetable crops, Behairy (1969) reported that growing either bean or cucumber plants on the ridges of dasheen depressed the growth of dasheen (plant height, number of leaves per plant, length and width of blades). In addition, dasheen plants caused depressions in the growth of bean and cucumber plants expressed as plant height and number of leaves per plant. Rich and Hansen (1982) studied the growth of maize, beans and squash when grown in pure stands and mixtures. They found that vegetative biomass/ plant in squash were significantly smaller in mixture with maize than in pure stands. Ojeifo and Lucas (1987) in a study on intercropping Jew's mallow with tomato, they found that leaf area, plant height and dry weight were not significantly different from values obtained when Jew's mallow was grown alone. Abd El-Baky (1994) reported that interplanting squash on the ridges of okra reduced the dry matter content of squash plants and its different parts, i.e., leaves, branches and roots, as compared to solid planting. Interplanting cowpea on the ridges of okra reduced the dry matter content of cowpea plants and its different parts, i.e., leaves, branches and roots, compared to plants grown alone. Fathallah and Gawish (1997) found a significant decrease in taro growth when it was intercropped with cucumber or cowpea. While taro growth was not affected by intercropping with Jew's mallow or snap bean. They indicated also that the growth characters of Jew's mallow were not affected by intercropping. Bader and Fekry (1998 a) found that the maximum values of growth rate per plant was recorded by growing taro plants on one ridge alternating with cucumber plants on the other ridge. As for the effect of interplanting on plant chemical composition, Mason *et al.* (1986) showed that intercropping cassava (*Manihot esculenta*) with cowpeas resulted in 0.8, 0.6 and 0.3 g P/ kg and 5.2, 4.9 and 2.9 g N/kg lower in cassava stems, leaves and storage roots, respectively, at 50 days after sowing than when grown alone. Intercropping had no effect on the N, P, and K contents of cassava at later harvest dates or of cowpeas at any harvest date. Bader and Fekry (1998 b) reported that growing taro plants on one ridge alternating with the other ridge of cucumber plants was the most effective treatments on N, P, K, total carbohydrates and proteins of corms.

Concerning the effect of interplanting on yield and its components, Behairy (1969) reported that growing either bean or cucumber plants on the ridges of dasheen depressed the yield of dasheen. Fathallah and Gawish (1997) reported that intercropping taro with cucumber or cowpea decreased its yield as compared to sole crop in two seasons. Awah and Mboussi (1999) found that cassava significantly decreased the tuber yields, while its own fresh root yields were only slightly less than when grown sole on cowpea. EL-Zawily *et al.* (1993) indicated that the lowest seed yield was obtained when cowpea was planted with cucumber plants on the same side of ridges. Abd El-Baky (1994) found that interplanting cowpea on the ridges of okra decreased average weight of cowpea dry seeds as well as the total yield of

crop compared with the plants grown alone under the different levels of nitrogen fertilizer. Askar *et al.* (1997) showed that intercropping bean with cucumber significantly decreased yield of dry bean / feddan. Shiyam *et al.* (2004) studied the effect of intercropping with cowpea and / or maize on the productivity of banana and they found that intercropping significantly reduced the yields of cowpea and maize. Also, on squash, Rich and Hansen (1982) noticed that intercropping significantly decreased yield / plant in squash when intercropped with bean plants. In addition, Abd El-Baky (2000) reported that the highest yield of squash was obtained when grown as mono crop compared to the intercropped. Fatthallah and Gawish (1997) indicated that yield of Jew's mallow was not affected by the intercropping with taro.

Studying the effect of interplanting on associated weeds Unamma *et al.* (1986) reported that the highest economic returns were obtained from using cowpeas or Egusi melon (*Colocynthis citrullus*) to suppress weed growth under the cassava and maize. Kolo and Abdullahi (1994) studied the effects of intercropping the cover crops (*Citrullus lanatus*, watermelons, and cowpeas cv. L 25) with maize cv. TZESR-Y for weed control in maize and they concluded that both cover crops significantly reduced weed growth compared with the control (maize alone). Cowpeas were significantly better for reducing weed growth in maize than with melons.

As for the effect of interplanting on land equivalent ratio (LER), many investigators found that the values of land equivalent ratio resulting from interplanting were more than one. This means that more land is needed for the two sole crops to reach the maximum yield of the two crops. Many of them also indicated that intercropping recorded yield advantage than the sole crops. Rich and Hansen (1982) planted maize, beans (*Phaseolus vulgaris*) and squash (*Cucurbita maxima*) in pure stand and mixtures. They reported that land equivalent ratio was greater for all mixtures. Fatthallah and Gawish (1997) indicated that land usage was increased by 84, 47, 75, and 42% in the first season and 82, 39, 75, and 42 % in the second season, when taro was intercropped with Jew's mallow, cucumber, snap bean or cowpea, respectively, compared to that obtained if the unit area was sown with sole crop. Recently, Dapaah *et al.* (2003) showed that cowpea yield was higher when intercropped with two cassava varieties and the intercrops had higher land use ratios (LER=1.27-2.83) and were more stable than the sole crops.

Therefore, the object of this work was to study the effect of interplanting cowpea, squash and Jew's mallow with taro on vegetative growth, mineral contents of taro corms and land equivalent ratio.

MATERIAL AND METHODS

The experiments were conducted at the Barrage Horticultural Research Station, Kalubia Governorate, during the summer seasons of 2003 and 2004 to study the effect of interplanting of some vegetable crops. The main crop in this experiment was taro cv. Balady. The interplanted crops were cowpea (*Vigna unguiculata* subsp. *unguiculata*) cv. Kaha 1, squash

(*Cucurbita pepo*) cv. Eskandarani, and Jew's mallow (*Chorchorus olitorius*) cv. Balady.

The experiments included seven treatments, namely taro alone, cowpea alone, squash alone, Jew's mallow alone, taro with cowpea, taro with squash and taro with Jew's mallow. These treatments were arranged in a randomized complete block design with three replicates. The plot area was 12 m² included 4 ridges (each was 3 meter in length and 1 meter in width) for taro, Jew's mallow and taro with Jew's mallow. In the case of interplanting cowpea and squash with taro, each ridge was divided into 2 rows (0.50 meter in width) one for taro and the other for cowpea or squash interplanting.

Taro cv. Balady was planted on March 17 and 27 in 2003 and 2004 seasons, respectively. Seed pieces from the mother corms were used as planting materials. Seed pieces were inserted at distances of 50 cm in the row beneath the soil surface for about 5-7 cm. Seeds of cowpea and squash were sown on March 24 and April 2 in 2003 and 2004 seasons, respectively. Cowpea seeds were sown in hills at 20 cm apart on both side of the ridge (0.50 meter in width), squash seeds were sown on one side of the ridge at 50 cm apart and Jew's mallow seeds were sown on the top of the ridge (one meter in width) at the same time of taro planting.

The systems of planting were the same either in monoculture or in interplanting patterns in both seasons. All cultural practices were applied according to recommendation of the Ministry of Agriculture for each crop.

Data recorded:

1. Plant growth measurements:

a. Taro:

Representative plant samples, each of 3 plants, were picked randomly from each plot at 210 days after taro planting for determining plant height measured from ground level up to the highest petiole, number of leaves per plant, total chlorophyll determined using MINLOTA-SPAD502 Chlorophyll Meter (MINOLTA CO., LTD. Japan), average fresh weight of leaf blades per plant and average dry weight of leaf blades per plant.

b. Cowpea:

Representative plant samples, each of 3 plants, were picked randomly from the two outer rows of each plot at 45 and 90 days after cowpea seed sowing to determine plant length, number of leaves, fresh and dry weight per plant.

c. Squash:

Representative plant samples, each of 3 plants, were picked randomly from the two outer rows of each plot at 30 and 60 days after squash sowing to determine plant length, number of leaves per plant, fresh and dry weight per plant.

d. Jew's mallow:

Representative plant samples, each of 5 plants, were picked randomly from the two outer rows of each plot at 30 and 60 days after Jew's mallow sowing to determine plant length, number of leaves per plant and plant fresh and dry weight per square meter.

2. Chemical analysis of taro:

At the harvest, N, P, K, protein and starch content were determined in corms. Samples of corms were oven dried at 70 °C till constant weight then used for chemical determinations that were calculated on dry weight basis. Corm content of nitrogen was determined according to the procedure described by FAO (1980). Phosphorus concentration was determined as described by Chapman and Pratt (1961). Potassium concentration was analyzed according to the method described by Brown and Lilliland (1946). Protein content was determined as nitrogen content and converted to its equivalent protein content by multiplying with 6.25 as described by Pregl (1945). Starch content was determined according to A.O.A.C. 1990.

3. Yield and its components:-

a. **Taro:** Taro plants were harvested at 270 days after planting. Height and diameter of the corm, fresh and dry weight of corms / plant, number of cormel / plant, total yield of corms / feddan and total weight of leaves / feddan were recorded.

b. **Cowpea:** The dry pods were harvested at the end of the cowpea growing season. Number and weight of pods per plot, number and weight of seeds per plot, weight of pods per feddan and weight of seeds per feddan were estimated. .

c. **Squash:** Fruits were harvested through the harvesting season at 3-day intervals and the weight and number of fruits per plant and weight of fruits per feddan were determined.

d. **Jew's mallow:** The total yield of 2 cuts was measured at 30 and 60 days after sowing.

4. Associated weeds:

Weeds appeared in each treatment after 90 days from planting the companion crops were collected and divided into main groups, i.e., annual narrow weeds, annual broad leaved weeds and perennial weeds. Then number, fresh and dry weights of weeds were determined.

5. Land equivalent ratio (L E R):

The land equivalent ratio was calculated according to the formula described by Willy and Osiru (1972) using the following Equation:

$$LER = L. \text{ Taro} + L. \text{ Interplanted crop.}$$

Since:-

$$L. \text{ Taro} = \frac{\text{Interplanted yield of taro}}{\text{Pure stand yield of taro}}$$

L. Interplant crop

$$L. \text{ Cowpea} = \frac{\text{Interplanted yield of cowpea}}{\text{Pure stand yield of cowpea}}$$

$$L. \text{ Squash} = \frac{\text{Interplanted yield of squash}}{\text{Pure stand yield of squash}}$$

$$L. \text{ Jew's mallow} = \frac{\text{Interplanted yield of Jew's mallow}}{\text{Pure stand yield of Jew's mallow}}$$

Statistical analysis:

The data were exposed to proper statistical analysis of variance and combined analysis was done for both years as described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION**1. Effect of interplanting on vegetative growth.****a. Effect of interplanting on vegetative growth of taro:****1- Plant height:**

The tallest plants were obtained when taro was grown alone (Table 1). Taro plants grown with cowpea tended to be higher than those interplanted with squash or Jew's mallow. The depressions in taro plant height were 2.15%, 11.06% and 32.44 %, respectively, when interplanted with cowpea, squash and Jew's mallow compared to taro growing alone. These results are in agreement with those obtained by Behairy (1969) and Fathallah and Gawish (1997).

2-Number of leaves:

Data in Table (1) revealed that there was no significant effect for interplanting on number of leaves when taro was grown alone or with cowpea. However, interplanting decreased the number of leaves when taro was grown with squash or Jew's mallow and the reduction was significant. Such decreasing effect of the used treatments when compared with the pure stand may be due to the competition between the two intercropped plants as mentioned by Bader and Fekry (1998b).

Table 1. Effect of interplanting cowpea, squash or Jew's mallow with taro on plant height, number of leaves per plant, chlorophyll, fresh and dry weight of leaf blade of taro plant at 210 days after planting (combined analysis of two growing seasons).

Treatments	Plant height (cm)	Number of leaves per plant	Chlorophyll SPAD reading	Leaf blade per plant	
				Fresh weight (gm)	Dry weight (gm)
Taro alone	155.14	4.48	42.74	841.66	139.84
Taro with cowpea	151.79	4.44	41.00	858.88	143.70
Taro with squash	137.97	4.16	39.71	580.55	97.88
Taro with Jew's mallow	104.81	3.97	37.55	416.66	72.13
L.S.D at 5%	1.2	0.20	0.24	39.37	6.14

3- Total chlorophyll:

The highest values of chlorophyll were obtained when taro was grown alone (Table1) and significantly decreased when interplanted with cowpea, squash and Jew's mallow.

4- Fresh and dry weight of leaf blade:

Taro alone or interplanted with cowpea gave the highest fresh and dry weight of leaf blade and interplanting taro with squash or Jew's mallow decreased fresh and dry weight significantly. Mason *et al.* (1986) on cassava came to similar results.

b. Effect of Interplanting on vegetative growth of cowpea:

1- Plant length:

Results presented in Table (2) showed that the average of plant length was higher in solid cowpea than in interplanted cowpea. The depression in cowpea plant length was 12.77 % and 10.29% compared to planting cowpea alone at 45 and 90 days, respectively. The depression in cowpea plant length could be due to the competition for nutrients and place, as well as other environmental factors. The obtained results are in harmony with those reported by Behairy (1969).

Table 2. Effect of interplanting with taro on vegetative growth of cowpea, squash and Jew's mallow plants (combined analysis of two growing seasons).

Treatments	Plant length (cm)	No. of leaves per plant	Plant fresh weight (gm)	Plant dry weight (gm)	Plant length (cm)	No. of leaves per plant	Plant fresh weight (gm)	Plant dry weight (gm)
a- Cowpea								
	45 days after planting				90 days after planting			
Cowpea alone	47.83	45.39	125.18	21.25	98.41	55.50	200.27	52.26
Cowpea with taro	41.72	36.50	87.04	16.75	88.28	44.72	152.22	42.57
L.S.D at 5%	1.15	4.32	1.81	0.73	2.28	3.00	6.84	2.13
b- Squash								
	30 days after planting				60 days after planting			
Squash alone	51.99	21.39	369.99	36.62	105.11	38.22	1130.83	110.89
Squash with taro	49.33	19.78	339.72	34.69	94.72	34.77	957.49	98.75
L.S.D at 5%	N.S	1.32	4.88	0.88	2.28	1.80	96.67	11.28
c- Jew's mallow								
	First cut (30 days after planting)				Second cut (30 days from first cut)			
Jew's mallow alone	29.27	13.10	1641.67*	321.36*	30.42	14.10	1845.00*	363.07*
Jew's mallow with taro	28.80	12.83	1473.33	292.97	30.25	13.57	1661.67	336.22
L.S.D at 5%	0.44	N.S	34.36	9.33	N.S	N.S	18.53	10.06

*Weight gm / m

2- Number of leaves:

The higher number of leaves per plant was recorded for cowpea alone compared to those interplanted with taro at both 45 and 90 days after planting.

3- Plant fresh and dry weight:

Interplanting cowpea with taro (Table 2) significantly decreased the plant fresh and dry weight by 30.46% and 23.99% for the fresh weight and 21.17 % and 18.54 % for the dry weight due to interplanting cowpea with taro at both sampling dates, respectively, compared to solid cowpea. Abd El-Baky (1994) came to similar results.

c. Effect of interplanting on vegetative growth of squash:

1- Plant length:

After 30 and 60 days from planting significant reduction occurred in plant length of squash interplanted with taro comparing with squash alone. This agrees with the views of Behairy (1969) and Fathallah and Gawish (1997).

2- Number of leaves per plant:

Interplanting squash with taro had a significant effect on number of leaves per squash plant (Table 2). Squash plants growing alone recorded the higher values of number of leaves per plant. Whereas, interplanting squash with taro gave the lower number of leaves per plant at 30 and 60 days after planting.

3- Plant fresh and dry weight

Results presented in Table (2) indicated that the fresh and dry weight of squash plants grown alone significantly exceeded those grown with taro. These results were true at both sampling dates, i.e., after 30 and 60 days from planting. Rich and Hansen (1982) mentioned that vegetative biomass / plant in squash was significantly smaller in mixture with maize than in pure stands. Similar findings have been found by Abd El-Baky (1994).

d. Effect of interplanting on vegetative growth of Jew's mallow:

1 – Plant length:

The length of Jew's mallow plant interplanted with taro was shorter (Table 2) than that of Jew's mallow grown alone. The decrease was slight but significant in the first cut. While, in the second cut, no significant effect was observed for interplanting Jew's mallow with taro on Jew's mallow plant length. The obtained results are in harmony with those reported by Ojeifo and Lucas (1987).

2 – Number of leaves:

There was no significant difference in leaf number between Jew's mallow grown alone and the interplanted with taro (Table 2). The results were similar in the first and second cut. The obtained results are in harmony with those reported by Fathallah and Gawish (1997).

3- Fresh and dry weight:

Interplanting had significant reducing effects on fresh and dry weight / m² of Jew's mallow (Table 2). The reduction was 10.25% and 9.94 %, for fresh weight and 8.83 % and 7.39% for dry weight in the first and second cut, respectively.

2. Effect of interplanting on chemical composition of taro corms:

Taro grown alone or interplanted with cowpea showed the highest percentage of N, protein and starch compared to taro with squash or Jew's mallow (Table 3). The differences of N, protein and starch percentage of taro

corms when interplanting with squash or Jew's mallow were not significant. Bader and Fekry (1998 b) on taro came to similar conclusion.

Data in Table (3) revealed also that the P and K percentages of taro corms did not differ significantly by interplanting any crop with taro. This trend agrees with that of Mason *et al.* (1986) on cassava.

Table .3. Effect of interplanting cowpea, squash or Jew's mallow with taro on chemical composition of taro corms (combined analysis of two growing seasons).

Treatments.	Nitrogen %	Phosphorus %	Potassium %	Protein %	Starch %
Taro alone	0.409	0.273	2.625	2.562	50.584
Taro with cowpea	0.406	0.264	2.651	2.541	50.212
Taro with squash	0.345	0.269	2.525	2.159	46.184
Taro with Jew's mallow	0.315	0.262	2.470	1.969	44.009
L.S.D at 5%	0.04	N. S	N. S	0.21	2.61

3. Effect of interplanting on total yield and its components:

a-Taro:

It is clear from Table (4) that interplanting taro with cowpea, squash or Jew's mallow had a significant effect on corm height and diameter. Taro interplanted with cowpea had the highest corm height and diameter. Interplanting cowpea with taro increased significantly fresh weight of corms per plant by 2.15 % compared to taro grown alone. However, interplanting squash or Jew's mallow reduced the fresh weight of corms per plant by 21.82 % and 49.88 %, respectively, compared to fresh weight of taro grow alone. No significant effect was observed for interplanting cowpea with taro or taro grown alone on dry weight of corms per plant (414.11 and 405.34 g / plant, respectively). While, taro interplanted with squash or Jew's mallow decreased significantly the dry weight of corms per plant (316.7 and 200.31, respectively). Interplanting cowpea with taro increased the number of cormels per plant than taro grown alone but the difference was not significant. Although, taro with squash had 3.67 cormels per plant and taro with Jew's mallow had the lowest number of cormels (2.83).

As for yield, it is evident from Table (4) that interplanting cowpea with taro showed the highest taro yield (14.1 ton /feddan) followed in decreasing order by taro alone (13.62 ton /feddan), squash interplanted with taro (11.53 ton / feddan) and Jew's mallow interplanted with taro (7.07 ton /feddan). The yield increased by 3.52 % when interplanting cowpea with taro. However the yield decreased by 15.34 % or 48.09 %, when interplanting squash or Jew's mallow, respectively, with taro as compared with taro grown alone. Illustrated data in Table (4) show that interplanting cowpea with taro increased weight of leaves per feddan (8.01 ton / feddan) than taro alone (7.85 ton/feddan) with no significant differences between them. Interplanting squash and Jew's mallow decreased significantly the weight of taro leaves per feddan. The obtained results are in harmony with those of reported by Bahairy (1969), Fatthallah and Gawish (1997) and Awah and Mboussi (1999).

Table 4. Effect of interplanting cowpea, squash or Jew's mallow with taro on the yield and its components of taro plants at harvest (270 days after planting) combined analysis of two growing seasons.

Treatments	Corm height (cm)	Corm diameter (cm)	F.W. plant (gm)	D.W. plant (gm)	No. of cormels plant	Yield of corms ton/fed	Yield of leaves ton/fed
Taro alone	15.31	11.36	1700.52	405.34	4.61	13.62	7.85
Taro with cowpea	15.54	11.62	1737.22	414.11	4.83	14.10	8.01
Taro with squash	13.75	11.25	1329.44	316.70	3.67	11.53	5.42
Taro with Jew's mallow	11.61	9.69	852.22	200.31	2.83	7.07	3.88
L.S.D at 5%	0.37	0.17	34.88	10.08	0.26	0.24	0.37

b-Cowpea:

Concerning the effect of interplanting cowpea with taro on number and weight of pods per plot, data reported in Table (5) indicated that number and weight of pods per plot were higher when cowpea was grown alone than interplanting cowpea with taro. Cowpea interplanted with taro significantly decreased the number of pods by 34.04% and the weight of pods per plot by 37.10 % compared to planting cowpea alone. The number and weight of dry seeds per plot was decreased comparing with planting cowpea alone. In this connection, Abd El- Baky (1994) observed that interplanting cowpea with okra decreased average weight of cowpea dry seeds.

Concerning yield, the results in Table (5) showed that cowpea intercropped with taro gave fewer yield of pods per feddan (602.77 kg / feddan) than cowpea grown alone (958.32 kg / feddan). These results agree with those of Shiyam *et al.* (2004), who mentioned that intercropping significantly reduced the yields of cowpea when intercropped with banana. In addition, cowpea grown in pure stands produced greater seed yield per feddan (479.21 kg/feddan) than cowpea interplanted with taro (333.64 kg / feddan). The reduction in seed yield was 30.38% comparing with planting cowpea alone. This reduction in seed yield might be attributed to the nitrogen translocation from cowpea to taro plants as mentioned by Askar *et al.* 1997. Similar conclusions were obtained by El-Zawily *et al.* (1993) on cowpea.

Table 5. Effect of interplanting cowpea with taro on yield and its components of cowpea plants (combined analysis of two growing seasons).

Treatments	Number of pods/plot	Weight of pods (gm) /plot	Number of dry seeds /plot	Weight of dry seeds (gm) /plot	Yield of dry pods (kg) /fed	Yield of dry seeds (kg) /fed
Cowpea alone	1903.57	2875.00	9551.18	1437.62	958.32	479.21
Cowpea with taro	1255.67	1808.33	5872.00	1000.92	602.77	333.64
L.S.D at 5%	182.87	106.14	448.22	72.039	35.392	24.01

C- Squash:

As shown from Table (6), interplanting squash with taro reduced significantly the number and weight of fruits per plant and per plot, compared with the single squash plantation. Similar results have been reported by Rich and Hansen (1982), who indicated that intercropping significantly decreased

squash yield. The obtained results are in harmony with those reported by Fathallah and Gawish (1997), who found that the yield and its components of cucumber was significantly decreased by intercropping taro with cucumber as compared to sole cropping.

Regarding yield, the results indicated that the effect of interplanting squash with taro on the number and weight of fruits per feddan of squash plants were higher in squash plants grown alone than squash plants grown with taro. In other words, reduction in the yield was 26.27 % for squash interplanting with taro compared to squash grown alone. These results may be attributed to the competition for nutrients and water absorption between the mixed crops as mentioned by Abd El- Baky (2000). Also, Askar *et al.* (1997) found that intercropping bean with cucumber significantly decreased total yield of cucumber. Abd El- Baky (2000) noted that the highest yield of squash was obtained when grown as mono crop compared to the intercropping.

Table 6. Effect of interplanting squash with taro on yield and its components of squash plants (combined analysis of two growing seasons).

Treatments	Number of fruits/plant	Weight of fruits (gm)/plant	Number of fruits/plant	Weight of fruits (Kg)/plant	Yield of fruits (ton)/fed
squash alone	5.23	536.22	125.57	12.87	4.30
squash with taro	3.83	395.90	92.00	9.50	3.17
L.S.D at 5%	0.49	23.68	11.71	0.57	0.20

d- Jew's mallow:

It is evident from Table (7) that interplanting Jew's mallow with taro reduced the yield of Jew's mallow. The total Yield of Jew's mallow grown alone was higher than the obtained yield from interplanting (13.95 ton/feddan and 12.54 ton/feddan, respectively). This reduction in the yield was 10.11% compared with single plantation of Jew's mallow.

Table 7. Effect of interplanting Jew's mallow with taro on the yield of Jew's mallow plants (combined analysis of two growing seasons).

Treatments	Yield per square meter (gm)	Yield per plot (Kg)	Expected yield per feddan (ton)
Jew's mallow alone	3486.67	41.84	13.95
Jew's mallow with taro	3135.00	37.62	12.54
L.S.D at 5%	34.36	0.41	0.13

4. Effect of interplanting on associated weeds:

The prevailing weeds in the experiment during the two growing seasons were nutsedge (*Cyperus rotundus*), bermuda grass (*Cynodon dactylon*) and field bind-weed (*Convolvulus c*) as perennial weeds. The main annual broad-leaved weeds were lambs quarter (*Chenopodium abum*) and purslane (*Portulaca deracea*) while abou Rokba (*Echinochloa colonum*) as annual narrow weeds. Weeds in each plot were hand-pulled, separated

and classified into three groups: annual narrow weeds, annual broad-leaved weeds and perennial weeds. Number, fresh and dry weight of weeds per unit area could be used as a reliable index to distribution.

Data in Table (8) revealed that interplanting cowpea or squash with taro reduced significantly number of weeds / m² after 90 days from taro planting. However, interplanting Jew's mallow with taro had no effect on weed control. The highest number of weeds was recorded by taro alone or Jew's mallow alone. Concerning cowpea alone or squash alone they gave low values of weed number than Jew's mallow alone. Interplanting cowpea, squash or Jew's mallow with taro had significant effects on fresh weight of the associated weeds. Jew's mallow grown alone exhibited the highest values of annual narrow weeds, annual broad leaved weeds and perennial weeds fresh weight at 90 days from taro planting followed by taro grown alone and taro with Jew's mallow. Whereas interplanting cowpea or squash with taro recorded low values of fresh weight of weeds compared to growing cowpea or squash alone. It could be suggested that the highest fresh weight of these weeds was correlated with individual plantation of Jew's mallow, taro, squash and cowpea. The lowest fresh weight was recorded with mixed plantation of cowpea with taro and squash with taro.

Concerning the effect of interplanting on dry weeds / m² after 90 days from taro planting, taro alone had the highest value of dry weight of weeds / m² followed by Jew's mallow alone and taro with Jew's mallow compared with taro with cowpea and taro with squash which had the lowest values . In other words, interplanting cowpea or squash with taro significantly decreased the dry weight of weeds / m² in the field of taro. This agrees with the views of Unamma *et al.* (1986) and Kolo and Abdullahi (1994)

5. Land equivalent ratio (LER):

Data in Table (9) indicated that the values of LER were greater than one by interplanting although the yield of each crop was greater when it was grown alone than as combined crop. This means that yield advantage was obtained and land usage was increased by interplanting. In other words, interplanting was more efficient than sole cropping. The land usage increased by 74%, 59% or 42% when interplanting cowpea, squash or Jew's mallow with taro, respectively, than that obtained if the unit area was planted with sole crops. The obtained yield advantage may be due to the differences in rooting system of taro plants or companion crops, nutrient requirements and efficiency of photosynthesis process. Thus they are able to complement each other and to make better overall use of environmental resources when grown in combination than grown separately as mentioned Fatthallah and Gawish (1997). The obtained results on taro are in harmony with those of Awah and Mboussi (1999) and Dapaah *et al.* (2003). On squash, Rich and Hansen (1982) reported that land equivalent ratio was greater for all mixtures when planting maize, beans and squash in pure stands and mixtures.

Table 8. Effect of interplanting cowpea, squash or Jew's mallow with taro on number, fresh and dry weight of weeds / m² at 90 days from taro planting (combined analysis of two growing seasons).

Treatments	Number of weeds			Fresh weight of weeds			Dry weight of weeds		
	Annual narrow	Annual broadleaved	Perennial	Annual narrow	Annual broadleaved	Perennial	Annual narrow	Annual broadleaved	Perennial
Taro alone	82.00	67.33	98.67	376.56	446.00	267.25	44.91	53.74	71.10
Taro with cowpea	38.67	46.00	50.00	229.35	260.19	184.40	31.11	35.23	40.91
Taro with squash	50.67	54.67	56.67	258.97	278.15	194.97	34.25	42.35	52.30
Taro with Jew's mallow	66.00	69.33	88.00	331.93	378.94	220.30	39.99	47.03	60.92
Cowpea Alone	46.67	50.67	67.33	270.21	278.61	190.14	35.18	41.68	52.12
Squash Alone	52.00	59.33	74.67	289.09	304.23	204.53	36.01	45.61	55.17
Jew's mallow alone	88.68	76.67	91.33	380.88	462.15	234.12	44.74	52.78	63.27
L.S.D at 5 %	4.79	4.07	4.34	19.71	24.74	9.62	1.80	2.46	2.21

Generally, it could be concluded that it is capable to use the interplanting system in case of taro cultivation. Moreover, in case of using this system it is better to choose cowpea than squash or Jew's mallow to be cultivated with taro, because cowpea is less competitive to taro than squash or Jew's mallow.

Table 9. Effect of interplanting cowpea, squash or Jew's mallow with taro on land equivalent ratio (combined analysis of two growing seasons).

Treatments	LER
LER of taro	1.04
LE R of cowpea	0.70
Total LE R	1.74
LE R of taro	0.85
LE R of squash	0.74
Total LE R	1.59
LE R of taro	0.52
LE R of Jew's mallow	0.90
Total LE R	1.42

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الزراعة البينية لللوبيا و الكوسة و الملوخية مع القلقاس

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أجرى هذا البحث خلال الموسم الصيفي لعامي 2003، 2004 لدراسة تأثير الزراعة البينية لكل من اللوبيا و الكوسة و الملوخية مع القلقاس على النمو الخضري و المحتوى الكيماوي لكرومات القلقاس و كذلك نمو المحاصيل المرافقة و محصول و مكوناته ونمو الحشائش المصاحبة و نسبة المكافئ الأرضي

و يمكن تلخيص النتائج المتحصل عليها كالآتي:

- 1 - أدت الزراعة البينية لكل من اللوبيا و الكوسة و الملوخية مع القلقاس إلى نقص معنوي في النمو الخضري للقلقاس.
- 2 - أثرت الزراعة البينية كذلك على نمو اللوبيا و الكوسة و الملوخية فقد انخفض محتواها النمو الخضري لكل منهم مقارنة بالزراعة المنفردة.
- 3 - أعلى قيم لمحتوى كورمات القلقاس من النيتروجين و البروتين و النشا كانت عند زراعة القلقاس منفردا بينما لم يتأثر محتوى الكورمات من الفسفور و البوتاسيوم.
- 4 - أدت الزراعة البينية لنبات اللوبيا مع القلقاس إلى زيادة محصول القلقاس مقارنة بزراعته منفردا أو مع أي من الكوسة أو الملوخية.
- بالإضافة إلى ذلك فإن محصول كلا من اللوبيا و الكوسة و الملوخية كان أعلى في حالة الزراعة المنفردة عنه في حالة زراعتهم مع القلقاس.
- 5 - أدت زراعة اللوبيا و الكوسة مع القلقاس إلى انخفاض معنوي في عدد الحشائش المصاحبة له و الوزن الطازج و الجاف لها في وحدة المساحة (م²) بعد 90 يوم من زراعة القلقاس . على الرغم من أن زراعة الملوخية مع القلقاس ليس لها تأثير معنوي في مقاومة الحشائش.
- 6 - أمكن الحصول على أعلى قيم لنسبة المكافئ الأرضي باستخدام الزراعة البينية و كانت أقصى قيمة لنسبة المكافئ الأرضي بزراعة اللوبيا مع القلقاس و ترايدت كفاءة استخدام الأرض بنسبة 74% - 59% - 42% عند زراعة اللوبيا و الكوسة و الملوخية مع القلقاس على الترتيب مقارنة بالزراعة المنفردة لكل محصول تحت الدراسة على حده.
- و بصفة عامة فانه يمكن أن نخلص إلى أن : زراعة اللوبيا مع القلقاس كانت أكثر المعاملات تأثيرا وفضلية في معظم الحالات تحت ظروف هذه التجربة حيث أن اللوبيا لا تعتبر محصولا منافسا بدرجة كبيرة .