EFFECTS OF DEFOLIATION, RUNNER REMOVAL, AND FERTILIZATION ON TUBER YIELD OF TARO

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ABSTRACT

Three degrees of defoliation (light, medium, and heavy), removal and non-removal of runners and three levels of complete fertilizers were studied on taro cv. Kalpao under lowland conditions. Light defoliation treatment did not affect the leaf area index but increased plant height at maturity, size of tubers, and tuber yield compared to the undefoliated plants, and those subjected to heavy defoliation. Heavy defoliation, on the other hand, resulted in a significant decrease in plant height and tuber yield. The removal of runners from the mother plant markedly enhanced better growth of plants and significantly increased tuber yield as manifested by the development of larger tubers. Tuber yield and other agronomic characters significantly increased with increasing levels of complete fertilizer applied from 50 to 150 kg/ha each of N, P_2O_5, and K_2O. There was an increase of about 2 tons of tubers for every 50 kg/ha of NPK applied.

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INTRODUCTION

Taro, (*Colocasia esculenta* (L.) Schott), has long been an important root crop grown throughout the tropics and subtropics, and to a lesser extent as summer crop in the temperate regions (Plucknett, 1970). It is distributed worldwide and utilized as staple food in the Pacific Basin and as vegetable in most Asian and African countries (De La Peña and Plucknett, 1967).

Taro is one of the three most widely planted root crops in the Philippines (Cantilang, 1976), and is commonly grown along streams and small rivers as lowland crop and also under non-irrigated or upland conditions on elevated areas or hillsides. The average yield of taro in the Philippines is only 3.2t/ha which is way below those reported for other places like Hawaii and Egypt.

More than 90% of the plant parts of taro can be used as food. The leaves including the petioles and runners are utilized as vegetable, in addition to the tubers. If properly timed with the stage of plant growth, leaves and runners could be removed without affecting tuber production or even increasing it. Farmers, therefore, can occasionally harvest taro leaves and runners while waiting for the tubers to mature.

Tuber formation in taro may not just be a function of environmental factors such as light, carbon dioxide, water, and mineral elements. Runner production, which is an inherent characteristic among runner type of taro, may affect growth and development of corms or tubers. Redistribution of the assimmilates from the tuber to the runners may reduce the size and weight of corms.

MATERIALS AND METHODS

Setts. - The setts used for planting were taken from a local taro variety known as *Kalpao.* This is a runner or rhizome type of taro with green broad peltate leaves, prominent veins and which produces large main tubers under suitable environmental conditions.

Treatments and Experimental Design. — The different treatments used were as follows:

1. Defoliation - The older leaves and petioles were cut at three, four, and five months after planting.

   Control - The leaves and petioles were not cut.

   Light defoliation - The last younger four expanded leaves were left during each process.

   Medium defoliation - The last younger three expanded leaves were left during each process.

   Heavy defoliation - The last younger two expanded leaves were left during each process.
2. Runner removal
   - Runners were not removed.
   - Runners were removed every three weeks.
3. Fertilizer levels in kg/ha of N, P_2O_5, and K_2O were 0-0-0; 50-50-50; 100-100-100; and, 150-150-150.

Each treatment had a split application of fertilizer: the first half was applied 15 days after planting and the second half, 75 days after planting.

A 4 x 2 x 4 factorial arranged in a randomized complete block design (RCBD) was used. Each treatment was replicated three times. The plot size was 5 m long and 3.75 m wide.

The experimental area was prepared as in lowland rice. Plants were spaced at a distance of 75 cm x 50 cm at the rate of one plant per hill. The area was continuously submerged in water except for few days before and after the application of fertilizer when the field was partially drained. Weeds were controlled by passing a rotary weeder first followed by hand weeding. Pesticides were periodically sprayed to protect the plants against insects and diseases.

Seven and a half months after planting, the three inner rows per plot (based on 27 plants from inner three rows in each plot) were harvested. Tuber weight, girth, and length were taken. Tuber yield per hectare was calculated from plot yields.

RESULTS AND DISCUSSION

Leaf Area Index (LAI).

Leaf area indices for light and medium defoliations were not significantly different from those of the undefoliated plants. Heavy defoliation resulted in a significantly reduced LAI compared to no defoliation.

Removal of runners or rhizomes did not significantly affect the LAI of the mother plant (Table 1). This suggests that optimum LAI in taro may be attained even if runners were periodically removed. However, LAI increased significantly with the application of complete fertilizer. For instance, plants supplied with 50 kg/ha each of N, P_2O_5, and K_2O attained 1.22 LAI which was significantly higher than those of plants which did not receive any fertilizer (0.89), while application of 150-150-150 kg/ha NPK significantly increased the LAI of plants to 1.71 compared to those applied with lower levels of fertilizer.

Plant Height at Maturity.

Light defoliation significantly increased plant height compared to no defoliation. Medium defoliation did not show significant effect over no defoliation; heavy defoliation resulted in a significantly shorter plants at maturity. The results suggest that the amount of leaves left after light defoliation was sufficient to supply plant food needed for growth up to maturity. On the other hand, heavy defoliation resulted in reduced plant height due to the severe removal of photosynthetic tissues of the plant which led to reduced food production (Beaty *et al.*, 1965).

The removal of runners from the mother plant significantly decreased plant height at maturity (Table 1). This is expected because plants allowed to grow without removing the runners developed new plants at the growing tip of runners which consequently increased plant population five- to tenfold per unit area. This condition enhanced mutual shading which became apparent five months after planting and had been observed up to maturity causing the plants to grow taller. Meanwhile, treatments with runners removed resulted in lower plant density, exposing the plants to sunlight and enhancing shorter plants.

The level of complete fertilizer applied also affected plant height at maturity. Plants supplied with 50 kg/ha each of N, P_2O_5, and K_2O were significantly taller than the unfertilized plants. Increasing the fertilizer level up to 150 kg/ha each of N, P_2O_5, and K_2O resulted in further significant increase in plant height at maturity compared to plants applied with lower levels of complete fertilizer.

Maximum Number of Leaves Per Plant.

Variety *Kalpao* attained maximum leaf production five months after planting. Heavy defoliation of leaves and petioles resulted in a significant decrease in the average maximum number of leaves at vegetative stage. Light and medium defoliation did not significantly affect the average maximum number of leaves compared to the undefoliated plants. These results indicate that heavy defoliation of vegetative parts in taro reduced top growth which left an inadequate functional leaf area for photosynthesis.

Removal of runners significantly increased the average maximum number of leaves as compared to non-removal of runners. This greater number of plants per unit area resulted in fewer leaves of the mother plant.

Leaf production was greatly affected by the levels of complete fertilizer application. With increasing levels of complete fertilizer, the number of leaves also significantly increased (Table 1).

Tuber Girth.

Plants subjected to light defoliation produced the largest average girth of tubers at 24.4 cm. This did not significantly differ from tubers obtained from the medium defoliation or undefoliated plants which had an average girth of 23.9 cm. The smallest tuber girth was obtained from heavily defoliated plants with an average of 23.0 cm. These results indicate that light defoliation is better than non-defoliation, medium and heavy defoliation as far as tuber formation with larger girth is concerned.

Removing the runners from the mother plants significantly increased tuber girth at harvest. When runners were not removed, new shoots developed which competed with the mother plant hence producing the smallest tuber girth.

Tuber girth was positively influenced by the levels of complete fertilizer applied (Table 1). Plants supplied with 50 kg/ha of N, P_2O_5, and K_2O significantly increased tuber girth compared to plants with zero fertilization. Increasing the rate of fertilizer application to 100 and 150 kg/ha of the same nutrients resulted in increased tuber girth at harvest.

Table 1. Means of growth and yield components of taro as affected by different degrees of defoliation, removal of runners, and levels of complete fertilizer application.[1]

Treatment	Growth Components			Yield Components		
	Leaf area index	Pl. ht. at maturity (cm)	Max. no. of leaves per plant	Tuber girth (cm)	Tuber length (cm)	Tuber yield (t/ha)
Defoliation						
Control	1.34a	86.30b	3.67a	23.85a	13.30ab	9.61b
Light	1.37a	89.34a	3.73a	24.37a	13.97a	10.45a
Medium	1.37a	87.72ab	3.69a	23.52a	13.52a	9.85ab
Heavy	1.21b	82.86c	3.51b	22.96b	12.81b	8.46c
Runner treatment						
Not removed	1.29a	87.66a	3.57b	22.44b	12.79b	8.12b
Removed	1.35a	85.44b	3.73a	25.07a	14.04a	11.06a
Fertilizer levels (kg/ha)						
0-0-0	0.89d	76.28d	3.29d	20.84d	11.64d	7.14d
50-50-50	1.22c	82.86c	3.58c	23.43c	12.97c	8.82c
100-100-100	1.47b	89.21b	3.78b	24.94b	14.11b	10.52b
150-150-150	1.71a	97.87a	3.96a	25.81a	14.96a	11.88a

[1] Mean of 3 replications. Means followed by a common letter are not significant at 5% level based on Duncan's Multiple Range Test.

Tuber Length.

Light defoliation slightly increased tuber length but did not show significant difference compared to either medium defoliation or undefoliated plants. On the other hand, heavy defoliation significantly decreased tuber length compared to light and medium defoliation (Table 1).

Plants with runners removed produced longer tubers which were significantly different from those plants with runners not removed. This can be attributed to the absence of new plants that would have developed from runners and competed with the mother plant.

Tuber length was greatly affected by the levels of complete fertilizer applied. It significantly increased with increasing levels of fertilizer application.

Tuber Yield.

The tuber yield response of taro to defoliation, runner removal, and fertilization are presented in Table 1. Plants subjected to light defoliation produced the highest tuber yield (10.45 t/ha), followed by medium (9.85 t/ha), and no defoliation (9.61 t/ha). With heavy defoliation, a significant decrease in tuber yield (8.46 t/ha) was obtained compared to other defoliation treatments.

The results suggest that light defoliation is better than other defoliation treatments in terms of optimum yield per hectare. Light defoliated plants had the optimum number of leaves developed and leaf area formed for further tuber development. Cutting of older leaves under light defoliation reduced the amount of food utilization of the plant in the vegetative organs thereby making more of the assimilate available for further growth and development of storage organs (Spence, 1970). The lower tuber yield in the heavily defoliated plants could be traced to the less number of functional leaves necessary for photosynthesis.

The removal of runners from the mother plant increased tuber yield by 2.94 t/ha. When runners were not removed, plants showed reduced tuber yield due to the presence of plants that developed from the runners which competed for nutrients, light and space. Developing buds and meristematic root regions place a demand on the available assimilate and compete successfully as sinks with the developing leaves (Beevers, 1961).

Taro responded positively to the different levels of complete fertilizer used in this experiment. Tuber yield increased significantly with increasing levels of fertilizer application. Increasing the fertilizer levels to 100 and 150 kg/ha resulted in tuber yield increases of 3.38 and 4.74 t/ha, respectively. These findings corroborate the study of Banaag (1958).

Figure 1 shows the interaction effects between fertilizer and runner removal. The application of 50 kg/ha each of N, P_2O_5, and K_2O to plants with runners removed gave slightly, although not significantly, higher yields than the application of 150 kg/ha each of N, P_2O_5, and K_2O. This was true when runners were allowed to grow and develop with the mother plants. The application of 100 kg/ha of the same nutrients to plants with runners removed resulted in significant differences in yields compared to other levels of fertilizer application in the non-runner re moval treatment. However, the highest significant increase in yield was obtained from the application of 150 kg/ha each of N, P_2O_5, and K_2O to plants with runners removed. These results indicate that fertilizer application and runner removal have positively influenced the tuber yield of taro.

Vegetative Growth and Tuber Characters in Relation to Yield.

Table 2 shows a significant positive relationship between tuber yield and each of the parameters such as leaf area index, number of leaves five months after planting, plant height at maturity, tuber girth,and tuber length. These findings confirmed the results of Shanmugan and Ramasamy (1974) which showed that tuber yield of *C. esculenta* was positively correlated with the leaf number and girth of tubers. The results suggest that the greater the vegetative growth and yield components obtained, the higher the tuber yield.

Table 2. Correlation of tuber yield with length, girth and vegetative characters.

Growth and Yield Components	Tuber Yield
	r
Leaf area index	0.84 **
Number of leaves	0.89 **
Plant height at maturity	0.66 **
Tuber girth	0.97 **
Tuber length	0.92 **

** - Significant at 1 % level
r - Coefficient of correlation

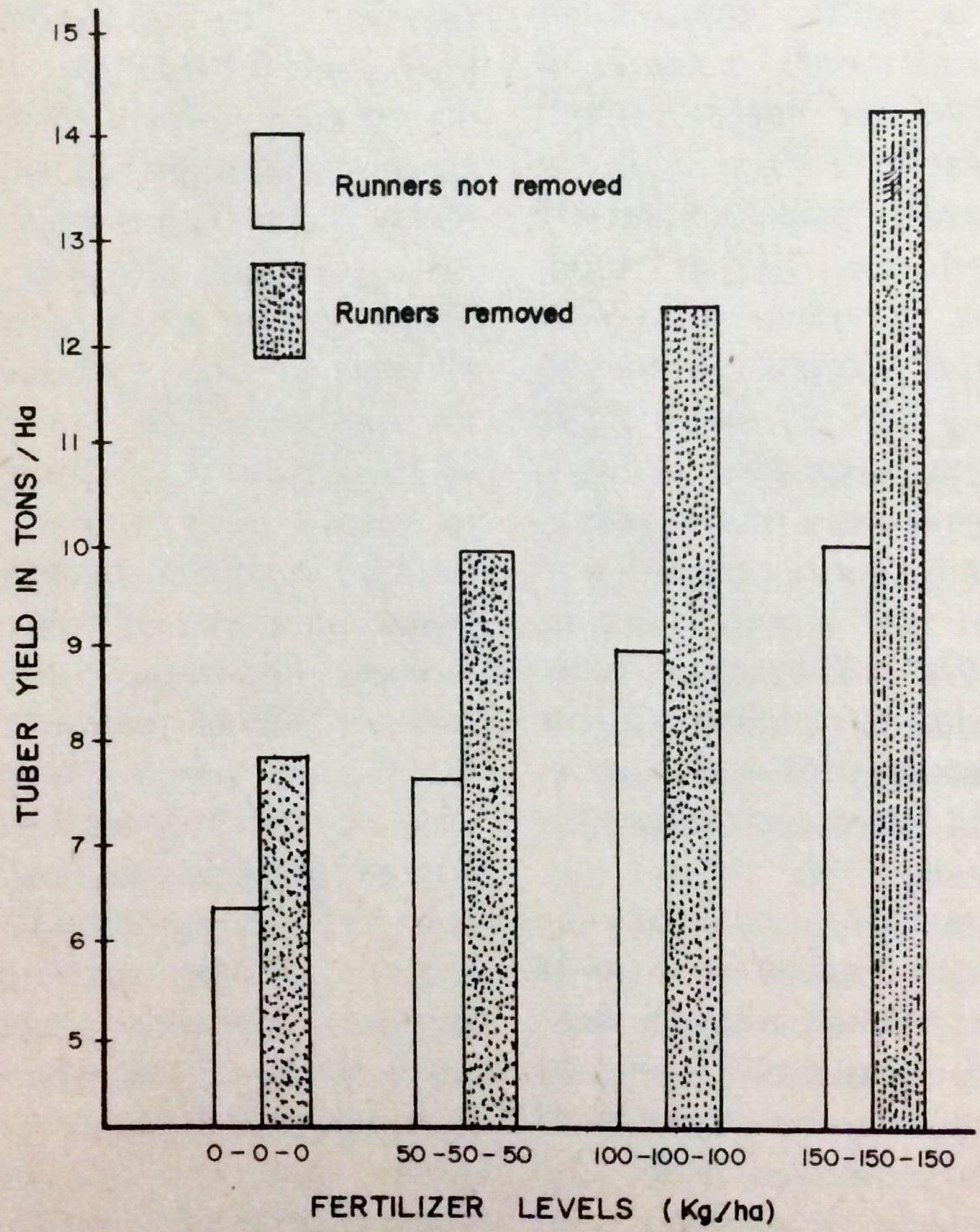

Fig. 1. Fertilizer X runner removal interaction effects on tuber yield.

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