EFFECTS OF SPACING IN TARO (*COLOCASIA ESCULENTA*)

P. Sivan*

SUMMARY

In Fiji taro is generally grown at spacings wider than 90 x 90 cm. Earlier experiments had indicated that closer spacings were superior only with the use of nitrogen fertilizer. Recent experiments have shown that yield can be more than doubled by closer spacings. Closer spacing increased corm yield per unit area and height of the plant but reduced the mean corm weight, the number of leaves and the number of suckers per plant. Spacing of 60 x 60 cm produced the highest yield of marketable size corms (over 450 gms). The yield was about 15 t/ha at 11 months maturity at this spacing, averaged over two sites and two seasons with several cultivars.

RESUME

Les espacements pour la culture du taro dans les iles Fiji dépassent généralement 90 x 90 cm. Des essais antérieurs avaient montré que des espacements plus étroits étaient plus satisfaisants seulement quand on utilise l'engrais azoté. Des essais récents ont montré qu'on peut doubler le rendement, et même plus, avec des espacements plus étroits. Des espacements plus étroits font augmenter le rendement en tiges bulbeuses par unité de surface de même que la taille de la plante, mais réduisent le poids moyen de la tige bulbeuse, le nombre des feuilles et le nombre de surgeons par plante. L'espacement de 60 x 60 cm donne le rendement le plus élevé de tiges bulbeuses commercialisable (plus de 450 g). Avec cet espacement on obtient environ 15 t/ha á 11 mois de maturité cette moyenne ayant été obtenue à partir de plusieurs cultivars essayés sur deux sites et deux saisons.

RESUMEN

En Fiji, la malanga se cultiva con espaciamientos mayores a los 90 x 90 cm. Los primeros experimentos habían indicado que los espaciamientos menores eran superiores sólo cuando se empleaba fertilizante nitrogenado. Experimentos recientes muestran que el rendimiento puede ser más que duplicados con espaciamientos mas cerrados. Tales espaciamientos incrementaron el rendimiento de cormo por unidad de área y la altura de la planta, pero redujeron el peso medio del cormo, el número de hojas y el número de hijos por planta. El espaciamiento 60 x 60 produjo el más alto rendimiento de cormos de tamaño comercial (más de 450 gms.). El rendimiento fue alrededor de 15 t/ha a los 11 meses con ése espaciamiento, como promedio de dos sitios y dos temporadas, con varios cultivares.

INTRODUCTION

Taro (*Colocasia esculenta* (L) Schott) is grown throughout the tropics and sub-tropics for its edible corms or leaves. The effect of spacing in this crop has been little studied and Plucknett *et al.*[5] have reviewed this topic.

Taro in Fiji is grown mostly on the wet sides of the islands in either mixed or pure stands. In mixed stands, various crops including other root crops such as yams, cassava or sweet potato are grown together. The taro spacing used in this system has not been studied but it is both wide and very variable. With pure stands of taro two brief reports[3,4] published about 1938 suggested the traditional spacing to be around 90 x 90 cm. In the 1968 census[1], a large number of plots of pure stands of taro were enumerated, but measurements of spacing and yield were obtained from only 91 of these, the results of which are now shown in Table 1.

The yields were recorded as yield of taro as marketed, i.e. the corms plus about 30-40 cm of petiole-base attached. The petiole base comprises about 25 percent of the total weight, so the yield of corms alone will be only about 75 percent of that shown in the Table. (All other yields shown in this paper are for corms only). Despite this, the survey strongly suggests that spacings wider than 120 x 90 cm (9,000 pl/ha.) are usual in Fiji, and that within these limits there is a general trend of increasing yield with increasing plant population.

The table also shows that in Fiji, taro yields are very low (about 6 t/ha) in comparison with those recorded in other countries. Plucknett *et al.*[5] reported yields of about 25 t/ha in the Philippines, 34 t. in India and 15-25 t. for upland taro in Hawaii. In both India and Hawaii, the crop is grown at much closer spacing than that in Fiji.

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*Department of Agriculture, Koronivia Research Station, Nausori, Fiji Islands.

METHODS

1965-68 series

The first series of spacing experiments were planted at Koronivia Research Station in alluvial soils using the cultivar Vavai Dina during the winters of 1965, 1966 and 1967 and harvested about eleven months later. They have been described in detail by Rhodes and Siven *et al.*[6,9].

Only two spacing treatments 90 x 90 cm and 90 x 60 cm were common to all experiments. In 1965 and 1967 there was also a 90 x 75 cm spacing. The first two experiments were unfertilized; the third was a spacing (S) x nitrogen (N) factorial, with each spacing occurring with N at the rates of 0.85 and 170 kg/ha. Various ridging and mulching treatments were also included but these will not be discussed here.

1971-1972 series

The 1965-68 experiments had an insufficient range of spacings. The 1971-72 series of experiments tested a much wider range of spacings varying from 120 x 90 cm to 60 x 45 cm. Details of these experiments have been published elsewhere[7,8,9]. Both in 1971 and 1972 the experiments were carried out at two sites, at Koronivia Research Station on flat alluvial soils, and at Waidradra Research Station on hilly, humic latosolic soils. Both stations lie in the wet zone of Fiji and receive over 3200 mm of rain evenly distributed throughout the year. The 1971 Koronivia experiment was a spacing x variety factorial with the spacing whole plots split for the two cultivars, Qawe ni Urau and Kurokece. The 1971 Waidradra experiment was a spacing x nitrogen factorial with the spacing whole plots split for three rates of N (0, 112, and 224 kg/ha).

Both the 1972 experiments were spacing x cultivar factorials with the spacing whole plots split for cultivars. At Koronivia the same cultivars were used as in 1971, whereas at Waidradra two commercially grown hill soil cultivars, Samoa and Tausala ni Samoa, were used.

The whole plot layouts for all experiments were 5 x 5 latin squares.

RESULTS

1965-68 series

The effects of spacing and N treatments in this series of experiments are shown in Table 2.

The spacing x N interaction in the 1967/68 experiment was highly significant, so in considering the results across all experiments only the N_o results of this experiment could be averaged with those of the other two. The mean results in the absence of N were as follows:

90 x 90 cm – 10.2 t/ha.
90 x 60 cm – 11.5 t/ha.

The S.E. of these figures based on the 'pooled' internal errors of the experiments was about $\pm$ 0.5 t/ha, so that the difference between the mean results was not significant at 5 percent level. The variations from experiment to experiment (i.e. experiment x spacing interaction) was rather more significant. The highly significant superiority of 90 x 60 cm over 90 x 90 cm spacing in the presence of N in the 1967/68 experiment suggested the experiment to experiment variation might be due to N status of the soil.

The overall results therefore were a strong suggestion that 90 x 60 cm was better than 90 x 90 cm spacing, particularly in the presence of N.

1971-72 series

The N effect in the 1971 Waidradra experiment and the varietal effect in the other three experiments have been discussed elsewhere[7,8,9] and will not be discussed here.

Individual yield results of the spacing treatments for the four experiments together with the aggregate yield data are shown in Table 3. The interaction between spacing and N in the 1971 Waidradra experiment and the interaction between spacing and cultivar in the other three experiments were negligible and non-significant, so the spacing results of these can be shown fully as in Table 3.

The aggregate means show that yield increases with close spacings. The yield of two closest spacings did not differ significantly, but both these spacings significantly outyielded all other spacings. In a recent experiment at the Fiji College of Agriculture[2], yield increases were obtained with populations up to 17,800 plants/ha. The replication in the college experiment was so slight that little confidence can be placed in the results, however, the suggestion that yield continues to increase with increasing plant population, even to this very close spacing, is noteworthy.

Closer plant spacing was observed to have various other effects on the plant. These are shown in Table 4. Apart from the data for sucker numbers per plant, all other data shown in the table are the means of the four varieties from the 1972 trials. The data for the suckers are the means for three cultivars only; the fourth cultivar, Samoa, hardly produced any suckers at all at any spacing. The heights and the leaf numbers were recorded when the plants were about 6 months old; that was near their peak vegetative growth, and the sucker numbers and corm weights were recorded at harvest (10-11 months).

The mean plant height increased at first with closer spacing and then levelled off with a further decrease in spacing. The plant heights at the three closest spacings did not differ significantly. The mean leaf number and the mean corm weight per plant decreased almost linearly as spacing decreased. The mean number of plantable suckers per plant fell off rapidly at first with decrease in spacing but at closer spacings it appeared to be levelling off.

Figure 1 shows the yield distribution of various size of corms for different spacings. At closer and at wide spacings the yields of various size corms appeared to have a skewed distribution; at closest spacing the total yield consisted of a high proportion of small sized corms and a low proportion of large corms, whereas at wide spacings the yield consisted of a very high proportion of large corms and a low proportion of small corms. At an intermediate spacing of 60 x 60 cm corm size distribution tended towards normal. At this spacing over half the corms were of medium size (450-900 gms).

DISCUSSION

The extension of the range of treatments in the 1971-72 experiments, as compared with the previous experiments has clarified the situation. It shows that yield of taro, under upland conditions in Fiji, continues to increase with closer spacing, certainly down to about 60 x 45 cm. Spacings as close as 60 x 45 cm in Hawaii and 45 x 30 cm in India, were reported to be used for upland taro[5].

Although total corm yield increased with closer spacing, the mean weight of corms per plant decreased. For many vegetable crops there is a point at which increasing yield with closer spacing is unprofitable because the decreasing size of marketable products makes them less valuable per unit weight. This applies well to taro in Fiji where corms under 450 gm (1 lb.) are regarded as too small for marketing. As can be seen from Fig. 1, although 60 x 45 cm gave slightly higher yield than 60 x 60 cm spacing, it consisted of a much higher proportion of corms less than 450 g in weight. Spacing of 60 x 60 cm gave the highest yield of corms over 450 g. This spacing appears to be more suited for the wet zones of Fiji where taro is grown in pure stand and is hand cultivated. However, since at this spacing taro forms a dense canopy, it will not be suited for intercropping.

Close spacing, apart from giving higher yield, has an added advantage in that it provides a much earlier, full ground cover which suppresses weeds. Weed competition during the early stages of growth has been reported to be most critical for taro.[5]

The main method of propagating taro in Fiji is by suckers. Suckers for planting cost between $1.00-$2.00 per hundred, a price at which close spacing could be expensive in planting material. However, in practice, markets for suckers are very limited. Most established growers plant their new crop after harvest and the old crop furnishes planting material for the new crop.

Some cultivars may produce less suckers than others, and suckering is generally depressed by closer spacing. The cultivar Samoa produced few suckers at any spacing. At 60 x 60 cm spacing the three remaining cultivars each produced more than two plantable suckers/plant. Hence, at this spacing for most cultivars there should be ample planting material, not only for maintaining the previous acreages but also for expansion if needed.

Although close spacing will require extra labour for planting and harvesting a unit area of crop, the vast increase in yield, together with savings in weed control costs, should more than offset the additional planting and harvesting costs. An economic study of spacing and these factors is planned for the near future.

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FIGURE 1

YIELD OF VARIOUS SIZE CORMS FOR DIFFERENT SPACINGS

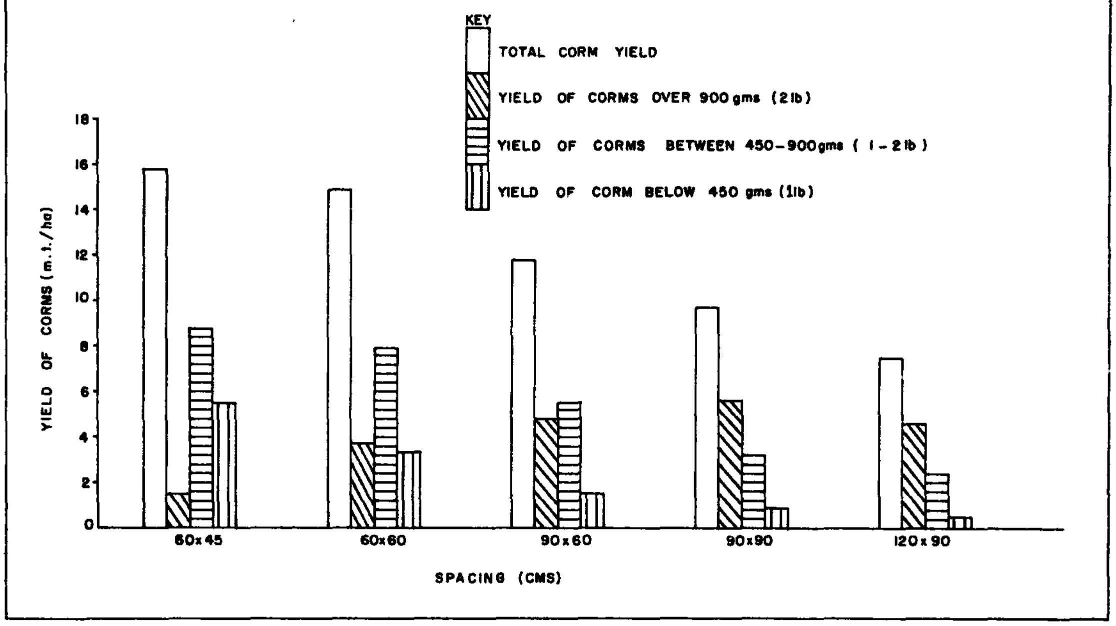

TABLE 1

Result of 1968 survey (I)

Province	Average no. of plants/ha.	Average yield* metric tons/ha
Cakaudrove	1,900	2.2
Tailevu	3,500	4.8
Macuata	4,500	6.9
Naitasiri	4,900	4.6
Others	6,400	7.9
Kadavu	8,650	8.0
Average	5,000	5.7

* Yields include yield of corm plus about 30-40 cm of petiole-base attached.

TABLE 2

Taro yields, 1965-1968 spacing experiments (t/ha.)

	Nitrogen treatments				
	N_0	N_0	N_0	N_1	N_2
Spacings (cm)	1965/66	1966/67	1967/68	1967/68	1967/68
90 x 90	11.0	12.1	7.5	7.0	7.5
90 x 75	12.5	-	7.8	8.0	9.0
90 x 60	12.0	16.6	6.0	8.5	12.5
SE±	0.75	1.1	0.9	0.9	0.9

N_0 = Nil N, N_1 = 85 kg N/ha, N_2 = 170 kg N/ha.

TABLE 3

Effect of spacing on taro corm yield (t/ha)

Spacings (cm)	Population plants/ha.	Waidradra site 1971	Waidradra site 1972	Koronivia site 1971	Koronivia site 1972	Aggregate means
120 x 90	9,000	8.5	8.0	6.6	6.8	7.5
90 x 90	11,950	10.6	0.8	9.8	8.6	9.7
90 x 60	17,930	12.6	13.1	10.3	11.1	11.8
60 x 60	26,900	14.1	17.3	15.5	12.5	14.9
60 x 45	35,860	14.1	18.3	17.4	13.2	15.8
S.E.±		0.92	0.34	0.90	0.68	0.65*

* This S.E. is based on experiment x treatment interaction

TABLE 4

Effect of spacing on corm size, height, leaf number and sucker number and sucker production in taro

Spacings (cm)	Mean height (cm)	Mean leaf no/plant	Mean no. of plantable suckers/plant*	Mean corm weight/plant (gms)
120 x 90	102.1	3.47	7.2	870
90 x 90	100.6	3.34	5.5	820
90 x 60	116.3	3.19	4.1	710
60 x 60	115.9	3.00	2.5	570
60 x 45	115.0	2.76	1.9	460
S.E.±	3.0	0.08	0.8	40

* Suckers over 2.54 cm (1") in diameter were taken as plantable.