Control of Flowering, Seed Germination and Progeny Evaluation of Taro *Colocasia esculenta* (L.) Schott

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ABSTRACT

Breeding work in gabi ***Colocasia esculenta*** *(L.) Schott has lagged behind breeding work in other root crops. This is due to flowering and seed germination problems. This research was conducted to evaluate the potential of producing hybrids.*

Four experiments using gibberellic acid (GA_3) as flower promoter, two experiments in seed germination and a series of evaluation trials of progenies produced were done.

Flowering using GA_3 in 28-day-old plants was better compared to that in 60-day-old plants. Genotypic differences were significant in terms of plant response to GA_3 application. Addition of nitrogen (N), phosphorus (P) and potassium (K) in GA_3-treated plants affected flowering competence, number of flowers per plant and proportion of flowers with pollens.

Germination of seeds in sterilized soil medium was comparable to germination of those sown in agar media. Surface sterilization of seeds with $Ca(OCl)_2$ was effective in controlling fungal growth.

Some clones among the 2000 genotypes evaluated were identified to possess qualities comparable to VG-1 (standard check). Problems regarding progeny evaluation, particularly on dry matter content and acridity determination, were identified.

INTRODUCTION

Colocasia esculenta (L.) Schott, popularly known as taro (or locally as gabi) is probably the oldest cultivated crop in the Asian-Pacific countries (**20**). It is a staple in many Pacific Island nations and a supplement to rice and corn in the Philippines.

In the Philippines, people cultivate taro on a small-scale to augment cash derived from selling the leaves for vegetables and corms for carbohydrates. However, the crop ranks lower than sweet potato and cassava in crop production and hectarage of planting. Moreover, the breeding program for the production of improved varieties has lagged behind.

One major constraint in taro breeding is the sporadic occurrence of flowers in very few taro plants growing in natural conditions. It is believed to be a non-flowering plant (**14, 24**) although materials were found to produce flowers naturally (**13, 17**). Earlier findings have shown that a great proportion of different genotypes failed to flower (**16,17**) under a two-year observation period. Flowering is synchronous and not all plants may flower in an accession.

Sometimes taro flowering leads to fruit setting but seed germination under natural conditions has not been observed. It is believed that taro seeds may lose viability before they are dispersed onto the ground. Likewise, the small seeds (which are usually 1 mm long and 0.5 mm in diameter) are easily lost after the fruit decays due to fungal attack. Sometimes, unripened fruits are eaten by grasshoppers and other chewing insects.

This paper presents results of the methodology adopted for progeny production and evaluation -- simple experiments on the promotion of flowers and seed germination on taro done from 1988 - 1990.

MATERIALS AND METHODS

A. Experiments on Flowering

1. Effect of timing and frequency of GA_3 application

The effects of time of initial application (28 and 60 days after planting) and frequency of application (once, twice, thrice and four times) on the flowering of local taro clones (PRG 078

and PRG 092) were evaluated. Both clones were observed to rarely flower under natural conditions.

There were five experimental units per treatment combination per replication. The experiment was laid out in RCBD with three replications.

A single headsett of each clone with three defoliated petioles was planted in a clay pot (32 cm top diameter) filled with a soil and rice hull compost mixture (5500 cm^3 at 1:1 by volume). The soil-compost mixture had 0.34% total N, 71.42 ppm extractable P and 1,415 ppm exchangeable K.

All opened leaves were sprayed with 250 mg GA_3/L. In each liter of solution, 1.5 ml of chemical sticker was added. Spraying was done using a mist sprayer at a rate of about 100 ml of solutions per plant or until dripping point.

Data gathered for this experiment were: (1) flowering competence as expressed by the percent of treated plants that flowered; (2) number of days to first normal inflorescence emergence; (3) number of flowers per plant; and (4) per cent of flowers with pollen per plant. THe anova with subsampling was used when appropriate. Similar data were gathered for the succeeding experiments.

2. Effects of genotype and strategy of application

Six accessions of gabi were selected based on their propensity to flower under natural conditions. Headsetts were prepared from PRG-066 and PRG-092 (rarely flowering), PRG-068 and PRG-062 (moderately flowering) and PRG-686 and PRG-687 (highly flowering) genotypes. The same planting procedure as in Experiment 1 was adopted.

The strategies of GA_3 application were: (1) 500 mg/L applied at 30, 45 and 60 DAP; (2) 750 mg/L applied at 30 and 45 DAP; and (3) 1500 mg/L applied at 30 DAP only. FIve potted plants were assigned to each treatment per replication. The RCBD was used with three replications.

3. Effect of fertilization and GA_3 on flowering

The genotypes PRG-068, PRG-694, PRG-066 and PRG-687 were used in this experiment. Planting material preparation was similar to Experiment 1.

Nursery beds of 2m x 2m were prepared and planted to four plants spaced at 1m x 1m. The soil was clay loam with 0.21% total N, 13.94 ppm extractable P and 176 ppm exchangeable K.

The treatments were the following: (1) plants sprayed with water only; (2) plants sprayed with 1000 mg GA_3/L; (3) plants sprayed with water and fertilized at the rate of 6.75 g N, 4.5 g P_2O_5 and 4.5 g K_2O per plant; and (4) plants sprayed with 1000 mg GA_3/L and fertilized similarly as in treatment 3. Spraying of GA_3 or water was done at 28 DAP.

The RCBD was used with two replications.

4. Effect of N, P, K

Fertilization affected flowering based on the results of Experiment 3 and a pot experiment was conducted to determine the effect of N, P and K. There were eight (2^3) treatment combinations. Five pots were assigned to a treatment combination. The RCBD with three replications was used.

The N, P and K were applied at the rate of 2.25 g per pot.

B. Experiments on Seed Germination

1. Effect of media on germination

Fruits of PRG-689 were collected one month after pollination from self-pollinated plants. To extract the seeds, the fruits were squashed on a 2-mm wire mesh under slowly running tap water and the extracted seeds were air dried for three days prior to sowing.

The media used in the experiment were: (a) 1% agar; (b) 2% agar; (c) soil extract agar; (d) soil + 1% agar; (e) soil; (f) rice hull compost; and (g) tissue paper. All the media were autoclaved at 250^0C (15 psi) for 20 min.

Sterilization of seeds was done by soaking them in 5% NaOCl for 10 mins, then rinsing with three changes of sterile distilled water.

The RCBD was used with three replications. The experiment lasted for only 60 days.

2. Effect of seed source and $Ca(OCl)_2$ on seed germination

Seeds from 10 genotypically different sources were extracted, air dried for three days and soaked either in 5% $Ca(OCl)_2$ or distilled water for 10 minutes. One hundred seeds were sown in a petri dish lined with tissue paper moistened with distilled water. The experiment was laid out in RCBD with three replications. Daily scoring for germination was done for 100 days. A seed was considered to have germinated when the green cotyledon had emerged from the seed coat. The percent germination 22 was obtained and the coefficient of velocity was computed using the formula:

$$\text{Coefficient of Velocity} = \frac{\text{total number of seedlings}}{A_1 T_1 + A_2 T_2 + \ldots + A_n T_n}$$

where: A = number of seedlings emerging on a particular number of days (T)

C. Progeny Evaluation and Selection

After four months of seedling growth (from petridishes to seed boxes), the materials were transferred to a nursery bed for two-month acclimatization before the field trials were started. A schematic diagram of the flow of progeny evaluation is shown in Figure 1.

In each phase of the evaluation, selection was done based on either the dry matter content, palatability or yield. Dry matter evaluation was based on fresh weight while palatability and general acceptability scoring (Hedonic scale) were adopted on some materials presumed to have high dry matter content based on the "flotation method" of uncooked corms. Raw clean corms were dropped in a plastic pail filled with 3 l of water. Materials that floated were considered as having low dry matter content (less than 38%).

During the single plot evaluation, 12 plants were grown. Plant heights of 10 sample plants were measured from the base to the tip of the first fully expanded leaf. This was done on some samples of progenies only of the trial done in 1989. Corm yield (kg/plant) and corresponding dry matter content (%) were gathered at the single plot trial stage, which had two rows of 12 plants. Out of the 20 plants in a plot, 5 sample corms were chipped, sun dried for a day and transferred to an oven set at 50^0C for two days. The materials were weighed obtaining dry matter content as:

$$\text{DMC (\%)} = \frac{\text{Dry Weight}}{\text{Fresh Weight}} \times 100$$

A replicated trial, consisting of 21 genotypes selected from various evaluation trials, was conducted to examine the possibility of obtaining an outstanding genotype. There were six replications and the experiment was laid in RCBD.

RESULTS AND DISCUSSION

Effect of Plant Age on Flowering

A higher percentage of plants flowered when those were sprayed once at 28 DAP(Table 1), indicating an increase in flowering competence of the plants. Likewise, early emergence of flowers was observed in about 14 weeks after planting or about 10 weeks after initial spraying (Table 2). Further GA_3 application seems to retard the flowering competence (**12**) and delay floral emergence.

With a single application of GA3 lesser plants sprayed at 60 DAP flowered. Late floral emergence was observed, but further application enhanced early floral emergence, about seven weeks from initial application.

These results show that application of GA_3 at 250 mg/L may be sufficient when applied only once, specially in younger plants. Secondly, it could be inferred that timing of GA_3 application is important in synchronizing flower emergence.

It was observed in other crops that GA_3 played a role in assimilate distribution (**25**). Under natural conditions, the dry matter tends to be distributed toward the storage organs as the plant matures. But with GA_3 application, the partitioning of dry matter is disturbed, leading to dry matter being distributed toward the shoot apex. Gibberellic A_3 induces mitotic activities (**4**) in the apical meristem. Both photo-induction and GA_3 enhanced floral initiation. This could possibly be supported by the increase of nutrients (**22, 6, 7**) and energy brought about by the action of GA_3 (**4, 19**) in the breakdown of starch.

In younger taro plants, though these had less stored starch, the translocation of assimilates toward the shoot from the leaves after a period from GA_3 application may have encouraged flowering. Nevertheless, further application may lead to ineffectivity since taro also has to translocate starch to the corms.

For the older plants, the re-routing of the assimilate toward the shoot may have been delayed (**25, 22**), resulting in a reduction in flowering competence and delay of floral emergence. Subsequently, further spraying increased GA_3 concentration resulting in the mobilization of stored starch (**7**) for use in the cell division (**5**) at the apical meristems.

Effect of Genotype and Strategy of Spraying on Flowering

In Experiment 1, both rarely flowering and highly flowering genotypes had similar reactions. However, in Experiment 2, strong genotypic differences were observed. In the highly flowering genotypes, 100% flowering was obtained even if different strategies of applying GA_3 were used (Table 3). Moderately flowering types had an enhanced flowering competence (80-90%); and the rarely flowering genotypes had only 60-80% plants with flowers. This shows that even if GA_3 was applied, flowering competence was still genotypically dependent.

In rarely flowering types, the flowering competence may not be perfected by either applying GA_3 at 1500 mg/L once or at 500 mg/L three times or 750 mg/L two times. Staggered application may be efficient as observed in the response of PRG-066 and PRG-062.

Likewise, genotypic differences were observed in the date of floral emergence. The date of flowering varied continuously depending on the propensity of the genotype to flower (Table 4). This suggests that even if GA_3 is applied, emergence of flowers may not be warranted to be uniform and perfectly synchronized. Hence, staggered planting may solve the problem of synchrony of flower emergence. The number of flowers produced per plant was a function of the genotype. The strategy of GA_3 application did not affect the date of emergence and the number of flowers per plant.

Effect of Fertilizer Application on Flowering

Flowering competence of GA_3-treated plants seemed to be affected by the addition of phosphorus (P) and potassium (K) (Table 5). This could be related to the function of both P and K on the energy accumulation and assimilate distribution toward the reproductive organs. Flowering is an energy-requiring process; the addition of both P and K is necessary. A high nitrogen (N) nutrition (**15**) failed to significantly affect flowering competence.

The application of fertilizer failed to affect the date of flower emergence. However, combined application of N, P and K affected the number of flowers produced in GA_3-treated plants (Table 6). An interaction between genotype and fertilizer addition was apparent. This implies that fertilizer can affect responses to GA_3.

Of the three nutrients, P and K significantly affected the number of flowers (Table 7). This indicates that both elements should be added to enhance flowering. It is possible that the apical meristem may have been further stimulated to flower as one more leaf axil was found to bear flowers. Normally, only a single leaf axil produces two or three flowers.

Both P and K affected the number of flowers with pollen (Table 8). It seems that P was important in pollen production, though K was equally likely to affect the presence of pollen. Without N, combined application of P and K resulted in a significant increase in the proportion of flowers with pollen. Without adding K, combined application of N and P was able to enhance pollen production. A similar effect was obtained when P was left out; N and K warranted sufficient pollen produced. Nonetheless, N alone was not sufficient for pollen production.

Inducing plants to flower leads to the doubling of the activity rate of glucose-6-phosphate dehydrogenase in the short apex (**12**), indicating an active breakdown of carbohydrates. SInce the energy requirement increases, supplemental nutrition becomes imperative (**6**). In taro, both P and K must be readily absorbed for use in the energy-requiring process of floral development. The role of P is related to ATP production while K aids in the translocation of assimilates. Likewise, the number of flowers and number of flowers with pollen were subsequently affected.

Seed Germination: Effect of Medium

Germination of seeds was enhanced by using agar media (Table 9). However, this encouraged fungal growth which infected the germinating seeds. The speed of seed germination (coefficient of velocity) was faster in agar medium than in compost or moistened paper. Because of the favorable growth condition afforded by the agar media (**13**), the rapid multiplication of the fungus overcame seed germination (**16, 17**).

Like the agar media, compost medium harbored some fungi and even encouraged the growth of some bacteria. It seems that the compost medium was not effectively sterilized by the method used. Probably compost medium may have germination inhibiting substances affecting germination of taro seeds.

The pure soil medium had an advantage over the media with agar. It did not encourage fungal growth. Also, the germination was comparable to media with 1% agar and soil + 1% agar.

This shows that pure soil could be used to reduce cost of seed germination.

Seeds sown in tissue paper resulted in low germination but the emerging cotyledon was easily observed. This makes paper an effective medium in testing germination. Fungal infection was low, hence effective sterilization techniques should be sought to eliminate possible seed decaying agents.

Effect of Seed Source and Pre-germination Treatment

Genetically, all seeds gathered from seed source #028-4 to 169-68 (Table 10) were different. Although they were gathered from naturally self-pollinated plants, all of these seeds were collected simultaneously, from plants growing under similar conditions.

The use of $Ca(OCl)_2$ was intended to test its effectivity and its use as a possible substitute of NaOCl. It was observed that pre- germination sterilization with $Ca(OCl)_2$ resulted in insignificant reduction of germination. Hence, $Ca(COl)_2$ was effective as a surface sterilant for taro seeds. A comparable percent germination was observed with $Ca(OCl)_2$ and distilled water although fungal growth was observed in seeds soaked with distilled water.

The role of NaOCl and $Ca(OCl)_2$ in the surface sterilization of seeds had been found to be effective in seeds of several plant species. It was effective in overcoming thermo-inhibition of germination (**8, 9, 10** and **11**). It is the chlorine component that weakened the pericarp. Although both NaOCl and $Ca(OCl)_2$ were recommended for surface sterilization, they both failed to achieve uniform germination. It is highly probable that non- uniformity in taro seed germination was not controlled by thermo- inihibition. Other causes may be inherent in the seed, which led to slow rate of germination.

Progeny Evaluation

The flow of evaluation from single plant to replicated trials was consistent with the general norm of evaluating clonally propagated plants. Nonetheless, from the seedling stage to the single plant stage (acclimatization period), losses were incurred due to changes in the environmental conditions particularly the heat of the sun at noon time.

At the single plant evaluation, variation in plant height, petiole coloration and corm flesh color were observed. But at this stage, natural selection was allowed to act, thus adapted genotypes were obtained.

Wide variation among progenies obtained from self-pollinated plants was more pronounced than among cross-pollinated progenies (Table 11). Selection of materials was based on the dry matter content and corm yield and compared with the performance of the standard check (VG-1).

Evaluation of systematically produced progenies was carried out until the single plot trial. The summary data from this batch is shown in Table 11. It is shown that yield and dry matter content varied largely among families. Again, progenies of self- pollinated plants had larger variabilities than those from cross-pollinated plants. This suggests that both selfing and crossing could enhance variant production. Variabilities, in terms of chemical compostion and morphological characters (**23**) were also observed in seedlings from selfed plants. Variability through hybridization therefore can be increased, to be able to select improved genotypes.

At single plot, selection was done. After evaluating 2000 seedlings from five separate batches, twenty-four progenies were identified (Table 12). However, selection based on yield resulted in low quality and less acceptability. Consumers considerably favor taro with high dry matter content (more than 38%) and no acrid taste. With such criteria, most progenies that could have been selected would possess low yield potential. This indicates that further hybridization needs to be done to assemble all desirable genes in one plant.

Further evaluation of materials at the replicated trial stage (Table 13) showed that identification of an improved variety could be done.

Correlation (for a given character trait) between different stages of evaluation shows that corm yield was affected by the environmental condition prevailing in each trial (Table 14). Even within a family, i.e., PRG-686 x PRG-068 and PRG-094 progenies, negative correlation coefficients were obtained. However, the dry matter content seemed to hold a positive correlation between stages of evaluation. This implies that dry matter content should basically be a major criterion in the early selection of progenies.

One major problem in evaluating progenies is the acridity factor. Although Ca oxalate has been thought to affect acridity, other substances associated with Ca oxalate is believed to

control it (**3, 24, 27**). There is no easy method for *en masse* selection of progenies with non-acid character. At present, evaluation on acridity uses human panelists. However, once a panelist had tasted an acrid sample, further evaluation was effected, rendering later results inaccurate.

At present, it seems likely that selection in taro must first concentrate on dry matter content, taking yield only at a later stage. At the single plant to single row trial, dry matter evaluation using the flotation method could be done. Quantitative analyses of dry matter should be done either at single plot or during the replicated trials. At the more advanced stage of evaluation yield, starch content and other properties (**18**) may be used as criteria in the ultimate selection of a new variety.

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Table 1. Effect of frequency and initial date of GA_3 application on flowering competence (% plant that flowered)

Frequency	Date of Initial Spraying	
	28 DAP	60 DAP
Once	93	47
Twice	87	47
Thrice	87	60
Four Times	67	80
cv (%) = 26.67	Sy = 14.15	$LSD_{0.05}$ = 28.3

Table 2. Number of days to emergence (DAP) of first normal inflorescence as affected by date of initial spraying and frequency of GA_3 application

Frequency	Date of Initial Spraying	
	28 DAP	60 DAP
Once	98	146
Twice	108	142
Thrice	115	126
Four Times	127	112
cv (%) = 8.96	Sy = 5.41	$LSD_{0.05}$ = 11.53

Table 3. **Effect of genotypes and strategy of GA_3 application on flowering competence (% plants that flowered)**

Strategy	Genotype					
	PRG 066	PRG 092	PRG 062	PRG 068	PRG 686	PRG 687
Water	NF	NF	NF	NF	27	27
500 mg/L GA3 applied 30, 45 60 DAP	80-	67	93	80	100	100
750 mg/L GA3 applied at 30 and 43 DAP	60	60	93	93	100	100
1500 mg/L GA3 applied at 30 DAP	67	67	80	93	100	100
cv (%) = 27. 08		Sy = 14.17			LSD0.05 = 14.17	

Table 4. **Number of days to emergence (DAP) of first normal inflorescence and average number of flowers per plant as influenced by genotypes**

Genotypes	Days of Emergence	No. of Flowers per Plant
PRG 066	160	2
PRG 092	156	2
PRG 068	153	2
PRG 062	134	3
PRG 686	132	5
PRG 687	115	5
cv (%)	11.62	0.73
Sy	20.62	13.86
LSD0.05	23.76	1.5

Table 5. Effect of P and K interaction on the proportion of plants that flowered on GA_3-treated *C. esculenta* (cv. Kalpao)

Treatment Combination	Flowering Plants (%)
P_0 K_0	100
P_0 K_1	86
P_1 K_0	93
P_1 K_1	100
cv (%) = 11.82 Sy = 5.48	$LSD_{0.05}$ = 13.9

Table 6. Effect of genotype and fertilizer on number of flowers per plant treated with 1000 ppm GA_3

Genotype	With Fertilizer	Without Fertilizer
PRG 066	9	4
PRG 068	6	2
PRG 687	8	4
PRG 694	4	4
cv (%) = 11.82	Sy = 5.48	$LSD_{0.05}$ = 13.9

Table 7. Average number of flowers per plant as affected by N, P and K addition in GA_3-treated *C. esculenta* (cv. Kalpao)

	Without N		With N	
	W/O P	With P	W/O P	With P
Without K	4	3	2	4
With K	4	4	4	5
cv (%) = 14.39	Sy = 0.331		$LSD_{0.05}$ = 0.71	

Table 8. Effect of N, P and K fertilization on proportion (%) of flowers with pollens of plants treated with GA_3

	Without N		With N	
	W/O P	With P	W/O P	With P
Without K	21	22	13	31
With K	13	44	32	31
cv (%) = 61.91	Sy = 1.38		$LSD_{0.05}$ = 3.01	

Table 9. Effect of medium on germination of C. esculenta and number of replications with fungal growth (observed for 60 days)

Medium	Germination Percentage	Coefficient of Velocity	Number of replication w/ fungal Growth'
1% agar	71	0.070	3
2% agar	59	0.068	3
Soil extract agar	61	0.073	3
Soil + 1% agar	71	0.076	3
Soil + Distilled Water	70	0.077	0
Compost + Distilled Water	30	0.042	3
Tissue paper + Distilled Wataer	63	0.054	1
cv (%)	14.05	8.43	
Sy	6.82	0.004	
LSD0.05	14.05	0.01	

Table 10. **Effect of seed sources and soaking with 5% CaOCl on seed germination of C. esculenta (observed after 10 days)**

Seed Source (Genotypes)	Germination Percentage		Coefficient of Velocity	
	CaOCl	Distilled H_2O	CaOCl	Distilled H_2O
028-4	73	78	0.032	0.026
169-3_2	96	97	0.068	0.024
169-21	95	82	0.030	0.043
169-22	97	94	0.040	0.048
169-6	90	85	0.052	0.031
169-171	96	96	0.057	0.042
169-172	98	94	0.065	0.044
169-173	97	99	0.051	0.107
169-174	91	87	0.055	0.059
169-68	85	80	0.038	0.041
cv (%)		10.78		32.89
Sy		5.62		0.09
$LSD_{0.05}$		11.36		0.018

Table 11. Plant height (cm), yield (kg/plant) and corm dry matter content (%) of some progenies of either self or cross-pollinated plants

Parents[1] (PRG)	Number of Progenies (n)	Mean	S.D.	C.V. (%)
		Plant Height[2]		
688 x 686	94	162.18	40.38	24.9
688 x 105	28	168.89	32.15	19.04
688 x 006	16	147.25	36.24	24.61
244 x 218	21	166.81	25.37	15.21
690	13	108.31	19.89	27.6
		Corm Yield[3]		
686 x 068	50	0.21	0.07	33.81
374 x 100	8	0.23	0.04	16.43
265 x 068	8	0.24	0.09	36.13
263 x 213	12	0.24	0.07	29.9
094	28	0.26	0.16	61.54
687	22	0.22	0.11	50.60
169	40	0.32	0.40	31.25
		Dry Matter Content[4]		
686 x 068	50	28.26	5.24	18.56
374 x 100	8	23.83	16.17	67.85
265 x 068	8	32.11	6.36	19.82
263 x 213	12	29.48	8.19	27.78
094	28	30.10	8.94	29.70
687	22	24.37	4.0	16.41
169	40	37.38	6.87	18.39

1 Number refers to accession numbers based on the records of PRCRTC, ViSCA, Baybay, Leyte

2 Plant height measured from 10 sample plants at the single row trial evaluation

3 Yield measured as an average of 20 sample plants grown during the single plot trial

4 Dry matter content measured based from five sample plants at the single plot trial

Table 12. Some characteristics of "elite" progenies selected from 2000 seedlings based on single plot trials

Progeny Code[1]	Parental Source	Yield kg/plant)	Dry Matter Content (% FW)	Acridity[2] Scores
GO 049	PRG 094	0.39	39.83	6.9
GO 245	PRG 068	0.80	22.42	6.3
GO 236	PRG 068	0.30	24.23	6.66
GO 227	PRG 068	0.42	30.83	6.4
GO 186	PRG 028	0.61	24.00	6.1
GO 243	PRG 142	0.45	28.24	3.8
GO 250	PRG 142	0.47	22.50	5.7
GO 201	PRG 142	0.55	24.73	.nd
GO 211	PRG 142	0.44	25.73	.nd
GO 212	PRG 142	0.45	28.00	.nd
GO 214	PRG 142	0.44	15.50	.nd
GO 151	PRG 169	0.53	34.00	5.57
GO 153	PRG 169	0.48	40.33	7.48
GO 164	PRG 169	0.41	36.67	6.83
GO 217	PRG 169	0.44	21.07	.nd
GO 219	PRG 169	0.46	28.63	.nd
GO 134	PRG 687	0.43	20.00	7.3
GO 137	PRG 687	0.47	21.67	8.4
GO 140	PRG 687	0.41	31.07	6.92
GC 001	PRG 686 x 068	0.40	34.33	7.33
GC 221	PRG 687 x 006	0.50	28.57	.nd
GC 235	PRG 687 x 006	0.88	21.42	.nd
GC 241	PRG 686 x 006	0.58	20.20	.nd
GC 139	PRG 213 x 642	0.47	21.77	.nd
VG.1	check	0.39	39.87	6.6

[1] GO : progenies from naturally poliinated flowers
GS : progenies from artificially self-pollinated
GC : progenies from crosses

[2] Acridity scores based on the Hedonic scale;1, disliked very much; 9, liked very much; means computed from scores of 20 independent panelists; nd means not determined.

Table 13. Yield (t/ha) and dry matter content (%) of selected progenies evaluated under replicated trial

Progenies[1]	Yield (t/ha)	Dry Matter Content (%)	Acridity	Rating[2] Acceptability
GC 127	4.77	27.97	nd	nd
GC 119	4.77	25.41	nd	nd
GC 120	4.51	40.61	6.9	7.17
GC 117	4.48	37.43	nd	nd
GC 121	5.20	29.79	6.4	6.69
GC 125	4.32	38.66	nd	nd
GS 141	5.23	24.24	nd	nd
GC 122	4.77	27.45	nd	nd
GC 138	2.67	27.97	nd	nd
GS 137	4.17	28.88	nd	nd
GS 123	2.24	28.61	nd	nd
GC 134	1.95	32.28	nd	nd
GC 142	6.32*	32.87	6.4	7.08
GC 139	5.68*	28.08	nd	nd
GC 133	5.96*	32.20	nd	nd
GC 131	3.47	38.0	nd	nd
GS 140	3.95	36.48	nd	nd
Iniito local check	6.08	48.41	7.6	7.79
VG-1 standard check	5.12	38.94	7.4	7.74
Sy	0.0153	2.28		
HSD	0.078	12.38		
C.V. (%)	22.27	10.33		

[1] GC - progenies from crosses
GS - progenies from selfs

[2] Acceptability rating based on Hedonic scale: 1, dislike very much; 9, liked very much

Table 14. **Correlation coefficient values between stages of evaluation, in terms of yield and dry matter content of some taro progenies**

Stage of Evaluation	Single Plant	Single Row	Single Plot	Replicated Plot
		Yield		
		G-686 x 068 Progenies		
Single Plant	-	.(51)	(51)	(21)
Single Row	0.403	-	(51)	(21)
Single Plot	0.308^{*}	0.07^{ns}	-	(21)
Replicated Plot	0.334^{**}	0.656^{**}	0.142^{ns}	-
		PRG-094 Progenies		
Single Plant	-	.(33)	(33)	(20)
Single Row	0.277^{ns}	-	(31)	(20)
Single Plot	0.192^{ns}	0.057^{ns}	-	(20)
Replicated Plot	0.133^{ns}	0.622^{**}	0.261^{ns}	-
		Dry Matter Content		
		PRG-686 x 068 Progenies		
Single Plant	-	-	50	19
Single Plot	-	0.41^{**}	-	20
Replicated Plot	-	0.64^{**}	0.67^{**}	
		PRG-094 Progenies		
Single Plant	-	-	30	20
Single Plot	-	0.44^{*}	-	20
Replicated Plot	-	0.48^{*}	0.67^{*}	-
		General Computation		
		Yield		
Single Plant	-	.(115)	(114)	(59)
Single Row	0.314^{**}	-	(114)	(59)
Single Plot	0.019^{ns}	0.11^{ns}	-	(59)
Replicated Plot	0.192^{ns}	0.59^{**}	0.129^{ns}	-
		Dry Matter Content (%)		
Single Row	-	-	(110)	50
Single Plot	-	0.49^{**}	-	50
Replicated Trial	-	0.63^{**}	0.61^{**}	-

** highly significant; * significant; ns, not significant

Values enclosed in parenthesis refer to number of observation pairs.

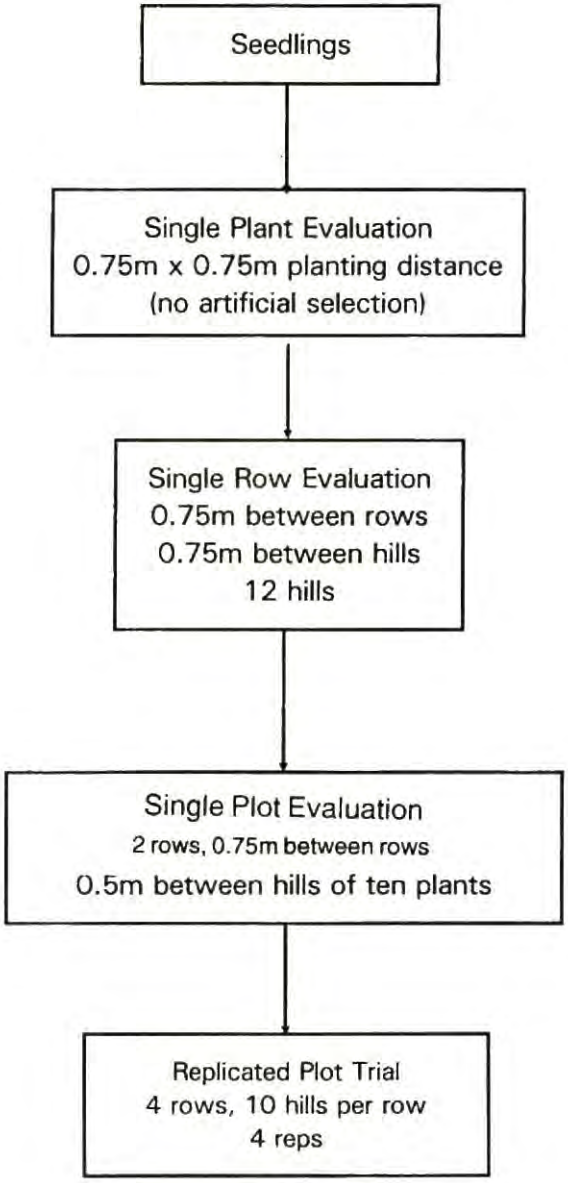

Figure 1. **Schematic diagram of the evaluational phase and flow of materials in a taro genotypic selection**

REFERENCES

1. **Alamu, S. and C.R. McDavid.** 1978a. Promotion of flowering in edible aroids by gibberellic acid. Tropical Agriculture, Trinidad 55: 81-86.
2. **Alamu, S. and C.R. McDavid.** 1978b. Effect of tissue and method of application of gibberellic acid on the growth and promotion of flowering in tannia (Xanthosoma sagittifolium). Tropical Agriculture, Trinidad. 55. 235-241.
3. **Bradbury, J.H. and W.D. Holloway.** 1988. Chemistry of Tropical Root Crops: Significant for Nutrition and Agriculture in the Pacific. ACIAR Monograph Series. Canberra, Australia.
4. **Bernier G.** 1988. The Control of floral evocation and morphogenesis, in Annual Review of Plant Physiology 36: 175-219

   Briggs, W.R., R.L. Jones and V. Walbot; Ed. (Annual Reviews Inc., California, U.S.A.)
5. **Besnard-Wibaut, C., T. Cochet and M. Noin.** 1989. Photoperiod and gibberellic acid-control the cell cycly in the meristem of Silene armeria and its effects on flowering. Physiologia Plantarum 77. 352-358.
6. **Brewster, J.L.** 1983. Effect of photoperiod, nitrogen nutrition and temperature on inflorescence initiation and development in onion (Allium cepa L.) - Annals of Botany. 51. 429-440.
7. **Davies, H.V. and R. Viola.** 1988. The effect of gibberellic Acid on starch breakdown in sprouting tubers of *Solanum tuberosum* (L.). Annals of Botany 61. 689-693.
8. **Drew, R.L.K. and P.A. Brocklehurst.** 1984a. Investigation on the control of lettuce seed germination at high temperatures. Journal of Experimental Botany. 35. 986-993.
9. _____. 1984b. The effect of sodium hypochlorite on germination of lettuce seed at high temperature. Journal of Experimental Botany 35. 975-985.
10. _____. 1985a. The effects of pH during treatment of lettuce seeds with chlorine-releasing compounds on germination and seedling development. Annals of Applied Biology 106. 157-161.
11. _____. 1985b. The effect of sodium hypochlorite on thermo-inhibition of lettuce seed, in Symposium on Seed Research in Horticulture. Acta Horticulturae. H.H. van der Borg, Ed. Geisenhein, Germany, May 6-10, 1985.

12. **El Toukhi, F.M., G. Anderset, P.B. Gahan and H. Greppin.** 1988. Histochemical study of photoperiodic and low temperature effects on floral induction of *Spinacea oleracea*. Annals of Botany 61. 237-241.

13. **Jackson, G.V.H., E.A. Ball and J. Arditti.** 1977. Seed germination and seedling proliferation of taro, *Colocasia esculenta* (L.) Schott *in vitro.* Journal of Horticultural Science 52. 162-171.

14. **Kikuta, K., L.d. Whitney and G.K. Parris.** 1938. Seeds and seedlings of the taro, *Colocasia esculenta*. American Journal of Botany. 25. 186-188.

15. **Papakosta-Tasopouluns, D. and A.G. Sficas.** 1978. Boltin-fresh root yield and soluble solids of sugar beets as affected by sowing date and gibberellin treatment. Journal of the Americal Society of Sugar Beet Technologist. 20. 115-126.

16. **Pardales Jr., J.R.** 1980. Factors limiting fruit and seed set in taro. Annals of Tropical Research. 2. 172-177.

17. _____.1981. Floral morphology and biology, fruit and seed set, seed germination and seedling development of taro. Annals of Tropical Research. 3. 169-176.

18. **Peña. R.S. dela.** 1990. Development of new taro varieties through breeding, in Taking Taro Into the 1990s: A Taro Conference.

    Janes R. Hollyer and Dwight M. Sato. Ed. (College of Tropical Agriculture and Human Resources, University of Hawaii)

19. **Pharis, R.P. and R.W. King.** 1985. Gibberellins and reproductive development in seed plants. Vol. 36. In Annual Review of Plant Physiology. 36: 517-568.

    Briggs, W.R., R.L. Jones and V. Walbot Ed. (Annual Reviews Inc., California, U.S.A.)

20. **Plucknett, D.L.** 1976. Edible Aroids. in Evolution of Crop Plants.

    N.W. Simmonds, Ed. (Longman Group Limited, London). pp. 10-12.

21. **Plucknett, D.L., dela Peña R.S. and Obrero F.** 1970. Taro (*Colocasia esculenta*): A Review. Field Crop Abstract 23, 413-426.

22. **Sachs, R.M.** 1977. Nutrient Diversion. Horticultural Science 12. 220-222.

23. Scott, S.J., R.A. Jones and W.A. Williams. 1984. Review of data analysis methods for seed germination. Crop Science 24. 1192-1199.

24. Strauss, M.S., G.C. Stephens, C.J. Gonzales and J. Arditti. 1980. Genetic variability in taro, *Colocasia esculenta* (L.) Schott (Araceae). Annals of Botany 45. 429-437.

25. Thomas, T.H., A. Barnes, W.E.F. Rankin and C.C. Hole. 1983. Dry matter distribution between the shoot and storage root of carrot (*Daucus carota* L.) II. Effect of foliar application of gibberellic acid. Annals of Botany 51. 189-199.

26. Wilson, J.E. 1979. Progress in the breeding of Cocoyam (*Colocasia* and *Xanthosoma*). IFS Provisional Report No. 5: 299- 308.

27. _____. 1980. Cocoyam breeding by flower induction, pollination and seed germination. IITA Manual Series No. 4.

28. _____. 1981. Effects of formulation and method of applying gibberellic acid on flower promotion in cocoyam. Experimental Agriculture 17. 317-322.