PLANT IMPROVEMENT & SEED PRODUCTION

PROJECT

ANNUAL REPORT FOR 1997

Activity Report for the Steering Committee Meeting n° 9

(March 1998)

ICSB / CIRAD-Forêt

Effect of different fertilizers and soil components at the nursery stage (update and conclusion)

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Introduction

In the CIRAD-Foret/ICSB Steering Committee Meeting Report of the last year (1997), we presented a preliminary study on the effect of fertiliser and soil composition on rattan growth at the nursery stage. In this paper we present the data of the second assessment of the trial and its conclusion.

In this experiment, we compared the usual fertilizer (NPK granules) with a slow release fertilizer (Agroblen) applied only once after transplanting, at two dosages. In order to assess the advantage of adding sand and compost to the usual soil, and also to assess the interaction between the fertilizer and the soil components, this experiment also tested four different soil mixtures.

Material and method

This experiment started on April 5, 1996 for *Calamus subinermis* and *C. ornatus*, and July 20 for *C. manan* . The plants were potted in 6'x9' polybags at 1-2 leaf stage. All the plants were under a 50% sarlon net, watered once a day.

List of fertilizer treatments:

1) Control: NPK blue: 3-4 granules / polybag / month for small plants, 7-10 for middle plants and 18-20 for big plants. **F1**

2) Agroblen: 5g/polybag after transplanting **F2**

3) Agroblen: 10g/polybag after transplanting **F3**

The Agroblen fertilizer was added in the polybags just after transplanting the seedlings. The granules were mixed with the soil at the top of the polybags.

For the fertiliser factor, we decided to not establish a control as the comparison between NPK and no fertiliser has already been carried out many times in the past, showing without any doubt that no fertilisation always results in a very slow growth as compared to a NPK treatment.

List of soil treatments:

1) Control: 100% top soil from river edge	**S1**
2) 80% top soil + 20% sand	**S2**
3) 60% top soil + 40% sand	**S3**
4) 70% top soil + 20% sand and 10% saw dust (Batu and Lasun) 50% top soil + 20% sand + 30% saw dust (Manau)	**S4**

The mixture was manually prepared and the proportions were measured in volume and not in weight. Each experimental unit included 20 rattan seedlings and each treatment was replicated 3 times. Overall, per species, the experiment included:

20 plants * 3 fertilizer * 4 soil components * 3 repetition = 720 plants per species

The first assessment (March 1997) was carried out 11 month after transplanting for *C. subinermis* and *C. ornatus* and after 8 month for *C. manan*. For this assessment, 3 characters were measured: mortality, shoot length and basal shoot diameter.

The second assessment was done four months later (July 1997), 15 months after transplanting for *C. subinermis* and *C. ornatus* and 12 months after transplanting for *C. manan*. For this assessment, only the mortality and the shoot length have been measured. In fact, analysing the first assessment's data, we observed that, being correlated one to each other, diameter and height gave essentially the same information. The data have been analysed with the SAS software (SAS Institute Inc. 1988).

Results

Mortality

The statistical model used for this analysis was:

$$Yijk = X... + Xi.. + X.j. + X...k + error$$

i = fertilizer
j = soil
k = repetition

The statistical model and the fertilizer effect were significant for all the species; by contrast, the soil effect was not significant (data not shown). The frequency of mortality by fertilizer and species is presented in Table 1 below.

Table 1. Mortality rate ranked by species and fertiliser treatment, over the two assessments.

First assessment	*C. manan*		*C. subinermis*		*C. ornatus*	
F1 (NPK 10 granules per month)	0.20	A*	0.42	A	0.39	A
F2 Agroblen 5 grams	0.02	B	0.14	B	0.24	B
F3 Agroblen 10 grams	0.06	B	0.31	C	0.43	A
LSD (least significant difference)	*0.07*		*0.06*		*0.13*	

Second assessment	*C. manan*		*C. subinermis*		*C. ornatus*	
F1 (NPK 10 granules per month)	0.63	A	0.62	A	0.46	A
F2 Agroblen 5 grams	0.13	B	0.15	B	0.27	B
F3 Agroblen 10 grams	0.27	B	0.32	C	0.50	A
LSD (least significant difference)	*0.09*		*0.02*		*0.02*	

(*) Duncan grouping

For all species, the normal NPK fertilizer induced a considerable mortality, that increased over the time as the NPK application was repeated monthly. The conventional NPK treatment is to be considered already toxic. For all species, the higher F3 Agroblen dosage induced higher mortality if compared to the F2 treatment.

Shoot length and shoot diameter

At the first assessment, shoot length and shoot diameter gave similar results because they are intrinsiquely correlated (please see the Steering Committee Report of 1997). The differences in diameter among treatments were less important than for length, but the treatments' ranking was similar. The next part will only shows the results concerning the shoot length.

The statistical model used for this analysis was:

$$Yijk = X... + Xi.. + X.j. + X.k. + Xij. + X.jk + Xi.k + Xijk + error$$

i = fertilizer
j = soil
k = repetition

For all species, the analysis of variance (Table 2) showed that both the statistical model and the fertilizer (FER) effects were significant at the 0.01 error rate. The soil effect (SOIL) was highly significant for Manau, slightly significant for Batu (with an error rate at 0.09) and not significant for Lasun. The repetition effect (REP) was significant in Manau and Batu but not in Lasun. The interaction FER*SOIL, the study of which was one of the main objectives of the study, was not significant in any of the species.

Table 2. Analysis of variance showing the significance level of the effects, for each species.

Calamus manan					
Source	***DF***	***Type III SS***	***Mean Square***	***F Value***	***Pr > F***
REP	2	199.563	99.781	11.97	0.0001
FERT	2	1094.009	547.004	65.64	0.0001
SOIL	3	1083.971	361.323	43.36	0.0001
REP*FERT	4	302.544	75.636	9.08	0.0001
FERT*SOIL	6	78.949	13.158	1.58	0.1515
REP*SOIL	6	325.072	54.178	6.50	0.0001
REP*FERT*SOIL	8	496.755	62.094	7.45	0.0001
Calamus subinermis					
Source	***DF***	***Type III SS***	***Mean Square***	***F Value***	***Pr > F***
REP	2	299.919	149.959	7.55	0.0006
FERT	2	524.878	262.439	13.22	0.0001
SOIL	3	122.015	40.671	2.05	0.0964
REP*FERT	4	122.236	30.559	1.54	0.1898
FERT*SOIL	6	96.667	16.111	0.81	0.5613
REP*SOIL	6	118.086	19.681	0.99	0.4305
REP*FERT*SOIL	11	191.556	17.414	0.88	0.5629
Calamus ornatus					
Source	***DF***	***Type III SS***	***Mean Square***	***F Value***	***Pr > F***
REP	2	32.918	16.459	1.29	0.2759
FERT	2	265.008	132.504	10.40	0.0001
SOIL	3	55.654	18.551	1.46	0.2260
REP*FERT	4	28.816	7.204	0.57	0.6878
FERT*SOIL	6	52.308	8.718	0.68	0.6624
REP*SOIL	6	16.112	2.685	0.21	0.9733
REP*FERT*SOIL	12	229.732	19.144	1.50	0.1202

NOTE: DF=degrees of freedom. SS=sum of squares; Pr>F=probability rate of the hypothesis of a difference among treatments.

Fertilizer effect:

The effect of the fertiliser treatments on the shoot length is given in Table 3 below. In a similar way than for mortality, Agroblen showed to be the more suitable treatment for all species compared to NPK. The higher Agroblen dosage did not give an appreciable increase in growth if compared to the lower dosage. At the first assessment, we doubted that the Agroblen dosage of 5 grams could not be enough to last over the whole duration of the nursery stage. The second assessment showing that there is no differences between the 5 and 10 grams applications, we can conclude that either the 5 grams is sufficient for the whole period, or that the 10 grams dosage was uneffective because it was leaked and/or degraded without being utilised by the plant. For Manau, the Agroblen treatment resulted in an increase in growth of 40%.

Table 3. Shoot length (cm) ranked by fertiliser treatment and species, over the two assessments.

First assessment	*C. manan*		*C. subinermis*		*C. ornatus*	
F1 (NPK 10granules per month)	9.5	A*	7.5	A	14.0	A
F2 Agroblen 5 grams	11.3	B	12.1	B	16.0	B
F3 Agroblen 10 grams	11.8	C	11.7	B	14.5	A
LSD (least significant difference)	*0.5*		*0.9*		*0.9*	

Second assessment	*C. manan*		*C. subinermis*		*C. ornatus*	
F1 (NPK 10granules per month)	12.71	A	12.7	A	17.38	A
F2 Agroblen 5 grams	17.00	B	15.4	B	19.51	B
F3 Agroblen 10 grams	17.83	C	16.5	B	19.07	B
LSD (least significant difference)	*0.8*		*1.2*		*1.0*	

Soil effect:

For Lasun, we could not detect any soil effect, probaby because of the high mortality, especially for some of the combinations (80% of mortality for fertilizer F1 x soil S1 x repetition R2). The average height over the four soil treatments for Lasun was consistently around 18.4 cm. Table 4 only shows the results for Batu and Manau.

Table 4. Shoot length (cm) ranked by soil treatment and species, over the two assessments.

First assessment	*C. manan*		*C. subinermis*	
S1 100% soil	13.6	A	11.2	A
S2 80% soil + 20% sand	10.9	B	11.1	A
S3 60% soil + 40% sand	9.7	C	10.7	A B
S4 70% soil + 20% sand + 10% saw dust or 50% soil + 20% sand + 30% saw dust	9.6	C	9.9	B
LSD (least significant difference)	*0.6*		*1.0*	

Second assessment	*C. manan*		*C. subinermis*	
S1 100% soil	19.7	A	15.2	A
S2 80% soil + 20% sand	16.7	B	15.6	A
S3 60% soil + 40% sand	15.1	C	15.9	A B
S4 70% soil + 20% sand + 10% saw dust or 50% soil + 20% sand + 30% saw dust	14.5	C	14.4	B
LSD (least significant difference)	*0.8*		*1.2*	

For Manau, the top soil without any mixture gave the best results: the shoot length was 18% higher compared to the best of the mixtures (S2). The higher the sand proportion was, the less was

the growth. This could be explained by a diminution of the soil retention capacity for water and mineral components.

The soil effect on Batu was not really significant (α=0.09), but it was interesting to note the difference between this species and Manau, the former preferring more clayey soils, the second apparently preferring more sandy soil.

The mixture top soil, sand and saw dust always performed very bad, probably because: 1) the retention capacity of this material is poor; 2) the nitrogen content is also very low, so that a portion of the nitrogen in the media is absorbed during the decomposition of the saw dust into compost; 3) the process (2) acidifies the soil; 4) finally, an alternative explanation is the possible presence of toxic elements as resins in the saw dust.

Interaction fertiliser*soil

At the first assessment, the interaction soil*fertiliser was only significant for Manau (Steering Committee Report, 1997). However, even this effect disappeared over the second assessment. We do not show the results here.

Conclusion

- There is a strong correlation among diameter and shoot length (r^2>0.75 for all species); it is possible to interpret the experiment only by measuring the shoot length, thus saving time.
- The treatments with Agroblen 10 grams and with a monthly application of NPK resulted in much higher mortality compared to the treatment with Agroblen 5 grams.
- The two treatments with Agroblen 5 and 10 grams resulted in similar plant performances. Both of these treatments did however considerably better than NPK.
- The soil effect was highly significant only in Manau, that demonstrated to prefer top soil with neither sand nor compost. In Batu, even if the significance of the differences was light, the pattern was the reverse: this species seemed to prefer more sandy soils.
- The interaction soil*fertiliser was not significant over the duration of the experiment, so that the best fertiliser (or conversely, soil) will be always the best treatment no matter which soil (or fertiliser) is used.

Summarising, we are confident that a fertilisation with 5 grams of Agroblen is the best treatment for all the above rattan species. Agroblen, even if it is more expensive than NPK, allows to save the manpower needed for the monthly application.

The top soil was the best soil for Manau; the other two species were relatively indifferent to the soil treatment, so that the same soil can be adviced for all species.

The only consideration that needs to be added is that the watering regime in PISP was finely regulated. This is not always the case in the main nursery, where sometimes in the past we observed an excess of water, resulting in "floaded" polybags. In this case, the addition of a low portion (10%) of sand can help to drain the water without affecting too much the growth. If the top soil is too clayey (that is often the case in Luasong) the use of a low portion of sand can also help

to: 1) avoid soil compaction, 2) avoid breakages of the polybags and consequently of the roots; 3) avoid difficulties to water the polybags once the soil is dry.

Bibliography

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