

Evaluation of alternative media to potting mixture for raising coconut seedlings in polybags*

(Manuscript Received : 9-5-2000; Revised : 26-8-2000; Accepted : 5-12-2000)

Key words : Polybag nursery, Fertilization, Growing media, Coconut seedlings, Biofertilizers, Vermicompost

Production of vigorous seedlings is the first step in achieving higher production and productivity in coconut. Raising of coconut seedlings in polybags was introduced in 1969 in Ivory Coast (Wuidart, 1981), superseding the technique of conventional field nursery for production of vigorous seedlings. Their advantages and disadvantages in planting programmes have been well documented (Harries, 1983; Peries and Everard, 1991; Srinivasa Reddy *et al.*, 1996).

An earlier study, conducted at CPCRI, Kasaragod, has shown that sowing in potting medium of 1:1:1 mixture of red earth, cow dung and sand either in polybag or cement tank is beneficial in producing vigorous seedlings and also to get higher recovery due to the fact that potting mixture not only holds more moisture but also provides better nutrition to growing seedlings (Srinivasa Reddy, 1998). In Sri Lanka, it was reported that river sand could be a successful alternative to the more expensive potting media currently used in polybags (Peries and Everard, 1991). However, further study indicated that a mixture containing 3 parts of river sand, 2 parts of cow dung and 1 part of coir dust was shown to be the best (Perera *et al.*, 1996). Since, the potting mixture is not only costly but, now-a-days the availability is also very much limited, the current study was designed to test the feasibility of using sand along with chemical fertilizers and biofertilizers as substitutes for potting mixture for production of vigorous WCT coconut seedlings in polybags.

The field study was conducted during 1998 at CPCRI farm, Kasaragod in open space with partial shade during summer months, to find out the alternative media for growing vigorous WCT seedlings in polybags. The study comprised of 6 treatments *viz.* T1-sand, T2-

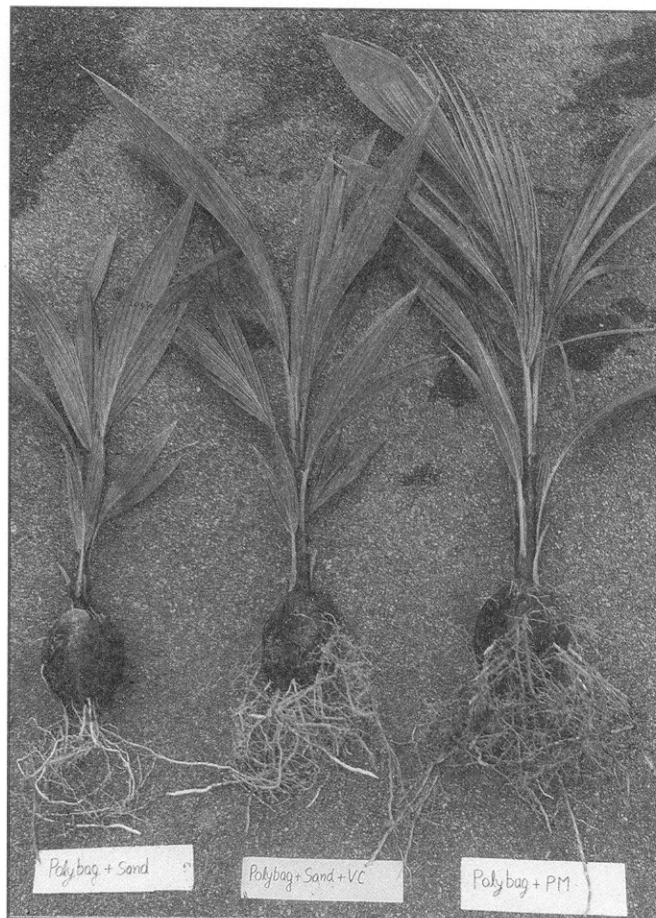
sand+NPK, T3-sand+NPK+Biofertilizer (BF), T4-sand+PK+BF, T5-potting mixture (PM) in 1:1:1 proportion of red earth:sand:cow dung, T6-sand+vermicompost (VC) in 3:1 proportion. The seed nuts used in the study were collected during April-May from the selected WCT coconut mother palms. The seed nuts were laid in a conventional pre-nursery bed very closely during the second fortnight of June after storing under shade for a month for subsequent transplanting in polybags. Good sprouted nuts with uniform height were collected at 5th month from the pre-nursery bed and transplanted in the polybags (60 x 45 cm size; 500 gauge black polythene) which were filled up to two-third with different media as per treatments. The lower half of each bag was provided with 10-12 holes to allow excess water to drain off. The sprouted nut was placed vertically in the centre of the two-third filled bag and the sides filled with media and compacted around the nut. Forty seedlings/treatment were arranged in four rows with spacing of 60 x 40 cm in a Completely Randomized Design (CRD). Polybags were irrigated once in four days uniformly during rainless months. The chemical fertilizers and biofertilizers were added to the polybags after one month of planting in polybags as per treatments. The fertilizer dose was 15 g each of N, P and K per seedling in the form of urea, Rajphos and muriate of potash respectively. Biofertilizer was prepared using an efficient strain of *Azospirillum brasiliense* isolated from coconut palm roots. The carrier used was sterilized lignite and the biofertilizer contained 10^8 bacterial cell population/g at the time of application.

Observations on growth parameters such as seedling height, number of leaves/seedling, girth at collar at 6th, 9th and 12th months, above ground drymatter

(DM), leaf area (LA), number and dry weight of roots/seedling were recorded at 12th month. The leaf samples were collected from the 3rd leaf at 12th month, oven dried and ground. The powdered fraction (0.5 mm) of leaf sample was digested in diacid ($\text{HNO}_3 : \text{HClO}_4$ (3:1)) and analysed for phosphorus and potassium content (Jackson, 1973). Nitrogen content in plant sample was estimated according to modified Kjeldahl procedure as described by Jackson (1973) using Tecator Kjeltec Auto Analyser. Leaf area was estimated by recording the number of leaves (N) and product of length and width of 3rd leaf (X) by following equation: $\text{Log}(Y) = 0.819 - 0.041 \text{Log}(N) + 0.915 \text{Log}(X)$ (Satheesan *et al.*, 1983). The physiological parameters such as stomatal conductance, net photosynthetic rate and transpiration rate were estimated by using a portable infra red gas analyser (ADC-LCA4-UK) and instantaneous and intrinsic WUE were calculated. The photosystem II efficiency was estimated by using chlorophyll fluorescence meter (Morgon-USA). All these physiological parameters were estimated on 10 seedlings/treatment, and the data statistically analysed (Gomez and Gomez, 1984).

Seedling Vigour

Morphological Growth : Seedling growth in terms of height, number of leaves and girth at collar at 6th, 9th and 12th months after sowing varied significantly among treatments. Seedling height and number of leaves were significantly higher in potting mixture (PM) and sand+NPK and sand+PK+BF treatments at 6th month, and sand+PK (15g each/seedling)+biofertilizer (BF) treatment was on par with PM and sand+VC treatments for most of the morphological growth parameters. The poor performance of sand+NPK+BF treatment on growth parameters could be due to inhibitory effect of nitrogen compounds on nitrogen fixation by *Azospirillum sp.*



Growth and vigour of coconut seedlings grown in polybags with different media

(Gallori and Bazzicalupo, 1985). The results indicated that seedlings grown in sand+VC and sand+PK+BF treatments were similar to those grown in popular potting mixture media in terms of morphological growth parameters such as girth, height and number of leaves/seedling.

Table 3. Leaf nutrient contents and physiological parameters in coconut seedlings grown in polybags as influenced by different media and fertilizers at 12th month

Treatments	Leaf nutrient content (%)			Physiological parameters					
	N	P	K	Pn (μ mol/m ² /sec)	gs (mol/m ² sec)	Transpiration rate (m mol/m ² /sec)	WUE (Pn/E) (μ mol/m mol)	WUE (Pn/gS) (μ mol/mol)	Fv/Fm
Sand	1.20	0.13	1.80	6.255	0.025	1.406	4.52	259.7	0.756
Sand+NPK	1.41	0.13	2.00	6.481	0.022	1.344	4.96	293.5	0.759
Sand+NPK+BF	1.37	0.13	1.93	7.748	0.025	1.962	3.97	322.4	0.786
Sand+PK+BF	1.27	0.13	2.54	7.134	0.025	1.460	4.94	297.2	0.805
Potting mixture	1.49	0.15	1.88	7.033	0.026	1.520	4.66	277.1	0.772
Sand+VC (1:1)	1.34	0.15	1.58	7.677	0.025	1.189	6.48	314.2	0.789
CD (0.05)	0.10	NS	0.42	0.937	NS	0.261	0.622	NS	0.017

PM - potting mixture; BF - biofertilizer; VC - vermicompost; Pn-net photosynthetic rate; gs-stomatal conductance Pn/E WUE-instantaneous water use efficiency; Pn/gS WUE- intrinsic water use efficiency; Fv/Fm- photosystem II efficiency : NPK applied @ 15 g each/seedling

Table 1. Growth of coconut seedlings in polybags as influenced by different media and fertilizers

Treatments	6th month			9th month		
	Girth (cm)	Height (cm)	No. of leaves	Girth (cm)	Height (cm)	No. of leaves
Sand	7.4	47.3	1.5	10.3	104.3	4.5
Sand+NPK	7.2	55.0	1.7	9.1	93.1	4.1
Sand+NPK+BF	7.6	57.0	1.8	9.1	93.6	4.0
Sand+PK+BF	7.4	52.2	1.7	11.3	112.2	4.7
Potting mixture	7.9	64.0	2.4	11.5	133.7	5.3
Sand+VC(1:1)	7.9	70.2	2.2	11.8	134.9	5.1
CD (0.05)	0.37	6.30	0.38	0.50	9.14	0.22

PM - potting mixture; BF - biofertilizer; VC - vermicompost
NPK applied @ 15 g each/seedling

Root mass : Number of roots/seedling was significantly higher in sand+VC (16.0), sand+PK+BF (15.8), PM (14.5) and sand+NPK+BF (13.5) treatments compared to sand (8.0) and sand+NPK (8.5). The dry weight of roots was significantly higher in sand+VC (36.52 g), followed by sand+PK+BF (32.5 g), compared to sand (14.2 g), and sand+NPK (13.6 g). The root dry matter in potting mixture treatment (25.0 g) was on par with sand+PK+BF (32.5 g) and sand+NPK+BF (22.1 g) treatments. Treatment with sand+VC, sand+PK+BF and PM resulted in increased root growth, especially feeder roots to absorb moisture and nutrients. *Azospirillum* strains from coconut roots have been shown to produce plant growth promoting substances such as IAA (Tien *et al.*, 1979) and the observed response maybe due to these hormones.

Table 2. Growth and dry matter accumulation in coconut seedlings grown in polybags as influenced by different media and fertilizers at 12th month

Treatments	Girth (cm)	Height (cm)	No. of leaves	No. of roots	Root dry wt. (g/seedling)	Leaf Area/ seedling (cm ²)	Drymatter (g/seedling)
Sand	12.0	120.3	5.1	8.0	14.2	3066.5	71.4
Sand+NPK	11.0	111.9	4.6	8.5	13.6	2951.5	108.6
Sand+NPK+BF	11.1	113.0	4.7	13.5	22.1	3088.2	130.9
Sand+PK+BF	13.6	129.1	5.3	15.8	32.5	3635.2	148.9
Potting mixture	14.1	158.2	5.6	14.5	25.0	4828.5	234.2
Sand+VC (1:1)	13.5	152.8	5.6	16.0	36.5	4263.2	155.4
CD (0.05)	0.77	13.89	0.29	5.40	10.21	606.5	21.01

PM - potting mixture; BF- biofertilizer; VC- vermicompost
NPK applied @ 15g each/seedling

Leaf area and dry matter production : Leaf area (LA) per seedling was significantly higher in PM (4828.5 cm²) and sand+VC (4263²) compared to rest of the treatments

(Table 2). The above ground dry matter production was significantly higher in PM (234.2 g/seedling) followed by sand+VC (155.4 g/seedling) and sand +PK+BF (148.9 g/seedling). Dry matter was significantly lower in sand (71.4 g/seedling) and sand+NPK (108.6 g/seedling) treatments.

Despite the fact that seed nuts contain adequate nutrients for germination and growth, it has been shown that growth and vigour of seedlings can be improved through the addition of fertilizer (Mathew and Ramadasan, 1964; Maravilla, 1989; Srinivasa Reddy *et al.*, 1998). In this study also, seedlings in potting mixture comprising of red earth : sand:cowdung in 1:1:1 proportion, sand+VC (3:1) and sand+PK+BF had better root system as indicated by higher number of roots and root dry weight. This could be due to better nutritional availability leading to higher production of photosynthetically functional leaves and high Pn rates (Table 3) in these treatments, finally resulting in higher accumulation of photosynthates in morphological growth components. Thus, these seedlings showed higher vigour in terms of seedlings height, number of leaves, girth, LA and DM/seedling. The seedlings raised in sand media had reduced seedling vigour as indicated by the growth components such as less height, girth, number of leaves, LA and DM. Peries and Everard (1991), also noticed reduced seedling vigour in terms of height, girth and number of leaves in sand media in polybags. This reduced seedling vigour could be due to moisture deficit and lack of nutrition leading to poor growth in sand media.

Physiological parameters

The net photosynthetic rate and PS-II efficiency as indicated by Fv/Fm was significantly higher in sand+NPK+BF and sand+VC treatments compared to sand alone and sand+NPK treatments (Table 3). However, gas exchange rates did not differ among the treatments. Transpiration rate was maximum in sand+NPK+BF and minimum in sand+VC treatment. Consequently, the instantaneous WUE was significantly higher in sand+VC and least in sand+NPK+BF. Interestingly, the intrinsic WUE was significantly higher in sand+NPK+BF and sand+VC treatments and was least in sand alone treatment. The results indicate that the plants treated with biofertilizers or potting mixture or vermicompost maintained higher Pn rates than sand alone or sand in combination with NPK fertilizers. The transpiration and Pn rates significantly differed among the treatments eventhough the gas exchange rate did not differ significantly indicating that nutrient and water uptake in biofertilizer and vermicompost treatments was better as also indicated by leaf N,P,K status and thus, the

photosynthates are readily used for growth and development. Higher WUE in sand+VC treatment indicated that in this treatment frequency of watering can be reduced. Lower Fv/Fm in sand and sand+NPK treatments indicate that plants are slightly stressed possibly due to less availability or lower uptake of water resulting in lower PS-II efficiency.

Leaf nutrient contents

Leaf N content was significantly higher in PM (1.49%) followed by sand+NPK (1.41%), sand+NPK+BF (1.37%) and sand+VC (1.34%) compared to sand alone (1.20%) and sand+PK+BF (1.27%). Leaf K content was lowest in sand +VC (1.58%) compared to sand+PK+BF (2.54%) and sand + NPK (2.00%). Larger root system might have further assisted in efficient moisture and nutrient absorption and hence, higher nutrient content in leaf in BF treated plants. Leaf P concentration did not vary significantly due to treatments (Table 3). However, seedlings grown in PM and sand+VC recorded higher leaf P (0.15%) compared to rest (0.13%) of the treatments.

Conclusions

The study indicated that sand+VC mixture and sand+PK+BF treatments were similar in response to potting mixture media in terms of seedling growth, physiological parameters and the final seedling vigour. Therefore, sand+VC mixture or sand + PK + BF treatment could replace potting mixture for raising coconut seedlings in polybags. The effect of biofertilizer treatment not only helps seedling growth in polybag, possibly it may also result in better establishment of microbial population in the main field when field planted with these polybag seedlings and helps in better growth and development and field establishment of seedlings.

Acknowledgement

The authors wish to thank Dr. K.U.K. Nampoothiri, Director, and Dr. C.C. Biddappa, Head of

Crop Production Division, Central Plantation Crops Research Institute, Kasaragod for the encouragement. They also thank Miss Bindu Chandran, Research Associate (IVLP) for her help in analysing leaf samples for nutrients and Mr. A. Bhaskaran, JTA for the management of nursery.

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