Studies on Ion Exchange Capacity in Coir Pith

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Abstract

The coir extraction from coconut husks leaves a dusty, non fibrous spongy material called coir pith. This coir pith is considered as a waste or reject and its huge accumulation around coir processing centres has been creating disposal problems. This problematic waste is actually a valuable biomass if used in some specialized works. The presence of native sodium in coir pith even after washing is a matter of concern if it has to be used as a soilless medium for cultivating various ornamental or vegetable crops. Whil irrigating the coir pith with nutrient medium, sodium is slowly released. In turn, essential ions like calcium are exchanged into the coir pith making such elements unavailable to the plant. Further, ions like sodium released from coir pith cause stress to the plant roots. Hence in the present investigation, an attempt was made to remove the accumulated sodium ion from coir pith using suitable agents like calcium nitrate. This calcium nitrate impregnated coir pith was further subjected for culture trials as a soilless medium.

Keywords: Coir Pith, Problematic Waste, Accumulated Sodium

Introduction

The coir pith is generally a mixture of dust, bits and fibres of lesser length which is being released during the process of coir extraction. It is usually dumped along the roadside near the coir factory in huge mounds. It is also assessed that around 7.5 million tonnes of coir pith is being produced annually [1] in India. The accumulation of this rejected coir pith around coir fibre processing centres year by year is creating disposal problems. This coir pith poses fire hazard, space problem, health hazard and disposal problem if an appropriate solution is not found. In the present investigation, an attempt was made to revert the ion exchange characteristics of coir pith by impregnating it with suitable chemicals and to utilize it as an soilless medium for the culture of vegetable crops.

Materials and Methods

Coir pith samples were collected from Kurinjipadi, Cuddalore District, Tamil Nadu State. A known quantity of coir pith (500 ml) was taken in a series of containers which were previously washed to an EC of less than 0.5 mS/cm. These were then wetted. Calcium nitrate salt was mixed with it in various concentrations and kneaded (1.0, 2.0, 3.0, 4.0, 5.0, 7.5, 10.0. 12.0 and 17.0 g per litre of coir pith). This was allowed to stand for about 10 minutes. Then the pith was washed with distilled water till it reached an EC of less than 0.5 mS/cm. The washed pith was dried in the sun for two days. These dried samples were stored for further analysis.

Distilled water extract of the above material was taken at 1:1.5 ratio and filtered through whatman filter paper No.l. The filtrate was analysed for sodium, potassium and calcium.

Another sample of coir pith (treated with calcium nitrate and washed) was taken and extract was prepared in 1 millimolar solution of barium chloride with the ratio 1:1.5. The extract was filtered and analysed for sodium, potassium and calcium.

Making use of the above values, the following parameters were worked out.

a. The difference in the concentration (mmol/1) of potassium between the distilled water extract and barium chloride extract.

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b. The difference in the concentration (mmol/1) of sodium between distilled water and barium chloride extracts.

c. The above calcium nitrate treated coir pith was used for the culture experiment. The vegetable crop, Abelmoschus esculentus was selected for culture trials in culture rooms with temperature, humidity and light intensity maintenance. The modified all-nitrate nutrient medium was used as an irrigant.

Result

The differences in the molar concentration of sodium, potassium and calcium between the distilled water and barium chloride extracts were worked out and all the values are presented in the Table.

Table: 1 Analysis of chosen parameters and their difference between distilled water extract and barium chloride extract of coir pith

Calcium nitrate treatment /litre of coir pith	Difference between the two extracts		
	(Na) $BaCl_2$ - (Na) dist. Water (m.mol/l)	(K) $BaCl_2$ - (K) dist. Water (m.mol/l)	(Ca) BaCl2- (Ca) dist. Water
Control	0.75	0.92	0.05
1 g calcium nitrate/litre	0.57	0.89	0.13
2 g calcium nitrate/litre	0.35	0.66	0.20
3 g calcium nitrate/litre	0.28	0.51	0.28
4 g calcium nitrate/litre	0.21	0.49	0.33
5 g calcium nitrate/litre	0.20	0.43	0.35
7.5 g calcium nitrate/litre	0.10	0.25	**0.39**
10 g calcium nitrate/litre	0.02	0.21	0.66
12 g calcium nitrate/litre	0.02	0.15	0.84
17 g calcium nitrate/litre	0.02	0.16	0.92

The level of sodium, potassium and calcium in the barium chloride extract was higher than that of the distilled water extract. The levels of sodium and potassium both in the distilled water extract and in the barium chloride extract were more when the coir pith was treated with low dose of calcium nitrate (lg calcium nitrate per litre coir pith). The concentration gradient decreased when calcium nitrate quantity was increased. Naturally the calcium content in the extract increased according to the level of calcium nitrate treatment in coir pith. The differences in the levels of sodium and potassium between the two extracts became feeble when calcium nitrate treatment increased.

With the increase in the calcium nitrate treatment the level of sodium and potassium decreased due to ion exchange mechanism and the level of calcium automatically increased even though the overall EC was kept at 0.5 mS/cm. The figure clearly depicts this phenomenon.

After studying the ion-exchange behaviour in coir pith, culture trials were carried out using it as soilless medium.

Discussion

The principal problem in using coir pith as a soilless medium was the accumulation of sodium, potassium and chloride in the root environment which on high concentration could readily affect the root function as viewed by [2]. Similarly, the absorption of calcium will be adversely affected by a high concentration of sodium and chloride [3,4]. With increase in sodium concentrations in root environment, an increase in the calcium concentration may be necessary for the plant in order to maintain an adequate ion activity ratio.

One of the aims of the present study was to remove the excess of sodium and potassium from the inner matrix of the coir pith. Therefore strongly charged cation calcium was used to knock out the lesser charged cations. Thus the sodium was pushed out by the calcium. This study of cation exchange in coir pith is important from the view point of understanding and explaining the practical problems concerning the availability of nutrient cations to plant roots for a sustained crop production.

In the search for a suitable salt to eliminate the undesirable cations such as sodium and potassium as well as anion like chloride, calcium nitrate was found ideal because of various reasons. Being an insurance against nitrogen and calcium deficiencies in the coir pith, calcium nitrate also could reduce both chloride and sodium. Calcium nitrate has a high solubility (60%) when compared to that of other calcium salts. Moreover it is a deliquescent salt richly used in farming activities. Hence calcium nitrate was chosen for exchanging the non-essential ions from the coir pith.

To understand the efficiency of calcium impregnation, coir pith treated with calcium nitrate was divided into two portions. One portion was extracted with distilled water and the other portion was extracted with one molar solution of barium chloride. According to [5], the Ba^{++} exchangeable K and Na demonstrated the feasibility of using the barium chloride as extractant. [6] also used barium chloride for exchange studies in soil.

The results of the present study showed that the level of calcium increased and the levels of sodium and potassium

decreased with the increase in the calcium nitrate treatment. A saturation point was noticed beyond which, no further significant exchange of sodium and potassium took place.

Acknowledgement

The author sincerely acknowledges the authorities of St. Joseph College of Arts and Science, Cuddalore for permitting to pursue the research programme.

Reference

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