

# Performance of Ecologically Friendly Coir Grow Bags for Improving the Plant Root Architecture with Enhancement in Growth and Yield

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**Abstract**—Grow bag cultivation, a method popular among urban gardeners, is regarded as an ideal system for rooftop farming. It is not only space-efficient, but also ensures there is enough space for root growth and air circulation. One of the main benefits of growing in grow bag is their versatility and mobility. They can also be used in place of garden beds in areas with poor soil quality. This paper focuses on the sustainable agricultural and economic development by finding out alternatives to the use of ever harmful plastic grow bags. This work investigates on the idea of substituting plastic bags by coir grow bags for growing vegetables, flowers, medicinal plants, trees etc. The coir grow bag using treated coir and synthetic grow bag with minimal soil media were used for the study. In addition, the study also focuses to compare the plant growth, yield, effect of root pruning in coir grow bag and in the plastic grow bag using a diverse range of plant species. The objective was to evaluate the effect of coir grow bag on root and shoot growth. Seedlings of amaranthus, tomato, brinjal, chilli, herbs, eighty five varieties of medicinal plants, ornamental plants were transplanted. The yield and growth of amaranthus in control plastic grow bag and in coir bag were well studied. The experiment were conducted for vegetative growth, yield and root growth. The coir grow bag variant exhibited noticeable impact on visual plant condition. The yield and height of the plant was found to be high in coir grow bag compared to synthetic grow bag. The trial studies proved that the plant grown in these coir grow bags is superior to those of a conventional plastic control grow bag.

**Keywords**—Grow bag; coir; root pruning; plastic; sustainable

## I. INTRODUCTION

Sustainable development is one of the most important issues in the world today. The primary objective of sustainable development is to raise living standards without using more natural resources than the environment can sustainably provide. It is necessary to implement several eco-efficiency principles, such as lowering energy and material consumption, reducing service intensity and hazardous dispersion, recycling materials, and enhancing product durability. Consequently, there has been a proliferation of new products in all sectors fashioned to these ideals.

Grow bags are a convenient option for terrace farming because the land for cultivation is shrinking drastically especially in urban areas. Grow bag farming on a terrace garden helps to produce healthy food in limited space. After being used to cultivate vegetables and produce seedlings, plastic grow bags generate tons of garbage. The conventionally used polyethylene bags, which are difficult to recycle due to the substantial amount of organic material linked to the bags, are thrown out in the soil or burned after transplant. Fully biodegradable bags that are safe for soil are the finest options for plastic grow bags. Moreover, they might be manure for the soil after decomposition.

Any suggested replacements to plastic bags must either have less negative environmental effects than the current ones or, ideally, none at all. Otherwise there would be no benefit for the people and agricultural development. This study focuses on finding out how plastic bags could be substituted by coir grow bags and how it would contribute to the sustainable development. This is environmentally benign and has no negative effects on agriculture or the environment. Work also focuses on to determine the advantages of coir grow bag for growing plants comparing with other types of pots and bags. The fundamental physiological processes involved in growing any crop are not changed when plants are grown in containers, and neither are the genetics of the plants. However, there are some conditions that are specific to the container production system when compared to other plant production systems, Whitcomb, (2003).



FIG.1 Coir Grow Bags

Coir grow bags are perfect for urban, rooftop, balcony, and patio gardeners. Coir has excellent water holding capacity that also encourages proper drainage and aeration. Coir has a stronger tearing strength than other natural fibers, even when wet. It is biodegradable, porous, hygroscopic, and dampness-resistant. Coir fiber is natural and capable to withstand compression. Cross stitched coir is offered in a range of thickness and tensile strengths to meet the technical requirements cited by engineers around the world. Further benefits are less damage from solar radiation to the soil, preservation of constant soil temperature, and an increase in soil moisture. As a result, it creates the conditions for vegetation to develop. Coir fibre prevents nutrients from leaching away and also helps in the diffusion of water and air. The texture of the coir grow bags thus allows the water and air to penetrate quickly. Due to this, the roots can breathe, and there is no concussion of roots. Since these coir bags are porous in nature helps extra water drains away, preventing overwatering and water stagnation. The coir grow bags enable root aeration, taking much of the heat away from the roots. An improved yield can also be attained with well-developed roots.

Plants can develop ring-shaped roots when grown in a plastic grow bag-like container. These roots, known as girdled roots, are brought on by the solid plastic coating, which restricts airflow and inhibits root growth. The physiological development capacity of a root system is arguably more significant than the physical structure. Some major physical abnormalities like girdling roots, circling roots and misdirected roots are common in container production and should be discouraged (Altland, 2007). Plants that are root-bound experience slowing growth rates as a result of root entanglement, congestion, and a reduction in oxygen and space for additional root growth (Whitcomb, 2003). Air root pruning is the technique wherein root tip exposure to air movement desiccates and kills the root tip in a suitable container. As roots are pruned, the region behind the root tip is stimulated to generate branches, resulting in the formation of several more secondary roots. The development of more secondary roots boosts nutrient uptake, allowing the plant to grow more quickly. The air-pruning in two planting systems—coir grow bags and synthetic plastic grow bags—is also evaluated in this study.

National Coir Research and Management Institute (NCRMI) has designed and fabricated 100% natural and biodegradable grow bags made of treated coir. These coir grow bags are different from plastic grow bags in that they are compostable and comprised of plant-derived materials. In essence, coir grow bags are made to break down over time in soil or in a composting environment. The integrity and longevity of coir grow bags are impacted by the specific conditions. The performance of a coir grow bag and a plastic grow bag control are examined in this study. Beyond measures of coir bag performance, the study also investigates impacts on plant shoot, root growth, quality and algal growth assessment.

## II. MATERIALS AND METHODS

### A. Specification of Coir Grow Bags

Raw materials : Treated coir  
Height and diameter : 30cmx27 cm

Filling volume : 15 litre

The fact that coir bags are composed of plant-derived materials and compostable sets them apart from plastic grow bags. If a plant produced in a sustainable environment with less inputs resembles its conventionally grown counterpart, it has succeeded. Beyond size, other elements that affect grow bag design include grow bag shape, material, and the presence or lack of drainage holes. NCRMI has designed and developed eco-friendly grow bags made of treated coir and are flexible, lightweight, durable, easy to store.



FIG.2 Plants in coir Grow Bags

Coir grow bags are well aerated and have superior drainage over traditional plastic grow bags. Coir bags can be used to grow various vegetables and even plants such as small to medium-sized trees. In interior decoration repositioning of coir grow bags with respect to change in light conditions is possible with less effort. Coir Grow bags can be used to create the illusion of a raised flower bed by placing a series of bags side by side and can be shaped and re-shaped as needed.

## III. RESULT AND DISCUSSION

### A. Location of Experiment

The trial studies were conducted at NCRMI campus, Thiruvananthapuram.



FIG.3 Medicinal plants growing in Coir Grow Bag



Comparative trial studies were conducted using plastic grow bags and coir grow bags for the growth of selected vegetables including amaranthus, chilli, brinjal, cauliflower, cabbage, herbs, medicinal plants, ornamental plants respectively. All grow bags were filled with a designed potting mix with minimal soil. Plants were grown under ambient light conditions. Irrigation was supplied by hand on an as-needed basis at the experiment (i.e., plant) and treatment level (i.e., grow bag type). Watering demand was assessed by sight. Measurements for this experiment were categorized broadly as plant- focused measurements and grow bags focused measurements. The former included measures of shoot length, diameter of the stem, dry mass, and a visual ranking of plant quality. All measures were conducted at harvest or, in the case of flowering, as it occurred. Grow bag focused measurements included post-harvest grow bag degradation and post-harvest grow bag fungal/algae growth.

TABLE. I

Duration (days)	Height (cm)		Yield in (g)	
	<i>Coir Grow Bag</i>	<i>Synthetic grow Bag</i>	<i>Coir Grow Bag</i>	<i>Synthetic grow Bag</i>
35	84	43	130	56

As noted in Table I performance of grow bag and synthetic bag were compared for growing amaranthus for a minimum period of 35 days .The plant grown in coir bag showed significant growth and yield .The height of the plant grown in coir bag was of 84 cm and in synthetic grow bag was of 43 cm.The yield was also found to be high in coir grow bag ie of 130 g and in the synthetic grow bag it is of only 56 g. The coir grow bag type did noticeably impact visual plant condition. In ornamental plant varieties flowering, size and overall quality were considered. Flowering significantly improved in the coir grow bag compared to the plant grown in synthetic grow bag. Herbs and medicinal plants growth were also visibly much better in coir grow bag.



FIG.4 Shoot height of amaranthus in coir grow bags

Coir bags encourage healthy root system .This coir grow bags are designed with pores that exposes the potting mix to air thus encourages new roots to sprout and promotes branched root system, thus prevents roots from spiraling. Coir grow bag with aerated wall effectively prune roots at the walls preventing the lateral roots from turning downward. This results in a root system with many short, branched roots. Short lateral branching roots promotes seedling stability and

increased survival and growth. A fibrous root system results in a larger root tip surface area, which increases the efficiency with which water and nutrients are absorbed; this increases growth rate, establishment, and vigour; transplant survivorship; and, eventually, results in better performance. Coir bags allows air exchange around the surface area of the entire bag, not just the surface in case of plastic grow bags. The air feeds the plants and the microbial life. The fungicide treatments against root rot was not necessary in coir grow bags. The plants have in general more root mass and significantly well branched main roots. Study concluded that excellent rooting with continuous formation of white active roots in amaranthus harvested from coir grow bag than the traditional plastic bags.



FIG.5 Root structure of amaranthus in plastic grow bag



FIG.6 Root structure of amaranthus in coir grow bag

Grow bags made of coir can help facilitate plant growth and strengthen the plants roots. The substantial difference between the root architecture can be visually identify from the Fig.5 and Fig.6. In general, grow bags offer superior functionality over traditional plastic and clay pots. With their porous exterior surface, grow bags have superior ventilation, temperature control, and water drainage abilities. Plants grown in coir growbag found to be having more lateral roots as well as significantly larger stem diameters than plants grown in plastic grow bags. While comparing the growth of amaranthus in height and also in yield, plants grown in coir grow bag appears to be greater compared to the plastic grow bag. The plant growth pattern of other plant varieties such as herbs and medicinal plants showed better growth.

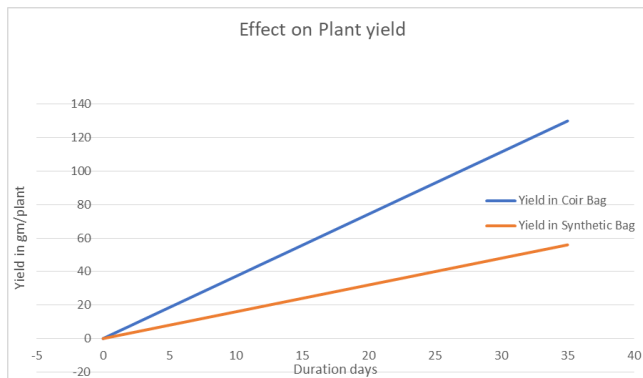


FIG.7 Stem diameter of amaranthus in plastic grow bag



FIG.8 Stem diameter of amaranthus in coir grow bag

## B. Performance of Coir Grow Bag vs Synthetic grow bag



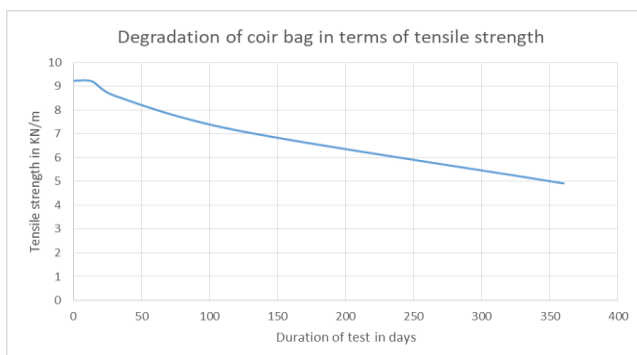
GRAPH.I

The coir grow bag was characterized for the water holding capacity and was found to be 2.12 and its water absorption capacity was found to be of 112%. This test was conducted as per the IS 15868 (part 4). The work also assess the decomposition of the coir grow bag in soil, Table II. The structural integrity of coir grow bag was not compromised even after one and half year. These bags are designed to degrade in soil after 2-4 cycles. Considering the durability the actual life span of coir bags varies greatly depending up on the sun exposure, type of crop, relocation, product quality etc. The rate of degradation is slow enough to meet the needs of growers. In coir grow bags plants are stronger with faster shoot formation and higher yield.

## C. Degradation Study Chart on laterite soil

Sl. No.	Duration of Experiment (Days)	Tensile Strength (KN/3)	Percentage of degradation after 360 Days
1	0	9.23	46.6%
2	14	9.20	
3	30	8.61	
4	120	7.15	
5	360	4.92	

TABLE II



GRAPH. II

## IV. CONCLUSION

The coir grow bag is truly a sustainable product which is environmental feasible, economically sound, and socially acceptable. Future studies will inevitably cover problems such as the impact of irrigation method, mechanization, spacing, and grow bag degradation, etc. Plants could conceivably be grown in a coir bag and inserted into a decorative container for sale, if market demand exists for a sustainably produced product in certain market. Clearly there is still much to learn about the impact of coir grow bag on plant growth, as well as the economic and environmental consequences along with energy costs associated with these new products. It is obvious that the public will become more conscious of the impact on the environment so the pressure to reduce the use of plastics. Studies are going on to extend the lifespan of coir grow bag using various natural or synthetic adhesives, resins, waxes and binding agents which later determine the rate of biodegradability or composability of the grow bags. At some point, the purchase of coir bag becomes a symbol of one's commitment to sustainability. The potential of using innovative, sustainable, biodegradable, and 100% natural coir grow bags made of treated coir developed by NCRMI take a step closer to a greener and well-balanced ecosystem.

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