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Lignocellulosic Wastes as A Potential Resource for the Production of Sustainable Plant Nursery Polybags

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Abstract: In India, lignocellulosic wastes generated from wood-based industries on a large scale are still not utilized effectively. Beyond the conventional disposal strategies, there exists great scope for the utilization of these waste materials as a way to sustainability and economic well-being of the country. The developmental urge that occurred in the agricultural sector resulted in a series of environmental and plant growth impacts. The introduction and use of plastic plant polybag is such a faulty strategy that introduced to the agriculture sector. The environmental impacts from the use of plastic plant polybag have created a renewed interest in this field which mainly focused on sustainable agriculture ensuring environmental well-being and plant growth. This article reports the findings from our study on various easily available bio-wastes from a fibreboard unit of a large wood processing industry, which are used for developing biodegradable nursery polybags to deal with the environmental and other concerns regarding the employment of the plastic nursery polybags.
Keywords: Lignocellulosic wastes, nursery polybags, eco-friendly substitutes, biodegradability.

I. INTRODUCTION

In India, plastic nursery polybags are employed by the nurserymen for growing seedlings and other young plants in the initial stages of their cultivation practices. During 2000-01, polybags produced in forest department nurseries alone constitutes 20,914.47 lakhs and during 2001-02, it was about 19,977.48 lakhs. According to Soni et al (2013), polybags of 10,000 to 15,000 lakhs per year and 2,500 to 10,000 lakhs per year of plastic root trainers are used in Indian forest nurseries. And there are no adequate data about the plastic nursery polybag production outside the forest nurseries. As we are well aware, the agriculture sector plays an important role in the economic growth of the country, production line up maybe apart from our expectations. It is assumed that the production of plastic nursery polybags or root trainers outside the forest nurseries will be more than double the amount of plastic nursery polybags produced within Indian forest nurseries. The inner surface of plastic polybags executes as an inhibiting surface for seedling growth and root development. Plastic polybags can event spiralling of roots and improper growth of taproot which results in the lack of plant tolerance towards the stress conditions and develop chances for the pathogen attacks on the root mass. (Ouya, 2013; Jalil et al.,2013). Another plant growth related problem addressed by the plastic nursery polybags is the difficulties in the removal of plant stock from the polybags (Bilck et al., 2014). This imparts shocks to the root system of the seedlings, which affect plant development. Here the necessity of biodegradable polybags arises which degrades itself under the soil conditions and does not interfere with the plant growth. These two seeding growth allied problems created a path to the development of biodegradable nursery polybags from the industrial lignocellulosic wastes. Industrial lignocellulosic waste materials which hold a higher organic makeup tend to degrade under normal soil conditions and also to put in more organic moiety to soil (Kuokkanen et al., 2007 and Kharazipour et al, 2007). Biodegradable nursery polybags developed with industrial lignocellulosic material have a higher porosity which enables the proper aeration and root growth. Hence the possibilities towards root development without root coiling can be expected. The organic makeup of industrial lignocellulosic materials possesses a higher potential for further application and usage within the development of humankind (Thyagarajan et al, 2010). Hence, the current study was carried out to use various easily available bio-wastes for creating nursery polybags to deal with the environmental and other concerns regarding the employment of plastic nursery polybags (Nandakumar, 1996; Muriuki et al, 2013 and Sreenivasan, 2020). Utilization of the industrial lignocellulosic waste materials is a reliable sense of approach in industrial waste management and to terminate conventional issues evolved from plastic nursery polybags (Isikgor and Becer, 2015). The economic and environmental benefits of these low-cost abundant waste materials can be exploited as the simplest way to sustainability. The outstanding properties of these lignocellulosic wastes such as surface area, porous structure, and organic moiety are a good boon for this sustainable utilization (Bilal et al., 2020).

II. MATERIALS AND METHODS

The studies on developing biodegradable plant nursery polybags were carried out in the R&D laboratories of The Western India Plywoods Ltd(WIP), Baliapatam, Kannur from January to March 2020. Various industrial lignocellulosic waste materials were collected from the campus of WIP. The paper mill sludge for the experiments was also collected from the campus. PMS is one of the raw materials for making hardboard and was received from Bank Note Paper Mill India Private Limited (BNPM India), Mysore. PMS was converted to a binder solution and the polybag samples were prepared accordingly:

Sample	Raw material Combinations	Experimental ratio
S1	Sawdust + PMS binder solution	1:1, 1.5:1, 2:1
S2	Sawdust + Soft board trimming waste + PMS binder solution	1:1:1, 1:1:1.5, 1:1:2
S3	Sawdust + coconut fibre + PMS binder solution	1:1:1, 1:1:1.5, 1:1:2
S4	Bark + Shredded currency notes + PMS binder solution	1:1:1, 1:1:1.5, 1:1:2
S5	Shredded currency notes + PMS binder solution	1:1, 1:1.5, 1.5:1, 1:2
S6	Shredded currency notes + Coconut fibre + PMS binder Solution	1:1:1, 1.5:1:1, 1:1:1.5, 1:1:2

Table1: The raw material combinations and their experimental ratio

The plant growth and sturdiness study are conducted in five samples excluding the primary one using the seedlings of *Swietenia macrophylla*. Water retention is determined in four samples with better plant growth and durability, excluding the first and fifth samples. Water retention is determined by weighing each of the sample polybags in an electronic weighing machine in five sets sequentially with one hour of the time interval (table 2). To review the root growth and root coiling, seeds of *Vigna radiata* were used. Samples under the study were identical as in the case of water determination. The root growth pattern of seedlings germinated was examined, beyond the root growth same seeds were made combined with the raw materials during the sample preparation. Growth patterns of these seeds without potting mixture were also observed under an identical set of conditions in different raw material combinations.

$$G\ (\%) = (TGs / TMs) \times 100$$

Where: G (%) = germination percent of mixed seeds within sample combinations, TGs = total number of seeds germinated, and TMs = total number of mixed seeds. Using the same types of four samples as in the previous case biodegradability was examined. Biodegradability was observed under soil conditions for ten days.

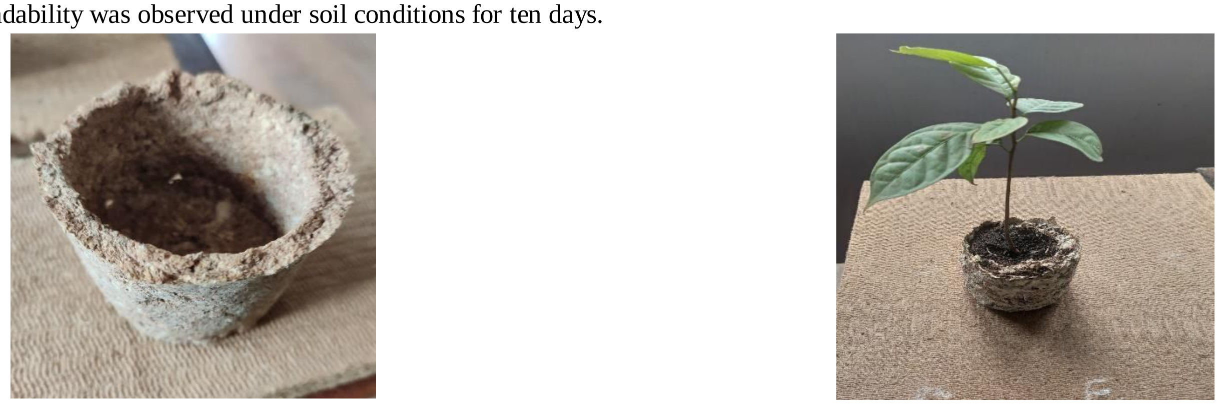

Fig 1:(a) Polybag sample and (b) Swietenia macrophylla seedling grown within the polybag sample

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Fig 2: (a)Polybag sample with Vigna radiata seedlings and (b) outward root growth observed

Fig 3(a) Grown Solanum lycopersicum (b) Solanum lycopersicum seedlings transplanted directly to the field

III. RESULT AND DISCUSSIONS

The polybag samples prepared as per the raw material combinations and ratios were given in Table 1. Out of the 6 combinations tried, the S3 exhibited a stable form enabled by the strong bonds of coconut fiber. Observation-based on the growth of the *Swietenia macrophylla* seedlings in different polybag samples discarding the S1 gave an outline about the plant growth patterns and the durability of plant polybags. During the observation period of one-month plant polybags containing these seedlings have not undergone any deformation. And when handling these samples separately the S5 combination, exhibited more flexibility and looseness compared to other plant polybags which remained the same as in the initial stages of the experiment. And for the later experiments, this polybag sample was excluded.

Time	S2 weight (gm)	S3 weight (gm)	S4 weight (gm)	S6 weight (gm)
T1	0.090	0.090	0.090	0.090
T2	0.088	0.087	0.089	0.087
T3	0.087	0.085	0.086	0.087
T4	0.087	0.083	0.085	0.085
T5	0.085	0.080	0.083	0.081

Table 2: Water retention of developed polybags

The overall water retention capacity of the four samples is promising for the production of plant polybags (table:2). The higher water retention exhibited was due to the more compact arrangement and the higher water affinity of soft board trimming waste. The least water retention was resulted from the increased porosity due to the presence of sawdust and coir and the more water releasing tendency of sawdust when compared to tree bark, soft board trimming waste, and demonetized shredded currency.

As in many earlier studies, the importance of plant containers and substrate in plant growth development (Gruda & Schnitzler, 1999; Harris et al 2019; Muro et al, 2005, Gallegos et al, 2020; Haber, 2017 and Zakaria et al, 2020) were evaluated here.

Root growth study conducted in *Vigna radiata* exhibited outward root growth (Fig 2b) beyond the container wall within one week. And this exposes reduced chances for root coiling in the biodegradable nursery polybags developed from the industrial lignocellulosic waste materials, which can be attributed to increased porosity and air permeability which enabled the desired root growth. Favorable outcomes are also observed in seeds that mixed with the raw materials during the sample preparation those got germinated (Fig 2a and Tab 3). And the growing intensity of seedlings showed the easy penetrability of the roots on raw materials used in sample preparation and the ability of these raw materials to act themselves as plant growing substrates.

Sample	(TGs)	(TMs)	G(%)
S2	*23*	*27*	*85*
S3	*23*	*23*	*82*
S4	*22*	*26*	*84*
S5	*23*	*26*	*88*
S6	*20*	*24*	*83*

Table 3: Germination percent of seeds mixed with various sample combinations

The result of the biodegradability test with a period of ten days exhibited the degradation of polybags, except for the coconut fiber. The degraded portion of polybags is also characterized by the presence of small earthworms too (Fahim et al, 2018; Sreenivasan, 2020; Thyagarajan et al 2010). The biodegradability of the polybags indicated the presence of higher organic content, which easily gets degraded at field conditions in the soil. And the scope of degraded polybags to act as a source of initial manure to seedlings is also get strengthened. After the six months of exposure in altering climate, these polybags remained the same as within the initial post-production stage without any weathering or insect-fungal attack

IV. CONCLUSION

The present work investigated the possibilities of utilizing industrial lignocellulosic waste materials as a sustainable substitute for plastic plant nursery polybags. Apart from the environmental concerns regarding the plastic plant nursery polybags the biodegradable polybags prepared during this work can address various plant-related concerns too.

A. Insights about the possibilities to develop strong plants which might tolerate environmental stresses enabled by the shortage of root coiling.
B. Possibilities towards the employment of developed combinations as suitable substrates for seed germination and plant growth.
C. Promising water retention at normal atmospheric conditions due to the greater organic moiety.

Besides, the concept of biodegradable plant nursery polybags, the possibilities for biodegradable self-manuring polybags become strengthened. The employment of the industrial lignocellulosic waste materials might be a reliable sense of approach in industrial waste management (Daian and Ozarska, 2009) and to eliminate various issues evolved from the employment of conventional plastic nursery polybags.

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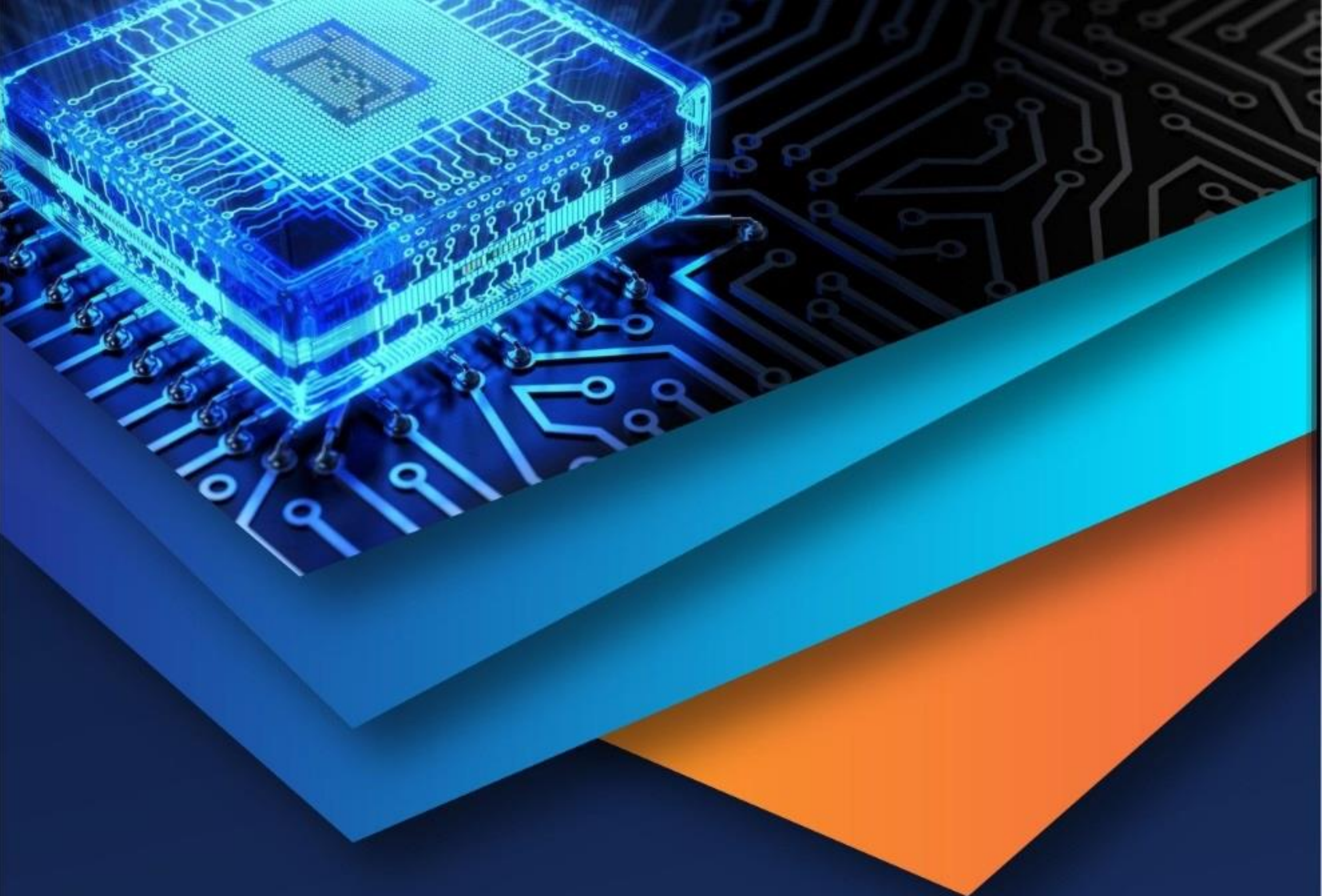

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