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Studies on the Agrowaste in Phytoremediation by Treating Textile Dye

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Abstract: ***Phytoremediation is a green technology that shows one of the ways to solve the problem of heavy metal pollution, and which shows many encouraging results. The plant used for remedy van hyper accumulate toxic heavy metals in their tissues, convert the pollutants to less toxic compounds and volatilize them [sweta et al., 2017]. In this present study, Paddy husk, corn cob shreds, coconut coir, sugarcane bagasse and wood powder were selected as an inexpensive adsorbent in the elimination of heavy metals from the textile dye. The absorption of heavy metals was estimated by AAS. The present study is focused to find the potential of various natural carriers for the treatment of textile dye. The Agro-wastes namely paddy husk, corncob shred, coconut coir, sugarcane baggase and wood powder are a natural coagulant which shows biosorption and phytoremediation activity. In this research, an attempt has been made to analyse the biosorption of heavy metals by Agrowastes namely paddy husk, corncob shred, coconut coir, sugarcane baggase and wood powder from the textile dyes. Heavy metals were estimated by atomic absorption spectrophotometer. The toxicity level of the treated dye was analysed by green gram germination with pot study bioassay and phytoremediation. Shoot length and root length of the germinated seeds were measured and seedling vigour index were calculated. The heavy metal removal efficiency of the agrowaste namely paddy husk and corn cob shred was higher there by making both the agrowastes a promising absorption for industrial textile treatment. These agro based compound could replace the chemical coagulant and is an environmentally friendly approach to textile dye treatment.***

Keywords: Agro- Waste namely paddy husk, corncob shred, coconut coir, sugarcane bagasse and wood powder, Biosorption, Phytoremediation, seed germination in green gram, Atomic Absorption Spectrophotometer, Acid Digestion

1. Introduction

Textile, paper and dyeing industries continuously release dyes into water sources. Colour in water streams causes aesthetic and real hazard to the environment. The aesthetic value considers the discoloration of recreational streams and waterways. The real hazard caused by colour in water is dye toxicity and the ability of the colouring agents to interfere with the transmission of light through water, thus hindering photosynthesis in aquatic plants. Removal techniques for dyes include coagulation, ozonation, membrane processes and adsorption [Seader J.D, *et al*., 2006].

Among these, the adsorption process gives the best results as it can be used to remove different types of colouring materials. Further, adsorption is an efficient method for the removal of tracer components from water. Activated carbon produced by carbonizing organic materials is most widely used adsorbent. However, the high cost of the activation process limits its use in wastewater treatment. Over the last few years, number of investigations has been conducted to test the low cost adsorbents for wastewater treatment.

The use of agricultural byproducts, i.e. plant waste such as rice husk, corn cob shreds, coconut coir, sugarcane bagasse and wood powder etc., are effective as absorbent for heavy metal removal from industrial wastewater. These agro-materials are mainly composed of cellulose, hemicellulose, lipids, proteins, lignin, sugar components, water and hydrocarbons, which consist of various functional groups such as carboxy, hydroxyl, sulfhydryl, amide and amine (Bhatnagar and Sukkanpaa, 2010).Removal of colour in textile effluents is achieved by numerous physical and chemical treatment techniques such a coagulation, flocculation, electro-flotation, membrane filtration, precipitation, ion-exchange, ozonation, electrolysis and adsorption (Bhatia, 2003). Adsorption is a proven technology for wastewater treatment and over the last few years number of investigations has been conducted to test the waste materials for removal of pollutants from water. Coir pith (Santhy and Selvapathy, 2006, Namasivayan, and Kavitha, 2002).

Rice husk, corn cob shreds, coconut coir, sugarcane bagasse and wood powder used as a sorbent in removing heavy Metals has been intensively studied and reported. Among the metal ions studied are: Au, Cd, Co, Cr (III), Cr(VI), Cu, Hg, Ni, Pb and Zn. The maximum absorption capacity for each metal McKay [19, 59] and his co-workers [G. McKay, *et.al.*, 1987] first reported their works on colour removal using rice Husk and other low-cost sorbents. Many subsequent works studied basic dyes. McKay[G. McKay, 1987].

2. Materials and Methods

1) Collection of taxtile dye:

Type of dye: Reactive dye, Place of collection: Villivakkam, Chennai, Nature of factory : Textile dyeing.

2) Mode of collection:

The textile dye was collected from Gautham dye and chemical Pvt.Ltd located at villivakkam, chennai. The sample was collected in a clean 10L plastic can and maintained at room temperature.

The textile dye collected from outlet pipes of textile factories, at the textile dye collecting point after primary treatment. The samples were collected two times during the study period.

3) Collection of agrowaste:
Paddy husk and corn cob shreds were collected from a local rice mill and a local shop in Arakkonam, Ranipet-001. It was photographed and given in (fig 1).

4) Preparation of agrowaste:
Paddy husk was washed with running tap water and sun dried for 4hours. The dried biomass of paddy husk was taken, and these dried biomasses were introduced into textile dye for further treatment. Corn cob shreds were washed with running tap water and sun dried for 4hours. The corn cob was cut into 2cm pieces in breath. These pieces are dried biomass were introduced into textile dye for further treatment.

Design of the Experiment:
The Agrowaste treatment was followed by different concentrations (25%, 50%, 75% & 100%).

1) Paddy husk: treatments in different concentrations
Control- Textile dye 100% + 5g paddy husk.
Running tap water + 5g paddy husk
Textile dye 25% + 5g paddy husk, Textile dye 50% + 5g paddy husk, Textile dye 75% + 5g paddy husk, Textile dye 100% + 5g paddy husk.

2) Corn cob shreds: treatments in different concentrations
Control- Textile dye 100% + corn cob shreds
Running tap water + 5g Corn cob shreds
Textile dye 25% + 5g Corn cob shreds, Textile dye 50% + 5g Corn cob shreds, Textile dye 75% + 5g Corn cob shreds, Textile dye 100% + 5g Corn cob shreds.

3) Coconut coir: treatments in different concentrations:
Control -Textile dye 100% + 5g coconut coir
Running tap water + 5g Coconut coir
Textile dye 25% + 5g Coconut coir, Textile dye 50% + 5g Coconut coir, Textile dye 75% + 5g Coconut coir, Textile dye 100% + 5g Coconut coir.

4) Sugarcane bagasse: treatments in different concentrations:
Control -Textile dye 100% + 5g sugarcane bagasse
Running tap water + 5g Sugarcane bagasse
Textile dye 25% + 5g Sugarcane bagasse, Textile dye 50% + 5g Sugarcane bagasse , Textile dye 75% + 5g Sugarcane bagasse , Textile dye 100% + 5g Sugarcane bagasse.

5) Wood powder: treatments in different concentrations:
Control - Textile dye 100% + 5g wood powder
Running tap water + 5g Wood powder
Textile dye 25% + 5g Wood powder , Textile dye 50% + 5g Wood powder , Textile dye 75% + 5g Wood powder , Textile dye 100% + 5g Wood powder

Treatment of textile dye using agro-waste:
The 5g of agrowaste and textile dye were soaked into the beaker at room temperature. The 5g of agrowastes namely Paddy husk, corn cob shreds, sugarcane bagasse, coconut coir and wood powder were treated in textile dye with different concentrations of 25%, 50%, 75% and 100% and kept in a room temperature. The experiment was studied for 15 days. After 15 days the agro-wastes such as Paddy husk, Corn cob shreds, coconut coir, sugarcane bagasse and wood powder were filtered with the help of using muslin cloth and stored in room temperature for further studies.

UV-Visible Spectrophotometer Scanning:
The treated dye and treated biomass were filtered by whatmann filter paper No 1 and stored in clean, dry glass bottles. The spectral scan of treated dye was taken in Uv-visible spectrophotometer ranging from 350nm - 700nm range.

Heavy Metal Analysis:
The treated dye and treated biomass were separated by filtration method. The treated dye was acid digested by hot plate method (Ponnusamy *et al*., 2014).

The heavy metal analysis was done in Siddha Central Research Institute, Chennai, Ministry of Ayush. Government of India. Tamil Nadu, Chennai.

Heavy metals namely Cd, Ni, Zn and Cu were estimated by using Atomic Adsorption Spectrophotometer. Both the treated dye and treated plant samples were acid digested and analyzed in AAS for metal ion concentration.

Selection of the seeds: Plant growth generally depends on the quality of seeds. Seed selection can improve the better production of crops by selecting efficient seeds. There are various diseases in plants that can be transmitted through seeds, therefore obtaining seeds from healthy plants is essential for agriculture. Sowing is the process of scattering selected seeds into the initially prepared soil.The following features of seeds are necessary during the selection of seeds for sowing:

Seeds should be free from infection.They should have a high germinating capability.A particular seed should not be mixed with other seeds or weeds.They should give desired crop production.Broken or crushed seeds should be avoided.They should be disease resistant.They should have the ability to tolerate adverse conditions.

Seed germination bioassay of the phytoremediated textile dye using agrowastes:
Eleven sterile Petri plates were lined with filter papers and muslin cloth. To each Petri plate 10 nos. of seeds were introduced and 2mL of the sample was poured. The germination of seeds was observed for 5 d. On the fifth day, the root length and shoot length were measured. Germination percentage and seedling vigour index was calculated.

Design of the experiment for pot study:
After the seed germination, the germinated seeds were sowed into the pot for further study. The number of the pots were taken in 11. The height and diameter of the plastic pot is 8.7cm and 28cm was used in the present study. The germinated seeds were sowed in to each pots with different concentration of textile dye 25%, 50%, 75% & 100% respectively. Textile dye with corn cob shreds, paddy husk, coconut coir, sugarcane bagasse and wood powder. textile

dye and water is taken as control. The treated textile dye was sprayed with the help of 2mm of high spore size nozzle.The morphological changes were observed day by day and photographed. After the treatment the plants were harvested and weighed. The harvested plants were washed with running tap water and after excess water was drained off and the wet weight was determined. The plants were dried in oven for 24h at 7℃ and weighed.

Acid digestion of dried plant material:
After harvesting the plants, the plant samples were dried and powdered separately using Teflon microwave unit. Take about 20-50mg of sample into the Teflon microwave digestion vessel and add 1ml of ultrapure nitric acid/hydrogen peroxide to digest about 45minutes using Anton Paar microwave digestion unit. After the sample is made up to a 50ml standard measuring flask. The calibration standard solution is prepared from 0.25micro gram/milligram to 1.25 microgram/milligram by using ultra-pure nitric acid and blank also. Agilent ICP_OES 5100 VDV instrument used with the following operation conditions: RF power 1.2 kW. A plasma gas flow rate 12L min 1, and a nebulizer and spray chamber for the analysis.

3. Results and Discussion

The spectral scan of Agrowaste namely Paddy husk, Corn cob shreds, Coconut coir, Sugarcane bagasse and Wood powder compared with untreated textile dye. It was observed and marked the line and graph showing the peak in 230nm & 360nm range of treated and untreated dye (Table 1&fig 1). The spectral scan clearly showed that the pollutants of raw textile dye when compared with Agrowaste namely paddy husk, corn cob shreds, coconut coir, sugarcane bagasse and wood powder. Sayogo *et al*., (2019) reported that the phytoremediation of textile dye using agrowaste namely paddy husk, corn con shreds, coconut coir, sugarcane bagasse and wood powder removed more than 90% of chromium from waste water under laboratory conditions Swetapatel (2017).

The heavy metal (AAS -Analysis) biosorption Cu and Zn ions was maximum observed in paddy husk which was 988.29ppm and 652.37ppm iron and compared with corn cob shreds, sugarcane bagasse, coconut coir and wood powder by AAS analysis. The biosorption efficiency of metals in paddy husk was maximum in Ni as 827.72ppm whereas other metals biosorbed was below detectable (Cadmium and Nickel) limit of paddy husk. Whereas the other treatment of corncob shred, sugarcane bagasse, Coconut coir and wood powder was moderate level of Cadmium ions, Copper ions, Nickel ions and Zinc ions. It was given on table 2 & graph 123. Overall analysis, the adsorption of metal ions and remaining metals were observed in various ranges. The paddy husk shoes maximum biosorption efficiency of the metal ions present in the textile dye when compared with other biomass used for treatment.

The seed germination bioassay was done to assess the toxicity of textile dye using *Vigna radiata* seeds. After 5d of germination, the shoot length and root length of the germinated seeds were measured and germination percentage and seedling vigour index was calculated and tabulated. The textile dye treated with Agro waste namely paddy husk, corn cob shred, coconut coir, sugarcane bagasse and wood powder biomass shows comparatively high, 100% germination percentage and seedling vigour index was 8.3, 4.1, 5.75, 10.3cm it is comparatively higher than untreated textile dye. The untreated dye shows Nill growth and seedling vigour index it was observed and tabulated. The highest seed germination, root length and shoot length was observed in 25% concentration of paddy husk which was 4.8cm& 5.45cm inother concentration was observed in moderate level when compared to untreated textile dye. It was given table 3, 4, 5, 6 & 7. The germination percentage is less in textile dye due to higher concentration of heavy metals. Metal stress and total dissolved solids which might have suppressed the germination of *Vigna radiata* seeds.Overall results of seed germination bioassay show that the bioremediation by the agro-waste was efficient. Whereas the untreated textile dye shows NIL grown in seed germination. It was observed, Photographed (Fig 2).

The pots were observed for 15d, Morphological changes were observed and noted. All the plants were able to survive in treated textile dyes of different concentration of 25%, 50%, 75% & 100%.The highest plant growth were observed in 25% concentration of Paddy husk (22.8cm) and second highest plant growth were observed in 25% concentration of corn cob shred which was 22.3cm.Whereas the untreated textile dye shows Nil growth of the plant (Fig.3) . In all the treated plant 25%, 50%, &75% Shows 2 number of leaves. It was observed, Photographed and tabulated (Table 8&9)**.**Similar results were observed in Andleeb *et al.*, (2010) found that textile dye caused a reduction in growth of sunflower along with the other parameters like chlorophyll content, protein, carbohydrate content and so forth. Similar observation was reported by Manu *et al.*, (2012) using treated and untreated dairy dye on the germination of maize seeds.

In the presence of untreated dye, it was in larger quantities which may due to the stressed condition of the textile dye. Germination percentage was more in treated dye of agrowaste in the *vigna radiata* seeds when compared to untreated textile dye. The germination percentage was higher in treated textile dye then the untreated textile dye which shows that they could tolerate the textile dye after bioremediation. (Suresh and Ravishankar 2004). Thus, plants serve as a good tool for phytoremediation (Ramesh*et al.*, 2010).

In the present research work, harvested plants and treated dyes were examined separately for heavy metal concentration by AAS after acid digestion. The overall heavy metal accumulation factor in the Agrowaste was in the sequence of Cd, Zn, Cu and Ni. Some metals eg., Zn, Cd, Cr are essential for living organisms (Xu *et al*., 2011). Phytoremediation takes advantage of the unique and selective uptake capabilities of plant root system together with the translocation and contaminant storage or degradation ability of the entire plant. Pot study can be effectively used to reduce pollutant level in water bodies

Heavy metal analyses of all the five rooted plants such as Paddy husk, corn con shreds, coconut coir, sugarcane bagasse and wood powder were estimated after 15d of treatment. All the plants were uprooted washed thoroughly and dried in oven and made into fine powder separately for root and shoot. The samples were acid digested and analysed for metal ions by AAS . The maximum and minimum concentration of Cu ion in the shoot when treated with the textile dye was found as 0.32% in paddy husk and 0.23% in corn cob shreds. Whereas the Cd uptake was below detection limit was found in all the treatments of agrowaste namely paddy husk, corn cob shreds, coconut coir, sugarcane bagasse and wood powder including the control treatment of raw textile dye in*vigna radiata*. The Zinc ion was maximum biosorbed in paddy husk as 652.37ppm and minimum in corn cob shreds measuring 526.22ppm. In Paddy husk maximum Zn ion accumulation was observed which was 652.37ppm and minimum absorption was seen in corn cob shreds measuring 526.22ppm. For Ni ion maximum uptake was noted in corn cob shreds which as 0.26% and minimum uptake was noted in paddy husk. The accumulation of Cd ions in the root of the plants treated with textile dye was below detectable for all treated and untreated dye.

The uptake of heavy metals and translocation factor of the treated plant was calculated. The accumulation factor of heavy metals in the root and shoot of *Vigna radiata* Cd ions in below detectable in all the treated and untreated plants namely Paddy husk, Corn cob shreds, Coconut coir, sugarcane bagasse and wood powder. The maximum Cu ions was observed in Paddy husk which was 0.32% and minimum Zn ions was observedin Coconut coir which was 226.18ppm, Ni ions was observed in Corn cob shred which was 0.26%. It was given on Table10, Fig 4 and graph 4.

When overall results were compared the translocation factor (Table10) for metal ions was maximum in paddy husk, Corn con shreds. The minimum translocation factor for metal ions was in coconut coir, sugarcane bagasse and wood powder.

Biosorption of toxic substances has emerged an innovative, ecofriendly, cost effective, practical feasible and probable substitute for the removal and recovery of inorganic contaminants from aqueous medium. In the quest, for ecofriendly and economical methods for environmental remediation, this study has been undertaken the indigenous agrowaste namely paddy husk, corncob shreds, coconut coir sugarcane bagasse and wood powders were used in the treatment of textile dye and the treated dye were pooled together to grow potted plants.

The research work was done in laboratory scale which could be applied in large scale. This work proves to be very good approach and solution to the tanning industries, which is one of the important revenues yielding industries of our country that produces large scale of pollutant dye.

4. Conclusion

In this present study, the utilization of agrowastes, specifically paddy husk and corn cob shreds, coconut coir, sugarcane bagasse and wood powder for treating textile dye has proven to be an ecofriendly and sustainable approach. The treated water exhibited promising results when used for plants. The study suggests that agrowaste based treatment method not only contribute to the reduction of textile dye pollutants but also offer a beneficial impact on plant health.

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Figure 1: Agrowaste Treatments

Treatment of textile dye with Paddy husk

Treatment of textile dye with corncob shred

Treatment of textile dye with coconut coir

Treatment of textile dye with sugarcane bagasse

Treatment of textile dye with wood powder

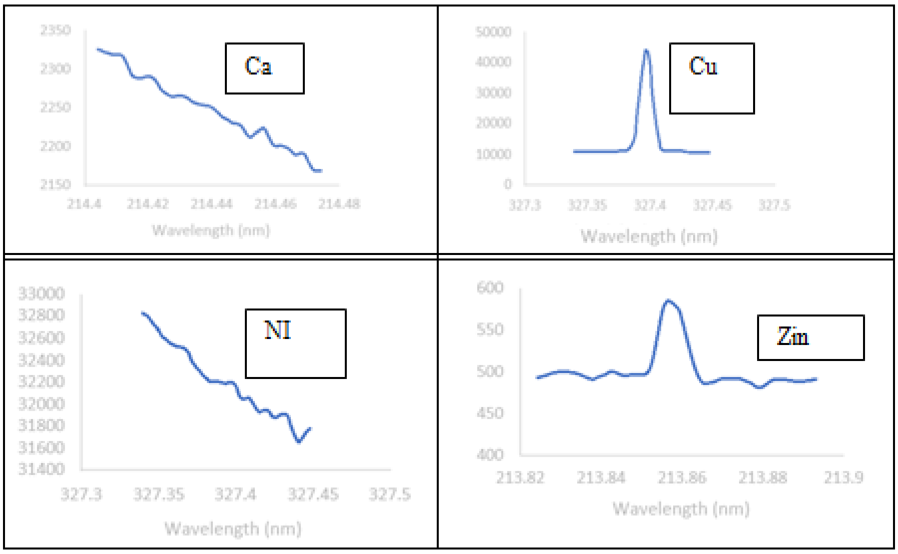
Table 1: UV-vis Spectrometry reading

S.No	Colour Variation	230NM	360NM
1.	RAW TD	6.0000A	6.0000A
2.	RAW TD + PH	6.0000A	6.0000A
3.	RAW TD + C	6.0000A	6.0000A
4.	WATER+PH	2.5421A	0.4958A
5.	WATER+C	6.0000A	6.0000A

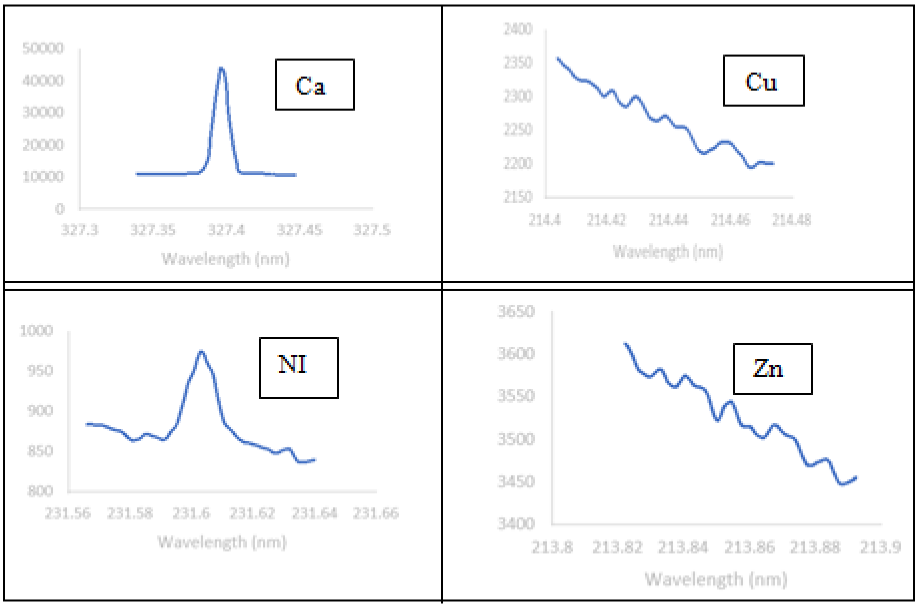
Table 3: Heavy metal analysis of treated and untreated dye

Elements	Un Treated Dye	Treated Texyile Dye				
		Paddy Husk	Corncob Shreds	Sugar Cane Bagasse	Coconut Coir	Wood Powder
Cd	BDL	BDL	BDL	BDL	BDL	BDL
Cu	827.02ppm	988.29ppm	730.39ppm	BDL	BDL	BDL
Ni	BDL	827.72ppm	BDL	BDL	BDL	BDL
Zn	289.42ppm	BDL	BDL	BDL	BDL	BDL

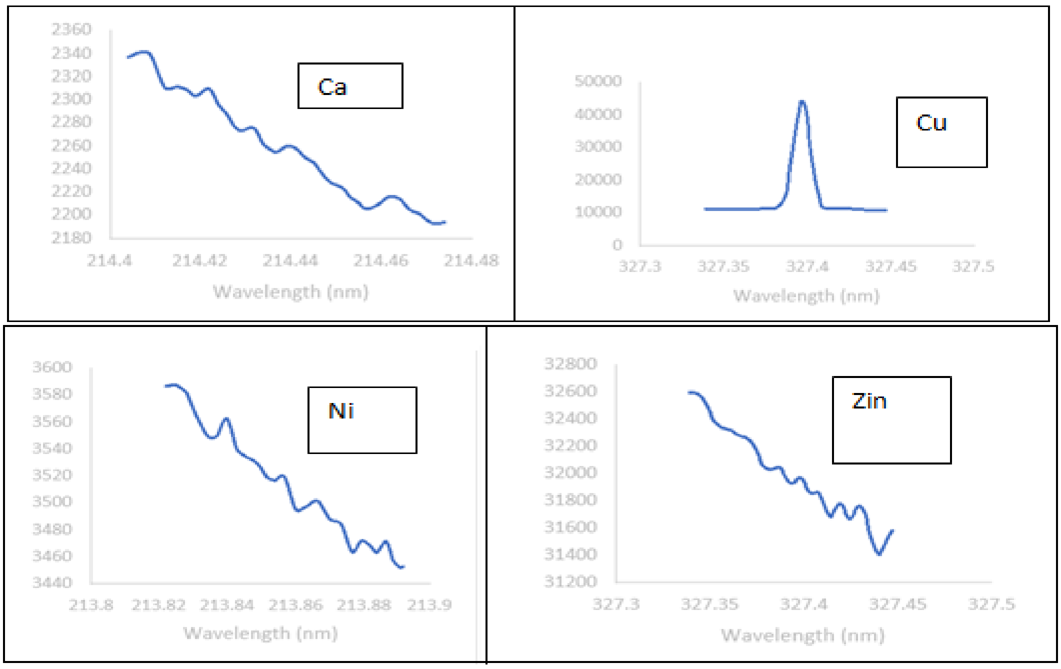
NOTE: BDL-Below detection limit. PPM- Parts per million. %- percentage.



Graph 1: Heavy metal analysis of Raw Dye



Graph 1.1: Heavy metal analysis of treated dye with Paddy husk 25%



Graph 1.3: Heavy metal analysis of treated dye with corn cob shreds 25%

Table 3: Treated dye of paddy husk in different concentrations

S. No	Treatment	No. of Seeds	No. of Seed Germinated	Germination %	Seedling Length (cm)		Seedling Vigour Index
					Root Length (cm)	Shoot Length(cm)	
1.	Control Water (Running tap water)	10	10	100%	3.4	4.9	8.3
2.	RAW TD (control)	10	Nil	Nil	Nil	Nil	Nil
3.	TD100%	10	7	70%	Nil	Nil	Nil
4.	TD 75%	10	10	100%	1.85	2.25	4.1
5.	TD50%	10	10	100%	3.05	2.7	5.75
6.	TD25%	10	10	100%	4.85	5.45	10.3

Table 4: Treated dye of corn cob shreds in different concentrations

S. No	Treatment	No. of Seeds	No. of Seed Germinated	Germination %	Seedling Length (cm)		Seedling Length (cm)
					Root Length (cm)	Root Length (cm)	
1.	Control Water (Running tap water)	10	10	100%	3.2	1.75	4.95
2.	RAW TD (control)	10	Nil	Nil	Nil	Nil	Nil
3.	TD100%	10	6	60%	Nil	Nil	Nil
4.	TD 75%	10	9	90%	2.6	2.1	4.44
5.	TD50%	10	9	90%	5.9	6.6	13.4
6.	TD25%	10	9	90%	2.6	2.2	4.54

Table 5: Treated dye of coconut coir in different concentrations

S. No	Treatment	No. of Seeds	No. of Seed Germinated	Germination %	Seedling Length (cm)		Seedling Vigour Index
					Root Length (cm)	Shoot Length(cm)	
1.	Control (Running tap water)	10	10	100%	5.5	5.85	11.35
2.	TD100%	10	6	60%	3.2	5.1	13.83
3.	TD25%	10	9	90%	2.75	3.25	6.00

Table 6: Treated dye of sugarcane bagasse in different concentrations

S. No	Treatment	No. of Seeds	No. of Seed Germinated	Germination %	Seedling Length (cm)		Seedling Vigour Index
					Root Length (cm)	Shoot Length(cm)	
1.	Control (Running tap water)	10	10	100%	6.75	7.7	14.45
2.	TD100%	10	7	70%	1.65	2.1	5.35
3.	TD25%	10	10	100%	2.94	6.15	9.09

Table 7: Treated dye of wood powder in different concentrations

S. No	Treatment	No. of Seeds	No. of Seed Germinated	Germination %	Seedling Length (cm)		Seedling Vigour Index
					Root Length (cm)	Shoot Length(cm)	
1.	Control (Running tap water)	10	10	100%	2.71	6.1	8.82
2.	TD100%	10	6	60%	1.25	2.1	5.58
3.	TD25%	10	10	100%	2.72	6.3	9.02

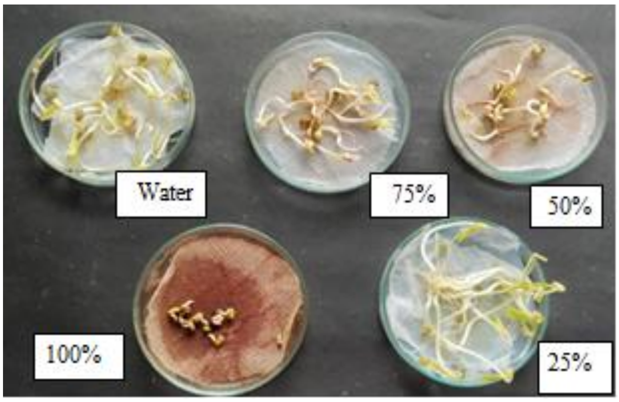


Figure 2: Seed germination in Paddy huskin different concentration (Water, 75%, 50%, 100% (control -Textile dye) & 25%)

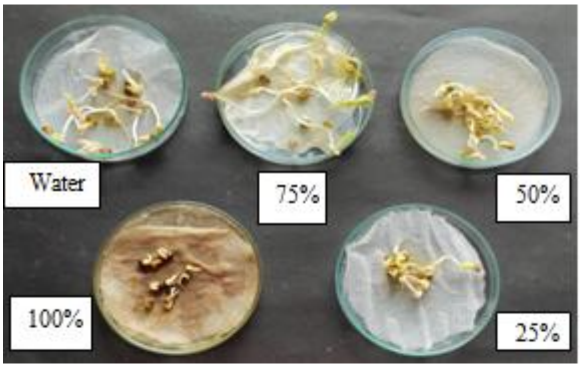


Figure 2.1: Seed germination in corncob shred in different concentration (Water, 75%, 50%, 100% (control -Textile dye) & 25%)

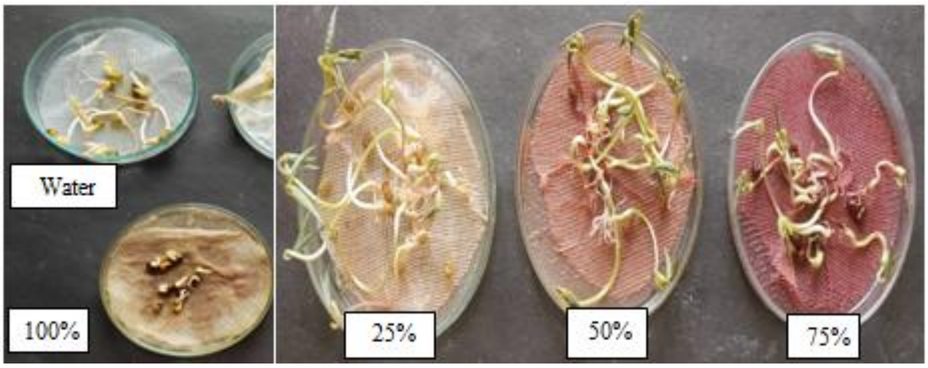


Figure 2.3: Seed germination in coconut coir in different concentration (Water, 75%, 50%, 100% (control -Textile dye) & 25%)

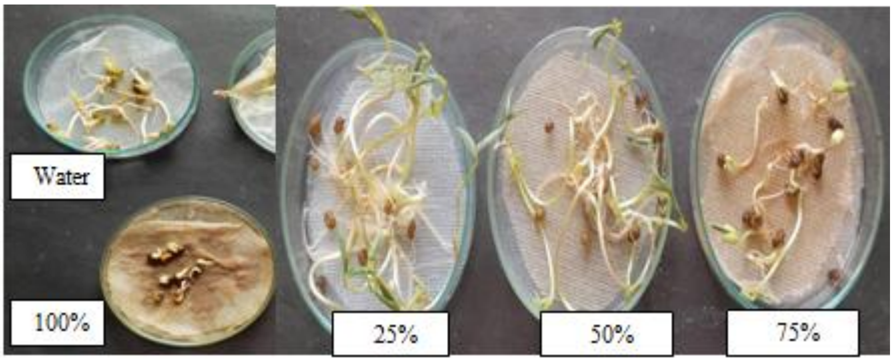


Figure 2.4: Seed germination in Sugarcane bagasse in different concentration (Water, 75%, 50%, 100% (control -Textile dye) & 25%)

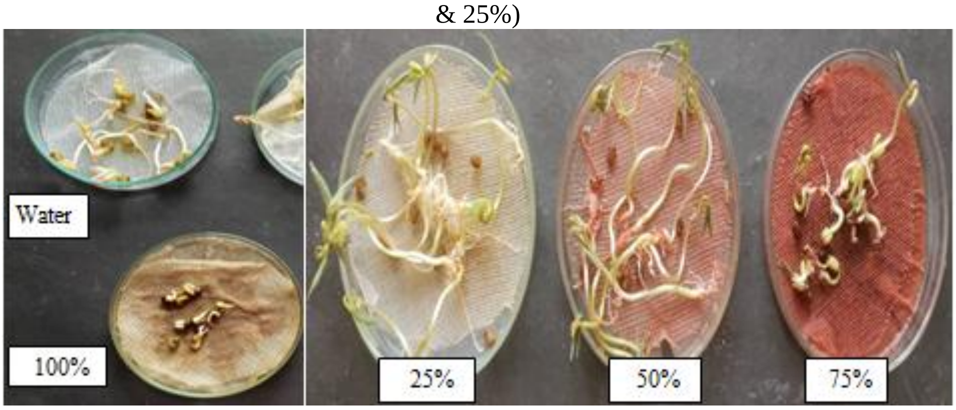


Figure 2.5: Seed germination in Wood powder in different concentration (Water, 75%, 50%, 100% (control -Textile dye) & 25%)

Table 8: Pot study for the growth of the plant treatment in Paddy husk

S.NO	Treatment	Height of the plant (cm)	No. of Leaves
1.	Control Water (Running tap water)	22.6	2
2.	TD100%	Nil	Nil
3.	TD 75%	21	2
4.	TD50%	21.7	2
5.	TD25%	22.8	2

Table 9: Pot study for the growth of the plant treatment in Corn cob shreds

S.NO	Treatment	Height of the plant (cm)	No. of Leaves
1.	Control Water (Running tap water)	21	2
2.	TD100%	Nil	Nil
3.	TD 75%	20	2
4.	TD50%	20.6	2
5.	TD25%	22.3	2


Figure 3: Plant growth in Paddy husk


Figure 3.1: Plant growth in corn cob shreds


Figure 3.2: Plant growth in 100% concentration control in textile dye


Figure 4: Paddy husk + water


Figure 4.2: Paddy husk 25%


Figure 4.3: Paddy husk 50%


Figure 4.3: Paddy husk 75%

Figure 4.4: Corn cob shreds + water

Figure 4.5: Corn cob shreds 25%

Figure 4.6: Corn cob shreds 50%

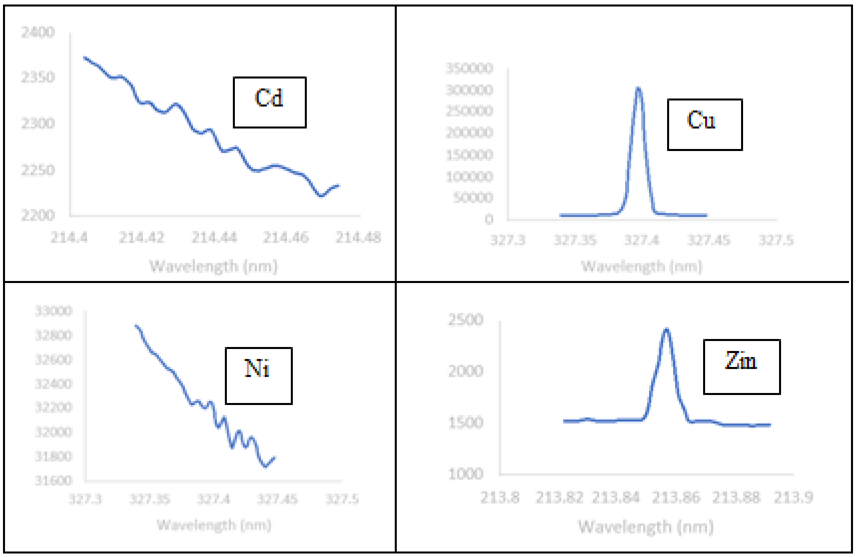
Figure 4.6: Corn cob shreds 75%

Figure 4: Acid digestion for wet Plants in *Vigna radiata*:

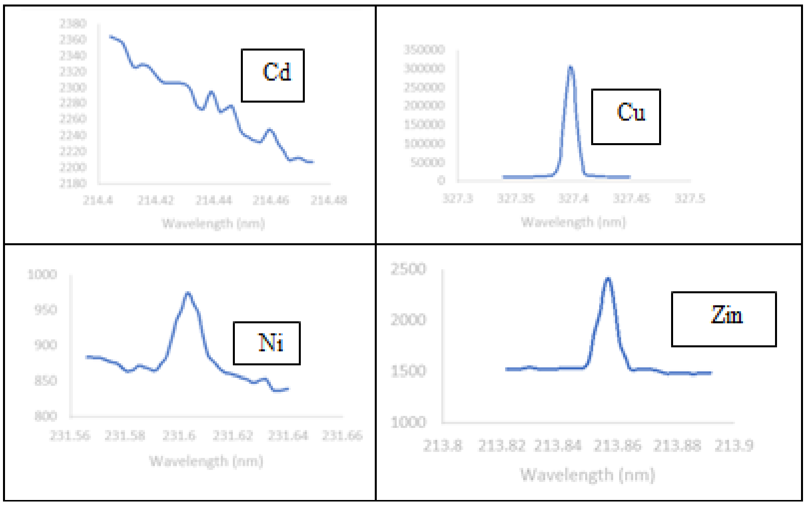
Table 10: Acid digestion of treated and untreated plants

Elements	Control	Treated Plants				
	Untreated Plants	Paddy Husk	Corncob Shreds	Sugarcane Bagasse	Coconut Coir	Wood Powder
Cd	Nil Growth	BDL	BDL	BDL	BDL	BDL
Cu	Nil Growth	0.32%	0.23%	0.10%	0.8%	0.8%
Ni	Nil Growth	BDL	0.26%	BDL	BDL	BDL
Zn	Nil Growth	652.37ppm	526.22ppm	326.12ppm	226.18ppm	266.23ppm

NOTE: BDL- Below Detection Limit; PPM- Parts Per Million; %- Percentage



Graph 4: Acid digestion of plant (Paddy husk 25%)



Graph.4.1. Acid digestion of plant (Corn cob shreds 25%)

Table 10: Acid digestion of treated and untreated plants

Elements	Control Untreated Plants	Treated Plants				
		Paddy Husk	Corncob Shreds	Sugarcane Bagasse	Coconut Coir	Wood Powder
Cd	Nil Growth	BDL	BDL	BDL	BDL	BDL
Cu	Nil Growth	0.32%	0.23%	0.10%	0.8%	0.8%
Ni	Nil Growth	BDL	0.26%	BDL	BDL	BDL
Zn	Nil Growth	652.37ppm	526.22ppm	326.12ppm	226.18ppm	266.23ppm

NOTE: BDL- Below Detection Limit;PPM- Parts Per Million; %- Percentage