MITIGATION OF LANDSLIDE IN NILGIRIS DISTRICT USING A GRASS *CHRYSOPOGON ZIZANIOIDES* AND A NOVEL METHOD FOR THE UPLIFTMENT OF TRIBAL WOMEN FOLK

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Abstract

Soil erosion is a natural process, occurring over geological time and indeed it is a process that is essential for soil formation. But 'accelerated' soil erosion – loss of soil at a much faster rate than it is formed - is a far more recent problem. It is always a result of mankind's unwise actions such as overgrazing by cattle or unsuitable cultivation practices. These leave the land unprotected and vulnerable. Soil erosion leads to landslide and this hazard is one of the most significant hazards that affect different part of India every year during rainy season. It has been observed that 21 states and Union Territory of Pondicherry, states located in hill tracts of Himalayas, North East India, Nilgiris, Eastern Ghats and Western Ghats. It has been observed that 21 states and Union Territory of Pondicherry, states located in hill tracts of Himalayas, North East India, Nilgiris, Eastern Ghats and Western Ghats The plant belongs to grass family (*Chrysopogon zizanioides*), commonly called Vetiver, and is chosen for the present study. This grass is well known for its control over soil erosion and has traditional uses. It is the multipurpose plant which is used for many engineering aspects of work in other countries. Vetiver grass can reduce or control soil erosion on the slope if planted in rows across the slope, the row spacing shall be 1m and clump (the base part where the root starts its growth) spacing should be 15 - 30 cm. The process of soil erosion protection occurs both in surface and sub-surface soil. This phenomena happened in such a way that when the vetiver clumps grow closed laterally, they act like living wall which stand against and slow down run off, and the eroded soil is deposited behind the vegetative barrier. The objective of this project is to prevent the landslide and to control the soil erosion; to educate tribal people about the cultivation techniques of *C.zizanioides*; to train them to use the leaves of the plant *C. zizanioides* for the production of edible mushroom

Keywords: Landslide, Nilgiris district, *Chrysopogon zizanioides*, Mushroom cultivation, Plant tissue culture

1. Introduction

Soil erosion and Land slide in India:

Soil erosion is a natural process, occurring over geological time and indeed it is a process that is essential for soil formation. Soil is naturally removed by the action of water or wind. In general soil erosion removes soil at roughly the same rate as soil is formed. But 'accelerated' soil erosion – loss of soil at a much faster rate than it is formed - is a far more recent problem. It is always a result of mankind's unwise actions such as overgrazing by cattle or unsuitable cultivation practices. These leave the land unprotected and vulnerable. In recent times, the use of

powerful agricultural implements has in some parts of the country led to the damaging amount of soil moving down slope merely under the action of gravity.

Landslide hazard is one of the most significant hazards that affect different part of India every year during rainy season. It has been observed that 21 states and Union Territory of Pondicherry, states located in hill tracts of Himalayas, North East India, Nilgiris, Eastern Ghats and Western Ghats. Western Ghats are affected by this hazard every year and suffer heavy losses in terms of life, infrastructure and property (Sharda, 2008). Though Niligiris and other mountainous areas are known to be susceptible to landslide, occurrence of such magnitude were unknown earlier (Thanavelu and Chandrasekaran, 2008).

The major Landslides of Nilgiris:

Consequent upon continuous heavy rains in the NilgiriHills,numerous landslides were reported to have occurred at the early hours on 14.11.2006 killing one and injuring three persons and disrupting traffic in NH - 67 and blocking of Mountain Rail track between Mettupalayam and Coonoor (nilgiris.nic.in).

Damage caused by November 2009 Landslides:

Heavy rains triggered a series of landslides in Ooty, Coonoor and Kotagiri regions of the Niligiris, killing 42 people within 48 hours. Most of the people were killed after the landslides slammed into their houses. Seven of a family died at Acchanakal hamlet near Ooty. The slides and uprooted trees also cut off access to Nilgiris via Mettupalayam. The approach road to Ooty from Tamil Nadu via Mettupalayam has been severely damaged.

After1978,this is the biggest rain-related disaster in the district. However, smaller landslid es and fallen trees are also blocking parts of the road. Houses and communication infrastructure came down, and roads and rail linesfell apart. The extent of damage caused to infrastructure is without precedent. About 1890 houses fully or partially damaged due to the landside and the total estimated losses are worth about Rs.300 crore by a Government report (The Hindu, 2009).

Rural People in Niligiri District:

The Nilgiris commonly termed as "Blue Mountains' of Eastern and Western Ghats are said to be the highest mountain ranges of South India.

These massive hills of Western Ghats were relatively isolated from the rest of the country and became the abode for certain human communities who could adapt themselves to these forests and shaped their life through livelihood strategies as pastoralists, artisans, sorcerers, gatherers, hunters and agriculturists. In the Nilgiri district there are six tribal communities namely the Toda, the Kota, the Kurumba, the Irula, the Paniya and the Kattunayaka these six groups considered as primitive tribal groups.

The primary occupations of these tribal people are:

- Working as a labourer in tea and coffee plantations
- Working as a labourer in agricultural activities
- Fire wood collecting and selling
- Cattle rearing
- Medicinal plants and tuber collecting and selling

About the Plant *Chrysopogon zizanioides* (Vetiver grass)

Vetiveria zizanioides (recently reclassified as *Chrysopogon zizanioides* (L) Roberty) belongs to the family *Poaceae* and commonly called as vetiver. There are flowering and non-flowering plants. The wild–growing variety commonly found in North India is a flowering type, where as in South India both types are found. *C.zizanioides* holds soil together, helps to

conserve water; land reclamation and hillside protection has strong ecological adaptability and can grow in different types of soils (Lavania, 2003). Soil erosion is a global problem and the need for conservation has become critical in many countries. Vetiver is traditionally and extensively utilized for its multifarious environmental applications (Lavania and Lavania, 2000; Lavania, 2004).

Vetiver grass can reduce or control soil erosion on the slope if planted in rows across the slope, the row spacing shall be 1m and clump (the base part where the root starts its growth) spacing should be 15 -30 cm. The process of soil erosion protection occurs both in surface and sub surface soil. This phenomena happened in such a way that when the vetiver clumps grow closed laterally, they act like living wall which stand against and slow down run off, and the eroded soil is deposited behind the vegetative barrier. The vetiver grass tillers grow up through it and goes on building up natural terraces, and adjust themselves to rise above this natural terraces which still act like living wall as long as the vetiver are alive.

Other uses of *C.zizanioides* (Vetiver):

This plant parts are used as

- Forage (Panichpol *et al*., 1996),
- Ornamentals (Pease, 2002a; Juliard, 2002b; Troung, 2002),
- Animal feed (Panichpol *et al*., 1996; Anon, 1990b)
- Mulch to control weeds and conserve soil water (Simon, 2003)
- Mushroom cultivation (Jayashree *et al.,* 2011; Xu Liyu *et al*., 2003
- Handicraft and herbal drink (Sastry, 1998)
- Perfumary (Downwaithe and Rajani, 2002)
- Roof thatch (Grimshaw, 2002a; Anon, 1990a)
- Energy sources (two forms – Ethanol (Kuhirun and Punnapayak, 2000 and Green fuel (Babpraserth *et al*., 1996)
- Industrial products (pulp and paper, panel) (Anon 1976).

Plant cultivation using different techniques:

The production of propagating materials is the first requirement for the establishment of vetiver cultivation. Various propagation techniques have been tested, for example tissue culture, tiller propagation in polythene bags, sack (Lakshmanaperumalsamy, *et al.,* 2006) and tiller propagation on strips. It is reported that the growth of vetiver can be enhanced by using various organic manure in a particular ratio (Lakshmanaperumalsamy, *et al.,* 2006).

2. Materials and Methods

REPORT OF PHASE I:

1. Selection of suitable ecotype: The Vetiver plant was selected for suitable ecotype in Niligiri district
2. Collection of Vetiver plant : Vetiver plant was collected in Nehru Herbal Garden from Nehru Arts and Science College, T. M. Palayam, Coimbatore- 641 105
3. The production of the propagating material of Vetiver by tissue culture to maintain the source material in the lab level.
4. Transplantation of plantlets in plastic chamber (keeping carefully for 1 month)
5. Transfer of all mini-seedlings to the nursery near or within the Vetiver growing area
6. Discussed with High way Department about land slide areas
7. Area selected with the help of High way Department.
8. Plantation of Vetiver in the selected sites in the Niligiri District affected by landslide/soil erosion.

REPORT OF PHASE: II

1. Awareness Programme for women folk conducted About Vetiver plant and hands on training were given to them for Mushroom cultivation by using Vetiver leaves.
2. Propagation of the plant by using sacs and wooden boxes. (Hands on training was given to the tribal people)
3. Monitoring and recording the growth of the plants and the production of handicrafts items shown to them
4. Evaluation of the site and examining the product were done
5. Finding the new sites for plantation carried out
6. Final report was prepared.

3. METHODS

Explants used for the present study

Meristem tip and Shoot tip explants were collected from *in vivo* grown plants for multiple shoot regeneration.

Preparation of nutrient medium stock solution

Nutrient medium used for the present study was MS (Murashige and Skoog, 1962) medium. Stock solution of Macro, Micro, Potassium iodide, Fe (EDTA), glycine and vitamins was prepared in sterilized well-stopper bottle and kept in the refrigerator. Culture media composition varies for different purpose such as multiple shoot induction.

Growth regulator preparation

In the present study, 2,4-D and NAA were dissolved in 0.5 ml of 1N NaOH, after dissolving completely it was made up to 100 ml with double distilled water for 1mg/L concentration. Kinetin was dissolved in 1N HCl and 6-BAP was dissolved in 1N NaOH, and diluted to 100 ml with double distilled water for 1 mg/L concentration. IBA, IAA were also dissolved in 1N NaOH. Gibberllic acid dissolved in alcohol.

Medium used for experiment

For our *in vitro* experiments, MS (Murashige and Skoog 1962) of modified MS nutrient media supplemented with various concentrations of growth regulators, Sucrose (30%) and agar (0.8%) were used. The modified MS medium contained MS macronutrients, MS micronutrients, 0.1 mg/l thiamine Hcl, 0.5 mg/l Pyridoxine Hcl, 0.5 mg/l Nicotinic acid, 100 mg/l Ferric EDTA and 2 mg/l Glycine were used with growth regulators Kin (0.1 mg/l), NAA (0.5 mg/l), GA3 (0.25 mg/l), BAP (0.25 mg/l). The stock solution was mixed with appropriate proportion for each medium. Growth hormones were added and pH was adjusted to 5.6-5.8 with 1N NaOH or 1N HCl. The 30g/l sucrose and 0.8% agar was added and the volume was made up to required amount and distributed to the bottles and test tubes plugged with non-absorbent cotton. The tubes and bottles were autoclaved at 121^{o}C for 15 minutes at 15 Ibs pressure.

Establishment and maintenance of multiple shoot regeneration

The explants of *Vetiveria zizanioides* were collected from the field. They were washed with sterile boiled water for 5 minutes. The explants were again washed thoroughly with sterile water for 2 minutes. The roots were cut off and the outer leaf sheaths were removed. The explants were trimmed to 5 cm long from the above part. The explants were wiped with rectified spirit in sterile condition. Since the explants were transfer to air chamber remove the outer sheath and trimmed again to about 2cm long. Young whorls were taken and surface sterilized was done by using 0.1% mercuric chloride for 5 minutes respectively. Following the sterilization, the cuttings were put on modified MS medium supplemented with 30g/l sucrose, 0.8% agar, 0.25 mg/l kinetin, 0.25 mg/l NAA, 0.25 mg/l GA3 and 0.25 mg/l BAP. After inoculation, the tubes

were incubated in the dark for 24 hours and were transferred to light and maintained under a 16/8 hour light/dark photoperiod at 25±2^{o}C. Shoot numbers and percentage of explants producing shoots were recorded after 6 weeks. The shoots were sub cultured regularly at an interval of seven days in new medium with same concentration of growth hormones.

Effect of growth regulators on root induction

The *in vitro* develops shoots were excised, and cultured on to MS medium fortified with different concentration of (1.0-3.0mg/l) IBA for root induction. After 10-15 days of culture the rooted plantlets were rinsed with water to remove agar and transferred to plastic pot for acclimatization.

Acclimatization

For in-*vitro* rooting, ¼ MS medium containing different concentrations of IBA was used. Successfully rooted *in vitro* Vetiver plantlets were acclimatized in a humid environment, prior to transfer to outside conditions. During acclimatization, rooted plantlets were protected from high temperature and irradiance.

Statistical analysis

Each treatment consisted of at least 20 explants and the experiment was repeated thrice. A complete randomized design was used in all experiments. Analysis of variance and mean separation were carried out adopting Duncan's Multiple Range Test (DMRT) and the significance was determined at 5% level.

4. RESULTS

Shoot formation from meristem tip and shoot tip

The effect of various concentrations of growth hormones (GA_3, BAP, Kin and NAA) in meristem and shoot tip explants of Vetiver was studied. The two different strength of MS media used for direct regeneration from meristem and shoot tip explant is presented in photos it shows the induction stage of explants. The excised meristem tip and shoot tip explants from well grown plants were cultured in to the half (½) and one-fourth (¼) strength MS medium with different hormones (0.25mg/l BAP; 0.25mg/l GA_3; 0.25mg/l Kin; 0.25mg/l NAA). The initiation was observed after eighth day of culture in one-fourth (¼) strength media compared to half (½) media due to the explants. The images show the shoots formation from meristem and shoot tip explants.

Multiplication of shoot

After three weeks of culture shoot proliferation occurred from the base of explants, these differ from half and one-fourth strength media due to the explants. Generally, best results for shoot proliferation were obtained in one-fourth (¼) liquid medium with meristem tip explant. The effect of plant growth regulators (PGRs) revealed differences in growth responses for both the explants presented in Table 1. As a result, a dense mass of shoots (10-15) was developed in each culture bottle. Shoot multiplication was maintained by regular transfer to new medium with same concentrations of plant growth regulators. This was achieved by sub-dividing shoots in clusters with elongation. The photos represent the multiplication stages from meristem tip explant.

Rooting of regenerated shoots

Root initiation in the successfully established shoots was achieved on ¼ MS liquid media supplemented with different concentrations of IBA (1.0-3.0mg/l) for root induction. The best root induction for *in vitro* derived shoots was obtained on 1mg/l concentration of IBA is show in the photos. The morphological parameters of rooted plantlets which reached approximately 7-14cm after 10- 15 days in rooted medium presented in Table 2.

Hardening and Acclimatization of Plants of *in vitro* Raised Plants

The *in vitro* plants were hardened and acclimatized in medium containing a mixture of in river sand, soil, coconut fibres (1:1:1). The rooted plants were washed with water to remove media from the roots and then it transfer to plastic bags containing the media (river sand, soil, coconut fibres) and kept in screen house for seven days. After one week the potted plants were nurtured in nursery bags placed under sunlight for further hardening of the plantlets.

Table 1: Effect of growth regulator formulation used for multiple shoot regeneration from *in vitro* meristem tip explant of *Vetiveria zizanioides*

Culture medium	Growth hormone mg/L	Percentage of response	No of shoots per explants	Shoot length (cm)
Full strength MS medium	0.25mg/l BAP 0.25mg/l GA_3 0.25mg/l Kin 0.25mg/l NAA	79.66 ± 5.50	8 ± 2.5	5.3 ± 1.10
Half strength (½) MS medium	0.25mg/l BAP 0.25mg/l GA_3 0.25mg/l Kin 0.25mg/l NAA	83.66 ± 7.09	12 ± 3.1	8.2 ± 0.86
One-fourth (¼) MS medium	0.25mg/l BAP 0.25mg/l GA_3 0.25mg/l Kin 0.25mg/l NAA	**90.33 ± 5.50**	**16 ± 5.5**	**12 ± 1.05**

The experiments were repeated three times with five explants for each treatment. Results were expressed as mean ± standard deviation. The data were analyzed with one way ANOVA and DMRT with 5% level of significance SPSS 16.0 software.

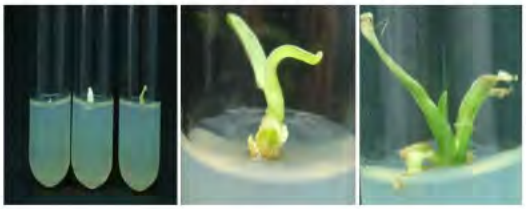
Table 2: Effect of growth regulator formulation used for root induction

Concentration of IBA	Percentage of response	Root length (cm)
1 mg/L	**96.67±4.1**	**14.10±0.36**
2 mg/L	80.33±3.51	11.23±0.31
3 mg/L	79.67±2.52	9.47±0.35

The experiments were repeated three times with five explants for each treatment. Results were expressed as mean ± standard deviation. The data were analyzed with one way ANOVA and DMRT with 5% level of significance SPSS 16.0 software.

A

Development stages of Vetiver Plant through Meristem Cultures



Rooting Stages of Vetiver Plant

Hardening the Vetiver Plant

B

After 7 days the plants were kept in normal environmental condition

Growing Vetiver Plant in Nursery Bags and Plastic Sacs

Selected area in Marapalam

C

Selected area in Kodapmund

Plantation of Vetiver with the help of Highway Department

Plantation of Vetiver in Agricultural Field & teaching to the farmer

Growth condition of plant during frequent visit

D

One Day Awareness Programme for women Folk
Inauguration by, Principal, PI, ADE, Participants

No of participants Attended the Programme

Interview with press reporters & Higher Officers
in Highway Department

Hands on Training given by Project fellow and teach them how to
cultivate the mushroom by using Vetiver leaves

E Participants are get trained by doing themselves individually

End of the training programme

F The Highway Department officer Explaining about the plant to the press reporters

Plantation of Vetiver plant in Soil eroded area by Principal, Highway Officer, PI, Co-PI and Students

Land Slide Controlled area

5. Discussion

Before the losses from landslides can be reduced, the hazard must first be recognized and the risk assessed appropriately. A landslide hazard assessment, which is commonly in the form of a map, provides people with a practical and cost effective way to recognize areas where landslides exist or could occur. So far landslide hazard zonation mapping for the study area has been attempted for the district only based on Landslide Susceptibility Index (LSI) considering factors like lithology, slope angle, distance from major thrust/faults, and land use pattern and drainage density in relation to frequency of existing landslides. These approaches are qualitative and some of them are quantification. Risk analysis involves assessing the hazard as well as considering the consequences if people and property are affected by these hazards. This paper provided an overview of the risk management processes on landslides. The district is categorized under Severe to Very High landslide hazard prone areas. This indicates the area is well known for the danger of landslides, and for the perennial threat to life and property. Restriction on all new constructions and adoption of improved land use and management practices deserve to be encouraged. Investments on landslide remediation measures, on public education and on early warning systems are strongly indicated. One of the most difficult problems concerning landslide hazards in place like Nilgiris is dealing with existing urban areas where buildings are constructed on or close to a landslide. The ideal approach in this situation is to avoid further development in high risk landslide prone areas, limit existing use rights to rebuild, and limit the use of buildings. The most realistic approach is to avoid further development and use of buildings (building type)

is consistent with the level of risk posed and the district plan maps clearly show landslide hazard zones.

6. Conclusion

Since *C. zizanioides* plant parts are used as Forage, Ornamentals, Animal feed, Mulch to control weeds and conserve soil water, Mushroom cultivation Handicraft and herbal drink, Perfumery, Roof thatch, Energy sources (two forms – Ethanol and Green fuel, Industrial products (pulp and paper, panel), the tribal people of Nilgiri District can learn the cultivation technique and earn the from the handicrafts items which will improve their economy status. They help us to prevent soil erosion, Land slide by planting the saplings as their social work.

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