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REVIEW ARTICLE

PHYTOREMEDIATION OF HEAVY METALS CONTAMINATED SOILS

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Abstract: Soils may be contaminated by the accumulation of heavy metals and metalloids through the emissions from rapidly expanding industrial areas, mine tailings, disposal of high metal wastes, leaded gasoline and paints, application of fertilizers, animal manures, sewage sludge, pesticides, wastewater irrigation etc. Excessive accumulation of heavy metals can have deleterious effects on soil fertility and productivity, disrupts ecosystem functioning and can lead to serious health risks to animals and human beings. Many methods of preventing or removing these pollutants from soils are identified, however, most of these conventional remedial processes are expensive and adversely affect the soil fertility and productivity. Therefore, phytoremediation which uses higher plants to reduce contaminant levels in soil is an eco-friendly and cost effective technology. The objective of this review is to discuss the different mechanisms of phytoremediation, their potentials, limitations, and techniques to enhance the phytoremediation efficiency.

Keywords: Phytoextraction, Hyperaccumulator, Ecofriendly, Cost effective, Chelates, Microbes

INTRODUCTION

Heavy metal is defined as d-block element of periodic table which may be transition metal, metalloid, lanthanoids or actinoids, having metallic properties, atomic weight more than calcium, density >5 Mg/m^3, have great capacity to form complexes with organic matter and often associated with contamination and potential toxicity (Duffus, 2002). As per the role of heavy metals in living systems, these are classified into two groups: essential and non-essential. Some metals like Mn, Fe, Ni, Cu and Zn are essential for plant growth, development and physiological functions at low concentration that is why known as essential heavy metals (Gohre and Paszkowski, 2006). Most of heavy metals are cofactors of enzymes. Some of them are involved in important processes such as photosynthesis (Mn, Cu), DNA transcription (Zn), hydrolysis of urea into carbon dioxide and ammonia (Ni), legume nodulation and nitrogen fixation (Co, Zn, Co), flowering and seed production (Cu, Zn), especially when their availability is very low. Second groups *i.e.* non-essential heavy metals includes elements like Cd, Pb, Hg and As which are not required by living organisms or plants for any physiological functions (Peng *et al*., 2009). Heavy metals are highly carcinogenic, teratogenic and mutagenic even at low or trace concentration. Phytotoxicity is mainly associated with accumulation of non-essential heavy metals which generally have very low toxicity thresholds (Clemens, 2006). The major hazardous heavy metals concerned with environmental and health issues are As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Mo, Zn, Tl, Sb (Basta *et al.*, 2005, Wright, 2007 and Gosh, 2010). Among these, Cd and Pb are the most dangerous metals for human health (Sekara *et al.*, 2005). Heavy metals at higher concentrations may disturb the normal physiology and biochemistry of living systems, can block the essential functional groups, displace other metal ions, or modify the active configuration of biological molecules. Threshold toxic limits of heavy metals in soil and plants and their associated health risk to humans are given in table 1.

Heavy metals may exist in colloidal, ionic, particulate and dissolved phase. They also have high affinity for humic substances, organo-clays and oxides coated with organic matter (MacCarthy, 2001 and DeVolder *et al.*, 2003). The soluble forms of heavy metals may be ions or organo-metallic chelates or complexes and their solubility or retention is controlled by pH (Ross *et al.*, 2003), amount of metal , cation exchange capacity, organic carbon content (DeVolder *et al.*, 2003), oxidation state of metals and the redox potential of the system. Among these factors, soil pH is predominant and solubility of heavy metals is increased with decrease in pH.

Sources of heavy metals in soil

Heavy metal can be introduced into any system from natural or anthropogenic sources. Naturally heavy metals are released into the soil, sediments or aqueous system through chemical as well as physical weathering of igneous, metamorphic rocks and soil. They are also generated from volcanic activities, wind erosion, forest smoke fire and fossil fuels. These metals may also be derived from remobilization from natural soils due to the changes in local redox conditions and the corrosion of subsurface engineering structures due to prolonged submergence under acidic groundwater. Whereas on other hand, anthropogenic sources such as mines, foundries, smelting of ores, electroplating, gas exhaust, coal burning power plants etc. also releases heavy metals and imposes a harmful threat to humans as well as environment. Among these

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factors, mining contribute the maximum in contamination of soil followed by agriculture and wastewater. The most hazardous trace-elements such as As, Cd, Co, Cu, Mn, Pb and Zn were found, mainly around industry and mining areas and poses risk to human and ecological health. The materials generated from various industries such as textile, tanning, petrochemicals from accidental oil spills or utilization of petroleum-based products, and pharmaceutical facilities are highly variable in composition (Sumner, 2000 and DeVolder *et al.*, 2003). Industrial activity has led to very high heavy metal concentrations on the environment, which are in general 100–1000 fold higher than those in the Earth's crust, and in turn, living organisms can be exposed to even higher levels. Second major source of heavy metal contamination is related to agricultural issues that include (i) uses of agrochemicals such as fertilizers, pesticides, fungicides, (ii) application of manures and bio-solids (iii) utilization of waste water for crop production. The fertilizers which are used to supply micronutrients contain trace amounts of heavy metals (e.g., Cd and Pb) as impurities and continued application of these fertilizers may significantly increase the content of heavy metals in the soil. Other than micronutrient fertilizers, certain phosphatic fertilizers also supply Cd, Pb and other potentially toxic elements such as F, Hg and As to the soil (Raven *et al.*, 1998). Besides fertilizers, commonly used pesticides or fungicides for insect-pest or disease control of field crops also contain heavy metals like Cu, Hg, Mn,Pb, Zn etc. (Jones and Jarvis, 1981). Bordeaux mixture, a Cu-containing fungicide, is most widely used for field crops while for fruit orchard, lead arsenate is fairly extensively used to control parasitic insects. Arsenic containing compounds are also used to control cattle ticks and pests in banana. The application of various bio-solids (e.g. livestock manures, composts, and municipal sewage sludge) in the fields to maintain soil fertility and productivity inadvertently lead to the accumulation of heavy metals such as As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Mo, Zn, Tl, Sb etc. in the soil (Basta *et al.*, 2005). In the pig and poultry industry, Cu and Zn are added to diets as growth promoters and As is a part of poultry health products, so manures produced from animals on such diets contain high concentrations of As, Cu, and Zn and repeated application of such manures cause considerable buildup of these metals in the soil and may have the potential to cause contamination of the soil (Sumner, 2000). Most commonly found heavy metals in bio-solids include Pb, Ni, Cd, Cr, Cu, and Zn. Heavy metal concentrations in bio-solids are determined by the nature and intensity of industrial activity and type of process employed during the bio-solids treatment and production. Several studies suggest that agriculture based on waste water irrigation accounts for 50 percent of vegetables supply to the urban areas (Bjuhr, 2007). Although, it is considered that waste water contains relatively low concentrations of heavy metals, however, long-term utilization of such waste water for irrigation purpose may lead to accumulation of heavy metals in the soil.

Remedial measures of heavy metals contaminated soils

Remediation refers to any process or technique with the help of which concentrations of contaminants are reduced below the threshold levels so that associated health hazardous can be eliminated (Martin and Ruby, 2004). Due to immutable nature of heavy metals, metal-contaminated soils are notoriously hard to remediate. For remediation of heavy metal-contaminated soils, selection of appropriate remedial process depends on physical and chemical form of the contaminants of concern, soil properties and site conditions. Among the best demonstrated available technologies for remediation of heavy metals contaminated soils, immobilization, soil washing and phytoremediation are most frequently used. Each of these remediation technologies has its specific benefits and limitations.

1. Immobilization: Immobilization refers to the process in which heavy metals remains in the soil itself but reduce the toxicity by decreasing its bioavailability through in situ immobilisation processes (Diels *et al.*, 2002). Immobilization uses organic and inorganic amendments to reduce the bioavailability and toxicity of heavy metals. These immobilizing amendments alter the physicochemical states of metal and transform them into more geochemically stable forms via sorption, ion exchange, precipitation, redox reactions and complexation phenomena (Hashimoto *et al.*, 2009 and Wang *et al.*, 2009). The mostly commonly used inorganic amendments include clay, cement, fly ash, blast furnace slag, calcium carbonate, Fe/Mn oxides, charcoal, zeolites, minerals, phosphates (Ling *et al.*, 2007 and Fawzy, 2008) whereas organic amendments include bitumen, organic composts, manures and microbes (Farrell, 2010) or a combination of organic-inorganic amendments may be used. Immobilization mainly includes stabilization or vitrification process. Vitrification is defined as high-temperature treatment of contaminated soil that volatilize/destroy volatile metals. However, because of very complexed nature of soil, immobilization is not so successful.

2. Soil Washing: It is defined as a volume reduction process in which contaminants are washed off from the soil with the help of aqueous solutions or chemicals. Washing solution may be water or aqueous solution of acids, alkali, solvents or surfactants (Chen and Hong, 1995 and Wuana *et al.*, 2008). Organic acids such as oxalic, citric, formic, acetic, malic, succinic, lactic and fumaric acids also dissolve the metal and make it available to biota (Labanowski *et al.*, 2008). Soil washing can be performed in situ or ex situ depending on nature of

soil and contaminant to be removed and extent of contamination. Soil washing is an efficient remedial process and eliminates the contaminants for longer time period. However, the most important problem is associated with disposal of hazardous waste solution. Secondly, it is high cost process that is economically infeasible. Also, the hazardous acids if persist in soil for longer time, they may cause adverse effects on plant growth and soil fertility and subsequently causes negative impacts on the ecosystem.

3. Phytoremediation The term phytoremediation was coined by Ilya Raskin in 1994, it consists of Greek word "phyto" means ''plant'', and the Latin suffix "remedium" means ''able to cure'' or ''restore'' (Cunningham *et al*., 1996). So, phytoremediation is defined as an in situ remedial process that uses plants to remove, transfer, stabilize, and destroy contaminants in soil, sediments or aqueous system. It is also termed as green remediation, botanoremediation, agroremediation, or vegetative remediation. Efficiency of phytoremediation depends on the nature of contaminant to be removed, its bioavailability and soil properties (Cunningham and Ow, 1996). Phytoremediation is an emerging non-destructive, aesthetically pleasing and cost effective strategy to clean up the contaminated soil. Additionally, it is socially acceptable technology. In contrast to its many positive aspects, limitations of phytoremediation includes: (i) all type of plants are not suitable for removal of all type of contaminants, in tern, its success is limited by growing habit of plants in specific environmental and soil conditions it is dependent on the growing conditions required by the plant, (ii) it is a slow process and takes longer time than other technologies (iii) success is dependent on the tolerance of the plant to the pollutant. Most of the conventional remedial technologies are expensive and inhibit the soil fertility, hence, in order to deal with these contaminants in an eco-friendly manner, phytoremediation is most suitable option.

Different mechanisms of phytoremediation

Phytoremediation is a broad term that has been used since 90's to describe the use of plants to remediate the contaminated media (USEPA, 2000). Phytoremediation includes six main mechanisms namely Phytostablisation, Phytoextraction, Rizofiltration, Phytodegradation, Rizodegradation and Phytovolatilisation (Figure 1). Use of the mechanism depends on the nature of the contaminant to be dealt with and soil conditions. Out of these six mechanisms of phytoremediation, for remediation of heavy metal contaminated soils, potentially used technologies are phytoextraction (phytoaccumulation), phytostabilization, and phytofiltration (Garbisu and Alkorta, 2001). Further among these three, phytoextraction is most primarily used (USEPA, 2000).

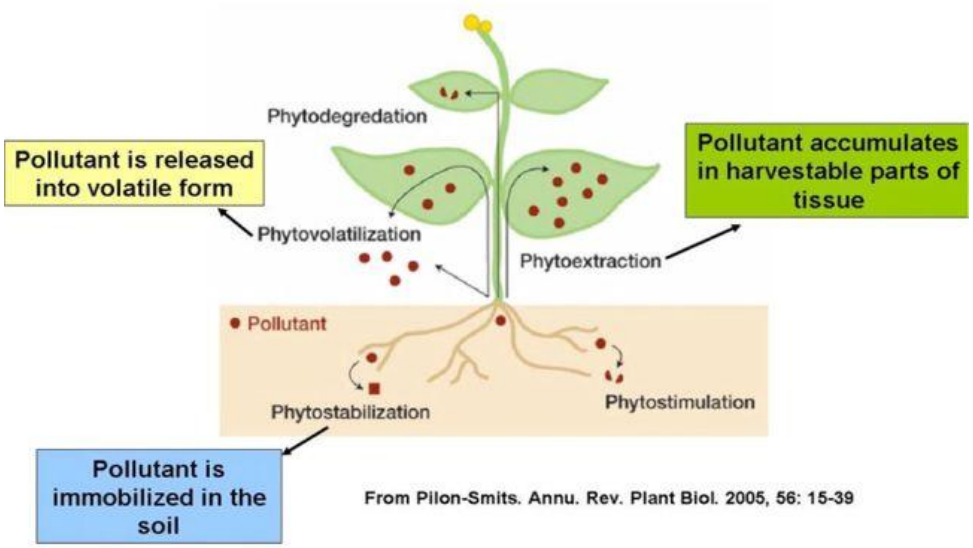

Figure 1: Different mechanisms of phytoremediation

Phytoextraction: It is defined as the process in which plants uptake the metal contaminants by roots from soil and then accumulate the contaminant into the above ground parts such as shoots, leaves etc. That is why it is also termed as phytoaccumulation. The discovery of hyperaccumulator plants lead to the idea of using plants for remediation of metal contaminated soils (Raskin and Ensley, 2000). A hyperaccumulator is defined as the plant species that have potential to accumulate high concentrations of metals in their foliage and often it is endemic (Raskin *et al*., 1997 and Brooks, 1998). Generally, it is believed that hyperaccumulator is capable of accumulating the metal about 100 times higher as compared to non-accumulating plants (McGrath *et al*., 2002). About 400 plants species have been discovered and identified as hyperaccumulators and these plant species differ widely in their potential of

phytoextraction for different heavy metals (Table 2). Majority of hyperaccumulator plants reported belong to the families like Asteraceae, Brassicaceae, Caryophyllaceae, Cyperaceae, Cunouniaceae, Fabaceae, Flacourtiaceae, Lamiaceae, Poaceae, Violaceae and Euphobiaceae. Among these reported families, Brassicaceae had the largest number of taxa viz. 11 genera and 87 species. Metals such as Ni, Zn, Cu are best studied for phytoextraction because these metals are preferred by majority of plants for uptake and accumulation. Hyperaccumulator plants used for phytoextraction purpose should have the following characteristics: (i) should extract high concentration of heavy metals from contaminated soil (ii) have capacity to translocate the extracted metals to the above ground biomass (iii) should have fast growing habit and produce large quantity of plant biomass and (iv) have capacity to tolerate high levels of metal (Brennan and Shelley, 1999 and Garbisu *et al.*, 2002). Plants suitable for phytoextraction also have been are characterized by shoot-to-root metal concentration ratio (also termed as Translocation factor) of >1 (McGrath *et al.*, 2002, Yoon *et al*., 2006). Ali *et al.*, 2012 observed that root bioconcentration factor of *Trifolium alexandrinum* for Zn, Pb, Cu and Cd were 4.242, 1.544, 1.071 and 0.604, respectively. The phytoextraction is fairly inexpensive technology as compared to conventional methods. Major limitation associated with phytoextraction is disposal of harvested above ground biomass. Volume reduction of contaminated material can be achieved by ashing or composting (Garbisu *et al.*, 2002). Harvested biomass can also be used for land filling or may be used for metal recovery (Salt *et al.*, 1998 and Koppolu and Clements, 2003).

Phytovolatilization: Phytovolatilization process uses the naturally occurring or genetically modified plants to absorb metals from the soil/sediments/water, transforming them into less toxic, volatile gaseous into plants and releasing them into atmosphere (USEPA, 2000). This process is applicable only for those heavy metals which can exist as gaseous forms in environment such as As, Hg, and Se may exist as gaseous species in environment. Remediation of heavy metals contaminated soils through phytovolatilization has been observed in several studies. Unlike phytoextraction, problem of disposal of harvested biomass is not associated with phytovolatilization. However, it is a promising technology for remediation of volatile heavy metals, but it is likely to be recycled through precipitation and re-deposited back into lakes and oceans (USEPA, 2000).

Phytostabilization: This mechanism of phytoremediation uses plant species to stabilize the heavy metals in soil through absorption and accumulation by plant roots (Vamerali *et al.*, 2009). It is also termed as in-place inactivation. Phytostabilization may also occur through precipitation or complexation of heavy metals within rhizosphere by exudates secreted by plant roots. The most important task is to find out suitable plant species (Rizzi *et al.*, 2004 and Mendez and Maier, 2008). This technique is useful for the remedial of Pb, As, Cd, Cr, Cu and Zn contaminated soils. However, this technology reduces the entry of toxic metals by decreasing their uptake by plants, but its drawback is that contaminants still remain in soil.

Phytodegradation: Phytodegradation is defined as breakdown of toxic compounds into simpler molecules by plant metabolism after the toxic metals has been uptaken by the plants and translocated to above ground tissues (Trap *et al.*, 2005). This is also termed as phytotransformation.

Rhizofiltration: Rhizofiltration is defined as adsorption and precipitation of toxic metals onto plant roots and roots are harvested after they become saturated with contaminants. Plants utilized may be terrestrial or aquatic in nature, however, because of having fibrous and longer roots, terrestrial plants are preferred (Raskin and Ensley, 2000). It is applicable for aqueous system where toxic elements are present in groundwater, irrigation water or wastewater. Metals suitable for rhizofiltration include Pb, Cd, Cu, Ni, Zn, and Cr etc. (USEPA, 2000). Potential of several plant species such as sunflower, Indian mustard, tobacco, rye, spinach, and corn have been studied for removal of lead from water.

Rhizodegradation: Rhizodegradation is defined as the breakdown of toxic metals/contaminants into less toxic forms within the rhizosphere. This degradation or break down can be carried out by microbes present in rhizosphere or by exudates (includes sugars, amino acids or amino sugars etc.) secreted by plant roots. This process is also known as phytostimulation.

Ways to improve efficiency of phytoremediation

Most of metals are immobile in nature so phytoremediation rate and efficiency are limited by solubility and diffusion of metals to root surface. There are a number of ways to enhance the efficiency of phytoremediation which includes uses of microbes, chelates, organic manures and compost, other chemicals like fertilizers, fungicides, genetic modified plants etc.

Chelating agents: Chelating agents increase metal bioavailability and plant uptake and increases efficiency of phytoextraction. Chelating agents may be organic and inorganic although inorganic are most commonly used (Quartacci *et al.*, 2006). Various inorganic chelates used are ethylene diamine tetraacetate (EDTA), ethylene diamine disuccinate (EDDS), nitrilo triacetate (NTA), di ethylene triamine pentaacetic acid (DTPA) and cyclohexane diamino tetraacetic acid (CDTA) (Ramprakash *et al.*, 2009). Among these, EDTA is most frequently used to enhance the uptake of several heavy metals (Huang *et al.*, 1997). Other than these inorganic chemicals, low molecular weight organic acids like

acetic, citric, oxalic, fumaric and succinic acids may also be used to improve efficiency of phytoremediation (Chen *et al.,* 2003 and Wenger *et al*., 2003). Singh *et al.,* 2013 reported that all the chelating agents increased Ni desorption from Ni spiked soil, however, order of effectiveness of chelating agents for desorption in Ni was followed as : NTA>CDTA>DTPA>CA. They also reported that desorption was highest in first extraction followed by second, third and fourth successive extraction. The increased uptake might have been due to increased availability of Ni in soils due to addition of chelating agents resulting in its higher accumulation in roots and shoots and higher dry matter yields of both the components of B. *juncea* (Ishikawa *et al.,* 2006). Amongst the commercial crops grown in this region B. *juncea* has been reported to produce high biomass and accumulate significant amount of heavy metals. Ramprakash *et al*., 2013 reported that mean uptake of Cr by shoot increased from 303.25 µg pot^{-1} in control to 389.57, 696.17, 868.19 and 427.43 µg pot^{-1} due to application of CDTA, CA, NTA, FYM, respectively (Table 3). EDDS is structural isomer to EDTA, however, its efficiency to improve is mainly associated with Cu or Zn or Pb (Tandy *et al.,* 2004). Application of microbial inoculants in combination with chelating agents further improves the efficiency of phytoextraction as reported by Panwar *et al.,* 2011. They conducted an experiment with *Brassica juncea* grown on a spiked soil with EDTA, farmyard manure, vermicompost and microbial inoculants (*Azotobacter* and *Pseudomonas*) and it was observed that application of microbial inoculants, EDTA, FYM and vermicompost significantly increased Cd uptake and highest uptake was recorded with vermicompost treatment (Table 4).

Genetic engineering/ modified plants: With the help of genetic engineering technique, transgenic plants are developed which have manipulated capacity to uptake, accumulate and can tolerate high concentration of pollutant. Genes which are involved in metabolism and detoxification of pollutants are identified and manipulated thus enhanced phytoextraction is achieved in several studies (Meda *et al.,* 2007 and Reisinger *et al.,* 2008). Genetic engineering also improved phytovolatilization potential of Indian mustard as reported by Banuelos *et al.,* 2005. They tested three transgenic lines of Indian mustard, over expressing the genes encoding enzymes adenosine triphosphate sulfurylase (APS), γ-glutamyl cysteine synthetase (ECS) and glutathione synthetase (GS), for their potential to remove Se from contaminated sediment. The APS, ECS and GS transgenic plants accumulated 4.3, 2.8 and 2.3 fold more Se in their leaves than wild type, respectively (Figure 2). Improved ability of APS Indian mustard may be due to the reason that APS plants over express ATP sulfurylase, a rate-limiting step in the conversion of selenate to selenite. This enables APS plants to rapidly convert selenate via selenite to organic-Se forms, while wild type plants accumulate mostly selenate. Secondly, APS plants may accumulate high concentrations of Se in shoots by accumulating more Se in nontoxic organic Se forms such as non protein amino acid methyl seleno cysteine (Met-SeCys). ECS and GS would have increased Se uptake and assimilation through increased activity of sulfate permease and ATP sulfurylase.

Humic Acids: Best part of organic matter which has significance importance in agriculture is humus, which is well decomposed part by action of microbes. Humic substances (humic acid+fulvic acid+humin) maintain soil fertility and productivity by improving soil chemical, physical and biological properties such as retention capacity, porosity, aggregate stability, cation exchange capacity etc. Other than these functions, humic acid typically contains of heterocyclic compounds with carboxylic, phenolic, alcoholic and carbonyl functional groups and this characteristic play a vital role in enhancing nutrient uptake and also heavy metals by plants. This is attributed to the reason that humic acids being acidic in nature increases solubility and bioavailability of heavy metals (Bianchi *et al.,* 2008). That is why humic acids can be used to improve phytoremediation as alternatives to inorganic chelating agents. In contrast to this, humic acids can also decreases the mobility of some toxic metals and results in phytoaccumulation (Halim *et al.,* 2003). Therefore, contradictory results have been reported related to mechanism of humic acids in improving phytoremediation.

Mycorrhizae Fungi: Role of mycorrhizae is well known in increasing nutrient uptake by exploiting more volume of soil. This positive effect is also applicable for improving phytoextraction by increasing uptake of heavy metals also (Giasson *et al.,* 2005). However, high concentration of toxic metals can also adversely affect the growth of mycorrhizae fungi.

Bacteria: Addition of bacteria significantly improves the microbial biomass in the rhizosphere and might help to increase As uptake and accumulation (Table 5). The possible explanation was that the application of arsenate reducing bacteria improved the rhizosphere microbial environment, and increased the number and the mycelium of microbes as well as enhanced the biomass of the plant root systems, which might help to take up As, hold soil As, and prevent As losing (Yang *et al.,* 2012).

Chemical fertilizers: Chemical fertilizers can improve phytoextraction process by improving plant growth. Mandal *et al.,* 2012 phytoextracted the soil with *Pteris vittata* grown for two cycles and fertilized with di-ammonium phosphate (DAP) and SSP. However, DAP was found more effective over SSP in stripping more arsenic by *Pteris vittata* resulting in lesser arsenic accumulation in rice crop (Figure 3). Phosphate may compete with arsenic for

plant uptake (Cao *et al.*, 2003). On the other hand, phosphate addition as an essential fertilizer for plant development, would enhance arsenic release from soil through competitive exchange (Smith *et al.*, 2002).

Possible utilization of biomass after phytoextraction: A serious challenge for the commercialization of phytoextraction has been the disposal of contaminated plant biomass especially in the case of repeated cropping where large tonnages of biomass may be produced. The biomass has to be stored, disposed of or utilized in an appropriate manner so as not to pose any environmental risk (Blaylock and Huang, 2000). The major constituents of biomass material are lignin, hemicellulose, cellulose, minerals, and ash. It possesses high moisture and volatile matter, low bulk density, and calorific value (Ghosh and Singh, 2005). Controlled combustion and gasification of biomass can yield a mixture of producer gas and/or pyro-gas which leads to the generation of thermal and electrical energy. Composting and compacting can be employed as volume reduction approaches to biomass reuse (Raskin *et al.*, 1997 and Garbisu and Alkorta, 2001). Ashing of biomass can produce bio-ores especially after the phytomining of precious metals. Heavy metals such as Co, Cu, Fe, Mn, Mo, Ni, and Zn are plant essential metals, and most plants have the ability to accumulate them (Jadia and Fulekar, 2009). The high concentrations of these metals in the harvested biomass can be "diluted" to acceptable concentrations by combining the biomass with clean biomass in formulations of fertilizer and fodder.

Table 1. Toxic limits of heavy metals in soil and plant and their toxic responses to humans

Heavy metal	Toxic limit in plant (mg kg^{-1})	Toxic limit in soil (mg kg^{-1})	Toxic response in human
Pb	30-300	600	Irreversible neurological damage, renal disease, reproductive toxicity
Cd	5-30	100	Stomach irritations, lung damage, cancer, bone defects
As	>2.6	20	Cancer, Cardiovascular, gastrointestinal, hepatic and renal disease, DNA damage
Cr	3-30	100	Genotoxic carcinogens, lung cancer, muscle cramps
Hg	0.1-10	270	Brain damage, birth defects, sensory impairment, hearing loss
Cu	100-200	600	Inhibition of dihydrophilhydratase, accumulation in liver and kidney
Zn	100-400	1500	Inhibition of copper absorption, nausea, loss of appetite, abdominal cramps

Source: Salt *et al.*, 1995

Table 2. Concentrations of heavy metals in field crops obtained from field experiments

Species	Metal concentrations (mg/kg)							
	As	Cd	Co	Cr	Cu	Ni	Pb	Zn
Brassica carinata	12	12	-	9.8	37	7.6	50	1650
Brassica juncea	30	10	-	5.2	71	-	55	2029
Brassica napus	5.8	11	-	9	40	7	39	1400
Festuca spp.	-	-	-	-	106	-	-	90
Glycine max	230	2.4	-	-	440	-	72	430
Helianthus annus	20	0.64	0.71	-	70	-	5	150
Hordeumvulgare	20	0.44	-	-	16	-	27	334
Medicago sativa	85	53	-	-	77	-	2177	-
Oryza sativa	-	-	-	-	34	-	6	90
Phaseolus vulgaris	-	53	-	-	2230	-	1000	1440
Pisumsatium	-	-	-	-	-	-	1390	-
Raphanussativus	-	9.4	-	5	34	6.5	28	1450
Sorghum bicolor	240	3.7	1.8	-	540	-	100	580
Triticumsecalotriticum	21	1.9	-	-	27.5	-	37	588
Zea mays	30	20	-	-	1220	-	257	1200

Source :Vamerali et al., 2010

Table 3. Effect of chelating agents and sewage sludge on Cr uptake (µg pot^{-1}) by roots and shoots of subsequent Brassica juncea crop in Cr contaminated soil

Treatment	50DAS		80DAS		
	Without SS	With SS	Without SS	With SS	Mean
Root					
Cr_{20}	34.31	53.91	128.52	154.43	92.79
Cr_{20} + CDTA	41.17	56.26	108.92	136.69	85.76
Cr_{20} + CA	98.68	133.81	201.84	232.73	166.77
Cr_{20} + DTPA	34.46	48.28	82.14	100.06	66.23
Cr_{20} + NTA	125.72	151.55	288.49	318.95	221.18
Cr_{20} + FYM	72.87	92.99	161.19	194.57	130.41
Mean	67.87	89.47	161.85	189.57	
CD (0.05) Soil=6.96, Time=6.96, Chelating agent= NS, S×T=9.84, S×CA=17.05, T×CA=NS, S×T×CA=NS					
Shoot					
Cr_{20}	51.59	124.61	469.35	567.46	303.25
Cr_{20} + CDTA	85.40	154.07	560.01	758.78	389.57
Cr_{20} + CA	335.41	530.77	881.29	1039.33	696.17
Cr_{20} + DTPA	59.36	99.43	453.53	581.73	298.51
Cr_{20} + NTA	411.44	646.53	1125.69	1289.10	868.19
Cr_{20} + FYM	194.26	273.84	547.09	694.54	427.43
Mean	189.57	304.88	672.83	821.82	
CD (0.05) Soil=38.7, Time=38.7, Chelating agent= NS, S×T=54.73, S×CA=94.8, T×CA=NS, S×T×CA=NS					

Source : Ramprakash *et al.*, 2013

Table 4. Cadmium uptake (µg pot-1) of shoots and roots of Indian mustard as influenced by different chelating agents and bio-inoculants in Cd-enriched soil

Treatments	Control	Cd_{100}	Cd_{100}+FYM	Cd_{100}+VC	Cd_{100}+EDTA	Mean
Shoots						
(-) Microbial inoculants	126.6	871.6	1381.6	2238.6	2139.0	1351.5
(+)Microbial inoculants	132.0	993.1	1485.7	2265.7	2251.2	1425.6
Mean	129.3	932.4	1433.6	2252.2	2195.1	
CD (5%) Microbial inoculants (M)=11.99, Cd=18.95, Interaction of M×Cd=26.81						
Roots						
(-) Microbial inoculants	36.7	233.3	395.3	477.9	417.6	312.2
(+)Microbial inoculants	47.0	250.6	413.0	499.7	455.0	333.0
Mean	41.8	241.9	404.2	488.8	436.3	
CD (5%) Microbial inoculants (M)=4.06, Cd=6.42, Interaction of M×Cd=9.08						

Source : Panwar *et al.*, 2011

Table 5. Effectiveness of arsenate reducing bacteria to enhance arsenic removal from polluted soils by *Pteris Vittata*

Arsenate reducing bacteria	As conc. (mg/kg)	As uptake (mg/m^2)
Control	615.74 c	30.47 c
Ts 1	704.32 b	53.39 b
Ts 33	886.47 a	65.04 a
Ts 37	652.55 bc	48.33 b
Ts 41	835.56 a	48.98 b
PSQ 22	698.47 b	44.04 b

Source : Yang *et al., 2012*

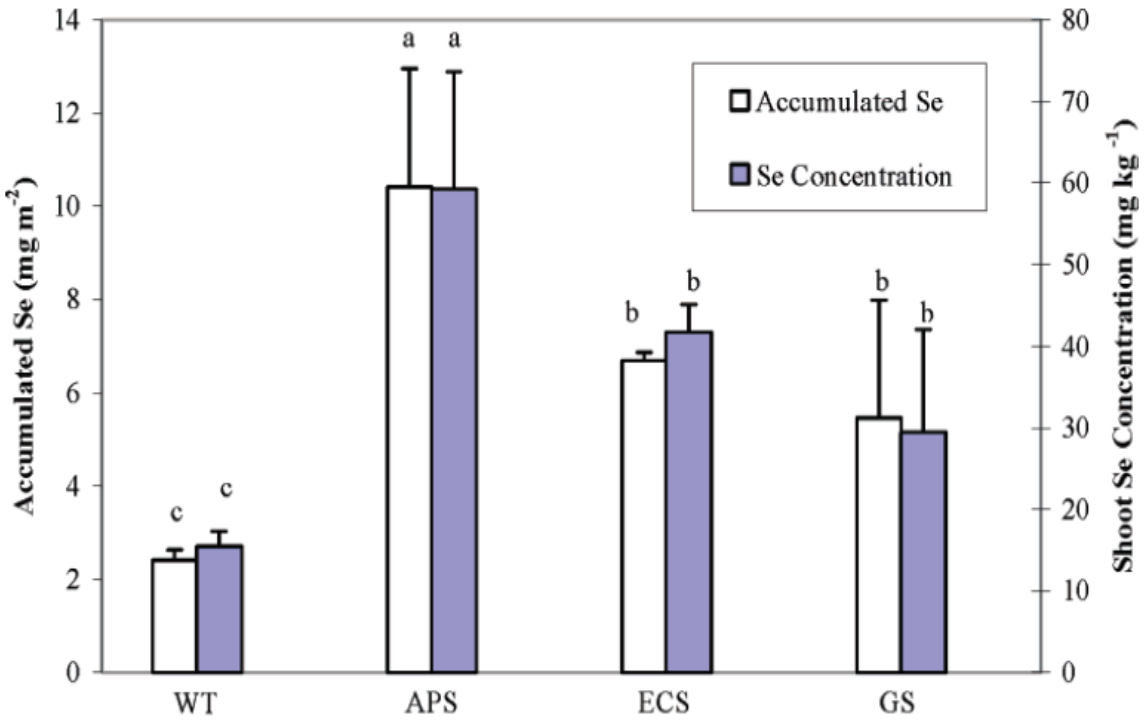

Figure 2: Field trials of transgenic Indian mustard for phytoremediation of selenium contaminated sediment (Source : Banuelos *et al.*, 2005)

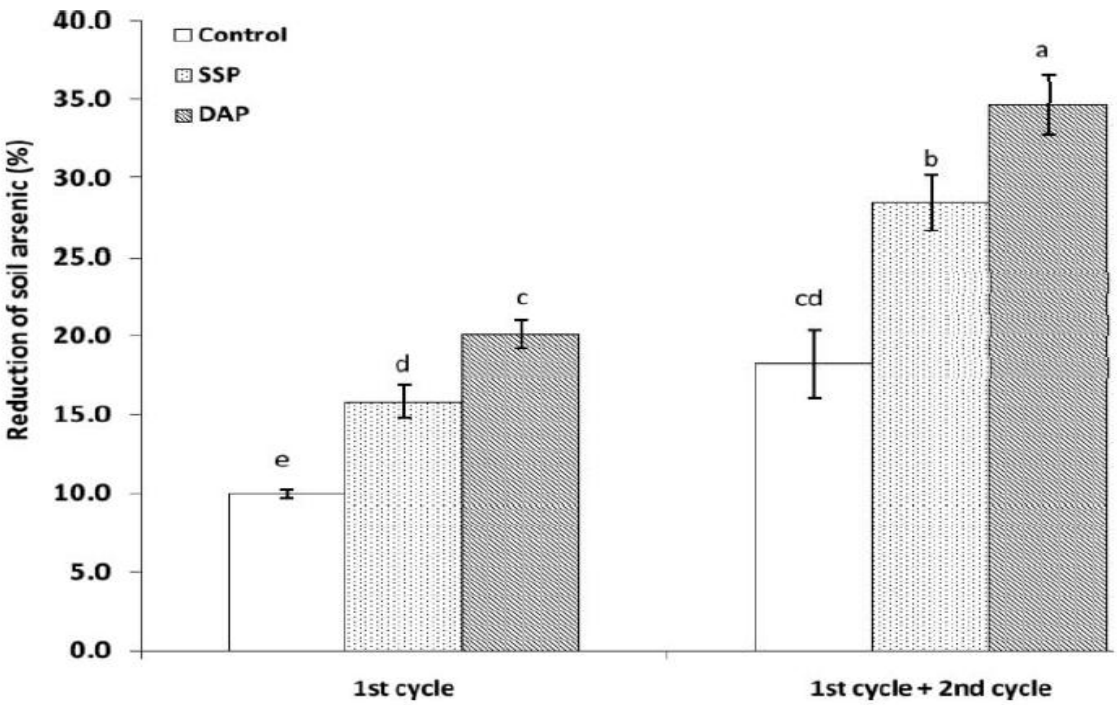

Figure 3: Phytoextraction of soil with *Pteris vittata* grown for two cycles and fertilized with DAP and SSP. (Source : Yang *et al.*, 2012)

CONCLUSION

As highlighted above, there are several ways in which plants are used to clean up or remediate contaminated sites. The success of phytoremediation at a given site cannot always be attributed to just one of these mechanisms because a combination of mechanisms may be at work. Phytoremediation is a low cost, solar energy driven and natural cleanup technique, which are most useful at sites with

shallow, low levels of contamination. In addition to this, it is easy to implement and maintain, does not require the use of expensive equipment or highly specialized personnel and is environmentally friendly and aesthetically pleasing to the public. Although it is an easy and cost effective process yet to become a commercially available technology in many parts of the world especially the developing countries like India.

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RESEARCH ARTICLE

THE SPECTRAL MODELLING OF ABOVE GROUND FOREST BIOMASS IN JHAJRA FOREST RANGE OF DEHRADUN FOREST DIVISION USING MICROWAVE DATA

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Abstract: Forests play an important role in the global carbon cycle as a carbon sink. Deforestation and degradation of forests lead to carbon emissions, which should be prevented or minimized by protecting forests. Radar remote sensing has proven to be particularly useful tomonitor forests especially in the tropics due toweather and daytime independence. Radar data fromthe ALOS PALSAR-2 provide a potential opportunity to monitor large areas of tropical forests due to the high resolution.The study describes the development of logarithmic model for the estimation of forest above ground biomass and carbon using ALOS-PALSAR-2 synthetic aperture radar (SAR) data. The backscatter coefficient of the SAR data in different polarization were quantified using field data collected Jhajra forest range. A significant correlation has been observed between HV backscatter and plot level biomass with a coefficient of determination (R^2= 0.8918). The up-scaled biomass ranges from 5.2 tonnes/ha to 397.45 tonnes/ha. The total amount of carbon stored in the Jhajra forest range is 237471.99 tonnes. The carbon sequestration potential of the forest is 871522.20 tonnes.

Keywords: Biomass, Backscatter, Spectral Modelling, ALOS-PALSAR-2, Carbon Sequestration

INTRODUCTION

According to The Kyoto Protocol's Clean Development Mechanism (CDM) and reducing emissions from deforestation and forest degradation (REDD), countries are allowed to offset a portion of their greenhouse gas emissions through the carbon sequestration of forestation, so as to reduce environmental pollution. On that way, the government schemes and conservation strategies adopted by India leads to an increase in forest cover. An increasing forest cover is an important factor to reduce the rise of atmospheric carbon dioxide through carbon sequestration. The industrial revolution and development strategies adopted by the countries across globe has seriously degraded the terrestrial ecosystem. It had reduced the actual carbon stored in the ecosystem than their potential carbon reserves (Houghton and Hackler, 2003; Lal, 2008). The amount of carbon stored by the forests, peat swamps, grasslands and other terrestrial ecosystem is more than it is stored by the atmosphere (Lal, 2004). The forests stores the carbon in their wood through the process of photosynthesis contribute in the climate change mitigation. Disturbing the forest ecosystems with deforestation, forest fire, land use land cover change (LULC), diseases leads to the release of the significant amount of stored carbon in the atmosphere (Kareiva *et al.*, 2011).

The traditional methods for above ground carbon stock assessment were based on field inventory data. The forest inventory data collected from statistically based surveys and then estimate carbon stocks using relationships between inventory variables and carbon stocks augmented with models for pools that are not sampled (Intergovernmental Panel on Climate Change (IPCC, 1997). Forest inventory data are a useful basis for estimating carbon stocks and net fluxes for the sampled area. However, not all forest carbon pools are represented well by attributes measured in forest inventories, and so there is a need to augment survey data with data from intensive research sites and models (Birdsey & Heath, 1995; Smith & Heath, 2002, 2004; Heath et al., 2003; Smith et al., 2003). Although the techniques were more accurate and reliable but it took ample amount of resources (Financial and Human resources) and time (Brown, 2002; Coomes et al., 2002; Gibbs et al., 2007; Machar et al., 2016). Therefore for larger and inaccessible area these methods are unusable. The traditional methods were taken by a new technique i.e. "Remote Sensing" which are free from the limitations of old techniques, but has its own limitations. That is why in current scenario numerous research has been carried out to incorporate remote sensing technology for quick and reliable estimation of carbon stock (Goodenough et al., 2005; Mandal and van Laake, 2005; Vicharnakorn et al., 2014). Space borne Synthetic Aperture Radar (SAR) remote sensing systems are active sensors with the advantage of all weather and daylight independency. The retrieval of forest parameters depends upon the wavelength of the sensor, the longer the wavelength the deeper the penetration (Le Toan et al., 2001; Henderson & Lewis, 1998). The backscatter from the forest depends upon the sensor parameters like polarization, incidence angle along with structural

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properties like roughness and dielectric constant (Imhoff, 1995a; Lu, 2006). A significant relationship has been established between the backscattering coefficients and the above ground biomass within particular types of forest (Baker et., 1994; Le Toan et al., 1992; Dobson et el.,1992; Imhoff, 1995b). It has already been proved that Longer wavelengths are more useful because of an increasing backscatter range with changing biomass (Castro et al., 2003; Dobson et al., 1992; Lu, 2006; Luckman et al., 1997). The estimation of AGB are valid up to certain threshold which depends on the wavelength and the models used for the estimation. For L-band backscatter published saturation levels range from 40 t/ha (Luckman et al., 1997; Imhoff, 1995) to 150 t/ha (Kuplich et al., 2005; Lucas et al., 2007; Mitchard et al., 2009). Austin et al. (2003) stated that the L band saturation level is possibly up to 600 t/ha.

Study Area

The study was conducted in the Jhajra range which is located in the south western part of Dehradun forest division. The study area lying between latitudes 30° 33' N to 30° 43' N and longitude 77° 83' E to 78° 03' E. The annual temperature in the region ranges from 1.8° C in January to 40° C in June. The area received an average annual rainfall of 2025.43 mm. The region receives most of its annual rainfall during June to September, the maximum rainfall occur in July and August. In Jhajra forest range comes under subtropical dry deciduous forests where*Shorea robusta* (sal),*Terminalia alata* are the dominant overstory species. The middle storey are represented by *Mallotus philippensis*, *Syzygium cumuni*in, *Ehertia laevis* tree species. *Clerodendron viscosum* and *Lantana camara* are present in the lowermost tree canopy, and the understory shrub and herb. Some abundantly found species from this site were *Murraya koinigii* L. Spreng., *Parthenium hysterophorus* L., *Xanthium indicum* Koenig., *Jasminum nudiflorum* Lindl., *Colebrookea oppositifolia* Smith., *Alternanthera sessilis* (L.) R. DC., *Phlogacanthus thyrsiflorus* (Roxb.) Nees., *Pogostemon benghalense* (Burm. f.) Kuntze., *Ziziphus mauritiana* Lam., *Androsace umbellata* (Lour.) Merrill, *Anisomeles indica* (L.) Kuntze, *Asparagus racemosus* Willd.

MATERIAL AND METHOD

Satellite Data

ALOS PALSAR -2 High-Sensitive mode full (Quad) Polarimetry (HBQ) scene was obtained from Japan Aerospace Exploration Agency (JAXA). The image was acquired with an off-nadir angle of 33.2° and covered an area of 70×70 km^2. The image was acquired in the month of March, 2016. The description of the data are given below:

Satellite	Polarization	Frequency Band	Range Resolution (m)	Azimuth Resolution (m)	Incidence Angle
ALOS PALSAR-2	Quad (HH+HV+VH+VV)	L	5.1	4.3	33.2°

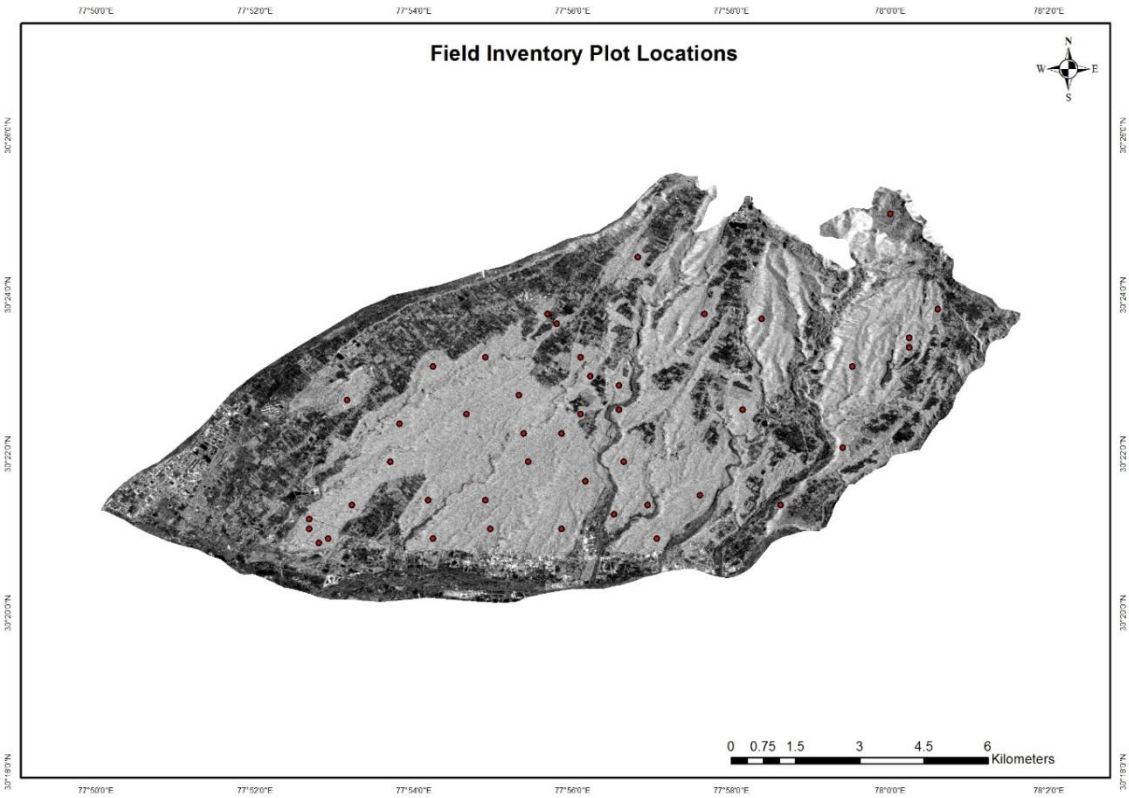

Figure 1. The location of *in-situ* field observation.

Field Inventory Data

A total of 44 sample plots were laid down randomly in the entire study area. The vegetation was analysed by the means of random sampling to give most representative composition of vegetation. A point one hectare (0.1ha) plots were laid out in the area. The girth at breast height (1.37m) were measured using measuring tape and height were measured using hypsometer. The location of the plot were recorded by using geographic positioning system (GPS). The locations were shown in the figure 1.

Estimating tree Volume and plant Biomass from field inventory data

The allometric equations developed by Forest Survey of India (FSI, 1996) were used for assessment of tree volume. The girth at breast height were converted into dbh, and basal area was calculated. The volume equations for a species were carefully chosen considering the 'n' (total number of sample tree on which regression equation are based) and 'R^2' (Coefficient of determination) for the nearest geographic region. The volume was multiplied with wood specific gravity (Forest Research Institute, 1996) and Biomass expansion factor (BEF) to estimate the biomass (Biomass = Volume × Specific Gravity× BEF). The plot level biomass was further scaled to pixel level biomass (per pixel biomass) as well as tones/ha biomass.

ALOS PALSAR data Processing

The data was processed in SNAP software. It was calibrated to provide imagery in which pixel value can be directly related to radar backscatter of the scene. Typical SAR data processing, which produces level 1 images, does not include radiometric corrections and significant radiometric bias remains. Therefore, it is necessary to apply the radiometric correction to SAR images so that the pixel values of the SAR images truly represent the radar backscatter of the reflecting surface. The image was studded with speckle which is due to coherent interference of the wave. Multi-looking was performed to reduce the speckle and improves interpretability. The image was further applied with speckle filtering (Refined Lee). Due to topographical variations of a scene and the tilt of the satellite sensor, distances can be distorted in the SAR images. Image data not directly at the sensor's Nadir location will have some distortion. Terrain corrections are intended to compensate for these distortions so that the geometric representation of the image will be as close as possible to the real world. The backscatter intensity image was converted into decibel (Sigma naught, σ°).

Spectral Modelling and Estimation of Carbon Sequestration

The spectral information were exported with the help of plot location. The relationship has been established between plot level biomass and backscatter coefficient of different polarization. The significant relation was used for the upscaling of phytomass from pixel to regional level. The biomass map gives the total amount of forest above ground biomass. The carbon stock has been calculated by multiplying the biomass with a factor of 0.47. The carbon sequestration by forests was calculated by multiplying the total amount of carbon by 0.36 (Belop, S.V., 1976,1980).

RESULT AND DISCUSSION

The result of this study can be seen in three ways i.e. the field data statistics, the derivatives of SAR imagery and the graphical representation of relationship between backscatter coefficient and biomass.The plot level forest inventory reveals that the top height of the plot varies from 12 m to 41 m. The number of trees varies from 12 in few plots to 53 in some plots. The biomass per plot varies from 8.2 tonnes/ha to 452.51 tonnes/ha. The processing of SAR image results in the generation of image having different polarization. The plot level biomass were plotted against the backscatter coefficient. It was concluded according to figure (2b) that the HV backscatter gave the highest correlation with a coefficient of determination (R^2) of 0.8918. It was followed by VV polarisation (R^2= 0.869) and HH (R^2 = 0.855). The correlation analysis indicates that the AGB has a logarithmic relationship with the variables. Based on the correlation analysis, the backscatter of HV polarisation was selected as the AGB predictionmodel as it gave the best R^2compared to the other variables.The cross polarized (HV) L-band backscatter appears to respond slightly more to differences in vegetation than the co-polarized (HH & VV) polarization. These observations support other studies of the SAR remote sensing of forests (Baker et al., 1994; Le Toan et al., 1992; Dobson et al., 1992) and are in agreement with predictions made by models of radar backscatter from forest targets (Richards, 1990).

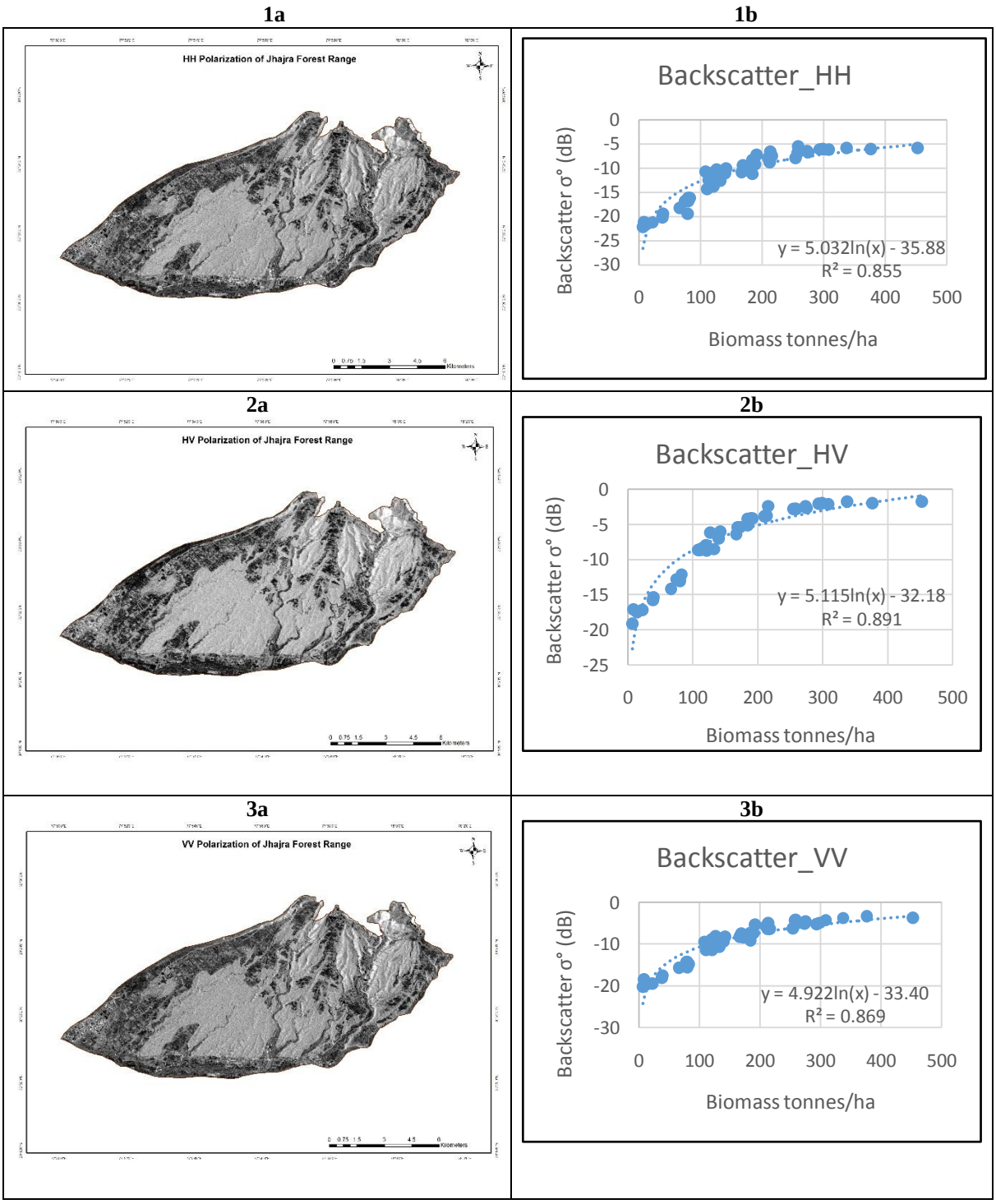

Figure 2: The SAR processed images are represented as 1a (HH Pol.), 2a (HV pol.) and 3a (VV pol.) and the respective backscatter relations are represented in 1b, 2b and 3b.

The modelled biomass ranges from 5.2 tonnes/ha to 397.45 tonnes/ha. It shows great relevance with the *in-situ* data. The underestimation of biomass through modelling is due to the saturation of biomass at higher level. It was observed that the study area is dominated with biomass greater than 150 tonnes/ha. The table 1 describes the distribution of modelled biomass and carbon in the study area. A total of 5, 05,259.55 tonnes of biomass is stored in the study area along with 2, 37,471.99 tonnes of carbon. The carbon sequestration potential of the study area is 8, 71,522.20 million gram carbon. There is no information for 225.14 ha of the area because of the effect of layover and foreshortening. This effect has been eliminated from the scene because it results in overestimation of biomass because of very high backscatter.

Table 1. The distribution of biomass and carbon in different density class of study area.

Forest Density Class	Total Area (ha)	Modelled Biomass (Tonnes)	Modelled Carbon (Tonnes)	Carbon Sequestration Potential(Million gram carbon)
Open Forest (<50t/ha)	712.58	21477.16	10094.27	37045.96
MDF (50-150 t/ha)	1862.23	205888.15	96767.43	355136.47
VDF (>150 t/ha)	1238.94	277894.24	130610.29	479339.78
NF	6724.01	0.00	0.00	0.00
Layover & Foreshortening	225.14	0.00	0.00	0.00
Total	**10762.9**	**505259.55**	**237471.99**	**871522.20**

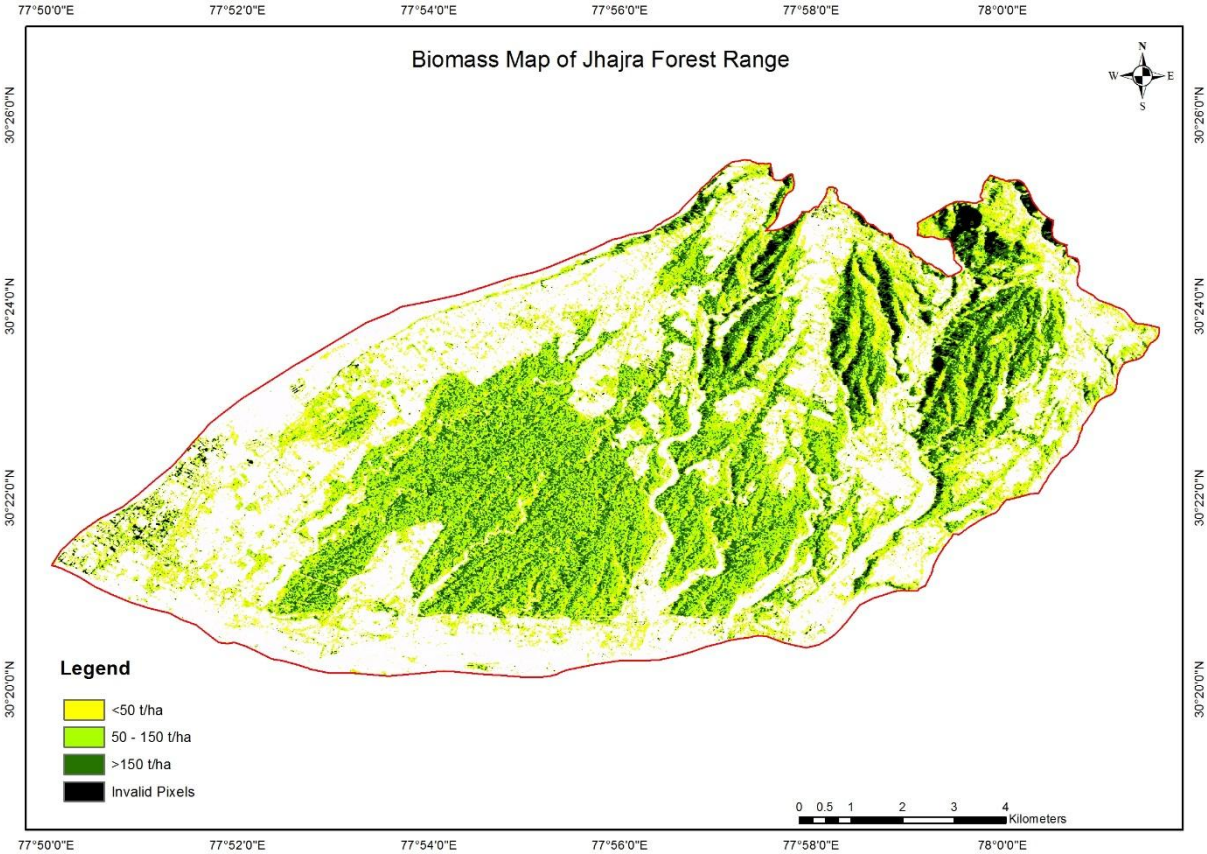

Figure 3. Biomass map derived from HV backscatter image.

CONCLUSION

This study provides a relevant information about the amount of biomass and carbon stored in the study area. It demonstrate the potential of L-band ALOS PALSAR-2 data to delineate the spatial distribution of biomass and carbon in Jhajra forest range.The study will be helpful to estimate the biomass for areas having similar species composition and topography. It will help in quick and accurate estimation which will reduce the human labour and time. The simple logarithmic regression approach used in the study is the most commonly used approach throughout the world. The integration of different polarization and inclusion of different parameters in the model will further enhance the accuracy and reliability. The effect of layover and foreshortening can be overcome by using different SAR scene having different incidence angle. The effect is very less in tropical forests but as we move up from tropical to sub-tropical and temperate the effect keep on increasing.

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RESEARCH ARTICLE

ISOLATION AND CHARACTERIZATION OF VARIOUS FUNGAL STRAINS AS PRIMARY COLONISER FROM WHEAT STRAW AT VARYING NITROGEN CONCENTRATIONS

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Abstract: The present study was undertaken with an aim to search for the fungal strains, which have the potential to efficiently decompose wheat straw with high C:N ratios. Identification and characterization of these microbial species is important to study their decomposition potential for use in soil fertility management. A total 19 strains of fungal primary colonizers were isolated from a sample of wheat straw. Out of these, one belonged to Zygomycota while the remaining 18 belonged to Deuteromycota. *Alternaria, Aspergillus, Cladosporium, Helminthosporium, Stachybotrys, Fusarium* and *Penicillium* were the most frequently isolated genera at low nitrogen concentration. Isolated strains at low nitrogen concentration seem to be the most probable candidates, as initial primary bio inoculants, for hastening the decomposition of wheat straw. The results of this study suggest the possibility of utilizing fungal inoculants as an integrated component of microbe-based strategies for biotechnological management of wheat straw.

Keywords: Wheat Straw, Microorganisms, Isolation, Decomposition, Serial dilution, Fertilizers

INTRODUCTION

Wheat is grown basically for the grains. But the utility of the remaining parts of the wheat plant cannot be ignored. A lot of wheat straw is produced in wheat-growing belts in the world. A significant proportion of wheat straw has been in use as feed for ruminants because of its abundance and low cost (Viola *et al.* 2008; Bals*et al*., 2010; Manriquez *et al*. 2016). However, it is also used for the production of pulp and paper (Zhao *et al.* 2004), strawboards (Deswarte*et al*., 2007), textiles and composites (Avella *et al.*, 1995; Reddy *et al.* 2007), plastics (Avella *et al.*, 1995) and for the removal of metals in wastewater industry (Kumar *et al*., 2000; Doan *et al*., 2008) and hybrid composite materials (Yu *et al.* 2016*).*

Incidentally, a major portion of straw is burnt in the field itself (Gupta *et al*., 2004). This results, on one hand, in a waste of organic sources in soil affecting C:N ratio and biota; and on other hand, leads to global warming and environmental problems (Badrinath *et al*. 2006; Sastre *et al*. 2015). Keeping in mind the harmful effects of burning straw in the field as well as the convenience of the farmer, economical, environment–friendly and low labour strategies should be adopted for effective utilization of the straw.

Primary colonizers are the microorganisms which play an important role in the initiation of decomposition. These organisms span parasitic as well as saprophytic phases. They possess cellulolytic (Sajith *et* al. 2015) and pectolytic activity at low nitrogen level, and are able to grow at faster rate on a comparatively drier resource (Charaya *et al.* 2005, 2006), (Chauhan *et al.*, 2006) and (Rani, 2008) also found that majority of the primary colonizers of plant litter possessed weak parasitic tendency.

Organic matter plays a unique role in soil fertility (Zhao et al. 2016). It acts as a sink as well as a source for nutrient. It prevents environmental pollution and the loss of nutrients. Above all, it helps in maintaining nutrients balance in the soil which is the basic attribute for sustainability (Raman, 2005). In a natural ecosystem, entire biomass of the plants is returned to the soil after the death of the plants through the process of decomposition. However, in agro-ecosystems, a significant proportion of the biomass is removed from the soil. Hence, intensive cultivation of crop requires massive application of synthetic fertilizers to compensate for the loss of nutrients from the soil as a result of their removal by the agricultural crops.

However, the prohibitive cost of chemical fertilizers as also numerous environmental problems associated with their production and use have prompted agricultural scientists to look for better alternatives. It is being gradually realized that organic wastes and biological sources of nutrients are better alternatives and these may serve as substitutes for inorganic fertilizers to a considerable extent, if not absolutely (Shukla and Mathur, 2000). Wheat straw provides one such alternative. The application of biodegraded products of straw into soil has enormous potential to recycle nutrients and maintain soil fertility (Gaind *et al*., 2006; Zhang *et al*. 2015, Rahman *et al*. 2016).

Straw contains approximately 0.5% nitrogen and 40% carbon. Straw, when subjected to colonization by fungi, has only 0.5 units of nitrogen to offer to the fungi which generally require 1.2 to 1.6 units for

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growth; thus, a deficit of 0.7 to 1.1 units of nitrogen appears in the environment (Alexander, 1977). Many workers including Park (1976) pointed out that the fungi which show high degree of cellulolytic ability under laboratory conditions fail to colonize and degrade the plant residues in a correspondingly effective manner.

Hence, it is important to take into account the nitrogen level of resources to be degraded in the selection of effective decomposers. Since wheat straw has low nitrogen content, it should be preferable to use those organisms for the purpose of decomposition which can grow, reproduce and carry out polysachharolytic activity at low nitrogen levels. In other words, those microorganisms which can operate the process of decomposition with lesser units of nitrogen would be more suitable as primary colonizers or primary bioinoculants.

However, van Fassen and van Dijk (1979) have demonstrated that hot composting of straw leads to considerable losses of nitrogen in the form of ammonia also, and therefore only relatively small gains in nitrogen appear to take place during decomposition. If it is so, the secondary colonizers also have to face the deficiency of nitrogen. The addition of nitrogen to crop residues has been reported to enhance the rate of decomposition of crop residues but only when a large amount of residues with low nitrogen was decomposing. Additional supply of nitrogen is believed to enhance the growth of decomposers (Fan *et al*., 1981; Yadav, 1987; Mary *et al*. 1996; Hu *et al. 2*015; Wang *et al*. 2015 and Maaroufi et al. 2017).

Primary colonizers are the microorganisms which play an important role in the commencement of decomposition of crop residues. Identification and characterization of these microbial species is important for studying their decomposition potential vis a vis soil fertility management. In the present study an attempt has been made towards isolation and characterization of fungal strains which can survive and flourish at low nitrogen concentrations or higher C/ N ratios.

MATERIAL AND METHOD

Isolation of Fungi

Freshly harvested wheat straw was collected from agricultural fields situated at village Khardoni, Meerut. The samples were collected aseptically in fresh polythene bags and brought to the laboratory for further studies. Serial dilution plate method (Waksman, 1927) was used to isolate the fungi from wheat straw sample. 1 g of the sample was placed in 250 ml of sterile water and stirred for fifteen minutes using a magnetic stirrer to get the stock solution. 10 ml of this solution were immediately transferred to a conical flask containing 90 ml of sterile distilled water to get a suspension of 1:10 dilution. This suspension was used for the preparation of further serial dilutions (1:100, 1:1000). From the suspension of each dilution (1:10, 1:100, 1:1,000), 1 ml aliquots were transferred to each of a set of three Petri dishes followed by the addition of approximately 20 ml of cooled (45°C) and sterilized culture medium. Czapek'sDox Agar medium (Raper and Thom, 1949) with 30 ppm of rose bengal and 30 mg of streptomycin was used for this purpose. This medium served as control and was designated as N. The media with 2/3 (two third), 1/2 (half) and 1/3 (one third) concentrations (i.e. 1.5 g/1, 1.0 g/1 and 0.67 g/1 respectively) of nitrogen (sodium nitrate) as compared to control (2.0 g/1) were also prepared. The media with 2/3, 1/2 and 1/3 concentrations of nitrogen were designated as N/1.5, N/2 and N/3 respectively.

Records of the Fungi Isolated

Isolation and identification of the fungi was done in the microbiology laboratory of the Department of Botany, CCS University, Meerut, India. The Petri dishes were observed from the third day itself when fast-growing fungi started appearing in the Petri dishes. The slow-growing fungi were transferred onto other Petri dishes just after their appearance to prevent them from being overrun by the fast growing fungi. A complete record of the fungal species and their numbers in cfus (cfus: colony forming units) in the Petri dishes was maintained. The identification of the fungal species was done on the basis of their morphology and cultural characteristics following Gilman (1957), Barnett and Hunter (1972), Subramanian (1971), Ellis (1971, 1976), Domsch and Gams (1972), Domsch *et al.* (1980), Nagmani *et al.* (2006), Venkateswarlu et al (2015), Singh et al. (2015).

Purification and Maintenance of Cultures

The fungal strains were purified by hyphal cut method and streak plate method. The pure cultures were maintained on PDA medium (Riker and Riker, 1936) on slants and were stored in a refrigerator.

RESULT AND DISCUSSION

The current practice of using media having low C:N ratio for the isolation of microflora colonizing the resources with much higher C:N level in most biological laboratories is not appropriate as it might not present a true picture of the colonizer microorganisms. There are greater chances that the microbes present on the resource would be favored by the medium having higher nitrogen levels, thus distorting the picture completely by tilting the balance against the active microorganisms not capable of growing fast enough on the medium with high nitrogen and in favor of those microbes which are not actually active on the litter but grow better on the medium employed. Therefore, it would be worthwhile to use media with the C:N ratio comparable to that in the resource under study. The dominance of Deuteromycota observed in the present

study is in full agreement with the earlier reports (Hudson, 1968; Dickinson and Pugh, 1974; Hayes and Lim, 1979; Charaya, 2006; Tiwari and Charaya, 2006; Sen and Charaya, 2010), Guleri *et al.* (2016). Only 1 members belonging to the order Mucorales were isolated in the present study thus supporting the findings of Galloway (1935), Singh and Charaya (1975), Dube *et al.* (1980), Singh (2004), Charaya (2006) and Tiwari (2010) which indicated the paucity of Mucorales in the tropical regions of India.

A total of 19 strains of fungal primary colonizers were isolated from the wheat straw through serial dilution plate method using media containing different levels of nitrogen. 19 fungal strains were isolated as: *Aspergillus flavus, A. fumigatus , A. luchuensis, A. oryzae, A. niger, A. sydowi, A. ustus, A. wenti, Alternaria alternata, Alternaria citri, Alternaria longipus, Alternaria palandui, Chaetomiumflavum, Dreschleraavenacae, Cladosporium herbarum, Fusarium* sp., *Helminthosporium microsorum, Penicillium frequentans, P. funiculosum, P. implicatum, P. paxilli, P. spinulosum, Rhizopus* sp., and *Stachybotrys atra.* Out of these, only one belonged to Zygomycota while the remaining 18 belonged to Deuteromycota.

Among the Deuteromycota, the Hyphomycetes constituted the major component. 13 species belonging to Moniliaceae and 5 species belonging to Dematiaceae were obtained. Among the Moniliaceae, 6 species belonged to the genus *Aspergillu*s while only 5 belonged to the genus *Penicillium*. It is widely believed that Aspergilli are more common in warmer regions of the world while the Penicillia are more abundant in the colder regions

Three species were isolated and identified as *Alternaria alternata, Aspergillus niger and Stachybotrys atra* at all concentration of media used in this study. Among these isolated fungal strains, *A. alternate* was obtained exclusively. 12 Isolates of this fungal sp. with 66.66 frequencies were obtained at N media while at N/1.5, N/2 and N/3 media total 8, 10 and 10 isolates were obtained with 33.33, 55.55 and 44.44 frequency respectively.

Total 33 fungal isolates belonging to 11 species were identified as *A. alternate (12), A. longipes* (1)*, A. luchuensis* (2), *A. niger* (1), *A. ustus* (2), *Fusarium sp. (2), C. herbarum* (3) *and P. funiculosum* (1), *P. paxilli* (1) *Rhizopus* sp (3) *Stachybotrys atra* (5). *A. Citri, A. palandui, A. flavus, A. fumigates, A. oryzae, H. microsorum* and *P. frequentans* were note obtained at media N. Total 26 fungal isolates belonging to 6 species were obtained from N/1.5 media and identified as *A. alternate* (8), *A.Citri* (1), *A. niger* (5), *A. oryzae* (7), *P. spinulasum* (1) and *Stachybotrys atra* (4). *A. longipes, A. palandui, Aspergillus flavus, A. fumigates, A. luchuensis, A. ustus, Cladosporium herbarum, Fusarium sp. H. microsorum, Penicillium frequentans, P. funiculosum, P. implicatum, P. paxilli and Rhizopus* species were absent at N/1.5 media. Results of this study have been summarized in table 1 and represented by figure 1.

Table 1. A comparison of the Total Isolate (TI) and Frequency (F), Frequency Class (FC) of fungal species isolated using media of different nitrogen levels (N, N/1.5, N/2, N/3) from wheat straw.

Fungal Species	**N**			**N/1.5**			**N/2**			**N/3**		
	TI	**F**	**FC**	**TI**	**F**	**FC**	**TI**	**F**	**FC**	**TI**	**F**	**FC**
Alternaria alternata	**12**	**66.66**	**VI**	**8**	**33.33**	**II**	**10**	**55.55**	**III**	**10**	**44.44**	**III**
A. citri	–	–	–	1	11.11	I	–	–	–	1	11.11	I
A. longipes	1	11.11	I	–	–	–	–	–	–	4	22.22	II
A. palandui	–	–	–	–	–	–	1	11.11	I	1	11.11	I
Aspergillus flavus	–	–	–	–	–	–	5	22.22	II	1	11.11	I
A. fumigates	–	–	–	–	–	–	5	22.22	II	–	–	–
A. luchuensis	2	11.11	I	–	–	–	–	–	–	–	–	–
A. Niger	1	11.11	I	5	33.33	II	3	33.33	II	1	11.11	I
A. oryzae	–	–	–	7	11.11	I	–	–	–	–	–	–
A. ustus	2	22.22	II	–	–		3	22.22	II	–	–	–
Cladosporium herbarum	3	22.22	II	–	–	–	3	22.22	II	–	–	–
Fusarium sp.	2	22.22	II	–	–	–	–	–	–	1	11.11	I
Helminth. microsorum	–	–	–	–	–	–	1	11.11	I	1	11.11	I
Penicillium frequentans	–	–	–	–	–	–	–	–	–	1	11.11	I
P. funiculosum	1	22.22	II	–	–	–	–	–	–	–	–	–
P. implicatum	–	–	–	–	–	–	–	–	–	1	11.11	I
P. paxilli	1	11.11	I	–	–	–	–	–	–	–	–	–

P. spinulosum	–	–	–	1	11.11	I	–	–	–	–	–	–
Rhizopus sp.	3	22.22	II	–	–	–	1	11.11	I	–	–	–
Stachybotrys atra	5	33.33	II	4	33.33	II	3	22.22	II	1	11.11	I
Total Isolates	**33**			**26**			**35**			**23**		
Total Species	**11**			**6**			**8**			**11**		

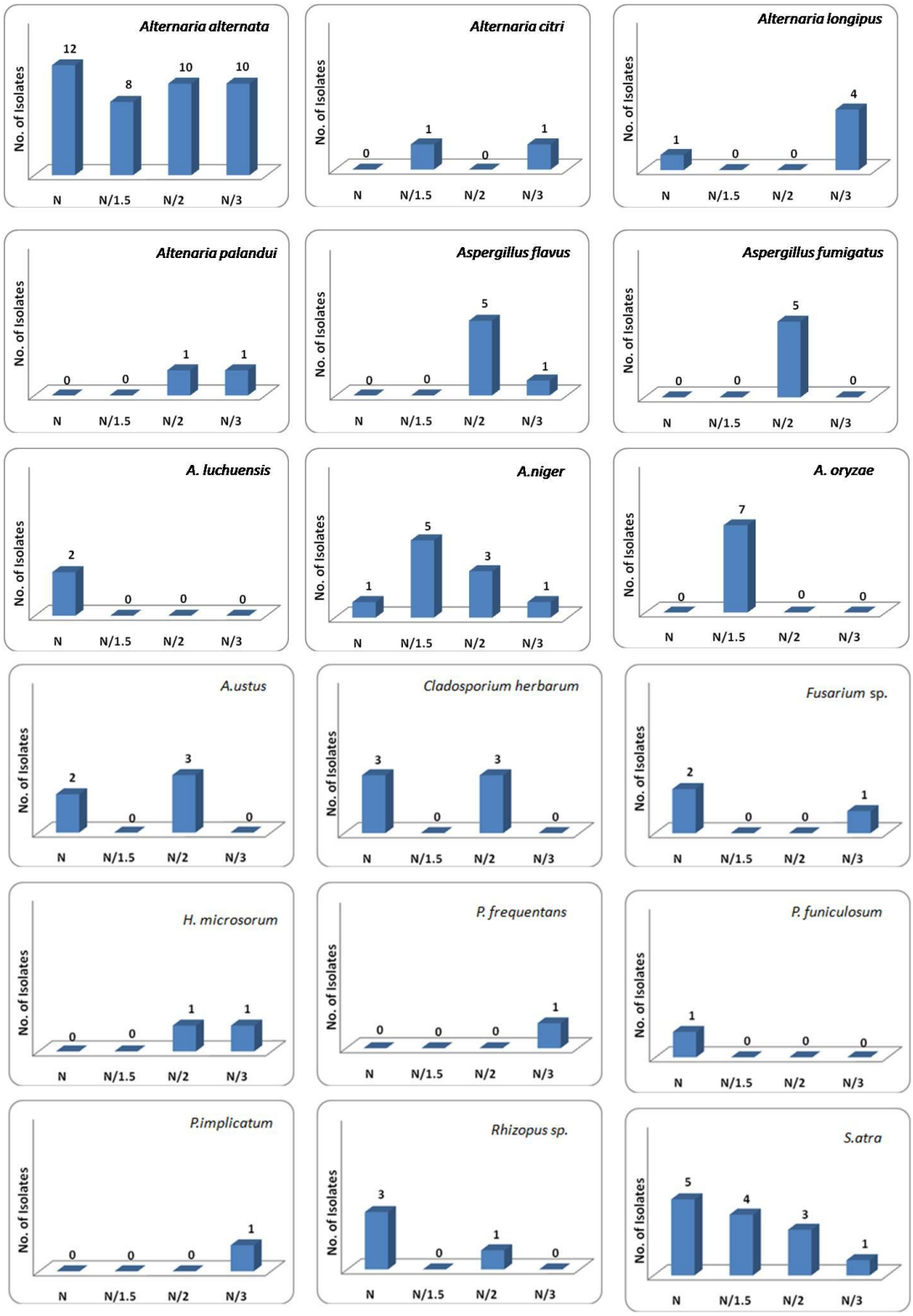

Fig 1: A comparison of the Total Isolate at different nitrogen levels

Total 35 isolates at N/2 media belonging to 8 fungal species were identified as *A. alternate* (10), *A. palandui* (1), *A. flavus* (5), *A. fumigates* (5), *A. niger* (3), *A. ustus* (3), *C. herbarum* (3) *and H. microsorum* (1). A. citri, A. *longipes, A. luchuensis, A. oryzae, Fusarium sp. P. frequentans, P. funiculosum, P. paxilli and P. spinulosum* were not obtained at this nitrogen concentration.

Total 23 fungal isolates belonging to 11 species were obtained at N/3 media and identified as *A. alternata* (10), *A. citri* (1), *A. longipes* (4), *A. palandui* (1), *Aspergillus flavus* (1), *A. niger* (1), *Fusarium* sp. (1*), H. microsurum* (1), *Penicillium frequentans* (1), *P. implicatum* (1) and *Stachybotrys atra* (1). *A. fumigates, A. luchuensis, A. oryzae, A. ustus, C. herbarum, P. funiculosum, P. paxilli, P. spinulosum and Rhizopus* sp. were not btained at N/3 media. It was apparent from the results that *Alternaria alternata* was abundant at all nitrogen concentrations used in this study (table 1 and and fig. 1).

CONCLUSION

The present study describes isolation and identification of fungal colonizers growing actively at low nitrogen concentrations, having potential decomposing activity and their enzyme make-up. Attempt has also been made to identify the fungal strains which respond favourably to supplementation of the resource with additional nitrogen. The results suggest the possibility of utilizing fungal inoculants as an integrated component of microbe based strategies for biotechnological management of agricultural wastes. Czapek's media with different concentrations of nitrogen were prepared to the study the effect of different nitrogen levels on radial growth of selected fungal species Eighteen fungal species *viz. Alternaria alternata, A. citri, A. longipes, A. palandui, Aspergillus flavus, A. fumigatus, A. luchuensis, A. niger, A. oryzae, A. ustus, Cladosporium herbarum, Fusarium* sp., *Helminthosporium microsorum, Penicillium frequentans, P. funiculosum, P. implicatum, P. paxilli, P. spinulosum* and *Stachybotrys atra* were taken for studying effect of nitrogen and results of this study would be communicated in a subsequent paper.

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RESEARCH ARTICLE

COMMUNITY STRUCTURE OF DANDACHALI FOREST OF TEHRI FOREST DIVISON, NORTH-WEST HIMALAYA

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Abstract: The present investigation was conducted in Dandachali forest of Tehri Forest Division, North-Western part of Himalaya. Surveys and sampling of the vegetation were done using standard ecological assessment methods with an aim to study plant species composition and natural regeneration status at community level. Forty seven woody species (17 trees) belonging to 12 families and 15 genera, and 6 forest communities *viz*., *Pinus roxburghii- Quercus leucotrichophora* mixed, *Pinus roxburghii*, *Pinus roxburghii- Rhododendron arboreum* mixed, *Cedrus deodara- Pinus wallichiana* mixed, *Cedrus deodara- Rhododendron arboreum* mixed and *Rhododendron arboreum- Quercus leucotrichophora* mixed, have been recorded in 16 sites between 1482- 2200 m asl. Among the communities, total tree density ranged from 263.34-1493.33 Ind ha^{-1}, TBA 260.2- 310.7 m^2 ha^{-1} and total shrub density 488.3- 4250 Ind ha^{-1}. Species diversity (H') for trees ranged from 0.58-1.89. Concentration of dominance (cd) of trees ranged from 0.20-0.76.

Keywords: Survey, Tehri Forest Division, North-West Himalya

INTRODUCTION

The Phytosociological characters express the quantitative information on analytical characters, composition and pattern of distribution of the species (Saxena, 1982; Ralhan *et al*., 1982; Sharma and Kumar, 1992). In a forest ecosystem, all plant species are not equally important but there are only a few overtopping species which by their bulk and growth modify the habitat and control the growth of other species of the community as these species are called dominants (Gaston, 2000). Therefore, phytosociological studies are essential for protecting the natural plant communities and biodiversity as well as understanding the changes experienced in the past and continuing on into the future.

The plant diversity and regeneration status of particular forests is baseline information for the management and conservation of biodiversity. Regeneration studies are important in view predictin g structure and composition of the species. Regenerating forests can be characterized by presenc e of seedlings, saplings and trees of different age groups, from young to old (Chauhan, 2001, Chauhan *et al*., 2001). regeneration status of tree species based on the age and diameter structure of their population (Khan *et al*., 1987; Bhuyan *et al*., 2003).

Study area

The study was carried out in Dandachali forest of Tehri Forest Division, Tehri Garhwal (district), Uttrakhand (State) part of North West Himalaya. Tehri Forest Division covers 143268.90 ha total forest areas, situated between latitude N-30^0-03'05" and 30^0-52'077" and longitude E-78^0-56'35" and 79^0-02'45". Tehri Range of the division lies between 30^0-22'077" North latitude and 30^0-25'599" East longitude which covers 16144.70 ha area. Lohital beat of this range covers 1117.30 ha area, comprises of 14 compartments. Out of 1332 Vanpachayats in Tehri district, 273 Vanpachayats are included in Tehri Forest Division.

METHODOLOGY

Selection of Sites and Habitats for Vegetation Sampling: Sites were selected on each and every accessible aspect along an altitudinal gradient. The habitats were identified based on the physical characters and dominance of the vegetation. Sites having closed canopy with high percentage of humus and moisture were considered as moist habitats whereas low percentage of the same as dry habitats.

Assessment of the Forest Vegetation: In each site, a plot of 50x50m (0.25 ha) was laid. Trees, saplings and seedlings were sampled by randomly placed 10, 10x10m quadrats and shrubs by 20, 5x5m quadrats. For the collection of data from these quadrates standard ecological methods (Curtis and McIntosh, 1950; Grieg-Smith, 1957; Kersaw, 1973; Muller-Dombois and Ellenberge, 1974; Dhar *et al*., 1997; and Samant and Joshi, 2004) were followed. The circumference at breast height (cbh at 1.37m from ground) for each tree individual was recorded. Based on cbh, the tree individuals were considered as tree (cbh ≥ 31.5 cm).

Data analysis and Formulae used: Data analysis has been done following standard ecological methods (Curtis & McIntosh, 1950; Grieg-Smith, 1957; Kersaw, 1973; Muller-Dombois & Ellenberge, 1974; Dhar *et al*., 1997; and Samant and Joshi 2004).

Species diversity: Species diversity (H') was determined by Shanon Wiener's information statistic (Shanon and Weiner, 1963). Diversity is usually considered as a function of relative distribution of individuals among the species. Shannon-Weiner

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information index (Shannon and Wiener, 1963) was used for estimating the diversity.

$$H= - \Sigma (Ni/N) \log 2 (Ni/N)$$

Where, Ni is the total number of individuals of a species and N is the total number of individuals of all species in that stand.

Concentration of dominance (Cd): Concentration of dominance (Cd) by Simpson's Index (Simpson, 1949). The index of dominance (C) of the community is calculated by Simpson's index (Simpson, 1949);

$$C= (Ni / N)^2$$

Where, Ni is the total number of individuals of species and N is the total number of individuals of all species.

RESULT AND DISCUSSION

Total of 16 sites were surveyed in the area. A total of 17 species belonging to 12 families and 15 genera were recorded in the study area (Table 6). Family Pinaceae dominated with maximum number of species (3 spp.) followed by Cornaceae, Ericaceae, Fagaceae and Symplocaceae, (2 spp., each (2 spp., each). All other families had only one species. Dominant genera were Quercus, Pinus and Symlplocus (2 spp., each), followed by all other genera is single were represented in all sites (16 sites) followed by *Lyonia ovalifolia* (15 sites), *Rhododendron arboreum* (12 sites) and *Pyrus pashia* (10 sites). Dry degraded habitat was the richest in number of species (15 spp.) followed by dry degraded (12 spp.) and shady moist (10 spp.). A total of 6 forest communities were delineated in the study area. *Pinus roxburghii* community represented in maximum sites (#6), followed by *Cedrus deodara - Rhododendron arboreum* mixed and *Pinus roxburghii -Rhododendron arboreum* mixed (#3, each), *Cedrus deodara- Pinus wallichiana* mixed (#2) and *Pinus roxburghii- Quercus leucotrichophora* mixed and *Rhododendron arboreum - Quercus leucotrichophora-* mixed (#1, each).

Community composition, Structure and Regeneration pattern: Community wise total density, total basal area (TBA) and IVI of tree species and relative density of shrubs have been presented in Table 2, 3, 4, and 6, respectively.

***Pinus roxburghii- Quercus leucotrichophora* mixed**

The physical characteristics of the community have been presented in Table 2) 1. This community has been represented only in 1 site.

Community and structure: A total of 17species (trees: 2) were recorded in the community. Total tree density and total basal area were 380.00 Ind ha^{-1} and 296.42 m^2 ha^{-1}, respectively (Table 2, 3). *P. roxburghii* (Density: 220 Ind ha^{-1}, TBA: 174.28 m^2 ha^{-1} and IVI: 166.69) was the dominant tree species, associated by *Q. leucotrichophora* (Density: 160 Ind ha^{-1}, TBA: 122.14 m^2 ha^{-1} and IVI: 133.31). Similar study was conducted by Singh *et al.* (1994) at Nainital Forest Division where maximum TBA (70.90 m^2 ha^{-1}) was found in pine dominated forest at 1850m and minimum in oak dominated forest at 1650m elevation. Ahmed (2012) conducted a study in Kumaon Himalaya where *Q. leucotricophora* was found dominant in terms of density (183.2 trees/ha), mean basal area (625.3 Ind ha^{-1}) and IVI (99.9).

Pinus roxburghii

The physical characteristics of the community have been presented in Table 1. This community has been represented in 6 sites.

Community and structure: A total of 17 species including trees (6 spp.) were recorded in the community. Total tree density, TBA and IVI were 263.33 Ind ha^{-1} and 310.74m^2 ha^{-1}, respectively (Table 2, 3). In which *P. roxburghii* (Density: 228.33 Ind ha^{-1}, TBA: 309.85 m^2 ha^{-1} and IVI: 271.57) was the dominant tree and associated by *M. esculenta* (Density: 11.67 Ind ha^{-1}, TBA: 0.62 m^2 ha^{-1} and IVI: 10.60) and *Lyonia ovalifolia* (Density: 11.67 Ind ha^{-1}, TBA: 0.21 m^2 ha^{-1} and IVI: 8.95). Similar results were observed by Singh *et al*. (2014) at Nainital Forest Division. He noted maximum TBA (70.90 m^2/ha) in pine dominated forest at 1850m elevation and minimum in oak dominated forest at 1650m elevation**.** Gurarni *et al.* (2010) recorded maximum total tree density (1000 tree /ha), TBA (14.55 m²/ha) in mixed pine-oak forest compared to pine dominated forest.

***Pinus roxburghii-Rhododendron arboreum* mixed**

The physical characteristics of the community have been presented in Table 1. This community has been represented only in 3 sites.

Community and structure: A total of 17 species (trees: 09) were recorded in the community. Total tree density and TBA were 980.1 Ind ha^{-1} and 264.7 m^2 ha^{-1}, respectively (Table 2, 3). *P. roxburghii* (Density: 376.7 Ind ha^{-1}, TBA: 192.56 m^2 ha^{-1} and IVI: 140.9) was the dominant tree and associated by *R. arboreum* (Density: 350 Ind ha^{-1}, TBA: 69.24 m^2 ha^{-1} and IVI: 99.24) and *Lyonia ovaliofolia* (Density: 63.3 Ind ha^{-1}, TBA: 1.14 m^2 ha^{-1} and IVI: 18.88). Results of the present study showed higher density of tree and shrubs as compared to other studies like Rai *et al*. (2009) in Western Himalayas in case of *R. arboreum* and Rawat *et al.* (2014) in Govind Pashu Vihar National Park, Uttarkashi.

***Cedrus deodara- Pinus wallichiana* mixed**

The physical characteristics of the community have been presented in Table 1. This community has been represented only in 2 sites.

Community and structure: A total of 17 species (trees: 11) were recorded in this community. Total tree density and TBA were 795.0 Ind ha^{-1} and 281.9 m^2 ha^{-1}, respectively (Table 2, 3). *C. deodara* (Density: 270 Ind ha^{-1}, TBA: 147.8 m^2 ha^{-1} and IVI: 127.2) was the dominant tree and associated by *Pinus wallichiana* (Density: 190 Ind ha^{-1}, TBA: 55.41 m^2 ha^{-1} and IVI: 60.12) and *R. arboreum* (Density: 115

Ind ha^{-1}, TBA" 35.17 m^2 ha^{-1} and IVI: 33.4). These results are in line with Sharma and Raina (2013) in Jammu province of north-western Himalayas where the highest density, TBA and IVI values for *C. deodara* (675 Trees/ha, 72.80 m^2 /ha and 213.54) were recorded. Results are very similar to Singh and Samant (2010) in North Western Himalaya where total shrub density was highest in *C. deodara* (2611.7 Ind ha-1) community.

***Cedrus deodara - Rhododendron arboreum* mixed**

The physical characteristics of the community have been presented in Table 1. This community has been represented only in 3 sites.

Community and structure: A total of 17 species including 13 species of trees (Table 6) were recorded in the community. Total tree density and TBA were 1493.33 Ind ha^{-1} and 260.23 m^2 ha^{-1}, respectively (Table 2, 3). *R. arboreum* (Density: 516.67 Ind ha^{-1}, TBA: 90.69 m^2 ha^{-1} and IVI: 96.83) was the dominant tree and associated by *C. deodara* (Density: 386.67 Ind ha^{-1}, TBA: 141.04 m^2 ha^{-1} and IVI: 101.85) and *Lyonia ovalifolia* (Density: 153.33 Ind ha^{-1}, TBA: 2.00 m^2 ha^{-1} and IVI: 20.45). As far as tree species are concerned, these results are in contradiction of Singh and Gupta (2009) in Western Himachal Himalayas. In this study, the Periodic Block I indicated that among trees species *C. deodara* had maximum and *R. arboreum* had minimum average density, TBA, percentage frequency and IVI.

***Rhododendron arboreum- Quercus leucotrichophora* mixed**

The physical characteristics of the community have been presented in Table 1. This community has been represented in only 1 site.

Community and structure: A total of 17 species (trees: 8;) were recorded in this community. Total tree density and total basal area were 1060.0 Ind ha^{-1} and 273.8 m^2 ha^{-1}, respectively (Table 2, 3). *Q. leucotrichophora* (Density: 390 Ind ha^{-1}, TBA: 81.00 m^2 ha^{-1} and IVI: 91.37) was the dominant tree and associated by *R. arboreum* (Density: 290 Ind ha^{-1}, TBA: 110.9 m^2 ha^{-1} and IVI: 92.87) and *C. deodara* (Density: 140 Ind ha^{-1}, TBA: 71.19 m^2 ha^{-1} and IVI: 56.7). Similar results were observed by Kumar (2012) in mixed forest in Garhwal Himalayas where *Lyonia ovalifolia, R. arboreum* and *Q. leucotrichophora* were the predominant tree species. However, these results are in contradiction with Giri *et al*. (2008) in relation to the tree density and Upreti (1982) in TBA of *Q. leucotrichophora.*

Species diversity (H^I)

Community wise diversity of trees are shown in Table 5. Diversity of trees ranged from 0.58-1.89. The diversity of trees was maximum in *C. deodara- P. wallichiana* mixed community (1.89), followed by *C. deodara- R. arboreum-* mixed (1.87) and *R. arboreum- Q. leucotrichophora* mixed (1.64) communities. Results are comparable with Pant and Samant (2007) where species diversity in Mornaula Reserve Forest in case of trees ranged from 0.99-2.93.

Numerous studies are available on species diversity in temperate Himalaya (Saxena and Singh, 1982, Tripathi *et al*. 1987, Rikhari *et al*. 1989; Tripathi *et al*., 1991, Giri *et al*., 2008). The increased disturbance intensity may favor higher natality and survival of seedling. Particularly, anthropogenic disturbance first decrease the tree diversity with increasing intensity of disturbance decreased trees and sapling diversity and increased seedling diversity. The diversity of disturbance decreased the overall richness and diversity of the ecosystem.

Concentration of dominance (cd)

Community wise concentration of dominance of trees are shown in Table 5. Concentration of dominance of trees ranged from 0.20-0.76. Concentration of dominance of trees was maximum in *P. roxburghii* community (0.76), followed by *P. roxburghii- Q. leucotrichophora* mixed community (0.51) and *P. roxburghii- R. arboreum* (0.29) communities. However, it was lowest in *C. deodara- P. wallichiana* mixed (0.20) community. In case of shrubs, maximum *cd* was observed for *R. arboreum- Q. leucotrichophora* mixed (0.43) and minimum in *C. deodara- P. wallichiana* mixed (0.15) community. These results are very close with the findings of Pant and Samant (2007) for Mornaula Reserve Forest. In their study, *cd* of trees ranged from 0.06-0.49, however, *cd* of trees was highest in *Myrica esculenta* community (0.49), followed by *Pinus roxburghii* (0.46) where *cd* of particular species is concerned. These values were comparable to the previous records (Sexena and Singh, 1982, Ralhan *et al*., 1982).

CONCLUSION

The study provides information on floristic inventory, compositional and structural diversity at community level of species, first time in the selected area. Therefore, there is an immediate need to develop an adequate strategy and action plan for augmentation of natural regeneration and to employ artificial regeneration of the plant species for long term conservation management of habitats, species, and communities.

Results of the present study can be used for development of conservation management and micro planning of this areas and thus, socio-economic development of the inhabitants, in particular and biodiversity of the Himalaya, in general.

Table 1. Community types, their distribution, habitats and major associated species in study sites

Community types	SR	AR (m)	Habitat	Slope (^{0})	Aspect	Latitude	Longitude	Major associated spp.
Pinus roxburghii – Quercus leucotrichophora mixed	1	1482-1495	D, Deg	45	NE	30^0 18.808'N 30^0 18.900'N	078^0 25.154'E 078^0 25.204'E	*Pinus roxburghii, Quercus leucotrichophora, Berberis aristata, Rhus parviflora, Rhus cotinus*
Pinus roxburghii	6	1525-1791	D, Deg	35-50	NW, NE	30^0 18.080'N 30^0 18.470'N	078^0 25.137'E 078^0 25.073'E	*Lyonia ovalifolia, Myrica esculenta, Rhododendron arboreum, Berberis aristata, Myrsine Africana, Asparagus adscendens*
Pinus roxburghii- Rhododendron arboreum mixed	3	1863-2015	D, SM	30-50	N, NE	30^0 18.204'N 30^0 18.242'N	078^0 25.059'E 078^0 25.995'E	*Lyonia ovalifolia, Cornus capitata, Cedrus deodara, Myrsine africana, Rubus ellipticus, Indigofra atropurpurea, Pogostemon plectranthoides*
Cedrus deodara - Pinus wallichiana mixed	2	1873-2015	M, SM	50-70	N, NW	30^0 18.204'N 30^0 18.189'N	078^0 25.059'E 078^0 25.936'E	*Rhododendron arboreum, Pinus roxburghii, Populus ciliata, Rubus ellipticus, Pogostemon plectranthoides, Rubus paniculatus*
Cedrus deodara- Rhododendron arboreum mixed	3	1928-2116	SM	60-50	NW, NW	30^0 18.101'N 30^0 17.893'N	078^0 25.145'E 078^0 25.004'E	*Lyonia ovalifolia, Pinus roxburghii, Populus ciliata, Myrsine africana, Rubus ellipticus*
Rhododendron arboreum- Quercus leucotrichophora mixed	1	2116-2200	SM	55	NE	30^0 17.893'N 30^0 17.995'N	078^0 25.004'E 078^0 25.009'E	*Cedrus deodara, Lyonia ovalifolia, Pinus wallichiana, Myrsine africana, Berberis aristata*

Table 2. Community wise total density of trees (Ind ha^{-1}) in different forest localities in study area

Species Name	Community types					
	1	**2**	**3**	**4**	**5**	**6**
Pinus roxburghii	220.00	228.33	376.70	50.00	140.00	-
Swida macrophylla	-	6.67	-	-	-	-
Lyonia ovalifolia	-	11.67	63.30	20.00	153.30	90.00
Myrica esculenta	-	11.67	46.70	25.00	56.70	10.00
Quercus leucotrichophora	160.00	1.67	-	25.00	60.00	390.00
Rhododendron arboreum	-	3.33	350.00	115.00	516.70	290.00
Cedrus deodara	-	-	56.70	270.00	386.70	140.00
Cornus capitata	-	-	60.00	25.00	10.00	40.00
Populus ciliata	-	-	-	45.00	80.00	-
Pinus wallichiana	-	-	-	190.00	46.70	80.00
Ilex dipyrena	-	-	-	20.00	16.70	-
Pyrus pashia	-	-	-	10.00	-	20.00
Fraxinus micrantha	-	-	-	-	6.70	-
Symplocus paniculata	-	-	-	-	10.00	-
Symplocus crataegoides	-	-	10.00	-	10.00	-
Trema orientalis	-	-	10.00	-	-	-
Acacia dealbata	-	-	6.70	-	-	-
Total	**380.00**	**263.34**	**980.10**	**795.00**	**1493.30**	**1060.00**

Abbreviations used: 1= *Pinus roxburghii- Quercus leucotrichophora* mixed; 2= *Pinus roxburghii*; 3= *Pinus roxburghii- Rhododendron arboreum* mixed; 4= *Cedrus deodara- Pinus wallichiana* mixed; 5= *Cedrus deodara- Rhododendron arboreum* mixed; 6= *Rhododendron arboreum- Quercus leucotrichophora* mixed

Table 3. Community wise total basal area (m^2 ha^{-1}) of trees in different forest localities in study area

Species Name	Community type					
	1	**2**	**3**	**4**	**5**	**6**
Pinus roxburghii	174.28	309.85	192.56	11.94	16.32	-
Swida macrophylla	-	0.04	-	-	-	-
Lyonia ovalifolia	-	0.21	1.14	0.14	2.00	1.13
Myrica esculenta	-	0.62	0.76	0.86	0.52	0.01
Quercus leucotrichophora	122.14	0.00	-	0.21	0.14	81.00
Rhododendron arboreum	-	0.01	69.24	35.07	90.69	110.93
Cedrus deodara	-	-	0.81	147.78	141.04	71.19

Cornus capitata	-	-	0.14	0.33	0.01	0.86
Populus ciliata	-	-	-	29.34	5.52	-
Pinus wallichiana	-	-	-	55.41	3.47	8.37
Ilex dipyrena	-	-	-	0.84	0.27	-
Pyrus pashia	-	-	-	0.02	-	0.32
Fraxinus micrantha	-	-	-	-	0.14	-
Symplocus paniculata	-	-	-	-	0.08	-
Symplocus crataegoides	-	-	0.02	-	0.03	-
Trema orientalis	-	-	0.01	-	-	-
Acacia dealbata a	-	-	0.02	-	-	-
Total	**296.42**	**310.74**	**264.71**	**281.92**	**260.23**	**273.80**

Abbreviations used: 1= *Pinus roxburghii- Quercus leucotrichophora* mixed; 2= *Pinus roxburghii*; 3= *Pinus roxburghii- Rhododendron arboreum* mixed; 4= *Cedrus deodara- Pinus wallichiana* mixed; 5= *Cedrus deodara- Rhododendron arboreum* mixed; 6= *Rhododendron arboreum- Quercus leucotrichophora* mixed

Table 4. Community wise Importance Value Index (IVI) in different forest localities in study area

Species Name	**Community types**					
	1	**2**	**3**	**4**	**5**	**6**
Pinus roxburghii	166.69	271.57	140.87	18.74	27.76	-
Swida macrophylla	-	3.59	-	-	-	-
Lyonia ovalifolia	-	8.95	18.88	7.01	20.45	16.40
Myrica esculenta	-	10.60	12.83	7.48	9.17	3.45
Quercus leucotrichophora	133.31	1.79	-	12.10	7.51	91.37
Rhododendron arboreum	-	3.50	99.24	33.45	96.83	92.87
Cedrus deodara	-	-	13.42	127.25	101.85	56.71
Cornus capitata	-	-	7.62	8.10	1.54	11.59
Populus ciliate	-	-	-	14.80	14.89	-
Pinus wallichiana	-	-	-	60.12	8.94	20.60
Ilex dipyrena	-	-	-	8.78	3.63	-
Pyrus pashia	-	-	-	2.18	-	7.00
Fraxinus micrantha	-	-	-	-	2.57	-
Symplocus paniculata	-	-	-	-	2.90	-
Symplocus crataegoides	-	-	2.32	-	1.96	-
Trema orientalis	-	-	2.32	-	-	-
Acacia dealbata a	-	-	2.51	-	-	-
Total	**300**	**300**	**300**	**300**	**300**	**300**

Abbreviations used: 1= *Pinus roxburghii- Quercus leucotrichophora* mixed; 2= *Pinus roxburghii*; 3= *Pinus roxburghii- Rhododendron arboreum* mixed; 4= *Cedrus deodara- Pinus wallichiana* mixed; 5= *Cedrus deodara- Rhododendron arboreum* mixed; 6= *Rhododendron arboreum- Quercus leucotrichophora* mixed

Table 5. Community wise species diversity (H^1) and concentration of dominance (cd) of trees in different forest localities in study area

Community type	**Trees Species diversity (H^1)**	**Trees Concentration of dominance (cd)**
Pinus roxburghii - Quercus leucotrichophora mixed	0.68	0.51
Pinus roxburghii	0.58	0.76
Pinus roxburghii- Rhododendron arboreum mixed	1.52	0.29
Cedrus deodara - Pinus wallichiana mixed	1.89	0.20
Cedrus deodara- Rhododendron arboreum mixed	1.87	0.21
Rhododendron arboreum- Quercus leucotrichophora mixed	1.64	0.24
Maximum	**1.89**	**0.76**
Minimum	**0.58**	**0.20**

Table 6. Diversity, Distribution

S. No.	Species	Alti. Range (m)	Habitat (s)	SR	Life Form
1	**Auilifoliaceae** *Ilex dipyrena* Wall.	2116-2116	SM	1	T
2	**Cornaceae** *Cornus capitata* Wall.	1863-2116	D, Deg, SM	5	T
	Swida macrophylla (Wallich)	2015-2015	D, Deg	1	T
3	**Ericaceae** *Lyonia ovalifolia* (Wall.) Drude.	1784-2116	D, Deg, SM	11	T
	Rhododendron arboreum Sm.	1784-1784	D, Deg, SM	11	T
4	**Fagaceae** *Quercus serrata* Murray	1868-1968	D	1	T
	Quercus leucotrichophora A. Camus	1482-2200	D, Deg, SM	7	T
5	**Mimosaceae** *Acacia dealbata* Link.	1968-1968	SM	1	T
6	**Myricaceae** *Myrica esculenta* Hem. Ex Don.	1784-2200	D, Deg	16	T
7	**Oleaceae** *Fraxinus micrantha* Lingelsh	2116-2200	SM	1	T
8	**Pinaceae** *Pinus roxburghii* Sarg.	1482-2915	D, Deg, SM	14	T
	Pinus wallichiana Jacks	1871-2116	D, Deg, SM	5	T
	Cedrus deodara Roxb. ex D. Don	1863-2200	D, Deg, SM	9	T
9	**Rosaceae** *Pyrus pashia Buch.-Ham.* ex D. Don.	1428-2200	D, Deg, SM	6	T
10	**Symplocaceae** *Symplocus crataegoides* Buch – Ham. ex	1525-2200	D, Deg, SM	3	T
	Symplocus paniculata (thumb.) Miq.	1525-1525	D, Deg	1	T
11	**Salicaceae** *Populus ciliata* Wall	1873-2015	D, Deg, SM	2	T
12	**Ulmaceae** *Trema orientalis* (L.) Bl.	1863-1863	D	1	T

Abbreviations used: SM=Shady moist; SR=Site Representation; D=Dry; Dgr=Degraded; T=Tree; S=Shrub.

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RESEARCH ARTICLE

AGRI-BUSINESS MANAGEMENT BEHAVIOR OF THE ONION GROWERS OF REWA DISTRICT (M.P.)

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Abstract: The present study was an attempt to assess the agri-business management behavior of the onion growers. The study was carried out in Rewa block of Rewa District of M.P. with a sample of 120 onion growers. An interview schedule was designed for collecting the relevant information on selected variables. The data were collected personally with the help of this pre-tested interview schedule. It was found that the respondents were managing the agri-business components such as information seeking management, information evaluation management, information preservation management, input management and technology management in a good manner while they could not manage the components i.e. financial management, storage management, labour management, planning and marketing management to the desired extent .It was also observed that the attributes education, occupation, land holding, annual income, farm assets, farming experience, marketing facilities, training received, mass media use, scientific orientation, economic motivation, risk orientation and decision making were determinants of agribusiness management behaviour of onion growers.

Keywords: Agribusiness management behavior, Onion growers, Determinants

INTRODUCTION

The importance of agri-business in nation's development is being increasingly recognized and financing for agri-business enterprise has grown considerably in recent years. Policy makers have rediscovered that creating a strong agri-business sector is prerequisite to achieve viable industrialization. In developing countries, both agricultural and on-farm/off-farm components become increasingly significant and preserve the overall economic contribution of agri-business. Agri-business management is a purposeful activity indulged in initiating, promoting and maintaining economic activities regarding farming and allied sector for the production and distribution of wealth. Agribusiness management may be defined as the sum total of all operations.

Agribusiness management may be defined as the sum total of all operations performed by a farmer/agri-entrepreneur in the manufacture and distribution of farm supplies, production operations involved in the farm, storage, processing and distribution of farm commodities and items

Onion being an important vegetable crop is produced in the states of Maharashtra, Karnataka, Andhra Pradesh, Gujarat, Orissa, Tamil Nadu and Madhya Pradesh. In context with Rewa district of M.P. Onion being a major vegetable crop of region is grown both Kharif & Rabi Season with an area of 6863 ha. and 206.42q/ha. productivity.

In spite of lot of efforts have been taken by extension agencies and scientists to materialize the potential of onion the profitability of onion was stagnate over a period of time due to traditional way of cultivation, dominance of old varieties, lack of supporting facilities like storage and wide fluctuation in market price of onion which reduce economic gain of the farmer from onion cultivations. Thus, there is huge scope to boost-up the economic gain of the farmers through equipping them with business management skill of onion crop. In the light of these above facts, the present study was undertaken with the following objectives.

1. To analyze the agri-business management behavior of onion growers.
2. To find out the association between personal, socio – economic, communicational and psychological characteristics of onion growers and their agri-business management behavior

METHOD AND MATERIAL

The study was conducted purposively in Rewa district (M.P.). Rewa district of M.P. was selected for the study because it has highest production and productivity in M.P. Rewa block of Rewa district was selected purposively on the basis of higher productivity i.e. 251.5 q/ ha. among all the blocks. A list of villages where onion is grown as commercial crop was prepared. Five villages on the basis of higher area under onion crop were selected purposively. The villages were Khajuha, Rithi, Kanoja, Mahsanw, Rakaria. The onion growers from these five villages were selected through proportionate random sampling method to make a sample of 120 onion growers. Hence, finally the sample was consisted of 120 respondents. An interview schedule was designed for collecting the relevant information on selected variables.

In the present study agri-business management refers to purposeful activity indulged in initiating, promoting and maintaining economic activities regarding agriculture production for the production

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and distribution of wealth. The individual as an agri-business manager is a critical factor in economic development and an integral part of socio economic transformation. Therefore, the basic concept of agri-business management in the present study refers to activities performed by the farmers for making onion cultivation a business venture. A scale was prepared to assess the agribusiness management behaviour of the onion growers. In this scale ten components of agribusiness management viz. planning, information seeking management, information evaluation management, information preservation management, labour management, input management, technology management, storage management, marketing management & financial management were included. The scale consisted of 50 sub items under all components. The responses of each respondent were recorded against each item in three points as completely, partially and not at all with the score 2, 1 and 0 respectively. Total score of each component was worked out by adding the scores against each item. Similarly total score of each respondent was also determined by adding the scores obtained by the respondent against each item.

The data were collected personally with the help of this pre-tested interview schedule. The researcher personally contacted the respondents. They were assured that the information given by them would be kept confidential and it would only be used for the academic purposes. Data collected were qualitative as well as quantitative. The quantitative data were interpreted in terms of percentage and qualitative data were tabulated on the basis of approved categorization method. The following statistical techniques were used in the study. Co-relation coefficients ('r' values) have also been worked out to assess the relationship between socio personal attributes and agri-business management behavior of the respondents

RESULT AND DISCUSSION

A. Agri-business management behavior of onion growers in relation various components.

(i) The mean score of selected components of agri-business management behaviour regarding onion cultivation

Table 1. The mean score of various components of agri-business management behaviour

S. No	Components	Extent of management			Total score	Mean score	Rank
		Completely	Partial	Not of all			
1	**Planning**						
a.	Time scheduling of operational work	32	62	26	126	1.05	III
b.	Plan and analysis of cost & return	25	65	30	115	0.96	IV
c.	Planning of water management	22	68	30	112	0.93	V
d.	Arrangement of field/nursery.	34	60	26	128	1.06	II
e.	Preparation of contingent plan	39	61	20	139	1.16	I
Overall mean score			**1.03**				
2	**Information seeking management**						
a.	Individual contact	98	14	8	210	1.75	II
b.	Group contact	100	16	4	216	1.80	I
c.	Mass media contact	95	18	7	208	1.73	III
Overall mean score			**1.76**				
3	**Information evaluation management**						
a.	Discussion with family member	72	16	32	160	1.33	IV
b.	Discussion with friend and neighbors	76	18	26	170	1.41	III
c.	Discussion with progressive onion growers	82	21	17	185	1.54	II
d.	Discussion with officers of line departments	86	22	12	194	1.61	I
Overall mean score			**1.47**				
4	**Information preservation management**						
a.	Self memory	65	50	5	180	1.50	I
b.	Note taking	61	56	3	178	1.48	II
c.	Collection of farm literatures	58	50	12	166	1.38	III
d.	News paper cutting	55	52	13	162	1.35	IV
e.	Use of computer storage devices	48	60	12	156	1.30	V
Overall mean score			**1.40**				
5.	**Labour management**						
a.	Utilization of family labour	28	68	24	124	1.03	II
b.	Labour management as per operational work	32	62	26	126	1.05	I
c.	Evaluation of labour	29	61	30	119	0.99	III
d.	Engagement of labour on the basis of their work efficiency	22	55	43	99	0.82	IV
Overall mean score			**0.97**				
6.	**Input management**						
a.	Arrangement of seed	59	49	12	167	1.39	I
b.	Arrangement of organic manures	42	60	18	144	1.20	V
c.	Arrangement of fungicides	48	55	17	151	1.25	IV

d.	Arrangement of insecticides	55	55	10	165	1.37	II
e.	Arrangement of herbicides	52	56	12	160	1.33	III
Overall mean score			**1.31**				
7.	**Technology management**						
a.	Nursery management	48	55	17	151	1.26	I
b.	Improved varieties	38	62	20	138	1.15	VII
c.	Sowing method	42	56	22	140	1.16	VI
d.	Application of bio fertilizers	46	57	17	149	1.24	II
e.	INM	39	65	16	143	1.20	IV
f.	Weed management	38	70	12	146	1.22	III
g.	Plant protection	36	70	14	142	1.18	V
Overall mean score			**1.20**				
8.	**Storage management**						
a.	Storage at home	55	25	40	135	1.12	I
b.	Storage in warehouse	22	56	42	100	0.83	III
c.	Bamboo made storage	40	30	50	110	0.91	II
Overall mean score			**0.95**				
9	**Marketing management**						
a.	Trends of Mandi selling rate	38	58	24	134	1.12	II
b.	Sale at block & district level	40	60	20	140	1.17	I
c.	Selling out of state	30	65	35	125	1.04	III
d.	Selling by contract with traders	25	68	27	118	0.98	IV
Overall mean score			**1.07**				
10.	**Financial management**						
a.	Kisan Credit card	30	44	46	104	0.87	II
b.	Bank loan	20	40	60	80	0.67	III
c.	Own capital	68	10	42	146	1.20	I
Overall mean score			**0.91**				
Over all average mean score of all components			**1.20**				

Table 1 exhibits agribusiness management behaviour of the respondents in relation to selected components of agribusiness management. Table reveals that regarding the planning component mean score was highest in preparation of contingent plan (1.16) followed by arrangement field/nursery (1.06), time scheduling of operational work (1.06), plan and analysis of cost & returns (0.96) and planning of water management (0.93).

As regards information seeking management mean score was arranged in descending order as group contact (1.80) individual contacts (1.75) and mass media contact (1.73).

As far as information evaluation management was concerned the mean score was arranged in descending order as discussion with officers of line departments (1.61), discussion with progressive onion growers (1.54), friends and neighbors (1.41) and discussion with family members (1.33).

Regarding preservation management mean score as was arranged in descending order as self memory (1.50), note taking (1.48), collection of farm literatures (1.38), news paper cutting (1.35) and use of computer storage device (1.30).

In case of labour management mean score was highest for labour management as per operational work (1.05), followed by utilization of family labour (1.03), evaluation of labour (0.96) and engagement of labours (0.82).

In context with input management mean score was found to be highest in arrangement of seed (1.39), arrangement of insecticide (1.37), followed by arrangement of herbicide (1.33), arrangement of fungicide (1.25), arrangement of organic manures (1.20).

Among the sub components of technology management mean score was highest in nursery management (1.26) followed by application of bio fertilizers (1.24), weed management (1.22), INM (1.20), plant protection (1.18) sowing method (1.16) and improved varieties (1.15).

Regarding storage management mean score was highest for storage at home (1.12) followed by bamboo made storage (0.91) and storage in warehouse (0.83).

Out of marketing management components, it was observed that the mean score was highest in sale at block & district level (1.16), trends of mandi selling rate (1.12).selling out of state (1.04) and selling by contract with traders (0.98).

In case of financial management it was observed that mean score was highest regarding own capital (1.21) followed by Kisan Credit Card (0.86) and bank loan (0.66).

It was found that among all the components of agribusiness management behavior, highest mean score was observed regarding technology management followed by information seeking management (1.76), information evaluation management (1.47), Information preservation management (1.40), input management (1.31), technology management (1.20), marketing management (1.07), planning (1.00), labour management (0.96), storage management (0.95) and financial management (0.91). The overall average mean score of agribusiness management behaviour was 1.20.

Similar results were reported by Anitha et al. (2004) and Singh et al (2010).

(ii) Extent of agri-business management behavior regarding onion cultivation

Table 2. Distribution of the respondents according to their agri-business management behavior regarding onion cultivation

S. No.	Extent of agri-business management behavior	Number of respondents	Percentage
1.	Low	23	19.17
2.	Medium	53	44.17
3.	High	44	36.66
Total		**120**	**100**

The Table 4.19 indicates that higher percentage of the respondents i.e. 44.17 percent belonged to medium extent of agri-business management behavior category; while 36.66 percent high agri-business management behavior and remaining 19.17 percent exhibited low agri-business management behavior.

B. Relationship between personal socio-personal attributes of the respondents and their agri-business management behaviour regarding onion cultivation

Table 3. Relationship between personal socio-personal attributes of the respondents and their agri-business management behaviour regarding onion cultivation

S.No.	Attributes	Co-relation coefficient ('r' value)
1.	Age	-0.10
2.	Education	0.21*
3.	Size of family	0.12
4.	Occupation	0.23*
5.	Social participation	0.11
6.	Land holding	0.25*
7.	Annual income	0.27*
8.	Farm assets	0.24*
9.	Farming experience	0.23*
10.	Marketing facilities	0.23*
11.	Training received	0.22*
12.	Mass media exposure	0.26*
13.	Source of information	0.13
14.	Scientific orientation	0.26*
15.	Economic Motivation	0.27
16.	Risk Orientation	0.29*
17.	Decision making	0.28

Significant at 5% level

On the basis of 'r' value Table 3 revealed that the characteristics namely education, occupation, land holding, annual income, farm assets, farming experience, marketing facilities, training received, mass media use, scientific orientation, economic motivation, risk orientation and decision making exhibited significant relationship with agribusiness management behaviour at 0.05% level of significance. The result also depict that the characteristics such as age, size of family, social participation, source of information of the respondents did not establish significant relationship with their agribusiness management behaviour of onion growers.

The findings of Shashidhara et.al (2008), Seeralan et al (2009) and Jaisridhar et. al. (2012) were in line with the present findings

CONCLUSION

It may be concluded from the results of the study that the respondents were managing the agri-business components such as information seeking management, information evaluation management, information preservation management, input management and technology management in a good manner while they could not manage the components i.e. financial management, storage management, labour management, planning and marketing management to the desired extent .It was also observed that the attributes education, occupation, land holding, annual income, farm assets, farming experience, marketing facilities, training received, mass media use, scientific orientation, economic motivation, risk orientation and decision making were determinants of agribusiness management behaviour of onion growers.

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RESEARCH ARTICLE

EFFECT OF BOTANICALS AND BIO-AGENTS ON *FUSARIUM OXYSPORUM* F. SP. *CICERI* CAUSES FUSARIUM WILTS OF CHICKPEA (*CICER ARIETINUM* L.)

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Abstract: Chickpea (*Cicer arietinum* L.) an important pulse crop in the world, is a good source of protein and fixes the atmospheric nitrogen in the fields. It is one of the best crops for arid conditions. Fuasrium wilt, a most severe disease and causes huge losses. The potential of anti-fungal activity of different botanicals and bio-agents were tested in laboratory conditions. Among seven botanicals tested, Palmarosa (*Cymbopogon martinii* var. *motia)* with minimum growth of pathogen and 56.36 per cent of inhibition was found most effective against *Fusarium oxysporum* f. sp. *ciceri* followed by others to inhibit the fungal growth in comparison to control. Among the bio-agents, *Trichoderma viride* inhibits the 62.57 per cent and proved to be best in suppressing the growth of the pathogen followed by others.

Keywords: Chickpea, Palmarosa, Bio-agent, *Trichoderma viride*

INTRODUCTION

Chick pea (*cicer arietinum* L.) or Bengal gram is a leguminous crop with chromosome number 8. It is major pulse crop, in India chick pea is grown for various purposes. It is good source of protein, fiber, calcium. Chickpea also has advantages in the management of soil fertility, particularly in dry lands and the semiarid tropics (Singh and Saxena, 1996). Being a leguminous crop it fixes atmospheric nitrogen to available of nitrogen. Chick pea suffers from various diseases like Ascochyta blight, Dry root rot, wet root rot, botrytis grey mould, chick pea stunt, in which fusarium wilt is most important disease of the chick pea causes about 60 per cent yield loses (Singh *et al*., 2007). Chickpea wilt is a very serious disease in India and is widely distributed in 32 chickpea growing countries of the 6 continents viz., Asia, Africa, Europe, North America, South America and Australia (Nene *et al*., 1996). *F. oxysporum* f. sp. *ciceri* infects chickpea at seedling stage as well as at flowering and pod forming stage with more incidence at flowering and podding stage if the crop is subjected to sudden temperature rise and water stress. The fungus is a primarily soil borne pathogen, however, few reports indicated that it can be transmitted through seeds (Haware *et al*., 1978). Fusarium is also affects various plant spieses and causes severe loss to them. Many plant posses antifungal and antibacterial property by the antifungal property we can control the growth of the fungus, various bio agent are available very easily and they are restricted the growth and reproduction of the various pathogen. The management of the disease through chemicals is very costly and harmful to the environment. Management through botanicals and boi agent is very cheap and also eco friendly.

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MATERIAL AND METHOD

The investigations based on laboratory and wire house experiments were undertaken at the Department of Plant Pathology, C. S. A. University of Agriculture & Technology, Kanpur, during the year 2014-15 and 2015-16.

Collection of Sample

Naturally infected chickpea plants were collected from the Oil seed Farm of Kalyanpur, Legume Research Farm of Nawabganj, Student Instructional Farm of C.S.A. University of Agriculture and Technology Kanpur, Indian Institute of Pulses Research, Kalyanpur, Kanpur and other adjoining areas of farmer's fields of Kanpur Nagar and Kanpur Dehat district during the rabi crop season of 2014-15.

Isolation of Pathogen

The affected chickpea roots were used for isolation. The infected roots were thoroughly washed with sterilized water to remove dust and others surface contaminations These pieces were thoroughly washed in 3 to 4 times changes of sterilized water after that dipping into 0.1 percent Mercuric chloride solution for 20-30 seconds with the help of sterilized forceps, then thoroughly and repeatedly washed in 3-4 changes of sterilized water to remove the last traces of Mercuric chloride solution. The excess moisture was removed by drying the pieces between the folds of sterilized blotting papers.

These sterilized pieces were then transferred into the sterilized Petri-dishes containing 2 per cent potato dextrose agar medium, 2 to 3 pieces were placed at an equal distance with the help of sterilized forceps in poured Petri-dishes and then the Petri dishes were incubated at 28±1°C temperature. After 24 hours of incubation period, as soon as white mycelial growth was visible in different Petri-dishes. It was transferred into sterilized culture tubes already

containing 2 per cent sterilized potato dextrose agar medium.

Anti-fungal effect of botanicals against the pathogen *in vitro*

The presence of naturally occurring substances in plants with anti- fungal properties has been recognized and tested against the pathogen. In present investigation, the efficacy of leaf extracts of seven plants viz., Palmarosa (*Cymbopogon martinii* var. *motia*), Pipal (*Ficus* sp.), Eucalyptus (*Eucalyptus* sp.), Neem (*Azadrachta indica*), Garlic (*Allium sativum*), Datura (*Datura fastussa*), Onion (*Allium cepa*) and Control (untreated) were tested *in vitro* for their antifungal efficacy against growth of *Fusarium oxysporum* f.sp. *ciceri* through poisoned food technique (Carpenter, 1942; Nene and Thapliyal, 1993). 10 per cent dose of leaf extracts were used against pathogen (*in vitro*) by food poision technique. The Fresh leaves of plant species were collected washed in tap water followed by sterilized water crushed in sterilized distilled water in 1:1 ratio (W/V) with mortar and pestle and filtered through 2 layers of muslin cloth to obtained extract. The 100 ml sterilized potato dextrose agar medium mixed with 10 ml of plant leaf extract contained in 150 ml conical flask then sterilized in an autoclave at 1.1 kg pressure/square cm for 5 minutes. Then sterilized media poured in three sterilized Petri plates and after solidification 5 ml disc of 7 days old culture of pathogen was transferred into the centre of petridish and incubated at 28±1°C temperature. PDA not amended with leaf extract served as control. Observation on radial growth of the test fungus was recorded after 10 days of incubation and % inhibition of growth was calculated using the following cited formula (Vincent, 1947). All plates were replicated three times in complete randomized deigns.

Evaluation of bio-agents against the pathogen *in vitro*

The culture of bio-agents viz., *Trichoderma viride, T. koningii, T. longibrachiatum, T. harzianum, T. virens, Chaetomium globosum* were isolated from the rhizosphere of chickpea plants of wilt sick plot of Nawabganj farm, C.S.A.U.A&T., Kanpur. Antagonistic activity of these bio-agents against test pathogen was determined by dual culture techniques Denis and Webster, 1971; Dhingra and Sinclair, 1985), five mm disc of pathogen was taken from the actively growing colonies of the test pathogen and antagonist with the help of sterilized cork borer. The disc of the pathogen was placed on one side in agar plates aseptically and the disc of antagonists was placed opposite side up, the pathogen in same Petri plates. All plates were replicated with three times and were incubated at 26±1 C for 7 days. After incubation radial growth measured and % inhibition of growth was calculated using the formula (Vincent, 1947). All plates also replicated three times in complete randomized design.

$$I = C – T/C \times 100$$

Where,

I= Percent inhibition.

C= Radial growth of test fungus in control plate

T= Radial growth of test fungus in treated plate

RESULT

Effect of Plant Extract

The results revealed that the phytoextract significantly inhibited the growth of *F. oxysporum* f.sp. *ciceri* at all the tested concentrations. Among of them, Palmarosa (56.36%) was most effective against *Fusarium oxysporum* f. sp. *ciceri* followed by Pipal (37.27%), Eucalyptus (34.90%), Neem (31.81%), Garlic (26.36%), Datura (20.36%) and Onion (8.18%) to inhibit the fungal growth in comparison to control.

Effect of Bio Agent

The results revealed that the antagonists significantly reduced the growth of *F. oxysporum* f.sp. *ciceri* either by exhibiting inhibition zones. Among of them the suppression of the growth of pathogen was maximum with *Trichoderma viride* (62.57%) followed by *Trichoderma koningii (58.15%), Trichoderma harzianum* (56.80%), *Trichoderma longibrachiatum (50.42%)* and *Trichoderma hamatum* (44.78%). The least effective bio-agent was *Chaetomium globosum* (40.61%).

Table 1. Evaluation of plant leaf extracts against the pathogen *oxusporum* f. sp. *ciceri in vitro* after 10 days of incubated at 28±1°C

S. No.	Plant leaf extracts	Dose %	Average diameter of fungal colony (cm)	Per cent inhibition
1.	Palmarosa (*Cymbopogon martinii* var. *motia*)	10	2.40	56.36
2.	Pipal (*Ficus* sp.)	10	3.45	37.27
3.	Eucalyptus (*Eucalyptus* sp.)	10	3.58	34.90
4.	Neem (*Azadrachta indica*)	10	3.75	31.81
5.	Garlic (*Allium sativum*)	10	4.05	26.36
6.	Datura (*Datura fastussa*)	10	4.34	20.36
7.	Onion (*Allium cepa*)	10	5.05	8.18
8.	Control (untreated)		5.50	
	C.D at 5%			0.1986

Table 2. Inhibiting effect of different bio-agents on the growth of *Fusarium oxusporum* f. sp. *ciceri in vitro* incubated of 28±1^{0}C.

S. No.	Bio-agents	Average diameter of fungal colony(cm)	Per cent inhibition over control
1.	*Trichoderma viride* + *Fusarium oxysporum* f. sp. *Ciceri*	3.05	62.57
2.	*Trichoderma koningii* + *Fusarium oxysporum* f. sp. *ciceri*	3.41	58.15
3.	*Trichoderma harzianum* + *Fusarium oxysporum* f. sp. *ciceri*	3.52	56.80
4.	*Trichoderma longibrachiatum* + *Fusarium oxysporum* f. sp. *ciceri*	4.04	50.42
5.	*Trichoderma hamatum* + *Fusarium oxysporum* f. sp. *ciceri*	4.50	44.18
6.	*Chaetomium globosum* + *Fusarium oxysporum* f. sp. *ciceri*	4.84	40.61
7.	Control	8.15	
	C.D. at 5%		0.2714

DISCUSSION

Chick pea (*Cicer arietinum* L.) is major rabi pulse crop growing in India. Madhya Pradesh, Uttar Pradesh, Bihar, Maharashtra are major chick pea growing states. Fusarium wilt causes severe losses to chick pea crop in Indian sub continents. Management of fusarium wilts through easily available plants having antifungal property and boi-agents are economical as well as good for environment.

Leaf extract of seven different plant species were evaluated *in vitro* against the pathogen. Among these leaf extract *viz.*, Palmarosa (56.36%) was most effective against *Fusarium oxysporum* f. sp. *ciceri* followed by Pipal (37.27%), Eucalyptus (34.90%), Neem (31.81%), Garlic (26.36%), Datura (20.36%) and Onion (8.18%) inhibiting the fungal growth. These results are similar to those as reported by Kamal Kanha *et al.* (2001), Devi and Paul (2003, 2005), Surendra and Harichand (2004), Sahani and Saxena (2009), Patra and Biswas(2017).

Six bio-control agents were evaluated in laboratory conditions. Among them, *Trichoderma viride* (62.57%) gave the best results in checking the growth of *Fusarium oxysporum* f. sp. *ciceri* followed by *Trichoderma koningii* (57.75%), *Trichoderma harzianum* (56.80%), *Trichoderma- longibrachiatum* (50.42%), *Trichoderma hamatum* (44.78%) and *Chaetomium globosum* (40.61%). Similar findings were also reported by Velikamov et al., (1994), Gaurdar et al., (2000), Prasad et al., (2003), Vaidya et al., (2004), Nikam et al., (2007), Bouraghda, and Bouznad, (2009).Patra and Biswas(2017).

Through these findings, famers will be benefitted by using the above mentioned plants and bio-agents for the management of Fusarium wilt of chick pea.

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RESEARCH ARTICLE

PEOPLE PERCEPTION ON THE USE OF HOUSEHOLD COPING STRATEGIES AGAINST SHOCKS: A CASE STUDY OF FOREST RESOURCES USE IN GARHWAL HIMALAYA

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Abstract: The present study investigates the use of forest resources as well as other coping strategies opted by rural households against addressal of shocks in securing and sustaining livelihoods. Multistage random sampling was applied for selection of blocks, villages and households (the primary sampling unit) in Garhwal Himalaya. The primary data on the forest resource use and coping strategies against the different types of household shocks were collected from 454 households using semi-structured questionnaire followed by discussions with local people during 2014-2016. The primary results of the study revealed that the rural households practice different strategies to minimize the adverse effect of shocks and use of forest resources for addressing household shocks. The result estimates of the study will be helpful in framing policies regarding evaluation of shocks and also development of mechanism to minimize the impact of shocks at household as well as at community level in Himalayan region.

Keywords: Addressal of shocks, Coping strategies, Forest conservation, Sustainability

INTRODUCTION

Traditionally, forests are critically important assets for supporting rural livelihoods (Agrawal *et al*., 2013) through supplying variety of products, services, and benefits for their use (FAO, 2005). The role of forest resources in household economies and for mitigating the poverty of rural areas in developing countries is important and also flagged as critical assets by the policy-makers around the globe (Das, 2010; Angelsen *et al*., 2014). Moreover, it is pertinent to note that rural households adopt a range of strategies such as adjusting their household chores and managing natural resources to safeguard their livelihoods during adversities (Ellis, 2000).

Forest resource use in Garhwal Himalaya has been examined by many researchers (Pandey, 2009; Sharma *et al*., 2009), however, their characterization within the limits of mix of natural and man-made resources accessibility and availability has not been briefly assessed (Pandey *et al*., 2014; Angelsen *et al*., 2014). Moreover, forest resource use by rural inhabitants against the shocks has not been examined potently and addressed very intermittently and scanty manner in Asian region (Rahut *et al*., 2016), though excellent work has been carried out in other parts of globe on the issue with acknowledging the mitigation potential role of forests in minimizing the impact of household shocks (Debela *et al*., 2012; Kalaba *et al*., 2013).

In this context to understand the use of forest resources as coping strategies in response to household shocks, the present study was undertaken with the hypothesis to evaluate use of various coping strategies used by households for addressing the household shocks. More briefly to confirm the hypothesis and to understand the role of forest resources in rural livelihood, the present study attempts to analyze the various rural household shocks and forest resource based coping mechanism in response to shocks. The findings of the study will assist policy planners for the formulation of suitable policy and programmes for forest conservation as well as sustainable forest resource use strategy with focus on creating awareness about the diverse role of forests particularly during household shocks.

MATERIAL AND METHOD

The present study was carried out in two districts of Garhwal Himalayan region of Uttarakhand i.e., Rudraprayag (spread between 30˚19’ to 30˚49’ N latitude and 78˚49’ to 79˚21’ E longitude in an area of 2439 km^2) and Pauri Garhwal (spread between 29˚45’ to 30˚15’ latitude and 78˚24’ to 79˚23’ E longitude in an area of 5230 km^2). Primary data on rural household shocks and different coping strategies used during shocks was collected through household survey from 454 randomly selected rural households from randomly selected villages located in the range of 400-2200 m asl altitude of Pauri Garhwal and Rudraprayag district during the year 2014-2016. All the surveyed villages generally lacks in basic infrastructure such as road connectivity in terms of transportation, banking and hospital services due to remoteness.

A semi-structured questionnaire was developed and tested in collaboration with 53 households before the survey to collect data for addressing the various rural household shocks faced during last five years by rural households and the corresponding use of forest resources. Further the noted changes were made with

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respect to the requirement of study. The questionnaire consists two parts i.e., (i) Various household shocks (ii) Different coping mechanism to minimize the effect of shocks and forest resource use. Shocks can be defined as any situation or condition that affect human well being as well welfare mechanism (Dercon, 2002; Debela *et al*., 2012). In the present study loan, unemployment and marriage were identified as shock based on pilot survey as well as available literature. In general loan can be defined as a situation of borrowing money from people or from other source which is to be returned back within a fixed period whereas unemployment creates shortage of money due to unavailability of job. During the survey households identified marriage as a shock due to involvement of huge amount of expenditure.

The respondents, generally the head of selected households were approached and face to face interviews were conducted by the first researcher at the informant's house, in Hindi or local dialect (Garhwali), as per the convenience of respondent. All informants interviewed were informed about the purpose of the interview and gave their oral consent for being interviewed. The descriptive statistics was analyzed using Statistical Product and Service Solutions (SPSS 21) software.

RESULT AND DISCUSSION

Household shocks

Rural households in the study region face various types of adversities (economically and socially), influencing the household welfare mechanism as pointed out by villagers during survey. Most of the households reported that they were affected by more than one type of shock which has long term and short term disturbances on their livelihood mechanism. These disturbances were mitigated by various prevailing as well as new and innovative coping strategies. These strategies facilitate them to overcome from the situation and also assist to safeguard their welfare. Based on the study by Tongruksawattana *et al*. (2010) the shocks addressed by rural households were categorized into economic and social shock. In the present study various shocks observed were loan and unemployment under the economic shock whereas marriage under the social shock.

The study results show that the majority of the households reported that they were severely affected by marriage activities due to unemployment and loan. The number of affected households by shocks was addressed more in lower altitude. Households in the study region used different strategies to overcome the situation arising due to unexpected expenditure and damages or losses. The study results also show that the households were able to cope up with the adversities related to studied shocks. Altitude wise proportion of households using different coping strategies during shocks is provided in Table 1. Similar findings regarding the use of various coping strategies to minimize the effect of shocks have also been reported by various researchers for rural poor households of different parts of the world (Dercon, 2002; Fafchamps, 2003; Debela *et al*., 2012).

Table 1. Households using different coping strategies during shocks

Parameter	Altitude	Shock type		
		Economic		Social
		Loan	Unemployment	Marriage
Affected households (in numbers)	Lower	24	38	58
	Middle	10	40	52
	Higher	6	12	23
Coping strategies (%)				
Internal resource use	Lower	16.7	42.1	93.1
	Middle	40.0	22.5	82.7
	Higher	16.7	25.0	95.5
Labour work	Lower	45.8	76.3	46.6
	Middle	70.0	97.5	55.8
	Higher	16.7	83.3	27.3
Forest resource use	Lower	16.7	44.7	91.4
	Middle	40.0	52.5	86.5
	Higher	0.0	41.7	95.5

Lower = 400-1000m, Middle = 1000-1600m, Higher = 1600-2200m

Coping strategies used during various observed shocks

In the present study results of the analysis reported that households adapt the situation first by using

mechanisms such as use of internal resource i.e., income saving, livestock for milk and meat, then by the engaging themselves in labour work as well as by the use of forest resources for maintaining livelihood security. Overall results reported that the use of internal resources and forest resources as coping strategy was observed maximum during marriage followed by unemployment and loan while use of labor work as coping strategy was observed maximum for unemployment followed by marriage and loan (Figure 1).

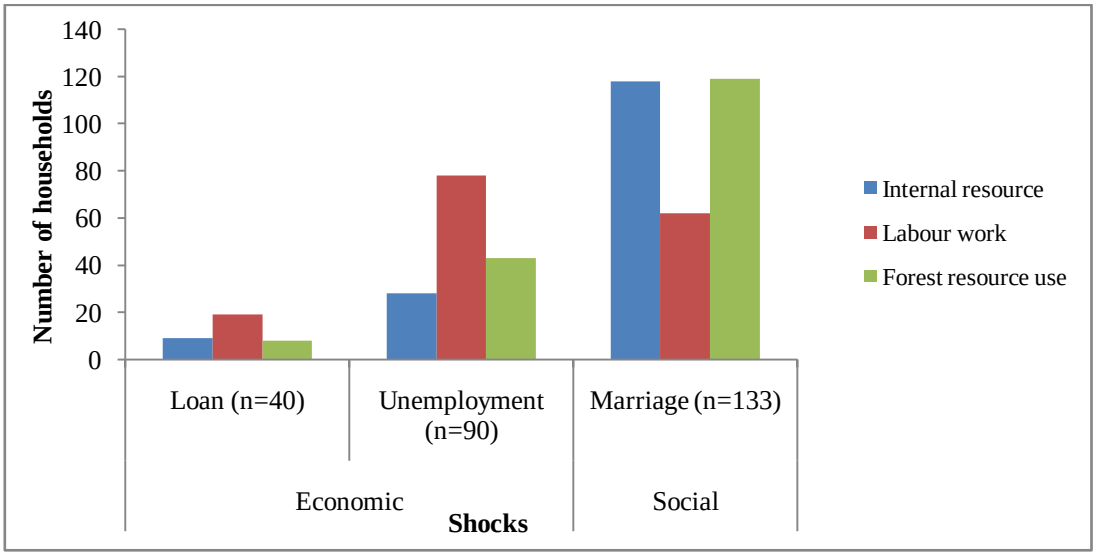

Figure 1. Overall number of households using different coping strategies during shocks

In India various researchers reported that forest are the base for rural livelihoods through providing various provisioning services help in subsistence and income generation (Saxena, 2003; Saha and Sundriyal, 2012; Banerjee and Chowdhury, 2013). Similar studies have also been reported by Arnold and Ruiz-Perez (1998) and Arnold et al. (2011) that agricultural communities worldwide use of forest resources for consumption purpose particularly during ecological. Most of the literature on forest based livelihoods has also highlighted the importance of forest resources to rural households in minimizing poverty particularly during lean season (De Beer and Mcdermott, 1996; Angelsen and Wunder, 2003; Rahut et al., 2016), or during shocks (Debela *et al*., 2012; Kalaba *et al*., 2013; Rahut *et al*., 2016). Cavendish (2000) has also reported in a study that forests helps in providing employment to poor and contributes significantly to the rural economy particularly during adverse situations besides income generation.

CONCLUSION

The findings of the study revealed that rural households of Garhwal Himalaya use various coping strategies such as internal resource use, labour work and forest resource use during shocks. Though different coping strategies contributed to overcome the situations arising due to shock, but the use of forest resources as coping mechanisms was observed maximum to overcome the expenditure due to marriage activities. Thus the results of the study conclude that forest contributions are important for rural people during adversities. The findings of the study will also be helpful in framing policies regarding shock evaluation and mechanism development to minimize the impact of shocks at household as well as at community level in Himalayan region.

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RESEARCH ARTICLE

IMPACT OF PARTICIPATORY SEED VILLAGE PROGRAMME ON ADOPTION LEVEL OF WHEAT SEED PRODUCERS IN REWA DISTRICT (M.P.)

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Abstract: The word seed or seeds may be defined as all propagating materials used in any kind of cultivation. The seed is considered as most precious input in agriculture. The quality seed availability at desired time determines the sustainable crop productivity growth. It has been observed that presently about 80- 85% of the seeds used by the farmers is their own farm produced seeds and which is managed and conserved by the farmers from his own produce for future use.. Due to poor quality of seed with low germination capacity of seed the crop growth is affected adversely which eventually reduces the productivity of the crop. Despite implementation of the organized seed program since the mid 60s, the seed replacement rate has touched the level of 15 per cent. only .In view of the above facts it has been realized that the availability of genetically good quality of seed materials are of great importance to improve the quality of farm saved seed. In order to accelerate the seed replacement rate of desired genetic seed materials Krishi Vigyan Kendras through its participatory Seed Village Programme was implemented by Krishi Vigyan Kendras of M.P. in the year 2006-07 and continued till 2011-12. Under this programme about twenty villages were covered. The seeds of high yielding varieties along with recommended seed production technologies were demonstrated at farmers' field. Besides this capacity building programmes were also conducted at critical stages of the crops. Since regular follow up and evaluation is a necessary concomitant of such programme to assess the impact and suggest strategy for further growth and expansion of the programme the present investigation entitled "The impact of participatory seed village Programme on adoption behaviour of wheat seed producers in Rewa district (M.P.)" was under taken to assess the impact of the programme on adoption behaviour of seed producers. The study was based on 120 respondents (60 beneficiaries and 60 non-beneficiaries as control) covering 10 villages of Rewa block of Rewa district for analyzing the impact of Seed Village Programme on adoption behaviour of seed producers.. The ex-post facto research design was adopted in this research work. The responses were obtained by administering a pretested interview schedule .The findings inferred there was significant difference between beneficiaries and non-beneficiaries as regards to extent of adoption of seed production technology. The beneficiaries had greater extent of adoption than non-beneficiaries. Correlation coefficient between independent variables and extent of adoption as dependent variable elucidated that knowledge, risk orientation, marketing orientation, attitude towards agricultural technology, extension participation, mass media exposure, innovativeness, education, land holding and annual income had positive and significant relationship with adoption behaviour of both the categories i.e. beneficiaries and non beneficiaries. Social participation and family type had negative and significant relationship with extent of adoption.

Keywords: Seed Production Technology, Krishi Vigyan Kendras , Adoption behaviour

INTRODUCTION

India remains mainly an agrarian economy in spite of intensive planned efforts to urbanization and industrialization. In the agrarian economy, agriculture exports have shown great significance and foreign trade has depicted dynamic character. The word seed or seeds may be defined as all propagating materials used in any kind of cultivation. The seed is considered as most precious input in agriculture. The quality seed availability at desired time determines the sustainable crop productivity growth. It has been observed that presently about 80- 85% of the seeds used by the farmers is their own farm produced seeds and which is managed and conserved by the farmers from his own produce for future use.. Due to poor quality of seed with low germination capacity of seed the crop growth is affected adversely which eventually reduces the productivity of the crop. Despite implementation of the organized seed program since the mid 60s, the seed replacement rate has touched the level of 15 per cent only. In view of the above facts it has been realized that the availability of genetically good quality of seed materials are of great importance to improve the quality of farm saved seed.

Government of India initiated various policy measures which contributed in the growth of seed industry in India. From a few units there has been a tremendous rise (more than 200 seed companies in private sector) in number of seed companies and corporations. Quality seed production was recorded 346.36 lakh quintals and 353.62 lakh quintals in 2012-13 and 2013-14, respectively .In order to accelerate the seed replacement rate of desired genetic seed materials Krishi Vigyan Kendras through its participatory Seed Village Programme was implemented by Krishi Vigyan Kendras of M.P. in the year 2006-07 and continued till 2011-12. Under this programme about twenty villages were covered. The seeds of high yielding varieties along with recommended seed production technologies were demonstrated at farmers' field. Besides this capacity building programmes were also conducted at critical stages of the crops. Since regular follow up and evaluation is a necessary concomitant of such

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programme to assess the impact and suggest strategy for further growth and expansion of the programme the present investigation entitled "The impact of participatory seed village Programme on adoption behaviour of wheat seed producers in Rewa district (M.P.)" was under taken to assess the impact of the programme on adoption behaviour of seed producers

Review of Literature

Singh (1983) studied 300 adopters and 150 non adopter's farmers of Sehore district to find out the impact of modern technology on production employment and income in agriculture. His study revealed that gross income per hectare for the farm business as a whole was 98% more on adopter farms than the non adopters, similarly, the intensity of cropping was higher (164.34%) among adopter farms than the non-adopter farms(132.59%) respectively

Dhillon and Kumar (2004) reported that maximum number of respondent (44.17%) were observed to have medium extent of adoption in terms of area under the crop, 26.67 per cent and 19.17 per cent were found to have low and high extent of adoption, respectively. Level of adoption was medium for nearly half of the respondents (49.17%) whereas 32.50 per cent and 18.33 per cent farmers had and high level of adoption, respectively

Manoj and Sharma (2004) stated that majority of small respondents had medium level of adoption about improved practices of gram cultivation, whereas majority of the marginal farmers had low level of adoption as compared to big and small farmers.

Singh *et al*. (2005): observed that the adoption of recommended varieties of wheat viz., Sonalika, K-65, C-306. Mukta were found to the level of 41.33 per cent of the total sample farmers, followed by paddy and gram.

METHOD AND MATERIAL

Ex-post-facto research design was used in the present investigation. It is a systematic inquiry in which researcher does not have direct control of independent variables because their manifestation have already occurred and they cannot be manipulated. The present study was carried out using ex-post facto research design during 2015-16 in the purposively selected Rewa district of M.P. as the participatory Seed Village Programme. was implemented in this district. The sample population consisted 120 (60 beneficiaries and 60 non beneficiaries) were selected from 10 villages of Rewa block of Rewa district. The statistical tools were used for determining the extent of knowledge on three points continuum as full, partial, and non-adoption. The independent variables represented personal, socio-economic and psychological characteristics of the respondents and were empirically measured by procedures evolved by earlier researchers. A structured and pre-tested interview schedule was used to collect data from the respondents by personal interview method.

Co-Efficient of Correlation ('r' Value)

Co-efficient of correlation was computed to find out the relationship between the variables. The correlation coefficient gives two kinds of information (i) degree of the relationship and (ii) direction of the relationship (whether positive or negative) between any two variables.

For computing the correlation coefficient 'r' the Karl Pearson method was used

Z Test

To test the hypothesis z test was used because of the large sample size. This test was used to find out if there were any significance difference between beneficiaries and non-beneficiaries as regarding their knowledge and adoption of seed production technology.

RESULT

Extent of adoption regarding seed production technology of wheat among beneficiaries and non beneficiaries

Adoption is a decision made by an individual or group to use an innovation in a continuous manner. Adoption is regarded by Rogers (1995) as a decision to make full use of an innovation or technology as the best course of action available. Adoption of innovation is the decision of an individual or group to use or apply an innovation. Modern agriculture requires an innovative technology which systematically adopts scientific knowledge to farming. In the present study the adoption refers to the actual implementation or use of the location specific seed production technologies of wheat disseminated to them in training programmes through various activities of seed village programme conducted by Krishi Vigyan Kendra Rewa (M.P.). Hence in the present study a scale as in case of was used consisting the recommended components of seed production technology of wheat crop. While administering the final adoption test of respondents score '3' was assigned for a complete adoption answer "2' for partial adoption and score '0' (zero) was assigned for non adoption for each practice. The summation of scores of all selected components of seed production technologies of wheat for a respondent was taken as his extent of adoption level. Based on the extent of adoption scores obtained (maximum and minimum) on the scale, respondents were classified into three following categories

S. No.	Level of adoption	Score range
1.	Low	Up to 33
2.	Medium	34-60
3.	High	Above60

Table 1. Overall adoption regarding seed production technology of wheat among beneficiaries and non beneficiaries

S. No	Categories of Level of adoption	Beneficiaries		Non- Beneficiaries	
		Frequency	Percentage	Frequency	Percentage
1	Low (Up to 33)	10	16.66	28	46.66
2	Medium (34-60)	13	21.67	19	31.67
3	High (above 60)	37	61.66	13	21.67
	Total	**60**	**100.00**	**60**	**100**

Mean adoption score of beneficiaries 57.9 & Mean adoption score of non beneficiaries 44.3
$S.d_1$=12.60 $S.d_2$=9.15
Z test= 2.97
Tabulated value at 5%=1.96

It is clear from the Table 3 that of out of 60 beneficiaries 61.66 per cent had high extent of adoption followed by 21.67 percent medium and 16.66 percent low adoption. In case of non-beneficiaries 48.66 per cent respondents were having low, 31.67 percent medium and 21.67 per cent had high extent of adoption. Thus, it may be inferred from the above observation that higher percentage of beneficiaries were found to have had higher extent of adoption as compared to non-beneficiaries.

In order to find out if there was a significant difference between beneficiaries and non-beneficiaries as regards to their overall extent of adoption, the null hypothesis (ho) i.e. there was no significant difference between beneficiaries and non-beneficiaries as regards their extent of adoption of seed production technology was tested. The calculated value of Z test was found to be 2.97 which was greater than the table value of z (1.96) at 5 % level of significance. Hence, the null hypothesis (Ho) was rejected and the alternate hypothesis was accepted.

It may be concluded that there was significant difference between beneficiaries and non-beneficiaries as regards to extent of adoption of seed production technology. The beneficiaries had greater extent of adoption than non-beneficiaries. The findings are in the conformity of the findings of Manoj and Sharma (2004), Bussain *et al*, (2009) and Burman *el al.* (2010).

Relationship between independent variables and adoption behavior of seed producers

Table 2. Correlation between independent variables and adoption behavior of seed producers

S.N.	Independent Variable	Beneficiaries	Non- beneficiaries
1	Age	0.076^{NS}	-0.028^{NS}
2	Education	0.24^{*}	0.21^{*}
3	Land holding	0.29^{**}	0.28^{**}
4	Social participation	-0.28^{**}	-0.37^{**}
5	Size of family	-0.36^{**}	-0.29^{**}
6	Annual income	0.31^{**}	0.31^{**}
7	Marketing orientation	0.36^{**}	0.44^{*}
8	Attitude towards	0.274^{**}	0.315^{**}
9	Risk orientation	0.35^{**}	0.38^{**}
10	Innovativeness	0.46^{**}	0.360^{**}
11	Mass media exposure	0.29^{**}	0.34^{*}

12	Extension participation	0.33**	0.40**
13	Knowledge	0.39**	0.42**

NS= Non-significant
** = Significant at 1%
*= Significant at 5%

Correlation coefficients between independent variables and extent of adoption as dependent variable are presented in Table 2. The table elucidated that knowledge, risk orientation, marketing orientation, attitude towards agricultural technology, extension participation, mass media exposure, innovativeness, education, land holding and annual income had positive and significant relationship with adoption behaviour of both the categories i.e. beneficiaries and non beneficiaries. Social participation and family type had negative and significant relationship with extent of adoption, while age had negative and non-significant relationship.. These findings of the present investigation are in the conformity with the findings of Shakya (2008) and Maraddi (2009).

CONCLUSION

It may be concluded from the above findings that the adoption behavior of beneficiaries about seed production technology was significantly higher than non-beneficiaries and the non-beneficiaries were found to be ignorant about some important aspects of technological practices. The study has brought into focus some attributes of the farmers viz. knowledge, risk orientation, marketing orientation, attitude towards agricultural technology, extension participation, mass media exposure, innovativeness, education, land holding and annual income which influenced positively the adoption of -seed based technology programme. On the light of the results of this research work it may be recommended that the modal farms, demonstrations plots and seed farms are introduced in the community development blocks to serve the farmers as key centers of technological information and in the process of diffusion of innovations.

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RESEARCH ARTICLE

ENHANCEMENT OF PRODUCTION AND PRODUCTIVITY OF SOYBEAN THROUGH THE CLUSTER FRONT LINE DEMONSTRATION OF OILSEED

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Abstract: Cluster front line demonstrations on soybean were organized in the kharif seasons of year 2015-16 different villages of Ashoknagar district by Krishi Vigyan Kendra, Ashoknagar for creating awareness among the farmers to popularize the high yielding variety of soybean. In this context, centre was conducted demonstration to assess the improved varieties of soybean JS 9560 along with existing varieties used by the farmers as local check in the district. The farmers followed the full package of practices like proper seed rate, seed treatment with biofertilizer, fertilizer application on soil test value, weed management, IPM practices etc. Result of front line demonstrations indicated that on an average of 25% more yield of soybean was found as compared to farmer's practices.The number of productive pods per plant of JS 9560 soybean was found 52.7 and non-productive pods per plant 7.9 under package of improved practices. The economic analysis of data over the years revealed that the adoption of improved technology of soybean not only gives the opportunity of higher yield, but also provides higher benefit cost ratio i.e. 1.62 as compared to 1.37 in the farmer's practices.

Keywords: CFLDs, Soybean, Front Line Demonstration, Ashoknagar

INTRODUCTION

Soybean (Glycine max Merrill) is a legume that grows in tropical, subtropical and temperate climate. It occupies third position among the oilseed crop in India after groundnut and rapeseed mustard. Madhya Pradesh has its major share in area (70%) and production (65%) of soybean in India (Sharma Saurabh, 2013), but productivity of soybean in M. P. is very low (10 qt/ha) as compare to genetic potential (25q/ha).

It has great potential as a *kharif* oilseed and has emerged as an important commercial oilseed in Madhya Pradesh. The main aim of Krishi Vigyan Kendras is to reduce the time lag between generation of technology at the research institution and its transfer to the farmers for increasing productivity and income from the agriculture and allied sectors on sustained basis.

The FLD is an important tool for transfer of latest package of practices in totality to farmers and the main objective of this programme is to demonstrate newly released crop production and protection technologies and management practices at the farmers' field under real farming situation. Through this practice, the newly improved innovative technology having higher production potential under the specific cropping system can be popularized and simultaneously feedback from the farmers may be generated on the demonstrated technology (Singh *et al*., 2012).

To sustain the production system of soybean, the Department of Agriculture, Cooperation and Farmers Welfare had sanctioned the project "Cluster Frontline Demonstrations on oilseed to ICAR-ATARI, Jabalpur through National Mission on Oilseed and oilpalm (NMOOP). Under these cluster front line demonstrations (CFLD), introduction of improved technologies/package of practices is the main objective with conductance of long-term educational activity in a systematic manner in farmers‟ fields.

This project was implemented by Krishi Vigyan Kendra, RVSKVV, Ashoknagar of Zone-IX with main objective to boost the production and productivity of Soybean through CFLDs with latest and specific technologies and varieties. The present study was carried out by the Krishi Vigyan Kendra, Ashiknagar with the following objectives:

1. To popularize the improved and high yielding varieties of soybeean along with their production and plant protection technologies.
2. To study the technological gap, extension gap and technology index.
3. To work out the difference in input cost and monetary returns under Cluster Front Line demonstrations and farmers practice.

MATERIAL AND METHOD

The present study was conducted by the Krishi Vigyan Kendra, Ashoknagar during Kharif season of year 2015-16 with the objective to identify the yield gap as well as to work out the difference in input cost and monetary returns. Improved varieties of soybean JS 9560 with full package of practice was demonstrated through cluster demonstration of soybean in the farmer's field of different villages of operational area of Krishi Vigyan Kendra. This variety was compared with the existing soybean variety JS - 335 used by the farmers as local check. Total 75 demonstration were conducted in 30 ha area. Each demo was conducted on an area of 0.4 ha and the same area adjacent to the demonstration plots was kept as a local check. Under the demonstrations, crop was fertilized with recommended dose of fertilizer @ 20:60:20:20:: N:P2O5:K2O: S kg/ha and

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full dose of fertilizer was added at the time of sowing. Seed (75 kg /ha) were sown by the seed cum ferti drill after treating by Cabendezim @ 2gm /kg seed + rhizobium @ 5g/kg seed + PSB @ 5 g/kg of seed. Weed management (imazathyper @ 800 ml/ha at 21 DAS + one hand weeding at 40 DAS) and pest management were adopted as per requirement. Crop was sown in the first week of july at sufficient moisture content in the soil.

Under farmers practice existing variety JS 335, was sown without any seed treatment with fungicides and bio-fertilizers, using higher seed rate (110-120 kg/ha), broadcasting of DAP at 20 days after sowing (DAS), and following injudicious use of insecticide and weedicide.

Soybean seed of JS 9560 was provided by the Krishi Vigyan Kendra, whereas, the fertilizer, herbicide, insecticides and other inputs were born by the farmers themselves.

Before conducting the demonstrations, KVK has collected the soil sample from the demonstrations field and analyzed the sample and applied the fertilizer on the basis of soil test values, training to the farmers of respective villages was imparted with respect to envisaged technological interventions. Site selections, farmer's selection, layout of demonstration and farmers participation were considered as suggested by Choudhury (1999). The observations on productive and non-productive pods per plant, seed yield per plant and seed yield per ha were recorded. Other parameters like harvest index, technology gap, extension gap and technology index (%) were worked out as suggested by Kadian *et al.* (1997) using following formulae.

Harvest index (%) = Grain yield/ Biological yield x 100

Technology gap (kg/ha) = Potential yield - Demonstration yield

Extension gap (kg/ha) = Demonstration yield – Farmers‟ yield

Technology index = Potential yield- Demonstration yield/Potential yield x 100

The economic analysis was done by working out cost of cultivation utilizing the inputs and output prices of commodities which prevailed during year of demonstration, gross and net returns, and benefit cost ratio.

Table 1. Description of Technological intervention and farmers practices under CFLD on Soybean

Particulars	Technological intervention (T1)	Farmers Practices (T2)	Gap
Variety	JS 9560	JS 335	Full gap
Seed Rate	75 kg/ha	120 kg/ha	Partial Gap
Soil Test	Soil Test Before demonstration	No soil test	Full Gap
Integrated Nutrient Management	20:60:20:20:: N:P2O5:K2O: S kg/ha + rhizobium @ 5g/kg seed + PSB @ 5g/kg of seed	Only N and P through DAP	Full Gap
Integrated Pest Management	Seed treatment with Cabendezim @ 2g/kg seed + one spray of proponophosh @ 1.5 lit/ha at the ETL	Two or three spray of Insecticide insufficient amount of water	Partial Gap
Weed Management	imazathyper @ 800 ml/ha at 21 DAS + one hand weeding at 40 DAS	imazathyper @ 800 ml/ha at 21 DAS	Partial Gap

RESULT AND DISCUSSION

While evaluating the demonstrated variety and comparing with the farmer practice, it was observed result of front line demonstrations indicated that the cultivation practices comprised under CFLD viz., use of improved varieties, proper seed rate, seed inoculation by rhizobium and PSB culture, soil test based application of fertilizer, integrated pest management, irrigation and hand weeding produced on an average of 25% more yield of soybean as compared to farmer's practices. The result indicates that the CFLD has given a good impact over the farming community of Ashoknagar district as they were motivated by the improved agricultural technologies applied in the demonstration plots.

The number of productive pods per plant of JS 9560 soybean ranged from 48.6 to 55.1 with a mean of 52.7 and non-productive pods per plant range from 7.2 to 8.8 with a mean of 7.9 under package of improved practices. In case of farmer's practice the respective figures recorded were 40.5 to 46.3 with a mean of 43.8 and 6.0 to 6.8 with a mean of 6.4, respectively.

The result revealed that the seed yield of soybean recorded was in the range of 840 to 1250 kg per ha (average 1075 kg/ha) by adoption of improved package of practices as compared to farmer's practice of 730 to 960 kg per ha (average 860 kg/ha). In comparison to farmer's practice, an increase of 15 to 30 per cent (average 25 %) in seed yield was recorded during 2015-16 due to improved package of practices. Similarly, higher harvest index was recorded under improved package of practices (ranged from 32.3 to 38.1 % with a mean of 35.7 % as) compared to farmers‟ practice (29.1 % to 34.6 % with a mean of 31.7 %). The higher number of productive pods and higher harvest index in imparted

pakage of practices justifies the higher yield achieved over farmer's practice. These results are in agreement with findings of Kumar *et al*. (2010), Jain *et al.* (1998) and Tiwari *et al*. (2013).

The technology gap is the gap in the demonstration yield over potential yield was found 9.25 qt/ha while extension gap was recorded 2.15 qt/ha. The technology gap observed dissimilar due to weather conditions, soil fertility status. Hence location specific recommendation appears to be necessary to bridge the gap between the yields. But to minimize the extension gap it is need to educate the farmers through various means for more adoption of improved high yielding variety and recommended practices to bridge the wide extension gap. This extension gap requires urgent attention from planners, scientists, extension personnel, development department and NGOs working in the agricultural fields.

The technology index shows the feasibility of the evolved technology at the farmer's field. The lower the value of technology more is the feasibility of the technology. The technology index was found 46.25% indicating the performance of this variety in Ashoknagar region was satisfactory.

The input and output prices of commodities prevailed during 2015-16 of demonstration were taken for calculating the cost of cultivation, gross return, additional net return and benefit cost ratio. The economic analysis of data over the years revealed that the adoption of improved technology of soybean not only gives the opportunity of higher yield, but also provides higher benefit cost ratio i.e. 1.62 as compared to 1.37 in the farmer's practices. This may be due to higher yield obtained under recommended practices compared to farmer's practices.

Similar results have earlier been reported on soybean (Sharma *et al.*, 2013; Tiwari *et al*., 2013) and on chickpea (Tomar *et al.*, 1999), Tomar (2010), Mokidue et. al, (2011) and Singh et al. (2014).It was also observed from the data of front line demonstration recorded higher gross return and net return as compared to local check. The gross and net returns were found Rs 34400 and Rs 13150 in CFLD while in farmer's practices these were found Rs 27520 and Rs 7555 respectively.

The result of front line demonstrations on the package of practices suggested that by its adoption, the farmers can realize higher yields and net profit in soybean cultivation.

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SHORT COMMUNICATION

PERFORMANCE OF STRAWBERRY (*FRAGARIA X ANANASSA* DUCH.) GENOTYPES FOR GROWTH AND YIELD CHARACTERS IN HILL ZONE OF KARNATAKA

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Abstract: The study was conducted on performance of seven genotype of strawberry (*Fragaria x ananassa* Duch.) at College of Horticulture Mudigere, Karnataka in naturally ventilated polly house during 2015-2016 the significant variation was occurred for all vegetative and Yield parameters. The genotype Sabrina accounted maximum plant height (32.30 cm), number of trifoliate leaves (30.40), plant spread (48.47 cm in north and south direction whereas 53.93 cm in east and west direction), leaf area (206.04 cm^2), leaf area index (6.95), plant dry weight at harvest (29.04 g), chlorophyll content (2.33 mg/100 g), number of fruits per plant (22.36) and yield per plant (380.29 g). number of runners per plant was maximum (10.70) in Cristle , weight of fruit was maximum (20.01 g) in Fortuna, maximum (4.43 cm) fruit length was recorded in genotype Cristle followed by Fortuna (4.12 cm), the breadth and volume of fruit was observed maximum in genotype Fortuna that was 3.28 cm and 24.37 cc respectively Among different genotypes evaluated the Sabrina accounted maximum for growth and yield parameters of strawberry..

Keywords: Genotypes, Strawberry, Growth, Yield, Hill zone

INTRODUCTION

Strawberry (*Fragaria* x *ananassa* Duchesne) is one of the most delicious, refreshing and nutritious soft fruits of the world. It belongs to family Rosaceae and native to America (Galletta *et al.*, 1990). In India, Strawberries were first introduced by NBPGR Regional Research Station, Shimla (Himachal Pradesh) in the early sixties. At present, the strawberry is being grown in a wide range of climatic zones extending to temperate, Mediterranean, Sub-tropical zones. Due to octaploid nature, considerable variations exist in various cultivars and these cultivars helped the crop to spread in cool place of India. It is now being grown in Shimla, Solan, Bilaspur, Kangra, Kullu, Palampur (Himachal Pradesh), Deharadun, Saharanpur (Uttaranchal), Muzaffarnagar, Ghaziabad (Uttar Pradesh), Hoshiarpur, Ludhiana, Jalandar, Patiala (Panjab), Gurgaon, Hisar, Karnal (Haryana), the work on identification of suitable high yielding variety of strawberry for different agro-climatic conditions remains scanty in literature. With the introduction of new cultivars, it was therefore felt imperative to evaluate for its feasibility and record pomological descriptions of strawberry cultivars for their proper identification and highlighting useful characters, which could be exploited for bringing about improvement in strawberry production in the state. Keeping these points in view the present investigation work entitled "Evaluation of different genotypes for growth, yield and quality of strawberry (*Fragaria X ananassa* Duch.*)* under naturally ventilated polyhouse in hill zone of Karnataka" was conducted in a low cost polyhouse .

MATERIAL AND MATHODE

The present investigation entitled "Evaluation of different genotypes for growth, yield and quality of strawberry (*Fragaria X ananassa* Duch.*)* under naturally ventilated polyhouse in hill zone of Karnataka" was carried out at college of Horticulture Mudigere, from October 2015 to march 2016, the experiment was laid out in completely randomized block design. In the present study seven genotypes of strawberry and considered each as single treatment and replicated thrice. The genotypes taken for evaluation are Winter Dawn, Sweet Charlie, Safari, Fortuna, Cristle, Elyana, Sabrina. The beds of 45 cm height, 60 cm width was prepared and mulched with black polyethene. The planting was done at spacing of 30 cm x30 cm, the morphological observation was recorded at an interval of 30, 60, 90 and 120 days after planting.

RESULT AND DISCUSSION

The various vegetative parameters like plant height, number of trifoliate leaves, plant spread, number of runners per plant, leaf area, leaf area index, plant dry weight at harvest, chlorophyll content, number of fruits per plant, yield per plant, weight of fruit, length of fruit, diameter of fruit and volume of fruit.

The genotype Sabrina accounted maximum plant height (32.30 cm), number of trifoliate leaves (30.40), plant spread (48.47 cm in north and south direction whereas 53.93 cm in east and west direction), leaf area (206.04 cm^2), leaf area index (6.95), plant dry weight at harvest (29.04 g),

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chlorophyll content (2.33 mg/100 g), number of fruits per plant (22.36) and yield per plant (380.29 g). The genotype Fortuna was on par with Sabrina for all the above parameters, where as the minimum plant height was recorded in Winter Dawn that is 21.50 cm, the minimum plant spread (31.87 cm in east and west direction whereas 32.37 in north and south direction) was

Table 1. Performance of strawberry genotypes for vegetative characters

Genotypes	Plant height (cm)	Number of leaves	Plant spread (cm)		R/P	LA (cm^2)	LAI	TDMW (g)	Chlorophyll content (mg/100g)
			N – S	E – W					
Winter Dawn	21.50	15.40	31.87	32.37	4.10	115.37	1.97	18.87	1.71
Sweet Charlie	26.27	21.20	43.60	46.37	4.83	165.72	3.90	22.24	1.94
Safari	24.87	15.27	33.63	36.20	4.17	100.59	1.70	18.45	1.62
Fortuna	27.63	22.50	41.20	42.40	8.33	182.69	4.50	25.07	2.06
Cristle	27.30	20.50	40.40	47.37	10.70	162.85	3.70	20.38	1.92
Elyana	26.50	19.43	40.10	37.83	6.70	129.84	2.80	19.28	1.85
Sabrina	32.30	30.40	48.47	53.93	1.67	206.04	6.95	29.04	2.33
S. Em ±	**0.34**	**0.47**	**0.62**	**0.64**	**0.49**	**9.69**	**0.13**	**0.36**	**0.11**
C. D. (P = 0.05)	**1.05**	**1.45**	**1.90**	**1.96**	**1.49**	**29.87**	**0.40**	**1.10**	**0.33**

R/P-Runners/plant, LA- Leaf Area, LAI-Leaf Area Index, TDMW-Total Dry Matter Weight

recorded in Winter Dawn. the minimum number of trifoliate leaves (15.27), leaf area (100.59 cm^2), leaf area index (1.70), plant dry weight at harvest (18.45 g), chlorophyll content (1.67 mg/100 g of fresh weight), number of fruits per plant (14.67) and yield per plant (191.77 g) was recorded minimum in genotype Safari where as the number of runners per plant was maximum (10.70) in Cristle where as minimum (1.67) was reported in genotype Sabrina, weight of fruit was maximum (20.01 g) in Fortuna followed by Sabrina (16.01 g) while, minimum (12.87 g) was observed in genotype Cristle, the maximum (4.43 cm) fruit length was recorded in genotype Cristle followed by Fortuna (4.12 cm) where as minimum (3.11 cm) was recorded in Sabrina, the breadth and volume of fruit was observed maximum in genotype Fortuna that was 3.28 cm and 24.37 cc respectively where as minimum was recorded in genotype Safari that was 2.55 cm and 12.12 cc respectively.

Table 2. Performance of strawberry genotypes for yield attributes

Genotypes	Number of fruits per plant	Fruit weight (g)	Length of fruit (cm)	Diameter of fruit (cm)	Volume of fruit (cc)	Yield per plant (g)
Winter Dawn	14.83	12.94	3.49	3.10	16.39	192.73
Sweet Charlie	19.24	13.45	3.15	3.05	13.50	259.65
Safari	14.67	13.07	3.11	2.55	12.12	191.77

Fortuna	20.91	20.01	4.12	3.28	24.37	367.24
Cristle	18.09	12.87	4.43	2.56	12.07	237.83
Elyana	15.53	15.03	3.27	2.93	14.07	233.87
Sabrina	22.36	16.01	3.67	3.16	17.72	380.29
S. Em ±	0.35	**1.43**	**0.18**	**0.12**	**1.58**	**25.86**
C. D. (P = 0.05)	**1.08**	**4.42**	**0.56**	**0.38**	**4.87**	**79.70**

The above results are in accordance with the findings of Singh *et al.* (2012), Hossan *et al.* (2013), Ankita Chandel (2014) and Uddin *et al.* (2016). The variation in cultivar may be due to genetic and environmental interaction.

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