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SYNOPTIC OVERVIEW OF TRENDS OF GLOBAL TROPICAL FORESTS MANAGEMENT

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PREAMBLE

Every year millions of hectares of precious forest especially of tropical countries continue to be lost or seriously degraded. Why is this? The civilized man started clearing land for settled agriculture since 10,000 years ago and the process continued to use the land for cultivation, settlement and the forests were used for grazing and gathering various products. At that time forest and open woodland covered 6.2 billion ha of the globe. The space of conversion of forestland to non forestry purposes was slow which maintained a balance with the human population. The social perception of natural resources changed with changing time and development in human history. Prior to Industrial revolution human race whether in east or west used nature to meet his needs. This period was characterized by agricultural and grazing practices without any management plan or strategic planning. After the discovery of new countries and continents, India and South east Asia, Africa by the Europeans, their commercial interest of the colonizers promoted them to gather and grow raw materials including wood from these areas to fuel their industrial development. This resulted in much of the deforestation. The commercial interest led to migration of population from other region to supply work force for raising commercial crops and development of communication, expansion of agriculture, mining, urban settlement, etc. that led to deforestation of large tracts of forest areas. Between 1700 and 1995, 13.9 million sq km of forests or 9.3% of the world's total forest area was cleared for industrial use, cultivation, pasture, illegal logging, fuel wood, mineral extraction etc. John Spears (1982) in his article of Preserving Water shade environments of Unasylva mentioned, "Studies have shown, for instance, that denudation of water catchment areas has caused the flooding in Indus river system in Pakistan to be higher in last 25 years than during previous 60 years, and has led to serious silting of dams and canals of Pakistan's irrigation system". The cost of repairing flood damage below the Himalayan catchments in India was, on an average $250 million a year (1982 figure), in addition to loss of production and livelihood suffered by millions. While part of the damage is due to geological erosion, much of it is due excessive population pressure and misuse of land. Severe soil erosion has occurred in Ethiopian highland, and in Java and Philippines where five million ha of denuded, formerly forested water shade are source of

increasing downstream flood and disruption of agriculture. The list of examples can go on. The progress of deforestation in some of the countries continues because of immediate benefit from export of wood from illegal logging and also clearing of forest agriculture and cash crops, and urbanization for immediate gain. So, the role of forest in soil and water conservation is being realized because of the faulty land use in the past and heavy expenditure is being incurred for its restoration. Further destruction of catchment areas affecting water yield and many rivers and streams are losing perenniality.

Though forests were known as carbon sink that it was never featured prominently in the past as an important role. But with the rising problem of emission and climate change, conservation and extension of forest area has become an important issue. There are several reports on the effect of climate change in the form of melting of glaciers in the Himalayas and in Peru, shortening of winter season resulting in yield reduction of crops especially winter loving crops like wheat and apple.

As per FAOs assessment report of 2005, global forests stores 283 Gt carbon in its biomass, 38 Gt in dead wood and 317 Gt in soil up to 30 cm and leaf litter from 4 billion ha of forests out of which 36% is primary forest).The total carbon content of forest ecosystem is estimated at 636 Gt, which is more than the amount of carbon in the entire atmosphere. The standing carbon is combined with territorial uptake of carbon, which was estimated as 2.4 Gt a year, good deal of which is sequestered by forests.

Apart from the significant role of forest in soil and water conservation, climate change, forests play important role in maintaining eco-system services, supply of timber and non timber forest produce for national economics, livelihood of the forest dwelling communities (about 1.6 billion people depend for food, medicines, fuel and other basic necessities), biodiversity and as habitat of wildlife, and also for cultural and recreational value.

As per the assessment report of FAO for the period of 2005 mentions the rate of deforestation is 13.2 million ha per year, 8000 tree species or 9% of total number of tree species are currently under threat of extinction.

In this article a brief account of recent trends tropical forests of the country of Africa, Asia Pacific and Latin American and Caribbean regions will be given as per latest published information and indicate key issues of concern for sustainable forest management.

Scientific Forestry : Past and Present

Georg Ludwig Hartig (1764-1837) and Heinrich Von Cotta (1763-1844) of Germany developed concept of modern silviculture which provided the technique of replacement of old growth by clear cutting followed by artificial regeneration (Vos, 1996). The economic aspect of forest management was considered to achieve maximum revenue from timber (Agnoletti, 2006). The term sustainability in the forestry context was used for the first time in 1713 by Hans Carl Von Carlowitz in his book "Sylvicultura Oeconomica". In the 1804, Georg Ludwig Hartig asserted sustainability was priority in Public Forest Management (Vehkamaki, 2005).

Increasing demand of wood and wood products and consequent increase of human pressure on the forest resources in post industrial revolution era were the main cause for elaboration of the two forest management doctrines : (i) timber primacy doctrine and (ii) sustained yield doctrine. These doctrines originated in the middle of nineteenth century in Germany and it had maximum importance in Europe after First and Second World War (Gluck, 1987).

Scientific Forest Management

The scientific forest management to obtain sustained yield of timber was introduced in the Indian subcontinent in 1854 by German forester Dr. Brandis who was appointed by the then Governor General Lord Dalhousie, primarily to obtain sustained yield of teak of Burma then province of British India. Actually the practice of scientific forestry and the management model for harvesting and regeneration was developed by Dr.Brandis and his German colleagues, was based on management of temperate forests of France and Germany after suitable modification for the tropical forests which contain large number of species but very few are of commercial importance unlike temperate forests of Europe. Fig. 1 shows teak forest of Pegu, Burma (present Myanmar) where scientific forestry was initiated by Brandis. Apart from management by natural regeneration system, regulation of yield for sustained supply of timber, he innoveted Taungya system (a method raising forest crop along with agricultural crop) for raising teak plantation at cheaper cost by modifying the practice of shifting cultivation being practiced by Karen tribes.This inovation lead successful raising of plantation of desired species like teak or sal at cheaper cost.Thus was adopted in areas where natural regeneration of sal failed to regenerate naturally like North Bengal, Lower Assam, Gorokhpur for crating plantation of sal as per suggestion of Brandis as Inspector General of Forests by setting up forest villages. Gradually Taungya system spread in may parts of tropical world for artificial regeneration of forest species.

The decision for organization of forest department was considered by the British Parliament, which mentioned that the expenditure for running the department should not exceed the income from forests. He organized forest management system of India and Indian Forest Service after being appointed as Inspector General of Forests of India in 1864. The Central Forest School was founded to train subordinate staff in 1878 and the officers of Indian Forest Service were trained in Europe. Forest Research Institute came into existence in 1906. The assertion of state's monopoly rights and exclusion of forest communities has marked the organizing principle of forest administration.

Teak forest of Pegu

This colonial forestry ideology was imported to Oxford, Cooper's hill in England for training of foresters of different countries including USA by some of the legendery foresters who served in India .

Brandis and, some of his junior foresters of Indian Forest Service contributed greatly for developing scientific management of tropical forests. Ribbentrop the author of Forestry of British India, Silviculture of India Trees, and Schilch who started the reputed forestry journal, Indian Forester, in 1875 and authored the book Manuals of Indian Forestry in five volumes during1889-1896 remains classic work in the field till date. He worked as Professor of Forestry in Royal Engineering College in Cooper's hill and lent his service to Forest Department of USA during its formative years. Gamble was collaborator of Brandis and they wrote the book Manual of Indian Timbers in 1881 which continues to be reference book of

forest scientists even today. Hooker the First Director of Royal Botanic garden, visited forests of India to study of its flora and submitted report about state of forests to Lord Dalhousie recommending need of scientific management which led the Governor General to take action for scientific management of forests. Later he and associates took twenty years to complete seven volumes of Flora of British India and Gamble opened a herbarium in 1890. Champion wrote two books of paramount importance namely, Experimental Manual and Forest Types of India and Burma in 1931. Osmaston carried out detailed studies in management of tropical and temperate forests and published a treatise. The various pioneering work for management of Indian forests carried out by German, English and Indian Foresters greatly influenced management of forests in tropical forests in other part of the world. Sir Dietrich Brandis-a German Forester is remembered as Father of Indian Forestry. He also played important role in founding forest department of USA.

The scientific forestry is practiced in most of the tropical countries of Asia Pacific region, a few African and in many Latin American and Caribbean countries for conservation and management of forests is mainly under government control under forest department for sustained yield of timber as the major goal. Prior to which there existed unrestricted user rights of forest dwelling communities on these forests. The problem of deforestation for various developmental activities and forest degradation by the forests and fringe area communities continued to be problem of forest conservation. Subsequently there were changes in forest policies with changing requirements and enactment of forest conservation act. The latest forest policy in India has put emphasis to restore and maintain the diversity of its native biota to provide both ecological and human communities. Joint Forest Management (JFM) has been introduced which is a positive step in the ultimate process of decentralization of decision making and building up meaningful framework for preservation and efficient use of forests. Seventeen million ha of the country has been covered under JFM. Remote sensing and Geographical Information System (GIS) have been combined with inventories of vegetation and land use to monitor changes in forest condition by Forest Survey of India.

Tropical deforestation control has been key priority since Rio conference in 1992.The possibility of reducing carbon emission through preservation of forest cover has led to renewed interest in tropical forests. International Tropical Timber Organization (ITTO) has the mandate for conservation of tropical forests which lie in African, Asia Pacific and Latin American and Caribbean region for Sustainable Forest Management (SFM) which is the process of managing forest to achieve one or more specific objective of management with regard to production of a continuous flow of desired forest produce and services without undue reduction in its inherent values and future productivity and without undesirable effect on physical and social environment. The Criteria and Indicators of SFM are formulated to find means to measure changes in Forest Management. A Criterion describes the different aspects of sustainable forest management; while Indicator is qualitative, quantitative or descriptive attributes that when measured would indicate direction of change. There is no globally agreed set of indicators for the identified criteria; indicators need to be adopted to the ecological, economic, social and institutional conditions of each country. The seven broad criteria are as follows:

i) Maintenance/increase in the extent of forests and tree cover for their contribution to global carbon cycle,
ii) Maintenance, conservation and enhancement of Biodiversity,
iii) Maintenance and enhancement of forest health and vitality,
iv) Conservation and maintenance of soil and water resources,
v) Maintence and enhancement of forest resources (timber and non timber forest produce) productivity,
vi) Maintenance and enhancement of social, cultural and spiritual benefits,
vii) Adequacy of Policy, Legal and Institutional frame work related to forests.

Criteria and Indicators (C&I) are in the process of development. FAO is the facilitator of the process. There are number of ongoing international process for C&I development for SFM started with a focus at the national and forest management unit level. In India, Indian Institute of Forest Management, Bhopal has been assigned the task of development of C&I which is known as Bhopal India process.

Management of Tropical Forests

Tropical forests are the most important forest type of the world for its value for its services such as carbon sequestration, biodiversity and soil and water conservation as well as the source of valuable commercial timber. Much of the forest areas of the tropical world are lying between the Tropic of cancer and the Tropic of Capricorn, higher altitude within the tropics that are effectively temperate forest types are taken as tropical. Sixty five countries which include twenty six in Africa, sixteen in Asia Pacific and twenty-three in Latin America and Caribbean have tropical forests are the members of ITTO, which contain 85% of global tropical forests, gradually using criteria and indicator frame work for SFM of their protective and productive forests.

Between 2005 and 2010 the area of natural forest covered under forest management plan increased in ITTO producer centers by 69 mha to 183 mha which is 24 percent of permanent forest. The natural forests of these areas include rain forest, mangroves, and dry forests, moist forests and savannas. Most valuable timber trees of the world are from the tropics like Mahogany native to Mexico to Bolivia, Teak from India to South East Asia, Gamar from India through Vietnam and Okouma from Gabon of Africa. The area under certified forest in ITTO producer countries increased from10.5 million ha in 2005 to 17 million ha in 2010. A number of consumer markets are being increasingly sensitive about environmental credentials of timber products. The major timber exporting countries of tropical woods are Cameroon, Brazil, Indonesia, Malaysia, and top importers in terms of quantity of importing timber are China, Japan, USA, South Korea, Taiwan, Thailand, India and others. Apart from logging from the prescribed logging from the primary forests, there are substantial illegally logged wood are exported which indeed has become a matter of serious concern.

CITES (Convention of International Trade of Endangered Species of wild flora and fauna) has restricted trade of many species of the region which are considered threatened or at risk in the wild or country likes to impose restriction.

Overview of the forests of the globe

FAO has grouped world forests under six regions: Africa, Asia Pacific, Europe, Latin America and the Caribbean, the near East and North America out of which bulk of the tropical forests exist in Africa, Asia Pacific and in Latin America and Caribbean. Major trends in the extent of forests, and changes in the rates of forest loss, as well as the current state of

productive and protective forests, show disparities between the six regions: The highest forest area worldwide was found in Europe, primarily because of the vast swaths of forest in the Russian Federation, while Latin America and the Caribbean had the highest net forest loss over the last decade. Whereas continued forest loss was reported in Democratic Republic of Cameroon, Congo, Angola of Africa, Brazil, Peru of South America and Indonesia of Asia Pacific region due to unsustainable harvesting of tropical wood for export, use of forest land for agriculture, plantation crops etc. However the overall trend in net forest loss in African region has slowed between 1990 and 2010 and the area of planted forests was increasing in particular in West and North Africa.

In general there is shrinkage of area under primary forests. The primary forest is defined by FAO "as naturally regenerated forests of natural species where there is no clearly visible indication of human activities and the ecological process is not significantly disturbed". Some forest planting programmes were established to combat desertification, while others were created in an effort to secure industrial wood and energy sources. The global forests have 7% planted forests (FAO 2010).

The global tropical forests by region along with area under primary forests of ITTO producer and non producer countries are given in Table 1.

As per 2010 assessment the global forest area stands 4 billion ha corresponding to 31% of land area and 0.6 ha per capita. A key message of FRA 2010 is while the rate of deforestation and loss of forests from natural cause is still alarmingly high but there is indication of slowing down. At global level it decreased from 16 million ha during the decade ending 1990 to around 13 million ha in the last decade.

Table 1

Global tropical forests by region

Region	Total forest cover in million ha	Percentage forests in ITTO Producer countries	Primary forest In million ha	Percentage of primary forests in ITTO Producer countries
Africa	440	61	102	98
ITTO (10 countries)	270		100	
Others (16 countries)	170		2	
Asia Pacific	317	89	108	97
ITTO (10 countries)	282		104	
Others (6 countries)	35		3	
Tropical Latin America & Caribbean	907	96	678	96
ITTO (13 countries)	868		647	
Others (10 countries)	38		30	
Global Total	1664	85	887	96

Source : Quoted from Status of Tropical forest management 2011, ITTO

Region wise overview

Africa

Forests of the region

Forests occupy an estimated area of 440.45 million ha out of which 102.26 million ha is primary forest. The rate of deforestation varies from country to country; the maximum deforestation rate is 5.75% in Togo and practically no deforestation in Gabon. In general primary forest exists in ITTO member countries whereas primary forest disappeared in other countries.

As per state of forest report of FAO 23% of the land area of Africa account for forest and woodland having scattered tree growth not classified as forest, comprise 17% of global forest cover. The percentage of forest area varies among the countries of the continent. The per capita forest area (forest and woodland combined) is 0.8 ha where as global average is 0.6 per ha.

Tropical Forest

The forests of Central Africa the Congo basin is the world's second largest continuous block of tropical rain forest, exceeded in area only by Amazon basin forests. The countries include Equatorial Guinea, Gabon, Cameroon, Congo, Central African Republic, and Democratic Republic of Congo. The forests of Gabon, Cameroon, Central African Republic and Democratic republic of Congo are ITTO member countries. Protected Areas (PAs) have been established as per Yaounete Declaration by the Governments of Central Africa for conservation and rational use of forests. But Congo basin forests are under threat from deforestation, degradation and fragmentation due to war and conflict.

FAO report mentions that there was a reduction in the rate of net forest loss in the region, from 4.0 million hectares per year in the decade 1990–2000 to 3.4 million hectares per year during the period 2000–2010. A major difference was seen in parts of North Africa, where the net loss dropped from 590 000 ha per year to just 41 000 ha per year. The reduction was mostly a result of Sudan's recent efforts to gather annual data on actual changes taking place, which resulted in much lower figures for 2000–2010 than those estimated for 1990–2000, which were based on fairly old data. Southern Africa had the highest net loss at the sub regional level over the last 20 years, although the rate has slowed in recent years.

The area, population, forest area, per capita forest area and deforestation rate of some of the countries of African region is given in Table 2.

Asia and Pacific region

Forests of the region

Asia pacific region covers 740 million ha of forests out of which 18% are forests and wooded land of which 31% are natural exploitable forests, 6%plantation forests and 61% are classified as low productive and open forests. The forest area of the region is 18.8% of global forest area. The region includes East Asia (China, DPR Korea, Republic of Korea, Japan, Mongolia, Singapore) with 255 million ha, Southeast Asia (Bruni, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Thailand, Timor-Leste, Vietnam having 214 million ha, Oceania (Australia, , Micronesia, New Zealand, Polynesia) with 191 million ha, South Asia (Bangladesh, Bhutan, India, Maldives, Pakistan) with 80 million ha.The region North West Pacific and East Asia has the largest forest area followed by Southeast Asia, Australia, New Zealand, Melanesia and Polynesia, South Asia, South Pacific and Central Asia.

The countries with the largest forest areas are China, Australia, Indonesia, India, and

Table 2

Area, population, tropical forest area, per capita forest and deforestation rate of some Countries of Africa

Region/ Country	Area in million ha	Population in million	Tropical Forest area in million ha	Per capita forest	Rate of deforestation
Cameroon	47.5	19.9	19.916	1.0	-1.07
Central African Republic	62.3	4.5	22.605	5.02	-0.13
Cote d'Ivore	32.2	21.5	10.40	0.48	–
Democratic Republic of Congo	233	66.0	154.13	2.33	-0.20
Gabon	26.8	1.5	22.0	14.6	0
Ghana	23.9	24.3	4.9	0.20	-2.19
Liberia	11.1	4.1	4.32	1.05	-0.35
Nigeria	92.4	158	9.04	0.05	-
Congo	34.2	3.7	22.4	0.65	-0.30

Source : Quoted from Status of Tropical Forest Management 2011, ITTO

Myanmar which account 74% forest area out of which share of China and Australia is 50% of regional forest cover. The most of the forests of China are plantations and there are very little primary forests. The region experienced loss of 0.7 million ha forest per year in 1990, but in the next decade there has been an increase of 1.4 million ha of forest area because of large scale afforestation by China, India and Vietnam. There was loss in primary forest in the region but biodiversity conservation areas have increased.

Sal forests of Buxa (West Bengal)

Jyanti forest of Buxa Tiger Reserve

Tropical forests of the region

Cambodia, Indonesia, India, Lao PDR, Malaysia, Myanmar, Philippines, Papua New Guinea (PNG), Sri Lanka, Thailand, Timor-Leste, LaoPDR and Vietnam are having tropical forest area of the region. The forest cover is about 316.74 million ha which about 6 percent of World's forest, out of which 107.62 million ha primary forest. The forest in the region is mainly tropical evergreen forests and seasonal monsoon forests. The major forested countries

of South east Asia sub region is broadly divided into continental zone comprising Thailand, Vietnam and Myanmar and Insular zone including Indonesia, Malaysia and Philippines .In continental zone expansion of agriculture and plantation of cash crop were taken up in delta area where as in insular zone such development took place after deforestation of rain forest. Large quantity of tropical timbers is imported from Malaysia, Indonesia to China, Japan and India among Asian countries. The sub-region contains four of 25 global biodiversity hot spot in which significant proportion of world's species under threat. Industrial agriculture, infrastructure development and population growth are primarily responsible for the loss of forest cover in this region.

In South Asia, India has 68 million ha tropical forest, out of which 15.70 million ha primary forest and there is increase in 0.21% forest area. The country has 50903 sq km area included in 225 Pas located in Himalayan and Western ghat region. 4.8% of geographical area of the country is set aside in the form of conservation reserve in the form of National Park, Sanctuary, Community Reserve, etc. India is a top producer of tropical logs among the ITTO member countries. Despite significant yield from its plantation and receiving supply from International sources it is facing severe shortage to meet her internal demand. India's domestic production was 29 million tonnes in 2000 (Report of WWF, ITTO).

The area, population, forest area, per capita forest area, rate of deforestation of some of the countries of the Asia Pacific region is given in Table 3.

Latin America and Caribbean region

Forests of the region

As per FAO's report of 2010, nearly half (49%) of the total area is covered by forests of which 14% is primary forests located in inaccessible areas. The primary forest of the region held is 57% of the world's primary forest. Forest areas in Central and South America declined in last two decades for conversion of forestland for agriculture. The five countries (Brazil, Peru, Colombia, Bolivia and Venezuela) have 84% of the forest area.

Table 3

Area, population, tropical forest area, per capita forest and deforestation rate of some Countries of Asia Pacific region

Region/ Country	Area in million ha	Population in million	Tropical Forest area in million ha	Per capita forest	Rate of deforestation
Cambodia	18.1	15.1	10.0	0.66	-1.22
India	316	1210	37.8	0.03	0.21
Indonesia	190	233	94.4	.405	-0.71
Malayasia	32.97	27.9	18.6	.66	-0.42
Myanmar	67.85	50.5	30.8	.60	-0.95
Papua New Guinea	46.3	6.9	8.0	1.15	-0.49
Phillipines	29.8	93.6	7.66	0.08	0.73
Thailand	51.3	68.1	23.5	0.34	

Source : Quoted from status of Tropical forest management, 2011 by ITTO

Tropical Forests

Amazonian basin forest is the largest area under tropical moist forest. Twenty countries of the region have either full or part of the area under tropical forests with an area of 906.8 million ha. The total area under primary forests is 677.53 million ha. Eleven countries are members of ITTO follow SFM practices. But the new major highways cutting across the Andes Mountains to provide export route of timber and agricultural produce has direct impact on rainforest ecology.

The area, population, forest area, per capita forest area and deforestation rate of some of the countries of Latin American and Caribbean region is given in Table 4.

Major Issues

A key message from FRA 2010 was that while the rate of deforestation and loss of forests from natural cause is alarmingly high, it has been slowing down. At the global level it decreased from an estimated 16 million ha in 1990 to around 13 million ha per year in last decade. Most of the loss is taking place in tropical region and most of the gain has been in temperate region.

In general the primary forests of tropical region are affected by unsustainable logging, deforestation for expansion of agriculture, livestock production, infrastructure development and urbanization. The development activities result fragmentation of forests and promoting further deforestation due to increase accessibility of forests.

ITTO is putting effort to increase the area under primary forest in ITTO member countries.

The covering of the entire tropical forests under SFM prescribed by the ITTO is an effective step for sustainable production of various goods and services and enforcing strict vigilance on export and import of timber to check illegal logging. On the other hand the

Table 4

Area, population, tropical forest area, per capita forest and deforestation rate of some Countries of Latin American and Caribbean

Region/ Country	Area in million ha	Population in million	Tropical Forest area in million ha	Per capita forest	Rate of deforestation
Bolivia	110	10.4	57.2	5.5	-0.53
Brazil	846	195	117	0.6	
Colombia	114	46	40.8	0.88	
Ecuador	27.7	13.7	9.87	0.72	-1.89
Guatemala	10.9	14.0	3.66	0.26	
Guyana	21.5	.76	15.2	20.0	
Honduras	11.2	7.6	3.62	0.47	
Mexico	194.2	110	2.26	0.02	
Panama	7.48	3.5	5.6	1.6	1.18
Peru	129	42.8	38.1	0.89	
Venezuala	91.2	29	46.3	1.59	

Source : Quoted from Status of Tropical forest management, 2011 by ITTO

encroachment of forest areas for livelihood, use of land for growing cash crops, illegal logging of timber, illegal mining etc. are adversely affecting the area under forest cover.

The International Climate Change related agreement, programmed on massive afforestation under Reduced Emission from Deforestation and Forest Degradation (REDD+) would help in increasing area under tree cover.

The increase in population growth with time will increase demand for land and forest products, which in turn cause deforestation unless there is check in population growth, non land based income generation opportunity, better institutional capacity and governance. Kannien (2006) mentioned in his article on "Contribution of forestry to the objective of UNFCC in Mitigation workshop : Agriculture, Forestry and Rural Development", that during the last 40 years deforestation was 500 million ha and consumption of forest products increased by 50% and estimated that during the next 40 years 100 million ha will be required for new agricultural development and wood requirement will increase by 50%. To cite the case of India, the country has 67.83 million ha of forests, out of which 38 m ha are well stocked (crown density above 40% Paciific region). Rabindran *et al.* (2008) estimated carbon stock in India's forest range from 8.58 to 9.57 Gt. The population is more than 1.2 billion and livestock density in forest area is 7 per ha. Nearly 196,000 villages are in forest fringe areas. So magnitude of the pressure on forests is tremendous in future there is chance of increasing pressure due to increasing interest in biofuels and biomaterials all over the globe and the top of it the forests are fragmented due to road construction, settlements etc.The wild animals like elephants, leopard and many other forest dwelling animals are now coming out of the forests for food etc. because of the destruction of their habitats.

Actually we are at a cross roads as to whether we conserve forests for sustained living in the planet or destroy them to meet our greed.

SUMMARY

Global forest area is shrinking. It is now 4 billion ha or per capita forest area is 0.6 ha. The rate of deforestation is more in some of the tropical countries who are not member of ITTO. The extent of primary forests has gone down in many countries due to indiscriminate logging operations for export earning, expansion of cash crop cultivation like oilpalm, rubber, illegal mining activities etc besides indiscriminate collection of biomass for the livelihood of the people living in forest fringe areas. Sustainable Forest Management System has been developed which is being adopted by ITTO member countries as a result there is increasing trend of primary forests. Criteria and Indicators are being framed to monitor forests. The effective implementation of the process will be effective step to monitor the quality of forests and take suitable preventive action. Deforestation and forest degradation produce 20% of world's emission. So massive afforestation programme under REDD + will help in containing pollution besides there is need for check in population growth, on land based income generation opportunity, better institutional capacity and governance for conservation of forests is necessary.

Ever increasing population pressure and excessive exploitation of forests for immediate benefits are the primary reasons behind the increasingly difficult task to effectively conserve and save forests for the posterity. Actually we are at cross roads whether we conserve forest for our sustained living in the planet or allow its destruction for short term gains.

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REVALUATION OF SERVICES OF A TREE IN 2012

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The value of a tree was published by the present author in 1979 in the Indian Biologist, in Vol. XI, No. 1-2, pp 73-79. For the first time, the intrinsic value of a tree was determined on the basis of a various environmental benefits and services derived from a tree during its life span of 50 years and its amount was Rs. 15,70,000 calculated at the market rate that prevailed in 1979.

When we estimate the conventional value of a tree we only count the total weight and quality of timber or fruit or biomass it produced and that could be sold in the market.

It was noted in the aforesaid 1979 calculation that all these together hardly make about 0.3% of the real value of a tree. Other benefits that are being derived from the tree in our society are totally overlooked. If we count these items at the prevailing market price in 2012 the value of a tree would be increased more than 20 times.

In 1981 the value of a tree was elaborately presented in the Presidential Address delivered by the present author in the Agricultural Sciences Section in the 68th Session of the Indian Science Congress at Varanasi. It received worldwide attention and the summary of the paper was reprinted and cited in reference books of related subjects including books on accountancy, and journals published by the United Nations Organisation. In those papers Indian Currency was converted in Dollar, Pound and Yen etc. and gave wide publicity through posting permanent exhibitions in forests Reserves, Botanical Gardens, Zoological Gardens, Museums (Fig. 1) of most of the countries.

In the field of accountancy a special branch of Social Accountancy and Corporate Social Reporting got incentives from this calculation for determining of social value of natural resources (Chattopadhyay 2000).

In 1983, the Film Division of the Govt. of India made a documentary film entittled 'Services of a Tree' which was widely acclaimed and received the First Prize in the International Documentary Film Competition in Spain. In the body of the orginal paper it was apprenhended that the estimated value would not be a constant

The Value of A Tree
From Singapore Zoo

According to Professor T. M. Das
of the University of Calcutta :
A tree living for 50 years will generate $31,250 worth of oxygen, provide $62,000 worth of air pollution control, control soil erosion and increase soil fertility to the tune of $31,250, recycle $37,500 worth of water and provide a home for animals worth $31,250.
A total value of $196,250.
This figure does not include the value of the fruits, lumber or beauty derived from trees. Just another sensible reason to take care of our trees.

Fig. 1. From Perth Museum : Australia

figure, it may increase with increasing price of oxygen, cost of energy and other inputs in 1991, Australian Horticulturalist Nancy Beckham published a comprehensive review on the subject in the Indian Biologist (1992).

Over three decades subject matter specialists of various disciplines such as Botany (Plant Physiology), Zoology, Environmental Sciences and amateur environmental activists have been increasingly urging for updating for the valuation of a tree. Accordingly, all the calculations of the original papers have been revised as per current market rate (accepting the minimal level/rate of 2012 prices).

Table 1

The Revaluation of environmental and social benefits derived from a tree during 50 years of growth

During 50 years of growth	Original (1979)	Revised (2011-12)
1. Production of oxygen	Rs. 2,50,000	Rs. 5,25,000 ($ 10500)
2. Conversion to animal flesh & bones	Rs. 20,000	Rs. 1,50,000 ($ 3000)
3. Controlling of soil erosion & soil fertility	Rs. 2,50,000	Rs. 5,00,000 ($ 10000)
4. Recycling of water and controlling humidity and Air temperature	Rs. 3,00,000	Rs. 77,28,000 ($ 154560)
5. Sheltering of birds, squirrels & insects	Rs. 2,50,000	Rs. 64,85,000 ($ 129700)
6. Removal of SPM, CO_2, SO_2 from air	Rs. 5,00,000	Rs. 2,01,25,000 ($ 402500)
Grand Total	**Rs.15,70,000**	**Rs. 3,55,13,000 ($ 710260)**

* 1$ = Rs. 50

A pipul tree which grow luxuriantly with an average weightage of 6 tonnes in India and South-East Asia has been chosen as an icon and its various environmental benefits received during its 50 years of growth have been valued at rupees three crores fiftyfour lac in this revision work.

This estimation is also applicable to other tree species with identical tonnage.

As in the original paper (and its revised versions) the value of timber has been omitted in this calculation.

The result of the revised figures are depicted in the Table 1 including the figures of the original calculation.

Details of Calculation

1. Production of oxygen

Average weight of full grown tree of 20 years (e.g. mango, aswatha, jackfruit, neem and arjuna trees)

Weight of trunk with branches	3.5 Tonnes
Weight of root system	0.5 Tonnes
Weight of young twigs with leaves	0.5 Tonnes
Total Weight	**4.5 Tonnes**

Fixation of 1 Mol. of CO_2 = Release of 1 Mol. of O_2

Total weight of oxygen produced = 4.5 Tonnes

Cost of oxygen @ Rs. 70/kg = Rs. 3,15,000

For coming 30 years production of branches

Young twigs and leaves approx. = @ 100 kg/year would be 3 Tonnes

Cost of oxygen production = Rs. 2,10,000

Value of total oxygen production = Rs. 5,25,000 during 50 years

Gross weight of the 4.5 + 3 = 7.5 Tonnes

Shedding of leaves during 50 years ~ 5 Tonnes

Net weight of tree after 50 years of growth ~ 6 Tonnes

2. Conversion to animal flesh and bones

Conversion to 10 kg of animal flesh and bones in a pair goat kids per year. In 50 years the cost of meat @Rs. 300/kg would be as follows

Total value of meat would be
Rs. 50 x 10 x 300 = Rs. 1,50,000

3. Controlling of soil erosion and soil fertility

Annual net benefit (including value of organic matter) would be Rs. 10,000 per year. In 50 years it would amount to Rs. 5,00,000.

4. Water recycling through transpiration

Capital expenditure

2 pcs. 1/2 HP pump	= Rs. 6,000
Cost of land & construction of shade (including installation cost)	= Rs. 1,50,000
Total	**= Rs. 1,56,000**

Maintenance cost

Salary of 2 operators (24 hours duty) Rs. 10,000 p.m. x 12 x 50	= Rs. 60,00,000
Electricity charge @Rs. 4/unit 1 unit per hour x 24 x 30 x 12 x 50 x 4	= Rs. 17,28,000
Total	**Rs. 77,28,000**

5. Sheltering of birds, squirrels, insects etc.

Capital expenditure

Construction of cages with cost of land	= Rs. 1,25,000
Salary of 1 expert @ Rs. 6,000 p.m.	
Salary of 1 helper @ Rs. 4,000 p.m.	
Total salary for 50 years	= Rs. 60,00,000
Food for animals & insects @ Rs. 20 /day	
Rs. 20 x 30 x 12 x 50	= Rs. 3,60,000
Total	**Rs. 64,85,000**

6. Removal of SPM, CO_2, SO_2 from air

Capital expenditure

Cost of two mega size high volume sampler with installation, along with setting up of a chemical system for removal of CO_2 & SO_2 after filtration of SPM from ambient air.

i) Two high volume sampler	= Rs. 2,00,000
ii) Installation of unit	= Rs. 1,00,000
Total	**= Rs. 3,00,000**

Recurring expenditure

Salary of two thchnicians (@Rs. 10,000 p.m.) and two helpers (@ Rs. 5,000 p.m.) for running the system for 24 hours. Monthly Rs. 30,000.

@ Rs. 30,000 p.m. for 50 years (30,000 x 12 x 50)	= Rs. 1,80,000

Consumption of electricity

Cost of 1 unit per hour @ Rs. 4 for 24 hours the cost is approximately Rs. 100

For one year 365 x 100	= Rs. 36,500
For fifty years Rs. 36,500 x 50	= Rs. 18,25,000
Total of capital and recurring expenditure : (Rs. 3,00,000 + 1,80,000 + 18,25,000)	= Rs. 2,01,25,000

How much oxygen we consume?

Each adult person inhale about 16 kg of air per day which contain minimum 3 kg of oxygen (20% of air) current market value of this amount is Rs. 210 (@ Rs. 70 per kg). Thus, Indian population of over 120 crores consume 120 x 3 kg crores of oxygen per day cost of which 120 x 3 x 210 = Rupees seventy five thousand fiftysix hundred crores (75,600 crores) per day corresponding value in West Bengal population (9 crores) would be 9 x 3 x 210 = Rupees five thousand six hundred seventy crores (Rs. 5,670 crores) per day.

In the animal world, other than human being a colossal amount of oxygen is consumed in respiration. During combustion process of fossil fuels in industries and transports huge amount of oxygen is consumed along with burning fuel woods for cooking purposes. Nearly 50% of Indian population approximately consumed 1 ton fuel wood per capita per year; considering

average weight of the tree is 5 tonnes (with small & large trees) hence the total number of trees burnt per year in India is around 12 crores per year.

All such consumptions of oxygen are coupled with productions of carbon dioxide (CO_2), carbon monoxide (CO), sulpher dioxide (SO_2), oxides of nitrogen (NO_2NO) and suspended particulate matter (SPM) etc. and these processes leading to changed composition of air are silently counter balanced by green plants in various ways.

During the process of photosynthesis molecules of glucose and other carbohydrates are synthesized, besides release of free oxygen. Some amount of oxygen is also used up by the tree an amount far greater than the rate of oxygen consumption, is released to the atmosphere for the respiration of animals and thus maintaining the oxygen balance of the atmosphere.

According to P. H. Raven, Director, Missouri Botanical Gardens, a disappearing plant species can take with it 10 to 30 dependent species, such as various species of insects, higher animals and even other plants.

When a tree is cut down the damage that inflicted is rather permanent in nature and cannot be recovered immediately. What is more significant, it is not a personal loss. It is a loss to the whole community, every individual of the locality would have to share this loss, the magnitude of which is still unknown to them.

The forest, the natural habitat for trees has been shrinking at an ever increasing rate. A detailed critical survey indicates that the world's original tropical rain forest had already been reduced by more than 40 per cent in 1970 to a total area of 935 million hectares, and that they are shrinking by about 11 million hectares each year. In India such shrinkage had been more than 60 per cent during the last 100 years and unfortunately, the major portion of such destruction was made after the independence. In future such process of destruction of forest with all probability may continue because of the irresistible pressure on land by ever increasing abnormal growth of human population.

How much green coverage do we require for our survival?

The whole animal world including human being is totally dependent on solar energy that is harvested by green plants. It is important as well as alarming to note that of the total amount of solar energy captured by the green plants 80% is consumed by the plants themselves, microbials organisms also consume a significant portion of it. Animals do not eat entire plant but only fruits or leaves. Thus only about 1% of total energy captured by the green plants would be available to the animal world.

Hence survival ratio of green plant to animals is 99 : 1 i.e., in order to survive one part of animals including human beings would require 99 times of their body weight of green coverage in their surroundings. Animal population is increasing by lips and bounds. Everyday about 3 lacs of human babies are born in the world which would require increasing of green coverage 99 times of the newly incorporated human population, but in reality an area of green coverage equivalent to 4 football grounds is vanishing per minute from the face of the Earth. We therefore, are fighting a losing battle.

To win this difficult-to-win battle the only option left to us is systematic controling of human and animal population together with total haltage of deforeststion followed by multifold increasing activities of aforestation programme including extension of green coverage in every nook and corner in rural and urban areas.

If the business is allowed to continue as it is, our journey towards unavoidable calamity of population crash with disruption of law and order situation would be surely be utterly disastrous.

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EFFECT OF LAND USE ON SOME SOIL QUALITY INDICATORS

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ABSTRACT

Microbial and biochemical parameters of soil under undisturbed grass land, rice-fallow, rice-rice, rice-wheat, rice-legume and mango orchard located at Agricultural Experimental Farm (22º22′N and 86º26′ E) of the University of Calcutta, West Bengal, India, were studied. The soils varied with respect to their organic carbon (OC) and total nitrogen (TN) contents. The microbial biomass carbon (MBC), basal soil respiration (BSR), fluorescein diacetate hydrolyzing activity (FDHA), urease, β-glucosidase, acid and alkaline phosphatases, and aryl sulphatase activities were found to be the highest in grass land soil compared to other studied soils. The grass land soil recorded the highest MBC/OC ratio and the lowest metabolic quotient (qCO_2) compared to other soils indicating that soils under different land use caused distortion of land to various degree.

INTRODUCTION

Sustainable cropping system demands thorough knowledge on impact of agricultural practice on the health/quality of soil systems. Effect of cultivation on soil system is usually addressed by comparison of cultivated soil with that of undisturbed grass land. Soil quality does not depend just on the physical, physico-chemical and chemical properties of soil, but it is very closely linked to microbial properties (Elliott *et al*., 1996). Currently microbial parameters in relation to soil quality involve the estimation of soil microbial biomass and its activity. Several enzyme activities of soils related to C, N, P & S cycle have also been included as a measure of soil quality (Dick *et al*., 1996).

Large number of crop and cropping system are followed in different soil and climatic condition in India. Information regarding such location or region specific cropping systems were identified, giving due consideration to the biophysical and socioeconomic condition of the farmers. In some district of West Bengal, existing cropping systems are rice-fallow, rice-rice, rice-wheat, rice-legume and fruit orchards. These copping systems are stable and traditional, and those were evolved through years of experience. Effect of different cropping systems on soil microbial parameters has been

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poorly studied, particularly under south Bengal condition (Tripathi *et al*., 2011).

Present investigation deals with the effect of different cropping system on soil physico-chemical, microbiological and biochemical properties.

MATERIALS AND METHODS

Four replicated surface soils (0-15 cm) with variable land use were collected from six different plots of the Agricultural Experimental Farm (22º22′N latitude and 86º26′ E longitude), University of Calcutta, Baruipur, West Bengal, India in February, 2011. The land use comprised of undisturbed grass land (GR), rice-fallow (RF), rice-rice (RR), rice-wheat (RW), rice-legume (RL) and mango orchard. Microbial and biochemical properties were measured with field moist soil samples and physico-chemical properties with air dried soil samples.

Analytical procedure

Soil pH (1: 2.5 soil-water suspension), soil organic carbon (Nelson and Somers, 1982), and total nitrogen (Black, 1965) were determined. The MBC was determined by the fumigation extraction method using a correction factor (Kec) of 0.38 (Vance *et al.,* 1987). The BSR (Alef, 1995), FDHA (Schnürer and Rosswall, 1982), and urease, β-glucosidase, acid and alkaline phosphatase and aryl sulphatase activities of soils (Tabatabai, 1994) were measured.

Statistical analysis

Assigning soil as treatment factor, analysis of variance (ANOVA) was carried out by completely randomized design (CRD) using STATISTICA 6.0 (Stat soft Inc., USA) package. The factor soil had six levels and the replicate had four levels. The least significance difference (LSD) test was applied to evaluate the significance of differences between the individual treatment factors. The treatment means were compared by Duncan's multiple range tests at 0.05P.

RESULTS

There was significant variation in reaction (pH) of soils (ranging from5.2 to 6.1) under study (Table1). Among the studied soil, RF soil was the most acidic. The OC and TN of the soils varied significantly among themselves. The GR soil recorded the highest OC and TN. The RR soil recorded the lowest value. Among the other studied soils, the MO soil recorded statistically higher organic carbon than RF and RL soils. The GR soil recorded the highest MBC and BSR and the lowest was in RR soil. Other soils could be ranked as MO>RL>RF>RW. Statistically significant highest MBC/OC was observed in GR soil and the lowest was observed in RR soil. The highest qCO_2 was observed in RW soil which was statistically at par with RR, RL and RF soils. The lowest qCO_2 was recorded in GR soil.

Highest enzyme activities of soil except acid and alkaline phosphatases were observed in GR soil (Table 2). The FDHA, β-glucosidase, urease and aryl sulphatase activities were lower in rice cultivated soils compare to GR and MO soils. Acid phosphatase activities of the soils were higher than the alkaline phosphtase activities. RF soil recorded the highest acid phosphatase activity while the lowest value was observed in RR soil. In contrast, highest alkaline phosphatase activity was recorded in MO and the lowest in RW soil, which was statistically at par with GR soil.

DISCUSSION

The difference in organic carbon in different soil could be explained by the root mass of different crop cultivated on those lands. Apart from root biomass the highest organic carbon

Table 1

Physico-chemical and microbiological properties of soils under study

Treatment factor / Soil	pH (1:2.5)	Organic Carbon (g kg^{-1})	Total Nitrogen (g kg^{-1})	Microbial biomass C (μg g^{-1} soil)	Basal soil respiration (μg CO_2 -C g^{-1} soil h^{-1}at 25°C)	Microbial biomass C/organic C (%)	qCO_2 Basal (μ g CO_2 - C h^{-1} mg^{-1} biomass C)
GR	6.1[a*]	16.3[a]	1.69[a]	530[a]	2.32[a]	3.25[a]	0.44[c]
RF	5.2[c]	11.1[bc]	1.08[e]	310[d]	1.68[d]	2.79[d]	0.54[a]
RR	6.0[a]	9.8[f]	1.02[e]	244[f]	1.31[f]	2.49[e]	0.54[a]
RW	5.8[b]	10.5[e]	1.16[d]	268[e]	1.48[e]	2.55[e]	0.55[a]
RL	6.0[a]	12.0[c]	1.25[c]	355[c]	1.88[c]	2.96[c]	0.53[a]
MO	5.7[b]	13.4[b]	1.39[b]	411[b]	2.02[b]	3.07[b]	0.49[b]

* Figures denoted by same alphabets are statistically similar at 5 % probability level by DMRT

Table 2

Enzyme activities of soils under study

Treatment factor / Soil	Fluorescein diacetate hydrolyzing activity (μ g fluorescein g^{-1} soil h^{-1} at 24°C)	β-glucosidase (μg pnp g^{-1} soil h^{-1} at 37°C)	Urease (μg urea hydrolyzed g^{-1} soil h^{-1} at 37°C)	Aryl sulphatase (μg pnp g^{-1} soil h^{-1} at 37°C)	Acid phosphatase (μg pnp g^{-1} soil h^{-1} at 37°C)	Alkaline phosphatase (μg pnp g^{-1} soil h^{-1} at 37°C)
GR	132[a*]	87[a]	131[a]	189[a]	481[e]	198[c]
RF	88[d]	56[d]	97[c]	141[b]	592[a]	175[d]
RR	68[f]	48[e]	86[d]	129[c]	464[f]	169[d]
RW	76[c]	41[f]	69[f]	113[d]	521[c]	196[c]
RL	84[c]	68[c]	76[e]	162[b]	531[b]	225[b]
MO	112[b]	74[b]	110[b]	166[b]	498[d]	247[a]

* Figures denoted by same alphabets are statistically similar at 5 % probability level by DMRT.

content in GR soil could be explained by the non-cultivation of such land (Saggar *et al*., 2001). Influence of land management clearly has a bearing of microbial biomass content of the soil. To predict accurately the effect of management of future organic matter levels, the size and turnover of microbial biomass must be known. Systems with higher organic matter tend to have higher microbial biomass with higher activity (Vaughan and Malcom, 1985). The data clearly indicated that the GR soil with the highest organic carbon recorded the highest microbial biomass. The trend of basal soil respiration value of the studied soils was similar to their biomass content. Results indicated that the cropping systems decided the metabolic status of the microorganisms. This seems to be related to several soil factors. Microbial biomass carbon generally comprises of about 1 to 4 % of soil organic carbon (Jenkinson and Ladd, 1981). Because of difference in soil and crop management practices a wide range of MBC/OC are reported in literature (Omay *et al*., 1977; Tripathi *et al*., 2011). The proportion of microbial biomass carbon in soil organic carbon has been suggested as an index for monitoring soil development, changes under different cropping system and land use (Schnürer *et al*., 1985; Anderson and Domsch, 1990). Data in this study clearly indicated that the land use pattern has a bearing on active pool of soil organic carbon i.e., soil microbial biomass. The qCO_2 could be used as a more sensitive indicator of soil microbial response to soil management and environmental stress (Anderson, 2003). Significantly higher qCO_2 value as observed in RW, RL, RF and RR indicated that the microbes in such soils are under stress due to cultivation practices. Comparing the qCO_2 value of MO and GR soil, it is also understood that the microbes in undisturbed GR soil are not under stress. During organic matter decomposition microorganisms incorporate a part of soil organic matter into microbial cell and a part respired out as CO_2 for cell maintenance (Alexander, 1977). Under stress free condition, microbes use more energy for cell proliferation than cell maintenance leading to lower CO_2 per unit of microbial biomass which was observed in GR soil in the present study.

FDHA assay could be a better choice for estimating soil quality as it is a broad spectrum enzyme assay mediated simultaneously by nonspecific protease, lipase and esterases. The highest activity of this enzyme in GR soil indicated the greater microbial activity in such soil. Effect of cropping on microbial activity is reflected in RF, RR, RW and RL soil. The range of β-glucosidase, urease and aryl sulphatase activities of the studied soils were within the range as reported by Dick *et al*. (1996) for other soils. Soil contains both acid and alkaline phosphatases. Acid phosphatases activity predominates in acid soil (Juma and Tabatabai, 1978). The soils under study were acidic. Thus, acid phosphatase activity of soils predominated over alkaline phosphatases.

CONCLUSION

Cultivation practices detrimentally influenced the microbial and biochemical parameters of soils. Rice cultivated soils variably influenced in this respect. Compared to grass land and mango orchard soils rice cultivated soils were more microbiologically and biochemically poor.

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HEAVY METAL POISONING IN HERBAL MEDICINE

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ABSTRACT

The herbal medicinal weed plant commonly known as black night shade (*Solanum nigrum* L.) and the surrounding soil were collected from industrial belts for heavy metal testing. Estimation of heavy metals were carried out on flame atomic absorption spectrophotometer. Heavy metals like iron, cadmium, chromium, manganese, nickel, lead and zinc were estimated from different parts of *Solanum nigrum*. Heavy metal accumulation in leaf was maximum rather than root and fruit. Iron as well as chromium concentration in soil was very high. As a result, they were also found in greater concentration within the root, leaf and fruit of *Solanum nigrum*. Some heavy metal like Cadmium crosses the permissible limit within the leaf of *Solanum nigrum*. So, every medicinal plant sample should be tested before going to any formulation. There should be a regular and stringent quality control mechanism so that its use in humans and animals are safe.

INTRODUCTION

Ayurveda is the most ancient health care system and is practiced widely in India, Srilanka and other countries. Researches on pharmacognosy, chemistry, pharmacology and clinical therapeutics have been carried out on medicinal plants and many of the major pharmaceutical corporations have renewed their strategies in favour of natural products drug discovery. Numerous drugs have entered the international pharmacopoeia through the study of ethnopharmacology and traditional medicine.

A recent correspondence by Daniel (2004) and subsequent response from Schmidt *et al.* (2005) published in *Current Science* highlight concerns regarding the quality of traditional medicine, particularly issues related to accidental or deliberate adulteration that could be hazardous to health. Saper *et al.* (2004) have reported the presence of toxic heavy metals in certain herbal medicinal products. Certainly, presence of such toxic contaminants cannot be justified in any material intended for consumption as a drug. Heavy-metal use in modern as well as traditional preparations is known. But it includes certain purification or detoxification processes to take care of putative toxicity of such heavy metals. The herbal material might contain heavy metals when grown on polluted soil. Such incidences certainly reflect failure of good agricultural and manufacturing practices and quality assurance, but not necessarily of the traditional systems. So the users of herbal medicine may be at risk for heavy metal toxicity (Aslam *et al*., 1979).

A heavy metal is a member of an ill-defined subset of elements that exhibit metallic properties, which would mainly include the transition metals, some metalloids, lanthanides and actinides. There is an alternative term toxic metal, for which no consensus of exact definition exists either. As discussed below, depending on context, heavy metal can include elements lighter than carbon and can exclude some of the heaviest metals. Heavy metals occur naturally in the ecosystem with large variations in concentration. In modern times, anthropogenic sources of heavy metals, i.e. pollution, have been introduced to the ecosystem. Waste-derived fuels are especially prone to contain heavy metals so they should be a central concern in a consideration of their use.

The contribution of medicinal plants in the traditional system of medicine for curing disease has been documented. Now-a-days increased scientific interest and consumer demand have promoted the development of herbal products as nutrient supplements. The medicinal plants which form the raw materials for finished products may be checked for the presence of heavy metals, further it regulates maximum permissible limits of toxic metals (WHO, 1989, 1998). Medicinal herbs are easily confined in plants finally enter the human body and may disturb the normal function of CNS, liver, lungs, heart, kidney and brain (Lynch and Braithwaite, 2005). So, it is very crucial factor from where and how we collect the medicinal herb to prepare medicine.

In our present study, we collected the *Solanum nigrum* L., a medicinal herb from industrial belts for heavy metal testing. *Solanum nigrum* L. belongs to the family Solanaceae which is commonly known as Black Night Shade, Makoy, Kakmachi. The fruits as well as the whole plants are used as medicine. In India, it is grown as a weed. It is very common in

agricultural fields, gardens, waste places and shady localities throughout India. It is an erect herb, 30-45 cm high. Leaves are generally ovate and entire. Flowers white, 3-8 flowered pendulous cymes. Fruits are berries and 6-8 mm in diameter, black in ripe conditions. The drugs obtained from *Solanum nigrum* are antiallergic, antidiabetic, aphrodisiac, astringent, cardiotonic, febrifuge, laxative, restorative and diuretic, etc.

The main objective of the present study is to give a scientific information about the presence of heavy metals on medicinal plants that grows on industrial areas.

MATERIALS AND METHODS

Soil Sample

Soil sample were collected from the forage region of *Solanum nigrum* plants i.e., eight inches depth from soil surface.

Location details

Plants and soil were collected from C. N. Roy Road, Golmath, Block–42 , Kolkata – 700039 (beside tannaries) i.e., sample I and Gulam Jilani Khan Road, Topsia, Kolkata – 700039 (beside rubber industry) i.e., sample II.

Plant analysis

Experiment was carried out at Export Testing Laboratory, Department of Agricultural Chemicals, B.C.K.V. Plants were collected from industrial belt of Topsia, Kolkata – 700039 during the month of June. Plant parts, especially roots were washed in fresh running water followed by treatment with deionized water and were dried in shade at 25-30°C. During this sample processing, necessary measures were taken in order to avoid any loss or contamination of heavy metals.

Acid digestion of plant samples

Weighed quantities of crushed and powdered portion from each part of plant : root, leaf and fruit were taken in a china dish and were heated in an oven at 110^0C to remove moisture. Then the samples were transferred to the digestion unit (Palical Digestion Unit). Then the samples were overnight treated with tri-acid mixture i.e. Conc. HNO_3, Conc. $HClO_4$ and Conc. H_2SO_4 in a ratio of 10:4:1 of 20ml each. In the very next day digestion was completed at 250°C until all the brown fumes were irradicated. Then digested solutions were cooled and the solution was filtered and transferred to a 25 mL graduated tube and diluted to 25 ml with distilled water. Estimation of heavy metals were carried out on Flame Atomic Absorption Spectrophotometer (FAAS; AOAC Standard methods).

Calibration of Equipment

For the elements under investigation, we established the following sensitivity and detection limits respectively of the used FAAS apparatus :-

Pb - 0.5, 1.0 and 2.0 ppm, **Cr** - 1.0, 2.0, and 4.0 ppm, **Cd -** 0.5, 1.0 and 2.0 ppm, **Fe -** 2, 4.0 and 8.0 ppm, **Ni -** 0.5, 1.0 and 2.0 ppm, **Mn -** 0.5, 1.0 and 2.0 ppm, **Zn -** 0.5, 1.0 and 2.0 ppm.

Soil analysis

Experiments were carried out in Bharat Foundation (Analytical and Research laboratory). For acid digestion soil samples were treated with 1:1 Conc. HNO_3 and water and heated followed by estimation of heavy metals (According to APHA. AWWA.WPCF, 1985).

RESULTS AND DISCUSSION

Heavy metals like iron, cadmium, chromium, manganese, nickel, lead and Zinc were estimated in *Solanum nigrum* which was collected from the surroundings of rubber industry and tannery industry. Besides, we have also measured the above mentioned heavy metal content in the soil of the particular area. Heavy metal accumulation in leaf was maximum in comparison to root and fruit. Iron as well as chromium concentration in soil was very high. As a result, root absorbed heavy metals like chromium and iron and accumulated in a greater concentration in root, leaf and fruit of *Solanum nigrum* (Table 1 and 2). Apart from these two metals, Cadmium and Lead were also high in soil sample as well as in the whole plant. Heavy metal like Zinc also showed higher accumulation in root, leaf and

Table 1

Heavy metal content in soil as well as plant sample (in ppm) collected from Golmath, Kolkata (Sample-I)

Name of Heavy Metals	Soil	Root	Leaf	Fruit
Iron	231.30	17.169	>25	8.849
Cadmium	8.40	0.254	0.420	0.201
Chromium	89.73	0.863	1.216	0.245
Manganese	3.47	0.577	1.753	0.531
Nickel	12.60	0.498	0.573	0.392
Lead	4.80	2.930	1.630	1.390
Zinc	12.24	2.448	7.573	2.280

Table 2

Heavy metal content in soil as well as plant sample (in ppm) collected from Topsia, Kolkata (Sample-II)

Name of Heavy Metals	Soil	Root	Leaf	Fruit
Iron	320.90	>25	>25	>25
Cadmium	9.00	0.199	0.240	0.213
Chromium	80.47	0.804	1.189	0.140
Manganese	5.69	1.686	4.831	1.755
Nickel	17.20	0.576	0.705	0.525
Lead	7.10	2.460	2.780	1.850
Zinc	11.57	7.644	5.815	8.652

fruit of *Solanum nigrum* than permissible limits. (Table 1 and 2). Plant and soil sample which were collected from Gulam Jilani Khan Road, Topsia, Kolkata – 700039 showed higher accumulation of all the above mentioned heavy metals. In sample II, especially Iron, Manganese, Nickel and Lead showed maximum deposition in plant sample (root, leaf and fruit). Some heavy metal like Cadmium crosses the permissible limit within the leaf of *Solanum nigrum* (Sample I).

The concentration of heavy metals in medicinal plants beyond permissible limit is a matter of great concern to public safety all over the world (Brearley and Forseythe, 1978; Anonymous, 1984; Tait *et al*., 2002; Cheney *et al*., 1995; Hambidge, 2007). The problem is more serious in the third world country like India, Pakistan, Bangladesh and Sri Lanka because medicinal plants which form the raw materials for the finished products are neither controlled nor properly regulated by quality assurance parameters (Rahman *et al*., 2007). We collected two plants samples (*Solanum nigrum* L.) from two different locations with tannery and rubber industry at Kolkata. After estimation, we have found heavy metals present in both the samples and specially sample-II showed greater accumulation of heavy metals than sample-I.

The unplanned and irregular discharge of all the by-products, garbage, pollutants and effluents from tannery and rubber industries are caused serious pollution problems in environment. As a result the pollutants containing heavy metals contaminated the soil and ultimately accumulate in plants. For that reason, we have found several heavy metals in *Solanum nigrum* L. Medicinal plants are used as a raw material to prepare herbal medicine. The cultivated medicinal plants or medicinal plants from the wild source must contain toxic metal and as a result prepared medicine from that particular plant may also contain heavy metals. The use of herbal medicine is common in human and increasing in many areas of the world. Many herbal medicines contains heavy metals including Lead, Mercury, Cadmium and Arsenic (Cheney *et al.*, 1995; Hambidge, 2007). That heavy metal comes from the raw materials use in herbal medicine.

There are several herbal medicine, which prepared by the combination of several medicinal plants. If each plant contain heavy metal (may not beyond permissible limit), but the finish product i.e. medicine may contain higher level of heavy metals. So, we should not collect the medicinal plant from industrial belts and we must have to consider the heavy metal content of medicinal plant before processing for medicine preparation.

CONCLUSION

The selected medicinal plants have been recommended as remedies for amnesia, eye diseases, fever, heart diseases, hiccough, piles etc. in the traditional system of medicine. In the field of phototherapy, tremendous progress has been documented regarding the scientific evaluation of medicinal plants across the globe.

The practical repercussion of the changing situation may be witnessed in the WHO monographs, National Pharmacopoeias and herbs processing industries.

Heavy metals like Fe, Cd, Cr, Ni, Zn, Pb, Mn were found in *Solanum nigrum* L., an important medicinal plant. The level of heavy metal content differed in the same medicinal plant collected from different sites of industrial belt. Whatever may be the quantity, it is a fact that the heavy metal is present within the medicinal plant. The concentration of heavy metal like Fe, Pb, Cd, Cr, Mn, Zn, Ni was found higher in both sample I and II. So, every medicinal plant sample should be tested before medicine preparation. There should be a regular and stringent quality control mechanism so that its use in humans and animals are safe. Cultivation of medicinal plant should not be recommended in industrial belt and industrial waste water should not use in medicinal plant cultivation. The implication of findings may be taken into consideration whilst using the herbs for human consumption. The results suggest that medicinal plants used for human consumption or for preparation of herbal products and standardized extracts should be collected from an unpolluted natural habitat.

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SCREENING OF PADDY GENOTYPES FOR COASTAL SALINE BELT OF WEST BENGAL

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ABSTRACT

Study was carried out to screen high productive salinity tolerant lines from forty-three paddy (O. *sativa.* L.) genotypes in laboratory at 5dS m^{-1} and the genotypes showing better performance were again put to higher salinity stress of 8dS m^{-1}. The same genotypes were tested at field level at a control location of Baruipur and at saline prone areas of Sagardeep (5 to 8dS m^{-1}) and Hingolgunje (5 to 10dS m^{-1}). Varieties like Bakulpriya, Lakshmikajal, Nangalmuda, Pankaj, Bhuri and Khaersal have shown salinity tolerance both at laboratory and field level.

INTRODUCTION

In 2030 global demand is projected to be approximately 533 million tonnes of milled rice as compared to 472 million tones projected for 2015. In view of the current situation of food insecurity, a number of factors such as availability of agricultural land, water resources, ever increasing biotic and abiotic stress and low economic activity in agricultural sector have lead to decrease in crop productivity. However it is generally believed that abiotic stress is considered to be the main source of yield reduction (Rehman *et al.*, 2005, Munns and Tester 2008).The estimated potential yield losses are 17% due to drought, 20% due to salinity, 40% due to high temperature, 15% due to low temperature and 8% due to other factors (Ashraf *et al.*, 2008). At present, extent of salinity throughout the world is increasing regularly. Out of 230 million hectares of irrigated land, 45 million hectares (~ 20%) are salt-affected. In India about 7.3 million ha have been estimated to be affected by salinity. Thus salinity affects the plants in several ways (Pearson *et al.*, 1966, Narale *et al.,* 1969, Lutts *et al.*, 1995). Average yield in costal saline area is about 1 tonne per ha as against the average National yield of 1.9 tonnes per ha. Against this backdrop the present study is carried out to screen the salinity tolerant lines from large number of paddy genotypes in laboratory as well as in saline prone area in field condition.

MATERIAL AND METHODS

Experiment 1 : Laboratory Screening for Salinity Tolerance Screening for Salt Tolerance in Rice in 5ds m^{-1} and 8ds m^{-1} Saline Solution

Forty three paddy genotypes were collected from different parts of India of which a major

portion were collected from the coastal belts of West Bengal and Orissa. The genotypes Pokkali and Nonabokra were used as tolerant check and IET-4786 (Shatabdi) and IR 64 were taken as susceptible check. The genotypes were screened for salinity tolerance in water culture method as proposed by IRRI for selecting salt tolerance at the seedling stage (Gregorio *et al.* 1997) with some modification in our laboratory. From each genotype, fifteen seeds were placed in 5dS m^{-1} saline solution for germination in petridishes. After four days five healthy germinated seeds were taken for each replication and their roots were inserted through the holes of the thermocol which was kept in the glass container containing the control solution (salinity absent) and 5dS m^{-1} saline solution. The set up was placed in a well lighted and aerated chamber for a period of 7 days in three replications. After 7 days the root and shoot lengths were measured and the percentage of reduction was calculated. Out of forty three rice genotypes used in 5dS m^{-1} screening, thirty genotypes having percentage reduction of root and shoot length lesser than 50 (considered salinity tolerant) were selected for higher salinity stress and screened in 8dS m^{-1} saline solution. The same procedure was followed and observations were recorded.

Experiment 2 : Field Screening for Salinity Tolerance at Baruipur, Sagardeep and Hingalgunje

The field experiment was conducted in two situation –i) Non saline situation in the Calcutta University Experimental Farm of Baruipur, 24 Praganas (S), West Bengal in the Aman season in 2010-11 and ii) Saline situation in Sagardeep, 24 Pgs (S) having salinity range 5 to 8dS m^{-1} and in Cyclone Aila affected regoin of Hingalgunje, 24 Parganas (N) having salinity range 6 to 10 dS m^{-1} in 2010-11. This was done to test the germplasm in the field level (Mahmood *et al.*, 2009) and also to compare the laboratory results with the field condition. The field was puddle and dressed with farmyard manure (FYM) at the rate of 1 tonne/ha without any standing water. The layout of the field was done as per Randomized Block Design (RBD) with three replications. Each block consisted of forty three plots representing the genotypes. The two days old germinated seeds were sown in each plot. The spacing between the lines was 25 cm and between plants was 20 cm (Hasanuzzaman *et al.*, 2009). Two seeds were sown in each pit. After harvesting, seed yield / plant and seed yield/plot was taken for each replication, from which seed yield/hectare in quintals (q) was calculated. Critical Difference (CD) value of seed yield was also calculated.

RESULTS AND DISCUSSION

Experiment 1 : Laboratory Screening for Salinity Tolerance Screening for Salt Tolerance in Rice in 5ds m^{-1} and 8ds m^{-1} Saline Solution

In 5dS m^{-1} saline solution less percentage (less than 50%) reduction of root and shoot length over the control (Pokkali and Nonabokra) were observed for the varieties Kataribough, Bakulpriya, Lakshmikajal, Bhuri, Nangalmuda, Lalswarna, Malabati ,Pankaj, Mohan CSR-4, Amulya, Moulow, SR-26B (Fig. 1 & 2). The cause of sensitivity to stress may be the participation of different agents for salt tolerance of different plant developmental stages (Akbar 1986; Iwaki, 1956). Thirty varieties, selected on the basis of 5dS m^{-1} screening, were further tested in 8dS m^{-1} saline solution. In 8dS m^{-1} saline solution Bakulpriya, Lakshmikajal, Bhuri, Nangalmuda, Pankaj, Mohan CSR-4, SR-26B recorded less percentage reduction of root and shoot length over the control (Fig.1 and 2). Similar type of variability in rice for growth characters was observed by Akbar *et al.*, (1972) and Yeo & Flowers (1986).

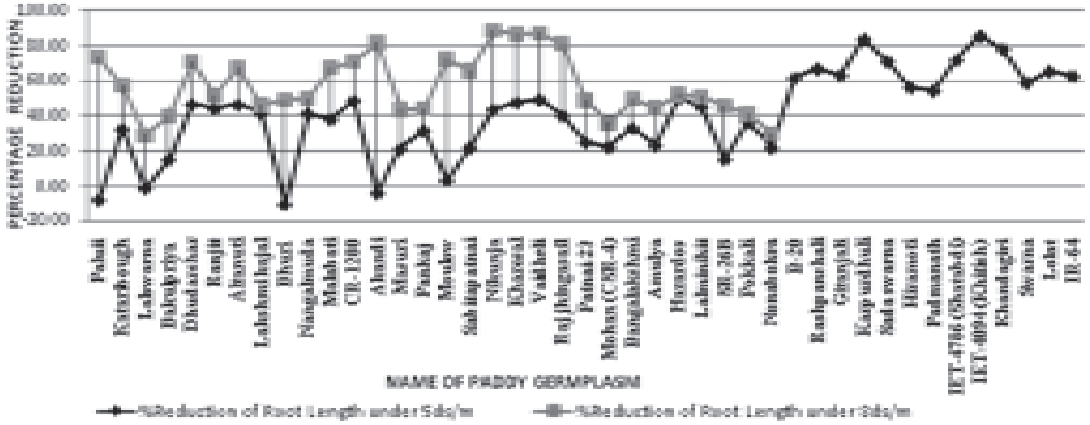

Fig. 1. Comparison of % Reduction of Root Length in 5dS m^{-1} and 8ds m^{-1} saline solution

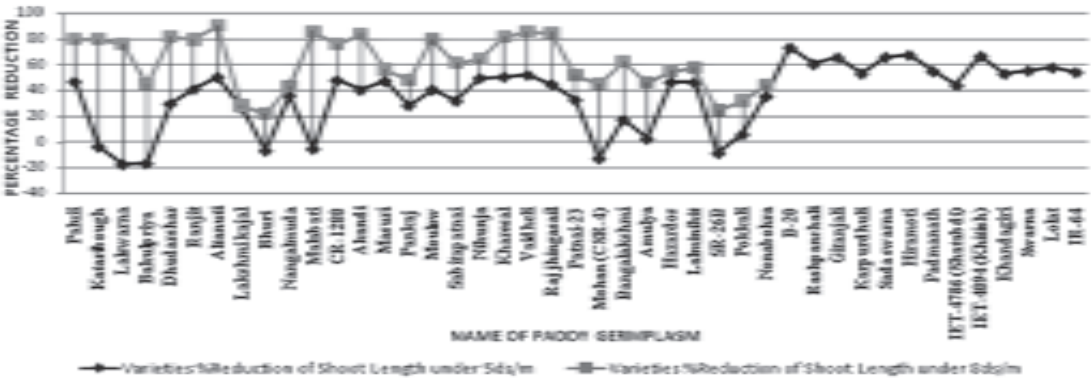

Fig. 2. Comparison of % Reduction of shoot Length in 5dS m^{-1} and 8dS m^{-1} saline solution

Experiment 2 : Field Screening for Salinity Tolerance at Baruipur, Sagardeep and Hingalgunje

A comparative study of the seed yield/ hectare (quintals) for the three locations in the year 2010-11 was studied and is represented in Table 1. In comparison of all the location i.e. control location in Baruipur and saline location in Sagardeep and Hingalgunje, seed yield was consistently good in all of the three locations for the varieties Bakulpriya, Lakshmikajal, Bhuri, Nangalmuda, Pankaj and Khaersal. Their average productivity was more than 40 q/ ha in all of the locations including the saline zones. Even the tolerant check (Pokkali and Nonabokra) showed an average yield of 35-40q/ ha in the saline locations. These results indicate that the genotypes were more salt tolerant than the others. Most of these varieties showed less percentage reduction in root and shoot length over the control as shown in Fig. 1 and 2. So considering laboratory and field screening it can be concluded that varieties Bakulpriya, Lakshmikajal, Bhuri, Nangalmuda, Pankaj and Khaersal have shown salinity tolerance and thus laboratory screening for salinity tolerance would be a practical and useful approach to augment the test right on the field. So in a nutshell all of these varieties have a good prospect for introduction as high productive varieties for coastal saline belt of West Bengal.

Table 1

Comparative studies the seed yield/ha (q) of different paddy genotypes in non-saline (Control) & saline locations

Germplasms	Seed yield/ha (q) Baruipur (Control)	Seed yield/ha (q) Sagardeep (Saline)	Seed yield/ha (q) Hingolgunje (Saline)
Paluii	50.10	36.39	64.60
Kataribough	35.20	25.76	54.60
Lalswarna	41.20	27.02	43.24
Bakulpriya	77.30	43.15	66.12
Dhudarshar	49.50	28. 39	58.90
Ranjit	38.80	36.29	53.55
Altanuti	42.70	26.27	42.24
Lakshmi kajal	62.90	43.79	46.17
Bhuri	59.10	42.94	64.17
Nangalmuda	62.80	45.38	46.02
B-20	34.80	25.51	38.40
Malabati	50.50	35.73	39.48
CR- 1280	39.80	31.68	32.68
Rashpanchali	56.40	35.14	33.75
Akandi	57.20	30.36	46.80
Gitanjali	53.90	34.85	34.56
Masuri	41.60	26.11	47.70
Karpurdhuli	39.90	42.47	29.00
Pankaj	42.10	42.65	60.80
Moulow	47.10	30.31	67.95
Sada swarna	39.90	25.04	37.37
Sabitapatnai	61.10	35.58	55.84
Nikinja	42.70	26.82	35.10
Hiramoti	40.80	20.75	59.78
Kharesal	68.50	41.25	45.36
Vaidheli	56.70	27.37	37.44
Padmanath	37.40	28.55	36.33
Rajjhingasail	47.10	33.15	39.97
IET-4786(Shatabdi)	29.80	18.88	18.87
IET-4094 (Khitish)	37.20	16.24	16.24
Khandagiri	35.00	19.97	17.87
Patnai-23	56.50	41.68	31.84
Swarna	35.30	21.67	40.27
Mohan CSR-4	29.90	14.98	13.09
Bangalakshmi	63.20	39.43	30.98
Amulya	55.20	37.74	50.92
Hazardos	26.80	25.57	21.12
Lolat	27.50	21.12	18.70
IR-64	33.90	23.38	14.07
Lalminikit	35.00	18.7	30.42
SR-26B	53.90	30.78	23.88
Pokkali	60.50	35.89	38.80
Nonabokra	71.30	42.01	39.21
CD	2.6007	3.3551	2.7720

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SEED TREATMENT FOR THE RETENTION OF VIGOUR, VIABILITY AND YIELD POTENTIAL OF HIGH-VIGOUR ONION (*Allium cepa* L.) SEEDS

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ABSTRACT

Freshly harvested (high-vigour) onion (*Allium cepa* L.) seeds were treated with powdered pharmaceutical formulations viz., aspirin @ 50 mg/kg of seed; chemicals viz., bleaching powder @ 2g/kg of seed; and crude plant preparations viz., red chilli powder @ 1g/kg of seed, neem leaf powder and spinach leaf powder @ 2g/kg of seed which effectively controlled the loss of vigour and viability as well as vigour index of seeds during subsequent storage under ambient conditions over untreated control. Among the treatment, aspirin, bleaching powder and red chilli powder have shown better results in improving storability. The field performance and productivity of the pre-storage dry treated seeds, especially with red chilli powder, bleaching powder and neem leaf powder significantly improved weight per bulb and diameter per bulb and other yield attributes than the untreated control. Pre-storage wet treatment (soaking-drying) did not show any significant improvement on germinability and productivity over control, probably due to soaking injury in harvest fresh seeds. Based on the above results, pre-storage dry dressing treatments with aspirin @ 50 mg/kg of seed, bleaching powder @ 2g/kg of seed and red chilli powder @ 1g/kg of seed may be suggested for the improvement of germinability and yield potential of harvest-fresh (high-vigour) onion seeds.

INTRODUCTION

Several orthodox agricultural and horticultural crop seeds face a serious problem in maintaining high germinability during storage due to prevailing high temperature and high humidity especially in the tropical and subtropical countries. In eartern parts of India, onion is generally grown in the early *rabi* (November – March) season and then stored in moisture pervasive containers where it absorbs a lot of moisture from the ambient humid atmosphere with consequent loss of germinability and yield potential of the crop.

Pre-storage dry dressing treatments and mid-storage wet (hydration-dehydration) treatments of stored seeds of several crop plants are effective in slowing down seed deterioration under subsequent storage conditions (Mandal and Basu, 1983; Andrea *et al.*, 1993; and Yagalakshmi *et al.*, 1996). Hydration-

dehydration treatments are not effective in freshly harvested high vigour seeds and thorough drying of large seed stock after hydration, especially during monsoon month (June-August) is problematic but proper drying after hydration is essential for restorage. Therefore, dry-dressing treatment in high-vigour seed with powdered halogenated compounds (bleaching powder) and several nontoxic chemicals, pharmaceutical formulations and crude plant materials would be of great advantage in controlling seed deterioration of wheat, soybean, okra and safflower (Mandal *et al.*, 1986; 1999; De *et al.*, 2003; Guha *et al.*, 2012; and Kapri *et al.*, 2005). In the present study, major emphasis has been given towards standardization of a suitable method of pre-storage seed invigoration treatments for the improvement of germinability and field performance of stored onion seeds.

MATERIALS AND METHODS

Freshly harvested onion (cv. Sukhsagar) seeds were cleaned and sun dried to a safe moisture content of 7.6% (ISTA, 1996) for safe storage in rubber stoppered air-tight glass bottles under ambient condition in the laboratory till they were used for treatments.

High-vigour onion seeds were dry-dressed with aspirin (active ingredient, *ortho*-acetyl salicylic acid) @ 50 mg/kg of seed, bleaching powder (active ingredient, calcium hypochlorite) @ 2g/kg of seed, red chilli powder (active ingredient, capsaicin) @ 1g/kg of seed, neem leaf powder (active ingredient, azadirachtin) @ 2g/kg of seed and spinach leaf powder @ 2g/ kg of seed in the rubber stoppered glass bottle at room temperature (29 $\pm$ 1°C) under ambient conditions, which were gently shaken once daily for seven days to thoroughly mix the powdered ingredients with the seed. In case of wet treatment, seeds were soaked in double volume of water for 2h followed by drying back to its original moisture content over a current of dehumidified air at 35 $\pm$ 1°C for 4 – 5 days in a drying cabinet. Then the seeds were transferred to a dessicator containing fused calcium chloride for 7 days to stabilize moisture at a low level.

After 15 days of treatment, treated and untreated seeds were taken separately in perforated paper packets (containing same amount of seed with equal number of holes) and then all packets were kept in a cloth bag under ambient conditions (RH 76$\pm$3.2% and temperature 30$\pm$1.6°C) for 120 days. The packets were shaken at a regular interval for uniform ageing. Germination test of treated and untreated seeds (more than 400 seeds for each treatment as specified by ISTA, 1996) were done following the method of Punjabi and Basu (1982) with minor modifications. Data on germination percentage and seedling length were recorded 10 days after germination.

Field experiment

Field experiments of treated and untreated onion seeds were studied at the Agricultural Experimental Farm of Calcutta University at Baruipur, 24-paraganas (South), West Bengal during *rabi* season (November – March) of 2010 and 2011 using randomized block design (RBD) with three replications for each treatment. For raising a crop for bulb production, onion seeds were sown @ 6 kg/ha on nursery beds to raise seedlings for transplanting into the field. Nursery beds of about $2m^2$ (2.0m × 1.0m) and 10 – 15cm above the ground level were prepared with FYM or compost. The onion seeds were soaked in water for 6 – 8 hours followed by surface drying before sowing to enhance germination advancement. The cultural practices like hand weeding, spraying of insecticides and irrigating every alternate day with the help of watering can, etc. were also made. Eight week old seedlings of about 20 –

30cm in height were transferred to the land divided into plots measuring 10m^2 (4.0m×2.5m) each at a distance of 10cm between the seedlings and 25cm between the rows. A fertilizer dose of N: P_2O_5: K_2O was given @ 20:40:40 kg/ha respectively. The entire amount of phosphate and potash and 50% of the nitrogen was added at the time of transplanting alongwith an immediate irrigation for proper field establishment. The rest of nitrogen was top dressed one month after transplanting. Besides, intercultural practices were made periodically during the cultivation period.

Data on field emergence was taken in the 7th week of sowing i.e. just before transplanting. The plant height, length per bulb, diameter per bulb and weight per bulb were recorded replication-wise for each treatment.

Data collected on various parameters were statistically analyzed (Fisher, 1948) to evaluate the treatment effects on germinability and field performance of onion seed. Germination percentage data were transformed to their respective angles (arc-sin) before analysis.

RESULTS AND DISCUSSION

Germination tests conducted immediately after pre-storage dry and wet treatments did not show any beneficial effect on germination percentage and seedling length over untreated control (Table 1). However, after natural ageing under ambient condition for 120 days, most of the dry treated seeds showed significant improvement on germinability over untreated control (Table 1). Among the treatments, aspirin, bleaching powder and red chilli powder has shown better results in improving storability. Pre-storage wet treatment (soaking-drying) did not show any significant improvement on germinability over untreated control (Table 1), probably due to soaking injury in harvest fresh seeds.

The crop raised from the pre-storage treated and untreated seeds showed that all the dry treated seeds showed significant improvement on plant height, length per bulb, diameter per bulb and weight per bulb over untreated control (Table 2). Among the treatments, red chilli powder, bleaching powder and neem leaf powder has shown better results in improving field performance and productivity (Table 2). Pre-storage wet treatment (soaking-drying) showed a marginal improvement on field emergence, weight per bulb and diameter per bulb. Pre-storage dry treatments were more effective than the pre-storage wet treatment in improving germinability and productivity.

Regarding the mode of action of dry treatment, chlorine stabilizes the double bonds of unsaturated fatty acid moieties of lipo-protein bio-membranes as a possible reason for viability extension. Rudrapal and Basu (1981) suggested the role of iodine (other halogenated compound) in the stabilization of double bonds of unsaturated fatty acid might be the possible reason of viability maintenance, besides the possibility of iodine acting as a free radical controlling agent (Pryor and Lasswell, 1975). The protein protective role of acetyl salicylic acid (aspirin) at much lower concentration (20 – 100 mg/kg of seed) might be responsible for viability maintenance of stored seed (De *et al.*, 2003; 2004). Aspirin, a non-steroidal anti-inflammatory drug and chemically is a weak organic acid. They may also decrease the production of free radicals and superoxide and may interact with adenyl cyclase to alter the cellular concentration of cAMP (Bertram, 1998). Further, Takaki and Rosim (2000) have reported that aspirin application to *Raphanus sativus* L. seed would increase the tolerance to high temperature and synchronize seed germination.

Table 1

Effect of pre-storage seed treatments for the maintenance of vigour and viability of onion before (immediately after treatment) and after natural ageing under ambient conditions (average RH 76 ± 3.2% and temperature 30 ± 1.6°C) for 120 days

Treatments	Before ageing					Natural ageing				
	Germination		Mean root length (mm)	Mean shoot length (mm)	Vigour index*	Germination		Mean root length (mm)	Mean shoot length (mm)	Vigour index*
	(%)	Arc-sin value				(%)	Arc-sin value			
Control	90	71.6	39	72	9990	64	53.1	18	38	3584
Aspirin	92	73.6	38	80	10856	75	60.0	24	44	5100
Bleaching powder	88	69.7	36	71	9416	70	56.8	22	43	4550
Red chilli powder	80	63.4	32	47	6320	70	56.8	20	40	4200
Neem leaf powder	96	78.5	37	66	9888	68	55.5	20	38	3944
Spinach leaf powder	92	73.6	28	66	8648	70	56.8	20	40	4200
Soaking-drying	88	69.7	39	78	10296	66	54.3	19	39	3828
L.S.D. at 0.05P	–	NS	NS	NS	–	–	3.7	0.9	3.3	–
L.S.D. at 0.01P	–	NS	NS	NS	–	–	5.2	1.3	4.7	–

*Vigour index = G% × Seedling length

NS = Non significant

Table 2

Effect of pre-storage seed treatments on field performance and productivity of onion (cv. Sukhsagar)

Treatments	Field emergence (%)	Plant height (cm)	Length/ bulb (mm)	Diameter/ bulb (mm)	Weight/bulb (g)
Control	52	22	45	36	42.9
Aspirin	62	25	48	38	45.6
Bleaching powder	55	24	47	41	48.7
Red chilli powder	61	25	49	42	49.9
Neem leaf powder	57	28	48	45	47.4
Spinach leaf powder	58	23	45	40	46.2
Soaking-drying	55	19	44	37	43.5
L.S.D. at 0.05P	NS	2.2	NS	3.2	1.9
L.S.D. at 0.01P	NS	3.1	NS	4.6	3.3

After treatment, seeds were restored in rubber stoppered glass bottles under ambient condition till sowing in the field. Other details are same as in Table : 1

Capsaicin an active ingredient of red chilli (*Capsicum frutescens* L.) is an acknowledged inhibitor of lipid peroxidation (Brand *et al.*, 1990; Dey and Ghosh, 1993). Wilson and McDonald (1986) suggested that seed deterioration would take place during ageing via lipid peroxidation. Sung and Chiu (2001) have given strong support to the concept of free radical induced lipid peroxidation as a causative factor of seed deterioration in sweet corn (*Zea mays* L.) thereby confirming similar findings of this laboratory.

The present findings confirm the entry of active ingredients into the dry stored seed but the mechanism of their entry requires a critical elucidation. However, the cracks and crevices in the seed coat may possibly serve as entry point of exogenously applied substances. On the basis of these results, pre-storage dry dressing treatments with aspirin @ 50 mg/kg of seed, bleaching powder @ 2g/kg of seed and red chilli powder @ 1g/kg of seed may be suggested for extended storability and improved field performance and productivity of high-vigour onion seeds.

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GENOTYPE x ENVIRONMENT INTERACTION AND ESTIMATION OF STABILITY FOR FOLIAGE YIELD OF SOME CASTOR GENOTYPES (*Ricinus communis* L.) SUITABLE FOR ERICULTURE

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ABSTRACT

Eri silk contributed to 12% of the total raw silk produced in India. The eri-sector of labour-intensive Indian sericulture pivoted on castor for foliage to rear eri silk worm. The relative ranking of foliage yield of 10 promising castor genotypes differed when compared over five macro-environments at Central Sericultural Research and Training Institute, Berhampore, India. Genotype x Environment interaction for castor foliage yield, thus far not reported till date, is presented herein for the first time. The study led to comprehension that five castor genotypes namely RG 2824, RG 2717, NBR 1, CSRS 1 and Talap Green can be considered as adaptable for yield stability. RG 2717 is expected to be the most stable among these castor genotypes studied with regard to foliage yield across both the favourable as well as unfavourable crop seasons.

INTRODUCTION

India is endowed with a unique sericultural diversity. It includes production of all four commercially exploited natural silks namely Mulberry, Eri, Tassar and Muga. Share of Eri amounts to 12% of the total raw silk produced in the country.

Labour-intensive Indian sericulture has an agricultural pattern with traditional strengths. It can generate income along the entire value chain right from managing food plants till the production of the finished silk product. The eri sector of sericulture was confined to the North-East and adjoining Eastern India till early eighties. Now it is a vocation for rural reconstruction in 16 Indian states since it involves low investment and high output source of employment and income.

Though Eri silkworms (*Samia ricini* D; Saturniidae: Lepidoptera) are polyphagous, rearing with castor leaves (*Ricinus communis* L. : Euphorbiaceae) scores the best cocoon harvest (Sarkar, 1980; Benchamin and Jolly, 1987). More than 90% of Indian eri silk is castor food plant-based and about 98% of castor foliage is harvested from naturally thriving flora of the region (De and Das, 2007). The capacity of castor to grow on diverse soils opens up the

scope for large scale extension of ericulture as the plant thrives almost all over India. It can alleviate poverty of the rural or semi-urban landless workforce who utilizes locally grown castor plants for rearing throughout the year (Singh and Benchamin, 2002; Bindroo *et al.*, 2007).

Since castor is not a cultivated oil seed crop in most of eastern India, the absence of any recommended variety or genotype compels the eri farmers depend mostly on either natural castor flora or indiscriminately raised castor plants (Chaudhuri *et al.*, 2009). Systematizing the castor food plant sector was acutely felt by both central and state sectors. Consequently, 10 promising castor genotypes were short- listed after intense screening on the basis of foliage yield and quality, standard growth parameters and bio-assay (Chakravarty *et al.*,2011) at Central Sericultural Research and Training Institute, Berhampore, West Bengal (88º 15′E: 24º 6′N; 19 m. MSL). But requirement of foliage is rearing season-specific and when the yield of 10 castor genotypes were compared over a series of macro-environments in terms of stratified crop seasons the relative ranking differed. Genotype x Environment interaction might be the outcome of genotype rank change from one environment to another, a difference in scale among environments or combination of both these phenomena as explained by Eberhart and Russell (1966). They pointed out that when GxE interaction prevails, the correlation between genotype and phenotype is reduced to express an optimum phenotype under different seasonal conditions. Phenotypic stability in castor seed yield has been investigated by many authors and recent study by Solanki and Joshi (2003); Patel and Pathak (2006); Patel *et al.* (2010); Thakkar *et al.* (2010) inferred that none of the castor hybrids were consistently stable for yield.

But the same for the leaf yield is yet to be reported as of now. This led to difficulty in demonstrating the significant superiority of any particular region-specific genotype(s) suitable for ericulture.

The goal of the present study is to identify high foliage yielding stable castor genotype(s) suiting ericulture by simultaneous selection of yield performance and stability, to estimate the contribution of each environment to total GxE interaction and the inter-relationships among studied stability parameters.

MATERIALS AND METHODS

Ten high quality and quantity foliage yielding castor accessions namely RG 3056, RG 2713, CSRS 1, RG 2717, RG 553, RG 2824-collected from the Director of Oilseeds Research, ICAR and NBR 1, Damalgiri, RedTalap green, Agia local-collected from Central Muga and Eri Research and Training Institute, were raised in balanced RBD with 3 replications successively for 2 years since 2006-07 at Central Sericultural Research and Training Institute, Berhampore, West Bengal (88º 15′E: 24º 6′N; 19 m. MSL). Primary data on per plant basis were recorded on foliage yield without petiole during 5 eri silkworm crop rearing seasons namely June (1), August (2), September (3), November (4) and February (5) for 2 years. 5 seasons were ascribed to 5 environments. The data were analyzed to test the significance of leaf yield under each environment and then they were further analyzed for stability parameters using the model proposed by Eberhart and Russell (1966).

RESULTS AND DISCUSSION

Analysis of the variance (Table 1) arising from genotypes (G), environments (E) and GxE interaction divulged existence of significant difference among environments in terms of

seasons indicating adequate heterogeneity of environments and their suitability for evaluating genotypes growing in them. The mean sum of squares (MSS) over genotypes was also significant over the environments revealing presence of genetic variability among the castor genotypes. The significant GxE interaction for leaf yield projected differential response of genotypes in varying environmental conditions for the trait. Fig. 1 reflects variability of mean yield of these genotypes across five environments vis-à-vis the environmental indices.

Table 2 showing analysis of variance for phenotypic stability with regard to castor leaf yield, reflects that mean square due to environment coupled with its interaction with genotype, i.e. E + (GxE) was highly significant

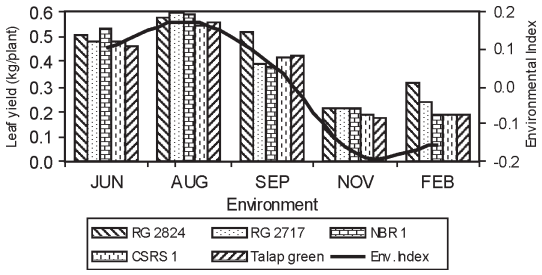

Fig. 1. Mean leaf yield of five superior castor genotypes across five crop seasons and environmental indices.

Table 1

Analysis of variance showing sums of squares of leaf yield of castor genotypes across environments for 2 years

Source	DF	SS	MSS	F
Genotype(G)	9	0.23	0.0255	4.62**
Environment(E)	4	2.98	0.7445	134.85**
Replication in E	10	0.005	0.0005	
G x E	36	0.2	0.0055	10.98**
Error	90	0.05	0.0005	
Total	149	3.46		

**Significance at 1% probability

Table 2

Analysis of variance showing sums of squares for phenotypic stability with regard to castor leaf yield

Source	DF	SS	MS	F
Genotype (G)	9	0.0766	0.0085	4.87**
E + GxE	40	1.059	0.0265	15.15**
Environment (linear)	1	0.9927	0.9927	567.9**
GxE (linear)	9	0.0138	0.0015	0.88 ns
Pooled deviation	30	0.0524	0.0017	10.53
Pooled error	100	0.0166	0.0002	
Total	149			

**Significance at 1% probability

which indicated variable response of genotypes to different environments under environmental variations. Insignificant GxE (linear) component for yield suggests that all the genotypes are expected to perform statistically at par due to their regression on environmental indices. The pooled deviation variance exhibited highly significant GxE (non-linear) and much higher magnitude than its counter part GxE (linear). The finding is suggestive of the yield registering GxE interaction might have consistent performance over environments. Therefore the leaf yield of the genotypes studied over environments based on only regression analysis may not result in good prediction and stability parameters namely mean yield, regression coefficient and deviation from regression were worked out.

Table 3 elucidates that out of 10 castor accessions, five genotypes namely RG 2824, RG 2717, NBR 1, CSRS 1 and Talap Green had higher mean yield than the population mean and ranked 1st to 5th. Nine genotypes had regression coefficients either one or not significantly different from one and all had very small magnitude of deviation from regression which

Table 3

Stability parameters for leaf yield of castor

Genotype	xi	Rank	bi	Rank	s^2di
RG 3056	0.272		0.71*	10	0.0201
RG 2713	0.310		0.89	7	0.0015
CSRS 1	0.363	4	1.06	5	0.0002
RG 2717	0.383	2	1	1	0.0042
NBR 1	0.380	3	1.13	9	0.0071
Damalgiri Red	0.346		1.12	8	0.0073
RG553	0.338		1.01	2	0.0005
Talap green	0.359	5	1.08	6	0.0001
RG 2824	0.423	1	0.96	4	0.0054
Agia local	0.345		1.04	3	0.0044
Mean	0.352				

*Significance at 5% probability, xi -mean, bi - regression coefficient and s^2di - deviation from regression.

did not differ significantly from zero while the castor genotype RG 3056 having the least mean yield and significant regression coefficient expressed no stability in yield performance. But out of aforementioned nine genotypes, RG 2824, RG 2717, NBR 1, CSRS 1 and Talap Green had higher mean yield than the population mean along with insignificant regression coefficients and deviation from regression. Hence all these five castor genotypes can be considered as adaptable for yield stability.

Genotype RG 2824 having highest mean yield and non-significant regression coefficient <1 indicated yield stability during unfavourable seasons while NBR 1, CSRS 1 and Talap Green with high mean and regression coefficient > 1 indicated stability in favourable seasons. Nevertheless, RG 2717 scoring unit regression, insignificant deviation from regression coupled with high mean foliage yield emerged as having superior stability among the genotypes studied across favorable as well as unfavourable seasons for utilization in eri silkworm rearing.

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EFFECT OF REPEATED AND SEQUENTIAL APPLICATION OF INSECTICIDES ON WHITEFLY (*Bemisia tabaci Genn.*) POPULATION IN EGGPLANT (*Solanum melongena* L.)

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ABSTRACT

The efficacy of repeated and sequential application of four different insecticides applied at their recommended doses in control of whitefly on eggplant in two consecutive *Kharif* and *Rabi* seasons was evaluated in the present study. Four consecutive sprays of each insecticide were applied in both the seasons at an interval of 15 days starting after one month of transplanting. Parallely, these four insecticides were applied sequentially at an interval of 15 days in two different spraying sequence of insecticide i.e., Triazophos-Carbaryl-Cypermethrin-Azadiractin(S1) and Azadiractin-Cypermethrin-Carbaryl-Triazophos (S2). The results reveal that the mean population of whitefly was significantly ($p<0.05$) reduced in all the treated plots in comparison to the control plot in both the season. However, more effective control of the pest was obtained by sequential application of insecticides in comparison to repeated application of the same insecticides.

INTRODUCTION

Eggplant (*Solanum melongena* L.) also known as brinjal is one of the important vegetable crop in the world. In India it is considered as the most-consumed and most-sprayed vegetable and one of the main sources of cash for many farmers (Miller, 2007). The cultivation of Eggplant is severely affected by the infestation of several insect pests which ultimately lead to heavy loss in the yield of the crop. Whitefly (*Bemisia tabaci* Genn.) (Homoptera : Aleyroidae) is one the pest among the various pests that attack eggplant (Seal, 1993). The pest causes severe damage to the plant by feeding the sap, by secreting honeydew where black sooty molds grow, and by transmitting viral diseases (Hirano *et al.*, 1993; 1995). It has been earlier reported by Dhamdhere *et al.* (1995) that pest remained active during both *Kharif* and *rabi* seasons. The control of this pest depends primarily on extensive use of insecticides. This practice has

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resulted in tremendous misuse of insecticides, causing a multitude of side effects that includes increased cost of production as well as exposure of farmers and consumers to pesticide residues and increased environmental contamination. Repeated application of some of the insecticide in the field to control this pest may lead to development of insecticide resistance of the pests as development of insecticide resistance due to repeated spraying has been reported earlier (Tattersfield *et al.*, 1953). Also repeated use of a single insecticide results in environmental contamination, bioaccumulation and biomagnification of toxic insecticide residues and disturbance in ecological balance (Dadmal *et al.*, 2004).

The following study was undertaken to evaluate the efficacy of repeated and sequential application of four different insecticides applied at their recommended doses to control the whitefly infestation on eggplant.

MATERIALS AND METHODS

Sites, design, and crop husbandry

Field experiments were conducted in two consecutive cropping seasons i,e. the Kharif season (May to September, 2009) and Rabi season (October to February, 2009-10) at the Agricultural Experimental Farm, University of Calcutta, Baruipur, (22º22′44.20″ N 86º26′08.55″ E) South 24 Parganas, West Bengal, India with a high yielding variety of Eggplant (var. Muktakeshi). The experiment was conducted in a Randomized Block Design (RBD) with 28 plots (measuring 4X3 Sq m.), involving seven treatments having four replications. Eggplant seedlings were first raised in seed bed and then healthy seedling of about one month old (3-4 leaf stage) were transferred to field. Each plot consisted of three rows and eggplant seedlings were transplanted in each plot with a spacing of 75 cm. Two buffer rows were placed in between each plot. All the plots received a recommended dose of fertilizers in the form of urea, single super phosphate and murate of potash.

Insecticides application

Four different insecticides namely Triazophos 40% E.C, Cypermethrin 10% E.C, Carbaryl 50% W.D.P and Azadiractin 10000 ppm were purchased from local agro market. The insecticides were applied at their field recommended dose of application i.e., Triazophos (300 g.a.i/ha), Cypermethrin (60 g.a.i/ha), Carbary W.D.P (1875 g.a.i/ha) and Azadiractin (5g.a.i/ha). Insecticide sprays were applied using a small knapsack sprayer at the rate of 500L/ha. Four consecutive sprays of each insecticide were given in both the seasons at an interval of 15 days starting from one month after transplanting. Parallely, these four insecticides were also applied sequentially at an interval of 15 days. The sequential application of insecticide include two different spraying sequence of insecticide i.e., Triazophos-Carbaryl-Cypermethrin-Azadiractin (S1) and Azadiractin-Cypermethrin-Carbaryl-Triazophos (S2) where each of insecticides were applied one after another at 15 days interval. The control plants were sprayed with water only. Precautions were taken to avoid drift of insecticides to the adjacent plots during spraying.

Data collection

Periodic observations were made at weekly interval. Five plants were selected from each plot randomly and labeled for recording observations. Three randomly selected leaves from each plant along with stem were scouted for the incidence of the pest. The mean population number of whitefly in treated and untreated plots after all the sprays were calculated from the above data for each season respectively.

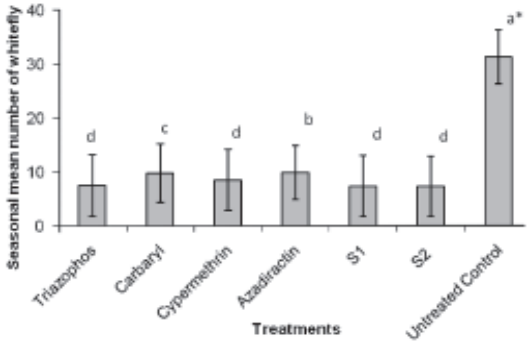
Statistical Analysis

Assigning different insecticide application either alone or in sequence as treatment factor,

analysis of variance (ANOVA) was carried out by Randomized Block Design (RBD) using SPSS version 10. The factor insecticide application had seven levels and the replicate had four levels. The least significance difference (LSD) test was applied to evaluate the significance of differences between the individual treatment factors. The treatment means were compared by Duncan's multiple range test at 0.05P.

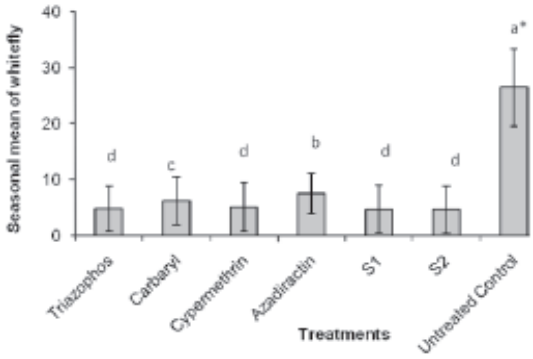
RESULTS AND DISCUSSION

The result obtained in the present study is represented graphically in (Fig. 1 and 2). The result reveal that the population of whitefly was significantly ($p<0.05$) reduced in all the treated plots in comparison to the control plot in both the seasons. However in *Rabi* season the mean reduction in population of whitefly was found to be higher than that of *Kharif* season. This may be due to more run off of insecticide from the plant during the *Kharif* season by rainfall. Maximum reduction of whitefly population i,e. 82.45 % over control was found in plots where sequential application of insecticide were done in the order from S2 in *Rabi* season while minimum reduction i.e., 68.33 % over control was found in Azadiractin treated plot in *Kharif* season respectively. The order of efficacy of the four insecticide application in repeated and sequential manner in both the season was found to be S2 >S1 >Triazophos> Cypermethrin> Carbaryl> Azadiractin. The more effective control of the whitefly population by sequential application of insecticide than repeated application of the same insecticide may be due to the development of insecticide resistance or better adaptatibililty of pest towards the individual insecticides due to its frequent application. Insecticide resistance development due to repeated spraying has been reported earlier (Tattersfield *et al.*, 1953).



*Figures denoted by same alphabets are statistically similar at 5% probability level.

Fig. 1. Effect of different insecticidal application on whitefly population in treated and untreated plots during *Kharif* season (2009).



*Figures denoted by same alphabets are statistically similar at 5% probability limit.

Fig. 2. Effect of different insecticidal application on whitefly population in treated and untreated plots during *Rabi* season (2009-10).

CONCLUSION

From the present study it can be concluded that infestation of whitefly on Eggplant can be more effectively controlled by sequential application of insecticides in comparison to repeated application of the same insecticide. However more field trials are required to have a more realistic approach for the above fact.

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EVALUATION OF SOME MULBERRY VARIETIES THROUGH BIOASSAY

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ABSTRACT

The silkworm, *Bombyx mori* L. consumes leaves of different mulberry varieties but the success of cocoon production depends on the efficient utilization and conversion of food to silk substance. Generally, the judgement is made from the rearing performance of silkworm on a mulberry variety emphasizing particularly the cocoon characters. Food is a factor of paramount importance which regulates the growth of silkworm, *Bombyx mori* L, development and silk yield in commercial sericulture. The silkworm consumes leaves of different mulberry varieties but the success of cocoon production depends on the efficient utilization and conversion of food to silk. The judgement is made from the rearing performance of silkworm on a mulberry variety emphasizing particularly the cocoon characters. Eleven mulberry varieties were evaluated by feeding on the popular bivoltine hybrid, CSR2 x CSR4 and popular multivoltine x bivoltine hybrid, Pure Mysore x CSR2. Silkworm rearing was conducted on all these varieties by following the standard rearing procedure. Based on the rearing performance on both the type of silkworm hybrids, the variety V-1 was found to be superior than other tested varieties.

INTRODUCTION

The silkworm, *Bombyx mori* L. consumes leaves of different mulberry varieties but the success of cocoon production depends on the efficient utilization and conversion of food to silk substance. Generally, the judgement is made from the rearing performance of silkworm on a mulberry variety emphasizing particularly the cocoon characters (Krishnaswami *et al.*,1970a, 1970b: Basu *et al.*, 1992). Food is a factor of paramount importance which regulates the growth of silkworm, *Bombyx mori* L, development and silk yield in commercial sericulture. The silkworm consumes leaves of different mulberry varieties but the success of cocoon production depends on the efficient utilization and conversion of food to silk. The judgment is made from the rearing performance of silkworm on a mulberry variety emphasizing particularly the cocoon characters. In breeding programmes of mulberry varieties, quality of mulberry leaves produced are adequately taken into account before selecting varieties for commercial exploitation. (Machi and Katagiri, 1991). Therefore, the present study was carried out to evaluate the nutritional value of different mulberry varieties of India by feeding trials.

MATERIALS AND METHODS

Eleven mulberry varieties which are under the final yield evaluation were evaluated by conducting bioassay at Central Sericultural

Research and Training Institute, Mysore. The mulberry varieties were evaluated by feeding on the popular bivoltine hybrid, CSR2 x CSR4 and multivoltine x bivoltine hybrid, Pure Mysore x CSR2. Three replications were maintained for each silkworm hybrid for all the varieties. Silkworm rearing was conducted on all these varieties by following the standard rearing procedure (Datta, 1992).

RESULTS AND DISCUSSION

The results on the comparison of the utilization of different mulberry varieties are presented in Table 1. The results indicated that all the characters vary among the different mulberry varieties. Among bivoltine hybrids, the cocoon weight ranged from 1.690 to 2.102 g with the highest of 2.102 g recorded for S-34 and the lowest of 1.690 g recorded for S-36. The cocoon shell weight ranged from 0.389 to 0.478 g with the highest of 0.478 g recorded for V-1 and the lowest of 0.389 g recorded for S-36. The cocoon shell percentage ranged from 21.0 to 23.9 % with the highest of 23.9 % recorded for V-1 and the lowest of 21.0 % recorded for G-3.

Among multivoltine x bivoltine hybrids, the cocoon weight ranged from 1.476 to 1.890 g with the highest of 1.890 g recorded for V-2 and the lowest of 1.476 g recorded for S-36. The cocoon shell weight ranged from 0.241 to 0.351 g with the highest of 0.351 g recorded for V-1 and the lowest of 0.241 g recorded for S-36. The cocoon shell percentage ranged from 14.79 to 19.58 % with the highest of 19.58 % recorded for V-1 and the lowest of 14.79 % recorded for S-36.

Table 1

Results of silkworm rearing utilizing mulberry leaf of different genotypes

Genotype	Bivoltine Hybrid CSR2 x CSR4				Multivoltine x Bivoltine hybrid, Pure Mysore x CSR2			
	5th instar Larval duration (h)	Cocoon weight (g)	Cocoon shell wt (g)	Cocoon Shell %	5th instar Larval duration (h)	Cocoon weight (g)	Cocoon shell wt (g)	Cocoon Shell %
V-1	156	2.000	0.478	23.9	156	1.793	0.351	19.6
V-2	164	2.000	0.438	21.9	164	1.890	0.294	15.6
V-3	170	1.993	0.442	22.2	170	1.538	0.283	18.4
V-4	170	1.955	0.439	22.5	170	1.739	0.328	18.9
G-9	170	1.946	0.418	21.5	170	1.738	0.283	16.3
G-3	170	2.000	0.420	21.0	170	1.645	0.295	17.9
S-13	180	2.010	0.440	21.9	180	1.785	0.316	19.2
S-34	168	2.102	0.468	22.3	170	1.629	0.277	15.5
S-36	168	1.690	0.389	23.0	170	1.476	0.241	14.8
S-54	168	2.005	0.450	22.4	168	1.587	0.270	18.3
K-2	168	1.991	0.428	21.5	168	1.680	0.310	19.5
C.D. at 5%	4.56	0.04	0.84	0.72	8.53	0.12	0.021	0.71

The silkworm, *Bombyx mori* L., consumes leaves of different mulberry varieties but the success of cocoon production depends on the efficient utilization and conversion of food to silk substance. Generally, the judgement is made from the rearing performance of silkworm on a mulberry variety emphasizing particularly the cocoon characters. From the present study, based on better rearing performance of silkworm hybrids, the mulberry variety, V-1 was found to be superior among the 11 varieties evaluated. This in concurrence with the earlier studies by Machi and Katagiri (1991). Susheelamma *et al.*, 1989; Sabhat *et al.*, 2011.

Quality of leaves plays an important role in the nutritional ability and feeding activity of silkworms. Growth and development in silkworm and cocoon characters are found to be affected by leaf quality (Krishnaswami, 1978; Koul *et al.*, 1979). Hence, based on the present study, it can be concluded that for higher leaf consumption, growth rate, digestibility and higher cocoon yield with superior quality of silk, V-1 is suggested as best suited host plant.

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DETERMINATION OF NUTRITION STATUS OF RURAL CHILDREN IN LODHAS POPULATION OF JHARGRAM SUB-DIVISION OF PASCHIM MEDINIPORE, WEST BENGAL, INDIA

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ABSTRACT

A longitudinal study was conducted in four villages in the Jhargram subdivision , Paschim Medinipore,West Bengal. One-hundred and ninety-seven children up to five years old were selected from Lodha populations in the study area. Pre-tested, structured interviews were conducted to collect information on child-related, maternal, paternal, and socio-economic factors from the households. Two child-related factors, number of diarrhoeal episodes and calorie adequacy of diet showed a highly significant effect on child's current as well as past nutrition status. The results of this study indicate a strong influence of socio-economic status and parental care on the control of infectious diseases and food intake, which are the two major causes for malnutrition among children in developing countries.

INTRODUCTION

Malnutrition is a burning problem of considerable magnitude in most of the developing countries of the world. Children age of 0 to 3 years are nutritionally the most vulnerable. More than half of the children in India are unable to grow to their full physical and mental potential owing to malnutrition. Nutritionists are always alarming that the condition is multifaceted and is not just a problem of food shortage. Realization is growing that malnutrition is a result of more complex big-social and behavioral determinants that affect child feeding and rearing (Chaudry, 1984)[1] .

In homogeneous poor communities living under fairly uniform socio-economic and environmental conditions, considerable variation is observed in the health and nutrition status of pre-school children. At one end of the spectrum, a very small number of children exhibit only minimal growth retardation; at the other end some children suffer from extreme forms of undernutrition such as kwashiorkor and

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marasmus; and in between are large numbers of children with various degrees of growth retardation.

The factors that underline these differences have not yet been properly elucidated. In a household where socio-economic status is consistently similar over a long period, only one child or some children suffer from the extreme forms of protein-energy malnutrition. The reasons for this are not well understood and established. The present study was an attempt to screen specific factors that are significantly associated with malnutrition in rural pre-school children of a poor socio-economic group in Jhargram and surroundings.

MATERIALS AND METHODS

This was a longitudinal study in four villages in the Jhargram sub-division. All low-income families with at least one pre-school child were selected from the villages using a suitable socio-economic scale (Naarayana, 1973)[4] with necessary modifications. The subjects were 197 children of up to five years old from these households.

Tools

Pre-tested, structured interviews were conducted to collect information on child-related, maternal, paternal, and socio-economic and environmental factors from the households. Child-related factors were age, birth order, age of starting weaning food, calorie adequacy of diet, immunization coverage, number of diarrhoeal episodes, number of upper respiratory tract infections, other infections, illness prior to the study period, regularity of baths, type of hospital visited during sickness, and primary care-taker when the mother goes out to work. Maternal factors were education, occupation, health status during pregnancy, health during the study period, help received from parents, help from family members for household activities, and nutritional awareness. Paternal factors were occupation, education level, health during study period, frequent quarrels with wife, expenditure on luxuries and amusements, time spent with the family after work, and whether the father is loving and affectionate with the child.

The socio-economic factors were type of family, caste, family size, per capita income, land availability, income from land, per capita food expenditure, type of roofing, floor space per person, source of drinking water, and number of children in the family attending school or college.

All the factors predicted to influence nutrition were included in the interview. Data were elicited both by interviewing the mother and through home observations during one year of the study period. These independent variables were suitably coded.

Assessment of dietary intake

Diet surveys were conducted in all the families in two seasons of the year, peak and lean, with regard to food consumption. Information about each pre-school child's diet was collected from all families using a 24-hour food weighing method. The percentage calorie adequacy of the child's diet was calculated taking the mean calorie intake in the two seasons of the year and comparing it with the recommended daily allowance prescribed by the Indian Council of Medical Research (ICMR, 1987)[3] .

Nutrition status assessment using anthropometry

Data on children's growth status was obtained by measuring weight and height. Weight was measured with minimum clothing and no shoes to the nearest 100 g using a beam balance. Length was measured with an

infantometer, following the standardized procedure. The correct age of the child was determined on the basis of a calendar of local events. Height and weight were recorded once every two months during the one-year study.

The weight and height measurements were converted into weight-for-age, height-for-age, and weight-for-height percentage of standard for each child using NCHS standards (WHO, 1983)[6]. The children were grouped into different grades of nutrition status by both Gomez's (Gomez *et. al*, 1956)[2] and Waterlow's classifications (Waterlow *et. al*, 1977)[5]. The cut-off points for the two classifications were as follows:

Gomez's classification

normal: >=90% of standard weight/age,

grade I malnutrition: 89%-75% of standard weight for age,

grade II malnutrition: 74%-60% of standard weight for age,

grade III malnutrition: <60% of standard weight for age;

Waterlow's classification

weight for height: >=80% = normal, <80% = wasted,

height for age: >=90% = normal, <90% = stunted. Children were assigned to a group of normal, grade I, grade II, and grade III malnutrition using Gomez's method, and normal, stunted, wasted, and both stunted and wasted using Waterlow's system.

Data analysis

To identify independent variables that had a significant role in influencing the three dependent variables (weight-for-age, height-for-age, and weight-for-height percentage of standard), stepwise multiple regression analysis was done using SPSS.

Table 1

Characteristics of study children

Variable	Classification	%
Age of child (month)	<24	35.1
	24-35	30.8
	36-47	24.2
	48-56	9.9
Birth order of child	1-2	42.2
	3-5	49.8
	6-11	8.0
Age of starting weaning (month)	6-12	59.7
	13-18	20.0
	19-24	14.2
	25-30	3.3
	31 -36	2.8
Diarrhoeal episodes last year	none	54.4
	1-2	28.9
	3-5	14.8
	6-10	1.9
Episodes of Upper respiratory Infections	none	37.0
	1 -3	53.1
	4-6	9.0
	7- 10	0.9
Episodes of other infections	none	39.8
	1-2	51.7
	3-4	6.6
	5-6	1.9
Previous severe Illness	not ill	84.8
	severely ill	15.2
Regularity of Bathing	irregular	64.0
	regular	36.0
Calorie adequacy of diet	<50%	47.4
	50-80%	31.7
	81-100%	16.7
	> 100%	4.2
Immunization coverage (DPT and polio)	Not immunized	49.3
	1-2 doses	34.1
	3 doses	16.6
Type of hospital visited	govt/private	17.5
	govt	22.8
	local private doctor	59.7

Table 2

Characteristics of mothers in study families

Variable	Classification	%
Occupation	agricultural labourer	82.5
	basketweaver	2.8
	housewife	14.7
Health status during Pregnancy	generally sick	19.4
	normal	80.6
Health during study Period	generally sick	13.3
	normal	86.7
Nutritional awareness score	low	84.8
	medium	15.2

Table 3

Characteristics of fathers in study families

Variable	Classification	%
Education	illiterate	89.7
	primary	5.7
	above primary	4.6
Health during study Period	generally sick	10.4
	normal	89.6
Expenditure on luxuries and amusements	does not spend	88.6
	spends	11.4
Spends time with family after work	no	8.1
	yes	91.9
Loving and affectionate with child	no	23.4
	yes	76.6

RESULTS

The villages selected for the study were typical dry land areas. Tables 1-4 summarize the characteristics of the study children and families according to the four groups of factors examined child-related, maternal, paternal, and socio-economic. Over 98% of the men and women were illiterate and their main occupation was agricultural labour. An average of 75% of the income was spent on food. To meet other

Table 4

Socio-economic characteristics of study families

Variable	Classification	%
Type of family	nuclear	63.5
	joint	36.5
Caste	Lodha (SC-ST)	46.9
	"Sabar"	53.1
Family size	3-6	64.5
	7-10	26.5
	11-14	9.0
Per capita income (Rs)	<750	20.9
	750-1,000	38.3
	1,001 -1,500	30.8
	> 1,500	10.0
Land availability (acres)	nil	32.2
	< 1	25.6
	1-2	31.3
	>2	10.9
Income from land	nil	45.0
	<1,000	25.6
	1,000-2,000	24.7
	2,001-3,000	1.9
	> 3,000	2.8
Per capita monthly food expenditure (Rs)	< 60	22.3
	60-89	46.0
	90-120	25.5
	> 120	6.2
Type of roofing	thatch	51.7
	tile	46.4
	cement	1.9
Floor space/person (sq. ft)	< 30	56.8
	30-49	29.9
	50-69	10.9
	70-90	2.4
Source of drinking Water	tank water	9.0
	deep well	38.4
	bore well	52.6
Number of children in family attending school/college	none	69.2
	1	21.3
	2	6.7
	3	0.9
	4	1.9

expenditures such as clothing, medical aid, and house construction and repair, loans were taken from larger farms at a high rate of interest.

Most families lived in one-room houses with poor ventilation, and cooked in the same room where they lived. None of them had toilet facilities. Household possessions were limited to cooking vessels, serving plates, and earthen pots for storing food grain and water. The people rarely moved out of their villages. The health facilities available to them were limited.

The distribution of children at the end of the study period according to age and sex is shown in table 5.

Distribution of children at the end of one year according to Gomez's and Waterlow's classifications is presented in tables 6 and 7.The set of factors that emerged in the final step after eliminating less significant factors in multiple regression analysis (backward elimination method) is shown in tables 8, 9, and 10.

Table 5

Age and sex distribution of study children

Age (month)	Boys	Girls	Totals
13-24	32	42	74
25-36	38	32	70
37-48	26	27	53
Totals	96	101	197

DISCUSSION

The results of the study confirm earlier reports that the prevalence of moderate and severe forms of malnutrition is high in children age of 13 to 36 months (i.e., pre-school age). Regression analysis indicated that numerous factors affect child nutrition with a maximum effect on weight for height and lead to wasting, stunting or underweight.

Tables 8 to 10 shows that the set of factors that influence weight for age are different from those that affect height for age and weight for

Table 6

Nutrition status of children according to Gomez's classification

Age (month)	Normal and Grade I		Grade II		Grade III		Totals
	No.	%	No.	%	No.	%	
13-24	21	28.4	47	63.5	6	8.1	74
25-36	24	34.2	38	54.3	8	11.4	70
37-48	19	35.8	31	58.5	3	5.6	53
Totals	64	32.5	116	58.9	17	8.6	197

Table 7

Nutrition status of children according to Waterlow's classification

Age (month)	Normal		Stunted		Wasted		Stunted and wasted		Totals
	No.	%	No.	%	No.	%	No.	%	No.
13-24	40	54.1	16	21.5	6	8.1	12	16.2	74
25-36	35	50.0	22	31.4	1	1.4	12	17.1	70
37-48	25	47.2	26	49.1	0	0.0	2	3.8	53
Totals	100	5.8	64	32.5	7	3.6	26	13.2	197

Table 8

Regression coefficient, SE, and t ratio in stepwise regression for dependent variable weight for age

Variable	Coefficient	SE	t ratio	Significance
Child-related factors				
Number of diarrhoeal episodes	– 0.862	0.134	– 6.429	a
Calorie adequacy of diet	0.186	0.019	9.449	a
Regularity of bathing	1.722	0.637	2.705	a
Number of other infectious episodes	– 0.800	0.367	– 2.181	b
Age	– 0.109	0.046	– 2.388	b
Immunization coverage	0.734	0.367	2.003	b
Primary caretaker	0.568	0.214	2.650	a
Maternal factors				
Health status during pregnancy	3.899	1.115	3.497	a
Socio-economic factors				
Income from land	0.0009	0.0004	2.670	a
Number of children in family attending school/college	1.172	0.510	2.298	b
Per capita food expenditure	0.033	0.018	1.868	c

R^2 57.62%; adjusted R^2 54.11 %; F 16.40.
a. Significant at 1%, b. Significant at 5%, c. Significant at 10%

height. This was expected, because each of these three anthropometric measures indicates a different type of nutrition status. Weight for age is an indicator of either current or past nutrition, whereas height for age is an indicator of past nutrition. Weight for height is a sensitive indicator of current nutrition status and of the degree of wasting. It is a useful tool specifically when ages are not known or not certain.

In addition to a child's calorie adequacy and number of diarrhoeal episodes, regularity of bathing the child had a significant effect on both height for age and weight for age, as it is indirect evidence of maternal care and personal hygiene. The number of upper respiratory infections and other infections, and late weaning (24-48 month), had a negative effect on growth status.

The child's age had a significant negative effect on weight for age and height for age, but a positive effect on weight for height of standard. Although immunization (DPT, polio) given to the child did not have a significant association with chronic nutrition, it emerged as a significant factor for current nutrition status. The mother as primary care-taker of the child compared with sibling care had a significant effect on both height for age and weight for age..

Health of the father during the study period, and the time he spends with family members after work, also had a positive and significant effect on the child's weight for age but not on height for age. Father's expenditure on luxuries and amusements had a negative effect on weight for height. This could be because of the more he spent on luxuries, the less time and money he will have for the family. Frequent quarrels between parents, and the father not being loving and affectionate toward the children, had a

Table 9

Regression coefficient, SE, and t ratio in stepwise regression for dependent variable height for age

Variable	Coefficient	SE	t ratio	Significance
Child-related factors				
Number of diarrhoeal episodes	– 0.304	0.081	– 3.770	a
Age	– 0.089	0.028	– 3.200	a
Calorie adequacy of diet	0.075	0.114	6.664	a
Regularity of bathing	0.865	0.371	2.329	b
Primary caretaker	0.384	0.136	2.826	a
Maternal factors				
Help received by mother's parents	– 0.131	0.077	– 1.697	c
Paternal factors				
Not loving and affectionate with child	– 1.013	0.567	– 1.784	c
Socio-economic factors				
Caste	1.548	0.563	2.747	a
Number of children in family attending school/college	0.752	0.311	2.419	b
Income from land	0.0005	0.0003	2.036	b
Land available	0.510	0.294	1.734	c
Per capita food expenditure	0.019	0.011	1.747	c

R^2 40.75%; adjusted R^2 36.54%; F 9.68

a. Significant at 1%, b. Significant at 5%, c. Significant at 10%

negative effect on height for age and weight for age, although not highly significant. These results strongly indicate the role of the father in influencing a child's nutrition.

Among socio-economic factors, income from land can be used as a good indicator of a child's nutrition. It emerged as a single but significant factor that influenced weight for age, height for age, and weight for height. Families who receive higher incomes from land may have fewer constraints in feeding children. Per capita income and per capita food expenditure emerged as important factors, but were not significant. Caste was not a significant factor for current nutrition status, but was highly significant for past nutrition, indicating that stunting was more prevalent in Lodhas.

From close observation and follow-up during the study period, differences in nutrition status of two pre-school children brought up under similar conditions can be traced to two basic causes. First, children who were more vulnerable to infections during early infancy (<24 month), and had higher morbidity, became malnourished. Second, some young children were unable to eat adequate food, perhaps owing to lack of appetite or because they did not care for the foods given. Such children were also highly prone to diarrhoeal diseases and consequently became malnourished. The effects of chronic calorie deficiency and infection appear to be the basic causes of the poor nutrition status of children below three years of age.

Table 10

Regression coefficient, SE, and t ratio in stepwise regression for dependent variable weight for height

Variable	Coefficient	SE	t ratio	Significance
Child-related factors				
Number of diarrhoeal episodes	– 0.606	0.137	– 4.422	a
Calorie adequacy of diet	0.050	0.019	2.716	a
Age	0.105	0.043	2.430	b
Number of upper respiratory infection episodes	– 0.671	0.262	– 2.563	b
Age of starting weaning	– 0.114	0.063	– 1.806	c
Maternal factors				
Health status during pregnancy	2.834	1.037	2.732	a
Help received for household activities	0.464	0.253	1.833	c
Paternal factors expenditures on luxuries and amusements	– 2.731	1.257	– 2.173	b
Socio-economic factors				
Income from land	0.0007	0.0003	2.212	b
Type of hospital visited	0.910	0.521	1.746	c
Per capita income	0.001	0.001	1.671	c
Number of children in family attending school/college	0.847	0.489	1.729	c

R^2 41.3%; adjusted R^2 37.47%; F 10.78

a. Significant at 1%, b. Significant at 5%, c. Significant at 10%

Controlling infection in early infancy and providing access to more easily digestible and palatable foods will promote adequate calorie intake. If pre-school children at risk of malnutrition can be identified before they reach their second year of life, if effective primary health care is made available, and if an acceptable food is provided for these children, malnutrition can be averted.

As the determinants of nutrition status vary from culture to culture, similar studies conducted in different geographic regions, perhaps including other variables, can identify the critical family and environmental factors that contribute to the growth and development of children. Relevant intervention strategies can be based on these findings and incorporated into continuing developmental programmes aimed at improving these factors.

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ALLELOPATHIC EFFECTS OF *Andrographis paniculata* ON GERMINABILITY OF DIFFERENT CROP PLANTS

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ABSTRACT

The water extracts of *Andrographis paniculata* on allelopathic effect of various crop plants viz., wheat, soybean, okra and sunflower showed inhibition of germination alongwith vigour as measured by root and shoot length of the seedling. The rate of suppression on germination percentage, root and shoot length increases with the increase in concentration of the extract. The maximum inhibitions were noticed in the 12.5%leaf extract of Andrographis. The inhibitory effect of *Andrographis paniculata* on germinability was observed in all the crops. However, the sensitivity of allelochemicals varied among different crops. The inhibition was more in soybean and okra followed by wheat and sunflower. Besides, the duration of soaking in the extract was also different in different crops. In case of wheat and soybean seeds were soaked for 6h whereas in okra and sunflower seeds were soaked for 24h. In the latter cases, the inhibitory effect was noticed after prolonged soaking, probably due to hard seed coat. The vigour index as calculated by multiplying the germination percentage alongwith seedling length was also decreased with the increase of extract concentration. The present findings clearly reveal the allelopathic effects on vigour and viability of different crop plants.

INTRODUCTION

When plants, alive or dead, release chemicals that affect the growth of neighbouring plants, allelopathy evolves. The term Allelopathy derived from two Greek words allelo (one another or mutual) and pathy (suffering). It refers to the release of chemicals, by one plant, that have some type of effect on another plant. These chemicals can be given off by different parts of the plant or can be released through natural decomposition. Allelopathy is a survival mechanism, that allows certain plants to compete with and often destroy nearby plants, by inhibiting seed sprouting, root development or nutrient uptake.

Allelopathic chemicals can be present in any part of the plant. They can be found in leaves, flowers, roots, fruits, or stems. They can also be found in the surrounding soil. For example, the Mature trees of *Ailanthus altissima* produce one or more potent inhibitors of seed germination and seedling growth. Inhibitor activity is highest in bark, especially of roots, intermediate in leaflets, and low in wood (Heisey,1990). Target species are affected by these toxins in many different ways. The toxic

chemicals may inhibit shoot or root growth, they may inhibit nutrient uptake, or they may attack a naturally occurring symbiotic relationship thereby destroying the plant's usable source of a nutrient. The importance of allelopathy in biological weed control and crop productivity has been highly recognized. (Fujii *et al.*, 2004; Terzi, 2008; Taiwo and Makinde, 2005).

Andrographis which is commonly known as Kalmegh or King of bitter, consists of 28 species of small annual shrubs essentially distributed in tropical Asia. Only a few species are medicinal, of which *A. paniculata* is the most popular. It is an erect annual herb extremely bitter in taste in each and every part of the plant body.

In Indian traditional medicine, kalmegh is widely used against coughs, headaches, edema, earache, pain conditions, inflammation and muscular pain, arthritis, rheumatism, fibro myalgia, multiple sclerosis, depression, diarrhoea, dysentery, cholera, candida, lupus, diabetes, piles, fevers, fatigue, hepatitis, herpes, leprosy, loss of appetite, swollen lymph nodes and other lymphatic conditions, jaundice, dyspepsia, dermatitis, eczema, burns, pneumonia, bronchitis, tuberculosis, chicken pox, mumps; sluggish liver, spleen, kidneys and adrenal glands; sleeplessness, vaginitis and constipation. In homoeapathy, it is used as kalmegh drops.

One of the main active constituents in the plant is andrographolide, which is a “diterpene lactone”, generally, have an affinity with the heart, also liver, gall bladder; and also have a cooling effect on the body and can bring down a temperature. The extremely bitter substance is water soluble and is distributed all over the plant body in different proportions. The leaves contain the highest amount of andrographolide (2.5%) while the seeds contain the lowest .The other medicinal chemicals are also bitter diterpenoids viz., deoxyandrographolide, 19-D glucoside and neo-andrographolide, all of which have been isolated from the leaves. In numerous instances, leached chemicals from the kalmegh plants have allelopathic influence on the germination and growth of various plants.

The present laboratory experiment was undertaken to study the behaviour of phytochemicals present in the leaf extracts of *Andrographis paniculata* as an allelopathic effect on the germination and seedling growth of wheat, soybean, okra and sunflower.

MATERIALS AND METHODS

The plant materials (mature fresh leaves) were collected from the Calcutta University Agricultural Experimental Farm at Baruipur, 24 Parganas (South), West Bengal. These were then washed with distilled water and dried for 3 days at 80^{o}C temperature. The dried leaves were finely powdered in grinder machine and sieved for extraction. After sieving, 12.5g leaf powder was soaked in 100 ml distilled water for 48 h with occasional stirring to get 12.5% extract. By dilutions with distilled water 5%, 10% and 12.5% concentrations of extracts were prepared.

Firstly, seeds were surface sterilized with 0.05% mercuric chloride for 5 min and repeatedly washed with distilled water. The seeds were then soaked in different concentrations of extracts for 6-24 h (wheat and soybean for 6h while sunflower and okra seeds were soaked for 24 h due to hard seed coat) alongwith the control (soaked in distilled water only). After soaking, seeds were surface dried under fan and placed for germination at room temperature (30 $\pm$ 1^{o}C) following the inclined glass plate blotter technique of Punjabi and Basu (1982). Over 400 seeds per treatments were tested for germination following the ISTA rules (1996). The growth parameters such as germination percentage, root length and shoot length were recorded after germination for 5

days. The data on various parameters were statistically analysed following the method of Fisher (1948).The vigour index was calculated by multiplying the total seedling length with germination percentage.

RESULTS AND DISCUSSION

In the present study, the leaf extract of *Andrographis paniculata* showed an inhibitory effect on the germination of wheat, soybean, okra and sunflower seeds. The inhibitory effect gradually increases with the increase in concentration. In all seeds, the germination percentage was maximum in the untreated control where the seeds were soaked in only distilled water.

In wheat, maximum germination percentage i.e., 93% was observed in 6 h distilled water soaked seeds whereas the percentage gradually decreases from 80% to 65% when the wheat seeds were soaked in 5% to 12.5% solution of kalmegh leaf extracts (Table 1). Similar trends of results were noticed with soybean, okra and sunflower seeds (Table 1 and 2).

Table 1

Effect of aqueous leaf extracts of *Andrographis paniculata* on germination and seedling growth of wheat and soybean

Concentration (%)	Wheat				Soybean			
	Germination (%)	Mean root length (mm)	Mean shoot length (mm)	Vigour Index	Germination (%)	Mean root length (mm)	Mean shoot length (mm)	Vigour Index
0 (control)	93	84.5	54.4	12843.6	86	122.7	115.0	20433.6
5	80	73.8	58.4	10572.0	73	80.5	61.7	10380.6
10	75	72.9	55.0	9592.5	50	73.9	60.5	6652.8
12.5	65	64.6	42.5	6958.3	53	68.4	42.3	5867.1
CD at 0.05P	18.9	10.3	5.36	–	29.5	22.5	26.1	–

Table 2

Effect of aqueous leaf extracts of Andrographis paniculata on germination and seedling growth of okra and sunflower

Concentration (%)	Okra				Sunflower			
	Germination (%)	Mean root length (mm)	Mean shoot length (mm)	Vigour Index	Germination (%)	Mean root length (mm)	Mean shoot length (mm)	Vigour Index
0 (control)	60	43.3	37.6	4822.7	56	136.6	70.4	11589.2
5	33	26.5	22.6	1621.1	53	125.7	65.5	10038.0
10	23	20.4	18.4	892.4	40	112.4	45.0	6294.0
12.5	23	15.1	9.8	577.8	37	116.6	41.4	5765.2
CD at 0.05P	17.7	6.89	12.19	–	NS	NS	12.8	–

The aqueous leaf extracts inhibits the seedling growth as measured by root and shoot length in wheat, soybean, okra and sunflower seeds in comparison to untreated control (Tables 1 and 2). The maximum inhibition on germinability was obtained in 12.5% concentration of Andrographis leaf extract. The vigour index as measured by seedling length multiplied by germination percentage were gradually decreased with the increase in concentration of the Andrographis leaf extract in all the categories of the seed.

The results of our study revealed that the leaf extracts of *Andrographis paniculata* inhibit the germination as well as vigour of the seedling. The inhibitory effect is probably due to the presence of allelochemicals, perhaps, andrographolides a major alkaloid of *Andrographis paniculata*. Alagesaboopathi (2011) reported the more or less similar type of result in sesamum. Akbar *et al.* (2012) found that the extraction of aerial plant part of *Calotropis gigantean* inhibit the seed germination and seedling vigour of wheat. Li M *et al.* (2010) showed that water extracts of *Andrographis paniculata* on allelopathic effects of cabbage and radish. They have also reported that high concentration inhibited and low concentration promoted to different receptor.

Whatever may be the allelochemicals present in the extract of *Andrographis paniculata*, seed germination and vigour as measured by seedling length of different crop plants have been affected drastically alongwith the increase in concentration of the extract.

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EDITORIAL

We are delighted to publish the Indian Biologist, volume 44, No. 1, 2012 as a special volume on Forest within the stipulated date. We will try our level best to publish the issue on scheduled time.

We are glad to announce that next six issues will be published as special issues on six burning problems of our environment which affect the very existence of a large number of biological species including human species. Topics of coming five special issues of Indian Biologist are as follows : (i) **Land & Soils and Water**, (ii) **Energy**, (iii) **Population vis-à-vis Natural Resources**, (iv) **Food, Nutrition and Food Adulteration**, and (v) **Genetically Modified Crops**.

Usual research papers of our Members on other biological topics also will be included in those special issues.

The Indian Biologist is circulated to all major countries around the world and abstracts of its articles are now being published regularly in leading abstracts of the world in different languages. During the last 44 years, Indian Biologist has gained notable reputation in India and abroad mainly due to the constant patronage from our members and well wishers. The quality of its publication are commendable. Due to high printing charges and paper cost, we have increased the rate of printing charges per page of Rs. 200/- from this issue. We hope, the authors/ contributors of the research papers or articles will bear us in this regard.

The contributors are cordially requested to send their manuscripts/ articles in original for publication in the journal of "Indian Biologist".

We sincerely request our members and well wishers to offer their patronage and co-operation as before.

T. M. Das and A. K. Mandal