INDIAN JOURNAL OF PLANT AND SOIL

The Indian Journal of Plant and Soil (IJPS) (ISSN 2348–9677) publishes original articles and commentaries on research in the fields of fundamental and applied soil and plant science. Original research papers, short communications including germplasm registrations, relevant book reviews, commentaries on papers recently published and, exceptionally, review articles will be considered for publication in the Journal. Manuscripts considered will address aspects of: Agronomical and Horticultural research including breeding and genetics, cultivar evaluation, management, nutrition, physiology, production and quality; Soil Science research including biology, chemistry, classification, fertility, mineralogy, pedology and hydropedology, physics, and soil and land evaluation of agricultural and urban ecosystems; Weed Science research including biological control agents, biology, ecology, genetics, herbicide resistance and herbicide-resistant crops, and physiology and molecular action of herbicides and plant growth regulators; Agro-climatology; Agro-ecology; Forage, Pasture and Turfgrass Science including production and utilisation; Plant and Soil Systems Modelling; Plant–Microbe Interactions; Plant–Pest Interactions; and Plant–Soil Relationships.

Readership

Soil scientists, plant physiologists, agronomists, plant breeders, geochemists, ecologists involved in soil protection.

Subscription rates worldwide: Individuals(annual)-Rs.4500; Institutional (annual)- Rs.5000/USD1700. Single issue Rs.2500/USD850. Payment methods: By Demand Draft/cheque should be in the name of **Red Flower Publication Pvt. Ltd**. payable at Delhi. By Bank Transfer/TT: **Bank name:** Bank of India, **IFSC Code:** BKID0006043, **Swift Code:** BKIDINBBDOS. **Account Name: Red Flower Publication Pvt. Ltd.,** Account Number: 604320110000467, Branch: Mayur Vihar Phase-I, Delhi – 110 091 (India) or contact on 91-11-22754205 or mail to redflowerppl@gmail.com

Printed at Mayank Offset Process, 794/95 Guru Ram Dass Nagar Extn, Laxmi Nagar, Delhi - 110092.

Subscription Form

I want to renew/subscribe to international class journal **"Indian Journal of Plant and Soil"** of Red Flower Publication Pvt. Ltd.

Subscription Rates:
• India: Institutional: Rs.5000, Individual: Rs.4500, Life membership (10 years only for individulas) Rs.45000.
• All other countries: $1700

Name and complete address (in capitals):

Payment detail:
Demand Draft No.
Date of DD
Amount paid Rs./USD

1. Advance payment required by Demand Draft payable to Red Flower Publicaion Pvt. Ltd. payable at Delhi.
2. Cancellation not allowed except for duplicate payment.
3. Agents allowed 10% discount.
4. Claim must be made within six months from issue date.

Mail all orders to
Red Flower Publication Pvt. Ltd.
48/41-42, DSIDC, Pocket-II, Mayur Vihar Phase-I, Delhi - 110 091 (India)
Tel: 91-11-22754205, 45796900, Fax: 91-11-22754205
E-mail: redflowerppl@vsnl.net, redflowerppl@gmail.com
Website: www.rfppl.co.in

Indian Journal of Plant and Soil

Volume 1 Number 2
July - December 2014

Contents

Indian Journal of Plant and Soil
Volume 1 Number 2, July - December 2014

Original Article

Trace Elements in the Soils of Ropar and Garhshankar Forest division of Punjab

Parul Bhatt Kotiyal*, Basanti Yumkhaibam, Sohni Sinha*****

Author's Affiliation: * Forest Soil and L and Reclamation divison, **,***M.Sc Environment Management, Forest Research Institute,

Abstract

The main objective of the study is to determine the availability of trace elements in soils of Ropar and Garhshankar Forest division of Punjab. For analysis of the soils, 34 soil samples were collected from different nursery plantation of Ropar and Garhshankar Forest division in Punjab. The available trace elements can be determined in DTPA extract using AAS. The trace elements consider in this soils were Zn, Mn, Cr, Cu, Fe and Co. After analyses, the result found to be highly contaminated with heavy metals in the soils of this region. The ranges of available trace elements are Zn(0.003-8.084)ppm, Mn(1-5)ppm, Cr(0-9.5)ppm, Cu(0-1.7)ppm, Fe(0-8)ppm, Co(0-1.5)ppm. The increasing order of the trace elements of this soils were Co<Cu<Mn<Fe<Zn<Cr. The pH of Punjab soil is slightly alkaline which ranges from 7 to 8.9. The bulk density and porosity are dependent on soil texture and the densities of soil mineral (sand, silt, and clay) and organic matter particles, as well as their packing arrangement. The bulk density and porosity in soil of Punjab shows that the soils in this region are loosely arranged and less compact.

Keywords

Trace Elements; Ropar; Garhshankar; Punjab; Bulk density; Porosity.

Introduction

Chemical elements in soil are referred to as trace elements (TEs) because of their occurrence at concentrations less than 100 mg kg-1. As a matter of fact, many of these elements are present at concentrations lower than this. Most of the trace elements of environmental and human/animal health significance are metals, for example cadmium, chromium, cobalt, copper, gold, lead, mercury, molybdenum, nickel, palladium, platinum, rhodium, silver, thallium, tin, vanadium, and zinc. Trace elements have also been termed 'toxic metals', 'trace metals' or 'heavy metals'. 'Heavy metals' is the most popularly use and widely recognized term for large groups of elements with density greater than 6 g cm-1 but not at all TEs are metals.

The term 'trace elements' is useful as it embraces metals, metalloids, non-metals and other elements in the soil-plant-animal system, but it is vague because it can include any element regardless of its function. Trace elements occur naturally in soils. However, production-oriented policies in the twentieth century, which exploited land for mineral extraction, manufacturing industry and waste disposal have resulted in the input and accumulation of large quantities of TEs in the soils. There are variety of both natural and anthropogenic input sources of trace elements in soils. The major natural sources include weathering (including erosion and deposition of wind-blown particles), volcanic eruptions, forest fires and biogenic sources1.The major anthropogenic sources of trace elements input to soils are: Atmospheric deposition, arising from coal and gasoline combustion, nonferrous and ferrous metal mining, smelting, and manufacturing, waste incineration, production of phosphate fertilizers and cement, and wood combustion; Land application of sewage sludge, animal manure and other organic wastes and co-products from agriculture and food industries; Land disposal of industrial co-products and waste, including

Corresponding Author: Parul Bhatt
Forest Soil and Land Reclamation Divison
Forest Research Institute Dehradun- 248006
E-mail: parulbhatt29@gmail.com

paper industry sludge, coal fly ash, bottom fly ash and wood ash; Fertilizers, lime and agrochemicals (pesticides) use in agriculture.

The soil is the primary source of trace elements for plants, animals and humans. Elevated levels of TEs in the soil as a consequence of human activities therefore pose a range of environmental and health risks. Trace elements, unlike organic contaminants, are required in soils essentially indefinitely because they are not degradable. Consequently, soils contaminated with TEs pose a long-term risk of increased plant uptake and leaching, with potentially adverse implications for the wider environment, including human health. Arsenic, Cd, Hg, Pb, and Se are the most important in terms of the food chain contamination and ecotoxicity viewpoints 5. When the concentration of trace elements excess it critical level then the soil become polluted or contaminated. At elevated levels, trace elements are harmful to humans. For example, Pb, which is added to gasoline to reduce automobile engine knock, has become widespread in soils. Other additions of Pb to the environment include contamination from Pb paint, smelters, and Pb arsenate, an insecticide. Lead is toxic to humans, especially children, and damages the central nervous system, causing retardation and even death in extreme cases.

Trace elements are also of concern in the environment because of their potential to bioaccumulate in the food chain. The well-known Minamata disease, which occurred in Japan, was caused by bioaccumulation of methyl mercury in the fish of Minamata Bay. The local people consumed fish that had bioaccumulated the compound. Also in Japan, Itai-Itai disease, a form of Cd poisoning, caused many Japanese to fall ill when they ingested Cd contaminated rice.

Materials and Methods

Punjab is located in the northwest of India surrounded by Pakistan on the west, the Indian states of Jammu and Kashmir on the north, Himachal Pradesh on its northeast and Haryana and Rajasthan to its south. It covers a geographical area of 50,362 sq. km which is 1.54 % of country's total geographical area. Punjab state is located between 29° 30' N to 32° 32' N latitude and between 73° 55' E to 76° 50' E longitude. Its average elevation is 300 m from the sea level. A belt of swelling hills extends along the northeast at the foot of the Himalayas. Punjab state is situated between the great systems of the Indus and Ganges rivers. Most of the state is an alluvial plain, irrigated by canals; Punjab's arid southern border edges on the Thar, or Great Indian, Desert. The Siwalik Range rises sharply in the north of the state. In Punjab, the soil characteristics are influenced to a very limited extent by the topography, vegetation and parent rock. The variation in soil profile characteristics are much more pronounced because of the regional climatic differences. Punjab is divided into three distinct regions on the basis of soil types. The regions are: South-Western Punjab, Central Punjab and Eastern Punjab. Rupnagar district is one of the twenty districts in the state of Punjab in North-West Republic of India. Rupnagar (formerly known as Ropar or Rupar) district, included in the Patiala Division of Punjab falls between north latitude 30°-32' and 31°-24' and east longitude 76°-18' and 76°-55'.

The experimental sites from where the soil samples were collected from Ropar and Garhshankar Forest Division were as follow:

Sampling and Analytical Procedure

Soils sampleswere collected from the above 11 sites , the term parent soil , planted soil and pot mixture soil. So, 33 soil samples were collected from different sites of Ropar and Garhshankar Forest division of Punjab. Collected soil samples were air dried for several days and ground to pass a 2 mm sieve and analysed for physical and Chemical attributes. The porosity was determined by the method described by Brady 2.The pH was estimated in soil: distilled water (1:2.5) suspension using a digital pH meter (Elico Model LI-10T) and Digital Conductivity Meter (CC-601), respectively 4 .The available trace elements were determined by making a DTPA extract of the soil samples and fitted it to the Atomic Absorption Spectophotometer (AA-6401 F, Shimadzu, Japan). The working standard solutions for each metal were prepared before every analysis. Concentrations of Fe, Mn, Cu, Co, Zn and Cr were measured by an air acetylene flame AAS.

Result and Discussion

The soil samples collected from Ropar and Garhshankar Forest Division of Punjab shows that The region of Balachur (parent soils) and Lamheri (parent soils) shows the minimum or least concentration of Zn i.e 0.003 ppm (table-1) the concentration of Zinc is highest in Lamheri (planted soil) region i.e. 8.084 ppm followed by Mait Majra (planted soils)(table-2) and Kathgarh (pot mixture soils) i.e 3.046 pm and 0.322 ppm (table-3). From the above results, we know that the Zn concentration

Map of the Study area

Experimental sites	Latitude	Longitude	Forest Range
Mait Mojra	N 300 57'03.3"	E 760 36' 49.2"	Ropar
Loghut	N 300 59' 16.3"	E 760 31' 29.1"	Ropar
Batarala	N 310 04' 34.2"	E 760 32'01.2"	Nurpurbadi
Raessira	N 310 400' .9"	E 760 22' 25.4"	Nurpurbadi
Kalyanpur	N 310 10' 39.2"	E 760 34' 09.3"	Ananpur sahib
Lamheri	N 310 15' 30.5"	E 760 30' 08.6"	Ananpur Saheb
Tonsa	N 310 00' 06.6"	E 760 26' 31.9"	Kathgarh
Fathepur	N 310 00' 15.9"	E 760 25' 31.1"	Kathgarh
Bacchola	N 310 27' 58.5"	E 760 03' 07.8"	Mahilpur
Sahapur	N 310 13' 45.9"	E 760 10' 53.1"	Garhsankar
Balachur	N 310 04' 09.0"	E 760 16' 48.4"	Balachur

Fig. 1 (a) : Garhshankar Forest division

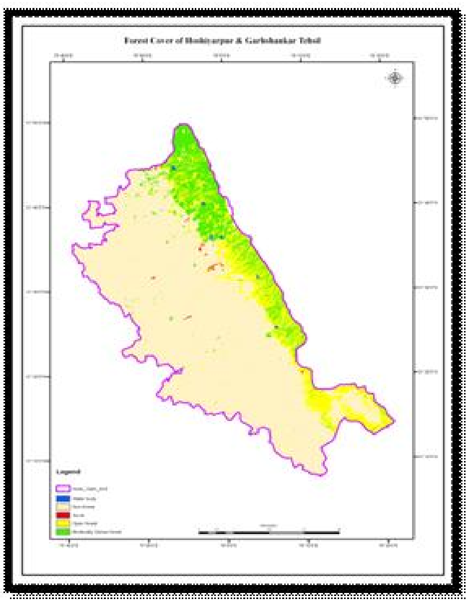
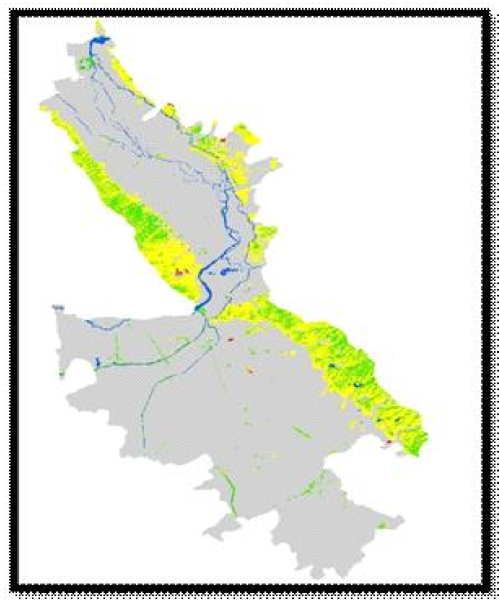


Fig. 1 (b) : Ropar Forest division



range from 0.003 to 8.084 ppm and it also shows that the concentration is highest in planted and pot mixture soils as compared to Parent soils. The manganese concentration range from 1 to 5 ppm. The Mn concentration is highest in Mait Majra nursery (pot mixture soils) i.e 5.937 ppm followed by Balachur (planted soil) i.e 4.481 ppm. The region of Loghut, Kathgarh and Baccholi has the least concentration of Mn i.e 1.011, 1.515ppm. The soils of these three regions are mainly of parent soil. Here also shows that the planted and pot mixture soils has highest concentration of Mn and the parent soil shows the least concentration.The soil of this two district i.e Ropar and Garhshankar has highest concentration of Chromium (Cr). It ranges from 0 to 9.5 ppm. The region of Loghut (planted soil) and Batrala (planted soil) has the highest concentration i.e 9.525 ppm followed by Batrala (planted soil) and Lamheri (planted soil) i.e 7.885 ppm. The region of Kalyanpur, Baccholi and Batrala (pot mixture soil) has the minimum value of Cr concentration i.e 0.24 ppm. Copper (Cu) concentration is highest in Fathepur (parent soil) region i.e 1.704 ppm followed by Loghut (planted, clonal, Eu soil) i.e 0.943 ppm and least in Log hut (parent soil) i.e 0.453 ppm. All the parent soil sample has least concentration of copper except in Fathepur region as compared to pot mixture soil and planted soil. The concentration of Cu range from 0 to 1.7 ppm.The concentration of Iron (Fe) range from 0 to 8 ppm. The region of Mait Majra (planted soil) shows

Table 1 : Concentration of trace elements in Parent soil of Ropar and Garhshankar Forest division of Punjab

Site (Nursery)	Zn (ppm)	Mn(ppm)	Cr(ppm)	Cu(ppm)	Fe(ppm)	Co (ppm)
Sahapur (parent soil)	0.192	3.25	2.305	0.805	1.633	0.502
Balachur (parent soil)	0.003	2.97	6.722	0.591	1.133	1.39
Fathepur (parent soil)	0.900	2.466	1.020	1.704	2.133	0.248
Kathgarh (parent soil)	0.042	1.515	4.941	0.667	3.133	0.882
Raessira (parent soil)	0.086	2.466	6.722	0.692	1.300	0.248
Kalyanpur (parent soil)	0.150	2.522	6.722	0.742	1.467	0.375
Kalyanpur (parent soil/ Forest Soil)	0.105	2.802	5.769	0.679	0.800	0.882
Kalyanpur (parent soil)	0.150	2.522	6.722	0.742	1.467	0.375
Mait majra (parent soil)	0.081	2.802	3.521	0.541	1.633	0.248
Log hut (parent soil)	0.054	1.011	1.750	0.453	1.967	0.628
Batrala (parent soil)	0.105	3.754	9.525	0.931	1.633	1.009

Table 2 : Concentration of trace elements in planted soil of Ropar and Garhshankar Forest division of Punjab

Site (Nursery)	Concentration of Heavy Metals/ Trace Elements					
	Zn (ppm)	Mn(ppm)	Cr(ppm)	Cu(ppm)	Fe(ppm)	Co (ppm)
Sahapur (planted soil)	0.144	2.466	2.305	0.78	1.633	0.502
Balachur (planted soil)	0.374	4.481	2.893	0.931	1.467	0.882
Bachholi (planted soil)	0.096	2.243	0.240	0.780	1.300	0.248
Fathepur (planted soil)	0.195	2.354	2.893	0.642	1.633	0.121
Kathgarh (planted soil)	0.108	1.571	3.521	0.503	1.300	1.263
Raessira (planted soil)	0.295	1.683	0.721	0.704	1.800	0.375
Lamheri (planted soil)	8.084	2.187	7.885	0.73	3.300	0.628
Kalyanpur (planted soil)	0.162	3.530	0.240	0.906	2.967	0.375
Mait majra (planted soil)	3.046	3.642	3.521	0.881	8.300	1.009
Log hut (planted soil)	0.060	2.97	9.525	0.881	1.800	0.121
Batrala (planted soil)	0.120	2.802	7.885	0.918	2.133	1.517

Table 3 : Concentration of trace elements in Pot mixture soil of Ropar and Garhshankar Forest division of Punjab

Site (Nursery)	Concentration of Heavy Metals/ Trace Elements					
	Zn (ppm)	Mn(ppm)	Cr(ppm)	Cu(ppm)	Fe(ppm)	Co (ppm)
Sahapur (pot mixture soil)	0.368	3.306	1.223	0.742	0.800	0.121
Balachur(pot mixture soil)	0.292	2.522	0.721	0.818	3.633	1.136
Bachholi(pot mixture soil)	0.094	2.345	0.125	0.562	1.300	0.502
Fathepur (pot mixture)	0.009	1.907	0.492	0.642	0.967	0.375
Kathgarh(pot mixture soil)	0.322	3.082	1.223	0.629	1.300	0.121
Raessira (pot mixture soil)	0.048	3.25	4.941	0.855	1.800	0.882
Lamheri (pot mixture soil)	0.069	1.515	2.305	0.516	2.967	0.375
Kalyanpur (pot mixture soil)	0.182	2.354	3.521	0.704	0.633	0.121
Mait majra (pot mixture soil)	0.319	5.937	4.941	0.818	2.633	0.502
Log hut (planted, clonal,EU, soil)	0.009	2.690	3.521	0.943	3.967	0.882
Batrala(pot mixture soil)	0.090	3.082	0.240	0.906	0.633	0.375

the highest concentration of Fe i.e 8.3 ppm followed by Log hut (planted, clonal, Eu soil) and Balachur (pot mixture soil) i.e 3.967 ppm and 3.633 ppm. The region of Sahapur (pot mixture soil) and Kalyanpur (planted/ forest soil) has the least concentration of Fe i.e 0.8ppm.The Cobalt (Co) concentration range from 0 to 1.5 ppm. Batrala (planted soil) region shows the maximum concentration of Co i.e 1.517ppm and the region of Sahapur (pot mixture soil), Fathepur (planted soil), Kathgarh (pot mixture soil) and Lamheri (parent soil) shows the minimum concentration of Co i.e 0.121 ppm. From the above result, the increasing order of trace elements or heavy metals of Punjab are arranged as follows:

Co<Cu<Mn<Fe<Zn<Cr

→

Increasing order of heavy metals in soil of Punjab

This result shows that concentration of Cr is highest and Co is least in soil of Punjab. Although the soil sample collected from Planted and Pot mixture soils shows higher amount of trace element as compared to Parent soil sample. This is due to the application of fertilization in pot mixture soil which changes their concentration.

Conclusion

The data presented above brings out that the soils of Ropar and Garhshankar forest Division of Punjab is highly contaminated with heavy metals. The soil where drain water is used for irrigation has higher DTPA-extractable metals contents as compared to the canal irrigated area. The vegetables grown using this polluted water also have much higher concentration of heavy metals. From the above result, we know that the concentration of heavy metal is higher in planted and pot mixture soils as compared to Parent soil due to the application of fertilization which altered it concentration. The concentration of Chromium (Cr) is highest followed by Zinc (Zn) and Iron (Fe) in the Ropar and Garhshankar forest division of Punjab. The toxicity of soil and interaction between soil particles and nutrient is depends upon the form in which they exist in the environment 3. The most adverse effect of heavy metals is that they can be introduced into the food chain and threaten human health. Agricultural products growing on soils with high metal concentrations are represented by metal accumulations at levels harmful to human and animal health as well as to the bio-environment. High concentrations of heavy metals in soils around industrial facilities originate from an anthropogenic source which is associated with unrestrained solid release and untreated or poorly treated fluid wastes from these industrial facilities.

References

1. Adrino, D.C and Nriagu, J.O.1989, 1988. Trace elements in the terrestrial Environment; Springer, New York
2. Brady, N.C. 1996. *The Nature and Properties of Soils* (10th edn.). Prentice Hall of India Pvt. Ltd New Delhi
3. Dube, A., Zbytniewski, R., Kowalkowski, T., Cukrowska, E., Buszewski, B. 2001. Adsorption and migration of heavy metals in soil. A reviews, *polish journal of Environmental studies*. Vol 10(1) pp 1-10
4. Jackson, M.L. 1967. *Soil Chemical Analysis*. Prentice Hall India, New Delhi
5. McLaughlin,M.J; Parker, D.R.; Clarke, J.M.1999. Metals and micronutrients-Food safety issues; *Field crop res*. Vol 60 pp143-163

Instructions to Authors

Submission to the journal must comply with the Guidelines for Authors.

Non-compliant submission will be returned to the author for correction.

To access the online submission system and for the most up-to-date version of the Guide for Authors please visit:

http://www.rfppl.co.in

Technical problems or general questions on publishing with *IJPS* are supported by Red Flower Publication Pvt. Ltd's Author Support team (http://ww.rfppl.org)

Alternatively, please contact the Journal's Editorial Office for further assistance.

A Lal

Publication -in-Charge

Indian Journal of Plant and Soil

Red Flower Publication Pvt. Ltd.

48/41-42, DSIDC, Pocket-II

Mayur Vihar Phase-I

Delhi – 110 091

India

Phone: 91-11-22754205, 45796900, Fax: 91-11-22754205

E-mail: redflowerppl@gmail.com, redflowerppl@vsnl.net

Website: www.rfppl.co.in

Indian Journal of Plant and Soil
Volume 1 Number 2, July - December 2014

Original Article

Harvest Index in Productivity Management

V. Ranganathan

Author's Affiliation: *Consultant, IMT Technologies Ltd., Pune - 4, Maharashtra

Abstract

Optimum diversion oftotal Biomassmanufactured by plants to parts supporting economic end product is vital in commercial agriculture. The fraction of bio mass used for economic end product out of total biomass manufactured by the plants is termed as Harvest index Factors that decide optimization of Harvest index for maximizing productivity in terms of economic end product vary with crops and their relevance In Tea cultivation are brought out in this paper.The physiological concepts have helped Agronomist to formulate guide lines for managing Harvest in Tea culture

Keywords

Harvest index. Biomass apportioning, productivity

Introduction

Plant growth could be defined as the continual addition of biomass to various parts. It has two stages ;!) fixing carbon – photosynthesis and manufacture of carbohydrates, 11) conversion of them to various organic chemicals by fixing Nitrogen, Phosphorus, Sulfur, and Calcium in various bio-cycles controlled by specific enzymes and associated mineral nutrients Biomass production therefore is a function of 1) climate, defined in terms of rainfall, sun shine hours and temperatue,2) photo synthetic area expressed as leaf area index by Plant physiologist or as density of planting by Agronomist 3) nutrients for biomass production. and 4) soil factors for nutrient and water retentivity and release of them to plant growth.Bio-mass produced is used for overall growth of plants and only a fraction of it is harvested as economic end product. Agronomic and cultural practices are evolved over the years to ensure optimal diversion of total bio-mass manufactured by the plants to maximize harvest of economic end product for which a particular crop is grown. In this article the discussions are limited to Tea. The economic end product in Tea is the growing points and the harvest index aims in keeping the health of plant by balancing diversion of biomass to growing pointsagainst their continual removal as harvest and, to other parts for overall growth and enough retention of foliage for supporting new growing points.

Biomass apportioning in TEA

A typical apportioning of biomass in tea is given in Table-1

In young Tea before first prune ,the emphasis is on development of frame of the plants and hence harvest index is low as more biomass is needed for frame development. After the first prune when the plants are brought under regular plucking the harvest index is high. In tea,Harvest index is the fraction (expressed also as percentage) of total biomass produced in a given time that is plucked as crop to manufacture tea . The productivity in Tea could then be expressed as follows

"Productivity = MadeTea (kg ha^{-1} yr^{-1}) = Biomass produced (kg ha^{-1} yr^{-1}) * Harvest index"

Corresponding Author: V. Ranganathan
Retired Scientist, Block 12 Flat H1 Jains Green Acres
91 Dagra Road, Pallavaram, Chennai 600043, Tamil Nadu
E-mail: vedantarangan@yahoo.com

Table 1 : Apportioning of biomass to various parts in Tea

No.	Parts	Parts by weight as %			
		A	B	C	D
1	Plucks (made Tea)	12.5	8.0	20.0	22.0
2	Foliage on the bush	15.0	16.5	13.0	13.0
3	Fallen leaves (tea litters)	10.0	9.0	3.0	5.0
4	Wood(Stem ,Branches)	40.0	43.0	44.0	42.0
5	Roots	22,5	23.5	20.0	17.0
	Total	100.0	100.0	100.0	100.0

A,B – young tea prior to formative prune*MAGAMBO and OTHIENO 1977 Personal communication*
C,D – High yielding bushes in regular pluckingAnnual Reports UPASI TRI 1976-1986

Under unlimited supply of nutrients and good climatic condition which determine biomass production, the productivity depends on management of Harvest index Data of on crop removal, annual leaf fall, and pruning weights and root weights maintained in various nutrient trials over the years are used to study the influence of Harvest index on productivity .

Absolute/Physiological and Apparent Harvest index

Harvest index is the ratio of economic biomass to total biomass produced by the plant.IT is calculated based on total biomass produced and apportioned to all the parts of the plant including roots as show in Table 1 is called absolute Harvest index or the Physiological Harvest index. Digging the soil after pruning the plants to record root weight is laborious and carried out in limited measure to collect basic data on Harvest index. But it is easy to collect information on above ground parts at the time of pruning and it is done as a regular practice in experimental plots. Harvest index calculated based on total biomass content of above ground parts pruned is called Apparent harvest index. While interpreting and making decisions, one should keep in mind that the amount of biomass removed as prunings decrease as the pruning height increases (the pruning becomes lighter) and the values appear unrealistically high. However ,this index gives information on apportioning of biomass to growing points and non-photosynthetic parts . Wood portion removed at different degrees of severity of pruning are given and they can be used to get the absolute harvest index values Harvest index referred here afterwards in this article is apparent harvest index. Typical mean harvest index values observed in South India are shown in Table2 Generally the harvest index is low in the pruned year as more of biomass is utilized for developing new frame and foliage Harvest index is high in the second and third years of the pruning cycle and declines thereafterwards. Main reasons are ; 1) Accumulation of too much older foliage which and

Table 2 : Harvest Index (*under South Indian conditions)*

	particulars	$DM ha^{-1} yr^{-1}$	$MT ha^{-1} yr^{-1}$	HI %
PRUNED YEAR				
1	Rejuvenation Pruned	5.0	0.6	12.0
2	Hard &medium pruned	7.2	1.3	18.0
3	Light pruned, cut-across / skiffing	10.9	2.0	18.3
Other years				
4	2nd year of pruning cycle	13.9	3.6	25.8
5	3rd year of pruning cycle	13.2	3.8	28.8
6	4th year of pruning cycle	12.7	3.4	26.7
Whole cycle				
7	Hard & Medium pruned	47.0	12.1	25.7
8	Light pruned, cut-across / skiffing	50.7	12.8	25.3

HI- harvest index based on total biomass of above ground parts at the time of pruning
DM- Total dry matter : MT – Marketable Tea:*RANGANATHAN . V The PLANTERS' CHRONICLE MAY 1986: 174-181*

are less photo-synthetically active and use more carbohydrate than what they manufacture and, also physiologists have shown that foliage beyond a critical level enhances the diversion of biomass to non- photosynthetic parts particularly for thickening of wood and,2)the inefficient plucking due to in increase in the height of plucking surface,smallness of leaves and increased bhanjiness. Factors that have bearing on Harvest index are discussed below.

A: Pruning Cycle

The influence of length of pruning cycle is shown in Table3.

As 2nd and 3rd year fields have maximum Harvest index ,the pruning cycles are managed in such a way that the percentage of 2nd and 3rd year fields form bulk of tea area under plucking all the time

B: Plucking rounds

As plucking alone activates the buds in leaf axils below the point of plucking for future crop, the plucking interval in relation to growing conditions it plays an vital role in achieving optimum Harvest index as the growing point are stimulated by regular plucking it leads to continual syphoning of biomass to growing points. The intensity of plucking that is plucking above 90 % of pluckable shoots at the time of plucking ensures sustaining growing points at high levels. The impact of plucking rounds on Harvest Index is shown in Table4.

Longer intervals , at the outset ,may appear beneficial to increase leaf weight but actually after 10 to 12 days there is a gradual loss of weight of leaves as their photosynthetic efficiency falls and respiratory losses increase. A balance is struck for optimizing shoot weight and Harvest index and it is in between 7 and 10 days during growing season and 10 and 15 days during lean months .

Table 3 : Harvest index For the pruning cycle – influence of Type of prune

No.	Type of Prune	Length of cycle in years				
		2	3	4	5	6
1	Medium Prune	21.9	24.2	24.8	23.9	23.0
2	Light prune, cut across prunes	22.4	24.5	25.6	24.5	23.4

Harvest index (%) based on total biomass of above ground parts at the time of pruning

C: Style and standard of Plucking

There are two facets of plucking- what is taken away for manufacture and what is left behind for supporting future crop. The former is termed as 'Standard of plucking'- finemedium and coarse depending on the proportion of two leaf and a bud, three leaf and a bud, coarser than 3 leaf and a bud and banjhi leaves.The later is termed 'style of plucking', light, hard and combination of both of them and refers at what level the pluckings are done. The former is important for quality control and it is related to type of manufacture practiced. How style and standard of plucking affect the harvest index is shown in Table 5.

The light plucking is done over a fish leave or mother leaf from where the plucked leaf originated. Hard plucking refers to plucking over a scale leaf from where the mother leaf originated thus the style of plucking is related to the depth at which plucking is carried out. Light plucking ensures the health of tea bushes as adequate foliage is left on the surface to support future crop .If more foliage than what it is required to support the plucking points is left on the surface , then the biomass will be diverted to non-

Table 4 : Harvest index-influence of plucking interval

No.	Plucking Interval	Harvest Index(%)
1	9 days	22.0to 30.0
2	7 days	39.0

Harvest index (%) based on total biomass of above ground parts at the time of pruning

Table 5 : Harvest index-influence of Style and Standard of plucking

No.	Standard of plucking	Light Plucking A	Hard Plucking B	Combination A & B
1	Fine	25.0	35.0	32.0
2	Medium Plucking	23.0	33.0	30.0
3	Coarse Plucking	20.0	30.0	27.0

Harvest index (%) based on total biomass of above ground parts at the time of pruning

Table 6 : Optimal ratios of Biomass apportioned to various parts

No.	Ratio between	Ratio
1	Shoot :root	2.5 to 4.5 : 1
2	Wood : Maintenance Foliage	2.0 to 3.5 : 1
3	Maintenance Foliage : Harvested crop in a year	0.8 to 1.2 : 1
4	Non-photosynthetic Parts : Photosynthetic parts	1.5 to 4.0 : 1
5	Non-photosynthetic Parts :Maintenance foliage	2.5 to 4.5 : 1

Non-photosynthetic Parts - wood (Stem + branches) + roots
Photosynthetic parts –Foliage on the bush (Maintenance Foliage) + harvested crop (growing points)

photosynthetic parts which on long run become sinks for biomass at the cost of growing points resulting in reduction in Harvest index. On the other hand Hard plucking stimulates diversion of biomass to growing points bestowing positive effect on Harvest Index , But continual hard plucking weaken the bushes as enough biomass is not diverted for non - photosynthetic parts for their sustenance. Therefore, in practice, a balance is struck between harvesting and retention of optimum foliage on the surface for health of the bush and adequate photo synthetic surface to support the next generation of crop. It is achieved by adopting a system in which a combination of light and hard styles are followed depending on weather conditions ,i.e., Hard plucking during rush season when the growing conditions favors high rate of biomass production and light plucking during dry or lean months when the growth is slow.

D: Leaf Area Index

Optimal ratios exist between various parts o f a plant. They are divided mainly into two groups -non-photosynthetic and Photosynthetic ones The ratio between them is important as it decides the health of the plant and the harvest of the economic end product. In tea, the economic end product is the growing points–buds, one leaf and a bud, two leaf and a bud and three leaf and a bud. Biomass has to flowcontinually to growing points without affecting the supply to other parts for their specific activities. The ratios found in yielding Tea are given in Table 6.

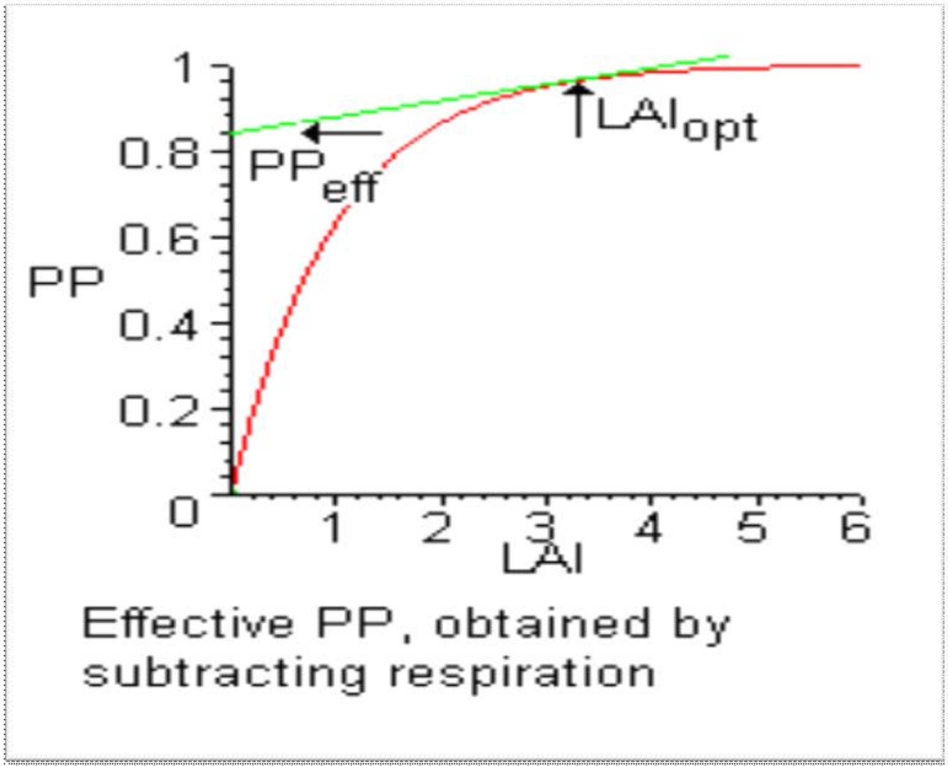
Roots act as sink for carbohydrates when the growing conditions are not favorable as in dry months This also helps in restoring growth rates when the conditions turn favorable for growth and also for recovery of bushes after the prune.Shoot- root ratio thus becomes important in storing and distributing carbohydrates to various parts for their sustained activities .

E: Physiological aspects

Metabolic and growth studies by Physiologists have shown that the net growth rate (or biomass accumulation) increases with leaf area index up to an optimal level and then decreases up to a ceiling value, after which there is a negative growth and debilitation starts.(Fig-1)

Increasing the leaf area index beyond an optimum limit increases the fattening of non-photosynthetic parts resulting in more respiratory losses of carbohydrates .In tea optimum yield occurs before optimal leaf area forhighest net growth rate is achieved. Any plucking policy in Tea culture should aim at keeping the leaf area index below the optimum

Fig. 1 : Leaf Area Index vs. primary product function the free encyclopedia Version ID: (641194753 2015 13:10 UTC)



required for getting highest net growth rate so as to ensure a constant demand for biomass for the new growing pointsactivated after each plucking. Light penetration depends on canopy architecture. Hence to maintain optimal growth rates ,a lower leaf area index is required for horizontal leaves (lower depth of maintenance foliage) and higher one for inclined and small leaves.

Summing Up

Harvest Index decides the productivity in terms of economic end product for which crops aregrown. In Tea culture, Harvest index is optimized by manipulating 1) pruning cycle between 3 and 4 years, plucking interval between 8 and 15 days depending on growing conditions, 3) combination of light and hard plucking for a given standard of plucking for a given type of manufacture, 4) intensive plucking (plucking all available shoots (above 90%) to a given standard and style of plucking employing adequate number of pluckers. A rigid control of plucking in all its' aspects is necessary to avoid addition of more than optimum foliage on the bush to eliminate the negative effect on Harvest index on the long run.

Acknowledgements

I acknowledge with gratitude to all mycolleagues who inspired me all through my career at UPASI Tea Research InstituteValparai , M/s Ram Bahadur Thakur Ltd., Cochin and IMT technologies Ltd., Pune. I, once again record the support of Dr. SS RANADE, Chairman and Managing Director Of IMT Technologies Ltd., Pune and late Mr. CB Sharma Chairman and Managing Director Of M/s Ram Bahadur Thakur Ltd., Cochin after my retirement for keeping me active in pursuing research.

References

1. AgnieszkaWnuk ,Andrzej G. Górny , Jan Bocianowski and, MarcinKozak , Visualizing harvest index in crops COMMUNICATIONS IN BIOMETRY AND CROP SCIENCE VOL. 8, NO. 2, 2013, PP. 48–59
2. Hay, R.K.M. (1995) *Harvest index: a review of its use in plant breeding and crop physiology.* Annals of Applied Biology, 126 (1). pp. 197-216.

3. Magambo, M.J.S. and Cannell, M.G.R. (1981): Dry matter production and partition in relation to yield of tea. Exptl. Agric. 17: 33-38.
4. Milthorpe F.L., Moorby J., An Introduction to Crop Physiology ; CAMBRIDGE University Press 1979, 2nd Edition.
5. Natesan.S and Ranganthan.V Content of various elements in different parts of the Tea plant and in infusions of black tea from Southern India J. Sci. Food Agric. 1950 51,125-139
6. Rahman, F., Partitioning of Assimilates and Productivity of Tea, Proceedings of the International Seminar on "Integrated Crop Management in Tea: Towards Higher Productivity" International Seminar of the Tea Research Institute and the International Potash Institute Colombo, Sri Lanka April, 26-27, 1994;224-234.
7. Ranganathan, V :Manuring Tea, IFA World fertilizer use manual: International Fertilizer Association, Paris. 1990;532-544.
8. Ranganathan.V, Raman. K, and Natesan.S Nutritional and Physiological interactions with length of plucking rounds and banjiness UPASI Tea SCI. Dept. Bull.1983 : 67-89.
9. Rebecca A. Reed, Mary Ellen Finley, William H. Romme, Monica G. Turner ,Aboveground Net Primary Production and Leaf-Area Index in Early Postfire Vegetation in Yellowstone National Park: Ecosystems, , Vol. 2, No. 1 (Jan. - Feb., 1999)Publ.Springer: pp. 88-94.

Indian Journal of Plant and Soil
Volume 1 Number 2, July - December 2014

Original Article

Role of Meteorological Models in Estimating Yield of Sugarcane Based on Weather Variables

***Rajeev Ranjan, **A.S. Nain**

Author's Affiliation: * Research Scholar, **Associate Professor, Dept. Of Agrometeorology, GBPUA&T., Pantnagar

Abstract

A field study was conducted at G.B.P.U.A.&T., Pantnagar to investigate the feasibility of estimating the yield of sugarcane crop based on weather variables. Five years (2004 to 2009) crop management data (sowing/harvest/irrigation etc.) for sugarcane were collected from Agricultural farm, Pantnagar. The development of multiple variable regression models employs that the dependent variable (yield) of multiyear is related with independent weather variables. SPSS (Statistical Package for the Social Sciences) software was used for the statistical analysis and development of multiple regression models based on fortnightly meteorological parameters. A total number of 8 models were developed using different combinations of fortnightly weather variables at different crop growth stages. Among all models, the performance of the model 8 was superior as compared to other models. The predicted yield by this model ranged between 349.39q ha-1 to 803.76q ha-1 with the value of R2 as 0.668, while the observed values ranged from 221.80q ha-1 to 824.16q ha-1. The RMSE between observed and predicted yield of sugarcane by model 8 was 15.49%, while the value of F test was 7.32 which is significant at 1% probability level. Hence, it can be concluded that the observed and predicted values were close enough in model 8 as compared to other meteorological models. The reason is obvious because model 8 used more number of weather variables.

Keywords

Weather parameters; Coefficient of correlation and Yield prediction models.

Introduction

Sugarcane (*Saccharum officinarum* L.) is a long duration tropical crop covering all the seasons' *viz., kharif,* rainy and *zaid* during its life cycle. A total of 1100mm-1500mm rainfall is adequate provided the distribution is right and abundant in the months of vegetative growth followed by a dry period for ripening. Optimum temperature for sprouting (germination) of stem cuttings is 32 to 38°C. Principal climatic components that control cane growth, yield and quality are temperature, light and moisture availability. Agriculture and climate are closely linked to crop growth, development and production[1] and is affected by both long term meteorological factors (the climate) and short term meteorological events (the weather). Forecasting of crop production is one of the most important aspects of agricultural statistics system. At present, yield forecasts are based on quite subjective estimates and the final crop production estimates based on objective crop cutting surveys become available long after the harvests. Crop weather models act as useful tools to predict crop yields in a vast country like India for planners and policy makers.[2] The weather parameters play an important role both in biology and control of pest.[3] There are numerous studies based on Fisher's (1924) techniques *viz.,* linear, curvilinear and multiple regression techniques for prediction of yield. The relationship between crop yields and weather parameters is generally carried out with the help of multiple regression models.[4] The production of crop and prediction of crop yields have direct impact on national and international economy and thus, play an important role in the food management.[5] Therefore, the present study was undertaken to

Corresponding Author: Ranjan Rajeev
Research Scholar, Dept. of Agrometeorology
GBPUA&T., Pantnagar
E-mail:rajeevranjanagri@gmail.com

investigate the feasibility of estimating yield of sugarcane crop based on weather variables.

Materials and Methods

Field study was conducted at H and I block of Agricultural Farm of G. B. Pant University of Agriculture and Technology, Pantnagar. Geographically, this centre is situated at 29°N latitude and 79.3°E longitude. The elevation of this place from mean sea level is 216 meters. The soil of the present experimental site belongs to Beni silty clay loam series. Plant and management data (sowing/harvest date/irrigation scheduling, etc.) related to sugarcane form the year 2004 to 2009 were collected from Agriculture Farm of G. B. Pant University of Agriculture and Technology, Pantnagar.

The daily weather data of crop seasons such as temperature, relative humidity, wind speed, bright sunshine hours, evaporation and rainfall used in the study as indicators in crop yield prediction and were collected for a period of five years (2004 to 2009) from the agrometeorological observatory located at Norman E Borlaug Crop Research Centre (NEB-CRC), G.B. Pant University of Agriculture and Technology, Pantnagar. The daily values of the meteorological parameters were converted in to the fortnightly weather data. These fortnightly weather variables were taken after six to seven months from the date of sowing. Number of fortnightly were varied (increase or decrease) because sowing dates of the sugarcane is not same in all the fields during the study period. This resulted into the varying crop duration of sugarcane in the different fields.

The two main factors affecting crop yield are inputs and weather. Use of these factors forms one class of models for forecasting crop yields. Weather plays a very important role in crop growth and development and hence, can be conveniently used as an indicator of change in the crop yield. Weather variables like rainfall, temperature, bright sunshine hours and relative humidity were used as indicators in the development of empirical statistical models using multiple linear regression techniques.[6-7] The development of multiple variable regression models employs that the dependent variable usually multiyear yield is related with the independent weather variables. Multiple regression models were developed with the help of SPSS software by using different sets of independent variables. The forward stepwise parameter selection approach was used which describes F range criteria. An example of multiple regression equation is given below.

$$\mathbf{Y = a + bx_1 + cx_2 + dx_3 + \ldots}$$

Where,

Y	= Crop yield (q ha^{-1})
a	= Multiple régression constant
b, c, d...	= Slope of the curve
x_1, x_2, x_3	= Average weather parameters.

Results and Discussion

Yield prediction of sugarcane

Each crop cultivar requires a set of weather conditions for its potential growth, development and finally economic yield. However, it may be noted that the variation in weather conditions introduce the year to year variability in yield. Sugarcane is a long duration crop which requires different types of weather conditions at its various phenophases. Even under optimum conditions small variations in weather influences growth and development of the crop. A total number of 8 models were developed using different combinations of meteorological parameters. All the models developed in the present study have been listed in Table 1.

Yield prediction of sugarcane: Model 1

Observed and predicted yield of sugarcane crop at H and I block of Agricultural Farm of G.B. Pant University of Agriculture and Technology is depicted in fig. 1. It was found that observed yield ranged from 221.80q ha-1 to 824.16q ha-1 and yield predicted by model 1 ranged from 457.02q ha-1 to 755.71q ha-1, respectively. The model 1 was developed using the weather variable wind speed of 13th fortnight from 6 to 7 month of sowing. Co-efficient of determination (R2=0.344) shows that about 34 per cent variability in yield of sugarcane may be addressed by the single weather variable of wind speed.

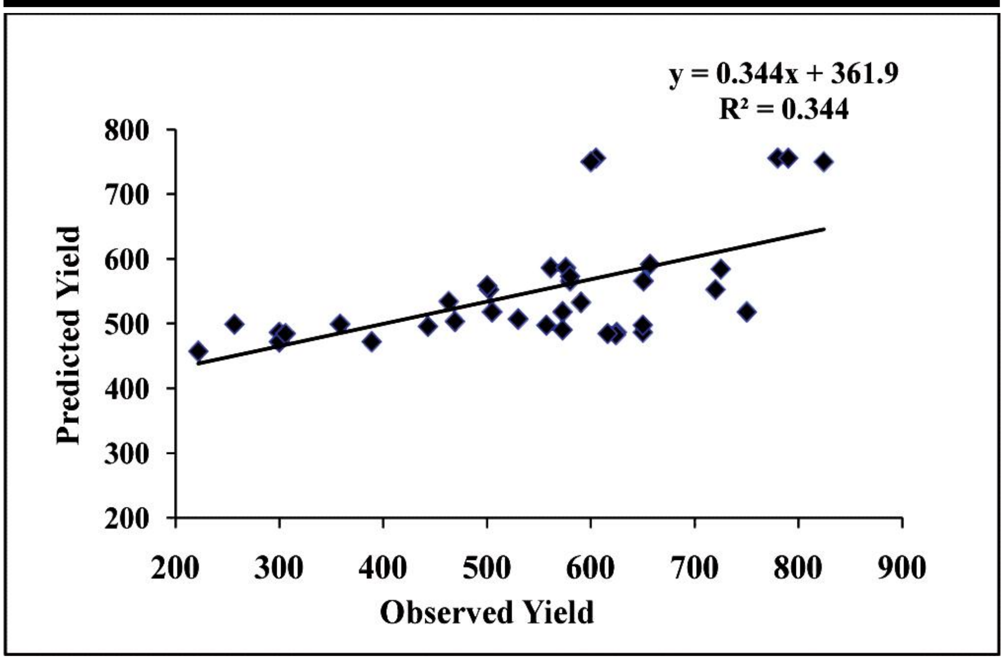
The RMSE (Root Mean Square Error) between observed and predicted sugarcane yield was 21.64 per cent while the value of F test was 18.91 which is significant at 1% probability level. Results show that wind speed is the most important factor in deciding sugarcane yield though it doesn’t influence directly. But indirectly it supplies CO2 which is an important gas required during photosynthesis. Wind increases the turbulence in atmosphere, thus increasing the supply of carbon dioxide to the plants resulting in higher photosynthetic process.[8]

Table 1 : Meteorological yield models of sugarcane crop based on fortnightly weather data

Model No.	Meteorological model equation	R^2
1	$Y = 401.708+36.875*(x_1)$	0.344
2	$Y = 523.577+39.524*(x_1)+(-24.5280)*(x_2)$	0.468
3	$Y = 438.79+41.767*(x_1)+(-19.234)*(x_2)+0.236*(x_3)$	0.515
4	$Y = 323.865+46.471*(x_1)+(-23.9150)*(x_2)+0.229*(x_3) +21.457*(x_4)$	0.544
5	$Y = 391.953+40.59*(x_1)+(-20.314)*(x_2)+0.3*(x_3)+43.693*(x_4)+(-66.977)*(x_5)$	0.586
6	$Y = 402.155+43.211*(x_1)+(-29.919)*(x_2)+0.41*(x_3)+ 51.274*(x_4) +(-109.027)*(x_5)+19.197*(x_6)$	0.620
7	$Y = 351.034+46.648*(x_1)+(-35.979)*(x_2)+0.418*(x_3)+ 54.718*(x_4) +(-100.479)*(x_5)+22.302*(x_6)+4.8*(x_7)$	0.648
8	$Y = -33.078+46.729*(x_1)+(-32.191)*(x_2)+0.549*(x_3)+58.828*(x_4) +(-156.253)*(x_5)+26.286*(x_6)+4.745*(x_7)+6.485*(x_8)$	0.668

Where, Y = Yield (q ha-1), X1 = Average wind speed of 13th fortnight, X2 = Average Bright Sunshine Hours (BSS) 1st fortnight, X3 = Sum of 2nd fortnight rainfall, X4 = Average Bright Sunshine Hours (BSS) 12th fortnight, X5 = Average evaporation of 6th fortnight, X6 = Average evaporation of 2nd fortnight, X7 = Sum of 11th fortnight rainfall and X8 = Average Relative Humidity of 6th fortnight.

Fig. 1 : Comparison between observed and predicted yield: Model 1



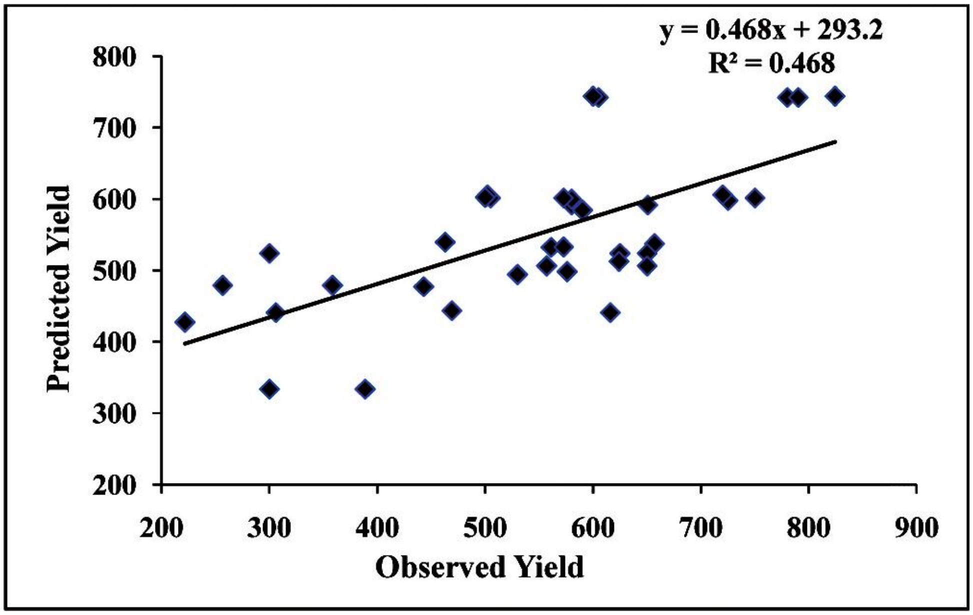
Yield prediction of sugarcane: Model 2

The comparison between observed and predicted yield of sugarcane crop by model 2 has been shown in fig. 2. The yield predicted by model 2 ranged from 333.77q ha-1 to 743.78q ha-1. The RMSE between observed and predicted sugarcane yield was 19.48 while the value of F-test was 15.45 per cent which is significant at 1% probability level. The value of co-efficient of determination (R2=0.468) shows that there is slight improvement in model performance. Higher value of R2 in model 2 reveals that BSS of 1st fortnight from 6 to 7 month of sowing is also a decisive factor in the final yield of sugarcane. The bright sunshine hours allows crop to participate in photosynthetic activities for a longer time. Sugarcane is a tropical plant and responds well to long period of sunlight (12 to 14 hours). A long and warm growing season with adequate long hours of bright sunshine permits rapid growth to build up adequate yield (more tonnage) and a ripening season of around 2-3 months duration having warm days, clear skies, cool nights and relatively a dry weather without rainfall for buildup of sugar are required.[9]

Yield prediction of sugarcane: Model 3

Fig. 3 shows the comparison between observed and predicted yield of sugarcane crop and it was found that yield predicted by model 3 ranged from 310.42q ha-1 to 746.81q ha-1, respectively. The RMSE between observed and predicted sugarcane yield was reported as18.60 per cent while the value of F-test was 12.07 which is significant at 1% level of probability. The value of co-efficient of determination was found to be 0.515 showing the improved performance of the model 3 over the previous two models. The additional parameter considered in model 3 in comparison to model 2 is rainfall, which shows that rainfall will significantly plays an important role in cane development and sugar production. During the active growth period rainfall encourages rapid cane growth, cane elongation and internode formation. Sugarcane is highly dependent on the availability of sufficient amounts of rainfall on a seasonal cycle of wet and dry periods. Without irrigation it grows best in regions with annual rainfall in the range of 1500-2500mm.[10]

Fig. 2 : Comparison between observed and predicted yield: Model 2



Yield prediction of sugarcane: Model 4

The predicted yields by model 4 ranged from 314.81q ha-1 to 770.93q ha-1, respectively. Fig. 4 shows the observed and predicted yield of the sugarcane crop by model 4. The RMSE between observed and predicted sugarcane yield was 18.04 per cent while the value of F-test was 9.85 which is significant at 1% probability level. R2 =0.544 shows that the inclusion of bright sunshine hours of 12th fortnight in the model improved accuracy of the yield prediction. Sugarcane is a sun loving plant and the plant thrives best in tropical hot sunny areas. Being a C4 plant, sugarcane is capable of high photosynthetic rates and the process shows a high saturation range with regards to light. Tillering is affected by intensity and duration of sunshine. High light intensity and long duration promote tillering while cloudy and short days affect it adversely. Stalk growth increases when daylight is within the range of 10-14 hours. Increase in leaf area index is rapid during 3rd to 5th month, coinciding the formative phase of the crop and attained its peak values during early grand growth phase.[11]

Yield prediction of sugarcane: Model 5

Fig.5 shows the comparison between observed and predicted yield of sugarcane crop by model 5. The predicted yields by model 5 ranged from 275.98q ha-1 to 755.28q ha-1, while, observed yield of sugarcane

Fig. 3 : Comparison between observed and predicted yield: Model 3

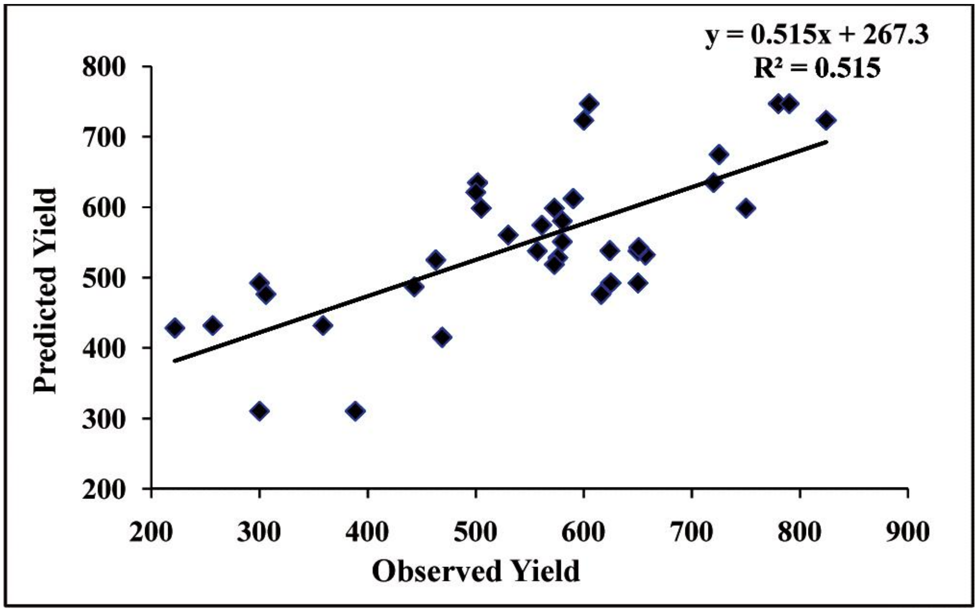
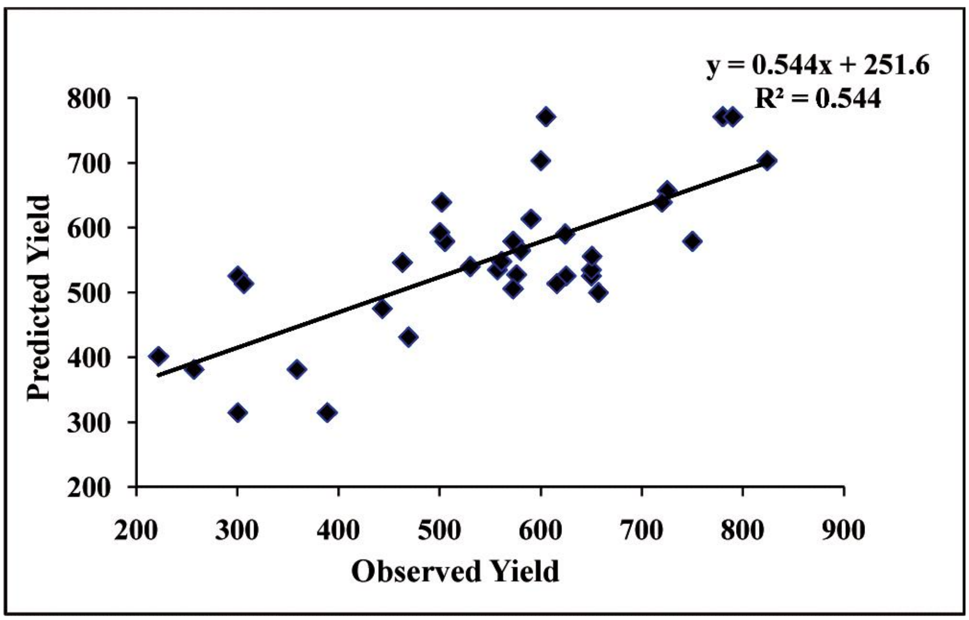


Fig. 4 : Comparison between observed and predicted yield: Model 4



was as discussed earlier. The RMSE between observed and predicted sugarcane yield reduced 17.18 per cent while the value of F-test was 9.09 which is significant at 1% probability level. The scatter plot between observed and predicted sugarcane yield produced R2 as 0.586, which shows that again there is slight improvement in the model accuracy over previous models, which can be attributed to the inclusion of evaporation of 6th fortnight from 6 to 7 month of sowing as independent weather variable. Evaporation does not influence the sugarcane yield directly however it shows the state of atmospheric conditions which will influence sugarcane yield. This stage (Boom stage) is the phase of maximum development in the sugarcane plant and is characterized by increases in stem size, weight and high leaf production. Evaporation at boom stage is the critical climatic factors affecting the variations in crop yield.[12]

Fig. 5 : Comparison between observed and predicted yield: Model 5

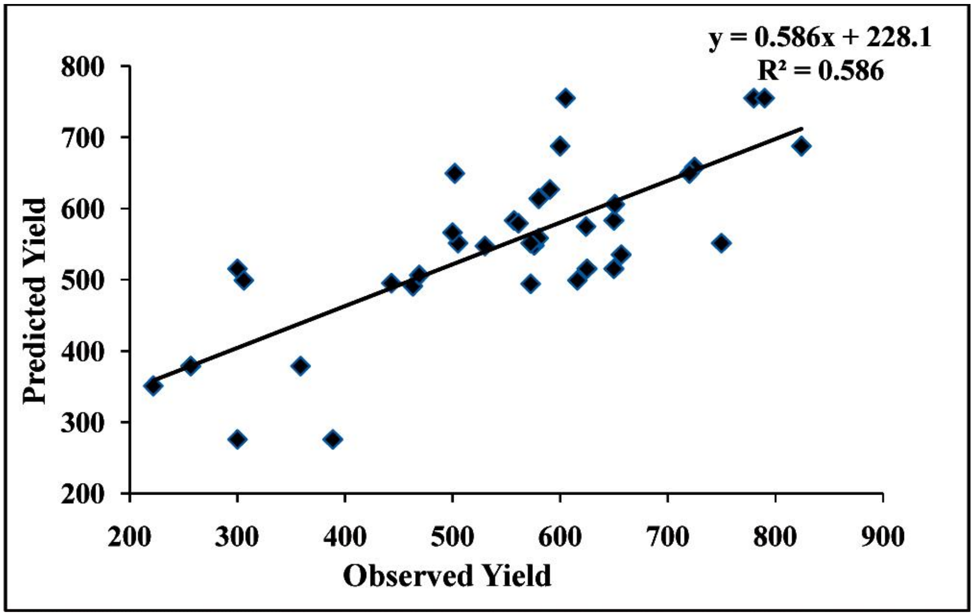
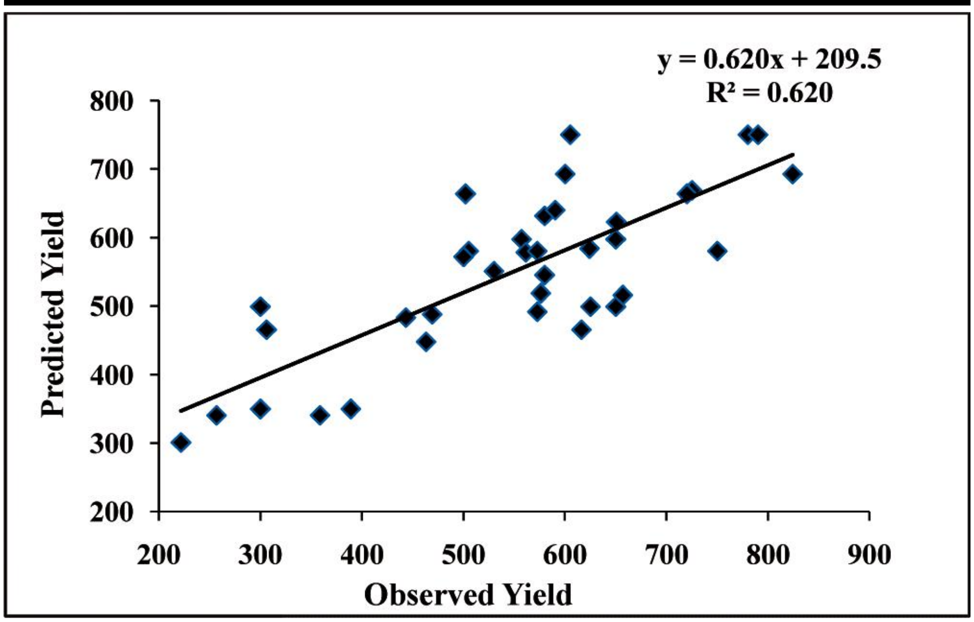


Fig. 6 : Comparison between observed and predicted yield: Model 6



Yield prediction of sugarcane: Model 6

The observed and predicted yields of sugarcane crop by model 6 have been depicted in figure 6. The predicted yield by model 6 ranged from 301.09q ha-1 to 750.18q ha-1. The RMSE between observed and predicted sugarcane yield was found to be16.46 per cent, while the value of F-test was 8.45 which is significant at 1% probability level. The value of co-efficient of determination (R2 = 0.620) shows that the evaporation of 2nd fortnight is also an important factor for the growth of crop. On inclusion of evaporation of 2nd fortnight in the forecast model, forecast accuracy significantly improved.

Yield prediction of sugarcane: Model 7

From the fig. 7 it was found that, there is close relationship between the values of observed and predicted yields of sugarcane crop by model 7. The

Fig. 7 : Comparison between observed and predicted yield: Model 7

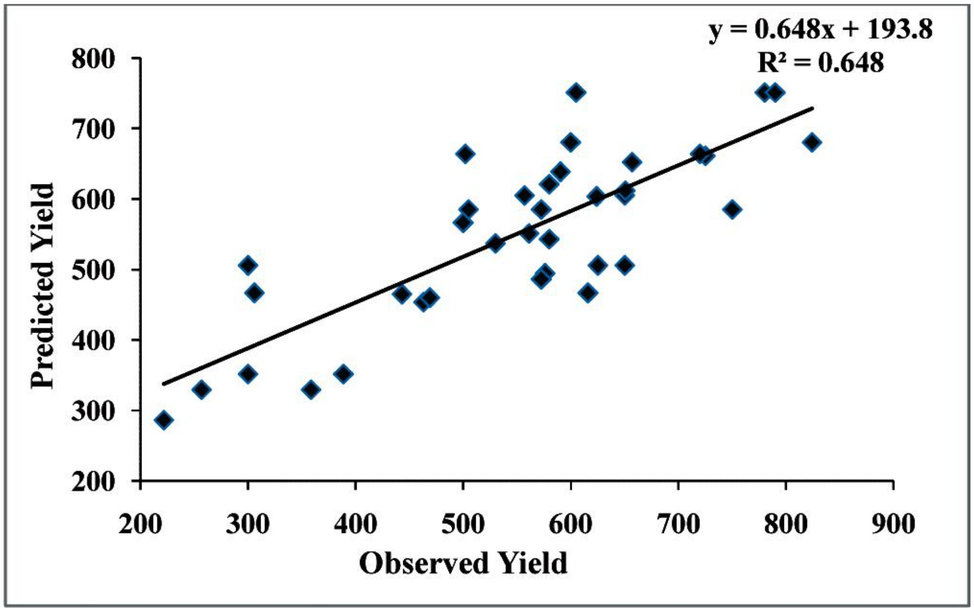
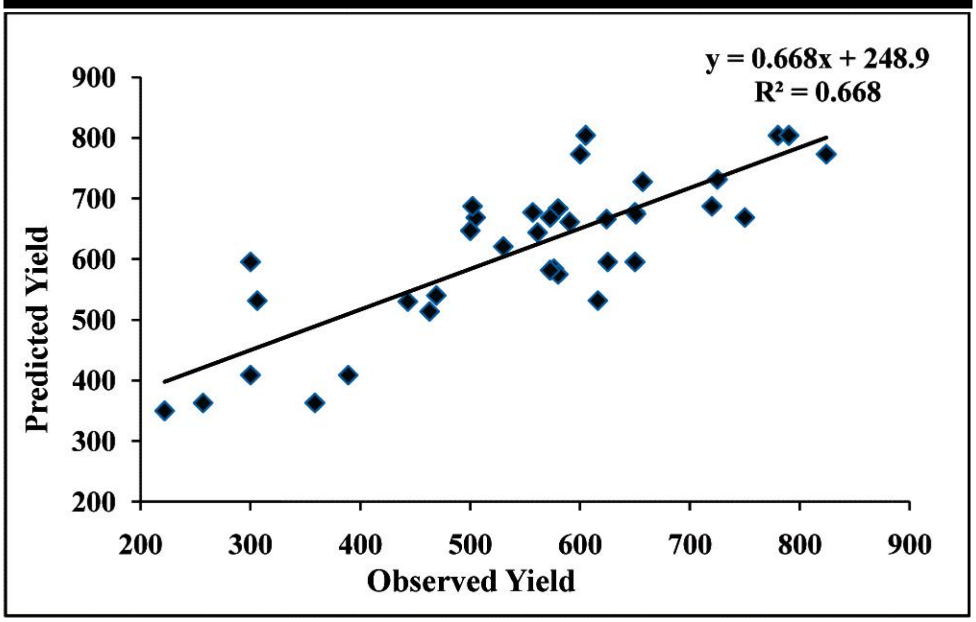


Fig. 8 : Comparison between observed and predicted yield: Model 8



predicted values of sugarcane yield by model 7 ranged from 286.44q ha-1 to 751.35q ha-1 with value of R2 as 0.648. The RMSE between observed and predicted sugarcane yield was reported as15.84 per cent, while the value of F-test was 7.92 (significant at 1% probability level). The addition of weather variable of rainfall of 11th fortnight significantly improved the model performance.

Yield prediction of sugarcane: Model 8

The comparison between the observed and predicted yields of sugarcane crop by model 8 has been depicted in fig. 8. It was found that yield predicted by model 8 ranged from 349.39q ha-1 to 803.76q ha-1. The RMSE between observed and predicted sugarcane yield reduced to 15.49 per cent while the value of F-test was 6.38 (significant at 1% probability level). Inclusion of relative humidity of 6th fortnight from 6 to 7 month after sowing increased the value of co-efficient of determination from 0.648 to 0.668, which is slightly better than the previous meteorological models. Therefore, it can be drawn from the results that the relative humidity of 6th fortnight is also an important weather variable in deciding the final yield of sugarcane in *Tarai* region. High humidities coupled with warm weather favours vegetative growth. Low environmental relative humidity levels can reflect a high vapor pressure deficit (VPD) which directly affects stomatal behavior and transpiration rates. High vapor pressure deficits initially induce high transpiration rates in plants causing them to lose water and turgor and in later stages may result in closure of the stomata and a reduction in the transpiration stream.[13-14-15]

Conclusion

A high degree of variability in the sugarcane yield prediction was observed as shown by the observed yields. Among all models, the performance of the model 8 was superior as compared to other models. The reason is obvious as model 8 incorporated more number of weather variables. These weather variables directly and indirectly affect the growth and development of sugarcane plant. Among all the wind speed of 13th fortnight was most important weather parameter influencing the sugarcane yield in *Tarai* region of Uttarakhand.

References

1. Fisher RA. The influence of rainfall on the yield of wheat at Rothamsted Roy Soc., London. Phil. Trans. Ser. B. 1924; 213: 89-142.
2. Varmora SL, Dixit SK, Patel JS, Bhatt HM. Forecasting of wheat yield on the basis of weather variables. J. Agrometorol. 2004; 6: 223-28.
3. Rao V, singh R, Singh D, Sharma PD, Bhan SC. *Helicoverpa armigera*-weather relationship studies in cotton at Hisar. J. Agrometeorol. Special Issue. 2004; 6: 120-23.
4. Dubey RC, Chodhary A, Kale JD. The estimation of cotton yield based on weather parameters in Maharashtra. Mausam. 1995; 46: 275-78
5. Hayes MJ, Decker WL. Using NOAA AVHRR data to estimate maize production in the United States Corn Belt. Int. J. Remote Sens. 1996; 17: 3189-3200.
6. Saha SK. IMD achievements and plans on the area of empirical crop weather modelling, crop yield forecasting & crop weather relationship. Proceedings of the national workshop on dynamic crop simulation modelling for Agrometeorological advisory services held at New Delhi. 1999; 271-284.
7. Vyas P, Patel JH, Rajak DR, Bhagia N . Relation of wheat yield in India to fortnightly average temperature. Int. J. Tropical Agric. 1999; 17 (1-4): 77-82.
8. TNAU AGRITECH PORTEL. Agrometeorology: Wind and Plant Growth; www.flickr.com/ www.ikisan.com/crop specific/eng/links/ ap_sugarcaneSoil and Climate.shtml.
9. www.laspilitas.com
10. Doorenbos J, Kassam AH. Efeito da agua no rendimento das culturas (*FAO. Irrigacao e Drenagem, 33*), FAO, Roma; 1979.
11. Ramanujam T, Venkataramana S. Radiation interception and utilization at different growth stages of sugarcane and their influence on yield. Ind. J. Plant Physiol. 1999; 4: 85-89.
12. Binbol NL, Adebayo AA, Kwon-Ndung EH. Influence of climatic factors on the growth and yield of sugar cane at Numan, Nigeria. Clim Res. 2006; 32: 247-252.
13. Sheriff DW. The effect of humidity on water uptake by, and viscous flow resistance of excised leaves of a number of species: Physiologicai and anatomical observations. J. Experimental Botany. 1977; 28: 1399-1407.
14. Nonami H, Schulze ED, Ziegler H. Mechanimis of stomatal movement in response to air humidity, irradiance and xylem water potential. Planta. 1990; 183: 57-64.
15. Assmann SM, Gershenson A. The kinetics of stomatal response to VPD in *Vicia faba*: electrophysioiogical and water relations models. Plant Cell and Env. 1991; 14: 455-465.

Indian Journal of Plant and Soil
Volume 1 Number 2, July - December 2014

Original Article

Production of Rose and Marigold Flower in Allahabad City

Nimisha Suryavanshi*, Dr. Razia Parvez**

Author's Affiliation: Research Scholar*, Associate Professor**, Department of Family Resource Management Ethelind School of Home Science, Sam Higginbottom Institute of Agriculture, Technology and Science, Allahabad 211007

Abstract

This topic describes the production of rose and marigold flower in Allahabad city. We have some data which are collected by survey and presented here by table and graph in part of result and discussion. This topic explain the commercial activity of production and marketing of floriculture products is also a source of gainful and quality employment to scores of people The harvesting processes of these crops are very drudgery prone. India being an agricultural country, where majority live in the rural areas, both men and women work very hard in the fields. The harvesting of rose comes under the severe drudgery prone activity (Ergonomic practices, 2003).Marigold is an annual flower plant. The harvesting of the Marigold flower is considered as the severe most drudgery prone activity (Ergonomic practices, 2003) where women have to keep their posture in bending position from the back facing the ground for the harvesting of flowers found that rose and marigold are the main cash crops of Allahabad that involves farmers at great number.

Keywords

Floriculture; Buds; Commercial; Agro-climate; Entrepreneurial; Drudgery; Rose; Marigold.

Introduction

India has a long tradition of floriculture. Appreciation of the potential of commercial floriculture has resulted in the blossoming of this field into a viable agri-business option. Availability of natural resources like diverse agro-climatic conditions permit production of a wide range of temperate and tropical flowers, almost all through the year in some part of the country or other. Improved communication facilities have increased their availability in every part of the country. The commercial activity of production and marketing of floriculture products is also a source of gainful and quality employment to scores of people.

Farmer involved into floriculture get very high entrepreneurial opportunities but, so far has found that rose and marigold are the main cash crops of Allahabad that involves farmers at great number. The harvesting processes of these crops are very drudgery prone. India being an agricultural country, where majority live in the rural areas, both men and women work very hard in the fields. The present study will be taken in Allahabad's rural areas where the women are engaged in harvesting of Roses and Marigolds. These two flowers- Rose and Marigold are very much in demand in Allahabad. Harvesting of these is a very drudgery prone activity for the rural women because Rose thorns make them bleed from their hands and over all body and their dress get torn. At the time of harvesting of Marigold, women feel pain in their backbone, thighs, and legs, neck etc. because

Corresponding Author: Nimisha Suryavanshi
Department of Family Resource Management
Ethelind School of Home Science, Sam Higginbottom Institute of Agriculture, Technology and Science, Allahabad 211007
E mail: suryavanshi_59@yahoo.co.in

bending during harvesting causes pain. These are major drudgeries of harvesting the Rose and Marigold for these rural women. These two flowers are planted frequently because Allahabad is a Holy and Religious city. Here every day in all the temples people use the flowers for worship God as well as the Dhoopbatti and Agarbatti sticks also used in temple which has fragrance and these two flowers are being used especially for fragrance. Rose and Marigold are cash crops in Allahabad city.

Rose is planted commercially by women in Allahabad city and nearby areas. The women are facing lot of difficulties in the cultivation of rose flowers. Rose thorns keep hurting them to their hands and other parts of body (that are in the contact with thorns) start bleeding and their clothes get thorn as well. Rose is grown in the city of Allahabad throughout the year. The Farm women have to harvest rose flower in standing posture by hand and collect them in a cloth wrapped around the waist, which result in decreasing the commercial value of flowers.

The harvesting of rose comes under the severe drudgery prone activity (Ergonomic practices, 2003).

Marigold is an annual flower plant. The harvesting of the Marigold flower is considered as the severe most drudgery prone activity (Ergonomic practices, 2003) where women have to keep their posture in bending position from the back facing the ground for the harvesting of flowers. It leads them to severe pain in their backbone, leg, and thigh and feet etc. To reduce such problems, the 'hybrid variety of tall plant' of Marigold as well as rose can help reduce or completely abandon the bending position of women while the harvesting process goes on.

Objective

The major objective of the study is to know number of harvesters in block Chaka of Allahabad city.

To know the income which comes from production of rose and marigold?

Methodology

The research procedure and technique used in arriving at

(i) Location of the study:-

- District -Allahabad,
- Block- Chaka,
- Villages of Block Chaka

(ii) Sampling Procedure:- Sample selection and size –A sample of 106 farmer, 53 from each harvesting of Rose and Marigold respectively will be selected for the study.

A village inventory and interview schedule will be developed and administered with the BDO, Sabhapati and farm women respectively.

iii) Tools for the data collection: - The following tools will be selected for the data collection:

(A) Interview schedule:

An interview schedule will be prepared to know the income of village by production of rose and marigold as well as got the information of male and female harvesters in selected area.

Table 1 : Flower's Incomes on Village

Flower	Income	Percentage
Rose	10,000	71.43%
Marigold	4000	28.57%
Total	14,000	100%

According to the table 3 of the study I got the information that the village earns approximately every month, 10,000rs by rose and 4000 by the marigold .The reason of this result is the production of rose is more than marigold.

Fig. 1 : Flower's Incomes on Village

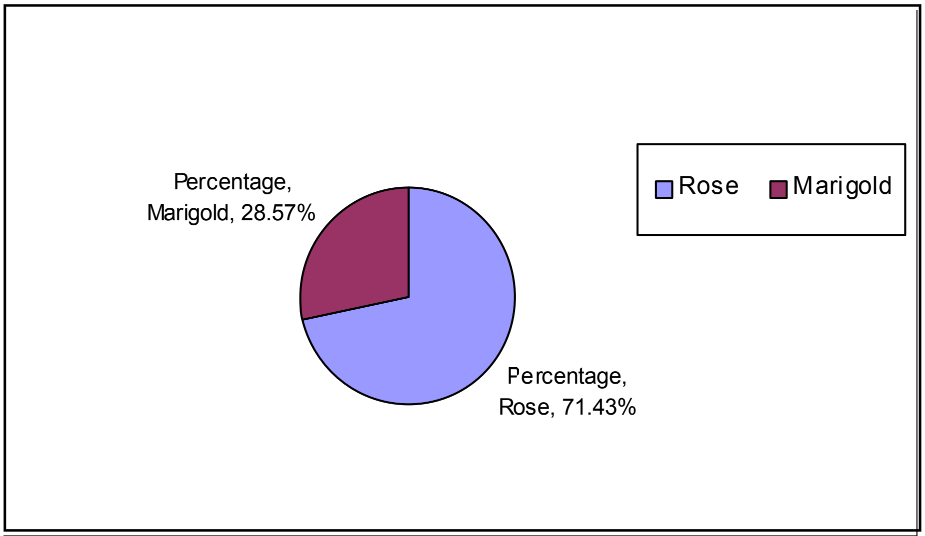


Fig. 2 : Labour involved in harveting of flower

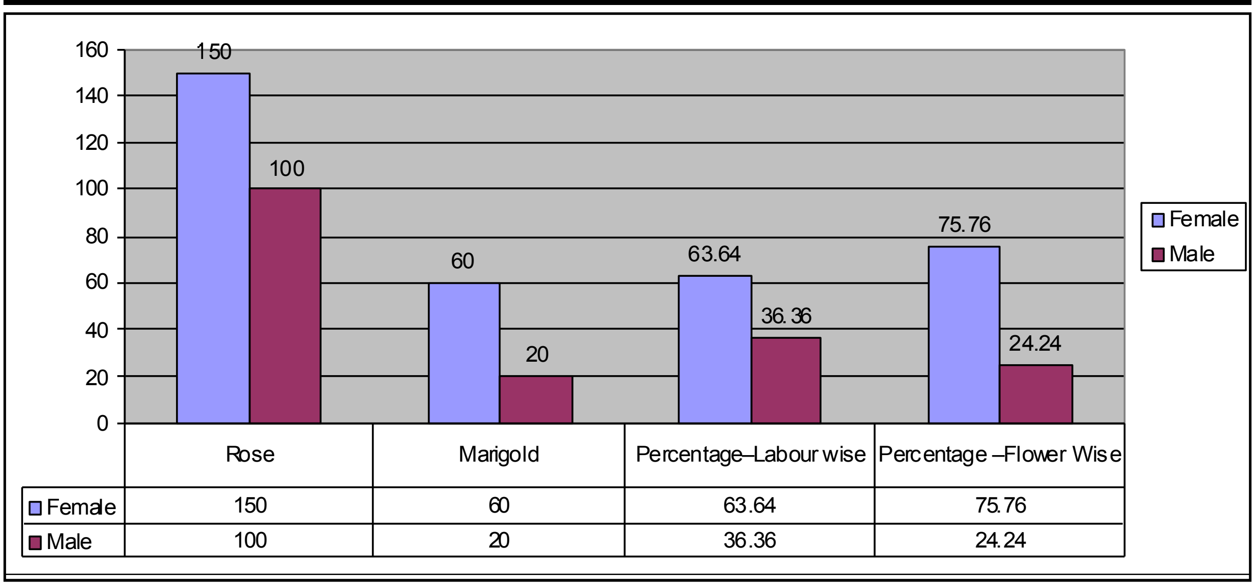


Table 2 : Labour involved in harveting of flower

Labour	Rose	Marigold	total	Percentage–Labour wise
Female	150	60	210	63.64 %
Male	100	20	120	36.36%
Total	250	80	330	100%
Percentage Flower Wise	75.76%	24.24%		100%

According to the study for rose harvesting 150 women and 100 men works and for marigold 60 women and 20 men works for marigold harvesting. Total 330 harvesters work for these flowers in which for study we select only 53 male and 53 female harvesters.

Table 3 : Type Of Flower Which Is Demanding

Type Of Flower	Flower Production GSR Analysis			
	Rose -area (%)	Rose (per kg. rate)	Marigold -Area (%)	Marigold (per kg. rate)
Cut Flower	50%	Rs. 180/	65%	Rs. 60/
Buds	35%	Rs. 16-20/- each	10%	Rs. 50/
Loose Flower	15%	Rs. 60/	25%	Rs. 35/

According to this table 4 of the study I got that 50%rose cut flower in market yet 65%maigold ,35%buds of roses available in market and marigold is only 10%,15%loose flower but marigold 25%. If talk its price the cut flower of rose is they sale in 180rs. / kg. While 60rs./kg. of marigold and buds of rose sale in 16-20 each yet 50 rs /kg. and loose flower in 60rs./ kg of rose in compeer of 35rs.of /kg of marigold. This data has been collected from market of Allahabad city. In village people work for only desi breed of both flowers means they sale only buds and loose flowers, the cut flower are comes from other areas of city.

Conclusion

This paper has been show that rose is costly flower then marigold and 210 female harvesters are working in compare of only 120 male for both flowers but in the research area famers use desi verities and are not able to sale cut flowers, they sale only buds and loose flowers in Allahabad market. There is need of awareness about different hybrid verities of both flowers for farmer's better income.

References

1. Gite L. P. Isometric strength of Women Agricultural Workers in Central India, Development in Agriculture and Industrial Ergonomics, volume II, Women at work, allied publisher Pvt. Ltd. Pg. 81 to 85 2007
2. Haslkar Musculoskeletal disorder of the farm women while performing top dressing and fertilizer activity Journal of Human Ecology, 212:109-112 2007
3. Jatinder K Cutting and Uprooting Tasks of Hil Women Some Solutions, evelopment in Agriculture and Industrial Ergonomics, volume II, Women at work, allied publisher Pvt. Ltd. Pg. 81 to 85. 2007
4. Honarvar, M. Khosh-Khui, M. Javidnia, K Effect of some factors on quantity and composition of flower essential oil in Damask rose. Acta Horticulturae. 870, 249-254. 13 ref. Journal article. Conference paper. 2010
5. Tixier, P. Salmon, F. Bugaud, C. Green-life of pink banana *Musa* spp., cv. Figure Rose Naine: determination of the optimum harvesting date. Journal of Horticultural Science and Biotechnology. 85: 3, 167-170. 13 ref. Journal article 2010
6. Yilmaz, D. Ekinci, K. Dilmacunal, T. Erbas, S.. Effect of harvesting hour on some physical and mechanical properties of *Rosa damascena* Mill. Journal of the Science of Food and Agriculture; 91: 9, 1585-1590. 22 ref. Journal article 2011
7. Kohan, A. Borghaee, A. M. Yazdi, M. Minaei, S. Sheykhdavudi, M. J. Robotic harvesting of Rosa Damascena using stereoscopic machine vision. World Applied Sciences Journal; 12: 2, 231-237. 15 ref. Journal article 2011)
8. Dobreva, A. Kovatcheva, N. Astatkie, T. Zheljazkov, V. D. Improvement of essential oil yield of oil-bearing *Rosa damascena* Mill.) due to surfactant and maceration. Industrial Crops and Products. 34: 3, 1649-1651. Journal article 2011)
9. Gupta, Y. C. Gupta, R. K. Moona Dhiman, S. R Stability analysis of different biostimulant applications to flowering characters of rose *Rosa hybrida*) cultivar First Red. Indian Journal of Agricultural Sciences. 82: 2, 106-111. 13 ref. Journal article 2012
10. Rusanov, K. Kovacheva, N. Rusanova, M. Atanassov, I. Reducing methyl eugenol content in *Rosa damascena Mill*rose oil by changing the traditional rose flower harvesting practices. European Food Research and Technology; 234: 5, 921-926. 25 ref. Journal article 2012
11. http://www.gardenguides.com/117401-marigold-flowers.html
12. http://www.agricultureguide.org/planning-harvest-for-roses/
13. www.fragrantica.com/perf http ume/Givenchy/Harvest-2009-Very-Irresistible-Rose-Centifolia-8309.html

Manuscripts must be prepared in accordance with "Uniform requirements for Manuscripts submitted to Biomedical Journal" developed by international committee of medical Journal Editors.

Types of Manuscripts and Limits

Original articles: Up to 3000 words excluding references and abstract and up to 10 references.

Original articles: Up to 2500 words excluding references and abstract and up to 10 references.

Case reports: Up to 1000 words excluding references and abstract and up to 10 references.

Online Submission of the Manuscripts

Articles can also be submitted online from http://www.rfppl.com (currently send your articles through e-mail attachments)

I) First Page File: Prepare the title page, covering letter, acknowledgement, etc. using a word processor program. All information which can reveal your identity should be here. use text/rtf/doc/PDF files. Do not zip the files.

2) Article file: The main text of the article, beginning from Abstract till References (including tables) should be in this file. Do not include any information (such as acknowledgement, your name in page headers, etc.) in this file. Use text/rtf/doc/PDF files. Do not zip the files. Limit the file size to 400 kb. Do not incorporate images in the file. If file size is large, graphs can be submitted as images separately without incorporating them in the article file to reduce the size of the file.

3) Images: Submit good quality color images. Each image should be less than 100 kb in size. Size of the image can be reduced by decreasing the actual height and width of the images (keep up to 400 pixels or 3 inches). All image formats (jpeg, tiff, gif, bmp, png, eps etc.) are acceptable; jpeg is most suitable.

Legends: Legends for the figures/images should be included at the end of the article file.

If the manuscript is submitted online, the contributors' form and copyright transfer form has to be submitted in original with the signatures of all the contributors within two weeks from submission. Hard copies of the images (3 sets), for articles submitted online, should be sent to the journal office at the time of submission of a revised manuscript. Editorial office: **Red Flower Publication Pvt. Ltd., 48/41-42, DSIDC, Pocket-II, Mayur Vihar Phase-I, Delhi – 110 091, India, Phone: 91-11-22754205, 45796900, Fax: 91-11-22754205, E-mail: redflowerppl@vsnl.net. Website: www.rfppl.co.in**

Preparation of the Manuscript

The text of observational and experimental articles should be divided into sections with the headings: Introduction, Methods, Results, Discussion, References, Tables, Figures, Figure legends, and Acknowledgment. Do not make subheadings in these sections.

Title Page

The title page should carry

1) Type of manuscript (e.g. Original article, Review article, Case Report)
2) The title of the article, which should be concise, but informative;
3) Running title or short title not more than 50 characters;
4) The name by which each contributor is known (Last name, First name and initials of middle name), with his or her highest academic degree(s) and institutional affiliation;
5) The name of the department(s) and institution(s) to which the work should be attributed;
6) The name, address, phone numbers, facsimile numbers and e-mail address of the contributor responsible for correspondence about the manuscript;
7) The total number of pages, total number of photographs and word counts separately for abstract and for the text (excluding the references and abstract);
8) Source(s) of support in the form of grants, equipment, drugs, or all of these;
9) Acknowledgement, if any; and
l0) If the manuscript was presented as part at a meeting, the organization, place, and exact date on which it was read.

Abstract Page

The second page should carry the full title of the manuscript and an abstract (of no more than 150 words for case reports, brief reports and 250 words for original articles). The abstract should be structured and state the Context (Background), Aims, Settings and Design, Methods and Material, Statistical analysis used, Results and Conclusions. Below the abstract should provide 3 to 10 keywords.

Introduction

State the background of the study and purpose of thestudy and summarize the rationale for the study or observation.

Methods

The methods section should include only information that was available at the time the plan or protocol for the study was written such as study approach, design, type of sample, sample size, sampling technique, setting of the study, description of data collection tools and methods; all information obtained during the conduct of the study belongs in the Results section.

Reports of randomized clinical trials should be based on the CONSORT Statement (http://www. consort-statement. org). When reporting experiments on human subjects, indicate whether the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional or regional) and with the Helsinki Declaration of 1975, as revised in 2000 (available at http://www.wma.net/e/policy/l 7-c_e.html).

Results

Present your results in logical sequence in the text, tables, and illustrations, giving the main or most important findings first. Do not repeat in the text all the data in the tables or illustrations; emphasize or summarize only important observations. Extra or supplementary materials and technical details can be placed in an appendix where it will be accessible but will not interrupt the flow of the text; alternatively, it can be published only in the electronic version of the journal.

Discussion

Include summary of key findings (primary outcome measures, secondary outcome measures, results as they relate to a prior hypothesis); Strengths and limitations of the study (study question, study design, data collection, analysis and interpretation); Interpretation and implications in the context of the totality of evidence (is there a systematic review to refer to, if not, could one be reasonably done here and now?, what this study adds to the available evidence, effects on patient care and health policy, possible mechanisms); Controversies raised by this study; and Future research directions (for this particular research collaboration, underlying mechanisms, clinical research). Do not repeat in detail data or other material given in the Introduction or the Results section.

References

List references in alphabetical order. Each listed reference should be cited in text (not in alphabetic order), and each text citation should be listed in the References section. Identify references in text, tables, and legends by Arabic numerals in square bracket (e.g. [10]). Please refer to ICMJE Guidelines (http://www.nlm.nih.gov/bsd/uniform_requirements.html) for more examples.

Standard journal article

[1] Flink H, Tegelberg Å, Thörn M, Lagerlöf F. Effect of oral iron supplementation on unstimulated salivary flow rate: A randomized, double-blind, placebo-controlled trial. J Oral Pathol Med 2006;35:540-7.

[2] Twetman S, Axelsson S, Dahlgren H, Holm AK, Källestål C, Lagerlöf F, et al. Caries-preventive effect of fluoride toothpaste: A systematic review. Acta Odontol Scand 2003;61:347-55.

Article in supplement or special issue

[3] Fleischer W, Reimer K. Povidone iodine antisepsis. State of the art. Dermatology 1997;195 Suppl 2:3-9.

Corporate (collective) author

[4] American Academy of Periodontology. Sonic and ultrasonic scalers in periodontics. J Periodontol 2000;71:1792-801.

Unpublished article

[5] Garoushi S, Lassila LV, Tezvergil A, Vallittu PK. Static and fatigue compression test for particulate filler composite resin with fiber-reinforced composite substructure. Dent Mater 2006.

Personal author(s)

[6] Hosmer D, Lemeshow S. Applied logistic regression, 2nd edn. New York: Wiley-Interscience; 2000.

Chapter in book

[7] Nauntofte B, Tenovuo J, Lagerlöf F. Secretion and composition of saliva. In: Fejerskov O, Kidd EAM, editors. Dental caries: The disease and its clinical management. Oxford: Blackwell Munksgaard; 2003. p. 7-27.

No author given

[8] World Health Organization. Oral health surveys - basic methods, 4th edn. Geneva: World Health Organization; 1997.

Reference from electronic media

[9] National Statistics Online—Trends in suicide by method in England and Wales, 1979-2001. www.statistics.gov.uk/downloads/theme_health/HSQ 20.pdf (accessed Jan 24, 2005): 7-18. Only verified references against the original documents should be cited. Authors are responsible for the accuracy and completeness of their references and for correct text citation. The number of reference should be kept limited to 20 in case of major communications and 10 for short communications.

More information about other reference types is available at www.nlm.nih.gov/bsd/uniform_ requirements.html, but observes some minor deviations (no full stop after journal title, no issue or date after volume, etc).

Tables

Tables should be self-explanatory and should not duplicate textual material.

Tables with more than 10 columns and 25 rows are not acceptable.

Number tables, in Arabic numerals, consecutively in the order of their first citation in the text and supply a brief title for each.

Explain in footnotes all non-standard abbreviations that are used in each table.

For footnotes use the following symbols, in this sequence: *, ¶, †, ‡‡,

Illustrations (Figures)

Graphics files are welcome if supplied as Tiff, EPS, or PowerPoint files of minimum 1200x1600 pixel size. The minimum line weight for line art is 0.5 point for optimal printing.

When possible, please place symbol legends below the figure instead of to the side.

Original color figures can be printed in color at the editor's and publisher's discretion provided the author agrees to pay

Type or print out legends (maximum 40 words, excluding the credit line) for illustrations using double spacing, with Arabic numerals corresponding to the illustrations.

Sending a revised manuscript

While submitting a revised manuscript, contributors are requested to include, along with single copy of the final revised manuscript, a photocopy of the revised manuscript with the changes underlined in red and copy of the comments with the point to point clarification to each comment. The manuscript number should be written on each of these documents. If the manuscript is submitted online, the contributors' form and copyright transfer form has to be submitted in original with the signatures of all the contributors within two weeks of submission. Hard copies of images should be sent to the office of the journal. There is no need to send printed manuscript for articles submitted online.

Reprints

Journal provides no free printed reprints, however a author copy is sent to the main author and additional copies are available on payment (ask to the journal office).

Copyrights

The whole of the literary matter in the journal is copyright and cannot be reproduced without the written permission.

Declaration

A declaration should be submitted stating that the manuscript represents valid work and that neither this manuscript nor one with substantially similar content under the present authorship has been published or is being considered for publication elsewhere and the authorship of this article will not be contested by any one whose name (s) is/are not listed here, and that the order of authorship as placed in the manuscript is final and accepted by the co-authors. Declarations should be signed by all the authors in the order in which they are mentioned in the original manuscript. Matters appearing in the Journal are covered by copyright but no objection will be made to their reproduction provided permission is obtained from the Editor prior to publication and due acknowledgment of the source is made.

Abbreviations

Standard abbreviations should be used and be spelt out when first used in the text. Abbreviations should not be used in the title or abstract.

Checklist

- Manuscript Title
- Covering letter: Signed by all contributors
- Previous publication/ presentations mentioned Source of funding mentioned
- Conflicts of interest disclosed

Authors

- Middle name initials provided.
- Author for correspondence, with e-mail address provided.
- Number of contributors restricted as per the instructions
- Identity not revealed in paper except title page (e.g. name of the institute in Methods, citing previous study as 'our study')

Presentation and Format

- Double spacing
- Margins 2.5 cm from all four sides
- Title page contains all the desired information. Running title provided (not more than 50 characters)
- Abstract page contains the full title of the manuscript
- Abstract provided: Structured abstract provided for an original article.
- Key words provided (three or more)
- Introduction of 75-100 words
- Headings in title case (not ALL CAPITALS). References cited in square brackets
- References according to the journal's instructions

Language and grammar

- Uniformly American English
- Abbreviations spelt out in full for the first time. Numerals from 1 to l0 spelt out
- Numerals at the beginning of the sentence spelt out

Tables and figures

- No repetition of data in tables and graphs and in text.
- Actual numbers from which graphs drawn, provided.
- Figures necessary and of good quality (color)
- Table and figure numbers in Arabic letters (not Roman).
- Labels pasted on back of the photographs (no names written)
- Figure legends provided (not more than 40 words)
- Patients' privacy maintained, (if not permission taken)
- Credit note for borrowed figures/tables provided
- Manuscript provided on a CDROM (with double spacing)

Submitting the Manuscript

- Is the journal editor's contact information current?
- Is a cover letter included with the manuscript? Does the letter

1. Include the author's postal address, e-mail address, telephone number, and fax number for future correspondence?
2. State that the manuscript is original, not previously published, and not under concurrent consideration elsewhere?
3. Inform the journal editor of the existence of any similar published manuscripts written by the author?
4. Mention any supplemental material you are submitting for the online version of your article?

Contributors' Form (to be modified as applicable and one signed copy attached with the manuscript)

Subject Index

Author Index

Revised Rates for 2015 (Institutional)

Title	Freequency	Rate (Rs): India	Rate ($):ROW
Dermatology International	2	4500	280
Gastroenterology International	2	5000	360
Indian Journal of Agriculture Business	2	4500	300
Indian Journal of Anatomy	2	6000	260
Indian Journal of Ancient Medicine and Yoga	4	7000	330
Indian Journal of Anesthesia and Analgesia	2	5000	600
Indian Journal of Anthropology	2	10500	500
Indian Journal of Applied Physics	2	3500	400
Indian Journal of Biology	2	3000	170
Indian Journal of Cancer Education and Research	2	6500	500
Indian Journal of Communicable Diseases	2	7500	58
Indian Journal of Dental Education	4	4000	288
Indian Journal of Forensic Medicine and Pathology	4	14000	576
Indian Journal of Forensic Odontology	4	4000	288
Indian Journal of Genetics and Molecular Research	2	6000	262
Indian Journal of Law and Human Behavior	2	5000	500
Indian Journal of Library and Information Science	3	8000	600
Indian Journal of Maternal-Fetal & Neonatal Medicine	2	8000	400
Indian Journal of Mathematics and Statistics	2	5000	200
Indian Journal of Medical & Health Sciences	2	6000	120
Indian Journal of Obstetrics and Gynecology	2	5000	200
Indian Journal of Pathology: Research and Practice	2	10000	915
Indian Journal of Plant and Soil	2	5000	1700
Indian Journal of Preventive Medicine	2	6000	250
Indian Journal of Reproductive Science and Medicine	4	3000	180
Indian Journal of Scientific Computing and Engineering	2	4000	280
Indian Journal of Surgical Nursing	3	3000	70
Indian Journal of Trauma & Emergency Pediatrics	4	8500	302
International Journal of Agricultural & Forest Meteorology	2	8000	800
International Journal of Food, Nutrition & Dietetics	2	4000	900
International Journal of History	2	6000	500
International Journal of Neurology and Neurosurgery	2	9000	276
International Journal of Political Science	2	5000	400
International Journal of Practical Nursing	3	3000	70
International Physiology	2	6500	240
Journal of Animal Feed Science and Technology	2	4000	280
Journal of Cardiovascular Medicine and Surgery	2	9000	238
Journal of Orthopaedic Education	2	4500	190
Journal of Pharmaceutical and Medicinal Chemistry	2	15000	350
Journal of Psychiatric Nursing	3	3000	70
Journal of Social Welfare and Management	4	7000	276
Meat Science International	2	5000	500
Microbiology and Related Research	2	6000	150
New Indian Journal of Surgery	4	7000	360
Ophthalmology and Allied Sciences	2	5000	150
Otolaryngology International	2	4500	300
Pediatric Education and Research	4	6500	150
Physiotherapy and Occupational Therapy Journal	4	8000	360
Urology, Nephrology and Andrology International	2	6500	350

Terms of Supply:

1. Advance payment required by Demand Draft payable to Red Flower Publicaion Pvt. Ltd. payable at Delhi.
2. Cancellation not allowed except for duplicate payment.
3. Agents allowed 10% discount.
4. Claim must be made within six months from issue date.

Order from

Red Flower Publication Pvt. Ltd., 48/41-42, DSIDC, Pocket-II, Mayur Vihar Phase-I, Delhi - 110 091 (India), Tel: 91-11-22754205, 45796900, Fax: 91-11-22754205. E-mail: redflowerppl@vsnl.net, redflowerppl@gmail.com, Website: www.rfppl.co.in

Call for Reviewers

The Indian Journal of Plant and Soil (IJPS) (ISSN 2348–9677) publishe original articles and commentaries on research in the fields of fundamental and applied soil and plant science. Original research papers, short communications including germplasm registrations, relevant book reviews, commentaries on papers recently published and, exceptionally, review articles will be considered for publication in the Journal. Manuscripts considered will address aspects of: Agronomical and Horticultural research including breeding and genetics, cultivar evaluation, management, nutrition, physiology, production and quality; Soil Science research including biology, chemistry, classification, fertility, mineralogy, pedology and hydropedology, physics, and soil and land evaluation of agricultural and urban ecosystems; Weed Science research including biological control agents, biology, ecology, genetics, herbicide resistance and herbicide-resistant crops, and physiology and molecular action of herbicides and plant growth regulators; Agro-climatology; Agro-ecology; Forage, Pasture and Turfgrass Science including production and utilisation; Plant and Soil Systems Modelling; Plant–Microbe Interactions; Plant–Pest Interactions; and Plant–Soil Relationships.

Readership: Soil scientists, plant physiologists, agronomists, plant breeders, geochemists, ecologists involved in soil protection

One must have at least five years of experience in the field after completion of the education in that field and at least five original research papers in journal(s).

Please note that the acceptance of your application will be at the sole discretion of the editors.

Please provide your complete information and affiliation in brief through e-mail or you can register your self on our website www.rfppl.co.in

For more information, please contact:

Publication–in-charge

Red Flower Publication Pvt. Ltd.

48/41-42, DSIDC, Pocket-II

Mayur Vihar Phase-I

Delhi – 110 091

India

Phone: 91-11-22754205, 45796900, Fax: 91-11-22754205

E-mail: redflowerppl@vsnl.net, redflowerppl@gmail.com

Website: www.rfppl.co.in