

**PERFORMANCE OF MANDARIN TREES (*Citrus reticulata* Blanco.) AT  
DIFFERENT ALTITUDES AND NUTRIENT MANAGEMENT  
IN MID-HILLS OF NEPAL**

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**DISSERTATION  
SUBMITTED TO THE  
TRIBHUVAN UNIVERISTY  
INSTITUTE OF AGRICULTURE AND ANIMAL SCIENCE  
RAMPUR, CHITWAN, NEPAL**

**IN PARTIAL FULFILLMENT OF THE  
REQUIREMENTS FOR THE  
DEGREE OF**

**DOCTOR OF PHILOSOPHY  
IN  
HORTICULTURE  
SEPTEMBER 2008**

## **CERTIFICATE**

This is to certify that the dissertation entitled “**PERFORMANCE OF MANDARIN TREES (*Citrus reticulata* Blanco.) AT DIFFERENT ALTITUDES AND NUTRIENT MANAGEMENT IN MID-HILLS OF NEPAL**” submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Horticulture of the Postgraduate Program, Institute of Agriculture and Animal Science, Rampur, is a record of original research carried out by **Mr. DILLI RAM BARAL** ID. No. R2002-HORT-01P, under my supervision, and no part of the dissertation has been submitted for any other degree or diploma.

The assistance and help received during the course of this investigation have been acknowledged.

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*Dedicated to*

*My Beloved  
Parents*

*&*

*Family*

## ACKNOWLEDGEMENTS

First of all, I express my sincere gratitude to my Major Adviser, Prof. Dr. Durga Datta Dhakal for his invaluable guidance, continual encouragement during my Ph.D. studies, and his assistance and helpful suggestions during the course of this project and preparation of this dissertation. To the advisory committee, Dr. Gyan Kumar Shrestha, Professor of Horticulture and Dr. Shree Chandra Shah, Professor of Soil Science for their time and constructive criticism of the dissertation is deeply and sincerely acknowledged.

Special thanks and appreciations are extended to Prof. Dr. Sundar Man Shrestha, Dean, Prof. Dr. Resham Bahadur Thapa, Assistant Dean (Academic) and PG Coordinator, Prof. Dr. Shanta Man Shakya, Assistant Dean (Examination) and Prof. Dr. Dainik Bahadur Nepali, Assistant Dean (Administration), IAAS, Rampur for their support and encouragement. I would like to thank to the External Examiner Prof. Dr. N. K. Mishra, Department of Horticulture, College of Agricultural Sciences, GBPU&AT, Pantanagar, India for evaluations of the manuscript.

Appreciation is extended to the members of the Horticulture Department and other faculty Dr. Madhav Kumar Shrestha, Dr. Mana Raj Kolachhapati, Dr. Mohan Prasad Sharma, Dr. Naba Raj Devkota, Dr. Mohan Kharel, and Mr. Phul Prasad Subedi, Rampur Campus, Institute of Agriculture and Animal Science, Tribhuvan University, Nepal, for their constant inspiration and encouragement.

To the host of farmer's field experiments, Mr. Narendra B. Sapkota, Chowka-8, Dudhekuna, Tanahun for providing the venue for the experiments and facilitation during the works is highly acknowledged.

I would like to thank postgraduate students Ram Ghimire, Shyam Prasad Poudel, Debraj Adhikari and Narayan Khanal as well as Surya Dutta Shapkota of final year

B.Sc.Ag. at IAAS, for their helpful assistance in lab. work, statistical analysis and graphics. My sincere thanks also renders to Mr. Puspa Raj Bagale without his services in computer help would be impossible to come into this present form of my dissertation.

Special thanks to my parents, my family especially my beloved wife Mrs. Laxmi Baral and my dearest son Mr. Pranaya Baral and daughter Miss. Pranita Baral and Bhauju Mrs. Binita Shrestha for their boundless and constant inspiration throughout the study.

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## ABSTRACT

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This work entitled “Performance of mandarin trees (*Citrus reticulata* Blanco.) at different altitudes and nutrient management in mid-hills of Nepal” was initiated and achieved in two phases. In the first phase, a nutritional survey based on foliar and soil analyses of the mandarin orchards located at high, mid, and low altitude citrus growing belts representing Gorkha, Lamjung and Tanahun districts, respectively and different orchard performances mainly health and age of the trees in the regions were conducted during 2003 and 2004 to elucidate the roles of these aspects on foliar as well as soil nutrient composition and to the appraisal of nutrients constraints in these regions. Two years of results showed that there was a strong association between soil fertility trends and altitudinal variations. At high citrus growing altitude (> 1100 m amsl) the total leaf P, K, Fe and Zn were higher as compared to lower altitude (500 to 1100 m amsl). Soil pH, organic matter, total N, available P, Ca, and Mg contents in soils varied according to the altitudes. Generally, soil organic matter, total soil N, available soil P were more at high altitudes and pH, available Ca and Mg contents in soils decreased as the altitudes increased. The rest of the nutrients did not show the systematic patterns with altitude variations. High performing orchards of healthy matured and young trees out-performed unhealthy trees with respect to the amount of N, P, Ca, Fe, Mn and Zn in leaf. Young mandarin trees of both healthy and unhealthy had high content of leaf, N, P, K, Mn and Zn at all the altitudes compared to mature ones. However, soil organic matter, total N and available P and Zn were affected by the orchard performances. Remaining nutrients were either no response or highly erratic with the age and health of the trees. This implicated that while taking samples for leaf and soil analyses of mandarin orchards for close interpretation of the test results, the samples needed to be taken altitudinally besides consideration of several other cultural management factors primarily age and health of the trees. Majority of the high altitudes citrus orchards were deficient in leaf Zn, Ca, Mg and Mn; at mid-altitude leaf Zn, B and Mn in leaf were

deficient; at low citrus growing belts mostly N, and Zn were deficient. Based on soil test results, low soil pH, and low availability of Ca and Mg were found at high altitudes whereas N and B were shown to be in low to medium ranges in most of the orchards at medium and low altitudes. Nitrogen fertilization was found to be the most problematic nutrients based on literatures reviews and findings of the first phase of the study. So, in the second phase of the studies, the plan for field N-management of experimentation in farmer's field conditions were initiated in 2004/05 fiscal year at Chowk-8, Dudhenkuna mandarin growing pockets of Tanahun district which is located in mid-hills (600-700 m amsl) of Western Region of Nepal. Main objectives of these studies were to elucidate the efficient roles of various N fertilization managements through its interaction with the major nutrient packages, amount and method of N application to observe trees growth, yield and quality variables of local landrace mandarin. The results showed that the efficient N fertilization management includes the soil application of complete package viz. 200-100-200 g NPK/plant/year with 2 sprays of Plantoplex (commercial formulation) and 2 kg of agri-lime per tree, the positive N–K containing fertilizer treatments interaction, the optimal N application rate of 400 g N/plant/year applied in winter and early spring for 5-6 years old trees and two basally applied N plus one foliar applied N as urea just after blossoms significantly increased number of leaves, length of shoots, number of matured and immatured fruits, fruit size and total fruit yield, peel thickness, TSS, TSS:TA ratio, and juiciness. However, flower number, TA, fruit firmness and coarseness were decreased by the above mentioned good N managements practices. The overall, these studies were achieved to suggest efficient N fertilization practices for local landrace mandarin under low zones of mid-hills of Western regions of Nepal and that resulted in the optimal production with quality fruits.

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Prof. Durga Datta Dhakal, Ph.D.  
Major Advisor

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Dilli Ram Baral  
Author

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## ACRONYMS

Ambia Flush/Bahar	: The blossom in citrus fruit trees appearing in December–February
APP	: Agricultural Perspective Plan
APROSC	: Agricultural Project Service Center
<b>Bari Land</b>	: Upland
CBS	: Central Bureau of Statistics
DADO	: District Agriculture Development Office
FAO	: Food and Agriculture Organization of United Nations
FDD	: Fruit Development Division
FYM	: Farm Yard Manure
GDP	: Gross Domestic Product
GON	: Government of Nepal
HMG/N	: His Majesty's Government of Nepal
IAAS	: Institute of Agriculture and Animal Sciences
<b>Khet Land</b>	: Low land
m amsl	: Meter Above Mean Sea Level
MHR	: Mid-hills region
MHWR	: Mid-hills western region
MOAC	: Ministry of Agriculture and Cooperatives
Mrig Flush/Bahar	: The Blossom in citrus fruit trees appearing in June - July
mt	: Metric ton
NCDP	: National Citrus Development program
<b>Tars</b>	: Flat Bari Land
VDC	: Village Development Committee

## शोधसार

नाम: डिल्ली राम बराल  
सत्र र भर्ना भएको वर्ष: प्रथम, २००२  
मुख्य विषय: वागवानी विज्ञान  
मुख्य सल्लाहकार: प्रा.डा. दुर्गादत्त ठकाल

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डिग्री: विद्यावारिधि  
विभाग: वागवानी विज्ञान

यो अनुसन्धान योजना आर्थिक वर्ष २००२/२००३, २००३/२००४ र २००४/२००५ गरी तीन वर्षमा दुई चरण गरी सफलताका साथ सम्पन्न गरिएको थियो । पहिलो चरणमा पश्चिम नेपालको मध्य पहाडी भागमा पर्ने गोर्खा, लम्जुङ्ग र तनहुँ जिल्लाहरूका क्रमशः उच्च, मध्य र तल्लो उचाईमा पर्ने प्रशिद्ध सुन्तला क्षेत्रहरूमा व्यवस्थित योजना अनुरूप सफल सुन्तला खेतीमा मलखाद समस्या पहिचानार्थ प्रयोगशालामा पात तथा माटो परीक्षण विश्लेषण गरी ती खाद्यतत्व सूचांकहरूले बोट तथा माटोमा विभिन्न उचाई, व्यवस्थित/अव्यवस्थित र फलेका/नफलेका बगैँचाहरू अनुसार खाद्यतत्वको के कस्तो अवस्थामा छन् र ती तत्वहरूको अवस्थाले मलखाद समस्या पहिचान गर्न समर्थ छन् कि छैनन् भन्ने जमर्को गरिएको थियो । प्रथम चरणको दुई वर्षको नतिजा अनुसार, सुन्तला बगैँचाको उचाई अनुसार मलखाद तत्वहरूको अवस्था फरक परेको देखियो । खास गरेर उच्च क्षेत्रहरूमा पातमा पाइने नाइट्रोजन, फस्फरस, पोटास, फलाम तथा जस्ता खाद्यतत्वहरूको मात्रा कम उचाईमा भन्दा बढी भएको विश्लेषण गरियो । जबकि माटोमा रहेका तत्वको विश्लेषण गर्दा उच्च सुन्तला क्षेत्रहरूमा प्रांगारिक पदार्थ, नाइट्रोजन र फस्फरसको अवस्था बढी र पि.एच., क्याल्सियम र म्याग्नेसियम घट्दो उचाई अनुसार बढेको पाइयो । दुवै फलेका र नफलेका, स्वस्थ व्यवस्थित बगैँचाहरू अस्वस्थकर बोटको तुलनामा पातमा पाइने खाद्यतत्वहरू खास गरेर नाइट्रोजन, फस्फरस, पोटास, क्याल्सियम, फलाम, म्याङ्गानिज र जस्ताहरूको मात्रा बढी पाइयो । पाँच वर्ष मुनिका नफलेका दुवै स्वस्थ तथा अस्वस्थकर सबै उचाईका बोटहरूमा पातमा पाइने नाइट्रोजन, फस्फरस, पोटास, म्याङ्गानिज र जस्ताहरूको मात्रा फलेको बगैँचाको तुलनामा उच्च पाइयो तर माटोको विश्लेषणको आधारमा भने मात्रै प्रांगारिक पदार्थ, नाइट्रोजन र फस्फरस र जस्ताको अवस्थामा मात्र बगैँचाको स्वस्थता तथा उमेरले फरक पारेको देखियो र बाँकी तत्वहरूमा भने उमेर तथा स्वस्थताले खास असर पारेको देखिएन । उच्च क्षेत्रका बहुसंख्यक सुन्तला बगैँचाहरूमा जस्ता,

क्याल्सियम र म्याग्नेसियम : मध्य उचाईमा जस्ता र बोरन : तल्लो क्षेत्रमा नाइट्रोजन र जस्ता तत्वहरूको कमी भएको पहिचान पातको विश्लेषणको आधारमा गरियो । माटो विश्लेषण गर्दा भने उच्च क्षेत्रमा कम पि. एच. को समस्या र नाइट्रोजन र बोरन मध्य तथा तल्लो क्षेत्रहरूमा कमी भएको पाइयो । यो अनुसन्धानको दोस्रो चरणमा, पहिलो चरणको नतिजाको आधारमा सुन्तला खाद्यतत्व व्यवस्थापनमा नाइट्रोजन मलखाद तत्वको समस्या केन्द्रमा रहेको र विशेष गरेर कम उचाई भएका बगैँचाहरूमा यो तत्व बढी समस्या भएकोले, यसको उपयोगलाई सुन्तलामा बढी प्रभावकारी बनाउने उद्देश्यले तल्लो उचाई क्षेत्रमा पर्ने चोक-८, दुधेकुना, तनहुँमा अवस्थित किसानको बगैँचा उपयोग गरेर आर्थिक वर्ष २००४/०५ मा नाइट्रोजन सफल व्यवस्थापनका लागि चार वटा अनुसन्धानहरू गरिएको आधारमा नतिजा प्रस्तुत गरिन्छ । प्रायजसो सबै बढी सुन्तला उत्पादनमा सहयोग पु-याउने सुचाङ्कहरू जस्तै हाँगामा नयाँ पातको संख्या, नयाँ हाँगको लम्बाई, नपाकेका तथा पाकेका फलहरूको संख्या, फलको प्रतिबोट र प्रतिरुख तौल, बोक्राको बाक्लोपना, फलमा पाइने चिनी, रसको मात्रा, पूर्ण मलखाद प्याकेज २००-१००-२०० ग्राम एन.पि.के. प्रतिवर्ष प्रतिबोट साथै सबै सूक्ष्मतत्व भएको मलको दुई पटक फलिसके पछि रुखमा छडकाव र २ के.जी. कृषि चुन प्रतिबोट जाडो मौसममा हाल्नाले : नाइट्रोजन तथा पोटासयुक्त मलको प्राथमिकताका साथ हाल्नु पर्ने: ४०० ग्राम नाइट्रोजन प्रतिबोट प्रतिवर्ष प्रयोग २ पटक जाडो समयमा र १ पटक युरिया फल फलिसकेपछि छर्कनाले यी सूचाङ्कहरू बढेको पाइयो । तर फूलहरूको संख्या, फलको अमिलो र साहोपना भने यी नाइट्रोजनयुक्त मल प्याकेजहरूले घटाएको पाइयो ।

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प्रा.डा. दुर्गादत्त ढकाल  
मुख्य सल्लाहकार

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डिल्ली राम बराल  
लेखक