Growth and Productivity of Winter Maize (*Zea mays* L.) Under Different Levels of Nitrogen and Plant Population

Jiban Shrestha

DISSERTATION.COM

Boca Raton

*Growth and Productivity of Winter Maize (*Zea mays *L.) Under Different Levels of Nitrogen and Plant Population*

Dissertation.com
Boca Raton, Florida
USA • 2015

ISBN-10: 1-61233-440-7
ISBN-13: 978-1-61233-440-0

ACKNOWLEDGEMENT

I wish to express my heartfelt gratitude and warm respect to Dr. Deo Nath Yadav, Professor, Department of Agronomy, Tribhuvan University, Institute of Agriculture and Animal Science (IAAS), Rampur, Chitwan, Nepal and the Chairman of Advisory Committee, for his constant guidance, encouragement and suggestion throughout the course of experimentation and preparation of this manuscript.

I would like to express my sincere and deep sense of gratitude to Mr. Lal Prasad Amgain, Assistant Professor, Department of Agronomy, IAAS, Rampur and member of Advisory Committee for his constant guidance, suggestion and encouragement throughout the experimentation and preparation of this manuscript.

I am also indebted to Mr. Jhanka Prasad Sharma, Assistant Professor, Department of Agricultural Economics, IAAS, Rampur and member of Advisory Committee for his suggestion and guidance throughout experimentation and thesis preparation.

My heartfelt thanks and deep respect go to Prof. Dr. Durga Datta Dhakal, Dean, IAAS, Prof. Dr. Sundar Man Shrestha, Assistant Dean (Academics) and Coordinator of Post gratitude Program, IAAS for providing necessary facilities during the study period.

The research funded by Directorate of Research and Publication (DOR), IAAS is greatly acknowledged.

I want to express my sincere gratitude to Prof. Dr. Resham Bahadur Thapa, Director, Directorate of Research and Publication, IAAS and Dr. Shrawan Kumar Sah, Associate Professor and the Chairman, Department of Agronomy, IAAS for their inspiration, encouragement and help during the study.

I am thankful to my colleagues: Ambika, Sabitri, Bhanu, Ramesh, Baburam, Raj Kumar, Bishnu, Shyam Lal, Anil, Arun, Naresh, Nawaraj, Nabin, Durga, Madhu Sudhan, Puspa Raj, Deepak, Rajiv, Arjun, Kamal, Sachesh, Chet Narayan and Keshav for their kind cooperation and help during the study. My special thanks go to my brother-in-law: Pratap Shrestha for providing computer facility for thesis writing and also to my friends: Bal Bahadur, Himal, Sagar, Ganesh and Ram Kumar for their constant help in recording data during the research works. My appreciation further goes to Yamkanta Gaire and Binod Silwal for their help in analyzing the soil and maize seed samples in NARC, Kumaltar.

The whole staff of Agronomy Department and Library staff of IAAS are acknowledged for their help and kind cooperation.

Finally, I am grateful to my father: Resham Lal Shrestha, brother: Ram Babu Shrestha and sister-in-law: Milan Shrestha for their support, encouragement, love and inspiration during whole period of study. All my relatives and well wishers who directly or indirectly contributed to my academic career are equally indebted in this endeavor.

Jiban Shrestha

TABLE OF CONTENTS

Content

4 RESULTS AND DISCUSSION

LIST OF TABLES

Table

LIST OF FIGURES

Figure

LIST OF APPENDICES

Appendix

ACRONYMS AND ABBREVIATIONS

@	At the rate of
a. i.	Active ingredient
ANOVA	Analysis of variance
B:C ratio	Benefit: cost ratio
CIMMYT	Centro Internacional de Mejoramiento de Maizy Trigo
cm	Centimeter
cm^2	Square centimeter
CV	Coefficient of variation
^0C	Degree centigrade
DAS	Days after sowing
DMRT	Duncan's Multiple Range Test
FAO	Food and Agriculture Organization
eds	Edited
et al.	et alii
g	Gram
ha	Hectare
IAAS	Institute of Agriculture and Animal Science
i. e.	That is
kg	Kilogram
kg/ha	Kilogram/hectare
km	Kilometer
K_2O	Potassium

LAI	Leaf area index
lit	Liter
LSD (0.05)	Least significance difference (at 5% level)
m	Meter
m^2	Meter square
Max	Maximum
Min	Minimum
ml	Milliliter
mm	Millimeter
MOAC	Ministry of Agriculture and Co-operatives
mt	Metric ton
N	Nitrogen
NS	Non significant
NARC	Nepal Agriculture Research Council
NMRP	National Maize Research Program
P_2O	Phosphorous
pp	Pages
SEM	Standard error mean
SINA	Statistical Information on Nepalese Agriculture
RH	Relative humidity
RCBD	Randomized Complete Block Design
Rs.	Rupees
t/ha	Ton per hectare
VDC	Village Development Committee
Wt.	Weight

$<$	Lesser than
$>$	Greater than
π	Pai

ABSTRACT

Name: Jiban Shrestha
Semester and year of admission: First, 2005 Id. No.: R-2005-AGR-04M
Major Subject: Agronomy Degree: Master of Science in Agriculture
Major Advisor: Prof. Deo Nath Yadav, Ph.D. Department: Agronomy

A field experiment was conducted at farmer's field of Anandapur, Mangalpur VDC-3, Chitwan, Nepal during winter season from September 2006 to February 2007 to study the effects of nitrogen and plant population on maize. Fifteen treatment combinations consisting of five levels of nitrogen: 0, 50, 100, 150 and 200 kg N/ha and three levels of plant population; 55555 plants/ha (60 cm × 30 cm spacing), 66666 plants/ha (60 cm × 25 cm spacing) and 83333 plants/ha (60 cm × 20 cm spacing) were tested in factorial randomized complete block design (RCBD) with 3 replications. "Rampur Composite" variety of maize was planted on sandy silt loam and strongly acidic soil having medium in total nitrogen (0.123%), high in soil available phosphorous (77.56 kg/ha) and low in soil available potassium (23.25 kg/ha). The research findings revealed that each level of nitrogen significantly increased grain yield upto 200 kg N/ha. The grain yield (6514.48 kg/ha) obtained under 200 kg N/ha was significantly higher than that of 0, 50, 100 and 150 kg N/ha. The percent increment in yield due to application of 50, 100, 150 and 200 kg N/ha was to the extent of 62.11, 104.74, 135.68 and 154.74%, respectively over control. Significant effect on grain yield due to different levels of plant population was observed. The grain yield (5113.46 kg/ha) obtained under 66666 plants/ha was statistically at par with that under 83333 plants/ha, but significantly superior over that under 55555 plants/ha. The interaction between different nitrogen levels and plant densities on grain yield showed that the highest grain yield (6925.79 kg/ha) was obtained under treatment of 200 kg N/ha + 66666 plants/ha. The yield attributes namely number of cobs/plant, cob length, cob diameter, number of grain rows/cob and 1000 seed weight significantly increased with increasing N levels and decreasing plant

population levels. The number of barren plants/ha decreased with increasing levels of N but increased with increasing levels of plant population. The net return (Rs. 42188.74/ha) and benefit:cost ratio (1.67) obtained under 200 kg N/ha were significantly highest than that obtained under other levels of nitrogen (150, 100, 50 and 0 kg N/ha). The plant population of 66666 plants/ha gave the highest net returns (Rs. 25812.28) which was 10.19 and 49.64% higher than that of 83333 plants/ha and 55555 plants/ha, respectively. The benefit: cost ratio (1.44) obtained under 66666 plants/ha was significantly higher than that of 55555 and 83333 plants/ha. The interaction between different nitrogen levels and plant densities on economics of maize production showed that significantly highest net return (Rs.48606.98) and B:C ratio (1.78) were under treatment of 200 kg N/ha + 66666 plants/ha. The highest grain yield and maximum profit were obtained when maize variety "Rampur Composite" was planted with 200 kg N/ha and plant population level of 66666 plants/ha (60 cm × 25 cm spacing).

Prof. Deo Nath Yadav, Ph.D.
Major Advisor

Jiban Shrestha
Author

शोधसार

नाम: जीवन श्रेष्ठ

सत्र तथा भर्ना मिति: प्रथम, २०६२ | परिचय पत्र नं.: आर-२००५-एजीआर.-०४ एम

मुख्य विषय : वाली विज्ञान | उपाधि: कृषि स्नातकोत्तर

मुख्य सल्लाहकार: प्रा.डा. देवनाथ यादव | विभाग: बाली विज्ञान

मंगलपुर गा.वि.स.वडा नं.-३, आनन्दपुर, चितवनमा मकै वाली उत्पादनमा नाइट्रोजन मल र वाली घनत्वको उचित मात्रा पत्ता लगाउन २०६३ आश्विन देखि २०६३ माघ सम्म हिउंदमा एक परीक्षण गरिएको थियो । उक्त परीक्षण बलौटे दोमट, अम्लीय, मध्यम नाइट्रोजन (०.१२३ %), उच्च फस्फोरस (७७.५६ के.जी. प्रति हेक्टर) र न्यून पोटासियम (२३.२५ के.जी. प्रति हेक्टर) भएको माटोमा फ्याक्टोरियल रेन्डोमाइज्ड कम्प्लीट ब्लक डिजाइनमा तीन पटक दोहोर्‍याई गरिएको थियो । सो परीक्षणमा मकैको जात 'रामपुर कम्पोजिट' लाई विभिन्न पाँच वटा नाइट्रोजन मलको मात्राहरु; ०, ५०, १००, १५० तथा २०० के.जी. प्रति हेक्टर र तीन वटा वाली घनत्वहरु; ५५,५५५ वोट प्रति हेक्टर (६० से.मी. X ३० से.मी.), ६६,६६६ वोट प्रति हेक्टर (६० से.मी. X २५ से.मी.) र ८३,३३३ वोट प्रति हेक्टर (६० से.मी. X २० से.मी.) को प्रभाव बारे अध्ययन गरिएको थियो । उक्त परिक्षणको नतिजा अनुसार नाइट्रोजनको मात्रा २०० के.जी. प्रति हेक्टर प्रयोग गर्दा सबैभन्दा बढी ६५१४.४८ के.जी. प्रति हेक्टर उब्जनी पाइयो । नाइट्रोजनको मात्राहरु; ५०, १००, १५० तथा २०० के.जी. प्रति हेक्टरको प्रयोगले नाइट्रोजन प्रयोग नगरेको भन्दा क्रमश: ६२.११, १०४.७४, १३५.६८ र १५४.७४ प्रतिशत (%) बढी उब्जनी दियो । वाली घनत्व ६६,६६६ वोट प्रति हेक्टर को प्रयोग गर्दा ५११३.४६ के.जी. प्रति हेक्टर उब्जनी पाइयो । जुन ५५,५५५ वोट प्रति हेक्टरको भन्दा बढी उब्जनी थियो । २०० के. जी. प्रति हेक्टर नाइट्रोजन र ६६,६६६ वोट प्रति हेक्टरको अन्तरक्रिया बाट सबैभन्दा बढी (६९२५.७९ के.जी. प्रति

हेक्टर) उब्जनी दियो । नाइट्रोजनको मात्रा बढाउदै लैजादा उत्पादकत्वमा प्रभाव पार्ने तत्वहरु जस्तै- घोगा संख्या प्रति वोट, घोगाको लम्बाई, घोगाको मोटाई, दाना हार संख्या प्रति घोगा, दाना संख्या प्रति हार, १००० वटा दानाको तौल बढ्दै गएको देखियो । तर वोट घनत्व बढाउदै लैजादा उक्त तत्वहरु घटेको पाइयो । नाइट्रोजनको मात्रा बढाउदै लैजादा घोगा नलागेका (थारो) वोटहरुको संख्या घटदै गएको र वाली घनत्व बढाउदै लैजादा सो तत्व बढदै गएको देखियो । २०० के. जी. प्रति हेक्टर नाइट्रोजनको मात्रा प्रयोग गर्दा सबैभन्दा बढी मुनाफा खर्च अनुपात (१.६७) र खुद नाफा (रु.४२१८८.७४) पाइयो । वाली घनत्व ६६,६६६ वोट प्रति हेक्टर प्रयोग बाट सबैभन्दा बढी मुनाफा खर्च अनुपात (१.४४) र खुद नाफा (रु.२५८१२.२८) पाइयो । ६६,६६६ वोट प्रति हेक्टरको प्रयोगले ८३,३३३ वोट प्रति हेक्टर र ५५,५५५ वोट प्रति हेक्टर को भन्दा क्रमशः १०.१९ र ४९.६४ प्रतिशत बढी खुद नाफा दियो । २०० के.जी. प्रति हेक्टर नाइट्रोजन र ६६,६६६ वोट प्रति हेक्टरको अन्तरक्रियाबाट सबैभन्दा बढी मुनाफा खर्च अनुपात (१.७८) र खुद नाफा (रु.४८६०६.९८) पाइयो । प्राप्त नतिजाको विश्लेषण गर्दा २०० के.जी. प्रति हेक्टर नाइट्रोजन र वाली घनत्व ६६,६६६ वोट प्रति हेक्टर (६० से.मी. X २५ से.मी.) को प्रयोगबाट सबैभन्दा बढी उब्जनी र आम्दानी पाइयो ।

प्रा.डा. देवनाथ यादव	जीवन श्रेष्ठ
मुख्य सल्लाहकार	लेखक

1 INTRODUCTION

Maize (*Zea mays* L.) is the world's widely grown cereal and primary staple food crop in many developing countries. It ranks the second position in terms of world's cereal grain production. Its global production area is about 140 million hectares, of which approximately 96 million hectares are in the developing countries. World maize production is about 602 million tons, although 68% of the world maize area is in developing countries, only 46% of the world's maize production is produced there (FAO, 2003).

It is the second most important staple food crop both in terms of area and production after rice in Nepal. It is grown in 850947 hectare of land with average yield of 2038 kg/ha. Maize occupies about 27.52% of the total cultivated agricultural land and shares about 22.65% of the total cereal production in Nepal (SINA, 2005/06). It shares about 6.87% to Agricultural Gross Domestic Product (MOAC, 2006). The proportion of maize area consists of 70% in mid hills followed by 22% in Terai and 8% in high hills (Pathik, 2002).

The per capita consumption of maize is 165 g/day but per capita consumption is 225 and 80 g/day in hills and Terai, respectively (Adhikari, 2001). As a result of growing maize consuming population in the hills as well as increasing use of maize for feed in the rapidly expanding poultry and dairy sector, the demand for maize is increasing very fast but its production is growing slowly. The production is increasing slowly at the rate of 1.4% per year (Koirala, 2001), however, the average annual growth rate of maize yield is 1.05% (Paudyal and Ransom, 2001). The growth in the use of maize grain as animal feed and for other industrial products is now at 10-15% per annum, particularly in Terai, inner Terai and urban areas. The overall demand for maize-driven by increased demand for human consumption and livestock feed is expected to grow by 4-6% per year over the next 20 years (CIMMYT, 1997/98).

Maize has got highest production potential among the crop plants and has wide variability in plant morphology. It is cultivated in a wider range of environment than wheat and rice because of its greater adaptability (Koutsika-Sotiriou, 1999). The present yield of maize in Nepal is quite lower than that of other Asian countries. There is wide gap between potential yield of open pollinated varieties having 5 t/ha (on station experimental yield), attainable yield of 3.5 t/ha (on farm yield with improved practices) and actual yield of 2.03 t/ha (national average yield) (Ojha, 2006). One of the main factors for low yield of maize is loss of soil fertility and lower use of fertilizer input. Chemical fertilizer especially nitrogen fertilizer is universally accepted as a key component to high corn yield and optimum economic return (Gehl *et al*., 2005). It plays important role in metabolism, growth, reproduction and heredity of plant (Jain, 1990). Plant growth is adversely affected due to deficiency of nitrogen as it restricts the formation of enzymes, chlorophyll and proteins necessary for growth and development (Reddy and Reddy, 2002). The effective management of nitrogen fertilizer in relation to time is also important aspect of crop production. The tasseling and silking stages are critical stages of maize for nitrogen application. So nitrogen application at these stages following 50% of total nitrogen as basal gives higher production in maize.

The highest yield of a particular crop can be obtained only if optimum plant population is maintained. Both thicker and thinner plant population than the recommended ones for a normal production system reduces economic yield. The appropriate plant population for each crop varies greatly from region to region depending upon climate, soil and management practices. The competition between plants may not occur and resources are not efficiently used at very low plant densities. Under low plant densities, grain yield is limited by the inadequate number of plants whereas at higher plant densities, it declines mostly because of an increment in the number of aborted kernels and/or barren stalks. At higher plant densities,