

## **INFORMATION TO USERS**

**This was produced from a copy of a document sent to us for microfilming. While the most advanced technological means to photograph and reproduce this document have been used, the quality is heavily dependent upon the quality of the material submitted.**

**The following explanation of techniques is provided to help you understand markings or notations which may appear on this reproduction.**

- 1. The sign or "target" for pages apparently lacking from the document photographed is "Missing Page(s)". If it was possible to obtain the missing page(s) or section, they are spliced into the film along with adjacent pages. This may have necessitated cutting through an image and duplicating adjacent pages to assure you of complete continuity.**
- 2. When an image on the film is obliterated with a round black mark it is an indication that the film inspector noticed either blurred copy because of movement during exposure, or duplicate copy. Unless we meant to delete copyrighted materials that should not have been filmed, you will find a good image of the page in the adjacent frame.**
- 3. When a map, drawing or chart, etc., is part of the material being photographed the photographer has followed a definite method in "sectioning" the material. It is customary to begin filming at the upper left hand corner of a large sheet and to continue from left to right in equal sections with small overlaps. If necessary, sectioning is continued again—beginning below the first row and continuing on until complete.**
- 4. For any illustrations that cannot be reproduced satisfactorily by xerography, photographic prints can be purchased at additional cost and tipped into your xerographic copy. Requests can be made to our Dissertations Customer Services Department.**
- 5. Some pages in any document may have indistinct print. In all cases we have filmed the best available copy.**

**University  
Microfilms  
International**

300 N. ZEEB ROAD, ANN ARBOR, MI 48106  
18 BEDFORD ROW, LONDON WC1R 4EJ, ENGLAND

8003377

SILVA, MARIA ISABEL DA

EFFECTS OF DEFOLIATION AND N-FERTILIZATION ON YIELD,  
NITROGEN UPTAKE, AND PROTEIN SYNTHESIS OF WHEAT CULTIVARS  
DIFFERING IN GENETIC POTENTIAL FOR PROTEIN CONTENT AND  
COMPOSITION

The University of Nebraska-Lincoln

PH.D. 1979

**University  
Microfilms  
International**

300 N. Zeeb Road, Ann Arbor, MI 48106

18 Bedford Row, London WC1R 4EJ, England

PREVIEW

PLEASE NOTE:

In all cases this material has been filmed in the best possible way from the available copy. Problems encountered with this document have been identified here with a check mark ☒.

1. Glossy photographs \_\_\_\_\_
2. Colored illustrations \_\_\_\_\_
3. Photographs with dark background \_\_\_\_\_
4. Illustrations are poor copy \_\_\_\_\_
5. Print shows through as there is text on both sides of page \_\_\_\_\_
6. Indistinct, broken or small print on several pages ☒ throughout  
\_\_\_\_\_
7. Tightly bound copy with print lost in spine \_\_\_\_\_
8. Computer printout pages with indistinct print \_\_\_\_\_
9. Page(s) 191 lacking when material received, and not available  
from school or author ☒
10. Page(s) \_\_\_\_\_ seem to be missing in numbering only as text  
follows \_\_\_\_\_
11. Poor carbon copy \_\_\_\_\_
12. Not original copy, several pages with blurred type \_\_\_\_\_
13. Appendix pages are poor copy \_\_\_\_\_
14. Original copy with light type \_\_\_\_\_
15. Curling and wrinkled pages \_\_\_\_\_
16. Other \_\_\_\_\_

University  
Microfilms  
International

300 N ZEEB RD., ANN ARBOR MI 48106 (313) 761-4700

EFFECTS OF DEFOLIATION AND N-FERTILIZATION ON YIELD,  
NITROGEN UPTAKE, AND PROTEIN SYNTHESIS OF WHEAT  
CULTIVARS DIFFERING IN GENETIC POTENTIAL FOR  
PROTEIN CONTENT AND COMPOSITION

by

Maria Isabel da Silva

A Dissertation

Presented to the Faculty of

The Graduate College in the University of Nebraska

In Partial Fulfillment of Requirements

For the Degree of Doctor of Philosophy

Department of Agronomy

Under the Supervision of Dr. V. A. Johnson

Lincoln, Nebraska

June, 1979

**TITLE**

Effects of Defoliation and N-Fertilization on Yield, Nitrogen Uptake,  
and Protein Synthesis of Wheat Cultivars Differing in Genetic Potential  
for Protein Content and Composition.

**BY**

Maria I. da Silva

**APPROVED**

**DATE**

V. A. Johnson (Chairman)

June 28, 1979

P. J. Mattern

June 28, 1979

M. G. Boosalis

June 28, 1979

R. A. Olson

June 28, 1979

**SUPERVISORY COMMITTEE**

**GRADUATE COLLEGE**

**UNIVERSITY OF NEBRASKA**

EFFECTS OF DEFOLIATION AND N-FERTILIZATION ON YIELD,  
NITROGEN UPTAKE, AND PROTEIN SYNTHESIS OF WHEAT  
CULTIVARS DIFFERING IN GENETIC POTENTIAL FOR  
PROTEIN CONTENT AND COMPOSITION

Maria Isabel da Silva  
University of Nebraska, 1979

Adviser: Dr. V. A. Johnson

Three field experiments were conducted at the Agronomy Farm near Lincoln, Nebraska. The main objectives were: 1) measure grain yield and protein content of varieties differing in genetic potential for protein content and composition under different nitrogen rates and defoliation treatments and 2) measure total dry matter and nitrogen accumulation on a weekly basis after heading time.

The varieties studied Lancota, Favorit/5/Cirpiz/Jang Kwang/4/Cmn/Velvet, CI 13449/Centurk, Martonvasar 3, NB 66403//Trader Sel./Riebesel, and Lancer have inherently different genetic potential for grain yield and/or protein content. Five defoliation treatments were imposed at heading and 15 days after heading in three experiments. Rows were harvested at weekly intervals after heading time to determine nitrogen and dry matter accumulation in foliage and heads.

In Experiment 1, grain yield of 3305 kg/ha with no defoliation decreased to 2819 kg/ha with defoliation of flag

.....

leaf plus 4th leaf at heading time. Similar results were obtained in the other experiments in which the defoliation of flag leaf plus 4th leaf at heading reduced grain yield, 1000-kernel weight and test weight more than the other defoliation treatments. The defoliation of flag leaf either at heading time or two weeks after heading significantly reduced grain yield in two of the three experiments.

Nitrogen application significantly increased average grain protein of the varieties from 15.6% with no nitrogen application to 17.4% with application of 120 kg/ha of nitrogen. Removal of flag leaf plus 4th leaf two weeks after heading resulted in the lowest grain protein (16.1%) as compared with the control plots (all leaves intact) with 17.2% in Experiment 1. However, in Experiments 2 and 3 defoliation of flag leaf plus 4th leaf at heading time had the most severe effect on grain protein.

Average lysine/protein and adjusted lysine/protein were the lowest with no defoliation. CI 13449/Centurk produced grain with the lowest protein in all experiments but the highest lysine % protein in two experiments.

Favorit/5/Cirpiz/Jang Kwang/4/Cmn/Velvet and Lancota produced significantly the highest grain yield and grain protein content among the varieties studied. The fact that both yield and protein content were high is unusual and indicates the presence of protein genes in these varieties. It was observed that the varieties which normally produce

relatively high yields of grain and high grain protein retained these characteristics despite the effects of nitrogen application and defoliation treatments.

CI 13449/Centurk reached maximum dry matter accumulation one week after heading but in Favorit/5/Cirpiz/Jang Kuang/4/Cmn/Velvet, Lancota and Lancer the maximum was reached one week later. A most pronounced weight reduction in both foliage and heads occurred from defoliation treatments performed at heading, especially when two leaves were removed.

The concentration on nitrogen in the foliage (stem plus leaves) decreased from 1.84% at heading to 0.61% at harvest in Experiment 1. Head nitrogen increased from 2.13% to 2.40% during this period. Similar results were obtained in Experiment 3.

The percent of nitrogen in the heads of varieties increased with the application of nitrogen but the increase resulting from the application of 120 kg/ha of nitrogen was not significantly different from 60 kg/ha of applied nitrogen except in the 4th sampling week.

Removal of flag leaf plus 4th leaf at heading time had a more severe effect on the concentration of nitrogen in the foliage and heads than the other defoliation treatments.

100  
100  
100



To my parents.

PREVIEW

## ACKNOWLEDGMENTS

The author expresses her sincere gratitude to Dr. V. A. Johnson for his advice, patience and encouragement throughout the course of this study and in the preparation of the manuscript.

Appreciation is expressed to Professors R. A. Olson, P. J. Mattern and Dr. M. G. Boosalis for serving on the supervisory committee and again to Prof. P. J. Mattern and Dr. M. G. Boosalis for their critical review of the manuscript. Appreciation also is expressed to Dr. R. F. Mumm for his assistance with statistical analyses of the data.

The author wishes to thank the Food and Agriculture Organization of the United Nations for providing financial support, the Universidade Federal de Santa Maria for the opportunity, and to the University of Nebraska for providing the facilities and materials for the study.

Thanks also are extended to the Agronomy Department and to the wheat project personnel who assisted her in the conduct of the research and preparation of this dissertation.

She wishes to express her gratitude to Mrs. Heloisa Scholl for typing the manuscript.

Finally, she wishes to express her deep appreciation to her friends and family for their encouragement during the course of the study.

## TABLE OF CONTENTS

	Page
LIST OF TABLES .....	vi
LIST OF APPENDIX TABLES .....	xi
LIST OF FIGURES .....	xv
INTRODUCTION .....	1
LITERATURE REVIEW .....	4
Contribution of Different Plant Parts to Grain Development.....	4
Nitrogen Absorption, Translocation and Dry Matter Accumulation in Wheat.....	18
Effect of Nitrogen Application on Wheat Yield and Protein Content.....	26
Other Factors Affecting Yield and Protein Relationship.....	41
MATERIALS AND METHODS .....	48
RESULTS .....	65
DISCUSSION .....	143
Effects of Nitrogen Application on Yield, Yield Components and Other Agronomic Traits...	143
Effects of Defoliation on Yield, Yield Com- ponents on Other Agronomic Traits.....	145
Effects of Nitrogen Application and Defolia- tion on Protein and Composition.....	149
Dry Matter Accumulation in Foliage and Heads..	156
Nitrogen Accumulation and Translocation from Foliage to Heads.....	160
SUMMARY .....	167
REFERENCES .....	172
APPENDIX .....	189

# LIST OF TABLES

Table		Page
1	Form of the analysis of variance used to analyse data for individual variables in Experiment 1, 1976-1977. ...	61
2	Form of the analysis of variance used to analyse data for individual variables in Experiment 2, 1976-1977 and Experiment 3, 1977-1978 with varieties and defoliation treatments. ....	63
3	Significance of mean squares for agronomic and quality traits studied over varieties, nitrogen rates and defoliation treatments in Experiment 1, 1976-1977. ....	66
4	Means and LSD values for grain yield, number of heads/m <sup>2</sup> , number of kernels/head, 1000-kernel weight and straw: yield ratio over varieties, nitrogen rates and defoliation treatments in Experiment 1, 1976-1977. ....	68
5	Means and LSD values for grain yield, grain protein, lysine/protein, adjusted lysine/protein and total grain protein over varieties, nitrogen rates and defoliation treatments in Experiment 1, 1976-1977. ....	70
6	Simple correlation coefficients (r) for various agronomic and quality traits combined over varieties, nitrogen rates and defoliation treatments in Experiment 1, 1976-1977 (n=60). ....	73
7	Significance of mean squares for agronomic and quality traits studied over varieties and defoliation treatments in Experiment 2, 1976-1977. ....	74
8	Means and LSD values for grain yield, number of heads/m <sup>2</sup> , number of kernels/head, 1000-kernel weight, plant height and test weight over varieties and defoliation treatments in Experiment 2, 1976-1977. ....	76

Table		Page
9	Means and LSD values for grain yield, grain protein and total grain protein over varieties and defoliation treatments in Experiment 2, 1976-1977. ...	78
10	Simple correlation coefficients (r) for agronomic and quality traits combined over varieties and defoliation treatments in Experiment 2, 1976-1977. (n=120). ....	81
11	Significance of mean squares for agronomic and quality traits studied in Experiment 3, 1977-1978. ....	82
12	Means and LSD values for grain yield, number of heads/m <sup>2</sup> number of kernels/head, 1000-kernel weight, plant height and straw:yield ratio over varieties and defoliation treatments in Experiment 3, 1977-1978. ....	83
13	Means and LSD values for grain yield, grain protein, lysine/protein, adjusted lysine/protein and total grain protein over varieties and defoliation treatments in Experiment 3, 1977-1978. ....	85
14	Simple correlation coefficients (r) for agronomic and quality traits combined over varieties and defoliation treatments in Experiment 3, 1977-1978. (n=60). ....	87
15	Significance of mean squares for three traits studied over varieties, nitrogen rates and defoliation treatments in all sampling weeks, Experiment 1, 1976-1977. ....	89
16	Significance of mean squares for five traits studied over varieties, nitrogen rates and defoliation treatments in all sampling weeks, Experiment 1, 1976-1977. ....	90
17	Significance of mean squares for foliage and head determinations over varieties, nitrogen rates and defoliation treatments for five sampling weeks in Experiment 1, 1976-1977. ....	92

Table		Page
18	Means and LSD values for foliage dry matter (kg/ha) over varieties, nitrogen rates and defoliation treatments in five sampling weeks in Experiment 1, 1976-1977. ....	94
19	Means and LSD values for head dry matter (kg/ha) over varieties, nitrogen rates and defoliation treatments in four sampling weeks in Experiment 1, 1976-1977. ....	97
20	Means and LSD values for total dry matter (kg/ha) in foliage and heads over varieties, nitrogen rates and defoliation treatments in four sampling weeks in Experiment 1, 1976-1977. ....	99
21	Means and LSD values for percentage of nitrogen in the foliage over varieties, nitrogen rates and defoliation treatments in five sampling weeks in Experiment 1, 1976-1977. ....	103
22	Means and LSD values for total nitrogen in the foliage (kg/ha) over varieties, nitrogen rates and defoliation treatments in five sampling weeks in Experiment 1, 1976-1977. ....	104
23	Means and LSD values for percentage of nitrogen in the heads over varieties, nitrogen rates and defoliation treatments in four sampling weeks in Experiment 1, 1976-1977. ....	107
24	Means and LSD values for total nitrogen in heads (kg/ha) over varieties, nitrogen rates and defoliation treatments in four sampling weeks in Experiment 1, 1976-1977. ....	109
25	Means and LSD values for total nitrogen (kg/ha) in foliage and heads over varieties, nitrogen rates and defoliation treatments in four sampling weeks in Experiment 1, 1976-1977. ....	111

Table		Page
26	Means and LSD values for mature dry matter and nitrogen accumulation over defoliation treatments in three nitrogen rates and four varieties, Experiment 1, 1976-1977. ....	113
27	Significance of mean squares for three traits studied over varieties and defoliation treatments in all sampling weeks, Experiment 3, 1977-1978. ....	115
28	Significance of mean squares for five traits studied over varieties and defoliation treatments in four sampling weeks, Experiment 3, 1977-1978. ....	116
29	Significance of mean squares for foliage and head determinations in five sampling weeks in Experiment 3, 1977-1978. ....	118
30	Means and LSD values for foliage dry matter (kg/ha) over varieties and defoliation treatments in five sampling weeks in Experiment 3, 1977-1978. ....	119
31	Means and LSD values for head dry matter (kg/ha) over varieties and defoliation treatments in four sampling weeks in Experiment 3, 1977-1978. ....	122
32	Means and LSD values for total dry matter (kg/ha) in foliage and heads over varieties and defoliation treatments in four sampling weeks in Experiment 3, 1977-1978. ....	124
33	Means and LSD values for nitrogen (%) in the foliage over varieties and defoliation treatments in five sampling weeks in Experiment 3, 1977-1978. ....	128
34	Means and LSD values for total foliage nitrogen (kg/ha) over varieties and defoliation treatments in five sampling weeks in Experiment 3, 1977-1978. ....	131

Table		Page
35	Means and LSD values for nitrogen (%) in the heads over varieties and defoliation treatments in four sampling weeks in Experiment 3, 1977-1978. ....	133
36	Means and LSD values for total nitrogen in the heads (kg/ha) over varieties and defoliation treatments in four sampling weeks in Experiment 3, 1977-1978. ....	137
37	Means and LSD values for total nitrogen (kg/ha) in foliage and heads over varieties and defoliation treatments in four sampling weeks in Experiment 3, 1977-1978. ....	140



# LIST OF APPENDIX TABLES

Table		Page
A1.	Mean squares, overall means and coefficients of variation from analyses of variance for agronomic and quality traits in Experiment 1, 1976-1977. ....	189
A2.	Mean values for agronomic and quality traits over varieties, nitrogen rates and defoliation treatments in Experiment 1, 1976-1977. ....	191
A3.	Mean squares, overall means and coefficients of variation from analyses of variance for agronomic and quality traits studied in Experiment 2, 1976-1977. ....	195
A4.	Mean values for agronomic and quality traits over varieties and defoliation treatments in Experiment 2, 1976-1977.	196
A5.	Mean squares, overall means and coefficients of variation from analyses of variance for agronomic and quality traits studied in Experiment 3, 1977-1978. ....	197
A6.	Mean values for agronomic and quality traits over varieties and defoliation treatments in Experiment 3, 1977-1978.	198
A7.	Mean squares, overall means and coefficients of variation from analyses of variance for foliage dry matter, foliage nitrogen and total foliage nitrogen over varieties, nitrogen rates, defoliation treatments and sampling weeks in Experiment 1, 1976-1977. ....	199
A8.	Mean squares, overall means and coefficients of variation from analyses of variance for five traits over varieties, nitrogen rates and defoliation treatments in sampling weeks 2, 3, 4 and 5, Experiment 1, 1976-1977. ....	200

Table		Page
A9.	Mean squares, overall means and coefficients of variation from analyses of variance for three traits studied in the first sampling week, Experiment 1, 1976-1977. ....	201
A10.	Mean squares, overall means and coefficients of variation from analyses of variance for eight traits studied in the second sampling week, Experiment 1, 1976-1977. ....	202
A11.	Mean squares, overall means and coefficients of variation from analyses of variance for eight traits studied in the third sampling week, Experiment 1, 1976-1977. ....	203
A12.	Mean squares, overall means and coefficients of variation from analyses of variance for eight traits studied in the fourth sampling week, Experiment 1, 1976-1977. ....	204
A13.	Mean squares, overall means and coefficients of variation from analyses of variance for eight traits studied in the fifth sampling week, Experiment 1, 1976-1977. ....	205
A14.	Means and LSD values for eight traits studied over varieties and nitrogen rates with no defoliation in five sampling weeks Experiment 1, 1976-1977. ....	206
A15.	Mean values for eight traits studied in four varieties over nitrogen rates and no defoliation in five sampling weeks, Experiment 1, 1976-1977. ....	207
A16.	Mean squares, overall means and coefficients of variation from analyses of variance for foliage dry matter, foliage nitrogen and total foliage nitrogen over varieties, defoliation treatments, and sampling weeks, Experiment 3, 1977-1978.	209

Table		Page
A17.	Mean squares, overall means and coefficients of variation from analyses of variance for five traits over varieties and defoliation treatments in sampling weeks 2, 3, 4 and 5, Experiment 3, 1977-1978. ....	210
A18.	Mean squares, overall means and coefficients of variation from analyses of variance for three traits studied in the first sampling week, Experiment 3, 1977-1978. ....	211
A19.	Mean squares, overall means and coefficients of variation from analyses of variance for eight traits studied in the second sampling week, Experiment 3, 1977-1978. ....	212
A20.	Mean squares, overall means and coefficients of variation from analyses of variance for eight traits studied in the third sampling week, Experiment 3, 1977-1978. ....	213
A21.	Mean squares, overall means and coefficients of variation from analyses of variance for eight traits studied in the fourth sampling week, Experiment 3, 1977-1978. ....	214
A22.	Mean squares, overall means and coefficients of variation from analyses of variance for eight traits studied in the fifth sampling week, Experiment 3, 1977-1978. ....	215
A23.	Means and LSD values for eight traits studied over varieties in five sampling weeks with no defoliation, Experiment 3, 1977-1978. ....	216
A24.	Means and LSD values for eight traits in four varieties and five sampling weeks with no defoliation, Experiment 3, 1977-1978. ....	217

Table		Page
A25.	Means and LSD values for mature dry matter and nitrogen accumulation over five defoliation treatments and three nitrogen rates for a) CI 13449/Centurk, b) Favorit/5/Cirpiz..., c) Lancota and d) Lancer, Experiment 1, 1976-1977. ....	218
A26.	Means and LSD values for mature dry matter and nitrogen accumulation in foliage and heads for four varieties and five defoliation treatments, Experiment 3, 1977-1978. ....	223

# LIST OF FIGURES

Figure		Page
1	Foliage dry matter for four varieties over nitrogen rates with no defoliation, Experiment 1, 1976-1977. ....	93
2	Head dry matter for four varieties over nitrogen rates with no defoliation, Experiment 1, 1976-1977. ....	96
3	Total dry matter production for four varieties over nitrogen rates with no defoliation, Experiment 1, 1976-1977. .	98
4	Dry matter accumulation in foliage, heads and total dry matter (foliage plus heads) over varieties and nitrogen rates with no defoliation in five sampling weeks, Experiment 1, 1976-1977. ....	101
5	Percentage of nitrogen in the foliage for four varieties over nitrogen rates and no defoliation, Experiment 1, 1976-1977. ...	102
6	Percentage of nitrogen in the heads for four varieties over nitrogen rates and no defoliation, Experiment 1, 1976-1977.	105
7	Percentage of nitrogen in foliage and heads over varieties and nitrogen rates with no defoliation, Experiment 1, 1976-1977. ....	108
8	Comparison of total nitrogen (foliage plus heads), total nitrogen in heads and total nitrogen in foliage over varieties and nitrogen rates with no defoliation, Experiment 1, 1976-1977. ....	112
9	Foliage dry matter for four varieties with no defoliation in five sampling weeks, Experiment 3, 1977-1978. ....	121
10	Head dry matter accumulation for four varieties with no defoliation in four sampling weeks, Experiment 3, 1977-1978.	123

Figure		Page
11	Total dry matter production for four varieties with no defoliation in four sampling weeks, Experiment 3, 1977-1978.	126
12	Dry matter accumulation in foliage, heads and total dry matter (foliage plus heads) over four varieties with no defoliation in five sampling weeks, Experiment 3, 1977-1978. ....	127
13	Percentage of nitrogen in the foliage for four varieties with no defoliation in five sampling weeks, Experiment 3, 1977-1978. ....	130
14	Total foliage nitrogen for four varieties with no defoliation in five sampling weeks, Experiment 3, 1977-1978. ....	132
15	Percentage of nitrogen in the heads for four varieties with no defoliation in four sampling weeks, Experiment 3, 1977-1978. ....	135
16	Percentage of nitrogen in the foliage and heads over four varieties with no defoliation in five sampling weeks, Experiment 3, 1977-1978. ....	136
17	Total nitrogen in the heads for four varieties with no defoliation in four sampling weeks, Experiment 3, 1977-1978. ....	138
18	Total nitrogen in foliage and heads for four varieties with no defoliation in four sampling weeks, Experiment 3, 1977-1978. ....	141
19	Comparison of nitrogen in foliage, nitrogen in heads and total nitrogen (foliage plus heads) over four varieties with no defoliation in five sampling weeks, Experiment 3, 1977-1978. ....	142

## INTRODUCTION

The causes of losses in grain yield of wheat are numerous. An important one is the loss of leaf area due to attack of diseases, insects or from physiological causes or mechanical injury. Reduction in leaf area changes the physiological processes in the plant, thus affecting important characteristics such as grain yield and grain protein.

Defoliation has been used by many investigators (Kiesselbach, 1925; Miller et al., 1948; Asana and Mani, 1950; Pauli and Laude, 1959; Hanway, 1969; and Mikesell and Paulsen, 1971) to study the contribution of different plant parts to the development of grain and consequently the grain yield. Most of the leaf contribution comes from the top two leaves that are green at the time of grain-filling. The leaves being the major sites of photosynthetic activity, appear to make an obvious contribution to the plant's grain-yielding ability. The literature provides good evidence that the flag leaf and morphological structures above it are important in the development of yield potential in cereals, of these the flag leaf is the more important. The defoliation of flag leaf and 4th leaf might be expected to have pronounced effects on assimilate supply to the grain. When plants are defoliated, the ear becomes the main source of assimilates to the grain.

Adequate nitrogen availability and proper environmental conditions after heading time are essential for rapid and efficient translocation of nitrogen from stem and leaves to the grain and for maximum grain protein. A number of experiments have been carried out to determine the optimum rate of nitrogen application to wheat varieties. Yield increases with nitrogen application are mainly due to an increase in tillering, number of kernels per head, and 1000-kernel weight. The effects of nitrogen application on yield, yield components and other agronomic traits have been studied in detail.

It is important to identify high-yielding wheat varieties that possess superior nutritive value. Efficient translocation of nitrogen from the foliage (stem plus leaves) to the grain has been offered as an explanation for varieties with high grain protein (Johnson, Mattern and Schmidt, 1967 and Youssef and Salem, 1975). Recent research indicates that protein content can be increased by breeding varieties that are high in grain protein content and also by the application of nitrogen fertilizer.

Some studies have demonstrated a negative relationship between grain yield and grain protein content (Gericke, 1930; Schlehuber and Tucker, 1959; and Haunold, Johnson and Schmidt, 1962). Now, the breeders are selecting for varieties with high grain yield and protein content. Some