MONTANA STATE UNIVERSITY

# Influence of paired rows on growth, yield, and fertility requirements of no-till spring wheat

by Arnold Norman Benson

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Soils
Montana State University
© Copyright by Arnold Norman Benson (1988)

Abstract:
Paired-row planting is a new method of planting small grains that may possibly improve weed control and increase fertilizer efficiency; however, studies to date with wheat (Triticum aestivum L.) have shown mixed results.

Field experiments were conducted in 1987 in three environments in north central Montana to evaluate the effect of paired rows (PR) on growth and yield of no-till spring wheat (cv. 'Rambo'). Secondary objectives were to evaluate fertilizer requirements of spring wheat in a PR system, and to determine optimum placement of P fertilizer. The experimental design was a randomized split-plot with three row configurations as main plot treatments, and various fertilizer rates and P placements as subplot treatments.

Grain yields were significantly reduced in the 15 x 35-cm PR at both dryland sites; yields at an irrigated site were similar across all three row configurations. The 20 x 30-cm PR and 25-cm equidistant row (ER) configurations responded similarly in terms of yield and yield components at all three sites.

Data from tissue samples taken at three growth stages revealed that although early growth differences due to row configuration were slight, and generally favored the PR, the 25-cm ER showed an increasing growth advantage with time compared to the 15 x 35-cm PR. In the combined analysis of variance across sites, this resulted in a significant ($P < 0.02$) row configuration x growth stage interaction for dry matter production. Plant shading within the PR and/or differences in water use efficiency were postulated as causal factors for these responses.

Grain yields were significantly increased by N at the two dryland sites. Considering both yield and grain protein, an N rate of 40 kg N Mg"1 grain was optimum for PR spring wheat. Since all three sites were high in P and K, few responses to P or K fertilizer were evidenced. Three P placements produced similar yields, except at the irrigated location.

Results of this study indicate that under no-till conditions there is no advantage to planting spring wheat in PR. Paired rows appeared to have little influence on fertilizer requirements of no-till spring wheat.

# INFLUENCE OF PAIRED ROWS ON GROWTH, YIELD, AND FERTILITY REQUIREMENTS OF NO-TILL SPRING WHEAT

by

Arnold Norman Benson

A thesis submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Soils

MONTANA STATE UNIVERSITY
Bozeman, Montana

August 1988

N 378
B442
Cop. 2



APPROVAL

of a thesis submitted by

Arnold Norman Benson

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

August 12, 1988 — Earl O. Skogley
Date — Chairperson, Graduate Committee

Approved for the Major Department

August 12, 1988 — James W. Bauder
Date — Head, Major Department

Approved for the College of Graduate Studies

September 9, 1988 — Henry L. Parsons
Date — Graduate Dean

## STATEMENT OF PERMISSION TO USE

In presenting this thesis in partial fulfillment of the requirements for a master's degree at Montana State University, I agree that the Library shall make it available to borrowers under rules of the Library. Brief quotations from this thesis are allowable without special permission, provided that accurate acknowledgement of source is made.

Permission for extensive quotation from or reproduction of this thesis may be granted by my major professor or, in his absence, by the Dean of Libraries when, in the opinion of either, the proposed use of the material is for scholarly purposes. Any copying or use of the material in this thesis for financial gain shall not be allowed without my written permission.

Signature Arnold Benson

Date 8-12-88

# ACKNOWLEDGEMENTS

The author wishes to acknowledge at the outset that without the guidance and encouragement of the Lord Jesus Christ, this thesis would not have been attempted, much less have been completed. I now more fully realize the truth of Ecclesiastes 12:12: ". . . of making many books there is no end, and much study wearies the body."

Dr. Greg Kushnak provided me the opportunity to research this subject, and patiently worked with me when field experiments were in progress. My faculty advisor, Dr. Earl Skogley, gave invaluable assistance during all stages of my thesis project. I am also grateful to Dr. Kushnak and Dr. Skogley for the financial support they have provided. Special mention must be made of the contributions of Bernard Schaff who spent many hours helping me with data entry and analysis (and a hundred other things).

I also thank Gladys Dunahoo and Judy Harrison for typing and other assistance.

My parents, Norman and Margaret Benson, and my family members have been faithful to support and encourage me at just the right times.

Last, but certainly not least, I want to thank my loving wife, Lora Jean Benson. She deserves a Ph.T. (putting hubby through) for her hard work and for putting up with the inconvenience of being separated from me during the school year.

# TABLE OF CONTENTS

TABLE OF CONTENTS--Continued

## LIST OF TABLES

LIST OF TABLES--Continued

LIST OF TABLES--Continued

LIST OF TABLES--Continued

LIST OF TABLES--Continued

LIST OF TABLES--Continued

## LIST OF FIGURES

ABSTRACT

Paired-row planting is a new method of planting small grains that may possibly improve weed control and increase fertilizer efficiency; however, studies to date with wheat (*Triticum aestivum* L.) have shown mixed results.

Field experiments were conducted in 1987 in three environments in north central Montana to evaluate the effect of paired rows (PR) on growth and yield of no-till spring wheat (cv. 'Rambo'). Secondary objectives were to evaluate fertilizer requirements of spring wheat in a PR system, and to determine optimum placement of P fertilizer. The experimental design was a randomized split-plot with three row configurations as main plot treatments, and various fertilizer rates and P placements as subplot treatments.

Grain yields were significantly reduced in the 15 x 35-cm PR at both dryland sites; yields at an irrigated site were similar across all three row configurations. The 20 x 30-cm PR and 25-cm equidistant row (ER) configurations responded similarly in terms of yield and yield components at all three sites.

Data from tissue samples taken at three growth stages revealed that although early growth differences due to row configuration were slight, and generally favored the PR, the 25-cm ER showed an increasing growth advantage with time compared to the 15 x 35-cm PR. In the combined analysis of variance across sites, this resulted in a significant ($P \leq 0.02$) row configuration x growth stage interaction for dry matter production. Plant shading within the PR and/or differences in water use efficiency were postulated as causal factors for these responses.

Grain yields were significantly increased by N at the two dryland sites. Considering both yield and grain protein, an N rate of 40 kg N $Mg^{-1}$ grain was optimum for PR spring wheat. Since all three sites were high in P and K, few responses to P or K fertilizer were evidenced. Three P placements produced similar yields, except at the irrigated location.

Results of this study indicate that under no-till conditions there is no advantage to planting spring wheat in PR. Paired rows appeared to have little influence on fertilizer requirements of no-till spring wheat.

# CHAPTER 1

# INTRODUCTION

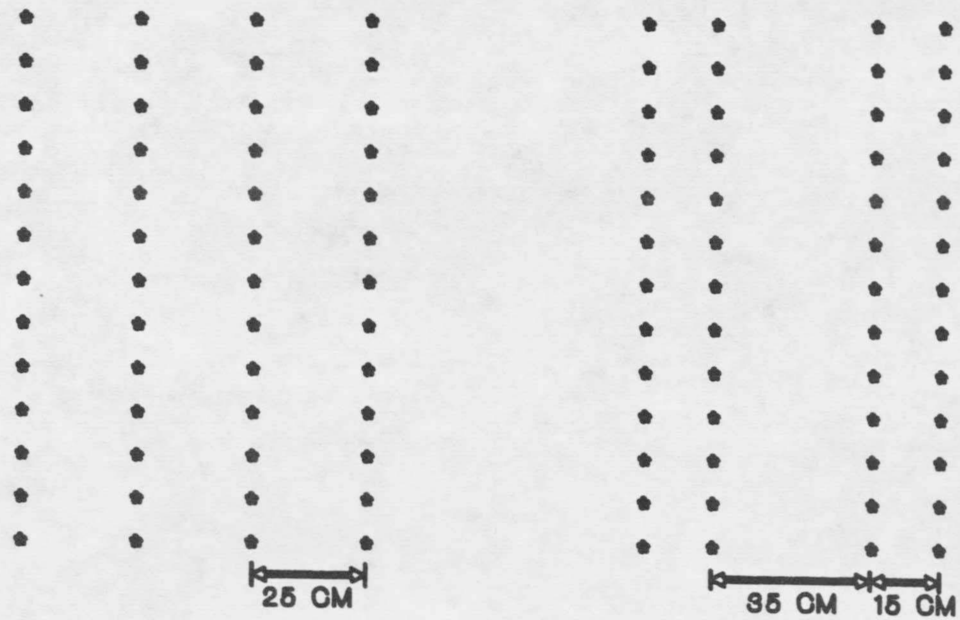
The use of no-till and minimum tillage systems for small grain production is growing rapidly in grain-producing regions of the western United States. These production systems have the potential to effectively control soil erosion and reduce production costs. Advances in fertilizer placement technology and equipment design have further increased the yield potential of these systems.

Despite these advantages, there is the frequent problem of grassy weeds, resulting in increasing dependence on herbicides for weed control (Papendick and Miller, 1977). Crop residues left on the soil surface also make planting more difficult, and can result in immobilization of applied fertilizer (Tomar and Soper, 1981).

Paired-row planting is a new method of planting small grains that originated in the Pacific northwestern United States in the early 1980's. In this method, two rows of seeds are planted 10 to 18 cm apart with an untilled zone of 33 to 40 cm between each set of rows (Fig. 1). Paired-row planting makes it possible to supply all of the crop's fertilizer needs at the time of seeding by placing a deep band (>10 cm deep) of fertilizer midway between the paired rows; the nutrients are thus equally accessible to each seed row. This represents a possible advantage over the practice of banding fertilizer prior to planting. Leikam et al.

Figure 1

## DIAGRAM OF EQUIDISTANT AND PAIRED-ROW CONFIGURATIONS




25-CM EQUIDISTANT ROW

15 X 35-CM PAIRED ROW

(1983) found that winter wheat growth was best immediately atop pre-plant fertilizer bands and poor midway between bands.

Fertilizer deep-banded between paired rows may also improve weed control in no-till systems by making nutrients less accessible to weeds. Easier field access for application of herbicides or soil fumigants has been suggested as another possible advantage of paired-row planting (Papendick et al., 1984).

Several studies have shown that deep-banded nitrogen fertilizer is more effective than unincorporated broadcast applications, especially in no-till systems (Parsons and Koehler, 1984; Carter and Rennie, 1984). The strategy of deep banding fertilizer is usually adopted along with a paired-row planting system. For this reason, when paired rows show an apparent yield advantage over equidistant rows, it is difficult to determine if the response is due to banded fertilizer or due to row configuration. Furthermore, direct comparison of row configuration is difficult because most drills do not allow for major adjustments in row spacing or configuration.

For these reasons, little information is available for comparing crop response to equidistant and paired-row planting systems. Studies to date with wheat have shown mixed results. The fertilizer requirements of wheat under paired-row cropping have not been fully evaluated.

Field experiments were conducted in 1987 at two dryland sites and one irrigated site in north central Montana with the following objectives:

(1) to determine the effect of paired rows on growth and yield of no-till spring wheat (*Triticum aestivum* L.) and investigate possible causes of differential response;

(2) to determine optimum nitrogen (N), phosphorus (P), and potassium (K) fertilizer rates for spring wheat in a paired-row system; and

(3) to determine the optimum placement of P fertilizer for spring wheat.