PHOSPHORUS FERTILIZATION AND IRRIGATION OF PULSE CROPS*

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I. INTRODUCTION

Pulse crops are occupying an increasing acreage in Saskatchewan. Recent research has shown that phosphate placement methods can provide substantially different yield increases for various pulse crops. There is also a need to test these newer crops on a wide range of soil and climatic conditions.

The objectives of this study were to determine the effect of phosphate placement on the growth of fababeans, peas, field beans, and lentils and to determine the response of these crops to irrigation.

This was a joint project between the Crop Development Center and the Department of Soil Science, University of Saskatchewan. Field experiments were conducted in 1976, 1977 and 1978 and this paper is intended to summarize the three years of data obtained.

II. EXPERIMENTAL METHODS

The soils selected for this study included Elstow loam soils at both Outlook and Saskatoon for all three years of the experiment. At the Outlook site the location was moved from field to field over the three years but all sites were on the same soil and within 2 km of one another. The Saskatoon site was on the Goodale Research Farm of the University of Saskatchewan. A Melfort silty clay loam soil was selected near the town of Melfort in 1976 and near the town of Hagen in 1977 and 1978.

Soil types and available nutrient status are presented in Table 1. The site at Outlook had been planted to wheat in the year prior to the experiment and the sites at both Saskatoon and for the Melfort soil had been fallowed in the year prior to the experiment.

Cultivars utilized are presented in Table 2. Seeding was done with a press drill with two sets of double-disc furrow openers in 1976 and with a specially constructed press drill with knife type furrow openers for both seed and fertilizer in 1977 and 1978. This allowed placement of the phosphate either with the seed or as a sideband application. For the

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Table 1. Soil analysis for the experimental sites

Location	Soil Type	Year	NO_3^--N kg/ha to 60 cm	P ---- kg/ha to 15 cm	K -----
Outlook	Elstow: loam	1976	40	15	595
		1977	57	6	424
		1978	43	8	555
Saskatoon	Elstow: loam	1976	57	14	---
		1977	--	--	---
		1978	73	12	530
Melfort	Melfort: silty clay loam	1976	62	22	---
Hagen		1977			
Hagen		1978	131	18	650

Table 2. Cultivars utilized in P placement experiments.

	1976	1977	1978
Peas	Trapper	Trapper	Trapper
Beans	Aurora	Great Northern U.S. 1140	Great Northern U.S. 1140
Lentils	P.1. 179307	P.1. 179307	P.1. 179307
Fababeans	Erfordia	Erfordia	Erfordia

sideband application the phosphorus was applied about 2.5 cm to the side and 2.5 cm below the seed.

The fertilizer treatments used are presented in Table 3. The phosphorus source utilized was monoammonium phosphate (11-55-0) for all treatments at all locations in all years. No additional nitrogen was utilized.

Herbicide applications were consistent with recommendations available for the crop and for the specific year. Some hand weeding was also done. At Outlook in 1977 a serious infestation of Russian thistle overcame the lentils plot and it was necessary to abandon the experiment in that year.

At the Outlook site the plot was duplicated to provide both a dryland and an irrigated plot. Irrigation was scheduled by tensiometers. Irrigation water was applied when tensiometers indicated a moisture tension of approximately 0.5 atmospheres in 1976 and at a tension of 0.7 atmospheres in 1977 and 1978. In addition, seamless aluminum access tubes were installed to allow moisture measurements with the neutron moisture meter. At approximately three to four weeks after seeding stand counts were taken.

At the Outlook site for all crops except peas, harvesting was done by hand cutting at the soil surface, the center rows of each crop over a distance of 3 m. This allowed determination of straw as well as grain yields. For peas at Outlook, harvesting was with the Hege combine and the straw material was collected, dried and weighed. At the other two sites all crops were harvested with the Hege combine.

III RESULTS AND DISCUSSION

3.1 Stand of Crops

The information obtained on stand counts is presented in Figures 1, 2, 3 and 4 for peas, beans, lentils and fababeans respectively.

For peas, phosphate applied as a sideband application had no affect on crop stands whereas seed placed phosphorus reduced the stand by approximately 50% at the highest rate of application. Even at a rate of 17 kg P_2O_5 per hectare stands of peas were reduced. The three year average data for peas was very similar for both dryland and irrigated conditions at Outlook and at the Saskatoon and Hagen - Melfort sites. It should be noted that one would expect both dryland and irrigated plots to be similar since no irrigation application had been made at the time the stand counts were taken.

Beans showed somewhat less reduction in crop stands with seed placed phosphorus (Fig. 2). Lentils showed large reduction in crop stand at both the Outlook and Saskatoon sites but relatively little change at the Hagen-Melfort site (Fig. 3).

The stand of fababeans was not affected by phosphorus fertilization either as a sideband or as a seed placed application even at the highest

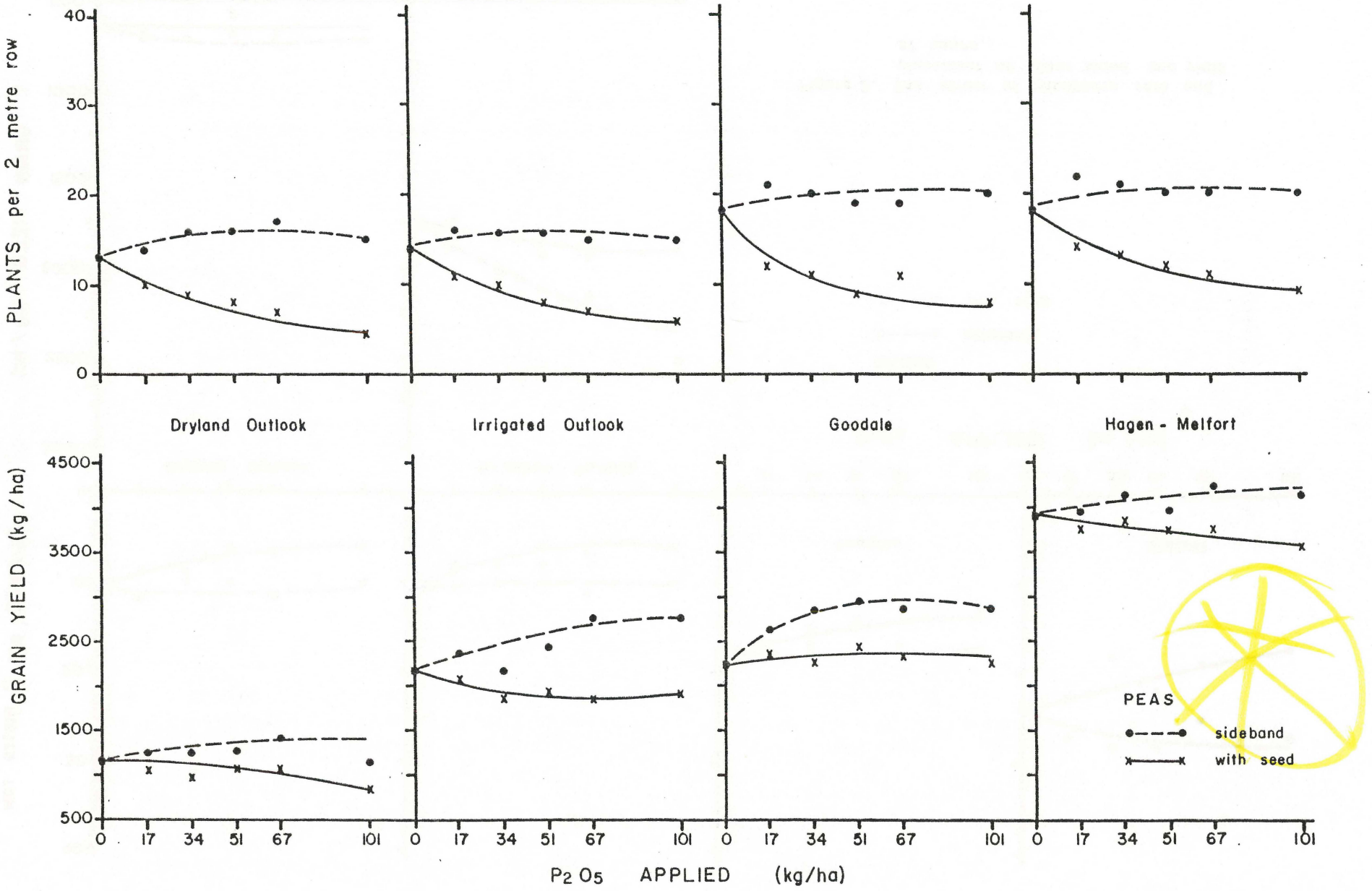

Figure 1. The effect of phosphate rate and placement on plant stand and yield of peas.

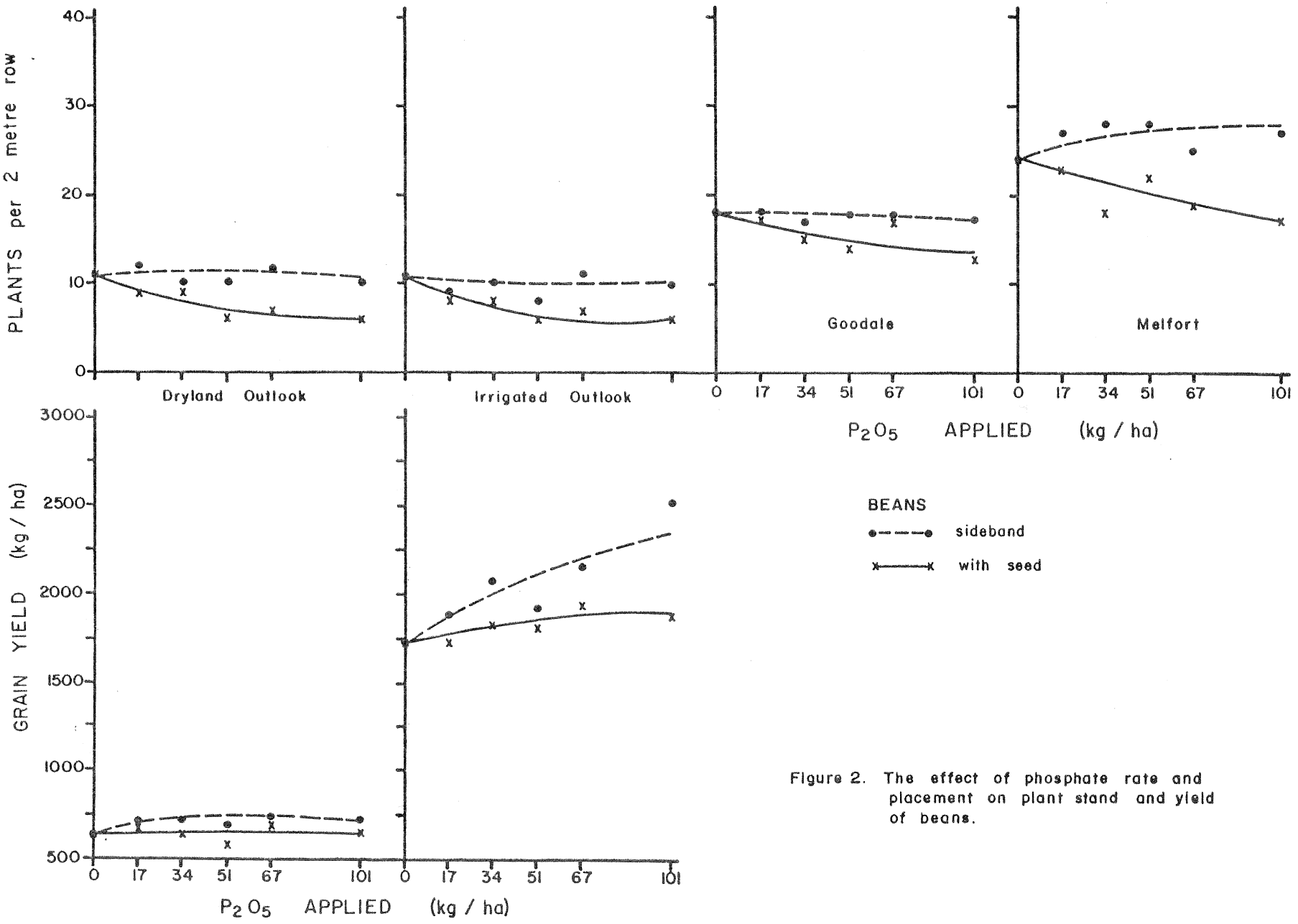

Figure 2. The effect of phosphate rate and placement on plant stand and yield of beans.

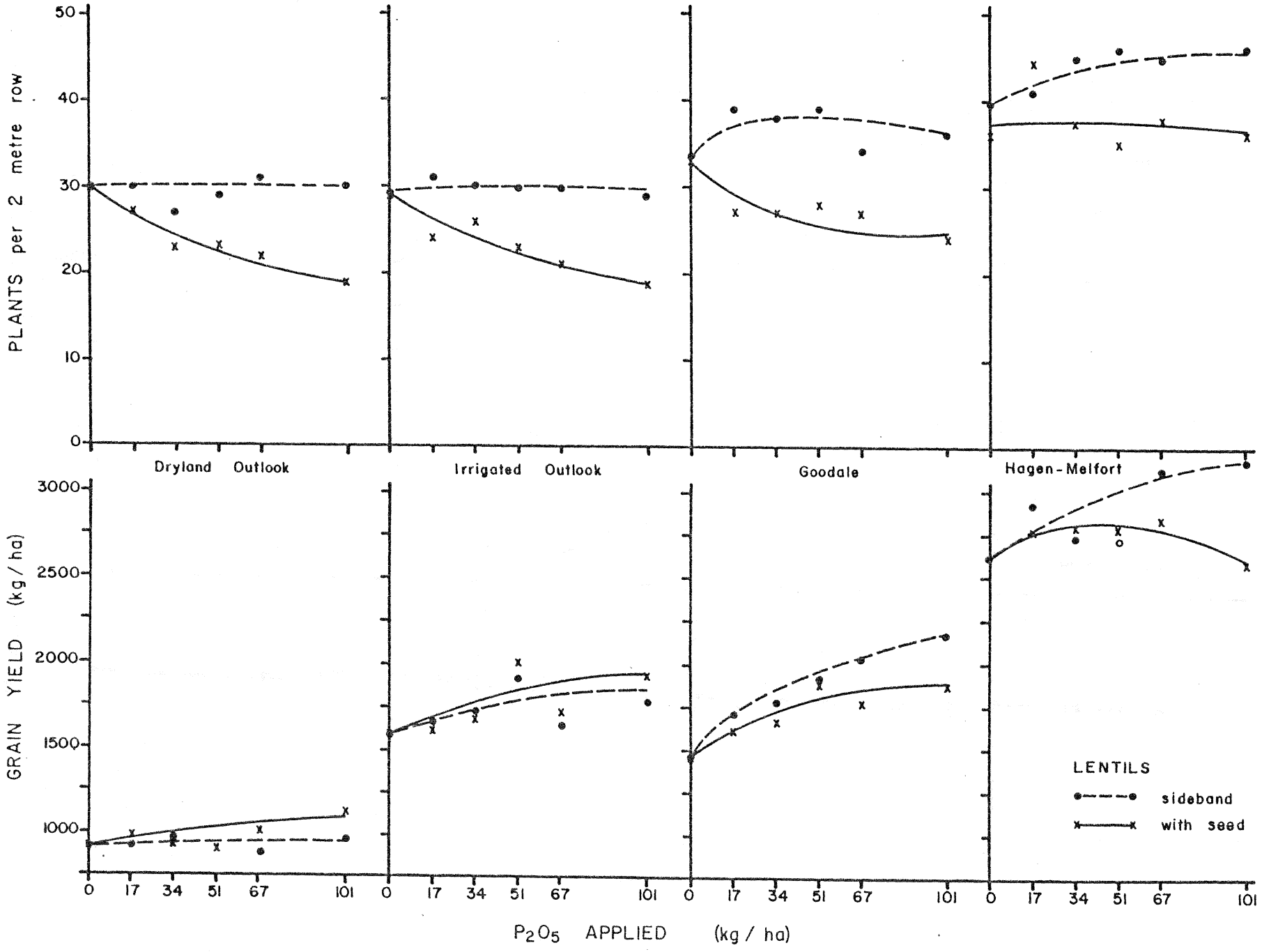

Figure 3. The effect of phosphate rate and placement on plant stand and yield of lentils.

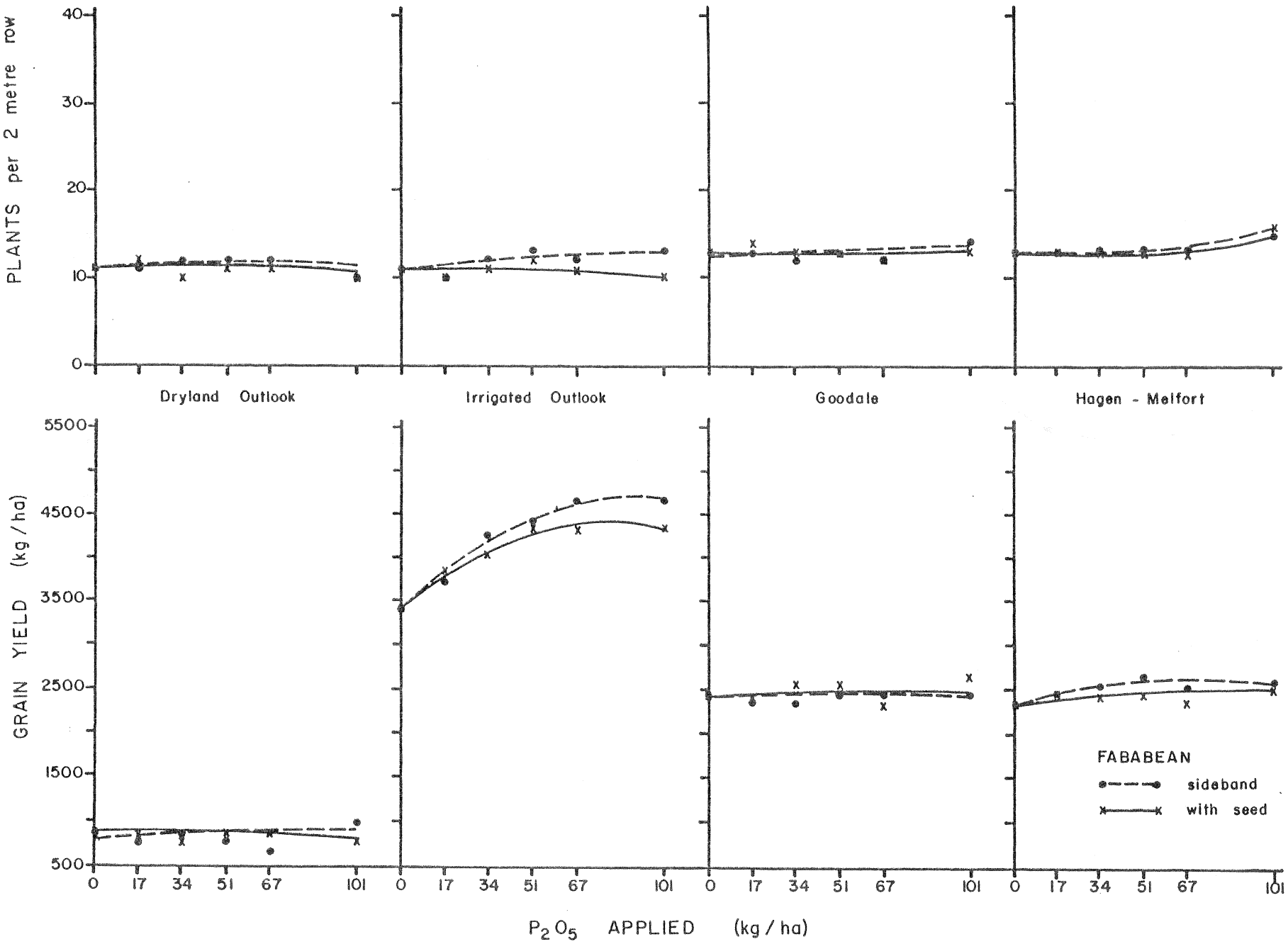

Figure 4. The effect of phosphate rate and placement on plant stand and yield of fababeans.

rates used in this study.

3.2 Grain Yield

Pea yields were increased substantially at both the Saskatoon site and under irrigated conditions at Outlook. Yield increases under dryland conditions at Melfort were small. Seed placed applications resulted in no increases in yield and the higher rates of application resulted in small decreases in yields at Melfort and dryland conditions at Outlook.

Bean yields were increased substantially under irrigated conditions at Outlook but under dryland conditions very small yield increases were obtained to sideband applications. Seed placed applications resulted in very small and uneconomic increases in yield (Fig. 3).

Lentil yields were increased by both seed placed and sideband applications at Saskatoon, Hagen, Melfort and Outlook irrigated sites. Sideband applications were generally superior to seed place but the differences were not as pronounced as with peas and beans.

The yield of fababeans was increased sharply by both sideband and seed placed phosphorus applications under irrigation at the Outlook site. Sideband applications were superior to seed placed but the differences were not large. Under dryland conditions at Outlook and at the other two sites no increases to phosphorus fertilization were obtained with fababeans for either placement methods.

3.3 Crop Adaptation

Summary data on grain yields and grain straw ratios is provided in Table 4. Fababean yields were very clearly superior under irrigated conditions at Outlook whereas the traditional high productivity area (Hagen - Melfort) produced the highest yields of both peas and lentils. At Outlook, dryland yields were approximately 50% of irrigated yields for both peas and lentils. For beans the dryland yields were only 35% that of irrigated while fababeans produced only 20% as much on dryland as under irrigated conditions.

Grain straw ratios for the Outlook site show that beans convert the largest percentage of the photosynthate into harvestable grain. These data also show clearly the greater efficiency of grain production when moisture stress is eliminated.

IV. CONCLUSIONS

The following conclusions are based on three years of field data and should provide reasonable guidelines to production of pulse crops.

1) Seed placed phosphorus results in serious stand reductions for peas, beans and lentils. For peas and beans these stand reductions are

Table 3. Treatments used in phosphate placement experiments.

Treatment Number	P_2O_5 Applied (kg/ha)	Placement
1	0	with seed
2	17	with seed
3	34	with seed
4	50	with seed
5	67	with seed
6	101	with seed
7	0	
8	17	sideband
9	34	sideband
10	50	sideband
11	67	sideband
12	101	sideband

Table 4. Site averages for grain yield and grain/straw ratio (1976-78).

	Fababean	Pea	Beans	Lentils
	kg/ha			
Outlook Dryland	810	1127	669	952*
Irrigated	4119	2189	1930	1746*
Saskatoon	2396	2245	----	1774
Melfort-Hagen	2478	3169	----	2805**
		Grain/Straw		
Outlook Dryland	0.74	0.87	1.15	0.69
Irrigated	1.03	1.13	1.51	0.83

* Lentil data for 1976 and 1978 only.

** High lentil yields at Hagen in 1978 (>4000 kg/ha) did not mature in the field. They were cut in the field and dried artificially.

so serious as to almost preclude yield response to seed placed phosphorus. Yield responses to seed placed phosphorus are so small that the economics is questionable and such recommendations should be closely examined with a view to eliminating the recommendation of seed placed phosphorus for those two crops.

2) Seed placed phosphorus results in significant stand reduction of lentils but useful yield increases were still obtained at most sites. It is probable that the current recommendation of a low rate of application of seed placed phosphorus is justified.

3) Placement of phosphorus away from the seed provides economic yield increases for peas, beans and lentils.

4) Fababean stands are not affected by phosphate placed with the seed. In irrigated agriculture phosphate applications at least as great as that for cereals is essential to maximizing production of fababeans. Under other conditions in this study no yield increases were obtained.

5) Fababeans are very definitely an irrigated crop and beans also respond well to irrigation. While increases in yield of both peas and lentils were obtained under irrigation it is doubtful whether these two crops could be considered as a high priority for irrigated acreage in a farm unit containing both dryland and irrigated portions.