Phosphate Placement for Rapeseed, Sunflowers, Peas and Flax

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Introduction

There are essentially two practical ways of providing phosphorus for grain crops on phosphorus deficient soils. These are 1) applying high rates of phosphate fertilizer by broadcasting and incorporating into the cultivated layer to raise the available P supply for several succeeding crops and 2) banding the phosphate required for the immediate crop with or adjacent to the seed.

Numerous investigations in Western Canada have shown that when phosphate fertilizer is applied at moderate rates in the drill row, most efficient use of fertilizer phosphorus is made when phosphate is banded directly in contact with or close to the seed for crops such as wheat and barley. Rates sufficient to supply the total current requirements of the crop can be applied in this way. This can be attributed to the low mobility of phosphate fertilizer when applied to soils having appreciable amounts of silt and clay, especially under our semi-arid conditions, recognizing the fact that most grain crops require and take up the major portion of their P requirements in the first few weeks of growth.

As a result of the low mobility of fertilizer phosphate, most efficient utilization is generally obtained when the P is placed with the seed of most crops. However, certain pulse and oilseed crops, and other small seeded crops have a relatively low tolerance for fertilizers, including phosphates when applied in contact with the seed, as compared to the cereal grains. Furthermore, the various crops differ substantially in root form and configuration as well as rates of root growth, and placement of an immobile nutrient such as P in relation to the seed may influence the rate and extent of utilization of the applied P.

Earlier investigations in Western Canada with rapeseed, sunflowers, peas and flax, in which phosphate was generally applied with the seed, produced results which indicated that these crops responded rather poorly to P fertilizers even on soils low in available P. The maximum yield increases were usually obtained at relatively low rates of applied fertilizer P, with little or no response at higher rates. These results suggested that the crops had either a low requirement for P or were able to extract soil P very efficiently. Subsequent P uptake studies showed that these crops actually had a relatively high requirement for P (Kalra and Soper, 1968) and other investigations (Racz, et al, 1965; Strong and Soper, 1974) also showed that some of the crops differed markedly in their ability to utilize soil and fertilizer P compared to the cereal grains such as wheat. However, the effects of phosphate fertilizers on germination and effects of P placement on yields and other responses were not adequately assessed. The lack of response at higher rates of seed-placed P was not explained.

In this paper the results of phosphate placement studies carried out over a period of several years on different soil types in west central Saskatchewan are summarized to compare the responses of different crops to phosphate rates and placement methods.

Materials and Methods

During the period 1969-75 a number of field experiments were carried out on different soil types in which monoammonium phosphate 11-55-0 was applied 1) with the seed in the drill row, and 2) banded 2.5 cm below x 2.5 cm to the side of the seed at rates from 11 to 112 kg/ha P_2O_5 for rapeseed, sunflowers, peas and flax. Wheat and barley were sown in adjacent plots and given identical fertilizer treatments to be used as "standards" for comparison. Peas and flax were used as test crops in 1975 only, and sunflowers were studied only on Scott loam. In 1975 an additional placement treatment was added for all the abovementioned crops, namely M.A.P. 11-55-0 at rates given above banded 2.5 cm directly below the seed. Seeding and fertilizer applications were done with a specially constructed two-gang double disc plot seeder capable of placing the fertilizer at different positions relative to the seed.

Plant counts were taken to determine effects of fertilizer treatments on germination and emergence, and mature yields as well as N and P contents of grain were determined. Some characteristics of the soils used in these studies are given in Table 1.

Table 1. Some characteristics and properties of soils used.

Soil Association	Zone	Texture	Surface pH*	kg/ha** $NaHCO_3$ - extractable P P
Sceptre (Sc)	Brown	HvC	7.9	9-16
Elstow (E)	Dark Brown	SiCL	7.0	20
Scott (Stt)	Dark Brown	L	5.2	17-34
Waseca (Wa)	Black	L	6.1	11-17
Waitville (Wv)	Grey	L	6.3	12-29
Loon River (Ln)	Grey	L	7.0	11-37

* saturated paste
** 0-15 cm depth minimum and maximum values for P in soils sampled in spring just before seeding.

Results and Discussion

Average yield increases for wheat and barley on fallow (Figure 1) show very little difference between methods of phosphate placement. With wheat, results were consistent over all soil types, showing only a slightly larger yield increase for the with-seed banding of fertilizer. Average results for barley show even less difference between the two placement methods, but occasionally significantly larger yield increases were obtained from banding the fertilizer 2.5 cm below-to the side of the seed as compared to with seed on the grey-wooded Waitville loam soil. Plant count data, presented in Figure 2, show that these crops were able to tolerate M.A.P. 11-55-0 placed with the seed at rates up to the maximum used in this study with no reduction in germination or emergence.

Rapeseed reacted quite differently to methods of fertilizer phosphate placement, giving strong response on P deficient soils to rates of applied P_2O_5 up to 67 kg/ha when banded 2.5 cm below x 2.5 cm to side of seed. When the fertilizer was placed with the seed in the drill run, maximum yield response occurred at the 22 kg/ha rate, with a sharp decline at higher rates. These data support results of earlier investigations which showed yield responses only at relatively low rates of phosphate placed with the seed. The strong response to phosphate banded close to, but separate from, the seed shows that the poor response to higher rates placed with the seed is not due to a low requirement for P by this crop. Average yield increases of Torch rapeseed over a period of several years and several soils are shown in Figure 3, and results for 1975 in Figure 4. Banding the fertilizer directly below the seed in 1975 produced yields somewhat lower than when phosphate was banded below-to the side of the seed. The reduced yields at higher rates of applied P with seed can be attributed, at least in part, to detrimental effects on germination and emergence as shown in Figure 5. The magnitude of the response differences due to placement varied somewhat in relation to soil type. The smallest yield differences between fertilizer placement methods occurred on the black Waseca loam, and the largest on the grey Waitville and Loon River loams.

Sunflowers responded to phosphate placement quite similarly to rapeseed. Ammonium phosphate 11-55-0 placed with the seed on fallow generally produced only a small response, with near maximum yield increase occurring at 22 kg/ha P_2O_5, with either no further increase or a decrease in yield at higher rates. Figure 6, giving 3-year average yield increases of Krasnodaretz sunflowers for two P placement methods, shows a marked improvement in response to P on Scott loam when fertilizer was banded 2.5 cm below x 2.5 cm to the side of the seed compared to with-seed placement. In 1975 banding the phosphate directly below the seed row produced lower yield increases than the below-to side treatment, and delayed flowering of the crop by as much as 4 to 5 days. Banding the fertilizer below-to the side of the seed hastened maturity and resulted in significant increases in seed oil content above the check. Plant counts taken in 1975 (Figure 7) show the most drastic reduction in germination and emergence occurred from fertilizer applied in contact with the seed, an effect which appeared to be related to final yield results.

Field peas appear to be even more sensitive to fertilizer placed with the seed than sunflowers. Rates of M.A.P. 11-55-0 in excess of 45 kg/ha P_2O_5 reduced yields of seed below the check level on Scott loam in 1975, with only moderate yield increases at lower rates. However, when the fertilizer was banded below-to the side of the seed, a strong response to rates of P_2O_5 up to 40-60 kg/ha was obtained in two experiments seeded on different dates. Banding the phosphate 2.5 cm directly below the seed was not as effective as banding below-to the side in these trials. Yield responses to placement of P are shown in Figure 8. Plant count data presented in Figure 9 show a marked reduction in stand due to high rates of seed-placed phosphate fertilizer.

Flax was the only crop in these studies that responded markedly better to phosphate fertilizer when it was applied directly below the seed, and this occurred only on the Scott loam soil. Obviously there is need for additional research to clarify the P uptake and utilization characteristics of flax in relation to P placement method. Response of flax was related quite closely to soil available P levels. On low to medium P soils substantial yield increases were obtained from fertilizer P banded separate from the seed. Effects of applied fertilizer on germination and emergence varied with soil type and moisture content at seeding time. On the ESiCL and WaL, rates of M.A.P up to 90 kg/ha P_2O_5 had little detrimental effect on germination or yields, but under drier conditions on ScHvC and SttL the higher rates sharply reduced stands and yields. Such tolerance of flax, even under good moisture conditions, was not expected. However, on all soils the placement of M.A.P. 11-55-0 with the seed produced the poorest results, and average yield increases were highest when P was applied directly below the seed. Effect of placement on yields on SttL is shown in Figure 10 and the average for 5 soil sites in Figure 11. Effect of fertilizer treatments on plant populations on SttL are presented in Figure 12.

Analyses of mature seed samples from the 1975 test plots showed that in rapeseed and peas the response to applied P also appeared as higher total P percentages in the seed, associated with the higher yields obtained from separate banding of seed and phosphate fertilizer.

Racz, G. J., Webber, M. D., Soper, R. J. and Hedlin, R. A. 1965. Phosphorus and nitrogen utilization by rape, flax and wheat. Agron. J. 57: 335-337.

Kabra, Y. P., and Soper, R. J. 1968. Efficiency of rape, oats, soybeans and flax in absorbing soil and fertilizer phosphorus at seven stages of growth. Agron. J. 60: 209-212.

Strong, W. M. and Soper, R. J. 1974. Phosphorus utilization by flax, wheat, rape and buckwheat from a band or pellet-like application. I. Reaction zone root proliferation. II. Influence of reaction zone phosphorus concentration and soil phosphorus supply. Agron. J. 65: 597-605.

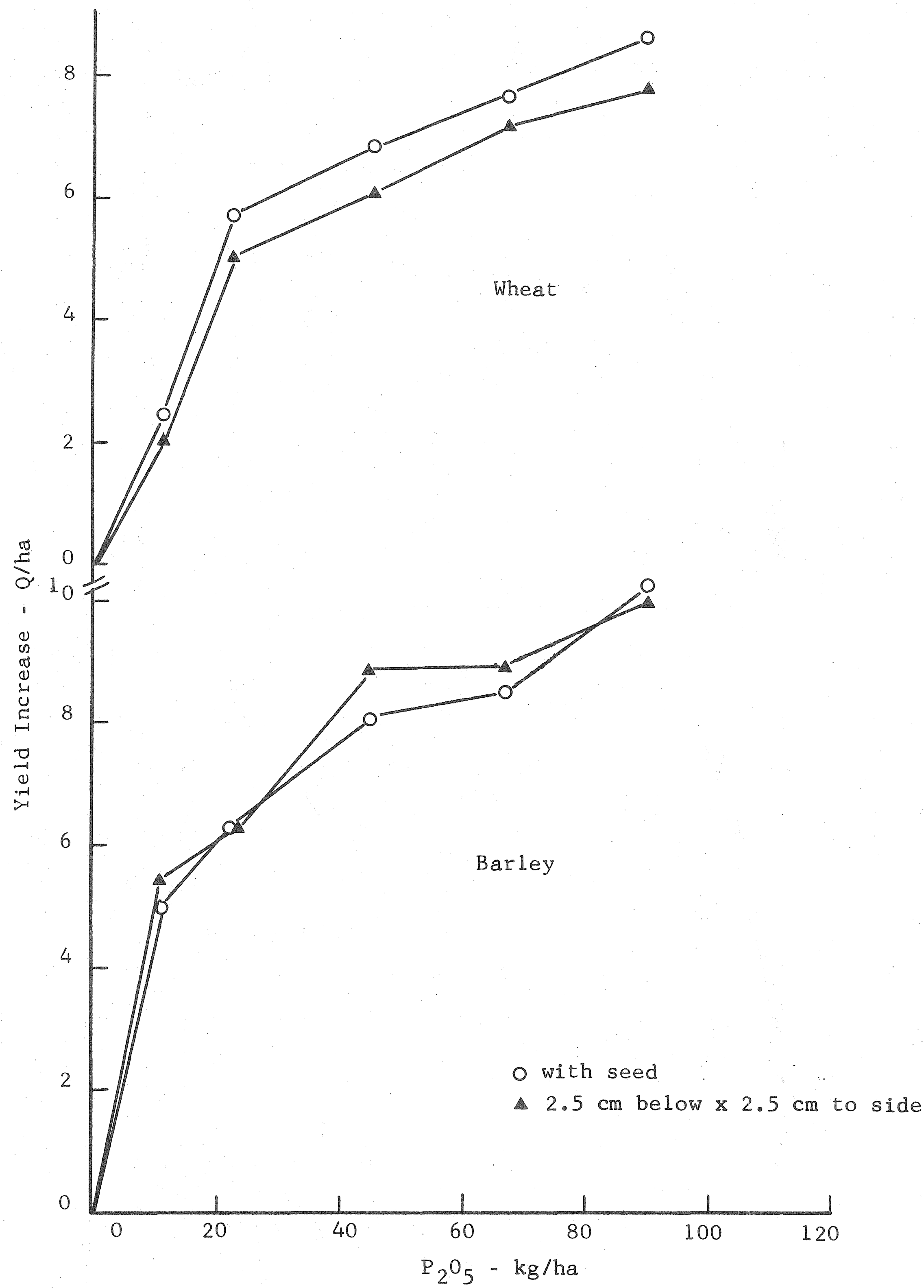

Figure 1. Effect of phosphate placement on yields of wheat and barley on fallow. Average increases for 2 - 7 years on each of 3 soil types for wheat, and 3 - 6 years on each of 4 soil types for barley.

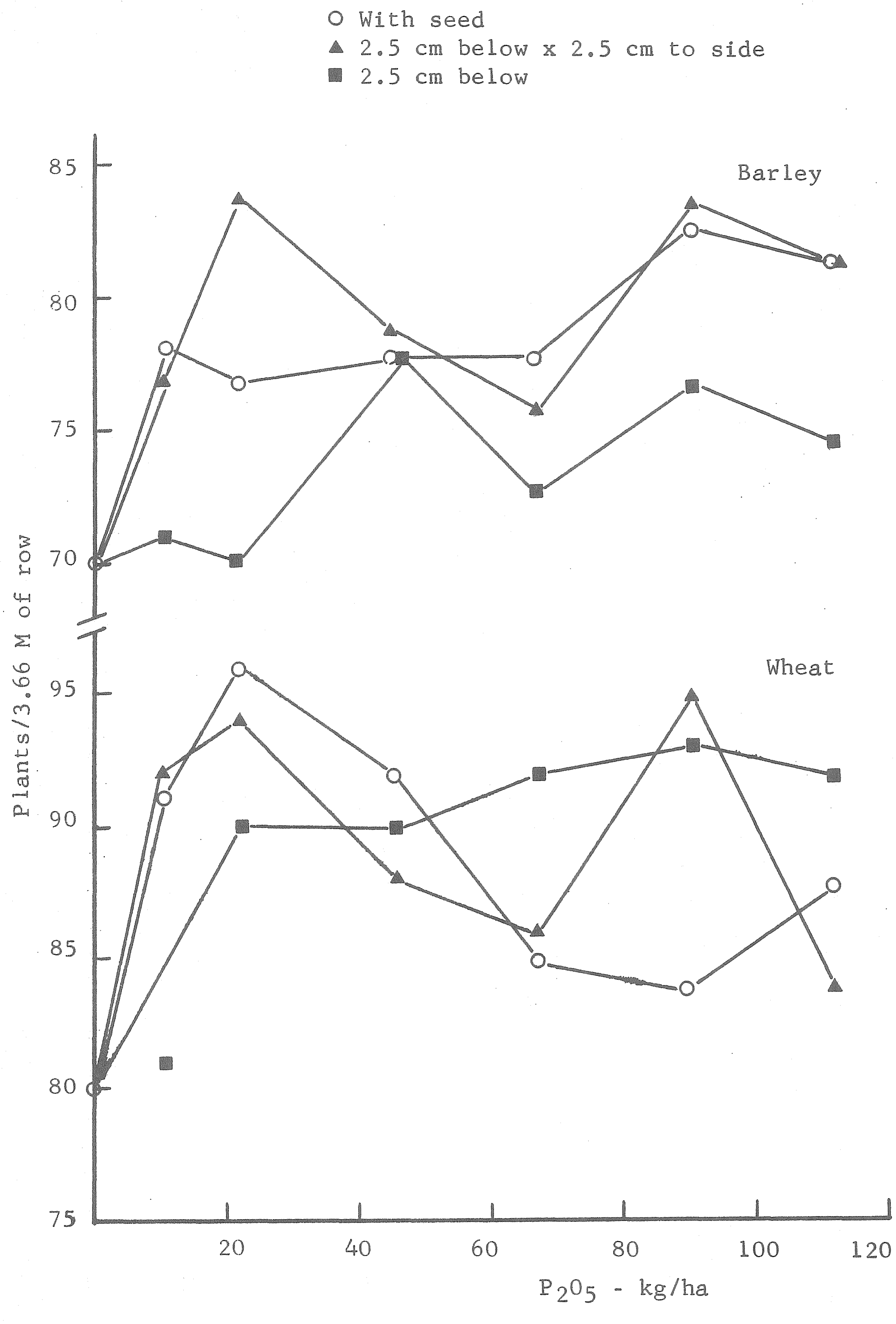

Figure 2. Effect of phosphate placement on plant populations of wheat and barley in field test plots in 1975. Average of 2 soil types for wheat and 3 soil types for barley.

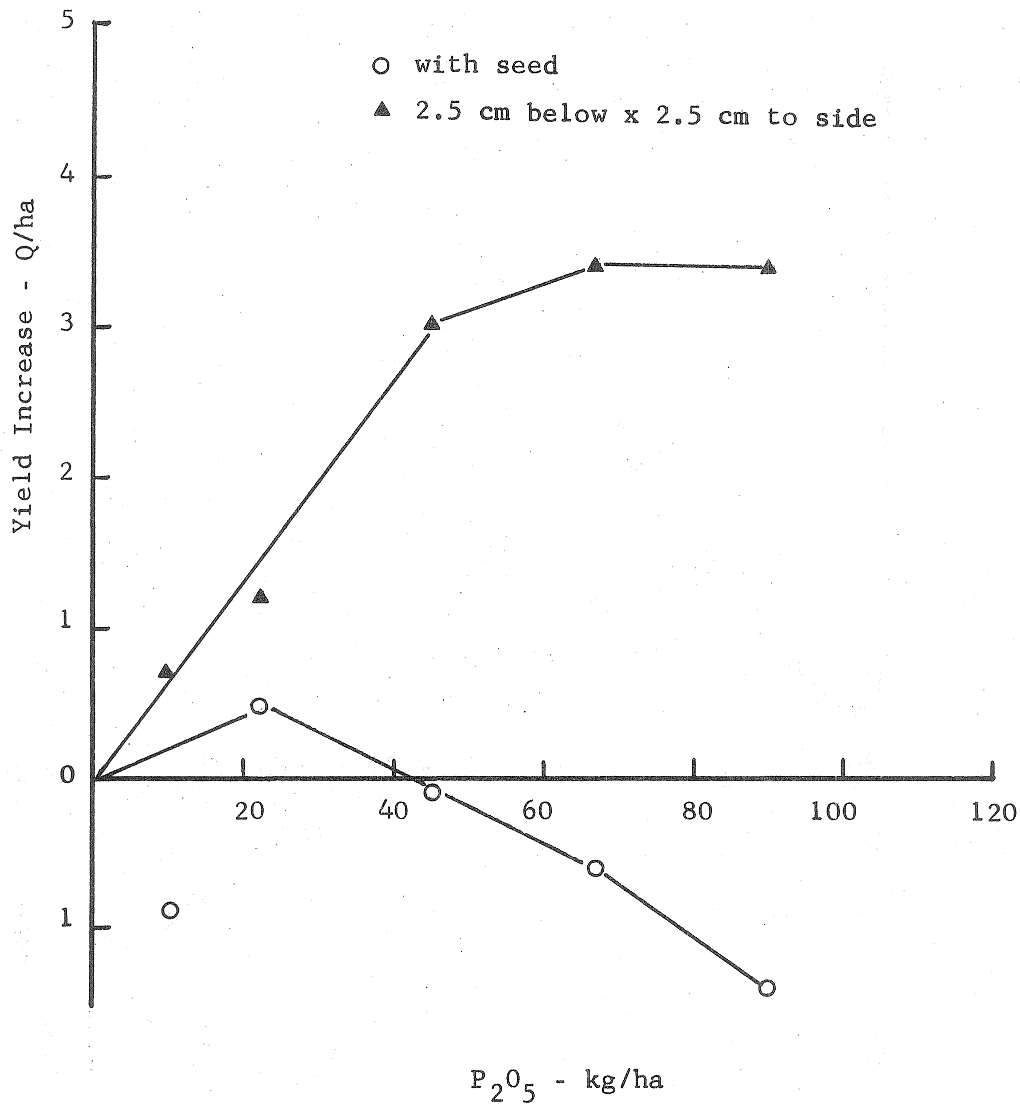

Figure 3. Effect of phosphate placement on yields of Torch (B. campestris) rapeseed on fallow. Average increases for 2 - 7 years on each of 4 soil types.

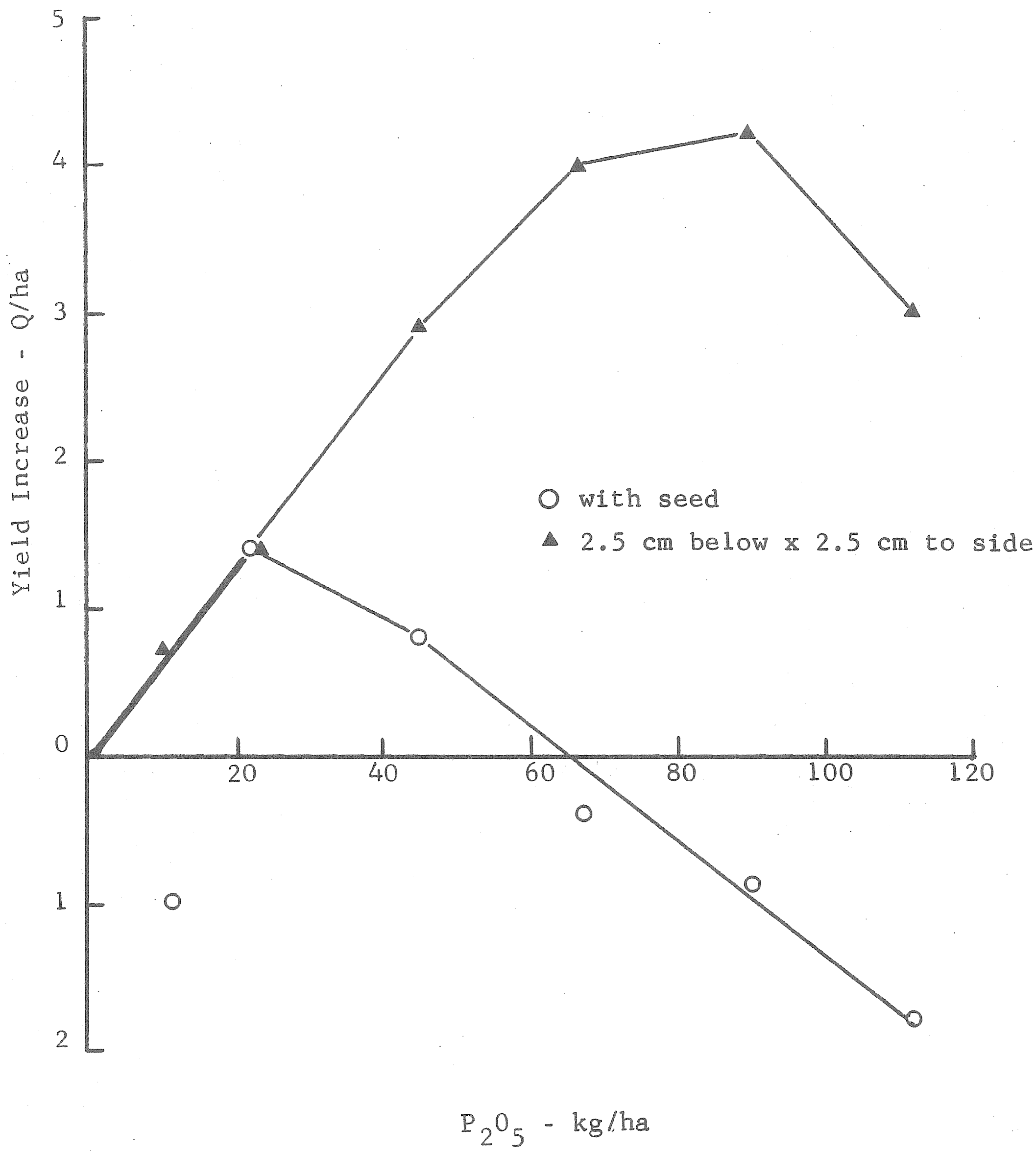

Figure 4. Effect of phosphate placement on yields of Torch (B. campestris) rapeseed on fallow in 1975. Average increase for 4 soil types.

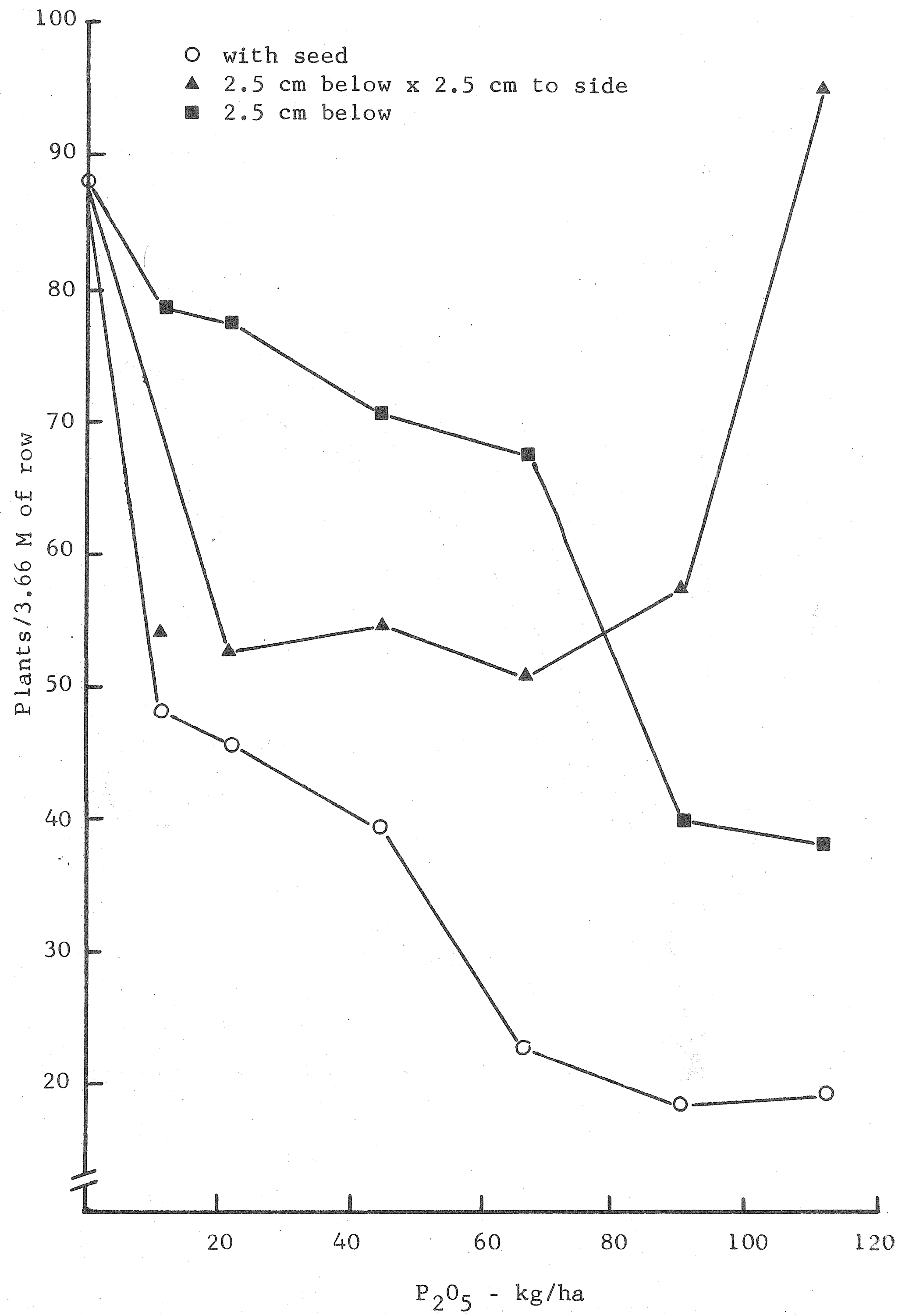

Figure 5. Effect of phosphate placement on plant populations of Torch rapeseed on Scott loam, 1975.

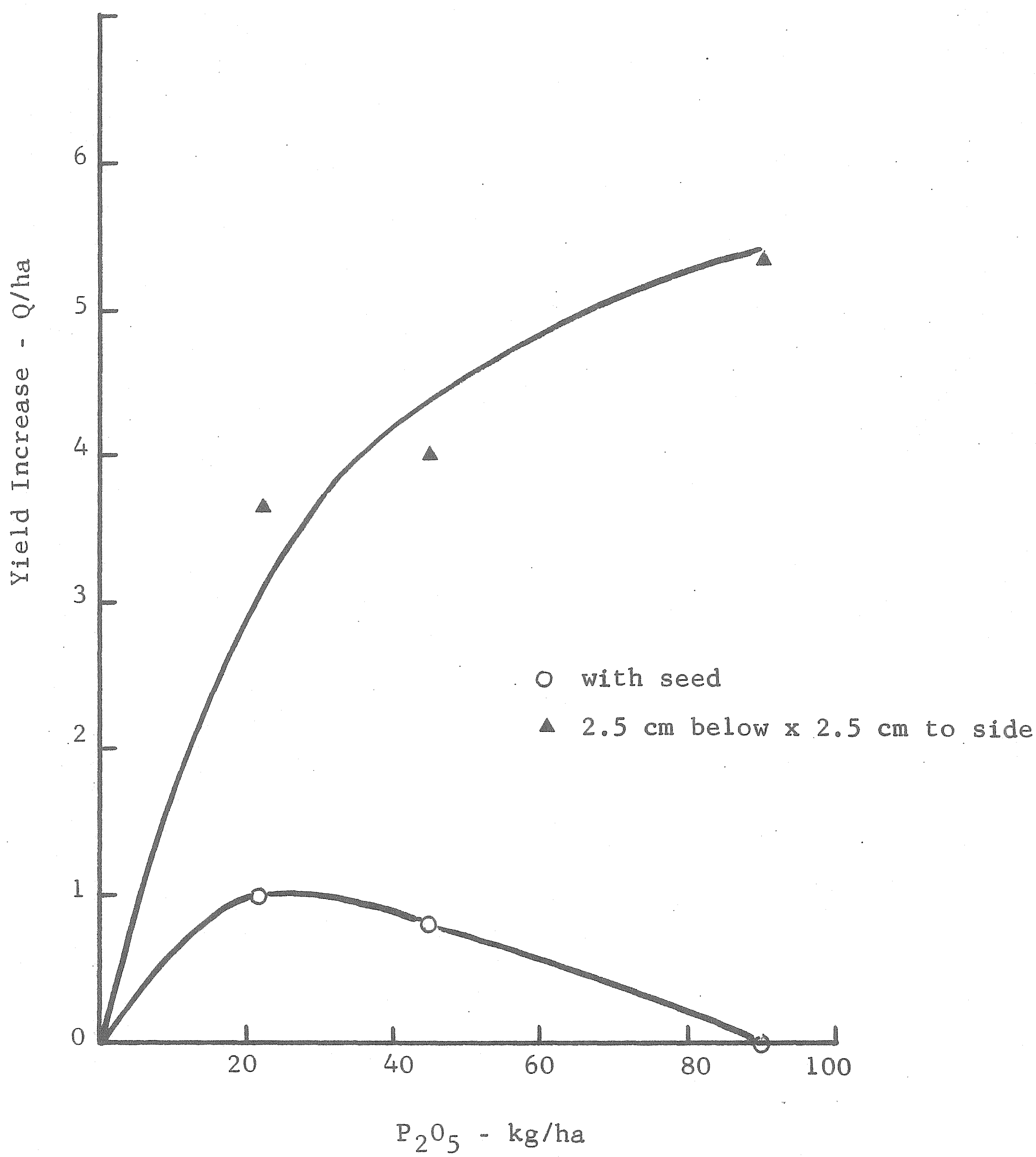

Figure 6. Effect of phosphate placement on yields of sunflowers on fallow on Scott loam. 3-year average increases.

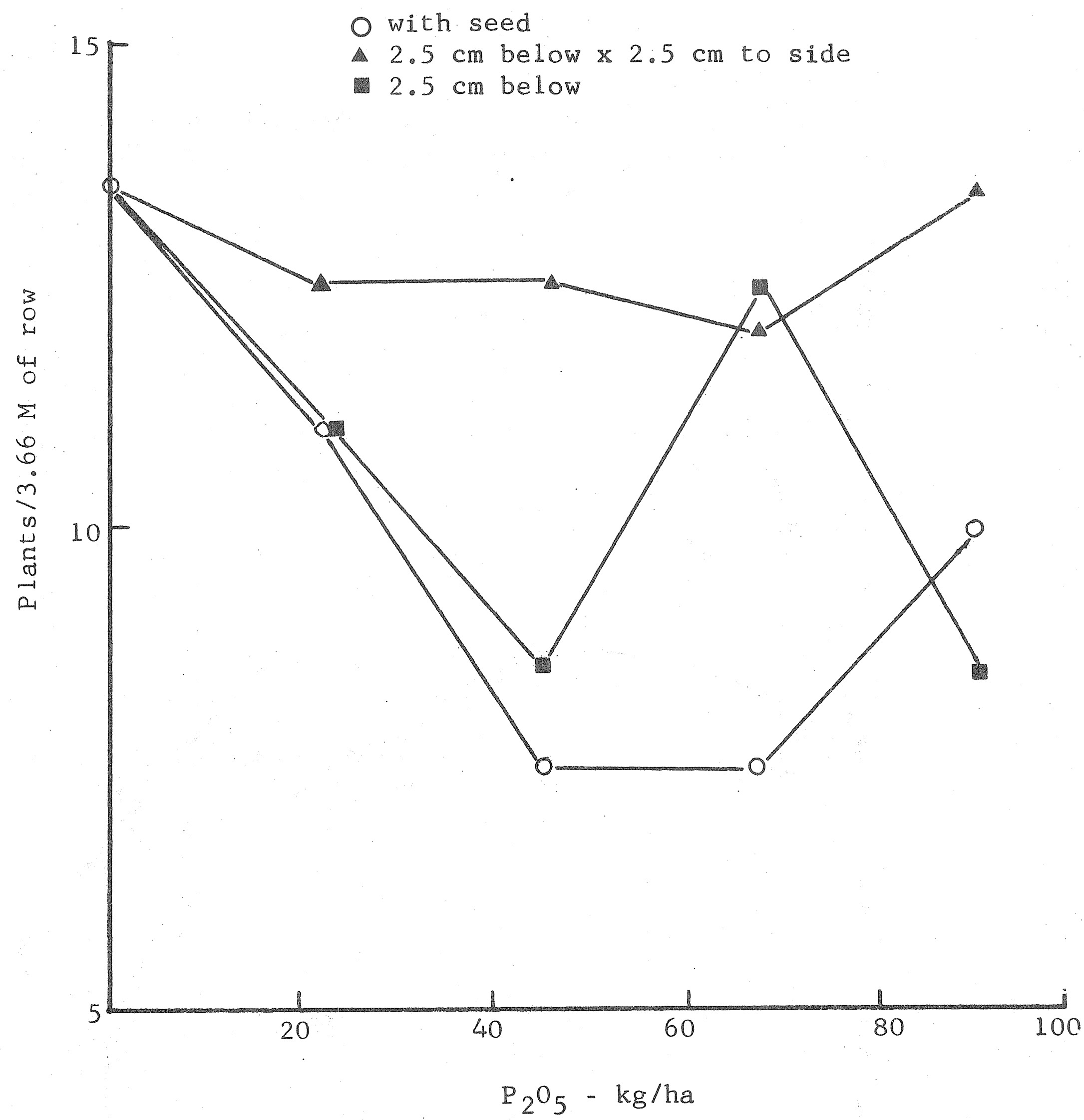

Figure 7. Effect of phosphate placement on plant populations of sunflowers on Scott loam fallow, 1975.