REVIEW OF WESTERN CANADIAN INFORMATION ON P PLACEMENT AND RESIDUAL P

J.W.B. Stewart
Department of Soil Science, University of Saskatchewan
Saskatoon, Sask.

Introduction

The purpose of this paper is to give a brief review of the discussions that took place at the Phosphorus Workshop of the Western Canadian Soil Co-Ordinating Committee on December 6, 1977, in Winnipeg, Manitoba. At this meeting representatives from Manitoba, Saskatchewan, Alberta and British Columbia reviewed the information available in each province on the yield response to placement of phosphate fertilizers with or near to the seed, and also reviewed data available on the residual effects of large phosphate applications in years subsequent to the year of application.

In general in Western Canada, the practice has been to apply phosphate with or in the vicinity of the seed at seeding time, and it has not been general practice to apply large applications of fertilizer phosphate except in special cases such as eroded knolls. The efficiency of applied fertilizer P during the first season by wheat crops has been found to range from 10 to 25%, and it is only in the last decade that residual P effects have been studied in great detail.

It has been shown that in the Calcareous Chernozemic soils of the Brown and Dark Brown soil zone that the residual fertilizer P is mainly held in the soil in the form of octacalcium phosphate and that this fertilizer phosphate will be available to plants in succeeding years. Several long term experiments have now been completed in which the residual effect of fertilizer phosphate has been examined by the utilization by native range, wheat and other crops over an eight year period (Read, 1969; Read et al., 1973; Read et al., 1977; Bailey et al., 1977). This research work which has been a co-operative effort between the Swift Current and Brandon research stations, plus the detailed laboratory work of Sadler (1973), Sadler and Stewart (1974, 1975, 1977) leave little doubt that applied fertilizer phosphate is not going to be fixed in an insoluble form when applied in large amounts to Chernozemic soils. Furthermore, that most of this applied phosphate can be recovered by plants in time.

From a farmer's point of view, the possibility of applying large applications of fertilizer phosphate every eight years without undergoing a reduction in yield has many advantages both in terms of the speed in which he can get his crop into the ground in the spring of the year and the subsequent lessening of the risk of losing crops through frost damage. This plus the ease of seeding operations have lead some large farm operators to compare the economic return and efficiency of annual phosphate fertilizer placement versus residual P effects.

The Phosphate Working Group in Winnipeg was asked to review the information on both methods of phosphorus application and to draft the recommendations that could be supplied to the farming public.

Phosphorus Placement Methods

There is a wealth of experimental data regarding the placement effects of phosphate fertilizers from most annual crops. Differences in placement techniques will depend on the size of the seed and the subsequent effect on germination of placing the seed close to the phosphate granule, on the root distribution and the rate of growth of the root material. As a result, fairly specific recommendations have been worked out for most of the annual crops grown on the Western Canadian prairies. These may be summarized as follows:

(a) Cereals

If cereals are grown on very phosphate responsive soils (low soil test P levels), it has been found at rates up to 88 kg P_2O_5/ha that seed-placed phosphate is better than or equal to side-banded phosphate which is much better than broadcast phosphate. Seed-placed refers to placement with the seed, side-banded is banded one inch beside and one inch below the seed, and broadcast is broadcast on the surface and incorporated. The amount of phosphate that is required when phosphate is broadcast is dependent on the soil type but in general at least two to four times the rate recommended for seed placement must be applied to achieve a near equal response in the year of application. More specific recommendations can be made on each soil type but the laboratory process is time consuming and this information is not presently available from most soil testing labs.

Where cereals are grown on marginally P responsive soils (medium to high soil test P levels), it has been found that on 20 to 30% of these soils there may be a response to seed-placed phosphate at rates up to 30 kg/ha P_2O_5. This so-called "pop-up effect" will depend on the temperature and moisture in the soil in specific years.

On non-P responsive soils (very high soil test P levels), there is obviously little point in applying phosphate whether seed-placed, side-banded or broadcast. However, some farmers practice added maintenance applications of 10 to 20 kg/ha P_2O_5 as a means of maintaining the P fertility of the soil.

With rapeseed, mustard, peas, beans, sunflowers and buckwheat which are grown on very P responsive soils (low soil test P levels), it is possible to seed-place phosphate up to 22 kg/ha P_2O_5. At rates greater than this, it is recommended that the fertilizer be side-banded because of the danger to germination of the seeds. Again the recommendation for broadcast depends on the amount of phosphate required to raise the fertility of the complete soil and is at least two to four times the recommended rate for seed-placed or side-banded phosphate. Again, it must be stressed that this will vary greatly with soil type and in many heavy textured soils, rates of broadcast P application may have to be increased by a factor of six to ten to achieve the same results as a seed-placed or side-banded treatment.

Flax, on the other hand, has a tap root system and does not explore the soil horizons completely. If phosphate is to be used by this crop, it has to be placed directly beneath the seed but not touching it.

Alternatively, phosphate has to be broadcast on the soil to raise the whole level of the top 6" of the soil and in particular the solution phosphorus levels to acceptable values. The concensus of opinion at the Winnipeg meeting was that the best results would be obtained from careful seed placement of phosphorus beneath the seed and that the amount of phosphate required on a broadcast treatment would be at least two to four times the rate recommended for placement purposes.

Corn, potatoes and sugar beets require that phosphorus applications should be side-banded and in the event that broadcast treatments are to be used, they should be at least two to four times the recommended rate for broadcast treatments.

(b) Forages

The recommendations with regard to grass, grass-legume, and legume forage crops are that at the time of establishment of the pasture the most efficient use of phosphorus would be from a broadcast phosphate prior to establishment or side-banding at the time of seeding. All laboratories have found difficulty in correlating the phosphate test used by their laboratories with the response of annual crops in the field to phosphate fertilization. All provinces reported that phosphate applications have been found to increase the phosphorus content of their forages and thereby the quality of the forage, although in some cases this did not mean an increase in yield. Once the stand was established, the general method of application of fertilizer phosphate was to broadcast it on the surface.

Summary and Conclusions

In summary, it can be seen that in all provinces the soil testing laboratories are sure of their recommendations for seed-placed and side-banded applications of fertilizer phosphate. No real concensus of opinion could be obtained on the practice of putting on large amounts of phosphate in any one year and no fertilizing with phosphate for the remaining eight to ten years. The data that has been published to date on a small number of soils lends support to the fact that residual phosphate is available to plants in succeeding years and in some cases was found to be as efficient as the annual application of a seed-placed or side-banded phosphate treatment. All provinces, however, could report other data that contravened this statement and it is obvious that it will be difficult to make concrete statements on all soil types without conducting a much larger survey and practical testing.

It is known that the reactions of a fertilizer phosphate granule in the soil are to form phosphate compounds whose solubility will decrease from the initial reaction product with time. It is also known that the range of possible fertilizer reaction products in soils will vary tremendously with soil type, subgroup profile and possible with time of application. However, it is equally obvious that some large farm operators are going to carry on with the practice of broadcasting fertilizer phosphate to their soils and that they will require information on the efficiency of this process. Any tests that are carried out will hopefully measure the change in soil phosphate form as well as the availability and yield response by specific crops.

References

Bailey, L.D. et al. 1977. Can. J. Soil Sci. 57: 263-270.
Read, D.W.L. 1969. Can. J. Soil Sci. 49: 225-230.
Read, D.W.L. et al. 1973. Can. J. Soil Sci. 53: 389-398.
Read, D.W.L. et al. 1977. Can. J. Soil Sci. 57: 255-262.
Sadler, J.M. 1973. Ph.D. Thesis, University of Saskatchewan, Saskatoon.
Sadler, J.M. and J.W.B. Stewart. 1974. Sask. Inst. Ped. Publ. No. 136.
Sadler, J.M. and J.W.B. Stewart. 1975. Can. J. Soil Sci. 55: 149-159.
Sadler, J.M. and J.W.B. Stewart. 1977. Can. J. Soil Sci. 57: 65-74.