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COMPARISON OF BIOSUPER WITH SUPERPHOSPHATE AS A PHOSPHATIC FERTILIZER FOR WHEAT

By M. J. Whitehouse, B.Sc. and W. M. Strong, B.Agr.Sc., Ph.D.

SUMMARY

Biosuper, a granulated mixture of five parts rock phosphate and one part sulphur, has been compared with superphosphate as a phosphatic fertilizer for wheat on two phosphorous deficient soils of the Darling Downs.

In field trials superphosphate supplying 25 kg P ha^{-1} increased grain yield by 250 kg ha^{-1} on a black earth and by 400 kg ha^{-1} on a red-brown earth. Large responses both in dry matter production and in tissue concentration of phosphorous also occurred with both soils in the glasshouse. Biosuper, however, had very little or no effect, either on yield or phosphorous uptake.

Biosuper was a completely unsatisfactory phosphatic fertilizer for wheat on these soils.

I. INTRODUCTION

Rock phosphate has been found to be an effective fertilizer only in acidic soils (Fried and Mackenzie 1949, Mattingly and Widdowson 1956). Physico-chemical processes are responsible for its weathering (Graham 1955). Soil micro-organisms also dissolve insoluble phosphates either directly or indirectly (Katznelson, Peterson and Rouatt 1962). A phosphate fertilizer, biosuper (R. J. Swaby 1975), relies on dissolution of rock phosphate by thiobacilli. This fertilizer consists of a granulated mixture of five parts rock phosphate and one part elemental sulphur. It contains 12·5% phosphorus. Rock phosphate is dissolved by sulphuric acid produced by the oxidation of elemental sulphur contained within the fertilizer granule.

Swaby (1975) reported that biosuper was more effective than superphosphate in seven out of twelve trials on tropical pastures in North Queensland, while other workers (Gillman 1973, Fisher and Norman 1970, Jones and Field 1976) also found biosuper successful under tropical conditions.

In the work reported here, biosuper was compared with single superphosphate as a source of phosphorus for wheat on two phosphorus deficient soils on the Darling Downs.

II. MATERIALS AND METHODS

Experiments were conducted with wheat in the field and in the glasshouse on two Darling Downs soils on which wheat is known to respond to phosphate fertilizer. Some properties of these soils, a black earth 55 km south-west of Toowoomba and a red-brown earth 35 km west of Toowoomba, are shown in table 1.

TABLE 1

SOME SOIL PROPERTIES (0 to 10 cm)

Great Soil Group Soil Series	Black Earth† Cecilvale	Red Brown Earth* Oakview loamy sand
Bicarbonate extractable P (ppm)	18	59
pH (1 : 5)	6·8	6·0
% clay	38	25
Total N %	0·08	0·08

† similar to soil described by Reeve, Thompson and Beckmann (1960) pp 83.
* similar to soil described by Reeve, Thompson and Beckman (1960) pp 49.

Experiment I—Field Trials

Field trials were of a randomized block design comprising 14 treatments as shown in table 2. There were four replicates on the red-brown earth site and three on the black earth site. Plots were 0·005 ha in area. Fertilizer was applied at planting with the seed. Biosuper was inoculated prior to application with thiobacilli. A basal application of 40 kg ha^{-1} N as urea was applied to both sites when the preplant biosuper applications were made. Both sites were planted to the wheat cultivar Gamut, the red-brown earth on 16 July 1973 and the black earth on 3 August 1973.

TABLE 2

FIELD TRIAL TREATMENTS

1. control
2. 5 kg P ha^{-1} as superphosphate at planting
3. 10 kg P ha^{-1} as superphosphate at planting
4. 25 kg P ha^{-1} as superphosphate at planting
5. 50 kg P ha^{-1} as superphosphate at planting
6. 5 kg P ha^{-1} as biosuper at planting
7. 10 kg P ha^{-1} as biosuper at planting
8. 25 kg P ha^{-1} as biosuper at planting
9. 50 kg P ha^{-1} as biosuper at planting
10. 5 kg P ha^{-1} as biosuper 2 months pre-planting
11. 10 kg P ha^{-1} as biosuper 2 months pre-planting
12. 25 kg P ha^{-1} as biosuper 2 months pre-planting
13. 50 kg P ha^{-1} as biosuper 2 months pre-planting
14. 10 kg P ha^{-1} as 1 : 4 super : biosuper at planting

Total dry matter yield was determined with quadrat samples at a late tillering growth stage and at maturity. Grain yield was measured with a small plot experimental header. Grain and straw samples from the black earth site were analysed for phosphorus.

Mice damaged the crop on the red-brown earth site and made yields very variable, and so plant samples from there were not analysed for phosphorus.

Experiment II—Glasshouse Trials

The two forms of fertilizer were compared in glasshouse trials using soil taken at 0 to 10 cm depth from both field sites. Four rates of phosphorus (0, 20, 40 and 60 ppm P in soil) were applied to each soil at three times (0, 2 and 4 weeks prior to planting) in a randomized block designed with three replicates.

Air dried soil (1 300 g) was placed in 15 cm plastic lined pots. At the earliest application (4 weeks prior to planting) fertilizer was applied in a layer 5 cm below the surface. All pots were then watered to a moisture content 5% less than the field capacity. Later applications of fertilizer were made as a layer beneath the top 5 cm of moist soil.

Applications of 60 mg N kg^{-1} soil and 50 mg S kg^{-1} soil were made in solution as a mixture of ammonium sulphate and ammonium nitrate at planting.

Wheat (cultivar Gamut) was planted and thinned to four plants per pot on emergence. Plants were harvested at late tillering after 56 days, weighed, and the ground tissue analysed for phosphorus using a perchloric acid digestion followed by the vanadomolybdate-yellow method of Jackson (1958).

III. RESULTS AND DISCUSSION

At both field sites grain yield increased when superphosphate was applied (figure 1). By contrast biosuper did not produce a grain response on either site. On the black earth site phosphorus uptake was increased with superphosphate application, but not with biosuper even when this was applied 80 days before planting (figure 2).

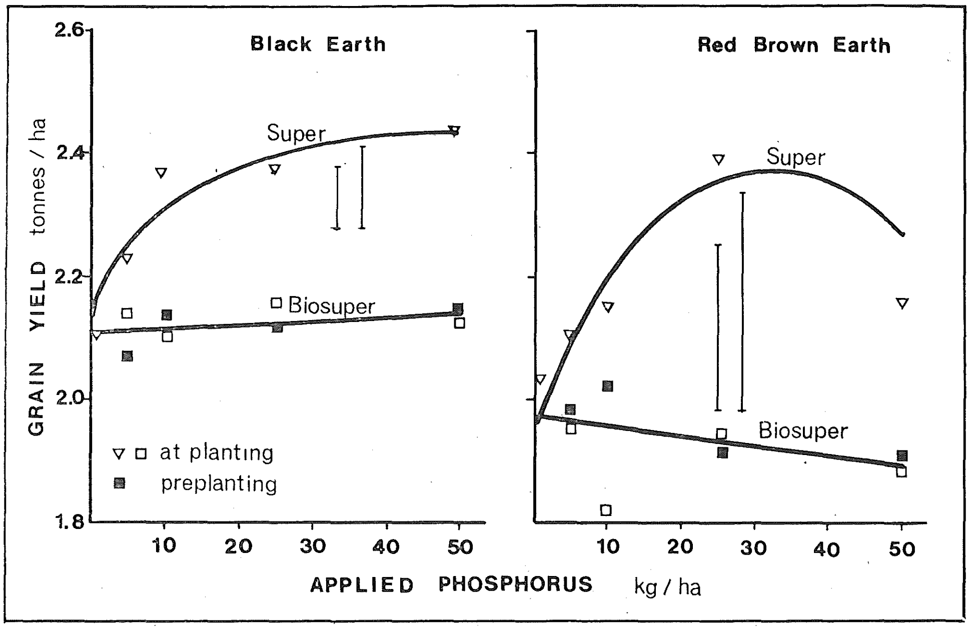

Figure 1. Grain yield response to superphosphate and biosuper at two sites on the Darling Downs. (Vertical bars represent L.S.D. at 5% and 1% respectively.)

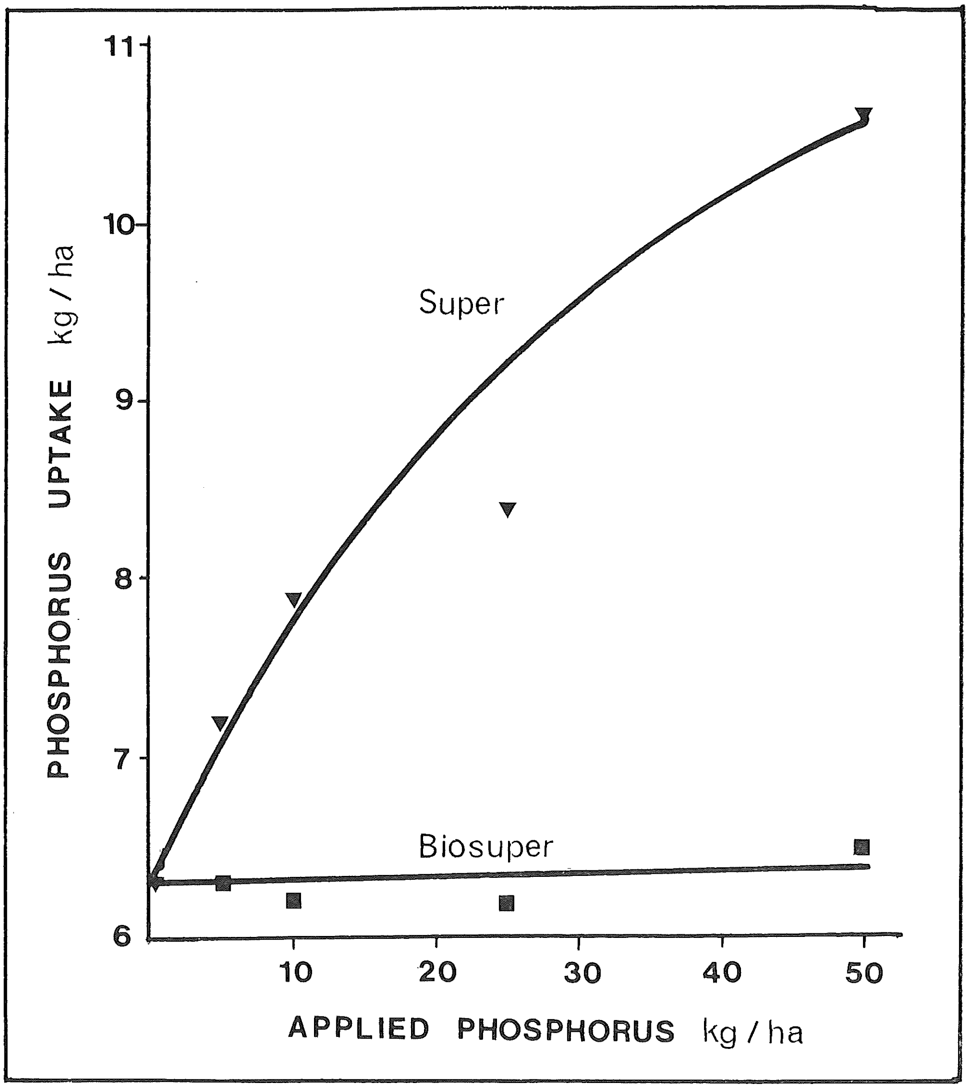

Figure 2. Effect of superphosphate and biosuper on phosphorus uptake of wheat on a black earth site on the Darling Downs.

Similarly, in glasshouse experiments both soils displayed striking responses in growth (figure 3), and in the concentration of phosphorus in tissue of wheat (figure 4), to applications of superphosphate. Response to biosuper, however, was small and yield was increased significantly ($p = 0 \cdot 05$) only when the fertilizer reacted in moist black earth soil for 4 weeks before planting.

There are a number of possible explanations for the unavailability of biosuper to wheat in these experiments. Firstly, the biological activity which solubilizes fertilizer is a delayed reaction; more than 4 weeks appears necessary before biosuper is of any value as a phosphatic fertilizer. Delayed availability can possibly be overcome by applying the fertilizer before planting. However, this makes it very difficult to place the seed in the most suitable position in relation to the fertilizer.

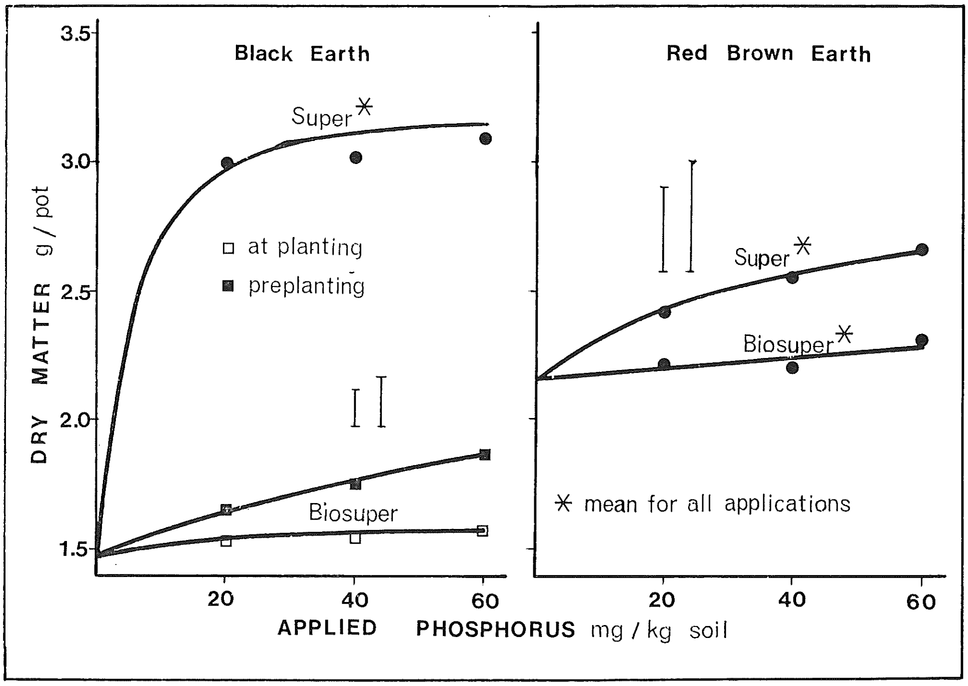

Figure 3. Growth response of wheat at 8 weeks to superphosphate and biosuper in a pot experiment with two soils of the Darling Downs. (Vertical bars represent L.S.D. at 5% and 1% respectively.)

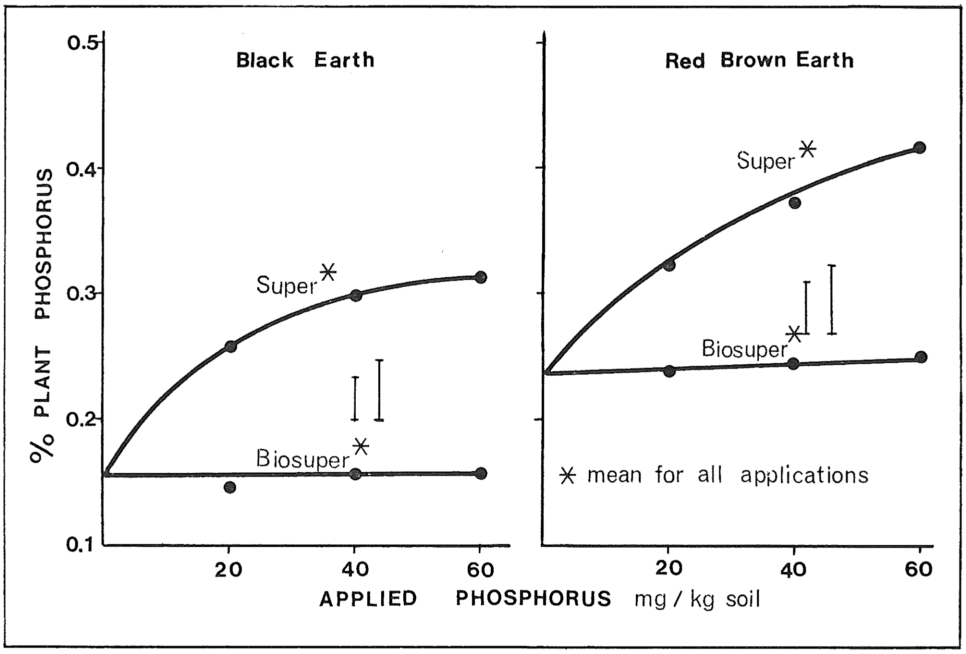

Figure 4. Effect of superphosphate and biosuper on the tissue phosphorus concentration of wheat at 8 weeks in a pot experiment with two soils of the Darling Downs. (Vertical bars represent L.S.D. at 5% and 1% respectively.)

The large size (3 to 6 mm) of the biosuper pellets used in these experiments may have been responsible for reducing its availability; they were considerably larger than the granules of superphosphate. However, Jones and Field (1976) found 10 mm granules satisfactory in their experiments. Smaller pellets may expose a greater surface area for bacterial colonization or may make the biosuper-phosphate more accessible to roots by providing more phosphorus-rich sites for exploration.

Root systems may not respond to the application of biosuper as has been reported with more readily available phosphatic fertilizers. Roots of various crops including wheat proliferate within reaction zones of readily available forms of phosphate, e.g. superphosphate (Jacques 1943) and dicalcium phosphate dihydrate (Strong and Soper 1974a), but not so readily in reaction zones of less available forms, such as hydroxyapatite (Strong and Soper 1974b). Biosuper may therefore be unsuitable for annual crops which require a ready supply of phosphorus during their early growth.

The sulphur-oxidizing bacteria responsible for releasing plant available phosphorus from biosuper favour acidic conditions for optimum growth (Vitolins and Swaby 1969). Although slightly acidic, soils chosen for these experiments may not have been ideal for these bacteria. Biosuper may be more suitable for wheat or other annual crops on soils of lower pH. However, as the base saturated soils of the Darling Downs are typically neutral-to-alkaline it is most unlikely that biosuper would be an effective phosphatic fertilizer for winter crops in this region.

IV. ACKNOWLEDGEMENTS

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The authors are respectively officers of Agricultural Chemistry and Agriculture Branches of Queensland Department of Primary Industries, stationed at Queensland Wheat Research Institute, Toowoomba.