AN ECONOMIC APPRAISAL OF SUPERPHOSPHATE USE ON WHEAT IN MID AND NORTH CANTERBURY

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ABSTRACT

Price ratios for four superphosphate costs and four Aotea wheat prices were calculated and applied to response curves of Aotea wheat grain yields as a function of applied phosphatic fertilizer over a range of modified Olsen test soil phosphorus levels.

The optimal economic rates of superphosphate application were calculated and found to vary with changes in the price of wheat and cost of superphosphate.

INTRODUCTION

Fertilisers are applied to pastures and crops to correct plant nutrient deficiencies and thereby improve quality and increase yields and nett cash returns. The profitability of an application of fertiliser is related to the size of the pasture/crop response, the cost of the fertiliser and the return obtained from the additional produce generated.

Much of the soil fertility research carried out in this country has been directed towards the identification and correction of plant nutrient deficiencies. Comparatively few reported studies are suitable for the prediction of the most economical rate of fertiliser application. Hudson (1931) showed that superphosphate at low rates could scarcely fail to be profitable on wheat. Karlovsky (1966) and Rickard (1968) have published data suitable for economic appraisal of the effects of applications of phosphatic fertiliser on pasture yields. More recently Grigg and Stephen (1973) related Aotea wheat grain yields at various soil phosphorus levels to applications of phosphatic fertiliser and calculated the profitability of phosphatic fertiliser applications.

Following publication of the estimates of Grigg and Stephen (1973) the price of wheat changed appreciably. The purpose of this paper is to re-examine their data, calculate the profitability of superphosphate applications to Aotea wheat grown on some Canterbury soils and to estimate the optimal economic rate of superphosphate application for each level of several soil phosphorous levels.

MATERIALS AND METHODS

1. **Aotea Wheat Grain Yield Responses to Superphosphate:**

Estimates of Aotea wheat grain yield responses to superphosphate are based on the data of Grigg and Stephen (1973) who over a period of four years, in a series of 82 field trials, carried out in Mid and North Canterbury measured over a range of soil phosphorus levels Aotea wheat grain responses to applied phosphate. They showed that on most soils Aotea wheat grain yield responses varied with soil phosphorous levels and correlated best with soil phosphorus levels determined by the Olsen bicarbonate test modified to 16 hour extraction and a soil: solution ratio of 2.2 ml: 100 ml. Soil sets for which the modified Olsen test best predicted Aotea wheat grain yield responses were Wakanui, Lyndhurst, Eyre, Templeton, Mayfield, Barrhill, Kaiapoi and Temuka.

2. **Economic Analyses**

Response curves of Aotea wheat grain yields as a function of applied phosphatic fertiliser were constructed for pooled data of Wakanui, Lyndhurst, Eyre, Templeton, Mayfield, Barrhill, Kaiapoi and Temuka soils for several modified Olsen test soil phospherous levels.

Price ratios Pp/Pw were calculated for all combinations of four superphosphate prices and four nett Aotea wheat grain prices.

Costs of superphosphate phosphate (Pp) were based on the ex fertiliser works price of bagged superphosphate plus cost of 24 km cartage less the value of the fertiliser freight subsidy.

Pp1 = 36c/kg P (approximate current prices less rock phosphate subsidy.)
Pp2 = 45c/kg P (a hypothetical price).
Pp3 = 54c/kg P (approximate current price plus rock phosphate subsidy).
Pp4 = 63c/kg P (a hypothetical price).

Nett prices for Aotea wheat grain were based on the guaranteed price less relevant costs such as cartage and wheat Broad levies as apply to a farm located 24 km from a major centre.

Pw1 = $57.16/t (1973/74 guaranteed price for Aotea wheat)

Pw2 = $89.32/t (1974/75 guaranteed price for Aotea wheat)
Pw3 = $102.70/t (a hypothetical price).
Pw4 = $139.00/t (a hypothetical price).

Each calculated price ratio was applied to Aotea wheat grain yield response curves to determine the optimal rate of superphosphate input at modified Olsen test soil phosphorus levels of 20 to 40. Also the relationship between modified Olsen test soil phosphorus levels and the optimal economic rate of superphosphate application was examined.

RESULTS

The optimal rates of superphosphate inputs kg P/ha for each price ratio at modified Olsen test soil phosphate levels of 20 to 40 are given in Tables 1 and 2 respectively.

The optimal rates of superphosphate application was affected by changes in price of superphosphate and changes in the nett price of Aotea wheat grain and differed for each modified Olsen test soil phosphate level.

At a modified Olsen test soil phosphorus level of 20 and at the superphosphate price Pp1, i.e. the current price of superphosphate; the optimal rate of superphosphate application increased from 34 kg P/ha at the nett Aotea wheat grain price Pw1, i.e. last season's price to 43 kg P/ha, at the highest nett Aotea wheat price Pw4 considered. At a modified Olsen test soil phosphate value of 40 the corresponding optimal rates of superphosphate application are 13 and 26 respectively. Conversely at the modified Olsen test soil phosphate value of 20 and at the Aotea wheat grain price Pw2, i.e. the current price, the optimal rate of superphosphate application declines from 40 kg P/ha at the superphosphate price Pp1 to 33 kg P/ha at the superphosphate price Pp4. At the modified Olsen test soil phosphate value of 40 the corresponding optimal rates of superphosphate input are 21 and 12 kg P/ha respectively.

The relationship between modified Olsen test soil phosphorus levels and the optimal rate of superphosphate application at the price ratio Pp1/Pw2, i.e. the current prices are shown in Figure 1. The relationship is linear over the range of modified Olsen test soil phosphorus levels considered. At modified Olsen test soil phosphorus level 50 the optimal rate of superphosphate application is 12.5 kg P/ha and for each 10 unit decline in the soil phosphate level from 50, the optimal rate of superphosphate, application increases by 9.5 kg P/ha. Thus at modified Olsen test soil phosphate level 10, the optimal rate of superphosphate, application is 51 kg P/ha.

TABLE 1: Optimal rates of superphosphate inputs kg P/ha for all combinations of superphosphate prices and nett Aotea wheat grain prices at modified Olsen test soil phosphorus level of 20.

Aotea wheat nett prices	Superphosphate Prices c/kg P			
$/t	Pp1 36	Pp2 45	Pp3 54	Pp4 63
Pwl 57.16	34	33	31	28
Pw2 89.32	40	37	35	33
Pw3 102.70	41	39	38	35
Pw4 139.00	43	42	41	39

TABLE 2: Optimal rates of superphosphate inputs kg P/ha for all combinations of superphosphate prices and nett Aotea wheat grain prices at modified Olsen cost soil phosphorus level of 40.

Aotea wheat nett prices	Superphosphate prices c/kg P			
$/t	Pp1 36	Pp2 45	Pp3 54	Pp4 63
Pwl 57.16	13	9	8	7
Pw2 89.32	21	19	16	12
Pw3 102.70	22	20	17	13
Pw4 139.00	26	23	22	20

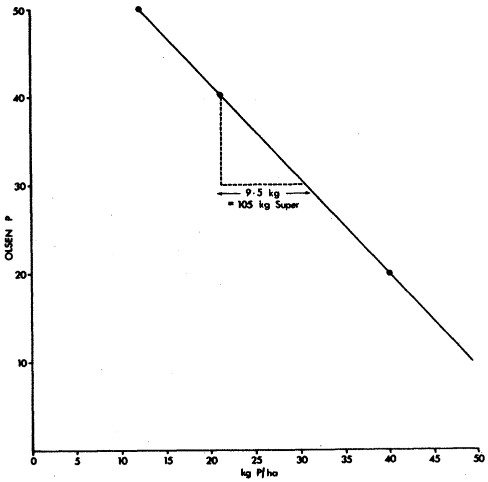

Figure 1:

DISCUSSION

The effects of changes in the prices of superphosphate and Aotea wheat grain on the optimal rate of superphosphate application have been shown. Notwithstanding large actual and large hypothetical changes in the nett price of Aotea wheat grain and large hypothetical changes in the price of superphosphate their effects on the optimal rate of superphosphate application are only moderate and similar at both modified Olsen test soil phosphorus levels considered in Tables 1 and 2. This is due to the low cost of superphosphate relative to the nett price of Aotea wheat grain. The nature of this relationship results in low price ratios and hence the optimal rate of superphosphate input occurs near the maximum point of the production function.

At the modified Olsen test soil phosphorus level 20, optimal superphosphate inputs are higher than those at soil phosphorus level 40 and the relative effects of changes in the nett price of Aotea wheat grain and cost of superphosphate are not great.

At the modified Olsen test soil phosphorus level 40 which is close to the mean value of all experimental sites used by Grigg and Stephen (1973), the optimal superphosphate input is low and the effects of changes in the nett price of Aotea wheat grain and the cost of superphosphate are relatively large.

Some caution is required in the application of this analysis to practice. The wide variation in the original Aotea wheat grain yield data resulted in wide confidence limits. This variation was probably caused by variations in soil moisture, soil texture, degree of stoniness and fluctuations in climatic factors. Additionally, the level of managerial skill may need also to be considered. For these reasons, the calculated optimal superphosphate inputs may need to be discounted.

The effect of the soil phosphorus level as indicated by the modified Olsen test, on the response by Aotea wheat to applied phosphatic fertiliser is marked and stresses the advantage of determining the soil phosphorus level before applying superphosphate to the crop.

Superphosphate is a profitable input for wheat production in Mid and North Canterbury and its use contributes to higher grain yields. The recent increase in the nett price of Aotea Wheat and the unchanged cost of superphosphate favours high inputs of superphosphate.

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