POTASSIUM FERTILISER USE IN SOUTH AUSTRALIA

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FOREWORD

This is the first of a continuing series of reports which will be compiled from time to time on subjects of agronomic importance.

The following report was presented at a Symposium on "Potassium in South-Eastern Australia" organised by the Victorian Branch of the Australian Institute of Agricultural Science, and held at Monash University on August 21-22nd, 1967.

The report deals mainly with research on potassium fertiliser use on pastures, and reviews what may be regarded as phase one of potassium research in this field. The majority of the work reported in detail was carried out by Agronomy Branch Officers, and takes in the period from the first discovery of payable potassium responses, up to the beginnings of detailed soil testing work which began under Burford in 1963 and is now being conducted by officers of the Soils Branch.

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South Australia, with a total area somewhat greater than New South Wales, is by far the driest of all the Australian states. Only 3.3% of its area receives more than 20 inches annual rainfall compared with 62.4% for Victoria, 39.3% for New South Wales, and 29.2% for the whole of Australia.

With such a relatively small area of intensively developed agricultural and pastoral land the use of potassium fertilisers is, understandably, the lowest of all the Australian states. Despite considerable increases in its use on fruit crops, potatoes, and particularly on pastures, the overall percentage of total Australian usage of potassium fertilisers by South Australia remains at about 3-4%.

Although some soils in South Australia are now known to have an absolute deficiency of potassium in the virgin state, and require annual applications for pasture production, most of the areas where potassium is used showed no responses during the early days of development because of low production resulting from deficiencies of other nutrient elements, or in the irrigation areas, of water.

Induced potassium deficiency is a product of more efficient land utilisation, and is a comparatively recent phenomenon. Responses on pastures and potatoes have only been reported during the last 15 years, although many earlier experiments were conducted.

The total usage of potassium fertilisers in South Australia in 1966, from figures supplied by Potash (Australasia) Pty. Limited, was 4,390 tons. This occurred in roughly the following pattern, 1/5 on fruit crops, 1/5 on vegetable crops, 1/5 on potatoes, and 2/5 on pastures. The level of increase over the last decade is shown in Table I.

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TABLE I:

SOUTH AUSTRALIAN USE OF POTASSIUM FERTILISERS (IN TONS)

Crop	1956	1966
Fruit	196	735
Vegetables	57	938
Potatoes	187	734
Pastures	81	1,857
Other	26	126

FRUIT PRODUCTION

Practically the whole of South Australia's irrigated citrus and stonefruit production takes place in the Upper River Murray region. The growing importance of salinity in River Murray water, and increased yields brought about by the change to spray irrigation over the last 10 years, have both led to increased interest in potassium fertiliser use on fruit crops.

Adequate potassium nutrition has been found to reduce damage caused by high levels of sodium chloride in the irrigation water, to promote blossom production, and to improve fruit quality.

A leaf analysis service, set up three years ago for the War Service Land Settlement areas, indicated that potassium levels in Upper Murray orchards were generally below the accepted standards.

Response to added potassium is normally rather slow but it has been possible to get leaf potassium levels back to normal in two years following very heavy initial fertiliser applications. These are then followed by annual applications in the order of 3-4 cwts. per acre of sulphate of potash.

Pome fruits grown in the Adelaide Hills with some supplementary irrigation have shown responses to added potassium on some soil types, and the use of sulphate of potash is standard in these areas.

VEGETABLE PRODUCTION

South Australian vegetable production is concentrated mainly within 25 miles of Adelaide on a range of soil types. These crops are grown with irrigation under highly intensive conditions, and heavy rates of complete N P K fertilisers are used practically universally.

POTATOES

All South Australian potato crops are produced under irrigation, on a wide variety of soil types in the Adelaide Hills, the Lower South-East, and the Plains just north of Adelaide.

Yield responses to applied potassium in the order of 2-5 tons per acre, or more, are frequently obtained, and under these circumstances the cost of fertiliser becomes relatively unimportant. Experiments by Moss (1959), and Feddersen (1961) have enabled detailed potassium recommendations to be given for all soil types. Potassium fertilisers are universally recommended at rates ranging from 1 to 4 cwts. per acre, applied at seeding time in a band, alongside the planted setts.

Sulphate of potash, although dearer than muriate, is used almost exclusively because of the problem of chloride toxicity associated with the use of saline water.

CEREALS

Potassium fertilisers are not used or recommended for cereal crops, although responses have been reported on oats in the Lower South-East on light calcareous coastal sands by Riceman, Donald and Evans (1940), and on a deep siliceous sand by Marrett (pers. comm.).

Grain responses have never been obtained on any of the major recognised cereal growing soils of the state, and soil analyses have shown that a need for potassium on most of these soil types, some time in the future, is unlikely, although soil potassium levels on two of the lesser soil types (the coastal calcareous sands of Lower Yorke Peninsula, and some of the solonetz soils of the Murray Mallee and Eyre Peninsula) are marginal (French, pers. comm.).

Responses have been obtained on irrigated grain sorghum in the Upper Murray region, and a rate of $\frac{1}{2}$-1 cwt. per acre of sulphate of potash is recommended for this crop (Boyce, 1967).

PASTURES

By far the greatest potential for increased production through the use of potassium fertilisers occurs on pastures.

Although recommendations for the use of potassium fertilisers on pastures on the sandy soils of the South-East were made by Perkins as early as 1919, the first definite reports of responses to experimental applications of potassium to pasture plants were not made until the 1950's when Coombe and Allen (1955) reported growth responses in clover crops in vineyards at Blewitt Springs, and Tiver and Marrett (1958) reported numerous pasture responses in the Adelaide Hills and Lower South-East.

Since this time it has become apparent that potassium deficiency can be induced by haycutting or cropping on practically every South Australian soil type occurring in the over-20 inch rainfall zone.

It is estimated that a total area of approximately 1½ million acres of pasture land would give payable responses to applied potassium following haycutting or cropping. The list of soil groups on which pasture responses are known to occur is set out below:-

Podsolic soils and lateritic podsols
Deep podsolized sands
Solodic soils
Shallow terra rossa
Groundwater rendzina
Krasnozem
Peat soils
Coastal calcareous sands
Volcanic ash soils

Effect of Haycutting versus Grazing

The majority of the estimated 1½ million acres of pasture land which responds to potassium applications after haycutting shows no response at all, or only limited response, under conditions of continuous grazing.

Some results from an experiment conducted by Lines (1963) to determine potassium requirements under conditions of both grazing and continuous haycutting are set out in Table II. This work was carried out near Mount Gambier on a solodic soil with an exchangeable potassium level of approximately 0.15 m-equiv/100 gms. soil in the top 4 inches.

TABLE II:

EFFECT OF CONTINUOUS HAYCUTTING AND GRAZING ON PASTURE RESPONSE TO ANNUAL APPLICATIONS OF POTASSIUM FERTILISER
(Lines, G.E. - 1963)

CONTINUOUS HAYCUTTING

Year	Dry Matter (Cwts./acre)			Clover %		
	Ko	$K\frac{1}{2}$	Sig. Diff.	Ko	$K\frac{1}{2}$	Sig. Diff.
1958	30.0	28.3	n.s.	9	19	*
1959	22.0	20.5	n.s.	20	54	* * *
1960	28.7	35.0	* *	8	29	* *
1961	20.6	36.5	* * *	19	69	* * *

GRAZING

Year	Dry Matter (Cwts./acre)			Clover %		
	Ko	$K\frac{1}{2}$	Sig. Diff.	Ko	$K\frac{1}{2}$	Sig. Diff.
1958	38.1	41.3	n.s.	10	13	n.s.
1959	30.8	29.5	n.s.	21	36	n.s.
1960	37.5	37.5	n.s.	20	38	* * *
1961	43.3	44.7	n.s.	58	70	n.s.

Over a 4 year period no response in total dry matter production and a response in only one year in clover growth, was obtained under grazed conditions.

Under continuous haycutting however, responses in clover growth were obtained in each year, and marked responses in total dry matter production occurred each year after the second haycut.

This experiment, and subsequent work on the same site by Fairbrother and Hagerstrom (1966) showed that ½ to 1 cwt. per acre of muriate of potash was required for each hay cut to promote normal pasture growth. These latter results are set out in Table III.

TABLE III:

EFFECT OF RATE OF APPLICATION OF POTASSIUM FERTILISER ON PASTURE PRODUCTION UNDER CONDITIONS OF ANNUAL HAYCUTTING

(Fairbrother & Hagerstrom, 1966)

Fertiliser (cwts. muriate of potash/acre/year)	Dry Matter (Cwts./acre)			
	1962	1963	1964	1965
0	32.2	16.2	20.5	24.2
¼	44.7	22.5	30.9	43.3
½	51.5	32.8	31.8	49.2
1	43.8	27.2	39.8	50.2
L.S.D. 5%	7.1	6.7	5.3	7.2

In practice it is common to apply potassium as muriate of potash at the rate of ½ cwt. per acre per ton of hay cut. This application is usually made in about August of the year after haycutting although some landholders apply the dressing in the year of haycutting at about the time of closing the paddock.

No local information is available on the correct time of the year for potassium applications, and work is being carried out at present to determine this.

Use is also made of the small available quantities of cement kiln dust as a source of potassium. This material contains about 5% potassium and costs $11 to 15 per ton, spread. Applications of about half a ton per haycut are used in the area within 60 miles of Adelaide on acid sandy soils which require both lime and potassium.

On some of the deeper sandy acid soils of the high rainfall region of the Adelaide Hills and Lower South-East very low levels of potassium occur. The area of such soils is limited to an estimated 70,000 acres, and on these areas it has been usual to recommend 1/4 to 1/3 cwt. per acre of muriate of potash for all new pasture sowings and sod seeding. In addition, recommendations have been made this year, for the first time, for annual autumn maintenance dressings of muriate of potash at 1/4 to 1/3 cwt. per acre for all pastures in these areas.

Frequency of Application

In areas of marginal deficiency the frequency of application of potassium fertilisers will be determined by the frequency of haycutting. Under conditions of more or less continuous haycutting the importance of residual effects must be considered. In the lighter soils, the nearness to surface of a clay layer is likely to determine whether annual dressings are required or not.

In one experiment, at Mt. Compass in the Adelaide Hills, reported by Watson (1962), a total of 312 lbs. of muriate of potash was applied over a period of 4 years either as annual dressings, biennially, or as a single application at the beginning of the experiment, on a lateritic podsol with clay at 8-12 inches. Some of the results of this experiment are presented in Table IV.

These figures show that under conditions equivalent to continuous haycutting, on this soil type, applications every second year were quite as effective as annual applications, but that two years was the limit of effectiveness. Similar results were obtained by Lines (1963) on a solodic soil with clay at 24 inches, although where a much heavier initial dressing was applied residual effects were still apparent after 4 years.

TABLE IV:

THE EFFECT OF FREQUENCY OF APPLICATION OF POTASSIUM FERTILISER ON PASTURE PRODUCTION (CWTS./ACRE) UNDER CONTINUOUS HAYCUTTING
(Watson, C.L. - 1962)

Fertiliser Application	Dry Matter (Cwts. /acre)		
	Year 2* 1959	Year 3 1960	Year 4 1961
Nil potassium	24.4	40.1	19.3
78 lbs. Muriate of Potash in years 1, 2, 3 & 4	35.3	51.3	34.6
156 lbs. in years 1 & 3	39.5	50.5	36.7
312 lbs. in year 1 only	37.5	41.6	23.4
L.S.D. 5%	4.9	5.8	3.3

* Year 1 - No harvest due to severe insect attack.

Irrigated Pastures

Pasture irrigation is of only limited importance in South Australia. The main areas are in the Lower South-East, the Adelaide Hills, and the Lower River Murray Swamps.

Worthwhile responses to potassium fertilisers are obtained in the Adelaide Hills and Lower South-East, and in those areas annual applications of 1 cwt. per acre of muriate of potash are recommended. These applications are made in July or early August and are often doubled after haycutting.

On the heavy swamp soils along the lower River Murray, confusing results have been obtained in several experiments, and at the present time potassium fertilisers are not recommended.

Likely Developments in the Use of Potassium Fertiliser

More accurate diagnosis of potassium fertiliser needs by means of soil test is of prime importance in South Australia. A field and laboratory investigation with the aim of determining suitable methods and criteria for a potassium soil test was commenced in 1963. Burford (pers. comm.) has shown that a reasonable prediction of response to applied potassium could be obtained by measuring exchangeable potassium (using .25-M NaCl as the extracting agent) on a 0-4 inch soil sample. Burford carried out his sampling during the June-July period.

His critical values were:

m-equiv. % exchange. K	
< 0.15	Deficient
0.15 - 0.30	Possibly deficient
> 0.30	Not deficient

The Agriculture Department now provides a soil test service based on this work, providing the soil sampling is done by a regional advisory officer of the Department.

Current work in this project aims at improving the precision of the method by determining "non-exchangeable but available" potassium and adding this to the exchangeable value, wherever the preliminary determination of exchangeable potassium reveals marginal values (French, pers. comm.).

One problem not covered by the above investigation is the large area of deep siliceous sand soils in the lower rainfall areas (15-20 inches p.a.). These soils have a very low potassium status and deficiency symptoms are frequently seen in pasture plants. The problem here is not so much the likelihood of a response as the economics of fertiliser usage in such an area.

Work commenced this year as a co-operative project between the Agriculture Department and C.S.I.R.O. Division of Soils should provide detailed information on the possibility of predicting economic responses in these areas from soil test data.

Accurate prediction tests for potassium requirements for optimum pasture growth will undoubtedly lead to greater confidence on the part of users (as occurred with leaf analysis results in fruit crops). The extent of the potential increase in potassium fertiliser usage is not known, but officers of the Agriculture Department have estimated that, based on current knowledge, there is a potential for at least a ten-fold increase. This figure is not incompatible with the estimate given above of $1\frac{1}{2}$ million acres of potentially potassium deficient pastures, and one can anticipate that this increase will undoubtedly occur during the next 10-15 years.

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