POTATOES

Fertilizer in Relation to Quality and Damage Susceptibility NAS 805 ML 1975

METHOD

For the third and final year a fully factorial design was used testing all combinations of the following treatments:-

a) Rate of potash fertilizer - 0, 125, 251, 376, 502, 627, kg/ha

b) Source of potash - muriate or sulphate

c) Level of nitrogen - 151, 226 kg/ha

As in previous years two separate trial areas were planted with Pentland Crown and Desiree. Fertilizer treatments were applied on 26 February allowing time for incorporation by rainfall and seedbed cultivations before planting. Due to the abnormally wet conditions, planting was delayed until 29 April (Desiree) and 30 April (Pentland Crown). Overall applications of kieserite (500 kg/ha) and triple superphosphate (213 kg P_2O_5/ha) were made on 28 April. Once grown seed was planted using a Howard Rotaplanter.

RESULTS - Pentland Crown

Final plant populations as recorded on 24 June were disappointing at 19,600 to 26,200/hectare and averaged 23,300. The emergence was not helped by a cloddy seedbed but there were no indications that the high levels of fertilizer were responsible in any way.

The soil analysis carried out before planting showed the site to be high in category I on the A.D.A.S. scale indicating that potash was less deficient than on some parts of the farm. No visual differences in crop vigour were observed during the season.

Table I

Ware Yield 44 - 83 mm ($1\frac{3}{4}$-$3\frac{1}{4}$in.)t/ha

Level of Potash kg/ha	Type of Potash Muriate	Sulphate	MEAN
	($\pm$1.112)		($\pm$0.787)
0	20.95	20.99	20.97
125	23.71	22.49	23.10
251	23.61	22.97	23.29
376	23.42	23.83	23.62
502	25.15	24.28	24.71
627	24.67	22.84	23.76
	($\pm$0.454)		
MEAN	23.58	22.90	

S.E. per plot=$\pm$2.725 (46 d.f.) or 11.7% of G.M.

The response to applied potash was significant at the 5% level but

differences between the various levels of applied potash were not significant. The mean yield was 0.78 t greater at the higher level of nitrogen but this was not significant.

Leaf samples were taken for analysis on 21 July and tubers were analysed after harvest. As shown in table 2 those follow the same trends as in 1974. Leaf and tuber potassium levels were increased by potash fertilizer while magnesium was reduced in the foliage and increased in the tubers. Thus the plant was able to maintain the magnesium level in the tubers although high rates of potash led to a reduction of magnesium in the leaves.

Table 2

Analysis of leaves and tubers

Level of Potash kg/ha	Leaves		Tubers		% dry matter
	% Potassium	% Magnesium	% Potassium	% Magnesium	
0	2.56	0.35	1.69	0.07	22.9
125	2.90	0.34	1.82	0.07	22.5
251	3.17	0.28	1.98	0.08	21.3
376	3.20	0.25	2.22	0.08	21.1
502	3.79	0.26	2.22	0.08	21.1
627	3.81	0.24	2.28	0.08	20.7

Increasing the level of potash fertilizer again reduced the tuber dry matter content and this was more marked when muriate was used than when sulphate of potash had been applied.

At riddling the ware sample was divided into three sizes and the medium grade (57 - 70 mm) tubers were tested for specific gravity. Table 3 shows the results for the two forms of potash and again indicates that muriate of potash reduces specific gravity (and dry matter) much more than suplhate of potash. The higher level of nitrogen reduced

Table 3

Specific Gravity of 57-70 mm tubers

Level of Potash kg/ha	Type of Potash		MEAN
	Muriate	Sulphate	
	($\pm$0.00103)		($\pm$0.00073)
0	1.0918	1.0930	1.0924
125	1.0920	1.0926	1.0923
251	1.0894	1.0911	1.0903
376	1.0861	1.0896	1.0878
502	1.0836	1.0873	1.0854
627	1.0852	1.0889	1.0871
	($\pm$0.00042)		
MEAN	1.0880	1.0904	

S.E. per plot = $\pm$0.00252 (46 d.f.) or 0.2% of G.M.

the specific gravity from 1.0904 to 1.0880. After peeling, the tubers in each of three ware grades were examined and the number of surface

bruises was recorded. The results shown in table 4 are for the middle size fraction and indicate a slight reduction in the number of bruises per tuber. On this size fraction the reduction in bruising with increasing potash was not statistically significant although it was significant on the smaller size fraction.

Table 4

Surface Bruises per tuber on 57-70 mm tubers

Level of Potash kg/ha	Type of Potash Muriate	Sulphate	MEAN
	(±0.220)		(±0.156)
0	3.15	2.84	2.99
125	2.70	2.66	2.68
251	2.31	2.62	2.46
376	2.55	2.61	2.58
502	2.47	2.57	2.52
627	2.44	2.48	2.46
	(±0.090)		
MEAN	2.60	2.63	

S.E. per plot = ±0.539 (46 d.f.) or 20.6% of G.M.

After peeling the tubers were sliced and each exposed surface was examined for signs of internal blackspot bruising. The areas affected in 1975 were generally much less than in the previous two years but nevertheless treatment effects were recorded as shown in table 5.

Table 5

% of tubers showing Internal Blackspot symptoms

Level of Potash kg/ha	Type of Potash Muriate 151N	Muriate 226N	Sulphate 151N	Sulphate 226N	MEAN
44-57 mm tubers		(±3.99)			(±1.99)
0	32.5	25.3	20.4	23.0	25.3
125	16.3	13.5	15.9	17.3	15.8
251	14.0	13.5	13.4	12.1	13.3
376	4.1	14.7	8.1	10.1	9.2
502	7.6	11.3	19.3	7.4	11.4
627	8.1	8.1	12.2	13.7	10.5
		(±1.63)			
MEAN	13.8	14.4	14.9	13.9	
57-70 mm tubers		(±4.61)			(±2.30)
0	30.6	35.6	32.3	33.6	33.0
125	22.5	20.2	29.4	26.8	24.7
251	18.7	18.1	16.1	21.5	18.6
376	9.3	11.3	15.5	15.8	13.0
502	10.1	14.7	17.1	12.7	13.7
627	14.5	11.7	17.0	13.6	14.2
		(±1.88)			
MEAN	17.6	18.6	21.2	20.7	

70-83 mm tubers		(±6.67)			(±3.34)
0	20.1	43.9	35.4	36.0	33.8
125	27.9	32.2	26.2	27.0	28.3
251	23.4	24.7	22.5	23.5	23.5
376	12.4	19.5	18.7	24.9	18.9
502	15.3	21.1	26.5	28.3	22.8
627	18.1	7.9	13.2	21.3	15.1
		(±2.72)			
MEAN	19.5	24.9	23.7	26.8	

S.E. per plot (44-57 mm tubers) = ±6.91 (46 d.f.) or 48.5% of G.M.
S.E. per plot (57-70 mm tubers) = ±7.98 (46 d.f.) or 40.9% of G.M.
S.E. per plot (70-83 mm tubers) = ±11.56 (46 d.f.) or 48.7% of G.M.

The short growing season, irregular plant distribution and other difficulties of the 1975 season resulted in a less clear cut picture than in previous years. However the reduction in blackspot as potash was increased remained and was statistically significant in all three size fractions. The reduction of bruising at the higher level of nitrogen and the greater effectiveness of muriate of potash which was observed in previous years was not evident on Pentland Crown in 1975.

Desiree

A separate trial on a similar adjoining area of land was conducted using the variety Desiree. Final plant populations were very low at 17,100-25,100/hectare and averaged 20,400/hectare. There was no significant effect of treatment on the final populations although there were indications that emergence was more rapid at the higher level of nitrogen and where the potash was applied in the sulphate form.

Table 1

Ware Yield 44-83 mm, t/ha

Level of Potash kg/ha	Type of Potash Muriate	Sulphate	MEAN
	(±0.846)		(±0.598)
0	18.08	17.63	17.85
125	18.90	18.62	18.76
251	19.58	17.62	18.60
376	21.06	17.93	19.50
502	21.33	20.24	20.79
627	22.32	19.24	20.78
	(±0.345)		
MEAN	20.21	18.55	

S.E. per plot = ±2.072 (46 d.f.) or 10.7% of G.M.

The ware yield was significantly increased by increasing potash levels and the yields recorded following the use of muriate of potash were greater than where sulphate of potash had been used. The higher level of nitrogen increased the yield of Desiree by 0.64 t/ha compared with 0.78 t/ha on Pentland Crown although once again this was not statistically significant.

The analysis of leaf and tuber samples again showed the increase in potassium levels following increases in applied potash fertilizer. Increasing potash reduced magnesium levels in the leaves but there was

Table 2

Analysis of leaves and tubers

Level of Potash kg/ha	Leaves		Tubers		% dry matter
	% Potassium	% Magnesium	% Potassium	% Magnesium	
0	2.20	0.42	1.57	0.07	23.5
125	2.58	0.32	1.64	0.07	23.1
251	2.60	0.27	1.77	0.08	22.6
376	3.31	0.29	1.92	0.08	22.5
502	2.93	0.27	1.96	0.08	22.1
627	3.28	0.26	2.14	0.08	21.2

a slight increase in magnesium in the tubers. Tuber dry matter content was consistently reduced by increasing potash fertilizer.

Table 3

Specific Gravity of 57-70 mm tubers

Level of Potash kg/ha	Type of Potash		MEAN
	Muriate	Sulphate	
	(±0.00080)		(±0.00057)
0	1.0959	1.0957	1.0958
125	1.0935	1.0951	1.0943
251	1.0921	1.0967	1.0944
376	1.0918	1.0951	1.0935
502	1.0893	1.0941	1.0917
627	1.0875	1.0912	1.0894
	(±0.00033)		
MEAN	1.0917	1.0947	

S.E. per plot = ±0.00197 (46 d.f.) or 0.2% of G.M.

The reduction in specific gravity as a result of increasing potash fertilizer was again demonstrated by the results in table 3. This effect was significantly greater following the use of Muriate of potash and there were indications that the higher level of nitrogen had also reduced the specific gravity although not as much as was recorded on the Pentland Crown.

Table 4

Surface Bruises per tuber on 57-70 mm tubers

Level of Potash kg/ha	Type of Potash Muriate	Sulphate	MEAN
	(±0.179)		(±0.127)
0	2.91	2.57	2.74
125	2.53	2.79	2.66
251	2.23	2.51	2.37
376	1.85	2.29	2.07
502	2.00	2.00	2.00
627	1.64	1.90	1.77
	(±0.073)		
MEAN	2.19	2.35	

S.E. per plot = ±0.439 (46 d.f.) or 19.3% of G.M.

The surface bruising was reduced by increasing potash fertilizer and again muriate of potash was more effective in this respect than sulphate of potash as shown in table 4. This improvement was recorded on all three ware size fractions for the variety Desiree. Nitrogen produced no significant change in the amount of surface bruising.

Table 5

% tubers showing Internal Blackspot symptoms

Level of Potash kg/ha	Type of Potash Muriate 151N	Muriate 226N	Sulphate 151N	Sulphate 226N	MEAN
44-57 mm tubers		(±3.88)			(±1.94)
0	15.2	18.1	17.2	17.5	17.0
125	8.8	17.5	26.1	10.7	17.8
251	11.6	13.4	12.7	22.2	15.0
376	13.0	11.4	12.1	12.8	12.3
502	6.0	6.1	15.8	10.1	9.5
627	6.1	10.7	10.7	12.1	9.9
		(±1.58)			
MEAN	10.1	12.9	15.8	15.6	
57-70 mm tubers		(±4.55)			(±2.28)
0	20.8	30.6	25.1	18.2	23.7
125	20.0	19.6	39.0	21.8	25.1
251	18.2	17.9	24.8	21.5	20.6
376	15.6	11.9	16.6	24.0	17.0
502	5.6	8.9	12.8	15.3	10.6
627	4.9	15.4	14.2	21.8	14.1
		(±1.86)			
MEAN	14.2	17.4	22.1	20.4	

70-83 mm tubers			(±7.56)		(±3.78)
0	24.2	29.0	36.6	19.0	27.2
125	25.0	22.0	57.8	26.6	32.9
251	21.2	17.5	37.1	43.4	29.8
376	30.5	8.6	15.8	32.9	22.0
502	10.0	16.5	34.6	18.5	19.9
627	14.0	16.4	25.0	33.0	22.1
			(±3.09)		
MEAN	20.8	18.3	34.5	28.9	

S.E. per plot = ±6.72 (46 d.f.) or 49.5% of G.M.
S.E. per plot = ±7.88 (46 d.f.) or 42.6% of G.M.
S.E. per plot = ±13.10 (6 d.f.) or 51.1% of G.M.

As in the case of Pentland Crown the reduction in blackspot bruising as potash increased was less consistent than in the 1975 trial. However the same trend was shown by all three size fractions in table 5 and in all except the largest fraction it was a statistically significant reduction. The muriate was significantly more effective than the sulphate in reducing the blackspot on all ware size fractions. Nitrogen level had no effect.

Conclusions

Table A

3 year Mean Ware Yield (t/ha)

Level of Potash kg/ha	Pentland Crown 1973	1974	1975	MEAN	Desiree 1973	1974	1975	MEAN	MEAN
0	32.15	38.19	20.97	30.44	24.24	37.26	17.85	26.45	28.45
125	36.70	38.62	23.10	32.81	28.76	40.64	18.76	29.39	31.10
251	39.22	39.96	23.29	34.16	30.66	42.81	18.60	30.69	32.43
376	39.67	37.34	23.62	33.54	33.34	44.62	19.50	32.49	33.02
502	38.25	40.01	24.71	34.32	34.20	44.94	20.79	33.31	33.82
627	38.16	40.68	23.76	34.20	32.90	46.24	20.78	33.31	33.76
MEAN	33.25				30.94				

Over the three years it has been evident that Pentland Crown is better able than Desiree to cope with adverse conditions. This is illustrated by its higher yield than Desiree in the absence of applied potash and its ability to out yield Desiree in the poor conditions and short growing season of 1975 in spite of being a late maturing variety.

The present cost of potash is about 10.8p/kg (5.5p/unit) which means that the cost of each treatment increment is £13.50/ha. If potatoes are worth £40/t after direct cost such as sacks, casual labour etc. than each fertilizer increment is justified by an increase of 0.3 t/ha. It can be seen from table A that on average the increases of potash fertilizer are justified on the basis of yield alone up to at least 500 kg/ha. This is obviously more than is removed by the potato crop and could therefore have an additional benefit to subsequent crops in the rotation.

The observed drop in yield at the highest level of potash tested was probably due to scorch caused by application to the seedbed in 1973. A further trial series has been started in 1976 to investigate the timing of fertilizer in order to obtain the maximum benefits without adverse effect on emergence.

In addition to the yield response, the trial series has also clearly demonstrated that as the level of potash application increased there was a reduction in both the dry matter content and the specific gravity of the tubers. There was also clear evidence that as the levels of those two factors fell, so the degree of surface bruising and internal blackspot declined. Sulphate of potash resulted in higher dry matter contents than muriate of potash and the degree of damage was proportionately greater. Justification for the use of sulphate of potash would therefore appear to be confined to its use on crops grown specifically for processing where the need for high dry matter contents was of high priority.

These results of course relate to a sandy loam which is naturally low in potash (ADAS category I). The results confirm that the potato crop is an obvious candidate for the application of the major part of the potash in a rotational fertilizer system since cereals and sugar beet have failed to give any significant response in trials at the Station.