

POTATOES

Fertilizer in Relation to Quality and Damage Susceptibility NAS 805 ML

1974

METHOD

A fully factorial design was used testing all combinations of the following treatments:

- a) Rate of potash fertilizer - 0, 100, 200, 300, 400, 500 units/acre
- b) Two types of potash - muriate and sulphate
- c) Two levels of nitrogen - 120, 180 units/acre

As in 1973 two separate trial areas were planted with Pentland Crown and Desiree. Fertilizer treatments were applied on 28 February allowing time for incorporation by rainfall and seedbed cultivations before planting on 1 April. Overall applications of kieserite and triple superphosphate were applied on 26 and 28 March respectively. Once grown seed which had been graded 1½-2in. was planted using a Howard Rotaplanter. — April

RESULTS - Pentland Crown

Emergence was rapid so that when counts were made on 17 May, 77% of the final population had emerged. Although severe ground frost affected many crops in the region no damage occurred on the trial. In 1973 emergence was retarded by the application of muriate of potash shortly before planting but no treatment significantly affected emergence in 1974, presumably because of the earlier application of the fertilizer.

The soil on the 1974 trial site had a considerably higher potash reserve than that used for the 1973 trial. Most of the samples taken were high in category 1 with some being in category 2 of the A.D.A.S. scale. In these circumstances it was not surprising that no clear deficiencies were observed in the haulm. However, significant differences in the vigour of haulm growth on 27 August were recorded as shown in Table I.

Table I - Vigour of Haulm on 27 August

Level of Potash units/acre	Vigour Score (0-10)				MEAN
	Muriate		Sulphate		
	120N	180N	120N	180N	
0	6.3	6.7	7.0	6.3	6.6
100	7.0	7.2	6.8	7.2	7.0
200	7.2	7.5	6.7	7.5	7.2
300	7.0	7.5	7.0	7.3	7.2
400	7.5	7.7	7.2	7.7	7.5
500	6.7	7.7	6.8	7.3	7.1
MEAN	6.9	7.4	6.9	7.2	

S.E. per plot = ±0.35 (46df) or 5.0% of G.M.

Total yield increased progressively from 19.4 ton per acre in the absence of potash up to 22.5 tons at both 400 and 500 units, but the form of the potash application failed to exert any influence. Table 2 shows that in the case of Pentland Crown although there was a tendency for ware yields to increase with increasing K usage, none of the responses were significant. In addition, there was no increase

following the use of 180 units of nitrogen compared with 120 units in spite of increases in haulm growth shown above.

Table 2 - Ware yield (1 $\frac{3}{4}$ -3 $\frac{1}{2}$ in.) ton/acre

Level of Potash units/acre	Ware yield		MEAN
	Muriate	Sulphate	
	(± 0.46)		(± 0.33)
0	15.1	15.4	15.2
100	15.5	15.3	15.4
200	15.0	16.8	15.9
300	14.2	15.5	14.9
400	14.9	16.9	15.9
500	16.1	16.4	16.2
MEAN	(± 0.19)		
	15.1	16.1	

S.E. per plot = ± 1.130 (46df) or 7.3% of G.M.

Leaf samples taken on 15 July and tubers taken after harvest were analysed for potash and magnesium giving the results shown in Table 3. In addition, there was little difference between muriate

Table 3 - Analysis of leaves and tubers

Level of Potash units/acre	Leaves		Tubers		
	% potassium	% magnesium	% potassium	% magnesium	% dry matter
0	1.82	0.78	1.61	0.068	23.0
100	2.34	0.73	1.64	0.075	21.9
200	2.49	0.63	1.89	0.088	21.8
300	3.18	0.61	2.07	0.090	21.3
400	3.26	0.58	2.20	0.093	21.0
500	3.63	0.58	2.38	0.098	20.2

and sulphate of potash in terms of potassium and magnesium uptake but muriate of potash reduced tuber dry matter far more than sulphate. Tubers grown with 500 units of muriate of potash had a dry matter of 19.5% compared with 21.0% where sulphate of potash had been used. The analyses confirmed last years findings that increased in fertilizer potash increased both potassium and magnesium levels in the tubers. However the leaf samples reflected the ^{common} situation where increasing potassium levels reduced the level of magnesium in the leaves. The crop received 2 cwt/acre of kieserite and no magnesium deficiency symptoms were observed.

At riddling, samples of 2 $\frac{1}{4}$ -2 $\frac{3}{4}$ in. tubers were tested for specific gravity which decreases as dry matter decreases. Table 4 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 sulphate of potash does. The higher level of nitrogen consistently reduced the specific gravity - the mean value of 180 units of N being 1.0917 compared with 1.0950 at 120 units of N. This approximates to a change in dry matter of just over 0.5%.

Table 4 - Specific Gravity of 2 $\frac{1}{4}$ -2 $\frac{3}{4}$ in. tubers

Level of Potash units/acre	Specific Gravity		MEAN
	Muriate	Sulphate	
	(± 0.00111)		(± 0.00078)
0	1.0976	1.0989	1.0982
100	1.0959	1.0964	1.0961
200	1.0917	1.0975	1.0946
300	1.0908	1.0933	1.0921
400	1.0859	1.0933	1.0896
500	1.0871	1.0922	1.0896
MEAN	1.0915	1.0953	
	(± 0.00045)		

S.E. per plot = ± 0.00271 (46df) or 0.2% of G.M.

Since the 1973 results indicated that there was no consistent effect of treatment on the size or depth of surface mechanical damage marks it was decided to record only the number of such impact marks. Tubers were however peeled in the same way as before and the number of bruises recorded on each tuber in 50 tuber samples from the three ware fractions 1 $\frac{3}{4}$ -2 $\frac{1}{4}$, 2 $\frac{1}{4}$ -2 $\frac{3}{4}$ and 2 $\frac{3}{4}$ -3 $\frac{1}{4}$ in. Tubers were then sliced to determine what percentage of the sample was affected by internal blackspot bruising.

The surface bruising shown in table 5 is that remaining after peeling with a commercial abrasive peeler. Although the trends are similar to those observed before in that muriate reduced the damage

Table 5 - Surface Bruises per tuber on 2 $\frac{1}{4}$ -2 $\frac{3}{4}$ in. sample

Level of Potash units/acre	Bruises/tuber		MEAN
	Muriate	Sulphate	
	(± 0.198)		(± 0.140)
0	3.17	3.27	3.22
100	3.08	3.57	3.33
200	2.64	2.78	2.71
300	2.95	2.77	2.86
400	2.58	2.87	2.72
500	2.40	2.74	2.57
MEAN	2.80	3.00	
	(± 0.81)		

S.E. per plot = ± 0.484 (46df) or 16.2% of G.M.

more than sulphate of potash, the only significant differences were recorded in response to the level of potash. It is interesting to note a slight reduction of surface damage as potash levels were increased but the more dramatic response is in the level of internal blackspot bruising and it is believed that this is the factor recorded purely as bruising by many investigators.

Table 6 - % of tubers showing Internal Blackspot symptoms

Level of Potash units/acre	% of tubers affected				MEAN
	Muriate		Sulphate		
	120N	180N	120N	180N	
	<u>1.75-2.25in. tubers</u> (± 4.08)				(± 2.04)
0	31.5	11.9	38.0	22.4	25.9
100	14.8	24.2	18.4	12.1	17.4
200	17.8	10.8	11.4	14.1	13.5
300	14.5	9.4	9.5	10.8	11.1
400	4.7	4.0	5.3	7.7	5.4
500	4.1	4.0	13.8	6.8	7.2
MEAN	(± 1.67)				
	14.6	10.7	16.1	12.3	
	<u>2.25-2.75in. tubers</u> (± 4.83)				(± 2.41)
0	36.0	22.1	43.5	23.1	31.2
100	37.9	35.9	29.4	23.8	31.7
200	26.7	25.5	19.2	23.3	23.7
300	22.3	19.9	27.5	22.9	23.2
400	10.0	8.9	23.5	19.9	15.6
500	12.7	9.3	20.9	12.6	13.9
MEAN	(± 1.97)				
	24.3	20.3	27.3	20.9	
	<u>2.75-3.25in. tubers</u> (± 5.69)				(± 2.84)
0	37.5	38.3	49.3	28.7	38.4
100	38.0	36.9	43.5	32.1	37.6
200	36.5	24.9	31.1	27.5	30.0
300	21.8	18.1	34.7	31.6	26.6
400	17.7	12.7	25.0	24.1	19.9
500	19.0	19.5	27.9	18.2	21.1
MEAN	(± 2.32)				
	28.4	25.0	35.3	27.0	

tubers)

S.E. per plot (1.75-2.25in. tubers) = ± 7.07 (45df) or 52.7% of G.M.
 S.E. per plot (2.25-2.75in. tubers) = ± 8.36 (46df) or 36% of G.M.
 S.E. per plot (2.75-3.25in. tubers) = ± 9.85 (46df) or 34% of G.M.

Table 6 shows a significant reduction in blackspot damage on each size fraction as potash applications were increased. The overall comparison of the two nitrogen levels for each size fraction also showed a significant reduction at the higher level of nitrogen. This trend was evident with both sources of potash. Muriate of potash was consistently more effective than sulphate of potash in reducing this form of damage although the difference only reached statistical significance on 2 $\frac{3}{4}$ -3 $\frac{1}{4}$ in. tubers.

The reduction in blackspot bruising (Table 6) follows very closely the reduction in dry matter of the tubers (Table 3) and the specific gravity (Table 4). A comparison of specific gravity records (2 $\frac{1}{4}$ -2 $\frac{3}{4}$ in. tubers) with the degree of blackspot incidence indicates clearly that blackspot can be correlated with dry matter and that it is reduced by increasing potash or nitrogen, or by the use of muriate of potash rather than sulphate of potash. However there is no evidence that tubers of similar dry matter produced with sulphate of potash are any more susceptible to damage than those grown at a lower level of muriate of potash to give the same dry matter.

Pentland Crown 805 ML

Appendix I - Total Yield (includes cracks, greens etc)

Level of Potash units/acre	Total Yield (ton/acre)		MEAN
	Muriate	Sulphate	
	(± 0.53)		(± 0.37)
0	19.0	19.8	19.4
100	20.7	20.0	20.3
200	21.2	21.7	21.4
300	20.7	20.6	20.6
400	22.1	22.9	22.5
500	23.0	22.1	22.5
MEAN	(± 0.22)		
	21.1	21.2	

S.E. per plot = ± 1.29 (46df) or 6.1% of G.M.

Appendix II - Total Sound Yield (includes sound tubers under 1 $\frac{1}{2}$ in. and over $\frac{3}{4}$ in.)

Level of Potash units/acre	Total Sound Yield (ton/acre)		MEAN
	Muriate	Sulphate	
	(± 0.50)		(± 0.35)
0	17.9	18.7	18.3
100	19.3	18.8	19.0
200	19.9	20.7	20.3
300	19.5	19.3	19.4
400	20.5	21.8	21.2
500	21.6	20.7	21.2
MEAN	(± 0.20)		
	19.8	20.0	

S.E. per plot = ± 1.22 (46df) or 6.2% of G.M.

Appendix III - Specific Gravity 2 $\frac{1}{4}$ -2 $\frac{3}{4}$ in. tubers

Level of Potash units/acre	Specific Gravity				MEAN
	Muriate		Sulphate		
	120N	180N	120N	180N	
	(± 0.00157)				(± 0.00078)
0	1.1010	1.0941	1.0989	1.0990	1.0982
100	1.0968	1.0949	1.0967	1.0961	1.0961
200	1.0907	1.0927	1.0990	1.0960	1.0946
300	1.0931	1.0885	1.0960	1.0906	1.0921
400	1.0879	1.0838	1.0957	1.0910	1.0896
500	1.0908	1.0834	1.0938	1.0906	1.0896
MEAN	(± 0.00064)				
	1.0934	1.0896	1.0967	1.0939	

S.E. per plot = ± 0.00271 (46df) or 0.2% of G.M.

RESULTS - Desiree

The Desiree part of the trial was conducted in the same way as the Pentland Crown but was lifted and stored in better conditions so that in general errors are lower and trends more distinct.

When emergence counts were made on 17 May 76% of the final population had established compared with 77% of the Pentland Crown. The mean final plant population at 11,740 per acre was slightly higher than the Pentland Crown. Once again there were no significant differences between treatments indicating that scorch had been avoided.

Although soil potash reserves were similar to those on the adjoining Pentland Crown, severe deficiency symptoms were visible in the Desiree grown without potash and this was also reflected in the vigour of haulm growth as shown in Table 1. The higher level of nitrogen also significantly increased haulm growth on this variety.

Table 1 - Vigour of Haulm on 27 August

Level of Potash units/acre	Vigour Score (0-10)				MEAN
	Muriate		Sulphate		
	120N	180N	120N	180N	
	(± 0.31)				(± 0.15)
0	4.2	4.7	4.3	6.2	4.8
100	5.7	6.5	5.8	6.0	6.0
200	6.2	7.3	6.0	6.8	6.6
300	6.0	7.8	6.5	7.2	6.9
400	6.3	6.8	6.5	7.0	6.7
500	6.5	7.7	6.0	7.2	6.8
MEAN	(± 0.12)				
	5.8	6.8	5.9	6.7	

S.E. per plot = ± 0.53 (46df) or 8.4% of G.M.

In the absence of potash there was a total yield of 17.2 ton per acre which increased progressively with increasing potash level to 21.0 tons when 500 units were applied. This pattern was noticeable whether the potash was given in the form of either muriate or sulphate and there were only minor differences between the two types at any of the levels of application.

Ware yields in Table 2 show the first significant yield increase observed in this trial series following the use of 180 units of nitrogen compared with 120 units. In the case of this variety there

Table 2 - Ware yield (1 $\frac{3}{4}$ -3 $\frac{1}{2}$ in.) ton/acre

Level of Potash units/acre	Ware yield				MEAN
	Muriate		Sulphate		
	120N	180N	120N	180N	
	(± 0.58)				(± 0.29)
0	14.0	15.0	13.3	17.1	14.8
100	15.4	16.8	15.6	16.9	16.2
200	17.1	17.4	16.5	17.3	17.1
300	17.4	18.7	17.0	18.0	17.8
400	19.2	16.9	18.0	17.7	17.9
500	17.9	19.7	17.1	19.0	18.4
MEAN	(± 0.24)				
	16.8	17.4	16.3	17.7	

S.E. per plot = ± 1.00 (46df) or 5.9% of G.M.

was a significant response to increasing potash at least to a level of 200 units/acre.

Table 3 - Analysis of leaves and tubers

Level of Potash units/acre	Leaves		Tubers		
	% potassium	% magnesium	% potassium	% magnesium	% dry matter
0	1.75	0.91	1.44	0.625	25.4
100	2.07	0.82	1.58	0.675	24.4
200	2.94	0.73	1.71	0.750	24.2
300	3.37	0.70	2.00	0.875	23.7
400	3.76	0.63	2.02	0.825	22.8
500	3.79	0.56	2.22	0.925	22.8

As shown in Table 3 the variety behaved in a similar manner to Pentland Crown in that increasing potash fertilizer increased the level of potassium in both leaves and tubers, while magnesium was increased in the tubers but depressed in the leaves.

Table 4 - Specific Gravity 2¹/₄-2³/₄in. tubers

Level of Potash units/acre	Specific Gravity		MEAN
	Muriate	Sulphate	
	(±0.00058)		(±0.00041)
0	1.0930	1.0934	1.0932
100	1.0914	1.0945	1.0929
200	1.0896	1.0936	1.0916
300	1.0868	1.0908	1.0888
400	1.0834	1.0912	1.0873
500	1.0828	1.0894	1.0861
MEAN	(±0.00024)		
	1.0878	1.0922	

S.E. per plot = ± 0.00142 (46df) or 0.1% of G.M.

The specific gravity was again reduced by increasing levels of potash and as in the case of Pentland Crown the higher level of nitrogen reduced specific gravity even further.

There was a significant reduction in surface damage on all three size fractions as the potash rate was increased. Similarly, damage was slightly reduced by the higher level of nitrogen although this failed to reach significance on any of the samples. The number of bruises per tuber following the various potash treatments is shown in Table 5 for the middle size fraction.

Table 5 - Surface Bruises per tuber on 2 1/4-2 3/4 in. sample

Level of Potash units/acre	Bruises/tuber		MEAN
	Muriate	Sulphate	
	(±0.151)		(±0.107)
0	3.49	3.25	3.37
100	2.99	2.95	2.97
200	2.46	2.45	2.46
300	1.97	2.24	2.11
400	2.15	2.11	2.13
500	1.80	2.05	1.92
Mean	(±0.062)		
	2.48	2.51	

S.E. per plot = ±0.371 (46d.f.) or 14.9% of G.M.

This table confirms the trends shown by Pentland Crown.

Table 6 shows the incidence of internal blackspot in each of the three grades within the ware fraction. Increasing levels of potash had a significant effect in reducing the incidence of blackspot

Table 6 - % of tubers showing Internal Blackspot symptoms

Level of Potash units/acre	% of tubers affected				MEAN
	Muriate		Sulphate		
	120N	180N	120N	180N	
	1.75-2.25in. tubers (±5.45)				(±2.73)
0	37.6	33.8	34.8	34.7	35.2
100	32.0	32.0	26.8	28.9	29.9
200	28.9	28.3	17.9	27.6	25.6
300	16.3	8.3	26.9	18.3	17.4
400	10.9	13.3	21.1	18.6	16.0
500	4.7	9.9	20.1	13.4	12.0
MEAN	(±2.23)				
	21.7	20.9	24.6	23.6	
	2.25-2.75in. tubers (±4.80)				(±2.40)
0	54.7	50.0	48.7	51.0	51.1
100	43.3	42.7	42.6	34.2	40.7
200	31.0	42.4	44.0	39.3	39.2
300	26.2	19.5	36.7	27.7	27.5
400	24.3	24.1	28.5	15.7	23.2
500	16.6	16.7	26.0	30.5	22.4
MEAN	(±1.96)				
	32.7	32.5	37.7	33.1	
	2.75-3.25in. tubers (±5.96)				(±2.98)
0	69.0	63.1	52.0	60.2	61.1
100	65.7	54.2	48.5	52.9	55.3
200	55.1	57.6	47.3	46.8	51.7
300	43.0	33.7	49.9	50.1	44.2
400	40.9	42.2	55.8	44.2	45.8
500	26.6	27.6	42.8	47.7	36.1
MEAN	(±2.43)				
	50.0	46.4	49.4	50.3	

S.E. per plot (1.75-2.25in. tubers) = ±9.45 or 41.6% of G.M.
 S.E. per plot (2.25-2.75in. tubers) = ±8.31 or 24.4% of G.M.
 S.E. per plot (2.75-3.25in. tubers) = ±10.33 or 21.1% of G.M.

in each of these grades. The effects of the nitrogen and the type of potash failed to reach statistical significance in any of the samples although they generally follow the established trend of muriate being better than sulphate and the higher level of nitrogen being better in reducing blackspot.

Conclusions

In both varieties increasing levels of potash (particularly as muriate) and the higher level of nitrogen reduced the dry matter of tubers and in turn improved tuber quality in terms of surface and internal damage.

Although it may still be difficult to quantify exactly the improvement in quality resulting from certain cultural techniques tested there is now considerable evidence that the quality and damage susceptibility of potatoes can be influenced by the fertilizer applied.

- 1) Increasing levels of potash up to at least 500 units/acre reduces damage susceptibility under conditions at Morley.
- 2) The use of adequate nitrogen - at least for maximum yield appears to improve resistance to blackspot damage.
- 3) Muriate of potash is more effective than sulphate of potash.
- 4) There was some evidence in 1973 that discolouration after peeling was reduced by the higher levels of potash.
- 5) To increase potash levels from normal (approx. 250 units) to 500 units might add £1/ton to production costs at the present time but if rotational manuring is practiced much of this could be recovered from the other crops in the rotation. In addition, provided the fertilizer was applied early enough (if muriate was used) then there appears to be every chance of obtaining extra yield as well.

Desiree 805ML

Appendix I - Total Yield (includes cracks, greens etc.)

Level of Potash units/acre	Total Yield (ton/acre)		MEAN
	Muriate	Sulphate	
	(± 0.43)		(± 0.31)
0	16.9	17.5	17.2
100	18.6	19.6	18.6
200	20.4	19.4	19.9
300	20.8	20.1	20.4
400	21.2	20.2	20.7
500	21.6	20.3	21.0
	(± 0.18)		
	19.9	19.3	

S.E. per plot = ± 1.06 (46df) or 5.4% of G.M.

Appendix II - Total Sound Yield (includes sound tubers under $1\frac{1}{2}$ in. and over $3\frac{1}{4}$ in.)

Level of Potash units/acre	Total Sound Yield (ton/acre)		MEAN
	Muriate	Sulphate	
	(± 0.41)		(± 0.29)
0	16.5	17.1	16.8
100	18.2	18.2	18.2
200	19.8	18.9	19.4
300	20.3	19.5	19.9
400	20.6	19.7	20.2
500	21.2	19.9	20.5
	(± 0.17)		
MEAN	19.4	18.9	

S.E. per plot = ± 1.01 (46df) or 5.3% of G.M.

Appendix III - Specific Gravity $2\frac{1}{4}$ - $2\frac{3}{4}$ in. tubers

Level of Potash units/acre	Specific Gravity				MEAN
	Muriate		Sulphate		
	120N	180N	120N	180N	
	(± 0.00082)				(± 0.00024)
0	1.0945	1.0915	1.0943	1.0926	1.0932
100	1.0920	1.0908	1.0953	1.0927	1.0929
200	1.0907	1.0884	1.0951	1.0921	1.0916
300	1.0983	1.0855	1.0930	1.0887	1.0888
400	1.0836	1.0833	1.0930	1.0895	1.0873
500	1.0841	1.0814	1.0914	1.0874	1.0861
	(± 0.00033)				
MEAN	1.0889	1.0868	1.0937	1.0907	

S.E. per plot = ± 0.00147 (46df) or 0.1% of G.M.