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Experiments to investigate some of the problems in mechanisation associated with the cultivation of potatoes in beds

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Zusammenfassung, Résumé p. 212

Summary

The experiments were designed to study some of the mechanisation problems associated with growing high populations of potatoes on the flat with near square spatial arrangements. In 1963 four row flat beds were used but draught problems at harvest caused the semi-bed system to be adopted for the following three years with 76.2 cm ridges as a control. A new planter and a multigrade potato riddle were developed, and the semi-beds were harvested by three types of digger.
It was shown that mechanisation of the semi-bed system of potato cultivation was quite practical, but when compared with 76.2 cm ridges, yields might not compensate for the higher seed rates and increased harvesting difficulties.

Introduction

Whilst the traditional method of potato cultivation has much to commend it, some of the main disadvantages are a highly rectangular plant distribution, high moisture loss from ridges due to their large surface area, and the risk of post planting cultivations creating clods and causing damage to roots and haulm. Experiments were carried out at the N.I.A.E. (Green, 1960 and 1962) using beds to minimise clod formation by tractor wheels, and using close sett spacings to compensate for the wide paths. It was found that overcrowding reduced yield in the middle rows and excessive greening occurred.
As methods of chemical weed control in potatoes became acceptable alternatives to mechanical cleaning operations in the growing crop, it was suggested (Bleasdale, 1962) that planting high population crops in flat beds, with no post planting cultivations except for blight spraying, could lead to reductions both in clods at harvest and less damage to roots and haulm during the growing season. Further advantages would be less risk of frost damage due to undisturbed soil surfaces, and a higher proportion of the tuber sizes required for pre-packing due to more even plant distributions. It was suggested that the optimum density of plants should be 8.6 plants per square metre i.e. 34.3 × 34.3 cm spacing, to achieve pre-pack grades of 4.1 – 6.1 cm and that for this purpose the seed size should be 3.6–4.4 cm.
The task undertaken by the N.I.A.E. (Wayman, 1967) was to investigate ways to

Fig. 1. N.I.A.E. Bulb Planter.

Abb. 1. NIAE-Setzmaschine.
Fig. 1. Planteuse à bulbes N.I.A.E.

mechanise the operations that would produce tubers of the appropriate size, when growing on the flat in a soil with a low clod population. Machinery was required both to plant the high populations and, when the crop was mature, to harvest from the flat.

Treatments

1963 Experiment

The treatments were as follows:

1. Two depths of planting, these giving 7.6 and 12.7 cm of soil cover over the setts.
2. Three row widths, 30.5, 33.0 and 35.6 cm, with 30.5 cm sett spacing along the row.
3. Two tractor wheel widths, 152.4 and 172.7 cm obtained simultaneously by setting the left hand wheel at 76.2 cm and the right hand wheel at 86.4 cm from the tractor centre line. Conventional ridges at 76.2 cm spacing were used as a control.

'Once grown' *King Edward* potatoes graded between 3.2 and 4.4 cm were planted by the modified N.I.A.E. bulb planter (Fig. 1) which was originally designed to plant flower bulbs at 5.1–15.2 cm spacing in narrow rows. The machine produced by agitation a single row of tubers on external platforms which were tipped on to a horizontal conveyor belt, the speed of which could be adjusted to meter the tubers into the furrows at a predetermined spacing. The machine planted four rows at one pass at the

Fig. 2. Fixed share two row digger with divider.

Abb. 2. Zweireihiger Roder mit festem Schar und Verteiler.
Fig. 2. Arrancheuse 2 rangs à soc fixe avec diviseur.

chosen row width and the planted bed was levelled by spring tines mounted on the rear frame.

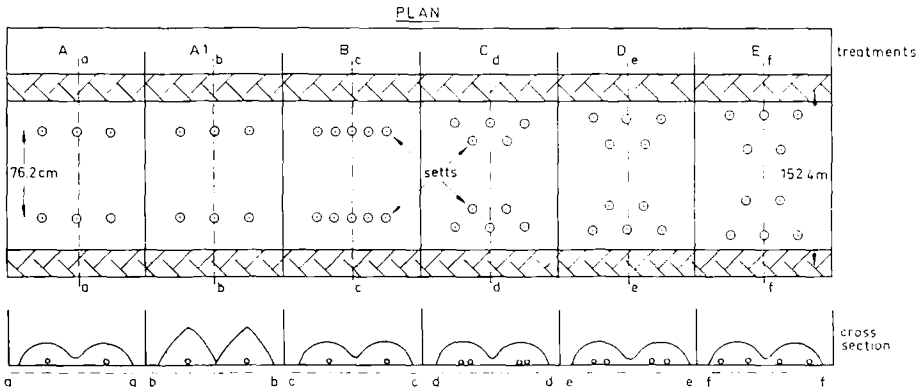
The machine used to harvest the plots was a 2-row mounted elevator digger with a 132.1 cm fixed share which was wide enough to lift a complete bed of four rows with one pass of the machine. In order to keep the treatments separate, however, a centre divider was required. The leading point was attached to the front edge of the share and the divider was carried back over the web to form a pair of deflectors at the rear. In effect the machine then behaved like two 66.0 cm diggers side by side and left the tubers from one bed in two distinct rows (Fig. 2).

1964–1966 Experiments

The semi-beds were a development of the flat bed system in that a shallow furrow was drawn along the centre of each bed giving the effect of two low ridges within a tractor wheel track of 152.4 cm. Six spatial arrangements of setts were used in the planting treatments (Fig. 3) which were as follows:

1. A single row of setts 30.5 cm apart along each low ridge (treatment A).
2. As in 1, but with high ridges formed during the early growing season, (treatment A1) carried out in 1965 and 1966 only.
3. A single row of setts 15.2 cm apart along each low ridge (treatment B).
4. Two rows 15.2 cm apart within each low ridge with setts at a staggered spacing of 30.5 cm in the row (treatment C).

Fig. 3. Spatial arrangement of setts.



Treatments – *Verfahren – Traitements*
Cross section – *Querschnitt – Section transversale*

Abb. 3. Räumliche Anordnung der Pflanzstellen.
Fig. 3. Dispositifs d'emplacements.

5. Two rows 22.9 cm apart within each low ridge with setts at a staggered spacing of 30.5 cm in the row (treatment D).
6. Two rows 30.5 cm apart within each low ridge with setts at a staggered spacing of 30.5 cm in the row (treatment E).

It will be noted that treatments A, A1 and B gave two rows of setts within each semi-bed, whilst treatments C, D and E gave four rows of setts per semi-bed. Under good conditions the whole area between the tractor wheels could be lifted by one pass of a two row machine with a 132.1 cm share, but if soil conditions deteriorated then the centre furrow allowed the semi-bed to be lifted by two passes of a single row machine with a 66.0 cm share.

To plant these experiments an N.I.A.E. experimental four row bed planter (Fig. 4) was developed. The machine was basically two semi-automatic twin row units, land wheel driven, delivering into four adjustable coulters. The two coulters on each side could be positioned between 17.8 and 55.9 cm from the centre line of the machine. It was also possible to align adjacent pairs of coulters and so deliver the setts from two units into one row. The tuber spacing within the row could be varied by changing sprockets in the drive train. Accuracy of spacing in the row and the staggering of setts in adjacent rows were controlled by shutters in each coulter. A small ridging body and two half-bodies on a bar at the rear built up ridges approximately 10.2 cm high, 61.0 cm wide across the base and 35.6 cm wide at the top. Drag chains finally rounded off the ridge contours. The setts were planted to a depth of 10.2 cm below the top of the ridge. Irish 'A' certified *Craig's Royal* seed potatoes graded 3.2–5.1 cm were used throughout the experiments.

Fig. 4. N.I.A.E. Bed potato planter.

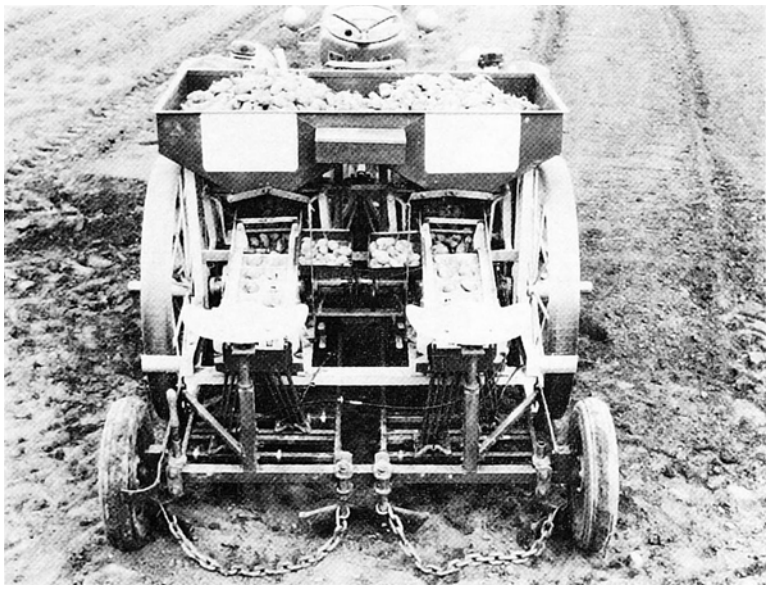


Abb. 4. NIAE-Kartoffelpflanzmaschine für Saatbeete.
Fig. 4. Planteuse à pommes de terre sur lit N.I.A.E

Of the three machines used to harvest the experiments the single row (66.0 cm share) and the two row (132.1 cm share) elevator digger were standard production rigid share machines, whereas the shares of the N.I.A.E. digger (Fig. 5) consisted of two power driven discs 55.9 cm in diameter, with a gap between them of 7.0 cm. The discs were inclined inwards towards each other so that the deepest cut was in the centre of the row, the included angle between the discs being 130°, and downwards at an angle of 22° in order to lift the tubers and soil on to the elevator web. The discs rotated inwards at the front so that soil tended to be gathered from the outside of the ridge towards the centre and then carried back towards the elevator chain.

The tuber samples were graded by the N.I.A.E. multigrade potato riddle (Fig. 6). This machine consisted of a stack of nine standard square mesh potato riddles ranging in size from 2.5 to 7.6 cm in mesh by ca. 0.6 cm steps. The riddles were arranged horizontally in the stack, 15.2 cm apart, with the largest mesh at the top and smallest at the bottom.

Each sample was placed on the top of the stack of riddles by a small elevator driven by an electric motor, and the riddles were reciprocated in the horizontal plane at 80 strokes per minute by the same means. After the tubers had been separated into the various size grades, they were hand picked off each riddle in turn, and the various size grades were analysed for sound, green and mis-shapen tubers.

Fig. 5. N.I.A.E. Driven disc digger.

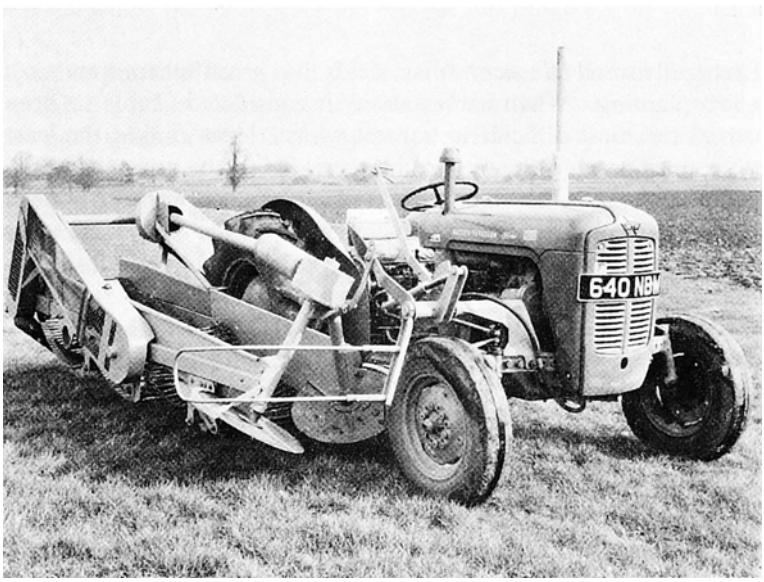


Abb. 5. NIAE-Roder mit Scheibenschar.
Fig. 5. Arracheuse à disques actionnés N.I.A.E.

Fig. 6. N.I.A.E. Multi-grade potato riddle.

Abb. 6. Vielfach-Kartoffelsortierer.
Fig. 6. Crible N.I.A.E. à plusieurs calibres.

Results

1963 Results

The treatments had generally small effects on tuber yields, but green tubers were most prevalent at the shallow plantings. When harvestability is considered (Table 1), deep planted flat beds proved the most difficult to harvest whilst ridges caused the least trouble. Soil conditions were good at the time of harvesting, but the power required to pull the share and the power absorbed by the elevator chain when working in deep planted flat beds meant that the Fordson Major tractor was working very close to its limit.

1964–1966 Experiments

Except for herbicide and fungicide spraying no weeding or cultivations (excluding ridging in the A1 plots) were carried out between planting and harvesting yet the crops remained weed free.

A practical difficulty arose in that, due to the combination of dense haulm and no deep furrows in the semi-beds, it was extremely difficult to keep the tractor wheels in the paths whilst spraying against blight.

An irregularity index (2K) was applied to the plant spacings over the four years and it was shown that the N.I.A.E. bed planter spaced the setts more regularly than the N.I.A.E. bulb planter. When using the index, 2 indicates completely random spacing

Table 1. Harvestability data (1963).

Method of cultivation[1] *Depth of share*[4]	*Flat beds*[2] *12.7 cm below surface*[5]	*Flat beds*[2] *17.8 cm below surface*[5]	*High ridges*[3] *2.5 cm below base of ridge*[6]
Clods delivered with tubers[7] (t/ha)	9.5	22.8	6.5
Soil lifted per hectare[8] (m^3)	1028.3	1445.4	700.7
Dry soil lifted[9] (t/ha)	1340.8	1863.9	973.4
Pull to move share through soil[10] (kg)	479.5	855.0	498.1

[1] *Anbaumethode – Méthode de culture*
[2] *Flach bedeckt – Lits plats*
[3] *Hohe Dämme – Buttes élevées*
[4] *Schartiefe – Profondeur du soc*
[5] *Unter der Oberfläche – Sous la surface*
[6] *Unter der Dammbasis – Sous la base de la butte*
[7] *Schollenanteil an Knollenernte – Mottes récoltées avec les tubercules*
[8] *Aufgenommen Erde pro Hektar – Terre récoltée par hectare*
[9] *Aufgenommene trockene Erde – Terre sèche récoltée*
[10] *Kraft, um das Schar durch den Boden zu führen – Travail développé pour mouvoir le soc dans le sol*

Tabelle 1. Angaben über die Rodbarkeit (1963).
Tableau 1. Données de récolte (1963).

whilst infinity indicates complete regularity, and the mean index for the bulb planter was 9.0 whilst the indices for the bed planter ranged from 10.2 to 24.7 with a mean of 14.4.

The data for total hand dug yield as an average of the three years (1964–66) is shown in Table 2 when differences resulting from the treatments were very small both in pre-pack grades (4.4–6.3 cm) and total yields. It would appear that, in this particular three year series of experiments, doubling the sett population and arranging the plants in a near square pattern had no obvious advantages (in terms of total yield) over the more common form of plant arrangement.

The total yield of imperfect tubers is shown in Table 3 and it should be noted that 'green tubers' refer to those with any green, however slight, similarly 'mis-shapen' refers to those tubers with any crack or indentation. Unsaleable tubers are those from the two previous classifications that were so badly blemished as to be unsaleable. Green tubers were most prevalent in the semi-beds and least on the high ridges, whilst mis-shapen tuber yields were greater from the high ridges than from the semi-bed treatments. Unsaleable tubers which were composed mainly of greens followed the same patterns as the greens, but it should be noted that the mean yield was only 0.7 t/ha or approximately 2 % of the total hand dug yield.

When machine dug (see Table 4) the mean total yield was 87 % of the total hand dug yield. Yields from treatments indicate that the three machines lifted a slightly greater

Table 2. Yield from hand dug samples (tonnes/ha).

Treatment[1]	*Up to*[2] *4.4 cm*	*4.4–6.3 cm*		*Over*[5] *6.3 cm*	*Total yield*[6]
		Yield[3]	*As % of total*[4]		
A	9.1	25.1	64.4	4.7	38.9
B	11.7	24.2	62.7	2.6	38.5
C	12.6	25.0	62.0	3.0	40.6
D	13.3	25.0	61.7	2.2	40.5
E	13.2	24.0	60.4	2.6	39.8
S.E. (whole plot means)[7]	± 2.82	± 4.42	–	2.58	± 4.84
S.E. for whole plots as % of mean[8]	10.2	7.8	–	38.0	5.3
Mean yield[9]	12.0	24.7	62.4	3.0	39.7
A1 (2 years only)[10]	8.7	24.1	64.6	4.6	37.4

[1] *Verfahren – Traitement*
[2] *Bis zu – Jusqu'a*
[3] *Ertrag – Production*
[4] *In % des Totals – En % du total*
[5] *Über – Au-dessus*
[6] *Gesamtertrag – Production totale*
[7] *S.E. (Mittelwerte der ganzen Parzellen – E.S. (moyennes sur la parcelle entière)*
[8] *S.E. für die ganzen Parzellen in % des Mittels – E.S. pour les parcelles entières en % de la moyenne*
[9] *Durchschnittlicher Ertrag – Production-moyenne*
[10] *A1 (nur 2 Jahre) – A1 (2 années seulement)*

Tabelle 2. Ertrag von handgerodeten Mustern (Tonnen/Hektar).
Tableau 2. Productions déterminées sur échantillons (tonnes/ha) arrachés manuellement.

Table 3. Imperfect tubers (tonnes/ha).

Treatment[1]	*Green tubers*[2]	*Mis-shapen tubers*[3]	*Unsaleable tubers*[4]
A	2.3	14.6	0.5
B	2.2	15.3	0.6
C	2.9	14.4	0.8
D	2.6	15.0	0.7
E	3.2	14.2	0.9
Mean[5]	2.6	14.7	0.7
A1 (2 years only)	1.7	19.5	0.3

[1] *Verfahren – Traitement*
[2] *Grüne Knollen – Tubercules verdis*
[3] *Missförmige Knollen – Tubercules malformés*
[4] *Unverkäufliche Knollen – Tubercules non commerciaux*
[5] *Mittel – Moyenne*
[6] *A1 (nur 2 Jahre) – A1 (2 années seulement)*

Tabelle 3. Nicht einwandfreie Knollen (Tonnen/Hektar).
Tableau 3. Tubercules défectueux (tonnes/ha).

proportion of the crop from the lower populations (A and A1) with the single row fixed share machine at 94% being more efficient than either of the other two, (N.I.A.E. 84% and two row digger 85%).

Table 5 gives details of the weight of tubers which escaped around the corners of the shares. The mean loss from this source was 1147.1 kg/ha and it is apparent that this type of loss increased as the lateral sett spacing widened. The driven discs of the N.I.A.E. machine effectively restricted the losses to a mean of 321.4 kg/ha whilst losses from the two row machine were lower than those from the single row fixed share machine. Losses from high ridges were very small.

It is apparent from Table 6 that whilst the two rigid share machines moved equal amounts of soil provided the depth of working was equal, the vee shaped cut made by the disc shares of the N.I.A.E. machine necessitated deeper working although the machine actually moved less soil. In this respect it is preferable to compare volumes of soil moved rather than weight as the latter varies with soil type.

Whilst the mean area of ridge in the semi-beds was 440.0 cm^2 and in high ridges was 564.5 cm^2 the shares of the machines had to be set deeper below the ridge base for semi-beds, consequently the rigid share machines moved the least soil from the high ridges, but the N.I.A.E. machine returned the same mean data from both treatments. If deep planted flat beds (Table 1, 1963) are compared with semi-beds it will be seen that the two row machine moved 1445.4 and 1011.7 m^3 of soil per hectare respectively or 30% less soil from semi-beds than from deep planted flat beds. Similarly it is shown in Table 6 that the two row machine moved 16% less soil from high ridges than semi-beds.

Table 4. Yields from machines (tonnes/ha).

Machine[1]	*N.I.A.E. driven disc single row digger*[2]	*Two row digger*[3]		*Single row fixed share digger*[5]	*Mean*[6]
		Row[4] *1*	*Row*[4] *2*		
Treatment[7]					
A	32.3	34.2	36.1	37.5	35.0 (90 %)
B	31.8	32.3	34.3	35.6	33.5 (87 %)
C	33.9	33.4	35.0	37.8	35.0 (87 %)
D	33.9	32.9	35.0	38.5	35.1 (87 %)
E	34.6	32.0	32.7	36.4	33.9 (85 %)
Mean[6]	33.3 (84 %)	33.0 (83 %)	34.6 (87 %)	37.2 (94 %)	34.5 (87 %)
A1 (2 years only)[8]	32.7 (88 %)	32.2 (86 %)	35.5 (95 %)	35.0 (94 %)	33.9 (91 %)

S.E. for treatment means = ± 5.66
S.E. for machine means = ± 5.07
S.E. for whole plots as % of mean = 7.1 %
} excluding treatment A1

Standardabweichung für die Mittelwerte der Verfahren = ± 5,66
Standardabweichung für die Mittelwerte der Maschinen = ± 5,07
Standardabweichung für ganze Parzellen in % des Mittels = 7,1 %
} *ausgenommen Verfahren A1*

E.S. pour les moyennes de traitements = ± 5,66
E.S. pour les moyennes de machines = ± 5,07
E.S. pour les parcelles entières en % de la moyenne = 7,1 %
} *traitement A1 exclus*

Figures in brackets denote machine dug yields as % of hand dug yield – *Die Zahlen in Klammern geben die maschinell geernteten Erträge in % der von Hand gerodeten Erträge an – Les chiffres entre parenthèses représentent les productions arrachées à la machine en % des productions récoltées à la main.*

[1] *Maschine – Machine*
[2] *NIAE-Roder mit Scheibenschar, einreihig – Arracheuse NIAE à un rang disque actionné*
[3] *Zweireihiger Roder – Arrancheuse 2 rangs*
[4] *Reihe – Rang*
[5] *Einreihiger Roder mit festem Schar – Arracheuse à 1 rang, soc fixe*
[6] *Mittel – Moyenne*
[7] *Verfahren – Traitement*
[8] *A1 (nur 2 Jahre) – A1 (2 années seulement)*

Tabelle 4. Mit Maschinen geerntete Erträge (Tonnen/Hektar).
Tableau 4. Production récoltées à la machine (tonnes/ha).

It could be assumed that the quantities of soil and clods collected from the rear of the diggers represented the amount that would require separation by complete harvesters working on the same principle. For each hectare harvested a mean of 62.7 tonnes of soil and clods were delivered with the 39.7 tonnes of potatoes, and these 62.7 tonnes of wet soil represented approximately 7 % of the total soil moved by the shares. The proportion of soil delivered with the tubers to total soil moved was slightly higher from

Table 5. Losses at the digger mouth (kg/ha).

Machine[1]	*N.I.A.E. driven disc single row digger*[2]	*Two row digger*[3]	*Fixed share single row digger*[5]	*Mean*[6]
Treatment[7]				
A	50.2	401.6	690.2	380.7
B	25.1	715.3	175.7	305.4
C	1029.4	1179.7	1468.3	1225.8
D	288.7	1543.7	3200.2	1677.5
E	213.4	2259.0	3965.8	2146.1
Mean[6]	321.4	1219.9	1900.0	1147.1
A1 (2 years only)[8]	75.3	62.8	62.8	67.0

[1-8] *Siehe Tabelle 4 – Voir Tableau 4*

Tabelle 5. Verluste am Rodeschar (kg/ha).
Tableau 5. Pertes à l'entrée de l'arracheuse (kg/ha).

Table 6. Details of soil moved by diggers from semi beds.

Machine[1]	*N.I.A.E. driven disc single row digger*[2]	*Two row digger*[3]	*Fixed share single row digger*[4]
Ridge height[5] (cm)	9.9 (17.5)	9.9 (17.5)	9.9 (17.5)
Depth of share below ridge peak[6] (cm)	16.0 (20.3)	15.0 (18.8)	15.0 (18.8)
Soil lifted per hectare[7] (m^3)	780.0 (780.0)	1011.7 (853.1)	1011.7 (853.1)
Dry soil lifted[8] (t/ha)	853.6 (800.9)	1104.7 (873.7)	1104.7 (873.7)

2 year means from high ridges (A1) in brackets – *Zweijahresmittel von hohen Dämmen (A1) in Klammern – Moyennes de 2 années, buttes élevées (A1) entre parenthèses*

[1] *Maschine – Machine*
[2] *NIAE-Roder mit Scheibenschar, einreihig – Arracheuse NIAE à 1 rang, disque actionné*
[3] *Zweireihiger Roder – Arracheuse à 2 rangs*
[4] *Einreihiger Roder mit festem Schar – Arracheuse à 1 rang, soc fixe*
[5] *Dammhöhe – Hauteur de la butte*
[6] *Schartiefe unter dem Dammgrat – Profondeur du soc sous la sommet de la butte*
[7] *Aufgenommene Erde pro Hektar – Terre récoltée par ha*
[8] *Aufgenommene trockene Erde – Terre sèche récoltée*

Tabelle 6. Einzelheiten über die durch Roder in Halbbeeten bewegte Erde.
Tableau 6. Détails de la terre manipulée par les arracheuses.

Table 7. Draught requirements of diggers (kg)

Machine[1]	*N.I.A.E. driven disc single row digger*[2]	*Two row digger*[3]	*Fixed share single row digger*[4]
Semi beds[5]	131.5	494.4	147.4
High ridges*[6]	93.0	356.1	133.8

* 2 year means – *Zweijahresmittel – Moyennes de 2 années*

[1] *Maschine – Machine*
[2] *NIAE-Roder mit Scheibenschar, einreihig – Arracheuse NIAE à 1 rang, disque actionné*
[3] *Zweireihiger Roder – Arracheuse à 2 rangs*
[4] *Einreihiger Roder mit festem Schar – Arracheuse à 1 rang, soc fixe*
[5] *Halbbeete – Demi-lits*
[6] *Hohe Dämme – Buttes élevées*

Tabelle 7. Zugkrafthedarf von Erntemaschinen (kg).
Tableau 7. Exigences de traction des arracheuses (kg).

the high ridge treatments than from the low ridges of the semi-beds. When compared with similar data from the flat beds the mean clod yield is considerably higher from the semi-beds, but this is weighted by the 1965 data being collected from heavy land where the clod yields ranged from 60–146 tonnes/ha: during 1963, 64, and 66 the land was much lighter with considerably fewer clods.

Table 7 shows that the single row machines require slightly less power when working in high ridges than in semi-beds, with the N.I.A.E. driven disc machine demanding less power than the rigid share digger. It has been shown that in order to lift a whole bed with a 132.1 cm share the deep planted flat beds (Table 1, 1963) required a pull of 855.0 kg, semi-beds 494.4 kg and high ridges approximately 356.1 kg. When semi-beds were lifted with 66.0 cm shares, however, the pull required fell to approximately 147.4 kg – a figure only slightly greater than when lifting high ridges.

Conclusions

1. The N.I.A.E. four row bed planter was able to plant tubers satisfactorily at all the required spatial arrangements with a more regular distribution of setts than that achieved by the modified N.I.A.E. bulb planter used in 1963.
2. In this particular series of experiments, doubling the plant populations and arranging the plants in a near square pattern had no obvious advantages in terms of yield when compared with more common forms of plant arrangement. Post planting ridging tended to lower yield.
3. Tubers classified as unsaleable, due to either greening or irregularities in shape, were more prevalent in the higher populations.

4. The diggers were able to recover approximately 87% of the crop grown in semi-beds compared with 91% from high ridges.
5. When working in flat beds the digger shares had much more soil to move in order to lift the crop than when working in semi-beds. The shares moved the least soil when working in high ridges.
6. Harvester draught was so high when working in flat beds that the operation would have had to be abandoned had the soil conditions been less than ideal. The semi-bed system reduced the draught to acceptable proportions but it was still greater than when lifting high ridges.
7. The mechanisation of the cultivation of high populations of potatoes with near square plant arrangements is practical provided that the semi-bed system is used. Yields may not, however, compensate for the increased seed rate and the difficulties in harvesting found in the semi-bed system.

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Zusammenfassung

Versuche zur Erforschung einiger Probleme der Mechanisierung in Verbindung mit dem Anbau von Kartoffeln im Streifenverfahren

Die Versuche wurden unternommen, um einige Probleme der Mechanisierung in Verbindung mit dem Anbau von Kartoffeln in grosser Pflanzendichte in Flachbeeten mit quadratischen oder ähnlichen Distanzanordnungen abzuklären.
Im Jahre 1963 wurde verreihig in flachgedeckten Streifen gepflanzt, und die Verfahren umfassten zwei Pflanztiefen (7,6 und 12,7 cm Bodendecke), drei Pflanzdistanzen in der Reihe (30,5, 33,0 und 35,6 cm) und zwei Spurbreiten des Traktors (152,4 und 172,7 cm) sowie die Pflanzung mit 76,2 cm-Dämmen als Vergleich. Ein zweireihiger Siebkettenroder (Abb. 2) mit einem festen Schar von 132,1 cm Breite wurde zur Ernte verwendet. Wenn man die Rodbarkeit in Betracht zieht (Tabelle 1), so waren die Kartoffeln in den tiefgepflanzten Streifen am schwierigsten zu ernten. Die Verfahren hatten nur wenig Einfluss auf die Knollenerträge, aber grüne Knollen waren am häufigsten bei flacher Pflanzung.
Nach 1963 wurde das Flachstreifen- oder Flachbeetsystem ersetzt durch Paare von niedrigen Dämmen (Halbbeete), die den Einsatz von ein- oder zweireihigen Rodern für die Ernte erlaubten. In den Versuchen 1964–1966 wurden folgende sechs Distanzanordnungen der Pflanzstellen (Abb. 3) angewendet:
Verfahren A: Eine Einzelreihe von Pflanzstellen mit 30,5 cm Pflanzabstand mit niedrigem Damm.
Verfahren A1: Wie bei A, aber mit hohen Dämmen, die im frühen Wachstumsstadium errichtet wurden.

Verfahren B: Eine Einzelreihe von Pflanzstellen mit 15,2 cm Pflanzabstand in der Reihe mit niedrigem Damm.
Verfahren C: Zwei Reihen mit 15,2 cm Zwischenabstand innerhalb eines niedrigen Dammes mit Pflanzstellen in gestaffeltem Abstand von 30,5 cm in der Reihe.
Verfahren D: Zwei Reihen mit 22,9 cm Zwischenabstand innerhalb eines niedrigen Dammes mit Pflanzstellen in gestaffeltem Abstand von 30,5 cm in der Reihe.
Verfahren E: Zwei Reihen mit 30,5 cm Zwischenabstand innerhalb eines niedrigen Dammes mit Pflanzstellen in gestaffeltem Abstand von 30,5 cm in der Reihe.
Die Knollen wurden mittels 3 Typen von Siebkettenrodern geerntet, nämlich mit der einreihigen NIAE-Versuchsmaschine (Abb. 5) mit Scheibenschar sowie mit den ein- und zweireihigen handelsüblichen Maschinen mit festem Schar. Eine neue Pflanzmaschine (Abb. 4) und eine Vielfach-Kartoffelsortier (Abb. 6) wurden entwickelt.

Aus den Angaben in den beiden Tabellen 2 betreffend von Hand gerodetem Ertrag und 3 betreffend unvollkommenen Knollen geht hervor, dass die Verdopplung der Pflanzstellen und das Anordnen der Saatknollen in einer nahezu einem Quadratmuster gleichenden Art in bezug auf Ertrag wenig Vorteil bot gegenüber den gewöhnlichen Formen der Saatgutanordnung. Die einreihige Maschine mit festem Schar erntete den grössten Anteil der Knollen aus den Halbbeeten (Tabelle 4), während der NIAE-Roder mit Scheibenschar die kleinsten Verluste am Schar (Tabelle 5) aufwies, am wenigsten Erde aufnahm (Tabelle 6) und den kleinsten Zugkraftbedarf aufwies (Tabelle 7).
Daraus wird geschlossen, dass die Mechanisierung des Anbaus von dichtgepflanzten Kartoffelbeständen mit nahezu quadratischer Saatknollenanordnung praktisch die Anwendung des Halbbeetsystems voraussetzt. Die Erträge dürften jedoch das höhere Saatgutquantum und die Ernteschwierigkeiten mit dem Halbbeetsystem nicht aufwiegen.

Résumé

Essai de solution de quelques-uns des problèmes de mécanisation en relation avec la culture de pommes de terre en lits

Des essais ont été organisés pour étudier quelques-uns des problèmes de mécanisation en relation avec le développement de pommes de terre en peuplements de hautes densités posées à plat en distancements à peu près carrés.
En 1963, on a planté sur quatre rangs dans un lit plat et les traitements consistaient en deux profondeurs de plantation (7,6 et 12,7 cm de couverture de sol), trois espacements de rangs (30,5, 33,0 et 35,6 cm) et deux largeurs de voie de tracteur (152,4 et 172,7 cm) et, comme témoin, des buttes de 76,2 cm. On a utilisé pour la récolte une arracheuse à deux rangs, à élévateur (Fig. 2) munie d'un socle fixe de 132,1 cm de large; si l'on considère les facilités de la récolte (Tableau 1), les rangs de plantation profonde s'avèrent être les plus difficiles à récolter. Les traitements ont des effets minimes sur les productions de tubercules mais les tubercules verdis sont les plus importants lorsque les plantations sont superficielles.
Après 1963, le système du lit plat a été remplacé par des paires de buttes basses (demi-lits) permettant ainsi l'emploi à la récolte d'arracheuses à rang simple ou double.
On a utilisé dans les essais de 1964–1966 six dispositions d'emplacements des plants (Fig.3):
Traitement A: Un rang unique d'emplacements, à 30,5 cm de distance, en longueur dans chaque butte basse;
Traitement A1: Comme en A mais avec des buttes hautes formées au cours de la première saison de croissance;
Traitement B: Un rang unique d'emplacents à 15,2 cm de distance, en longueur dans chaque butte basse;
Traitement C: Deux rangs à 15,2 cm de distance dans chaque butte basse, les emplacements dans le rang se trouvant à une distance approximative de 30,5 cm;
Traitement D: Deux rangs à 22,9 cm de distance dans chaque butte basse, les emplacements dans le rang se trouvant à une distance approximative de 30,5 cm;

Traitement E: Deux rangs à 30,5 cm dans chaque butte basse, les emplacements dans le rang se trouvant à une distance approximative de 30,5 cm.

La récolte fut effectuée par trois types d'arracheur à élévateur; une machine expérimentale de N.I.A.E., à un rang, à disque entraîné (Fig. 5) et des machines fabriquées à simple et double rang, à soc fixe. Une nouvelle planteuse et un nouveau crible à plusieurs calibres sont montrées, respectivement, dans Fig. 4 et 7.

Il ressort des données obtenues par arrachage à la main (Tableau 2) et des tubercules défectueux (Tableau 3) que le doublement de la densité d'emplacements et l'arrangement des plants en dispositifs approximativement carré donnent très peu d'avantages en ce qui concerne la production par rapport aux dispositifs habituels d'emplacements des plants. La machine à soc fixe à un seul rang arrachait la plus grande proportion de la récolte dans le cas de demi-lits (Tableau 4), tandis que l'arracheuse à disque N.I.A.E. donnait les plus petites pertes à l'embouchure du soc (Tableau 5), ramassait le moins de terre (Tableau 6) et avait les plus faibles exigences de traction (Tableau 7).

La conclusion est que la mécanisation de la culture de pommes de terre en hautes densité de peuplements en espacements approximativement carrés est possible pour autant qu'on utilise le système de demi-lit. Les productions ne peuvent, cependant, compenser la quantité accrue de semence, ni les difficultés de récolte rencontrées dans le système de demi-lit.

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