OBSERVATIONS ON THE SPROUTING OF SEED POTATOES

N. KRIJTHE

Institute for Biological and Chemical Research on Field Crops and Herbage (I.B.S.), Wageningen, Netherlands

Summary, Zusammenfassung, Résumé, p. 331

1. INTRODUCTION

An important property of the seed tuber is its sprouting capacity. Good seed sprouts rapidly and strongly. The number of sprouts per tuber is important in connection with the purpose for which the crop is to be grown.

To increase knowledge of sprout growth in general a study was made of the influence of dormant period, storage temperature, length of storage, maturity, soil in which the potatoes were grown and desprouting, on the condition of the tubers and their sprout growth.

2. DORMANT PERIOD

For the purpose of the investigation the dormant period was considered to have ended when at least 80 % of tubers held at 20°C developed sprouts at least 3 mm long within 3 weeks, the criterion used by EMILSSON (1949) and SCHIPPERS (1956).

The length of the dormant period was determined for 15 varieties in 1958 and 25 in 1959 (TABLE 1).

In 1959 most varieties sprouted about 9 weeks earlier than in 1958; the difference in length of dormant period between the varieties being about the same in both years.

3. INFLUENCE OF TEMPERATURE ON LENGTH OF DORMANT PERIOD

The conditions of storage during the dormant period influence its length: the most important factor being temperature. In the standard test (TABLE 1) the tubers were stored at 2°C and transferred to 20°C for sprouting. Storage at 9°C shortened by 2 or 3 weeks the dormant period of a few late varieties (*Voran, Ambassadeur, Rival*) out of the 35 varieties examined. SCHIPPERS (1956), using storage temperatures between 2°C and 20°C, found that at the higher temperatures *Bintje* had a dormant period 2 weeks shorter in 1953 and 5 weeks shorter in 1954 than at the lower temperatures. The variety *Alpha*, however, showed barely one week difference between high and low storage temperatures.

Received for publication 21st September, 1961.

TABLE 1. Date of ending of dormancy in seed potatoes of different varieties 1958 and 1959; in both years the tubers were harvested as immature seed potatoes

Variety *Sorte* *Variété*	Year – *Jahr* – *année* 1958	1959	Variety *Sorte* *Variété*	Year – *Jahr* – *année* 1958	1959	Variety *Sorte* *Variété*	Year – *Jahr* – *année* 1958	1959
Eersteling	15/10	10/8	Harli		24/8	Pionier		16/9
Eigenheimer	15/10	10/8	Ackersegen		24/8	Patrones		16/9
Meerster		10/8	CB 47/39	21/10		Ari		16/9
Tedria	21/10	10/8	Loman 43/35	28/10	24/8	Bea		16/9
Gineke	28/10	17/8	Bintje	28/10	24/8	Haeringa	18/11	
Profijt	21/10	17/8	Alpha	11/11	24/8	Ambassadeur	25/11	2/10
Remona		17/8	Voran	11/11	24/8	Up to date		2/10
Prinslander		17/8	Dekama	11/11	31/8	Pimpernel		14/10
Urgenta		17/8	Irene		31/8	Rival	17/12	14/10
Sientje		17/8	Climax		31/8	Arran Banner		14/10
Kwinta		17/8	prof. Broekema	11/11	8/9	Asoka		22/10
Furore		17/8	Record		8/9			
Marilla		17/8	Avenir		8/9			

TABELLE 1. *Enddatum der Keimruhe bei Saatkartoffeln von verschiedenen Sorten 1958 und 1959; in beiden Jahren wurden die Knollen unreif für Saatkartoffeln geerntet*

TABLEAU 1. *Date de terminaison de la dormance de plants de pomme de terre de différentes variétés en 1958 et en 1959; dans l'une et l'autre année les tubercules furent récoltés avant la maturité pour servir de plants*

4. INFLUENCE OF TEMPERATURE ON RATE OF SPROUT GROWTH

When the dormant period ends tubers may begin to sprout. The time taken by the sprouts to grow to 3 mm at 20° C was also measured on tubers which had been stored at different temperatures from harvest. At 25° C, 21 varieties out of the 35 examined did not sprout any sooner than at 20° C; the largest differences occurred in the varieties *Alpha*, *Ackersegen* and *Arran Banner*, in which sprouting at 25° C took 3, 3 and 6 weeks less respectively than at 20° C. The differences increase as the temperature is reduced below 20° C. This is shown for 8 varieties in FIG. 1.

5. DIFFERENCES IN LENGTH OF DORMANT PERIOD AND RATE OF SPROUTING

TABLE 1 shows the differences in length of the dormant period between a number of varieties and between two years. FIG. 1 suggests that differences in the rate of sprout growth between varieties at temperatures above 5° C are always about the same. Below 5° C sprout growth is retarded in some varieties more than in others. Tubers of any variety from the same field, harvested on different dates, showed only small differences in the rate of sprout growth. The greatest difference was found between tubers harvested very immature and those harvested mature: the immature tubers

FIG. 1. Dates by which tubers of different varieties produce sprouts of a length of 3 mm at different storage temperatures after harvest

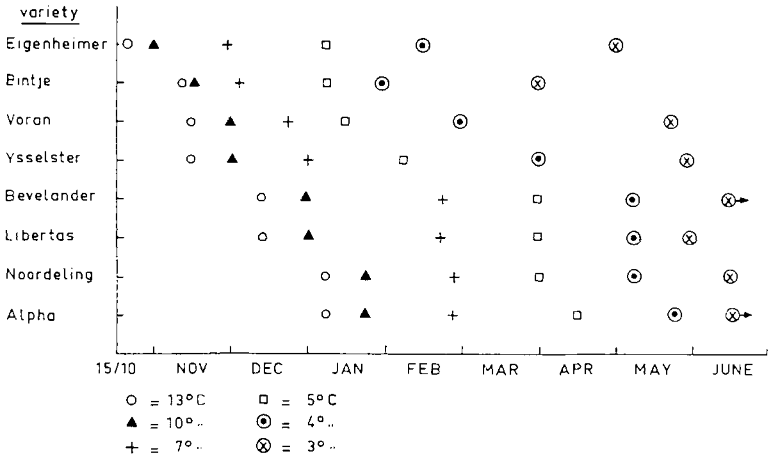


ABB. 1. *Daten, an welchen Knollen verschiedener Sorten bei verschiedenen Lagertemperaturen nach der Ernte Keime einer Länge von 3 mm entwickelt haben*

FIG. 1. *Dates auxquelles les tubercules de différentes variétés produisent des germes de 3 mm de longueur, pour différentes températures de stockage après la récolte*

having a slightly shorter dormant period and somewhat more rapid sprout growth than the mature tubers.

The time taken for sprouts to grow to a length of 3 mm was found to vary between different lots of the variety *Bintje*; in 1956 by 4 weeks and in 1957 by 10 days. At low storage temperatures differences were larger than at high temperatures.

Large and small tubers from the same lot, harvested on the same date in 1957, showed a difference of 4 weeks at a high storage temperature and 10 weeks at a low storage temperature (5°C), the small tubers sprouting more slowly. It has been observed that the eyes of the small tubers, although starting to grow at about the same time as the eyes of the larger ones, grow more slowly up to a length of 3 mm.

6. ORIGIN OF THESE DIFFERENCES

Some varietal characteristics can be related to differences in the length of the dormant period; varieties in which the haulm develops rapidly, those liable to second growth and those resistant to drought, often have a short dormant period. There is no correlation with early maturity or starch content.

The differences between lots of the same variety and between different years are considered to be due to differences in growing conditions: soil, manuring, and climatic factors such as rainfall. Such conditions affect the maturity of the tubers at harvest, which is an important factor in determining the length of the dormant period.

7. SEASONAL TREND IN SPROUTING CAPACITY

The method used to determine seasonal trends in sprouting capacity was as follows: tubers were stored at 2°C after harvest (and a "curing period") and every 2 weeks a sample of 20 tubers was taken from store and sprouted at 20°C and 80 % relative humidity for 4 weeks, thereafter the sprouts and the tubers were weighed. These weights, expressed as percentages of the initial weight of the 20 tubers, are called the "sprouting capacity".

If tubers are sprouted immediately after the end of the dormant period only a short sprout is formed in 4 weeks: in *Bintje* one of about 3 mm. If *Bintje* tubers are sprouted a month later, the length will be about 1 cm, in December 2 cm, in February 3 cm, in May 4 cm and in July 10 cm. After August (one year after harvest) the rate of sprout growth decreases.

HOGETOP (1930) carried out a similar experiment and found that the maximum rate of sprout growth in the variety *Deodora* was between 6 and 10 months after harvest.

Sprout weight increases not only as the result of an accelerated sprout growth per tuber, but also because of an increase in the total number of sprouts per tuber. At the beginning of the storage season tubers produce 1 or 2 sprouts, later on in the season 3 to 6. Moreover, the sprouts may branch, though this generally does not occur before February. Finally, about 1 year after harvest sometimes small tubers are formed on the sprouts.

The increase in the number of sprouts results from decreasing dominance of the apical growing point of the tuber. (There are substances inhibiting the sprouting of lateral eyes (MICHENER, 1942; LAGARDE, 1958)).

Branching is a result of the apex of the sprout becoming inactive (or damaged): often a ring of discoloured or black tissue can be found a few mm under the extreme apex of a branching sprout. This discolouration is often repeated on the new lateral branches, thus inducing still further branching (the explanation could also be loss of dominance of the various apical growing points in turn).

Unbranched sprouts which may be found until July grow much longer but do not weigh more than the branched ones.

Changes in the rate and nature of sprout growth during storage must be attributed to changes in the tuber. These take place while the tuber is kept sprout free in cool storage. Work by SZALAI (1959) and others established differences in the content of certain compounds between tubers just harvested and those which had been kept free of sprouts for sometime.

Changes in sprouting capacity can be used to measure the "age" of tubers. Branching of sprouts and small tuber formation, are typical ageing phenomena, as is the decrease in sprouting capacity which occurs in August, one year after harvest. The sequence of phenomena associated with ageing of tubers is:

1. the one sprout stage
2. the multiple sprout stage
3. the branching stage
4. the small tuber formation stage

8. VARIATION IN SEASONAL CHANGES IN SPROUTING CAPACITY

Differences in the trend of the sprouting-capacity curve can be established between different lots of the same variety, between years and between varieties. FIG. 2 shows differences between lots of *Bintje* harvested in 3 consecutive years. In 1957/1958 30 lots were examined in this way. The maximum sprouting capacity was always found between July and September although the figure varied considerably between the lots. A lot showing a lower sprouting capacity than another up till June may thereafter show a higher one and *vice-versa*. Differences between years may be due to the same factors causing differences between lots in any one year. The other varieties examined were *Eigenheimer*, *Alpha* and *Libertas*. These all showed the same trend in sprouting-capacity curve and similar differences between lots as had *Bintje* but *Alpha* and *Libertas* had slower sprout growth and not quite such a high maximum sprouting-capacity value as *Bintje*. The maximum always fell in July/August.

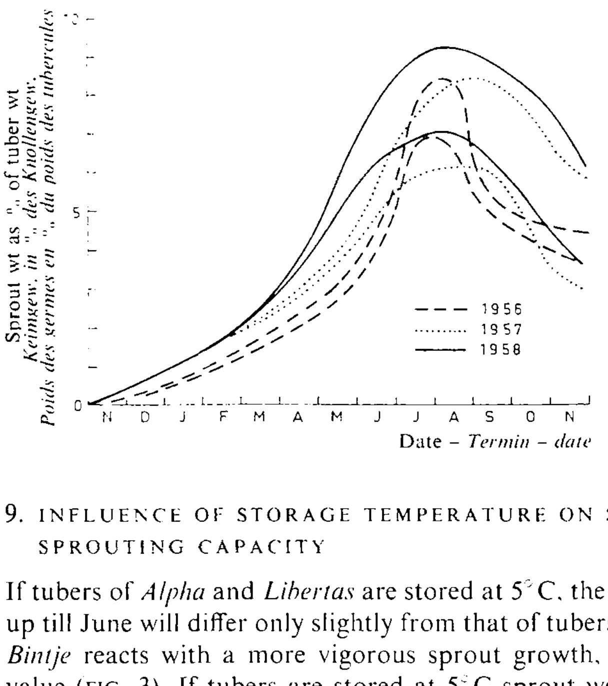


FIG. 2.
Seasonal trend in sprouting capacity of various lots of *Bintje* in different years

ABB. 2
Saisonale Tendenz der Keimungskapazität bei verschiedenen Herkünften von Bintje *in verschiedenen Jahren*

FIG. 2.
Tendance saisonnière de la faculté germinative de tubercules de la variété Bintje *provenant de différents endroits en differentes années*

9. INFLUENCE OF STORAGE TEMPERATURE ON SEASONAL CHANGES IN SPROUTING CAPACITY

If tubers of *Alpha* and *Libertas* are stored at 5° C, the trend in their sprouting capacity up till June will differ only slightly from that of tubers of these varieties stored at 2° C. *Bintje* reacts with a more vigorous sprout growth, *i.e.* a higher sprouting-capacity value (FIG. 3). If tubers are stored at 5° C sprout weights continue to increase after August (1 year after harvest) and small tuber formation on the sprouts will occur in the variety *Bintje*. If tubers of the variety *Libertas* are stored at 7° C their sprouting capacity will be higher than those stored at 2° or 5° C, the maximum is reached earlier, in June, after which sprouting capacity will decrease although sprout weight may be increased by the formation of small tubers.

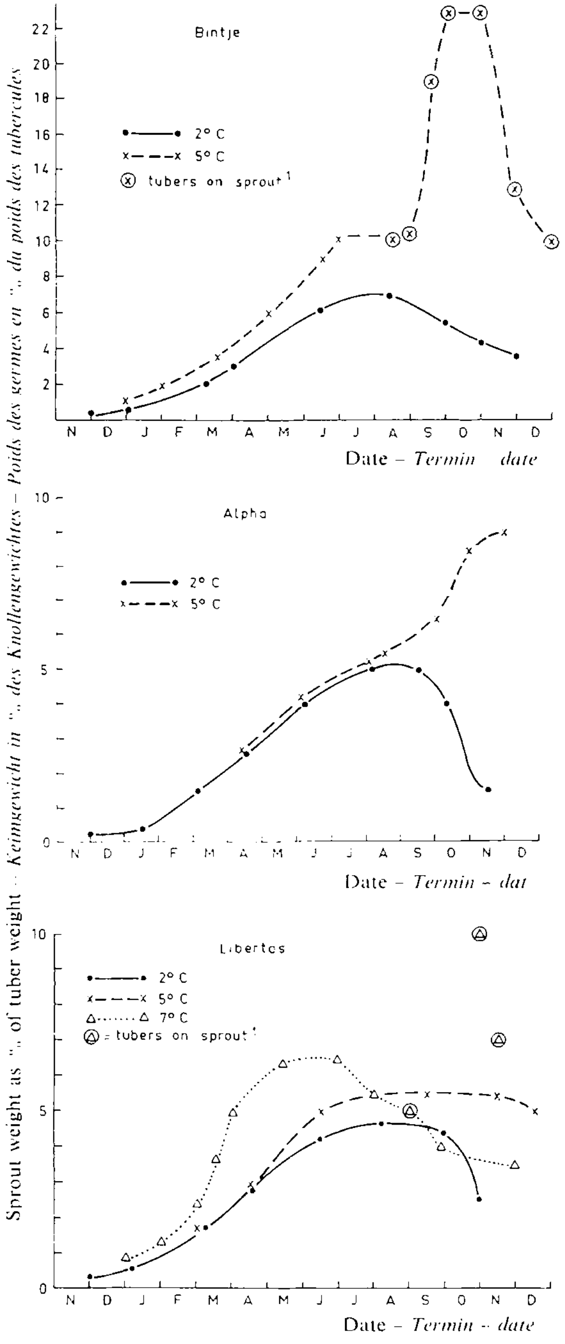


FIG. 3.
The influence of storage temperature on the sprouting capacity of the varieties *Bintje*, *Alpha* and *Libertas*

ABB. 3.
Einfluss der Lagertemperatur auf die Keimungskapazität der Sorten Bintje, Alpha *und* Libertas

FIG. 3.
Influence de la température de stockage sur la faculté germinative des variétés Bintje, Alpha *et* Libertas

[1] *Knollen an den Keimen – des tubercules sur les germes.*

10. SPROUT GROWTH AFTER REPEATED DESPROUTING

If after 4 weeks of sprout growth at 20° C the tuber is desprouted and left 4 weeks to sprout again, the second sprouts can be measured and weighed and their weight expressed as a percentage of the initial tuber weight. This can be repeated for the third, fourth and fifth sprouts. The results of such an experiment are shown in FIG. 4 and TABLE 2. Here the length of the first, second, etc. sprouts was determined for tubers of different weights and records kept of the eyes from which these sprouts had grown. The experiment was started in January, by which time one sprouting stage and the "apical dominance" of the tubers had already passed. Characteristic of these experiments is that after desprouting almost every eye on the tuber produces at least one sprout. Those eyes on the middle and lower part of the tuber usually produce several sprouts. This is due to the presence of several buds in the same eye.

If, following desprouting, the second sprouts of a tuber are heavier than the first, it is because there are more of them and they are longer and sometimes thicker. The same may hold good for the third sprouts in relation to the second and sometimes also for the fourth in relation to the third.

FIG. 4. *Bintje* tuber desprouted every 4 weeks from January onwards; eyes numbered from base to top

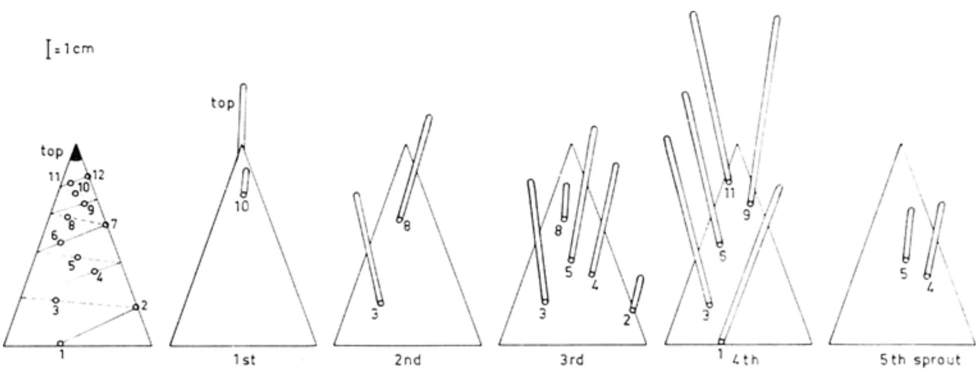


ABB. 4. Bintje-*Knolle, an der die Keime von Januar an alle 4 Wochen entfernt wurden; Augen numeriert vom Fuss zur Spitze*

FIG. 4. *Tubercule de* Bintje *dégermé toutes les quatre semaines à partir du mois de janvier; yeux numérotés de la base au sommet*

11. SEASONAL TREND IN SPROUTING CAPACITY AFTER DESPROUTING

Unsprouted tubers were sprouted at intervals during the storage season and repeatedly desprouted. The sprout weights were recorded as percentages of the initial tuber weights. FIG. 5 shows the results obtained in different years with different lots of the variety *Bintje*. The seasonal trend in the development of the first sprouts is similar to that shown in earlier figures.

TABLE 2. Length of sprouts (mm) produced by various eyes following desprouting on 4 occasions; eyes numbered from base to top; variety *Bintje*; desprouting started January, 1955

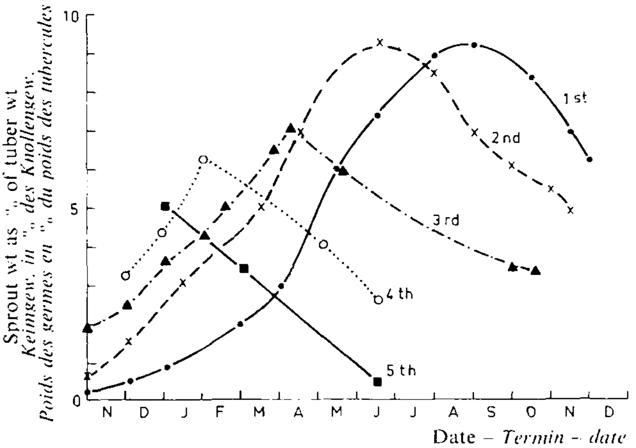
Number of eye / *Nummer des Augen* / *Numéro de l'oeil*	Tuber weight (g) *Knollengewicht (g) - poids du tubercule (g)* 98					80					70					60					50					40				
No of desprouting - *Nummer der Entkeimung - numéro du dégermage*	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Top sprout[1]	36										37										37					37				
15			**60**																											
14			82				**52**						**60**		45															
13	12				35		44					54																		
12		48				12								80			**43**													
11						12		48			35							87						**95**				**76**		
10		62	75				48					60	70	95							13							67		
9				70				12				64		70		13		72						110			54			
8	36							70	60													58	20				50			
7		47				38	25		70			64	53	100		13	11										53		90	
6						38	25	65		25				95			58							80					100	
5		12						22	65				75	130				50		30			75		25			72	100	
4			55				10		60					80									62		40	37			85	
3		52		85				48	75	30	10		58		35	46	65					57	67	95						
2			82					48							30			20	95				20						105	
1 (at the base[2])	32								70					130				70						90				72		60

Bold figures - 1st eye under top - *fett gedruckte Zahlen - 1. Auge unter Spitze - les nombres gras - 1r oeil au-dessous du sommet.*

[1] *Keim an der Spitze - germe au sommet.*
[2] *Keim am Fuss - germe à la base.*

TABELLE 2. *Länge der von verschiedenen Augen, nach Entkeimung an vier Zeitpunkten, erzeugten Keime (in mm); Augen vom Fuss zur Spitze numeriert; Sorte* Bintje; *Entkeimung begonnen im Januar 1955*

TABLEAU 2. *Longueur des germes (mm) produits par différents yeux après 4 dégermages; yeux numérotés de la base au sommet du tubercule; variété* Bintje; *dégermage effectué à partir de janvier 1955*



1st, 2nd ... 1st, 2nd ... sprout *1., 2. ... Keim* *1r, 2me ... germe.*

FIG. 5.
Seasonal trend in sprouting capacity following desprouting (*Bintje*)

ABB. 5.
Saisonale Tendenz der Keimungskapazität nach Entfernen der Keime (Bintje)

FIG. 5.
Tendance saisonnière de la faculté germinative après dégermage (Bintje)

FIG. 5 indicates that in the variety *Bintje:*

a. the second sprout is heavier than the first up till July;
b. the third sprout is heavier than the second up till April or May;
c. the fourth sprout is heavier than the third up till February;
d. if, immediately after the end of the dormant period, tubers are transferred to 20°C and then desprouted every 4 weeks, the fifth sprout can be heavier than the fourth,

but later on, tubers which have been desprouted four times show a considerable decrease in sprouting capacity, thus, tubers kept sprout free until February before desprouting four times hardly produced any sprouts at all in June (TABLE 2).

As in the formation of the first sprouts, differences in behaviour after desprouting have been established between lots, between harvest dates, between years and between varieties. In the variety *Bintje* it was found for instance that tubers from clay soil could normally withstand desprouting better than tubers from sandy soil, *viz.* in tubers from sandy soil, desprouting decreases sprouting capacity earlier in the storage season than in tubers from clay soil. However, in 25 lots of different origin (sand and clay, from the North as well as the South of the Netherlands), it was found that some lots from sandy soil withstood desprouting as well as the best stocks from clay soil. No differences of this kind could be established between tubers of different sizes (TABLE 2). Attempts have been made to establish correlations between sprouting behaviour and reaction to desprouting and the origin of stocks in the province of Drenthe; so far without success.

The fall shown by the sprouting-capacity curve following desprouting must be attributed to exhaustion of the tubers as a result of sprout loss and loss of weight by respiration and evaporation.

As sprouting capacity decreases with desprouting, small tubers may be formed on the sprouts, as mentioned previously, but never sooner than about one year after harvest. It is, therefore, an open question whether tuber formation on the sprouts can always be explained by exhaustion of the tuber. In France, MADEC and PERENNEC are working on this problem.

12. WEIGHT LOSS DURING SPROUTING

When a tuber of known weight has grown a sprout for a few weeks and this is removed, the total weight loss of the tuber during this period can be determined. This can be divided into:

a. weight of the sprout;
b. weight loss by respiration and evaporation by both tuber and sprout.

The relation between a. and b. was investigated and the results are shown in FIG. 6. Losses from respiration and evaporation during the formation of the first sprouts show a slow increase during the 12 months of the experiment. These weight losses are at first higher and later lower than the corresponding sprout weights; there is no direct relation to be found between a. and b. There is, however, a characteristic seasonal trend in the ratio a: b. FIG. 7 shows this for the first sprouts in *Bintje* for 3 consecutive years. The ratio 1:1, *viz.* sprout weight equal to weight loss by respiration and evaporation, is represented by a straight line. There are distinct differences between lots of the same year and between lots from different years. It is striking that 3 lots out of 4 had about the same losses from respiration and evaporation during part of the season and that those of the lot from 1957 were much lower.

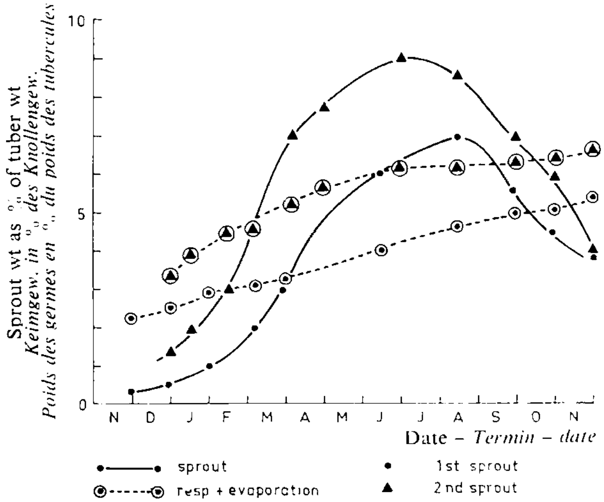


FIG. 6.
Seasonal trend in sprouting capacity and weight losses at the time of formation of 1st and 2nd sprouts (*Bintje*)

ABB. 6.
Saisonale Tendenz der Keimungskapazität und Gewichtsverluste am Zeitpunkt der Bildung der 1. und 2. Keime (Bintje)

FIG. 6.
Tendance saisonnière de la faculté germinative et des pertes de poids au moment de la formation du premier et du second germe (Bintje)

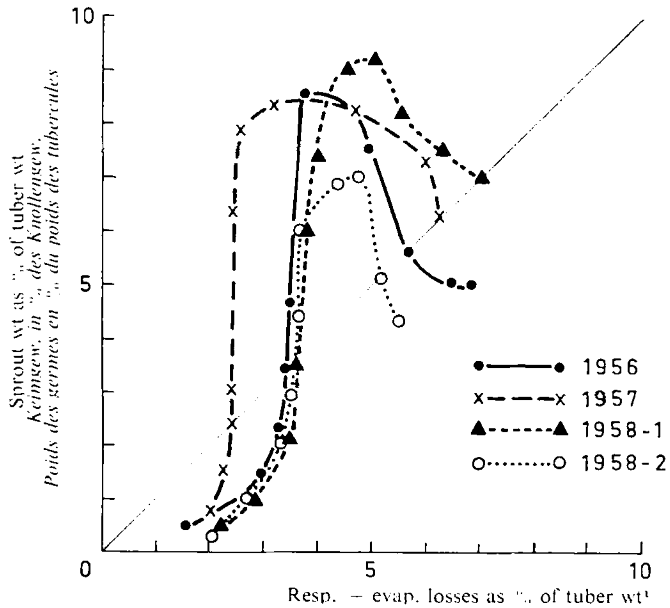


FIG. 7.
Seasonal trend in the ratio *sprout weight / corresponding losses by respiration and evaporation* at the time of formation of 1st sprouts in 3 consecutive years *(Bintje)*

ABB. 7.
Saisonale Tendenz im Verhältnis Keimgewicht/entsprechende Verluste durch Atmung und Verdunstung *am Zeitpunkt der Bildung der 1. Keime* (Bintje) *in 3 aufeinander folgenden Jahren*

FIG. 7.
Tendance saisonnière du rapport poids des germes / pertes correspondantes de poids par respiration et évaporation, *au moment de la formation des premiers germes* (Bintje), *pour 3 anneés consécutives*

[1] *Atmungs- + Verdunstungsverluste in % des Knollengewichtes – pertes par respiration + évaporation en % du poids des tubercules.*

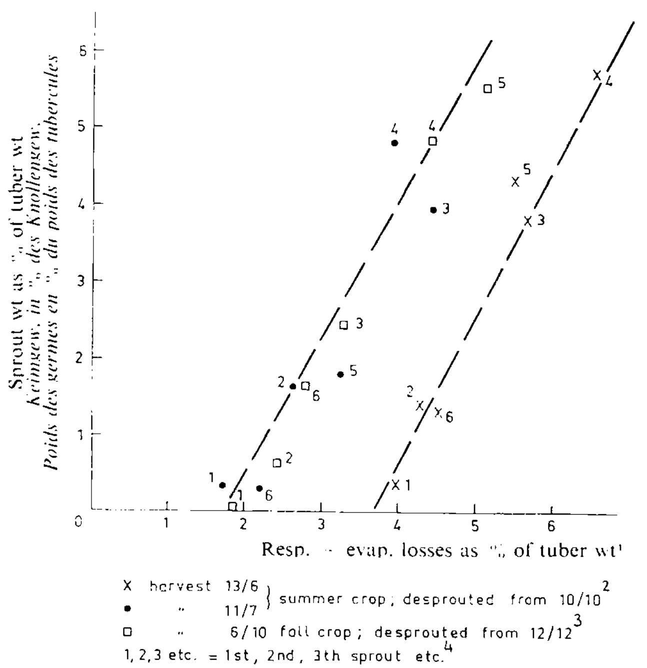


FIG. 8.
Relation of sprout weight to corresponding weight losses by respiration and evaporation at the time of desprouting *(Bintje)*

ABB. 8.
Beziehung zwischen Keimgewicht und entsprechenden Gewichtsverlusten durch Atmung und Verdunstung am Zeitpunkt der Entfernung der Keime (Bintje)

FIG. 8.
Rapport entre le poids des germes et les pertes correspondantes de poids par respiration et évaporation, au moment du dégermage (Bintje)

[1] *Atmungs- + Verdunstungsverluste in % des Knollengewichtes – pertes par respiration + évaporation en % du poids des tubercules.*
[2] *Sommerpflanzung; Keime entfernt vom 10. Okt. an – culture d'été; dégermage à partir du 10 octobre.*
[3] *Herbstpflanzung; Keime entfernt vom 12. Dez. an – culture d'automne; dégermage à partir du 12 décembre.*
[4] 1, 2, 3 ... = 1st, 2nd, 3rd ... sprout – *1., 2., 3. ... Keim – 1r, 2me, 3me ... germe.*

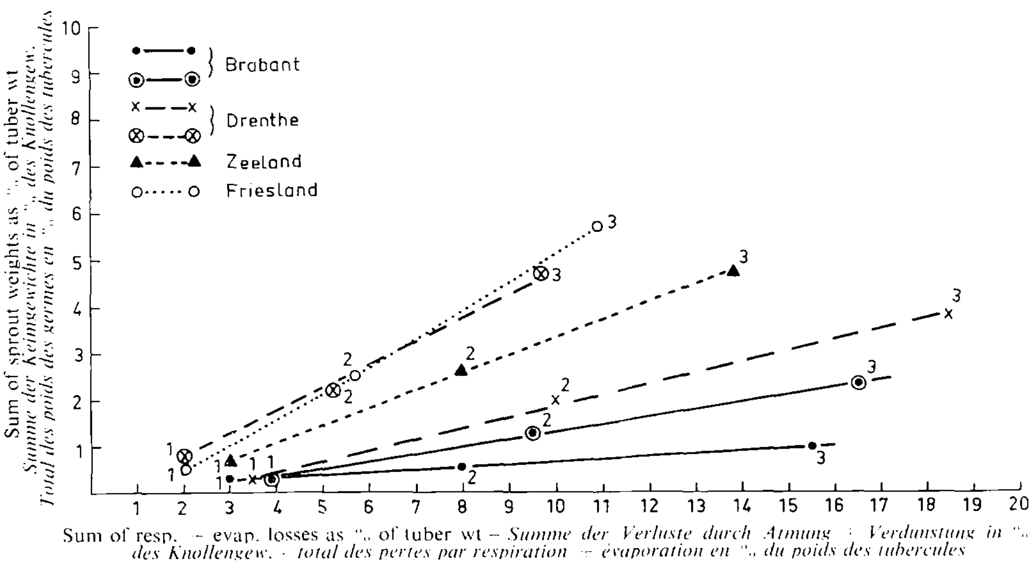
13. ANALYSIS OF WEIGHT LOSSES AFTER DESPROUTING

When sprout weight is plotted against the corresponding loss in weight from respiration and evaporation (r + e), for the first sprouts, the second and so on, it would appear that for any one lot the ratio remains about the same. In *Bintje* larger differences were found between tubers harvested immature and mature from the same field than between tubers of similar maturity from a spring and an autumn crop (FIG. 8).

By plotting the sum of the sprout weights (with repeated desprouting) against the sum of the corresponding losses in weight from respiration and evaporation straight lines are produced, the trends of which (with regard to the horizontal axis) are characteristic of the lots investigated (FIG. 9).

This method of recording is valid for the comparison of tubers from different soils (clay-sand), tubers of different sizes and tubers with different starch or sugar contents (FIG. 10). In FIG. 11 the weights of 2 lots (from clay and sand respectively, as in FIG. 10) have been plotted in another way, *viz.* the sprout weight against the weight loss suffered beforehand by desprouting. In the first 6 to 8 months after

FIG. 9. Relation of sum of sprout weights to sum of weight losses by respiration and evaporation at the time of desprouting in different lots of *Bintje*

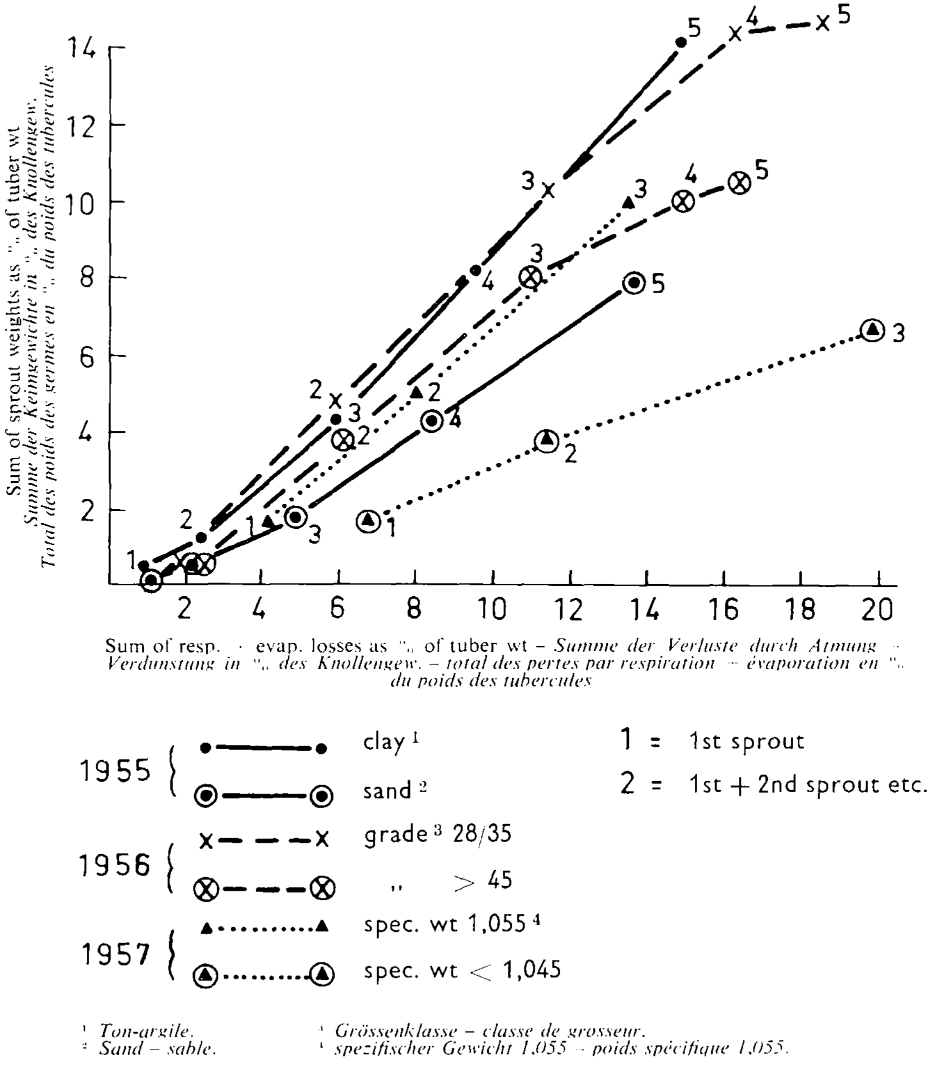


1 1st sprout – *1. Keim – 1r germe.*
2 1st + 2nd sprout – *1. + 2. Keim – 1r + 2me germe.*
3 1st + 2nd + 3rd sprout – *1. + 2. + 3. Keim – 1r + 2me + 3me germe.*

ABB. 9. *Beziehung zwischen Summe der Keimgewichte und Summe der Gewichtsverluste durch Atmung und Verdunstung am Zeitpunkt der Entfernung der Keime bei verschiedenen Herkünften von* Bintje

FIG. 9. *Rapport entre le total des poids des germes et le total des pertes de poids par respiration et évaporation au moment du dégermage, pour différentes provenances de la variété* Bintje

FIG. 10. Relation of sum of sprout weights to sum of weight losses by respiration and evaporation at the time of desprouting in different lots (1955) and different samples (1956 and 1957) of *Bintje*



[1] *Ton-argile.*
[2] *Sand – sable.*
[3] *Grössenklasse – classe de grosseur.*
[4] *spezifischer Gewicht 1,055 – poids spécifique 1,055.*

ABB. 10. *Beziehung zwischen Summe der Keimgewichte und Summe der Gewichtsverluste durch Atmung und Verdunstung am Zeitpunkt der Entfernung der Keime bei verschiedenen Herkünften (1955) und verschiedenen Proben (1956 und 1957) von* Bintje

FIG. 10. *Rapport entre le total des poids des germes et le total des pertes de poids par respiration et évaporation au moment du dégermage, pour différentes provenances (1955) et différents échantillons (1956 et 1957) de la variété* Bintje

Fig. 11. Sprout weight at the time of desprouting at different periods in the storage season with reference to weight losses suffered beforehand by tubers from clay and sand soils (*Bintje*)

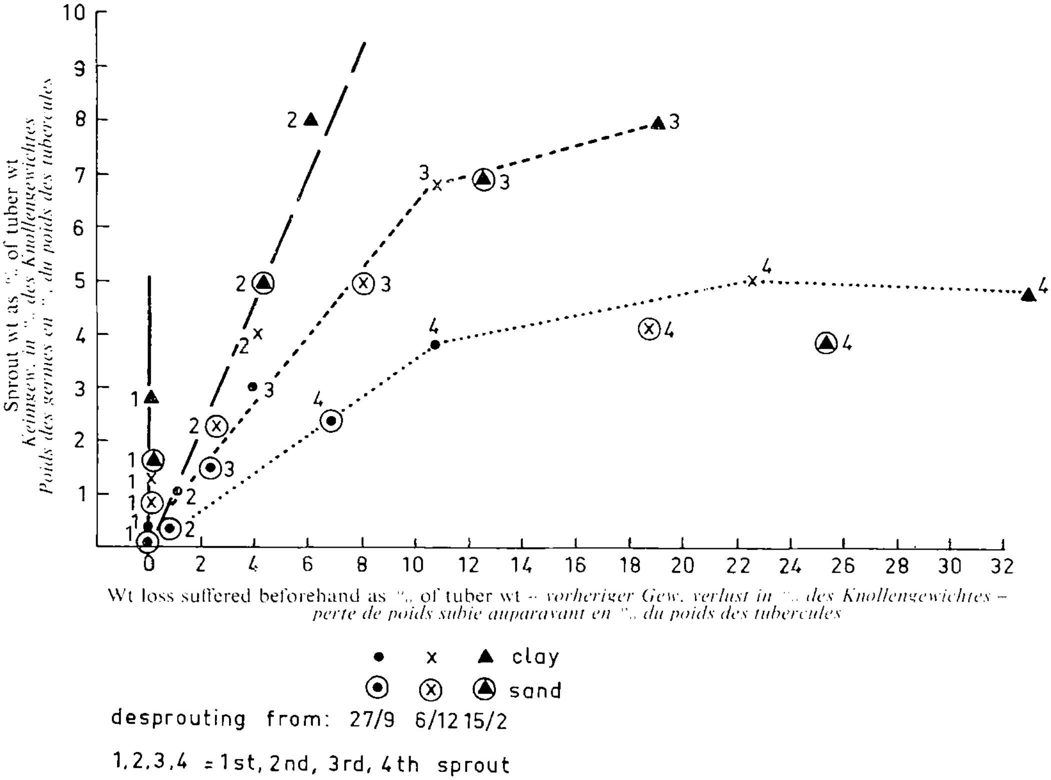


Abb. 11. *Keimgewicht am Zeitpunkt der Entfernung der Keime in verschiedenen Perioden der Lagerzeit bezogen auf vorherige Gewichtsverluste der Knollen von Ton- und Sandböden* (Bintje)

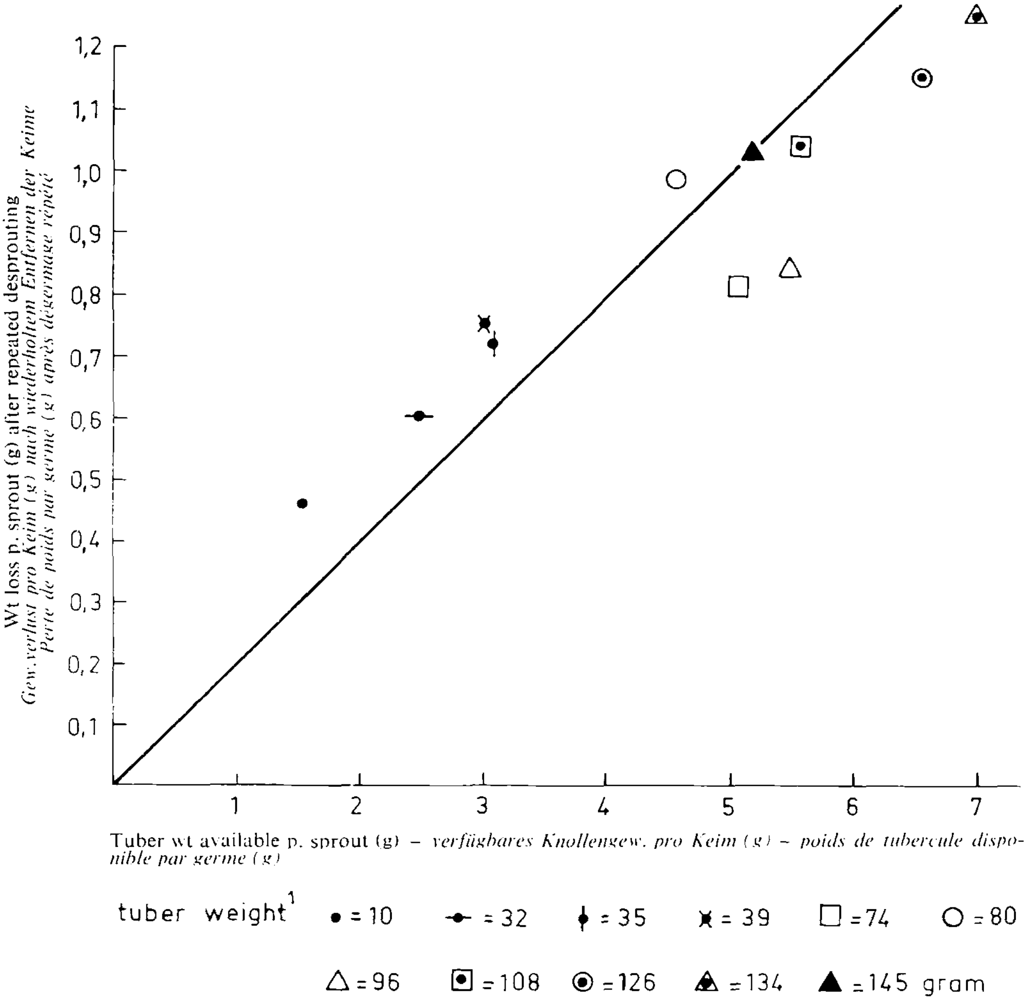
Fig. 11. *Poids des germes au moment du dégermage à différentes époques de la Saison de stockage, considérés en rapport avec les pertes de poids subies auparavant par les tubercules provenant de sols argileux et de sols sablonneux* (Bintje)

harvest these clay and sand lots apparently do not differ or differ very slightly; for the second sprouts the ratio sprout weight: loss suffered beforehand in both lots is approximately 1:1; for the third sprout 3:4 and for the fourth 3:8.

If desprouting is started in February the ratio for the third sprout will be somewhat lower and that for the fourth sprout clearly lower. At this stage there is a difference between the lot grown on sand and that grown on clay soil.

If a tuber is repeatedly desprouted the weight loss per sprout may be calculated (weight loss/number of sprouts). This weight loss per sprout is higher in large than in small tubers. The available tuber weight per sprout (tuber weight/number of sprouts) is also higher in large than in small tubers, although large tubers produce

FIG. 12. Weight losses and available tuber weight per sprout in repeatedly desprouted tubers of different sizes *(Bintje)*



[1] *Knollengewicht – poids de tubercule.*

ABB. 12. *Gewichtsverluste und verfügbares Knollengewicht pro Keim bei wiederholt entkeimten Knollen verschiedener Grösse* (Bintje)

FIG. 12. *Pertes de poids et poids de tubercule disponible par germe, pour des tubercules de dimension différente* (Bintje) *dégermés à plusieurs reprises*

more sprouts than the small ones (proportionally about 3 to 2). If the weight loss per sprout is plotted against the tuber weight available per sprout then it appears that small tubers have a slightly larger weight loss per sprout following repeated desprouting than the larger ones (FIG. 12). The small tubers show, per gram of tuber, slightly more than, and the large slightly less than 0,2 g weight loss per sprout after desprouting five times.

ACKNOWLEDGEMENT

I am greatly indebted to Dr. A. R. WILSON for thoughtful reading and correcting the English text.

SUMMARY

The sprouting of seed potatoes and the influence of temperature on this is analysed by means of a large number of experiments done over a period of several years. Differences in sprouting capacity have been established between lots, varieties and different tubers, mature and immature, large and small ones and from sand and clay soil. There is a distinct seasonal trend in sprouting capacity, which is apparent, also when tubers are repeatedly desprouted. Weight losses from respiration and evaporation of tuber and sprout play an important part in sprout growth after desprouting. The relation between sprout weight and weight losses have been investigated and used to characterize the differences between lots.

ZUSAMMENFASSUNG

BEOBACHTUNGEN ÜBER DIE KEIMUNG VON SAATKARTOFFELN

Die Dauer der Keimruhe ist je nach Sorte und Jahr verschieden (TABELLE 1). Während dieser Zeit hat die Lagertemperatur nur einen geringen Einfluss, obwohl sich je nach der Sorte einige Unterschiede zeigen: bei *Bintje* wird die Keimruhe durch höhere Temperaturen abgekürzt, während bei *Alpha* die Temperatur keinen Einfluss hat.

Bei reifen und unreifen, grossen und kleinen Knollen von derselben Pflanze kann die Dauer der Keimruhe verschieden sein. Während des Wachstums können verschiedene Faktoren, darunter Temperatur und Düngung, die Zeitdauer der nachfolgenden Keimruhe beeinflussen. Es besteht eine Korrelation zwischen Sortenunterschieden in der Länge der Keimruhe und bestimmten Charakteristiken oder Unterschiedlichkeiten der Sorten, wie kräftigem Krautwuchs, Anfälligkeit für Zwiewuchs und Resistenz gegen Trockenheit. Je niedriger die Lagertemperatur während der Keimruhe, umso langsamer das spätere Wachstum der Keime (ABB. 1).

Je länger Knollen nach Beendung der Keimruhe am Keimen gehindert werden, umso schneller geht der Keimwuchs, wenn dieser schliesslich eintritt. Das maximale Wachstum der Keime tritt normalerweise ein, wenn die Knollen erstmalig im Juli oder August etwa ein Jahr nach der Ernte gekeimt werden (ABB. 2). Die Art des Wachstums der Keime ändert sich im Laufe der Lagerzeit: je nachdem die Knollen altern, geht die Bildung von Einzelkeimen in die mehrfache Keimbildung über; später verzweigen sich die Keime, und nach einem Jahr kann Knollenbildung an den Keimen vorkommen.

Die Wachstumsgeschwindigkeit der Anfangskeimung ist je nach Partie, Jahr und Sorte verschieden.

Durch Erhöhung der Temperatur, bei der die Knollen gelagert werden, von 2° auf 5° C wird der nachfolgende Keimwuchs beschleunigt, insbesondere nach längerer Lagerzeit (ABB. 3).

Durch Entfernen der Keime wird eine Zunahme der je Zeiteinheit gebildeten Keimmasse bewirkt (ABB. 4). Nahezu jedes Auge der Knolle kann einen Keim bilden (TABELLE 2). Auch hier ist

deutlich eine saisonale Tendenz zu beobachten (ABB. 5) und lassen sich Unterschiede nach Sorten und Herkünften feststellen, auch zwischen Knollen von derselben Ernte, jedoch mit verschiedenem Stärke- oder Zuckergehalt.

Bei der Entwicklung der Keime entstehen in der Knolle Gewichtsverluste durch Atmung und Verdunstung aus der Knolle und den Keimen. Je später in der Lagersaison, umso grösser sind die beim Keimen gemessenen Verluste. Diese Gewichtsverluste sind dem Keimgewicht nicht proportional (ABB. 6).

Das Verhältnis des Keimgewichts zu dem gleichzeitigen Gewichtsverlust durch Atmung und Verdunstung am Zeitpunkt der ersten Keimbildung ist charakteristisch für die betreffende Partie (ABB. 7). Dies wurde deutlich durch die verschiedenen Versuche mit Entfernung der Keime gezeigt (ABB. 8, 9 und 10). In dieser Weise lassen sich Unterschiede zwischen Herkünften nachweisen: die eine Herkunft kann einen geringeren Gewichtsverlust als eine andere aufweisen bei gleichem Gewicht der Keime. Sekundäre Zwiewuchsknollen zeigen ein ausserordentlich ungünstiges Verhältnis zwischen Keimgewicht und Gewichtsverlust.

Es besteht eine Korrelation zwischen dem nach wiederholter Entfernung der Keime gemessenen Keimgewicht und dem gesamten Gewichtsverlust der Knolle infolge der vorherigen Entfernung der Keime (ABB. 11). Der Gesamtgewichtsverlust pro entwickelter Keim von der Knolle erlitten infolge der wiederholten Entfernung der Keime, ist bei kleinen Knollen etwas niedriger als bei grossen, jedoch zeigen die grösseren Knollen ein höheres verfügbares Knollengewicht pro Keim (ABB. 12).

RÉSUMÉ

OBSERVATIONS SUR LA GERMINATION DES PLANTS DE POMME DE TERRE

La durée de la dormance varie d'une variété à l'autre et d'une année à l'autre (TABLEAU 1). Pendant cette période, la température de stockage n'a qu'une influence minime, bien que cette influence ne soit pas égale pour toutes les variétés: chez la variété *Bintje* par exemple, les températures élevées abrègent la dormance tandis qu'elles n'ont pratiquement aucun effet sur celle de la variété *Alpha*.

La durée de la dormance peut varier chez les tubercules mûrs ou non, gros et petits, de la même plante. Durant la période de croissance, différents facteurs, y compris la température et la fumure, peuvent influencer la durée de la période de dormance qui suivra. Les variations de la durée de la dormance d'une variété à l'autre sont en corrélation avec certaines caractéristiques ou différences variétales, telles que la vigueur des fanes, la susceptibilité d'une croissance secondaire et la résistance à la sécheresse. Plus la température de stockage durant la dormance est basse, plus la croissance du germe sera lente ensuite (FIG. 1).

Plus l'on empêche longtemps la germination des tubercules après la fin de la dormance, plus la germination éventuelle s'effectuera rapidement par la suite. Normalement, la germination est la plus forte si on fait germer les tubercules pour la première fois en juillet ou en août presque une année après la récolte (FIG. 2). La nature de la germination se modifie également au cours de la saison de stockage: à mesure que les tubercules „vieillissent", ils passent de la phase monogerminale à la phase polygerminale; plus tard, les germes commencent à se ramifier, et après un an, il peut se produire une tubérisation sur les germes.

La vitesse de germination initiale peut varier d'une provenance à l'autre, d'une année à l'autre et d'une variété à l'autre.

Si l'on augmente de 2° à 5°C la température à laquelle les tubercules sont conservés avant la germination, on obtient ensuite une germination plus rapide, surtout après une longue période de stockage (FIG. 3).

Le dégermage entraîne une augmentation de la masse de germes formée par unité de temps (FIG. 4). Presque chaque oeil du tubercule est capable de produire un germe (TABLEAU 2). Ici encore, on peut constater une certaine variation saisonnière (FIG. 5) et établir des différences entre les variétés et les provenances, ainsi qu'entre les tubercules de la même récolte mais possédant une teneur différente en fécule ou en sucres.

Lorsque le tubercule produit des germes, il perd du poids du fait de la respiration et de la éva-

poration du tubercule et du germe. Plus la saison de stockage est avancée, plus les pertes constatées à la germination seront importantes. Ces pertes de poids ne sont pas proportionnelles au poids des germes (FIG. 6).

Le rapport entre le poids des germes et les pertes simultanées de poids par respiration et évaporation au moment de la formation des premiers germes est caractéristique pour la provenance en question (FIG. 7). Ce fait a été nettement démontré par différents essais de dégermage (FIG. 8, 9 et 10). De cette façon, il est possible de démontrer des différences d'une provenance à l'autre: il se peut que l'une présente une plus faible perte de poids que l'autre tandis que le poids des germes est égal. Les tubercules de croissance secondaire présentent un rapport très défavorable entre le poids des germes et les pertes de poids.

Le poids des germes mesuré après dégermage répété est en corrélation avec la perte totale de poids subie par le tubercule par les dégermages précédents (FIG. 11). La perte totale de poids par germe formé, subie par le tubercule par suite du dégermage répété, est un peu plus faible dans les tubercules de petite dimension que dans les gros, mais pour ces derniers, le poids de tubercule disponible par germe est plus grand (FIG. 12).

LITERATURE

DAVIDSON, T. M. W. (1958): Dormancy in the potato tuber and the effects of storage conditions on initial sprouting and on subsequent sproutgrowth. *Amer. Pot. J.* **35**, 4: 451–465.

EMILSSON, B. (1949): Studies on the rest period and dormant period in the potato tuber. *Acta agric. suec.*, Stockholm, **3**, 3: 189–275.

FISCHNICH, O. (1959): Beitrag zur Stoffwechsel- und Entwicklungsphysiologie der Kartoffel. *Landb-Forsch. Völkenrode.* **9**, 3/4: 68–74.

GERMANN, O. (1960): Einfluss ein- und mehrmaligen Abkeimens auf Entwicklung und Ertragsfähigkeit der Kartoffelpflanze. *Z. Acker- u. Pfl.Bau.* **111**, 1: 73–91.

HOGETOP, K. (1930): Untersuchungen über den Einfluss der Temperatur auf Keimung und Lebensdauer der Kartoffelknolle. *Bot. Arch.* **30**, 350–413.

KAWAKAMI, K. (1952): Physiological aspects of potato seed tubers. *Mem. Hyogo Univ. of Agric.* **2**, 1: 1–114.

LAGARDE, J. (1958): Dormance et corrélations entre germes dans le tubercule de pomme de terre, comportement de la variété Belle-de-Fontenay. *C. R. Acad. Sci.*, Paris, **247**, 832–834.

——— (1959): Influence comparée de l'éthylène chlorhydrine et de la gibberelline sur l'évolution des germes de pomme de terre (variété Bintje). *C. R. Acad. Sci.*, Paris, **248**, 4: 582–585.

MICHENER, H. D. (1942): Dormancy and apical dominance in potato tubers. *Amer. J. Bot.* **29**, 7: 558–568.

PERENNEC, P., et P. MADEC (1960): Influence du tubercule sur la croissance et le développement du germe de pomme de terre. *Ann. Physiol. vég.* **2**, 1: 29–67.

SCHIPPERS, P. A. (1955): Enige factoren, die van invloed zijn op de houdbaarheid van aardappelen. Sticht. v. Aardapp. Bew., Wageningen. *Publ.* No. 105, serie A, 7 pp.

——— (1956): De invloed van de temperatuur op de duur van de rustperiode. Sticht. v. Aardapp. Bew., Wageningen. *Publ.* No. 108, serie A, 37 pp.

——— (1956): De invloed van de bewaartemperatuur op de kiemkracht van aardappelen. Sticht. v. Aardapp. Bew., Wageningen. *Publ.* No. 109, serie A, 32 pp.

——— (1956): De spruitlustigheid van aardappelen. Sticht. v. Aardapp. Bew., Wageningen. *Publ.* No. 110, serie A, 14 pp.

SZALAI, I. (1959): Ergebnisse der Untersuchungen über die Stoffwechselphysiologischen Grundlagen des Activitätswechsels der Kartoffelknolle. *Acta Bio. Univ. Szeged.* N.S. 5, 1–2: 35–47.