Potato Research 29 (1986) 55 – 66

The distribution of dry matter during growth of a potato crop

H. D. J. VAN HEEMST

Centre for Agrobiological Research, (CABO), P.O. Box 14, Wageningen, Netherlands

Accepted for publication: 8 July 1985

Zusammenfassung, Résumé p. 64

Additional keywords: cultivars, soil type, seed size, plant density, nitrogen availability, daminozide

Summary

The distribution of dry matter increments to the plant parts of a potato crop was determined by analysing data from experiments in which potato plants were harvested periodically during the early stages of their growth. The distribution tended to follow a regular pattern if expressed as a function of phenological development stage represented by the effective temperature sum. The influence of cultivar, soil type, nitrogen dressing, seed size, and plant density on this distribution pattern is discussed.

Introduction

Crops are usually grown for their storage organs such as tubers, grains or pods whose growth starts only after some roots, leaves and stems have been produced. Insufficient biomass invested in the vegetative organs gives a poor crop and whereas a high investment in them may give a high total biomass a relatively low proportion may be used for the production of storage organs, especially if the maintenance requirements are high. Excessive vegetative growth can be compensated to only a limited extent by redistribution of dry matter from vegetative parts to storage organs. A study of the pattern of dry matter distribution to the various plant parts during its phenological development, of the variability of this pattern among cultivars, and of the effect of environmental conditions on it can help in understanding the yield-formation processes of crops and in selecting cultivars for particular conditions.

The partitioning of dry matter usually is calculated only at the final harvest, for example as shoot/root or grain/straw ratios. The partitioning of dry matter, however, is a dynamic process that changes continously during growth and such ratios at harvest time quantify no more than the overall static end-product of distribution as effected by the growth pattern from emergence till harvest. Partitioning is also dynamic in a perennial sense because patterns of phenological development vary from year to year and because of responses to differences in weather, soils and management practices. Therefore, information obtained only at maturity cannot be used in dynamic simulation models or for predictive purposes under varying environmental conditions. For that purpose, it is necessary to examine the distribution to the various plant parts of the total dry matter increments between successive harvests during the growth cycle (Bodlaender & Algra, 1966; Brouwer, 1962; Engel & Raeuber, 1960; Gmelig Meyling & Bodlaender, 1981; Wittenrood, 1957; Wittenrood et al., 1957).

Materials and methods

The partitioning of dry matter increments was analysed by calculating the total dry matter increase between two successive harvests and expressing its partitioning to various plant parts as a fraction of that total increase. This procedure yields unambiguous results only as long as plant parts do not die, because it is impossible to distinguish between increase as such and the balance between growth and dying unless all dead material is collected, which is seldom practicable. In well-managed potato crops there is usually little decay of plant parts during the first 7 weeks after emergence and it is therefore during that restricted period that the distribution can be examined with some accuracy.

The analysis was necessarily limited to those trials where potato plants were harvested periodically during the early stages of growth. Because it is impossible to recover all of the underground stem, stolons and small fibrous roots, complete data is never available for analysis. However, the total dry weight of roots and stolons in the observed growth period is relatively negligible because it never exceeds more than a few hundred kilograms per hectare thus only the dry weight increase of leaves, stems and tubers needs to be and is considered in this paper.

A crop not only accumulates weight, it also passes through successive phenological stages, characterized by the order and rate of appearance of its vegetative and reproductive plant parts. The major environmental conditions influencing the rate of phenological development are temperature and day length. Because in the Netherlands most potato varieties are grown under long-day conditions, temperature alone is supposed to affect development rate. However, since not all temperatures are equally effective, a threshold, an optimum and a maximum temperature all have to be assessed.

Sands et al. (1979) assume a threshold of 7 °C, below which development ceases, an optimum of 21 °C, where development is at its maximum rate, and a maximum of 30 °C, above which development again stops. Ingram & McCloud (1984) assume a similar relationship between temperature and the period until the onset of tuber initiation but with slightly different temperatures, whereas Bodlaender (1960) suggests an optimum for potato development of 18 °C, and a threshold value of 7 °C. Slater (1963) identified 29 °C as the temperature at which no tubers are formed.

The value of the threshold temperature could not be established from the available experimental data because in the trials used for the analysis the average daily air temperature during the first 7 weeks after emergence was seldom lower than 7 °C. Therefore this value was adopted from the literature. An optimum average air temperature of 18 °C, combined with a maximum of 29 °C yielded the highest correlation, when the data were analysed by linear regression.

Effective daily air temperatures are accumulated from emergence onwards to yield a temperature sum (with the dimension day · °C). The effective daily temperature is calculated according to the following formulae:

$$\begin{aligned} T &= \overline{Ta} - 7, && \text{if } 7 < \overline{Ta} \leq 18 \\ T &= 29 - \overline{Ta}, && \text{if } 18 < \overline{Ta} \leq 29 \\ T &= 0, && \text{if } \overline{Ta} \leq 7 \text{ or } \overline{Ta} > 29 \end{aligned}$$

where:

T is effective daily air temperature (°C),

$\overline{Ta}$ is average daily (24-h) air temperature (°C).

The experiments used to examine the development rate-temperature relation were carried out with 6 potato cultivars on a sandy soil at Wageningen during the years 1975–1977 (Gmelig Meyling, 1981). The trial was laid out in triplicate; the density was 50 000 plants/ha, the seed size 35–45 mm, and nitrogen dressing 150 kg/ha. Such conditions permit optimum growth. In each of the 3 years the first harvest took place at the beginning of June, about 1 week after emergence. Subsequent harvests were taken at intervals of 2 weeks. The plants were dissected into tubers, stems and leaves. From the total dry matter increment and that of the various plant parts between successive harvests, the dry matter distribution for each interval was calculated.

In well-managed field trials, the results of individual harvests have a standard deviation <10% of the mean. The weight differences between successive harvests are subject to much higher deviations and since these are used for the calculation of the distribution pattern, the accuracy of individual points is relatively low. In addition, weight increases at the early stages of growth are low and, so, a small deviation in weight of individual plant parts will cause a wide fluctuation in relative distribution. Consequently a large numbers of trials was analysed. The pattern of dry matter distribution for leaves as well as for tubers was regressed on temperature sums. Because of the errors associated with the individual data points, a constant slope is used for all trials, with an average value determined from the data of the trials used. A line with a constant slope is fitted by eye through the data in the figures presented.

The influence of factors such as: the choice of cultivar, soil type, nitrogen availability, seed size, plant density and the use of a growth retardant on the pattern of dry matter distribution has been evaluated. The analysis is based on trials, carried out by colleagues.

A short description of the different trials is given at the start of each section.

Results and discussion

Differences between cultivars

In the trials from which the data for Fig. 1, A–F were obtained, 6 cultivars were grown, 2 early, Doré and Favorita, 2 intermediate, Marijke and Irene, and 2 late, Mara and Multa. The slope of the lines, taken to be the same for all cultivars, is −0.003/day·°C for the leaves and 0.003/day·°C for the tubers, fitted by eye through the points, even though a better fit would be obtained by a line with a different slope, because of the relative inaccuracy of the individual points, especially those obtained shortly after emergence, when growth rates are small. The fraction invested in leaves was assumed to start at a constant level of 0.80 of the total increase in dry matter, and to decline after a varying temperature sum. This fraction of 0.80 is the average fraction derived over all cultivars, seasons and trials. The fraction allocated to the tubers is 0 until their initiation, reached by the early varieties (Fig. 1, A and B) apparently before emergence.

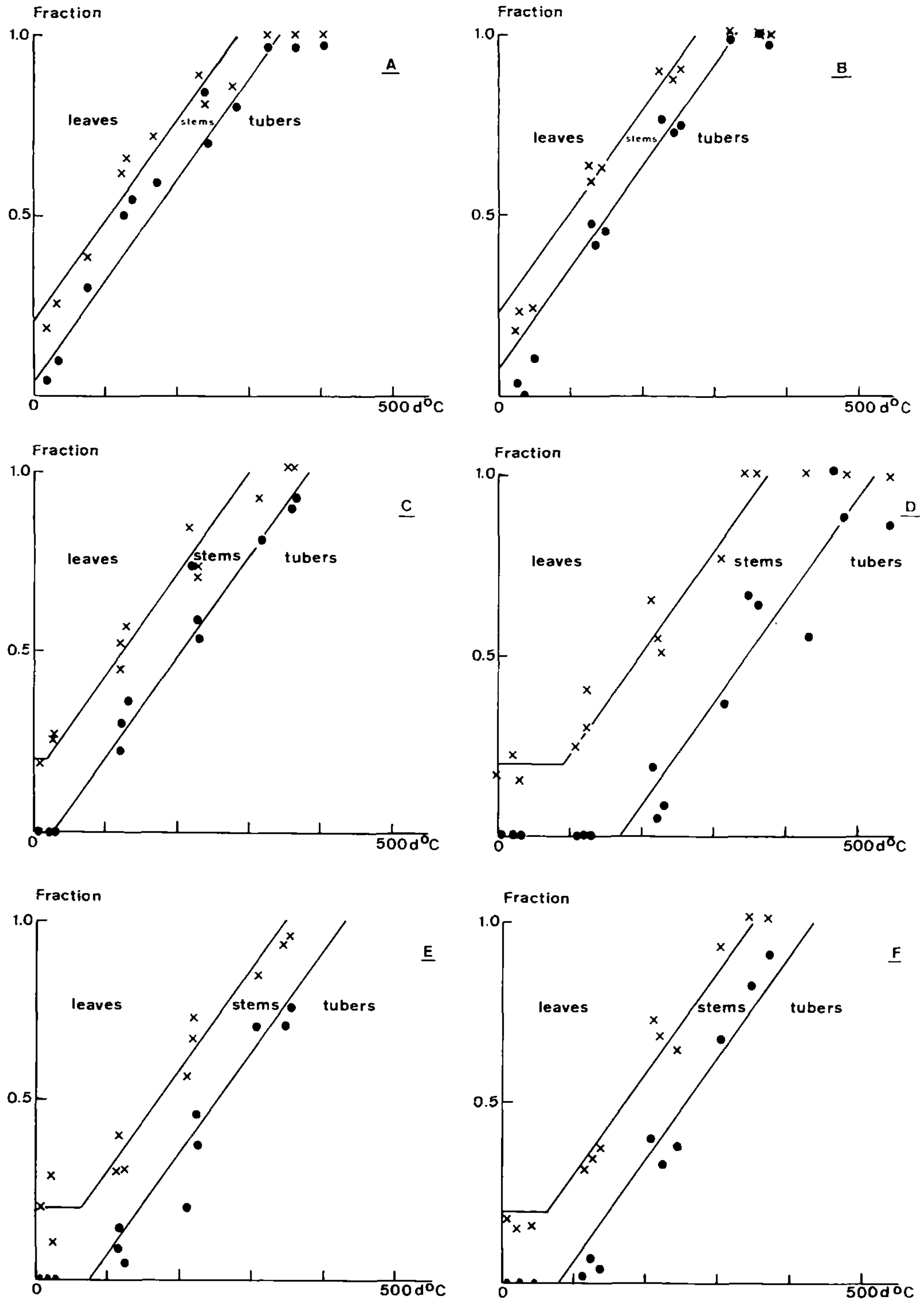
Fraction
1.0
0.5
0
500 d°C
leaves
stems
tubers
A
B
C
D
E
F

Fig. 1. Relation between fraction of total dry matter increase (minus roots and stolons) invested in leaves (×), stems and tubers (●), and temperature sum for 6 cultivars, 1975–1977.

A. cv. Doré; B. cv. Favorita; C. cv. Marijke; D. cv. Irene; E. cv. Mara; F. cv. Multa

Abb. 1. Die Beziehung zwischen der Fraktion der gesamten Trockengewichtszunahme (abzüglich der Wurzeln und Stolonen), in Blättern (×), Stengeln und Knollen (●) und der Temperatursumme für 6 Sorten, 1975–1977.
Fig. 1. Relation entre l'augmentation du pourcentage de matière sèche accumulée (en fraction de la matière sèche totale, non compris les racines et les stolons) au niveau des feuilles (×), des tiges et des tubercules (●) et la somme des températures pour 6 variétés, 1975–1977.

The construction of the figures was choosen to facilitate their use, e.g. in Fig. 1, A at 200 day·°C, the fraction allocated to the tubers is 0.60, that to the stems 0.16 and that to the leaves 0.24.

The graphs show that differences between the various cultivars can be represented simply by a shift in distribution lines along the temperature-sum axis. The fraction allocated to stems can be considered as the complement of that of leaves and tubers. When the fraction allocated to leaves declines before tubers are initiated, as with cv. Irene (Fig. 1, D), the fraction allocated to stems increases.

Nösberger & Humphries (1965) studied the effect of removing tubers on growth and net assimilation rate of potatoes, and found that it decreased total dry weight and increased accumulation of dry matter in leaves and stems. With insufficient sink capacity, a declining growth rate of the whole crop could be expected by feedback to processes of photosynthesis or respiration. In these trials there is indeed a correlation between growth rate during the linear phase of crop growth and the time of tuber initiation expressed as the temperature sum (Fig. 2), supporting the hypothesis that a limited sink size can restrict crop growth. The data points are taken from Fig. 1, A–F, the 2 negative values are the results of extrapolation of the lines for tuber distribution in Fig. 1, A and B.

Influence of soil type

In 1978 a field trial was carried out with the cultivars Favorita, Marijke, Irene and Multa on a clay soil in one of the new Dutch polders (Gmelig Meyling, 1981). There were 3 replicates planted at a density of 50 000 plants/ha, using seed of size 35–45 mm and nitrogen dressing of 100 kg/ha. The harvest interval was 3 weeks. The data were analysed as described and that for cv. Irene is presented in Fig. 3.

Comparison of this distribution pattern with that of cv. Irene grown on a sandy soil (Fig. 1, D), shows that in terms of temperature sums, tuber initiation was earlier and the period of constant allocation to leaves ended earlier. The stem received a smaller share. The same applies to the other cultivars, but to a smaller extent. The reason, however, is not clear, because many factors may play a role, such as soil temperature, and the water and nitrogen status of the soil of which the influence is unknown.

Influence of nitrogen application

In 1958 a field trial was carried out with the late cv. Alpha on a sandy soil at Leersum. The experiment was in triplicate, at a density of 40 000 plants/ha, with 2 plant-

Fig. 2. Correlation between crop growth rate during the phase of linear growth and timing of tuber initiation for 6 potato cultivars, 1975–1977.

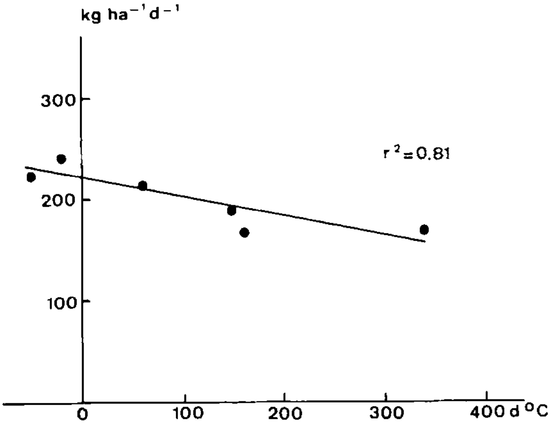

Abb. 2. Korrelation zwischen der Wachstumsrate im Bestand während der linearen Wachstumsphase und der Zeit des Knollenansatzes für 6 Kartoffelsorten, 1975–1977.
Fig. 2. Corrélation entre le taux de croissance au cours de la phase de croissance linéaire et le moment de l'initiation des tubercules pour 6 variétés de pommes de terre 1975–1977.

Fig. 3. Relation between fraction of total dry matter increase (minus roots and stolons) invested in leaves (×), stems and tubers (●), and temperature sum for cv. Irene on a clay soil, 1978.

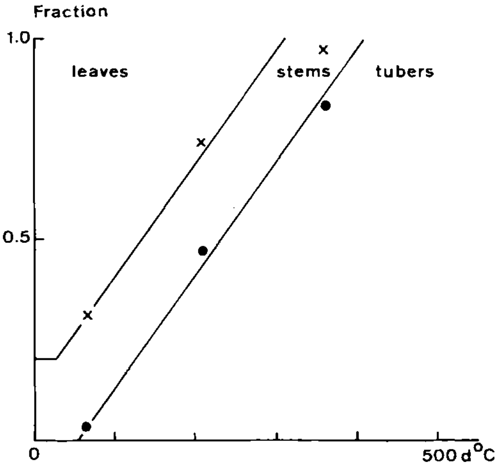

Abb. 3. Die Beziehung zwischen der Fraktion der gesamten Trockengewichtszunahme (abzüglich Wurzeln und Stolonen) in Blättern (×), Stengeln und Knollen (●) und der Temperatursumme für die Sorte Irene auf einem Lehmboden, 1978.
Fig. 3. Relation entre l'augmentation du pourcentage de matière sèche accumulée (en fraction de la matière sèche totale, non compris les racines et les stolons) au niveau des feuilles (×), des tiges et des tubercules (●) et la somme des températures pour la variété Irène cultivée en sol argileux, 1978.

ing dates, 15 April and 15 May; 2 seed sizes, 25 – 28 mm and 45 – 60 mm and 2 nitrogen dressings, 0 and 200 kg/ha (Bodlaender, pers. comm.). The harvest interval was 1 week. The results of the analysis are presented in Fig. 4, A – D.

A nitrogen application of 200 kg/ha delayed the onset of tuber initiation, and lengthened the period of constant allocation to the leaves in all treatments. Slater (1963) also found that withdrawal or a low supply of nitrogen resulted in earlier tuber initiation. This effect, although seemingly small, plus an adequate nitrogen supply which promotes overall growth rate, results in about 1000 kg/ha more leaves. At the same time, stem growth is promoted.

The same holds for a pot trial with the same cultivar, seed size 35 – 50 mm, grown in pots filled with river sand in a glasshouse at Wageningen in 1967 (Marinus, pers. comm.). Three nitrogen application levels were tested, equivalent to 100, 200 and 300 kg/ha. Here, each increase in nitrogen level progressively delayed the onset of tuber initiation, and extended the period of constant allocation to the leaves, whereas the fraction invested in the stems increased from 0.20, to 0.30 and 0.40, respectively.

Influence of seed size

Fig. 4, A – D suggests that the size of the seed potato influences the onset of tuber initiation as well as the end of the period of constant allocation to leaves. In crops grown from larger seed potatoes, tuber initiation is advanced and the period of constant allocation to leaves is shortened, both equally. Bremner & El Saeed (1963) made the same observation. This effect is probably caused by the number of stems, because stem number and seed size are closely related (Reestman & de Wit, 1959).

Influence of plant density

A number of trials was examined covering plant densities ranging from 10 000 to 160 000 plants/ha, and no density effect was found.

Influence of growth retardants

To study the possibility of achieving an economically more profitable dry matter distribution with the same total dry matter production, experiments were carried out to establish whether spraying a growth retardant on a potato crop would promote tuber growth at the expense of leaf and/or stem growth. A number of such experiments have been analysed, in which the growth retardant B995 (daminozide) was used. Some results are shown for cv. Pimpernel, a late cultivar, in Fig. 5. The results of an analysis of different trials are combined, all were done in the years 1967 – 69 and located at Varsseveld. They were planted with seed of size 35 – 45 mm at 60 000 plants/ha and given a nitrogen dressing of 200 kg/ha (Gmelig Meyling & Bodlaender, 1981). Only the trial in 1968 included a treatment sprayed with B995. Fig. 5 shows that in this experiment distribution to the various plant parts was not influenced by the growth retardant. In two other trials (Bodlaender & Algra, 1966; Gmelig Meyling & Bodlaender, 1981) at the same site, planted with seed of cv. Alpha, size 35 – 45 mm, 2 nitrogen dressings, 100 and 200 kg/ha were applied, in 1965 to 40 000 plants/ha and in 1968 to 60 000 plants/ha. Analysis showed that spraying B995 promoted allocation of dry matter to tubers at the expense of stems only at the higher N-level of 200 kg/ha. In the final yields, the effects of B995 also varied, depending on soil type and cultivar. Often there were no effects on final tuber yield because of re-growth of the foliage later in the season (Bodlaender, 1982).

Fig. 4. Relation between fraction of total dry matter increase (minus roots and stolons) invested in leaves (×), stems and tubers (●), and temperature sum for cv. Alpha; 2 planting dates, 1958.

A. seed size 25–28 mm, without nitrogen application – *Pflanzgutgrösse 25–28 mm, ohne Stickstoffanwendung – Calibre du plant 25–28 mm, sans apport d'azote.* B. Seed size 25–28 mm, with a nitrogen dressing of 200 kg/ha – *Pflanzgutgrösse 25–28 mm, mit einer Stickstoffbehandlung von 200 kg/ha – Calibre du plant 25–28 mm, avec 200 kg/ha d'azote.*
C. Seed size 45–60 mm, without nitrogen application.
D. Seed size 45–60 mm, with a nitrogen dressing of 200 kg/ha.

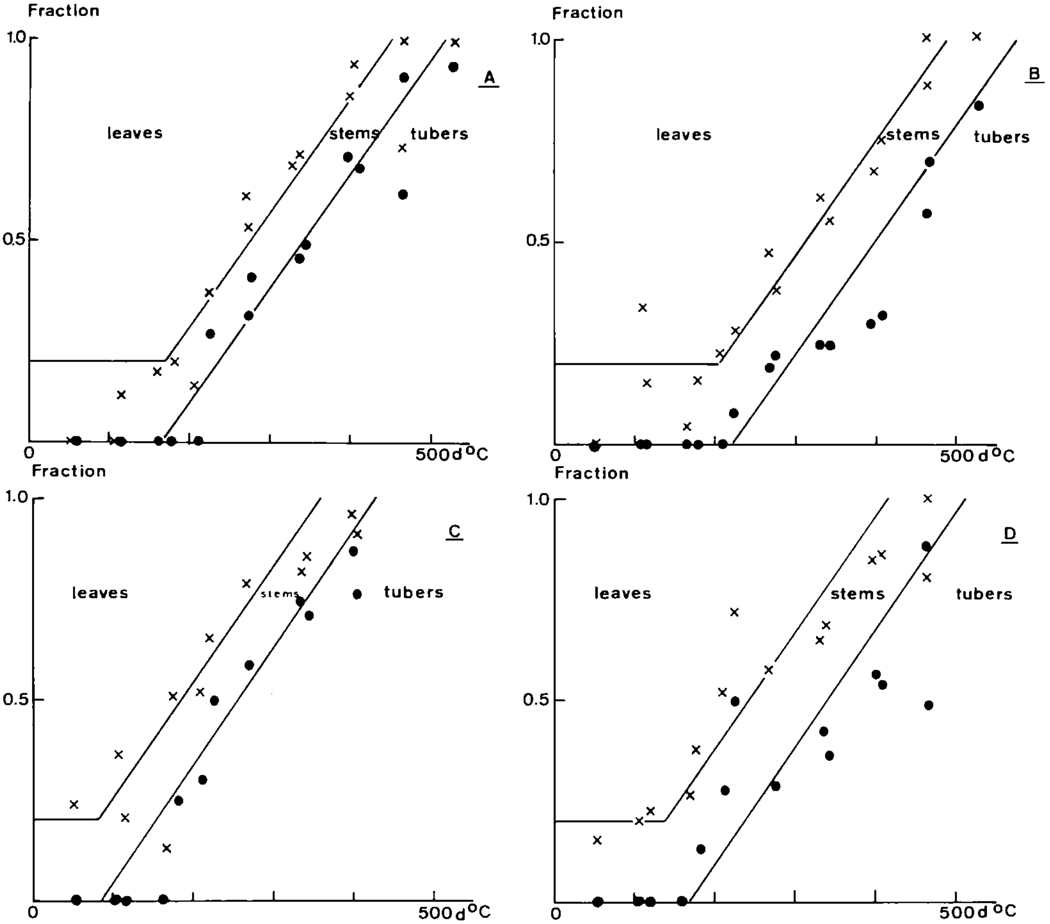

Abb. 4. Die Beziehung zwischen der Fraktion der gesamten Trockengewichtszunahme (abzüglich Wurzeln und Stolonen) in Blättern (×), Stengeln und Knollen (●) und der Temperatursumme für die Sorte Alpha; 2 Pflanztermine, 1958.

Fig. 4. Relation entre l'augmentation du pourcentage de matière sèche accumulée (en fraction de la matière sèche totale, non compris les racines et les stolons) au niveau des feuilles (×), des tiges et des tubercules (●) et la somme des températures pour la variété Alpha plantée; 2 dates différentes, 1958.

Fig. 5. Relation between fractions of total dry matter increase (minus roots and stolons) invested in leaves (×, ⊗, ▵), stems and tubers (●, ⊙, ○), and temperature sum for cv. Pimpernel, 1967–1969. Untreated 1967 and 1969 (●, ×), 1968 (⊗, ⊙), treated with B995 in 1968 (○, ▵).

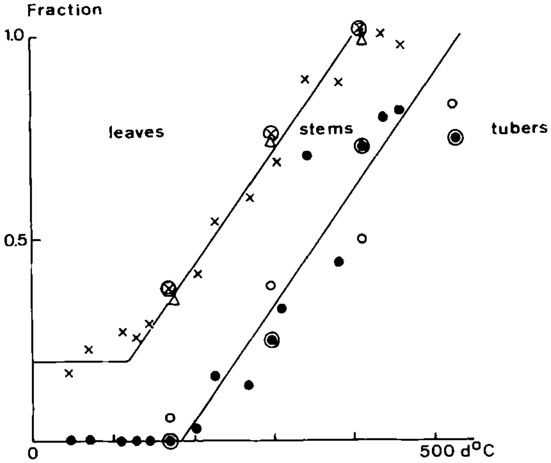

Abb. 5. Die Beziehung zwischen der Fraktion der gesamten Trockengewichtszunahme in Blättern (×, ⊗, ▵), Stengeln und Knollen (●, ⊙, ○), und der Temperatursumme für die Sorte Pimpernel, 1967–1969. Unbehandelt 1967 und 1969 (●, ×), 1968 (⊗, ⊙), behandelt mit B995 in 1968 (○, ▵).

Fig. 5. Relation entre l'augmentation du pourcentage de matière sèche accumulée (en fraction de la matière sèche totale, non compris les racines et les stolons) au niveau des feuilles (×, ⊗, ▵), des tiges et des tuberculus (●, ⊙, ○) et la somme des températures pour la variété Pimpernel, 1967–1969. Non traitée 1967–1969 (●, ×), 1968 (⊗, ⊙), traitée avec B995 en 1968 (○, ▵).

Conclusion

The distribution of dry matter increment to the various plant parts in potatoes apparently follows a regular pattern, which, if expressed as a function of phenological development stage, is represented by the effective temperature sum.

During a short period after emergence, the dry matter increment is distributed in a fixed proportion between leaves (0.80) and stems (0.20) as was also found by Wittenrood (1957) and Wittenrood et al. (1957). The actual proportions vary little between cultivars and are not distinctly influenced by environmental factors. The length of this period is variable and it is influenced by genetic factors (differences between cultivars), by environmental conditions (temperature), and by management measures (nitrogen application, seed size).

This period is followed by a second one in which the fraction of dry matter increment invested in leaf growth declines linearly with temperature sum, irrespective of internal or external growing conditions.

When assimilate utilization by the leaves declines before the onset of tuber initiation, stem growth was promoted. The timing of tuber initiation seems directly related to factors that influence the length of the period of constant allocation to leaves. From the onset of tuber initiation, the fraction of dry matter increase invested in tubers could be represented by a line with a constant slope of 0.003/day · °C, which in the situations examined here, again seems to be invariable with cultivar, environmental conditions or management practices. Finally, the tubers draw upon almost all available assimilates.

In conclusion, various crop events such as the end of constant distribution to the leaves and the onset of tuber initiation are influenced by genetic factors, temperature, nitrogen availability and seed size. Once the timing of these events is fixed, the distribution pattern is quantified when applying distribution lines with a constant slope.

The actual proportion of leaves, stems and tubers within the total biomass at a given time not only depends on the distribution pattern in the past, but also on the associated growth rates governed by leaf area, weather and nutrient availability. The overall effect of growth rate and distribution on the ultimate tuber yield can best be examined by using simulation models. With such models it is possible to examine the influence of different factors separately (Penning de Vries & van Laar, 1982).

Acknowledgments

The author is greatly indebted to K. B. A. Bodlaender, H. D. Gmelig Meyling, M. van de Waart and J. Marinus of the Centre for Agrobiological Research at Wageningen, for the use of the basic data from their field and pot experiments.

Zusammenfassung

Die Verteilung der Trockensubstanz während des Wachstums eines Kartoffelbestandes

Die Verteilung des Trockensubstanzertrages in den verschiedenen Pflanzenteilen eines Kartoffelbestandes wird an Hand von Analysenwerten aus Versuchen bestimmt, in denen Kartoffelpflanzen während früher Wachstumsstadien in periodischen Abständen geerntet wurden.

Um die Zuordnung des Trockengewichtsertrages zu den verschiedenen Pflanzenteilen eines Kartoffelbestandes zu analysieren, wurde ein Verfahren verwendet, in dem der gesamte Trockengewichtszuwachs zwischen aufeinanderfolgenden Ernten berechnet und dessen Verteilung in den Organen als eine Fraktion von der gesamten Zunahme ausgedrückt wird. Die Verteilung steht in Beziehung zu einer effektiven Temperatursumme mit einer unteren Temperaturschwelle von 7 °C, einer Optimaltemperatur von 18 °C und einer Maximaltemperatur von 29 °C. Aus Analysen einer grossen Anzahl von Versuchen ergab sich der Schluss, dass die Verteilungsmuster zwischen Blättern und Knollen approximiert werden können durch lineare Bezüge mit konstanten Neigungen, die für alle Situationen zutreffen. Abb. 1, A–F zeigt, dass Unterschiede zwischen den Sorten durch eine Verschiebung in der Geraden entlang der Temperatursummenachse dargestellt werden können.

Die den Stengeln zugeordnete Fraktion kann als Ergänzung zu derjenigen in den Blättern und Knollen betrachtet werden. Wenn die in den Blättern verteilte Fraktion vor dem Kollenansatz abnimmt, wie bei der Sorte Irene (Abb. 1, D), dann erhöht sich die Fraktion in den Stengeln.

Zusammen mit unzureichender Sinkkapazität konnte eine abnehmende Wachstumsrate im gesamten Bestand erwartet werden. In diesen Versuchen ergab sich deutlich eine Korrelation zwischen der Wachstumsrate während der linearen Wachstumsphase und der Zeit des Knollenansatzes, die als eine Temperatursumme ausgedrückt wird (Abb. 2).

Der Vergleich des Verteilungsmusters der Sorte Irene, die auf einem sandigen Boden

wuchs (Abb. 1, D) mit demjenigen der gleichen Sorte von einem Lehmboden (Abb. 3) zeigt, dass nach den Masseinheiten der Temperatursummen der Knollenansatz auf dem Lehmboden früher erfolgte.

Ein höheres Stickstoffniveau verzögerte den Beginn des Knollenansatzes und verlängerte die Periode der konstanten Zuwanderung zu den Blättern. Gleichzeitig wird das Stengelwachstum gefördert (Abb. 4, A–D).

In Beständen, die aus grösseren Pflanzkartoffeln erwuchsen, wird der Knollenansatz beschleunigt und die Periode der konstanten Zuwanderung zu den Blättern verkürzt (Abb. 4, A–D).

In Versuchen mit unterschiedlichen Pflanzdichten wurde keine grössere Differenz im Verteilungsmuster der Biomasse beobachtet.

Versuche, in denen die Verteilung der Trockensubstanz durch die Behandlung mit einem Wachstumshemmer (Daminozid) beeinflusst werden sollte, zeigten unterschiedliche Ergebnisse. Manchmal wurde überhaupt keine Wirkung festgestellt (Abb. 5), in anderen Versuchen begünstigte der Wachstumshemmer jedoch die Zuwanderung der Trockensubstanz zu den Knollen auf Kosten der Stengel. Die Wirkung des Daminozids variierte auch in den Enderträgen, weil oft das Laub in der späteren Jahreszeit wieder austrieb.

Zusammenfassend kann gesagt werden, dass die verschiedenen Abläufe im Bestand, wie die Beendigung der konstanten Zuwanderung zu den Blättern und der Beginn des Knollenansatzes durch genetische Faktoren, durch die Tempertur, die Stickstoffverfügbarkeit und die Pflanzgutgrösse beeinflusst werden. Ist einmal die zeitliche Regelung dieser Abläufe festgelegt, dann ist das Verteilungsmuster durch Verwendung der Verteilungsgraden mit konstanter Neigung quantitativ bestimmbar.

Résumé

Distribution de la matière sèche au cours de la croissance de la pomme de terre

La distribution de la matière sèche au niveau des différentes parties des plantes d'une culture de pomme de terre est déterminée à partir de résultats d'essais dans lesquels on a procédé à plusieurs arrachages périodiques durant les premiers stades de la croissance.

A cet effet, on a calculé l'augmentation de matière sèche entre 2 récoltes successives et exprimé la répartition de celle-ci au niveau des différents organes en fraction de cette augmentation totale. La répartition est mise en relation avec la somme des températures effectives en considérant un seuil minimal de 7 °C, une température optimale de 18 °C et une température maximale de 29 °C. L'analyse d'un grand nombre d'essais montre que le modèle de distribution entre les feuilles et les tubercules peut être évalué par des relations linéaires de pentes constantes, valables pour toutes les situations. La figure 1, A – F, montre que les différences entre les variétés peuvent être représentées par un déplacement des droites de distribution sur l'axe des sommes de températures.

La fraction attribuée aux tiges peut être considérée comme le complément de celle des feuilles et des tubercules. Lorsque la fraction accumulée au niveau des feuilles décroît avant l'initiation des tubercules, comme dans le cas de la variété Irène (fig. 1, D), celle des tiges augmente.

Lorsque la capacité d'absorption est insuffisante, on peut prévoir une diminution du taux de croissance de la culture. Dans ces essais, on observe en fait une corrélation entre le taux de croissance au cours de la phase linéaire de la croissance et le moment d'initiation des tubercules exprimé en somme de températures (fig. 2).

La comparaison du modèle de distribution de la variété Irène cultivée en sol sableux (fig. 1, D) avec celui de cette même variété cultivée en sol argileux (fig. 3) montre qu'en termes de sommes de température l'initiation des tubercules est plus précoce en sol argileux.

Un niveau élevé d'azote retarde le départ de la phase d'initiation des tubercules et allonge la durée d'accumulation constante au niveau des feuilles. En même temps, la croissance des tiges est favorisée (fig. 4, A–D).

Dans une culture issue de plants de gros

calibres, l'initiation des tubercules est avancée et la durée d'accumulation constante au niveau des feuilles raccourcie (fig. 4, A–D).

Les études concernant la densité de plantation, n'ont montré aucune différence importante des modèles de distribution de la matière sèche.

Des essais conduits à l'aide de retardateurs de croissance (daminozide), dans le but de modifier la distribution de la matière sèche, aboutissent à des résultats variables. Parfois, aucun effet n'est observé (fig. 5), alors que dans d'autres essais, en effet, le retardateur de croissance favorise l'accumulation de matière sèche vers les tubercules au dépend des tiges. Au niveau du rendement final, les effets du daminozide varient également, en raison le plus souvent d'une reprise de la végétation en fin de saison.

En conclusion, les différentes phases d'une culture telles que la fin d'accumulation constante vers les feuilles et le début de l'initiation des tubercules sont influencées par les facteurs génétiques, la température, la disponibilité en azote et le calibre du plant. Une fois que le déroulement de ces phases est fixé, le modèle de distribution est quantifié par les droites de distribution à pente constante.

References

Bodlaender, K. B. A., 1960. De invloed van de temperatuur op de ontwikkeling van de aardappel. Jaarboek IBS, p. 69–83.

Bodlaender, K. B. A., 1982. Groeiregulatie bij aardappelen. Landbouw en Planteziekten, No 1, p. 5–23 (in Dutch).

Bodlaender, K. B. A. & S. Algra, 1966. Influence of the growth retardant B995 on growth and yield of potatoes. *European Potato Journal* 9: 242–258.

Bremner, P. M. & A. K. El Saeed, 1963. The significance of seed size and spacing. In: J. D. Ivins & F. I. Milthorpe (Eds), The growth of the potato. Butterworths, London, p. 267–280.

Brouwer, R., 1962. Distribution of dry matter in the plant. *Netherlands Journal of Agricultural Science* 10: 361–376.

Engel, K. H. & A. Raeuber, 1960. Untersuchungen über die Beziehungen zwischen Phanometrie und Pflanzenzuchtung. Deutsche Akademie der Landwirtschaftwissenschaft zu Berlin, 22 pp.

Gmelig Meyling, H. D., 1981. Opbrengst en rasvroegheid bij aardappelen. CABO-Report No 36, 47 pp. (in Dutch).

Gmelig Meyling, H. D. & K. B. A. Bodlaender, 1981. Varietal differences in growth, development and tuber production of potatoes. *Netherlands Journal of Agricultural Science* 29: 113–127.

Ingram, K. T. & D. E. McCloud, 1984. Simulation of potato crop growth and development. *Crop Science* 24: 21–27.

Nösberger, J. & E. C. Humphries, 1965. The influence of removing tubers on dry matter production and net assimilation rate of potato plants. *Annals of Botany* 29 (116): 579–588.

Penning de Vries, F. W. T. & H. H. van Laar (Eds), 1982. Simulation of plant growth and crop production. Pudoc, Wageningen, 308 pp.

Reestman, A. J. & C. T. de Wit, 1959. Yield and size distribution of potatoes as influenced by seed rate. *Netherlands Journal of Agricultural Science* 7: 257–268.

Sands, P. J., C. Hackett & H. A. Nix, 1979. A model of the development and bulking of potatoes (*Solanum tuberosum* L.). I. Derivation from well-managed field crops. *Field Crop Research* 2: 309–331.

Slater, J. W., 1963. Mechanisms of tuber initiation. In: J. D. Ivins & F. I. Milthorpe (Eds), The growth of the potato. Butterworths, London, p. 114–120.

Wittenrood, H. G., 1957. Grafische voorstelling van de ontwikkeling van een plant. Jaarboek IBS, p. 87–94.

Wittenrood, H. G., A. J. Reestman & K. B. A. Bodlaender, 1957. Groei en productie van aardappelen. Jaarboek IBS, p. 95–115.