

The effect of two planting dates on the physiological age and yielding potential of seed potatoes grown in a warm temperate climate in Argentina

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Summary

The effect of two planting dates upon the physiological age of seed tubers, measured by their incubation period, and their yielding potential was studied during a three-year period with two medium-early and one medium-late cultivar. Although seed tubers of the December planting were physiologically significantly younger than those obtained from the November planting in two of the three seasons studied, no reliable effect upon tuber yield was found. Reasons for this lack of relation are discussed. The accumulated day-degrees above 17 °C (daily mean temperature) during the bulking period of the seed crop modified the incubation period of the tubers clearly.

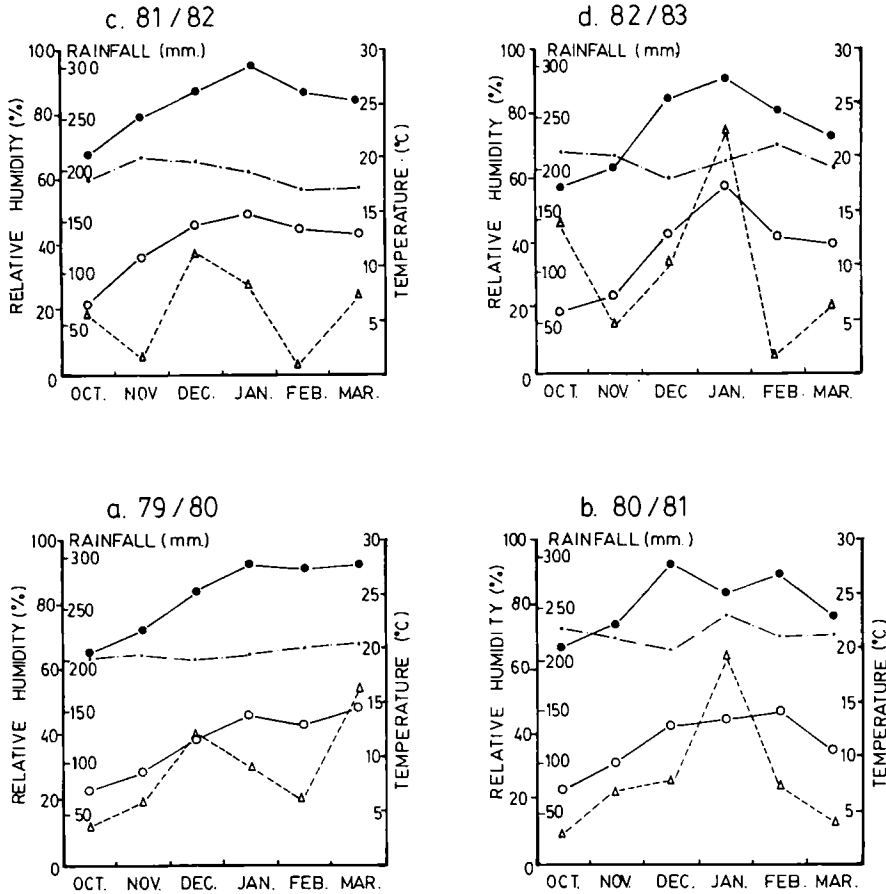
Introduction

Attempts are being made to produce seed potatoes in Argentina, and it is recognized that good pest and disease control, crop husbandry and environmental conditions during crop growth and storage are essential. These two last aspects may strongly influence the physiological age of the seed tubers, especially if temperatures are high (Carls & Caesar, 1979; Iritani, 1981; Caldíz et al., 1984).

In the south-east area of Buenos Aires Province, seed crops are grown during a long growing period, from October till March. The growing tubers are subjected to high temperatures in December and January, a factor that can adversely influence the physiological age so that yielding capacity may be reduced (Claver et al., 1957; Went, 1959; Iritani, 1968; Claver, 1975), although McCown & Kass (1977) and Hay & Allen (1978), working under phytotron and tropical weather conditions respectively, did not find such an effect.

The work reported here was carried out in a three-year period in an area with a warm temperate climate. Two planting dates were used in order to study the influence of temperature during tuber bulking and the effect of planting date on physiological age of the seed tubers and, in turn, the effect of physiological age upon yield.

Fig. 1. Meteorological data in the growing seasons of the seed crops and yield trials.



- — ● Monthly mean maximum temperature – *Durchschnittliche monatliche Maximumtemperatur* – *Température mensuelle moyenne maximale*
- — ○ Monthly mean minimum temperature – *Durchschnittliche monatliche Minimumtemperatur* – *Température mensuelle moyenne minimale*
- △ — — — △ Monthly rainfall – *Monatlicher Regenfall* – *Pluviosité mensuelle*
- - - - Monthly mean relative humidity – *Mittlere monatliche relative Luftfeuchtigkeit* – *Humidité relative mensuelle moyenne*

Relative humidity – *Relative Luftfeuchtigkeit* – *Humidité relative*; Rainfall – *Regenfall* – *Pluviosité*; Temperature – *Temperatur* – *Température*

Abb. 1. Meteorologische Daten in den Vegetationszeiten der Pflanzgutbestände und der Ertragsversuche.

Fig. 1. Relevé météorologiques durant la saison de culture des plants récoltés et des essais de rendement.

Materials and methods

During 1979, 1980 and 1981, certified seed tubers of the cultivars Spunta, Kennebec (medium-early) and Bonaerense La Ballenera MAA (medium-late) were planted on two dates (between 9–19 November and 15–24 December) at Miramar (38° 10' S.L. and 58° 0' W.L.), 50 m above sea level (for more detail, see Panelo et al., 1982). In 1980 and 1981 the harvested seed tubers were stored in a refrigerated stored (2–4 °C) and in 1982 in clamps in the field.

The incubation period, defined as the period between sprouting and new tuber formation on the sprouts, is taken as a measure of the physiological age of the seed tubers (Claver, 1951, 1953, 1973). Samples of 25 tubers were kept in the dark at 20±1 °C and 90 % relative humidity and the incubation period was considered to be finished when 90 % of them had formed tubers of 5 mm diameter.

Yield trials were planted between 16 and 18 November with 47 000 tubers/ha in 1980/81 and 1981/82 and with 57 000 tubers/ha in 1982/83. The haulm was killed 121, 124 and 113 days after planting the medium-early crops and 130, 129 and 127 days after planting the medium-late crop. The rate of fertilizer NPK was 170 kg/ha in 1982/83. Cultivation and pests and diseases control followed local practice.

The meteorological data for the four seasons are presented in Fig. 1.

An analysis of variance was carried out for the comparative yield trials and averages for total tuber yield compared by Tuckey's test ($P < 0.05$), while for the results of physiological age, averages were compared by Tuckey's test at $P < 0.01$.

Results

For both planting dates in all three seasons there are significant differences in incubation period, and so in physiological age, between seed tubers of cv. Ballenera MAA and those of Spunta and Kennebec (Table 1a, b and c). There are also significant differences in incubation period between Spunta and Kennebec from the December planting in 1979 and in 1981. Overall, seed grown in 1981/82 had the shortest incubation periods probably because of the warmer storage conditions in the clamps, although lower rainfall during the growing season may have had an effect on the incubation period (Fig. 1c). Planting date had a significant effect on the length of the incubation period for all the three cultivars in 1980/81 and 1981/82 and for Spunta in 1979/80 (Table 1a, b and c).

An analysis of the total tuber yield showed that cv. Ballenera MAA tended to out-yield Spunta and Kennebec, significantly so in 1980/81 and in the trial with seed from November planting in 1982/83 (Table 2a and c). The lowest yield of the three seasons was in 1981/82 due to unfavourable conditions for tuber production (Fig. 1c). No significant differences in total tuber yield have been found between seed of the two planting dates for all three seasons, although there were significant differences ($P < 0.01$) in physiological age.

In 1982/83, seed tubers were physiologically older (Table 1c) at planting than in the previous years (Table 1a and b) yet total tuber yield was the highest (Table 2c). This perhaps indicates that acceptable yields can be obtained with old seed, if it is properly managed and growing conditions are good, or that seed with an incubation period of 65 days at planting is not physiologically old (see also van Loon & Houwing, 1981).

Table 1. Incubation period (in days) of seed tubers from November and December planting in 1979, 1980 and 1981 at time of planting the comparative yield trials in November 1980, 1981 and 1982.

Cultivars ¹	Planting date ²		
	November	December	
<i>a. 1979/1980</i>			
Spunta	91 ^b	*	122 ^b
Kennebec	91 ^b		88 ^c
Ballenera MAA	136 ^a		135 ^a
Mean value ³	106		115
			v.c.: 8.31 %
<i>b. 1980/81</i>			
Spunta	110 ^b	*	126 ^b
Kennebec	106 ^b	*	130 ^b
Ballenera MAA	131 ^a	*	143 ^a
Mean value	116	*	133
			v.c.: 13.76 %
<i>c. 1981/82</i>			
Spunta	65 ^b	*	83 ^b
Kennebec	67 ^b	*	78 ^c
Ballenera MAA	83 ^a	*	115 ^a
Mean value	72	*	92
			v.c.: 2.70 %

* Significant difference ($P < 0.01$) between the two planting days – *Signifikantes Unterschied ($P < 0,01$) zwischen den zwei Pflanzterminen* – *Différence significative ($P < 0,01$) entre les deux dates de plantation.*

^{a, b, c} Different letters in a vertical column indicate significant differences at $P < 0.01$ level – *Unterschiedliche Buchstaben in senkrechter Spalte bedeuten signifikante Unterschiede bei $P < 0,01$* – *Les lettres différentes placées en comparaison des colonnes verticales indiquent les différences significatives à $P < 0,01$.*

¹ Sorte – *Variété*; ² Pflanztermin – *Date de plantation*; ³ Mittlerer Wert – *Valeur moyenne*

Tabelle 1. Inkubationsperiode (in Tagen) der Pflanzknollen aus der November- bis Dezemberpflanzung 1979, 1980 und 1981 zur Zeit der Pflanzung der entsprechenden Ertragsversuche im November 1980, 1981 und 1982.

Tableau 1. Durée d'incubation (en jours) des tubercules de semence récoltés en novembre et décembre 1979, 1980 et 1981 et plantés en novembre 1980, 1981 et 1982 dans des essais comparatifs de rendement.

PLANTING DATE, PHYSIOLOGICAL AGE AND YIELD

Table 2. Total tuber yield (t/ha) in the comparative yield trials planted in November 1980, 1981 and 1982.

Year of the comparative yield trial and cultivar ¹	Planting date of the seed used ²		
	November	December	
<i>a. 1980/81</i>			
Spunta	18.13 ^c	16.40 ^b	
Kennebec	12.28 ^b	13.32 ^c	
Ballenera MAA	24.83 ^a	21.10 ^a	
Mean value ³	18.41	16.94	v.c.: 8.5 %
<i>b. 1981/82</i>			
Spunta	8.63 ^a	8.29 ^a	
Kennebec	9.73 ^a	8.87 ^a	
Bellenera MAA	11.76 ^a	12.00 ^a	
Mean value	10.04	9.72	v.c.: 18.5 %
<i>c. 1982/83</i>			
Spunta	29.27 ^b	29.41 ^a	
Kennebec	31.00 ^b	26.41 ^a	
Ballenera MAA	39.00 ^a	33.27 ^a	
Mean value	33.09	29.69	v.c.: 11.26 %

a, b, c Different letters in a vertical column indicate significant differences at $P < 0.05$ level – *Unterschiedliche Buchstaben in senkrechter Spalte bedeuten signifikante Unterschiede bei $P < 0,05$* – *Les lettres différentes placées en comparaison des colonnes verticales indiquent des différences significatives à $P < 0,05$*

¹ *Jahr des vergleichbaren Ertragsversuches und Sorte – Années d'essai comparatif de rendement et variété;* ² *Pflanztermin des verwendeten Saatgutes – Date de plantation de la semence utilisée;* ³ *Mittlerer Wert – Valeur moyenne*

Tabelle 2. Gesamtknollenertrag (t/ha) in vergleichbaren Ertragsversuchen, gepflanzt im November 1980, 1981 und 1982.

Tableau 2. Rendement total en tubercules (t/ha) dans les essais comparatifs de rendement de 1980, 1981 et 1982.

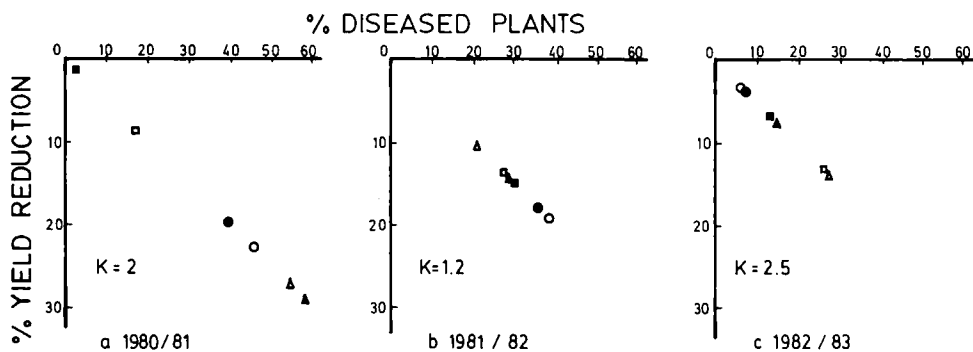
Discussion

In this study the incubation period of seed tubers was used as a measure of physiological age, which, according to Claver (1973, 1975), is adequate for that purpose. Reust & Münster (1975) and Reust (1982) also used it successfully to study the response to ageing and yield of cultivars on the Official Swiss List, reporting reductions in yield of 30% when the storage environment and seed management was not adequate for each cultivar.

Our results did not confirm such relationships. Even when significant differences in physiological age were measured (Table 1b and c), we found no significant effects upon total tuber yield (Table 2b and c). There were genotype differences as found by Reust (1981); seed tubers of cv. Ballenera MAA were always physiologically younger at planting than those of Spunta and Kennebec (Table 1a, b and c).

Seed from the December planting was usually more infected with PLRV and PVY than seed from the November planting, especially the seed from the 1979/80 season which was used for the yield trial in 1980/81. Yield reductions have been calculated

Fig. 2. Calculated yield reductions based on (1) the formulas used by Reestman (1970), (2) estimated crowding coefficients (K) and (3) the actual observed percentage of plants with secondary virus infection.



○ cv. Spunta, △ cv. Kennebec, □ cv. Ballenera MAA; closed symbols: 1st planting date; open symbols: 2nd planting date – geschlossene Symbole: 1. Pflanztermin; offene Symbole: 2. Pflanztermin – symboles pleins: 1ère date de plantation; symboles creux: 2ème date de plantation

Yield reduction – Ertragsreduktion – Réduction de rendement; Diseased plants – Erkrankte Pflanzen – Plants malades

Abb. 2. Kalkulierte Ertragsreduktionen entsprechend (1) der Formel von Reestman (1970), (2) geschätzte Mengenkoeffizienten (K) und (3) der tatsächlich beobachtete Prozentsatz an Pflanzen mit sekundärer Virusinfektion.

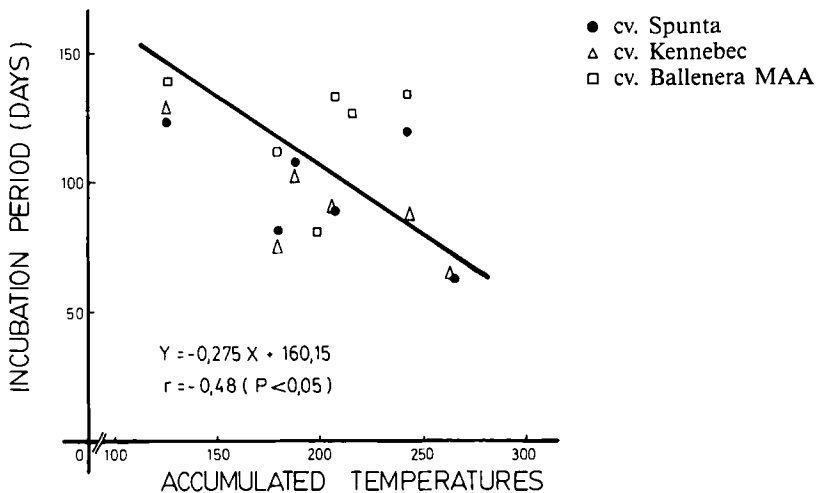
Fig. 2. Réductions de rendement calculées sur la base de (1) la formule utilisée par Reestman (1970), (2) le coefficient multiple (K) et (3) le pourcentage de plants atteints d'infection virale secondaire.

(Fig. 2a, b and c), based on Reestman's (1970) formulas and the estimated crowding coefficients of the crops. From these it can be concluded that it is unlikely that the absence of significant differences could be attributed to virus infection nullifying the effects of physiological age.

Various factors during the growing season interact with the physiological age of the seed tuber to influence yield (Pérennec & Madec, 1980), as is evident from our results in 1982/83. Moreover, the optimum physiological age of the seed tubers should be related to the length of the growing period of the crop grown from that seed (O'Brien et al., 1983). Taken together, these factors may explain why no effect upon yield was found in our experiments, in which per cultivar there was seed of only two physiological ages with only small differences between them.

With respect to temperature effects during tuber growth, numerous authors, as reviewed by Ewing (1981), have established a mean daily optimum temperature of 17 °C for tuber production, for both soil and air temperatures, higher temperatures reducing yields (Gregory, 1965; Slater, 1968). The accumulated day-degrees above a

Fig. 3. Relationship between physiological age (measured by the incubation period) and accumulated day-degrees above 17 °C (daily mean temperature) during the bulking period of the seed crop in 1979/80, 1980/81 and 1981/82.



Incubation period (days) – Inkubationsperiode (Tage) – Période d'incubation (jours); Accumulated temperatures – Akkumulierte Temperaturen – Températures cumulées

Abb. 3. Verhältnis zwischen physiologischem Alter (durch die Inkubationszeit gemessen) und akkumulierten Tagesgraden oberhalb 17 °C (tägliche Durchschnittstemperatur) während der Zeit des Knollenansatzes der Pflanzgutbestände in 1979/80, 1980/81 und 1981/82.

Fig. 3. Relation entre l'âge physiologique (évalué par la durée d'incubation et le cumul jour-degrés au-dessus de la température journalière moyenne 17 °C) durant la période de tubérisation des plants en 1979/80, 1980/81 et 1981/82.

daily mean temperature of 17 °C during the bulking period of the seed crop have been related to physiological age as measured by the incubation period (Fig. 3) and it is clear that daily mean temperature during the bulking period influenced the ageing of the progeny tubers. In agreement with these results, Reust (1982) considered that the incubation period could be used as a guide to crop and storage management for seed tubers.

Then, even when physiological age of seed tubers can be measured by other biological (Hartmans & van Es, 1981; O'Brien & Allen, 1981) or biochemical (Reust, 1982; Sacher & Iritani, 1982; van Es & Hartmans, 1984; Caldiz et al., 1985) methods, until now it has been difficult to express it in terms of potential yield, especially if differences in physiological age are small.

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Zusammenfassung

Einfluss zweier Pflanztermine auf physiologisches Alter und Ertragspotential von in warmer gemässiger Klimazone in Argentinien aufgewachsenen Pflanzkartoffeln

Der Einfluss zweier Pflanztermine auf das physiologische Alter von Pflanzkartoffeln und ihr Ertragspotential wurde während einer Dreijahresperiode an zwei mittelfrühen Sorten, Spunta und Kennebec, und einer mittelspäten Sorte, Bonaerense la Ballenera MAA, in warmer gemässiger Klimazone in Argentinien geprüft. Saatbestände aus November- und Dezemberpflanzungen von 1979, 1980 und 1981 wurden im November 1980, 1981 und 1982 in vergleichenden Ertragsversuchen gepflanzt. Das physiologische Alter der Knollen wurde bei der Pflanzung durch die Inkubationsperiode (Claver, 1973, 1975) gemessen. Abb. 1 zeigt die meteorologischen Daten der vier Vegetationsperioden. Es ergaben sich signifikante Unterschiede im physiologischen Alter zwischen den Sorten und den Pflanzterminen (Tab. 1). Bei Lagerung der Saatkartoffeln in Mieten im Feld beschleunigte sich das physiologische Alter (Tab. 1c).

Die Gesamtknollenerträge schwankten zwischen den Sorten in 1980/81 und 1982/83 (Tab. 2a und 2c), es ergaben sich jedoch keine signifikanten Unterschiede zwischen Pflanzgut der beiden Pflanztermine, obwohl sich zwischen beiden Pflanzterminen Unterschiede im physiologischen Alter ergaben. Der Gesamtknollenertrag war 1982/83 am höchsten (Tab. 2c), obwohl die Pflanzknollen physiologisch die Ältesten waren.

Es ist unwahrscheinlich, dass eine hohe prozentuale Infektionsrate mit PLRV und PVY der Pflanzknollen von Spunta und Kennebec aus der Dezemberpflanzung den Einfluss des physiologischen Alters auf den Ertrag derart überdeckte, dass keine signifikanten Unterschiede mehr gefunden werden konnten (Abb. 2). Weil die Unterschiede im physiologischen Alter innerhalb einer Sorte jedoch klein waren, waren andere ertragsbestimmende Faktoren offensichtlich wichtiger als die Unterschiede im Alter.

Die akkumulierten Tagesgrade über einer täglichen Temperatur von 17 °C während der Periode des Knollenansatzes hatten eine kla-

re Änderung der Inkubationsperiode zur Folge.

Résumé

Effet de deux dates de plantation, sur l'âge physiologique et le rendement potentiel des plants de pomme de terre cultivés en climat tempère chaud de l'Argentine

L'effet de deux dates de plantation sur l'âge physiologique de tubercules de semence et sur leur rendement potentiel a été étudié durant une période de trois années avec deux variétés demi-hâtives, Spunta et Kennebec, et une demi-tardive, Bonaerense la Ballenera MAA, cultivées dans un climat chaud d'Argentine. Les plants récoltés en novembre et décembre des années 1979, 1980 et 1981 ont été plantés en novembre 1980, 1981 et 1982 selon des essais comparables de rendement. L'âge physiologique des tubercules était évalué à la plantation par la période d'incubation (Claver, 1973, 1975). Les relevés météorologiques pour les quatre saisons sont donnés dans la fig. 1. On observait des différences significatives dans l'âge physiologique entre les variétés et les dates de plantation (tabl. 1). Quand les tubercules de semence étaient conservés en silo au champ, l'âge physiologique était avancé (tabl. 1c).

Le rendement total en tubercules était différent entre variétés pour 1980/81 et 1982/83 (tabl. 2a et 2c) mais il n'y avait pas de diffé-

rences significatives entre les plants des deux dates de plantation bien qu'il y ait des différences significatives dans leur âge physiologique. Le rendement total en tubercules était plus élevé en 1982/83 (tabl. 2c) malgré des tubercules de semence physiologiquement plus vieux.

Il est peu probable que le taux important d'infection par les virus de l'enroulement et Y des semences de Spunta et Kennebec observé à la plantation de décembre ait modifié l'effet de l'âge physiologique des plants sur les rendements, ceux-ci ne présentant aucune différence significative (fig. 2). De plus, parce que les différences d'âge physiologique des semences au sein d'une variété sont faibles, d'autres facteurs déterminants que le rendement doivent avoir été plus importants que la différence d'âge.

Le cumul jour-degrés au-dessus de la température journalière de 17 °C durant la période de tubérisation des tubercules de semence modifie sensiblement la durée d'incubation des plants (fig. 3).

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