Effect of physiological age of seed tubers, presprouting and time of nitrogen application on yield of potato

(SOLANUM TUBEROSUM L)

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INTRODUCTION

THE size and type of sprout at planting is largely influenced by the physiological or biochemical state of the seed tuber which is subjected to progressive changes as the chronological age of the tuber advances (Madec, 1955; Madec and Perennec, 1959; 1962). The physiological state of the tuber at any given time can be described as its physiological age, which is illustrated by an increasing amount sprout growth (Krijthe, 1962; Madec and Perennec, 1962). Sprouts from a physiologically old tuber, due to conditions of prolonged storage or high temperature, exhibit appreciable lateral branching owing to the sprout apex becoming necrotic or inactive. The apices of lateral branches may also die; resulting in branch ramification and swollen sprout bases. Sprouts from a physiologically young tuber are usually shorter, showing very little or no branching, at the base, Madec (1958). The physiological age of the seed tuber exerts a marked influence on the growth rate, size and time of maturity of the plant. Tuber initiation and growth are enhanced by increasing the physiological age of the seed tuber (Madec and Perennec, 1959; 1962).

Presprouting of the seed tuber has a marked influence on the growth pattern of the potato, resulting in a reduction of the total vegetative growth period. Consequently, every aspect of the growth cycle, such as emergence, growth and leaf senescence tuber initiation bulking and maturity can be expected to occur much earlier, as opposed to a crop resulting from an unsprouted or minichitted seed.

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For a potato crop grown under short day conditions, rapid foliage and tuber growth are imperative to obtain increased yields, and in this respect, the use of presprouted, physiologically old seed may be useful. Therefore, an experiment was designed to ascertain the influence of presprouted seed with different physiological ages, to study its effects on yield, earliness in maturity and other growth characteristics. Time of application of nitrogen was also incorporated into the investigations to assess its value in relation to the varying growth patterns that could be expected by having seed tubers of different sprout growth and physiological ages.

MATERIALS AND METHODS

The experiment was conducted at the Agricultural Research Station, Sita Eliya, during October 1974—January 1975, following a two-year rotation of grass. The soil was well drained and contained 4.9% organic matter, 0.41% available nitrogen, 110.88 kg/ha P_2O_5 and 0.42 me potassium/100 g of soil. The PH was 4.9.

The climatic data are given in Table 1. In general the crop received sufficient rainfall throughout its growth. Forst occurred about 2½ months after planting with little damage to the crop that was already senescing.

The treatments consisted of 2 seed types (presprouted and minichitted) 2 physiological age classes of seed (young and old) and 3 times of nitrogen application (at planting, early; at tuber initiation, late; and both at planting and initiation, split).

Presprouted seed tubers were obtained by desprouting the tubers to enhance more sprout growth. Subsequently, these tubers were placed in wooden trays and stored in diffused sunlight at a room temperature of 20-22°C for 50 days. This resulted in the appearance of sturdy, dark green sprouts about 2 cm. in length. The minichitted seed was also desprouted and stored in the dark under similar conditions described earlier. This resulted in yellowish white sprouts of about ½ cm. in length, which could easily be broken off.

Seed tubers of variety Arka, harvested on 18 February, 1974 were desprouted twice on 6 June and 6 August ,before the experiment was planted on 18th October to obtain physiologically old seed. (i.e. 8 month old seed tubers). After first desprouting, tubers were trayed and placed in the growth chambers at 44°C till the second desprouting, when they were taken out and kept at a room temperature of 20-22°C till planting. The physiologically young seed of the same variety was four months old at planting. This seed desprouted once, one month prior to planting. Nitrogen was applied at 201 kg/ha as Ammonium sulphate (21% N). Early and later applications received the total dressing of nitrogen and when split 1/3 of the total dressing was applied at planting and the remainder was top dressed at the time of tuber initiation.

All treatments received a basal application of 672 kg/ha of concentrated super phosphate (42% P_2O_5), and 112 kg/ha muriate of potash (60% K_2O). Tamaron was sprayed at weekly intervals at the rate of 28 g/ 15 litres of water for pest control. Antracol at the same rates was sprayed weekly for the control of late blight *Phytophthora infestans*).

The treatments were arranged in randomized blocks, replicated 3 times. Each plot measured 3.05 × 4.88m. (14.9 m^2). The plots were thrown into ridges and furrows at a spacing of 61 cm. from the centre of one furrow to the other. The tubers were planted at a distance of 25.4 cm. apart in the furrow on 18 October, 1974. Each plot had 8 rows of potatoes, with 12 plants per row, giving a total of 96 plants per plot. Sequential sampling was carried out at 15 day intervals commencing 30 days after planting. Only plants in the centre rows were sampled. Sampling was restricted to every alternate plant, leaving two plants within each row as border plants. Two plants per plot were sampled and were separated into tubers, leaves, roots, stem and stolons. Subsequently their dry weights were obtained by drying in and oven at 100°C for 18 hours. Tuber numbers were counted at each harvest and any swollen tip of a stolon was considered a tuber.

The leaf area was estimated by the disk method (Watson and Watson, 1953).

The cross sectional area of the punch was 1.76 cm^2.

RESULTS

Tuber data.—Presprouting increased tuber fresh weight yield at all harvests compared with minchitted seed, the differences being significant at 30, 45 and 90 days after planting (DAP) (Table 2). Presprouted seed increased tuber fresh weight yield at final harvest by 12% over minichitted seed.

Physiologically old seed increased tuber yield in the early stages of growth significantly but the difference at the final harvest (90 DAP) was not significant. Time of nitrogen application had no effect on tuber fresh weight yield up to 30 DAP. In the later harvest, early nitrogen increased tuber yield when compared with both split and late applied nitrogen. The increase due to early applied nitrogen at the final harvest was 9.85% and 32.61% over split and late nitrogen respectively.

Tuber number and size distribution.—At 30 DAP presprouted seed increased tuber number per plant by 155% over minichitted seed. However in the subsequent harvests the differences were not significant (Table 3). Physiologically old seed consistently increased tuber number per plant at all harvests the increase being 67.9% at 75 DAP (P=0.01).

Maximum tuber number per plant was recorded for early applied nitrogen (13.16), followed by split (12.37) and late applied nitrogen (10.41). Times of nitrogen application had no effect on tuber number at final harvest.

At the final harvest tubers were grouped into 3 size grades based on their diameter, viz., chats (25-35 mm.) seed (35-45 mm.) and ware (45-55 mm.).

Sprouting had no significant effect on ware or chat size tubers but increased seedl size tubers by 13.3%over minichitted seed (Table 4).

Physiologically old seed recorded significant increases of 17.4% and 112.2% in seed and chat size tubers. However no significant differecne was recorded in ware size tubers (Table 4).

Ware size tubers were not affected by time of nitrogen application but significant increases of 8.9% and 48.4% in seed size tubers were recorded for early nitrogen, over the split and late applications respectively. Similarly, early nitrogen also recorded significant increases of 21.93% and 74.8% in chat size tubers, when compared to split and late applied nitrogen respectively (Table 4).

Leaf area Index (L).—Presprouting increased L at 30 DAP (72%) over minichitted seed. However, at 60 and 75 DAP minichitted seed recorded significantly greater L compared to presprouted Tubers (Table 5). Both age classes of seed attained maximum L at 75 DAP, with L values of 3.45 and 3.22 for young and old seed respectively. Physiologically young seed increased L at all samplings except 45 DAP when compared with physiologically old seed. The early applied nitrogen consistently increased L over the split or late applied nitrogen except at 30 DAP. For all times of nitrogen application, maximum L was recorded at 75 DAP, with values of 3.72, 3.34 and 2.95, for early, split and late applied nitrogen respectively.

DISCUSSION

Presprouting of potato seed tubers results in a partial displacement of the vegetative period making each phase of the growth cycle namely, pre-emergence growth, tuber initiation and tuber bulking, senescence of foliage and the date of maturity to occur earlier (Toosey, 1963). In the present investigation pre-sprouted seed emerged 5 days earlier, and tuber growth was faster at all stages when compared with minichitted seed. The results are also in agreement with the findings of Beukema (1973). The growth and yield of a potato crop would therefore be influenced not only by the environment (Radley, 1963, Iving and Bremner, 1963) but also by the degree to which the seed tuber is sprouted prior to planting. Therefore for potato crops grown locally under short day conditions, early emergence and rapid foliage development will be a pre-requisite for rapid tuber bulking and high tuber yields. However an interesting feature in leaf development was that although leaf area was high for presprouted seed earlier, the rate of leaf area development was faster for minichitted seed towards the later stages of growth. If the period of growth could be extended for minichitted seed, the presence of a high leaf area in the later growth stages might increase tuber fresh weight yield considerably.

As reported by Madec and Perennce, (1952, 1962) physiologically old seed hastened tuber initiation and increased tuber number per plant during the entire growth period, however leaf area was significantly lower than that of the physiologically young seed, particularly towards the later stages of growth. Physiologically old seed had a significant effect on tuber fresh weight yields until 75 days after planting but the final tuber yield between the physiologically old and young seed was non significant. Leaf area has been reported to be the determinant of yield by many workers (Ivins, Ivins and Bremner. Gunasena and Harris) and the reduction in final tuber yield recorded for physiologically old seed may be due to the insufficient production of assimilates due to the presence of a sub-optimal leaf area index (Radley, 1961). Therefore the use of physiologically old seed has comparatively little advantage to offer as far as final yields are concerned, however it may have some use if early markets could be exploited to fetch high prices or as a means to avoid disease hazards such as late blight to which potato crops are usually exposed, towards the tail end of the growing season.

Later or split nitrogen application failed to induce early tuber initiation as reported by many workers, Bremner and Elsaeed (1963), Gunasena and Harris (1969) and contrary to the results reported by

Gunasena and Harris (1969), leaf area was significantly higher when nitrogen was applied at planting than when applied late or split. As reported earlier by the authors de Vaz and Gunasena (1974), nitrogen applied at planting increased tuber fresh weight yield and was significantly superior to all other times of application and this result agrees with the findings of other workers who reported that there is no advantage in delaying the nitrogen application for potato crops with a short period of maturation (Sawyer and Dallyn, 1958 ; Ing. 1965).

SUMMARY

An experiment was conducted at the Agricultural Research Station, Sita Eliya, to study the effect of sprouting, physiological age of seed tubers and times of nitrogen application on the growth and yield of potato. Presprouting hastened emergence and increased leaf area, resulting in increased tuber fresh weight yields over minichitted seed. Physiologically old seed increased tuber fresh weight yield during the early stages when compared with physiologically young seed, but the differences were not significant at final harvest. Nitrogen applied at planting increased tuber fresh weight yield and was significantly superior to both late and split applied nitrogen.

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Table 1.—Climatic data, Sita Eliya, 1974–75

Period	*Temperature °C*		*Soil Temperature °C (4 inch)*	*Rainfall mm*	*Number of days*
	Min.	*Max.*			
October 1974					
18—31	11.0	20.5	18.2	85.0	3
November 1974					
1—15	10.7	19.6	17.9	183.1	5
16—30	9.6	20.6	17.6	25.4	3
December 1974					
1—15	9.5	19.8	17.3	79.7	6
16—31	10.2	18.2	17.3	253.5	10
January 1975					
1—15	7.9	17.6	16.5	90.6	4

Table 2.—Main effects of treatments on tuber fresh weight, yields, tons/ba

	Days after planting				
	30	45	60	75	90
(*a*) *Seed types*					
Presprouted seed	0.640	7.96	13.41	19.57	30.58
Minichitted seed	0.097	5.18	12.78	19.52	27.3
L.S.D. (P=0.05)	0.261	0.883	NS	NS	2.15
(*b*) *Seed age*					
Physiologically young	0.211	5.53	12.0	12.39	28.57
Physiologically old	0.526	7.60	14.15	20.81	29.33
L.S.D. (P=0.05)	0.261	0.88	1.81	1.77	NS
(*c*) *Times of N Application*					
Early	0.242	7.80	15.87	20.14	32.57
Split	0.537	7.48	12.75	19.37	29.65
Late	0.308	4.44	10.66	19.42	24.56
L.S.D. (P=0.05)	NS	1.08	2.22	NS	2.64
C.V. (%)	10.2	19.5	20.0	13.1	10.7

Table 3.—Main effects of treatments on tuber number per plant

	Days after planting				
	30	45	60	75	90
(a) Seed types					
Presprouted seed	8.75	12.06	10.19	8.03	7.88
Minichitted seed	3.43	10.75	11.28	7.42	7.58
L.S.D. (P=0.05)	3.18	NS	NS	NS	NS
(b) Seed age					
Physiologically young	4.39	10.03	10.00	6.11	6.35
Physiologically old	7.28	12.78	11.47	9.33	9.08
L.S.D. (P=0.05)	NS	1.69	NS	1.11	1.92
(c) Times of nitrogen application					
Early	5.63	13.16	12.25	7.54	9.14
Split	7.08	12.37	9.54	7.58	8.10
Late	5.54	8.66	10.41	8.04	5.93
L.S.D. (P=0.05)	NS	2.07	1.88	NS	2.01
CV (%)	71.34	21.49	20.69	20.80	14.06

Table 4.—Main effects of treatments on different seed sizes at final harvest (1000'/ha)

	Ware size/ha	Seed size/ha	Chat size/ha
(a) Seed types			
Presprouted seed	44	398	233
Minichitted seed	46	351	253
L.S.D. (P=0.05)	N.S.	25	N.S.
(b) Seed age			
Physiologically young	14	344	156
Physiologically old	14	404	331
L.S.D. (P=0.05)	NS	25	20
(c) Times of nitrogen application			
Early	46	434	306
Split	47	398	251
Late	43	292	175
L.S.D. (P=0.05)	NS	32	24
CV (%)	20.07	10.25	11.85

Table 5.—Main effects of treatments on leaf area index

	Days after planting			
	30	45	60	75
(a) Seed types				
Presprouted seed	1.43	2.75	2.56	3.14
Minichitted seed	0.83	2.61	3.16	3.53
L.S.D. (P=0.05)	0.08	NS	0.14	0.13
(b) Seed age				
Physiologically young	1.22	2.62	3.18	3.45
Physiologically old	1.04	2.74	2.54	3.22
L.S.D. (P=0.05)	0.08	NS	0.14	0.13
(c) Times of nitrogen application				
Early	1.30	3.20	3.68	3.72
Split	1.22	2.65	2.66	3.34
Late	0.88	2.19	2.24	2.95
L.S.D. (P=0.05)	0.10	0.17	0.18	0.16
C.V. (%)	10.60	7.48	7.29	5.50