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EFFECT OF AGE OF MOTHER PLANTS ON GROWTH, YIELD AND SENESCENCE OF ROOTED STEM CUTTINGS AND BASIC SEED IN POTATO

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ABSTRACT

Growth and yield of Rooted Stem Cuttings (RSC) of potato are poor in the up country wet zone. Therefore, a study was conducted to determine the effect of mother plants age on the performance of RSCs. RSCs obtained from mother plants with 5 different age groups were tested along with tissue cultured plants of variety Desiree in aphid-proof polytunnels during *yala* 2000 at Agricultural Research Station, Sita Eliya, Sri Lanka. The pre-basic seed tubers harvested from these plants were sprouted under normal storage conditions and the yield was tested under field conditions in the subsequent year during *yala* 2001. The tissue cultured plants and the RSCs obtained from 3 and 6-week-old-mother plants were found to be the best planting material for pre-basic seed production in polytunnels. There was no yield difference between the pre-basic seeds obtained from RSCs and tissue cultured plants planted in the field. Since tissue cultured plants are expensive, RSCs obtained from 3 and 6-weeks-old-mother plants could be used for pre-basic seed production in polytunnesl under up-country wet zone conditions.

KEY WORDS: Potato, Rooted Stem Cuttings, Tissue-Cultured Plants, Pre-Basic Seed, Basic Seed

INTRODUCTION

Potato, (*Solanum tuberosum* L.), is a major world crop, ranking fourth after wheat, rice and maize in production. Potato is originated from Central and South America. It is now grown in temperate and in many tropical and subtropical countries. The major potato production areas in Sri Lanka lie in the up-country wet and intermediate zones while a small area in the northern dry zone. The area under potato cultivation is presently 9,000 ha and the annual seed potato requirement is 22,500 t. The major constraint in potato cultivation is poor seed quality and high seed cost.

Until 1996, Department of Agriculture imported certified seed from Europe and multiplied locally to meet seed requirement partially in the country. The development and application of *in-vitro* plant culture technology to potato propagation enabled rapid multiplication of pathogen free potato plantlets (Uyen and Vander Zaag, 1983; Bryan, 1988; Dodds, 1988; Knutson, 1988).

Tissue culture based pre-basic seed potato production was started to meet the seed requirement at the Government Seed Potato Farm, Sita Eliya in 1996 for the production of quality seeds locally. Under this programme tissue

cultured potato plantlets (mother-plant) established in a rooting media in aphid-proof net-house are rapidly multiplied. Apical cuttings are continuously taken from these mother-plants and rooted in a rooting media. Rooted Stem Cuttings (RSC) planted in the poly tunnels showed uneven growth, suggesting that the age of mother-plant could have influenced the performance of RSCs. However, there is no adequate research data available on the age of mother-plants on growth and yield performance of these RSCs. Therefore, this study was aimed to investigate the effect of age of mother-plants on growth parameters, senescence and yield of RSCs raised in poly tunnel under up-country wet zone (UCWZ) conditions at Sita Eliya. The effect of age of mother-plants on basic seed production in field was also studied.

MATERIALS AND METHODS

Two experiments were conducted at the Agricultural Research Station, Sita Eliya in the UCWZ of Sri Lanka.

Effect of age of mother plant on growth parameters, senescence and yield of rooted stem cutting

Virgin-forest soil and cattle manure were steam treated at 80°C for 3 h and mixed at the ratio of 1:1. Tissue cultured potato plantlets of Desiree, raised for 4-6 weeks in the laboratory was established in this mixture in pots and kept in an aphid-proof net-house at the Agricultural Research Station, Sita Eliya. Mother plants of 3, 6, 9, 12 and 15 weeks were produced by periodical decapitation.

RSCs were produce from different age classes of mother plants and rooted in wooden trays at 2.5 x 5 cm spacing. The soil was prepared to fine tilth and the pH was adjusted to 5.5-6.0 by application of quick lime and mixed with steam sterilized cattle manure at the rate of 1 kg/m^2 on dry weight basis. N, P and K fertilizer was also applied at the rate of 75: 125: 75 kg/ha as N, P_2O_5, K_2O respectively as basal dressing at planting.

The RSCs and tissue cultured *in-vitro* plants were planted in 0.75 x 0.9 m plots in raised beds at 15 x 15 cm spacing with three replicates in a randomized complete block design (RCBD) during *yala* 2000 (April–June) in aphid-proof polytunnel (22 ± 10°C day; 10 ± 4°C night and RH 80-90%). The plots were manually irrigated at 3-d intervals. Top dressing of N and K fertilizer at the rate of 75 kg/ha each was applied at 20-d after planting.

Data were collected from 12 plants avoiding the boarder plants. Plant height was measured from the collar region to apical bud initiation point at 8 weeks after planting. Ground cover by foliage was determined at weekly intervals, starting from second week of planting, using a one-cm^2 wire mesh grid. Number of main stems, *i.e.* shoots bellow the soil surface, was measured

at flowering. Stem thickness was recorded at 10 cm height from six selected plants at 8 weeks after planting. The crop senescence was recorded visually in terms of days when 80% of the canopy became yellowish. Plots were harvested after 14 weeks of planting and the number and weight of tubers in different grades, *viz.* <5 mm, 5-15 mm, 15-25 mm, 25-35 mm and 45-55 mm were recorded.

Performance of pre-basic seed from different age of mother plants in the field

Since, the recommended spacing is available only for 25-55 mm tuber size, this grade was selected for this study. The tubers harvested from all 6 treatments in experiment-1 were separately sprouted under normal storage conditions (12-25°C and 80-90% RH). Sprouted tubers were planted in a RCBD with three replicates in the experimental field at the Agricultural Research Station, Sita Eliya during *yala* 2001 (Feb-May). Each plot comprised 4 rows each containing 10 plants 25cm apart. Fertilizer was applied as in experiment-1. Supplementary irrigation was given as and when required. Recommended schedules of agro chemical sprays for preventing insect and foliar fungal diseases were followed.

Data was collected from 16 plants from the center of each plot. Plant height (cm) and ground cover (%) were measured at flowering. Plots were harvested 14 weeks after planting and number and weight of tubers in three grades, *viz.* <25 mm, 25-55 mm and >55 mm were recorded. The data was analyses using ANOVA and mean separations were done according to Duncan's Multiple Range Test (DMRT) for both experiments.

RESULTS

Effect of age of mother plant on growth parameters, senescence and yield of rooted stem cuttings

Main stem: A significantly maximum number of main stems per plant, 5.8 were observed in tissue cultured plants whereas this number was less than 3 in RSCs of all age groups. However, number of main stems in RSC_s decreased with age of mother-plant (Table 1).

Stem thickness: Tissue cultured plants and RSC_s from 3 and 6-week-old-mother plants had significantly greater stem thickness than the rest of the RSCs. Maximum stem thickness of 10.5 mm was observed in tissue cultured plants. Stem thicknesses of RSCs from 3 and 6-week-old-mother plants were 10.1 and 9.2 mm respectively. The minimum thickness of 6.6 mm was recorded from 15-week-old RSC (Table 1).

Plant height: A significantly high plant height was recorded from tissue cultured plants. Plan heights of RSCs from 3 and 6-week-old-mother plants were 46 and 47 cm respectively. However, plant height of RSCs decreased with the age of mother plant (Table 1).

Time of senescence: Tissue cultured plants and RSCs from 3 and 6-week-old-mother plants had significantly more time to senesce than the RSCs from 9, 12 and 15-week-old-mother plants (Table 1).

Table 1. Number of main stems, stem thickness, plant height at flowering and time of senescence in different treatments[1]

Treatment[2]	*Number of Main Stems/Plant*	*StemThickness (mm)*	*Plant Height (cm)*	*Time of Senescence (d)*
TCP	5.8 a	10.5 a	46 a	85 a
RSC_3	2.8 b	10.1 ab	47 a	86 a
RSC_6	2.7 b	9.2 b	43 b	84 a
RSC_9	2.4 bc	7.8 c	39 c	83 b
RSC_{12}	1.9 bc	7.3 c	38 cd	81 c
RSC_{15}	1.3d	6.6 c	37 d	81 c
CV (%)	12.90	5.05	2.29	15.50

[1]Means followed by the same letter(s) are not significantly different (p-0.05) according to DMRT
[2]TCP - Tissue cultured plants, RSC_3-RSC from 3 week old, RSC_6-RSC from 6 week old, RSC_9-RSC from 9 week old, RSC_{12}-RSC from 12 weeks old and RSC_{15}-RSC from 15 week-old-mother-plants

Ground cover: The significantly high canopy growth was observed in tissue cultured plants. Early cover by foliage was consistently greater in tissue cultured plants and RSCs from 3 and 6 week-old-mother-plants and these plants attained their maximum cover of 100%, 99% and 96% respectively at 5th week after planting. No foliage development was observed 5th week after planting in all the treatments (Table 2).

Table 2. Ground cover (%) achieved by different treatments from 2-6th weeks

Treatmenst	*2nd week*	*3rd week*	*4thweek*	*5th week*	*6th week*
TCP	68 a	79 a	94 a	100 a	100 a
RSC_3	47 b	62 b	87 b	99 a	99 a
RSC_6	33 c	43 c	72 c	96 b	96 b
RSC_9	28 c	42 cd	69 cd	90 c	90 c
RSC_{12}	27 c	38 d	65 d	90 c	90 c
RSC_{15}	26 c	37 d	62 d	85 d	85 d
CV (%)	9.33	4.98	4.71	1.61	1.61

Means followed by the same letter(s) are not significantly different (p-0.05) according to DMRT

Tuber yield: A significantly higher number of tubers per plant and weight per m^2 was recorded from tissue cultured plants. Number of tubers and weight of RSCs from 3 and 6-week-old-mother plants were also higher than the rest of the RSC. Number and weight of all tuber grades decreased in RSC_s with the age of mother plants. However, the weight grades of 15-25, 25-35, 35-45 and

45-55 mm and the tuber number grades of <5, 15-25, 25- 35 and 35-45 were not significant by different (Tables 3 & 4).

Table 3. Tuber weight (kg/m^2) of different tuber grades of RSC obtained from different treatments[1]

Treatment	*< 5 mm*	*5-15 mm*	*15-25 mm*	*25-35 mm*	*35-45 mm*	*45-55 mm*	*Total*
TCP	1.05 a	1.34 a	0.70	0.79	0.44	0.13	4.45 a
RSC_3	0.45 b	0.76 b	0.57	0.83	0.32	0.18	3.11 b
RSC_6	0.34 a	0.29 c	0.50	0.69	0.34	0.10	2.26 bc
RSC_9	0.12 b	0.25 c	0.47	0.59	0.31	0.07	1.81 c
RSC_{12}	0.12 b	0.12 c	0.54	0.79	0.31	0.00	1.88 c
RSC_{15}	0.26 b	0.31 c	0.28	0.63	0.22	0.07	1.77 c
CV (%)	83.5	29.0	43.2 ns	28.5 ns	36.5 ns	67.7 ns	20.4

[1]Means followed by the same letter are not significantly different (p-0.05) according to DMRT
ns - not significant

Table 4. Tuber number (per plant) of different tuber grades of RSC from different treatments[1]

Treatment	*< 5 mm*	*5-15 mm*	*15-25 mm*	*25-35 mm*	*35-45 mm*	*45-55 mm*	*Total*
TCP	1.39	2.53 a	1.34	1.68	0.84	0.25 ab	8.03 a
RSC_3	0.87	1.44 b	1.08	1.30	0.61	0.33 a	5.6 3b
RSC_6	0.64	0.56 c	0.94	1.51	0.64	0.19 abc	4.48 bc
RSC_9	0.38	0.47 c	0.89	1.58	0.58	0.08 bc	3.98 c
RSC_{12}	0.22	0.22 c	1.03	1.50	0.58	0.00 c	3.55 c
RSC_{15}	0.50	0.58 c	0.53	1.19	0.41	0.14 abc	3.35 c
CV (%)	68.8 ns	28.9	42.7 ns	27.5 ns	36.1 ns	61.9	18.5

[1]Means followed by the same letter(s) are not significantly different (p-0.05) according to DMRT
ns - not significant

Performance of pre-basic seed from different age of mother plants in the field

The results are given in the Tables 5, 6 and 7. Analysis of variance showed that there was no significant difference between the treatments in ground cover, emergence, stem density, tuber number and tuber weight. Ground cover was ranged from 93-100% in all six treatments. Similarly the emergence was more than 90% and the stem density was greater than 23.5 per plant (Tables 5, 6 and 7).

Table 5. Ground cover, emergence and stem density of pre-basic seed potato from different treatments[1]

Treatment[2]	*Ground cover (%)*	*Emergence (%)*	*Stem density/m*^{2}
P-TCP	93	92	24.4
P-RSC$_3$	98	90	27.1
P-RSC$_6$	98	95	25.1
P-RSC$_9$	97	91	24.9
P-RSC$_{12}$	100	92	25.5
P-RSC$_{15}$	98	91	23.5
CV (%)	2.80 ns	3.35 ns	3.50 ns

[1]ns-not significant

[2]P-TCP =Pre-basic tuber from tissue cultured plant, P-RSC$_3$ = pre-basic tuber from RSC of 3-week-old, P-RSC$_6$ = pre-basic tuber from RSC of 6-week-old, P-RSC$_9$ = pre-basic tuber from RSC of 9-week-old, P-RSC$_{12}$ = Pre-basic tuber from RSC of 12-week-old and P-RSC$_{15}$ = Pre-basic tuber from RSC of 15-week-old mother plants

Table 6. Average fresh tuber weight (t/ha) in different tuber grades (size) of pre- basic seed potato from different treatments[1]

Treatment[1]	*Fresh Tuber Weight (t/ha)*				
	(a)Large tuber (>55mm)	*(b)Medium tuber (28-55 mm)*	*Marketable tuber (a+b)*	*(c) Small tuber (<28mm)*	*Total tuber (a+b+c)*
P-TCP	4.20	13.96	18.16	0.62	18.78
P-RSC$_3$	3.95	17.66	21.61	1.39	22.00
P-RSC$_6$	2.75	20.70	23.45	1.58	25.03
P-RSC$_9$	2.68	16.64	19.32	0.48	19.80
P-RSC$_{12}$	2.61	15.06	17.67	0.62	18.29
P-RSC$_{15}$	4.40	21.18	25.58	0.89	26.47
CV%	67.81 ns	16.44 ns	20.16 ns	43.13 ns	20.15 ns

[1]ns - not significant

Table 7. Average number of fresh tubers (per plant) in different tuber grades (size) of pre- basic seed potato from different treatments

Treatment[1]	*Fresh Tuber Number (per plant)*				
	(a)Large tuber (>55mm)	*(b)Medium tuber (28-55 mm)*	*Marketable tuber (a+b)*	*(c) Small tuber (<28mm)*	*Total tuber (a+b+c)*
P-TCP	0.24	3.25	3.49	0.92	4.41
P-RSC$_3$	0.29	4.19	4.48	1.42	5.90
P-RSC$_6$	0.21	5.19	5.40	1.69	7.09
P-RSC$_9$	0.23	3.95	4.18	0.79	4.97
P-RSC$_{12}$	0.15	3.37	3.52	1.21	4.73
P-RSC$_{15}$	0.27	4.44	4.71	1.37	6.08
CV%	81.19 ns	22.41 ns	20.48 ns	36.73 ns	20.01 ns

[1]ns - not significant

DISCUSSION

The maximum number of main stems produced by tissue cultured plants could be attributed to the higher number of shoots initiated in tissue cultured plants whereas the RSCs had a single original stem at the stage of planting. Higher tuber yield of tissue cultured plant and RSC_s from 3 and 6-weeks-old-mother plant might be attributed to their higher number of main stems/plant, longer duration of crop in the field and fast canopy growth. Longer duration of crop in the field and faster canopy growth could have probably contributed much to the total tuber weight by facilitating high light interception. Haverkort *et al.* (1991) also reported that the tuber yield increased with increasing photoperiod and light intensities. Similarly, Haverkort & Harris (1987) explained that the dry matter accumulation and its direct relationship to radiation intercepted by potato foliage. It was clear from the results that early foliage development occurs when the RSCs were taken from tissue cultured plant and mother plants from 3 and 6-week-old.

Higher number of main stems of the tissue cultured plant and RSCs from 3 and 6-week-old-mother plant might also be a reason for higher number of tuber produced by these plants. Higher number of tubers recorded is related to the higher number of main stems produced by tissue cultured plant and RSCs from 3 and 6-week-old-mother plants. This is also confirmed by Allen (1978) where he has summarized the consensus of agricultural scientists, that the main stems are the best unit of population in potato production. It is a common observation that the number of tubers increased with the increasing number of main stem in potato (Pozo, 1997).

Though, tissue cultured plant gave better yield, it has several constraints, such as high cost and need of sophisticated laboratory facilities to produce large quantities in any tissue culture production unit. Mahroof (1996) reported that the tissue cultured plants are costly (Rs. 25 –30/plant) whereas the costing RSC is only Rs.1-2/cutting. Therefore, RSCs from 3 and 6-weeks-old-mother plants are the best available source for pre-basic seed production in polytunnels under UCWZ conditions.

CONCLUSIONS

Tissue cultured plants and the RSCs from 3 and 6-week-old-mother plants had thicker and higher number of stems, more crop duration in the field, faster canopy growth and produced maximum tuber in terms of number and weight. As tissue cultured plants are expensive and due to other constraints RSCs obtained from 3 and 6-week-old-mother plants are suitable for pre-basic seed production in polytunnel under UCWZ conditions in Sri Lanka. Though, the tubers obtained from 9, 12 and 15-week-old-mother plants performed equally well to that of 3 and 6-week-old and tissue cultured plants, it is not suitable to use RSCs from 9, 12 and 15-weeks-old-mother plants since their

performance as RSC was inferior to tissue cultured plants and RSCs of 3 and 6-week-old-mother plants in polytunnel under UCWZ conditions

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