Akd. Üniv. Zir. Fak. Derg., 10, 306-311, 1997

POTATO SEED PRODUCTION TECHNIQUES

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Abstract: This paper reviews the different potato seed production techniques used in many countries. There are several ways of seed production methods and each one should have means of preventing many potato diseases. It can be produced from its true seeds in tropical countries because of the warm climate which can cause many diseases. In many countries, the potato is propagated by tubers which have to be proved as disease free in highland areas and commercially be right type. The use of tissue culture techniques for the establishment and multiplication of pathogen tested potato seed stocks is widely accepted.The end products of these techniques are the production of micro and minitubers and their uses as seed tubers will only be feasible when they are produced in disease-free conditions.

Key Words: *Solanum tuberosum* L., micro and minituber, tissue culture

Patates Tohumluğu Üretim Teknikleri

Özet: Bu derleme bir çok ülkede kullanılan patates tohumluğu üretim tekniklerini ortaya koymaktadır. Farklı tohumluk üretim metodları bulunmakta olup her birinin patates hastalıklarını önleyici yöntemlere sahip olması gerekir. Hastalıklara neden olan sıcak iklimden dolayı tropik ülkelerde tohumdan üretim yapılmaktadır. Bir çok ülkede, hastalıklardan ari olarak kabul edilen yüksek yerlerde, tohumluk yumrularla üretilmektedir ve bunlar ticari olarak çeşit karakterlerini taşımalıdır. Hastalık testlerinden geçmiş patates tohumluğu stoklarının çoğaltılması için doku kültürü teknikleri geniş ölçüde uygulanmaktadır. Bu tekniklerin en son ürünleri "micro ve minituber" olup kullanımları ancak hastalıklardan ari şartlarda üretildiklerinde uygunluk kazanmaktadır.

Anahtar Kelimeler: *Solanum tuberosum* L., micro ve minitüber, doku kültürü

INTRODUCTION

The potato (*Solanum tuberosum* L) is a member of *Solanaceae* family. In its native habitat, it is a perennial, cool season crop but susceptible to frost or freezing temperatures. This crop is often referred to as the Irish potato or white potato to differentiate it from sweet potato. *Solanum* contains about 2,000 species of which about 150 are tuber-bearing. These occur in five cytological groups, with somatic

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chromosome numbers of 24, 36, 48, 60, and 72. Cultivated form is tetraploid and about 70 % of all potato species are diploid. Most of these are self-incompatible and are able to produce seeds only when they are pollinated with pollen containing a different S allele (1). Maximum yields require an average growing temperature between 10 and 15 ^{0}C. World production is concentrated in Northern Europe, centered on latitude 50 ^{0}N. From 75 to 85 % of the total dry weight produced by the potato plant is located in the tubers. On a fresh weight basis, starch content is 10 to 25 %, depending on cultivar. In addition to its starch content, the potato serves as a source of moderate levels of protein and minerals in human nutrition (2).

To prepare seed for planting, certified stock is cut into pieces weighing approximately 57 g. This size provides the necessary carbohydrate for aggressive early growth, yet it is not wasteful of seed tubers. Seed pieces substantially lighter than 57 g produce weak plants that are poor competitors. Once cut, the exposed surface of the seed piece suberizes, forming a corky protective layer important in reducing decay. Temperatures of 10-13 ^{0}C with high relative humidity (95 %) generally favor suberization, and these conditions may occur naturally in soil in favorable years. Normally, however growers precut and store seed pieces for 7 to 10 days to allow suberization to occur.

Traditional methods of vegetative potato tuber seed increase are based on a low multiplication ratio that varies from 1:3 to 1:15 and this ratio depends on variety and agronomic practices. When low multiplication ratio is compared to other field crops, it is considered to be low.

Multiplication techniques

There are number of techniques used to produce healthy potato seeds and these techniques are being used both by developed and developing countries in present time.

A- True seed

The potato is a tetraploid and some sterility exists among cultivars. Fully fertile cultivars flower and set fruit (seed balls) that resemble wild-type tomatoes. In only one instance has true seed been used to propagate potato commercially (Explorer), but seed propagation may have promise in tropical developing countries where maintenance of disease free vegetative seed is a problem. Seed propagation normally results in extensive variation and all instances will result in tubers of less than commercial size. This leads to unstable production. Pollination is most successful in the morning soon after the flowers are fully open

B-Clone

The traditional method of propagating the potato is by producing daughter tubers. In many countries, healthy seed is produced by repeatedly propagating a sample of tubers which have been proved to be completely free of pathogens and the right type. This system is called clonal selection. It is very laborious, expensive and time consuming. It

requires extensive control and has a low rate of multiplication. Because of this low rate of multiplication, it takes many years of field multiplication to build up a population. As a vegetatively propagated crop, the potato is prone to accumulative infection by bacteria, fungi and viruses. Especially, any portion of a field entered for certification which is within 200 feet of potatoes showing a total of more than ten percent virus disease will be rejected. Ring rot found at any time in bin or graded stock will causes rejection for certification (3). These infections can have a dramatic effect on yield and quality of the crop. Therefore, the application of tissue culture and rapid multiplication techniques in potato seed programmes became widespread in both developed and developing countries.

The potato seeds are distributed by private companies in Turkey. The parent nuclear stocks of these clones or seed tubers are imported from abroad and multiplied in high land areas such as Bolu, Niğde and Nevşehir. The certified seeds obtained from these production areas are distributed throughout Turkey and is still considered in not enough amount.

C-Microtuber production

Microtubers can be produced in many different ways. Nodal cuttings can be used to produce in vitro plantlets and rapid multiplication can be done until a large stock is available. Instead of transferring these plantlets to a normalization medium and subsequently to non-aseptic conditions, the plantlets can be transferred to a shoot culture medium after removal of roots and apex. The axillary buds of the stem pieces then start to develop and per flask many shoots are available. The tuberization can be induced by changing the medium or by adding growth substances to the existing medium. Among the growth regulators that affect in vitro tuberization, cytokinins have been found to be essential for tuber initiation. Some authors suggest that a specific tuber forming substance is responsible for the tuberization process and that this substance is like cytokinin-like in nature. BAP at a concentration of 0.25 to 10 mg/l can easily induce in vitro tubers in different genotypes as revealed by various authors. whilst kinetin has the same effect at concentration from 2.5 to 5 mg/l (4, 5)

Gibberellic acid has been reported to inhibit the tuberization process. This inhibition can be overcome by the addition of CCC to the medium. When included in MS medium at a concentration of 500 mg/l of BAP and 8 % sucrose, CCC can induce tubers in a broad range of potato genotypes within a period of 4 weeks (6). Some of the media used at Cornell University for microtuber production is as follows:

	1	2	3
Thiamine	1.0 ml	-	-
MS salts	4.3 g	4.3 g	4.3 g
Inositol	0.1 g	0.1 g	0.1 g
Sucrose	80.0 g	60.0 g	80.0 g
$NaH_2PO_4H_2O$	0.17 g	-	-
BAP	0.002 g	0.002 g	0.002 g
Agar	8.0 g	8.0 g	8.0 g

Ca pantothenic	-	0.1 ml	0.1 ml
Vitamin stock	-	0.1 ml	0.1 ml
CCC	-	-	0.5 g

Crucial factors during this tuberization period are:

a) The sugar concentration in the medium (8 % is optimal)

b) The presence of growth regulators, often cytokinin and chlornequat are added.

c) The nitrogen content. There is also a clear interaction between sugar concentration and nitrogen concentration.

d) The temperature. Incubation at 18-20 ^{0}C is preferred.

e) The light conditions. Incubation can occur in the dark or at low light intensities (100-500 lux) with a period of 8 h.

After 4 to 6 weeks small tubers (microtubers) can be harvested. These tubers have a rather low dry-matter concentration and are very dormant. They must be stored for quite some time before they can be used (7).

The tuber dormancy is related to the hormanal balance within the tuber. Thus, different methods of in vitro tuber induction play a regulatory role in containing in vitro tuber dormancy. The germination problem is related to tuber dormancy. Typically, the dormancy for microtubers seemed to be longer and more difficult to break than for field or greenhouse produced tubers. In addition, cold storage (e.g. 4 ^{0}C) will also enhance dormancy. Heat and chemicals are usually used to break dormancy. One of the treatments used is to hold the microtubres at 26 ^{0}C (25-27 ^{0}C range) for one week and then dip the microtubers in gibberellic acid (GA_3, 1 ppm) for 30 seconds. Tween-20 at 0.1 % to the GA_3 as a surfectant can be added. One key will be avoid desiccation while holding microtubers (relative humidity should be around 90 % at all times. Most of the varieties will normally pass through dormancy in 3-4 months. The pathogen free small tubers may produce crops of a very high health standard.

D- Minituber Production

Minitubers can be produced in many different ways:

a) Sprout cuttings: Sprouts are removed from selected tubers. The sprout is then cut into pieces with one or more nodes on each. These are rooted in fine sand and can be transplanted directly to the field or to pots in greenhouse. The number of sprout cuttings can be increased by stimulating the growth of lateral sprouts (8). They can be dip into a solution containing giberellic acid (1 to 2 ppm) in order to fasten rooting. Roots normally form and the axillary bud develops into aerial shoot within 10 to 15 days. These can be transplanted directly to the field or used as new mother plants for further increase. Non-systemic diseases and pests may be eliminated by this method if precautions are taken to avoid contamination. Each single node cutting may yield up to 500 g of normal tubers after transplanting to the field.

b) By using in vitro techniques, nodal

multiplication can be done in more aseptic conditions. To set up cultures, tuber sprouts (grown in dark) are surface sterilised in 2.5 % Deosan for 15 minutes and rinsed with sterile water before excision of the axillary buds which are planted into nutrient medium. Every 4-6 weeks the resulting microplants are sub-divided into nodal segments and transferred to fresh medium until required multiplication is reached. The growth medium used for culture work is that of Murashige and Skoog without growth regulators (M&S) but with additions of 30 g/l sucrose and 5-8 g/l Agar (9). The lowest concentration is used only for the final rooting in petri dishes. Cultures are incubated at 18-20 ^{0}C, 16 h photoperiod (cool-white fluorescent tubes). At the final multiplication the nodal segments are rooted in petri dishes then transferred in greenhouse. After 2-3 weeks they are planted into 9" pots where they are grown for further visual checks and pathogen tests. Depending on the ratio between costs of in vitro plantlets, labour and greenhouse space, the economically optimum density is in the range of 100-400 plants per m^2. Four weeks after planting, the plants are lifted and the first tubers are removed (10, 11). Even though the number of harvestable tubers may be very low, this step is crucial to obtain a high rate of multiplication.Tubers are harvested for distrubition to approved growers.

CONCLUSION

Potato is one of the most economically important crop plant in the world. Varieties must meet the approval of the certifying agency to be eligible for certification. True seeds are used for production in tropical countries where many diseases could occur in seed tubers. Since the production is done by true seeds heterogeneity could be seen in terms of yield and quality. The majority of potato is being grown from seed tubers in the world and these tubers should meet certification conditions. In vitro cultures free from bacteria, fungi and viruses are used for micro-propagation of large quantities of disease free plants. Disease free plants are high yielding and produce tubers of better marketable quality and resulting higher price.

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