

The Effect of Growth Medium and Nodes Number on the Acclimatization Success of Tissue Propagated Potatoes Seedlings *Solanum tuberosum*

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Abstract: The experiment was conducted at the period from 20th Dec. 2015 to 30th Mar. 2016 to know the effect of growth medium and nodes number on the acclimatization success of tissue propagated potatoes seedlings (Burrin class) and study some plant physiological properties. The first experiment involved testing growth media: loam, peat moss, and perlite with different portions (1:1) to plant tissue propagated potato tubers, while the second experiment involved testing the nodes number where 9, 8, 7, 6, and 5 plant nodes were chosen. Results of the first experiment showed the superiority of the culture media of peat moss + perlite to other culture media by giving the higher values of shoot system studied properties: plant height, branches number, leaves number, fresh weight, and dry weight of 15 cm, 2.33 branches, 14.66 leaves, 0.840 g, 0.082 g, respectively, and root system: root length, tubers number, fresh weight, and dry weight of 13.33 cm, 14.33 roots, 3.66 tubers, 0.660 g, and 0.068 g, respectively. The results of second experiment showed the superiority of the 9 nodes to other nodes number by giving the higher values of the studied properties (in the first experiment) for the shoot system of 17.33 cm, 4.33 branches, 15.33 leaves, 0.860 g, and 0.078 g, respectively, while for the root system of 12.33 cm, 8.00 roots, 3.66 tubers, 0.610 g, and 0.072 g, respectively. A conclusion can be drawn that the best growth medium to acclimate potato seedlings was loam + perlite and the 9 nodes was the best number due to their significant superiority compared with others.

Keywords: Growth medium, nodes number, potato seedlings

1. Introduction

Potato *Solanum tuberosum* is one of the *Solanaceae* [1], which includes tomatoes, peppers, and eggplants. The family comprising about 90 genera and 2000 species. *Solanum* is the most important and largest species of the family [2]. South America is the original habitat of potato and it is transported to Europe and the other countries of the world.

Potato is one of the main food crops due to its abundance, nutritional value, low production costs and the diversity of the environmental conditions in which it grows as well as it is an important source of energy where each 100 g of tubers contains about 79.8 g of water, also it contains a high percentage of minerals such as calcium, phosphorus, iron, sodium, potassium and manganese as well as a range of vitamins, such as A, C, B1 and B2 [3]. Potato, after maize, wheat and rice, is of economic importance and food consumption, particularly in European countries [4], the global potato production in 2015 was expected to reach 354 million tons due to increasing the interest in potato cultivation in the last two decades [5]. Potato can be reproduced in several ways, including seed, which is not preferred because the potato is heterozygous which causes a significant variation in tubers resulting from genetic isolation [6], the other method is vegetative reproduction using tubers (swollen stems growing under the surface of the soil called stolon). At present, the technique of tissue culture (off-body agriculture) has been adopted, which is the best way to produce high-grade tubers of the potato crop in most parts of the world to ensure producing good quality tubers and high productivity and free of pathogens [7].

The acclimatization is one of the important stages of plant tissue culture, where the failure or success of the reproduction program is determined. Burrin is a late species

that is known for its yield quality, abundance, strong vegetative growth, large size tuber, and cultivated in both spring and autumn (Ministry of Agriculture publication).

The present study aimed to find the best types of growth medium for potato acclimatization, to know the effect of the best nodes number on acclimated potato properties.

2. Materials and Methods

The experiment was conducted in the greenhouse of Green Life Ltd Co. for tissue planting in Baghdad from 20th Dec. 2015 to 30th Mar. 2016.

2.1 First experiment: Growth medium

The plants were acclimated according to the method of [8] where the plants, resulted from tissue planting, were taken at rooting stage and the plants with good and homogenous root and shoot systems, in terms of growth and size, were chosen and washed with desterilized water with taking into account that the root mustn't be cut. The seedlings were treated with Beltanol (fungicide) with concentration of 1 ml.L⁻¹ for 1 minute to control fungi growth. The seedlings were planted in 10 cm in diameter pots containing different mixture of growth media: loam, peat moss, loam + peat moss, loam + Perlite, and peat moss + perlite as 1:1 with three replicates for each treatment, then the seedlings were put into plastic covered tunnel made of polyethylene and regularly watered with desterilized water according to plant need, then the plastic cover was gradually removed to be removed finally after 4 weeks of planting, the experiment measurements were recorded.

2.2 Second Experiment

The good seedlings, resulted from tissue planting at rooting stage, were selected according nodes number where the plants with 5, 6, 7, 8, and 9 nodes were chosen and distributed into the best growth medium resulted from the first experiment (peat moss + perlite) with three replicates for each treatment then planted into the greenhouse for 4 weeks and the following measurements were recorded for the shoot system:

- 1) Plant height (cm): was measured using graduate ruler from the plant contact area with the soil to the end of growing top of the main stem.
- 2) The branch number of shoot system for each plant.
- 3) Leaves number for each plant.
- 4) Fresh weight (g): was measured by using electronic sensitive balance.
- 5) Dry weight (g): was measured after putting the plants into oven under 70°C until the weight stabilized.

For the root system:

- 1) Root length (g): was measured from the contact area with the stem to the growing top of the root.
- 2) The root number for each plant.
- 3) The number of the fine tubers: was measured for each plant of the three replicates according to the following equation:

$$\text{Average of Tubers Number} = \frac{\text{Tubers No}}{\text{Plants No}}$$

- 4) Fresh weight (g).
- 5) Dry weight (g).

Statistically, data was analyzed using SAS [9] and the averages were compared for Least Significant Differences (LSD) at 0.05 [10].

3. Results and Discussion

The results in table 1 showed the effect of growth medium on some shoot system properties and there were significant differences in the plant height, the loam + perlite and peat moss + perlite treatments had a superiority by giving a higher rate of 15.66 cm for both treatments, compared to other treatments, while the peat moss treatment gave a lower rate of 10.33 cm. About the number of branches, the loam + perlite and peat moss + perlite treatments gave a higher rate of branches number of 3.00 and 2.33, respectively, while the peat moss treatment gave a lower rate of 1.33 which had no significant difference to the other treatments, loam and loam + peat moss. The loam + perlite treatment gave a higher rate of leaves number of 14.66 leaves, while the peat moss treatment gave a lower rate of 10.33 leaves.

The results in table 2 showed the effect of growth medium on some root system physiological properties. The higher rate of root length was 13.33 cm at peat moss + perlite treatment, while the lower rate of 7.33 was at the loam treatment. The treatment peat moss + perlite gave a significant superiority of roots number of 14.66, while the loam treatment gave a lower of 9.33.

About the tubers number, the peat moss + perlite treatment gave a higher 3.33 tubers, while both loam and peat moss treatments gave a lower root number of 1.33 for each.

The growth medium had a significant effect on the dry and fresh weight for all treatments, in which the peat moss + loam treatment gave a higher fresh weight of 0.660 and dry weight of 0.068 g, while the peat moss treatment gave a lower fresh and dry weight of 0.230 and 0.025 g, respectively.

The results of the previous two tables (1 and 2) indicated that there was a significant effect of the components of the growth medium on the acclimatization success through affecting on some physiological and morphological properties, the acclimatization stage is an important and critical stage at the plants accurate propagation which attributed to that the plants that planted outside the body characterized by the presence of the fine layer of cuticle and their stomata differed to those planted into the greenhouse and field, while some tissue plants contain deformed stomata [11], thus it led to decreasing survival rate at transporting to the greenhouse [12]. However, the ability of plant to photosynthesis and water tension the main reasons of decreasing survival rates [13].

The study conducted by [14] found that Changes occur at this stage, in which the thickness of cuticle layer and increasing the dry matter in the leaves as well as increasing carbohydrates and amino acids. The method of [8] used in the process of acclimatization has shown the need to raise the level of moisture in the growth medium and around the plant by providing a medium with light soil, which contributed to the success of acclimatization and increasing growth, where the process of photosynthesis begins after transferring plants to the soil for a short period to be self-dependent [15].

The study of [16] indicated that the best medium for acclimatization of *Fragaria* was in the sand - peat moss 1: 1 due to the absorption of nutrients in the growth medium had an important role in the efficiency of photosynthesis, food production, and division of cells thus increasing the weight. The results showed the superiority of the peat moss + perlite treatment compared with others due to well retention of required moisture by the peat moss medium and the perlite acting as providing the necessary aeration to the roots, which facilitates soil penetration and the formation of a large root system, and this agreed with [17]. As well as the medium of peat moss had a high content of nutrients that important for the growth of the plant compared to the loam only, and this agreed with [18]. In a study on *Fragaria* plants, [19] found that the success of acclimatization was in the peat moss - soil medium 1:1.

About the effect of the number of plant nodes on some physiological characteristics of the shoot system, the results in table 3 showed that the treatments with 9 nodes had a superiority in the plant height, compared with the others, which gave a higher rate of 17.33 cm, compared with 5 nodes that gave a lower rate of 10.33 cm.

Also, the results showed that a higher rate of plant branches number was at the 9 nodes treatment which gave 4.33 branches which significantly had a superiority compared to the others, while the lower branches number was at the 5 nodes treatment. The 8 and 9 nodes treatment had a superiority to give a high rate of leaves number of 15.33 leaves for both treatments, while the 5 nodes treatment gave a lower rate of 8.66 leaves.

The number of nodes had a significant effect on all the treatments. The fresh and dry weight increased by increasing the number of nodes. The 9 nodes treatment had superiority and gave a higher rate of 0.86 g as a fresh weight and 0.078 g as a dry weight, while the 5 nodes treatment gave a lower rate of 0.380 g as a fresh and 0.041 g as a dry weight.

The results in Table 4 showed that the number of nodes had no significant effect on root length. The number of roots increased significantly at the 8 nodes treatment of 8.66 roots, while the lower rate was at the 5 nodes treatment of 6.66 roots. No significant differences were observed in the number of the fine tubers for the 8 and 9 nodes treatments, which gave a rate of 3.67 tubers which had a superiority compared to the others, while the lower rate of tubers was at the 5 and 6 nodes treatments of 2.33 tubers for both treatments. About the fresh and dry weight of the root system, they increased significantly for all treatments with increasing the number of nodes. The 9 nodes treatment gave a higher rate of 0.610 g as a fresh and 0.071 g as a dry weight, while the lower rate was at the 5 nodes treatment of 0.160 g as a fresh and 0.021 as a dry weight.

Through the tables 3 and 4, the positive effect of the nodes on plant growth, where their increment led to a significant effect on all studied properties due to it considered as a center of Auxins, Gibberellins, and cytokines synthesis. Cytokines have an active role in stimulating the growth and opening of axillary buds, leading to increasing the number of branches and the promotion of protein synthesis, The stolens ends also contain high levels of Cytokines, Auxins, and other hormones [21], making it a sink attraction for nutrients that affecting significantly on growth [22]. Cytokines have an important role to play in breaking the top of side branches thus increasing the number of Stolens leading to an increment in the plant weight [23], which assisting to increase the response of the vegetative part to the nutrients and thus increase the opening of axillary buds, growth of branches and leaves [24], and assisting cytokinein to prevent oxidation due to containing defense materials for the oxidation of chlorophyll and this led to a significant increase in fresh and dry weight of the root system [25, 26]. As well as its effective role in the transporting process of minerals that necessary into plant [27], [28] confirmed that the increase in the number of nodes led to a significant increase in growth by increasing the content of cytokines, especially the hormone BA, which activates the formation of tubers and the cytokines have an important role in stimulating the cells to divide and grow and increase the rate of amino acids production and protein synthesis [29]. The study of [30] about the effect of cytokines on the production of potato tubers, they have stimulated the growth, increasing the number, diameter, and fresh and dry weight. Auxins have an effect on the elasticity of plant cell walls, causing their

elongation and amplification due to the activity of certain enzymes responsible for cellular cell elasticity and increased permeability [31]. Gibberellins have an active role in influencing elongation of the parasites and stimulating growth and other physiological effects through their role in cell wall relaxation [32]. Gibbrolins act to stimulate the elongation and expansion of cells and help to stimulate cell division in the macrophytes and macrophages and stimulate the growth and expansion of cells because of their influence in enzymatic activity and activation of metabolism, which led to an increase in carbohydrates [33], and has an important role in reducing the effectiveness of the enzyme IAAoxidase inhibitor of Auxins [34].

Table 1: The effect of growth medium on some shoot system properties of Burrin class seedlings

Growth Medium	Height cm	Branches No	Leaves No	Fresh Weight g	Dry Weight g
Loam	11.33	1.66	10.66	0.620	0.065
Peat moss	10.33	1.33	10.33	0.470	10.04
Loam+Peat moss	14.33	1.66	11.00	0.660	0.071
Loam + Perlite	14.66	3.00	13.33	0.770	0.075
Peat moss+Perlite	15.00	2.33	14.66	0.840	0.082
LSD	1.140	0.688	1.166	0.039	0.00276

Table 2: The effect of growth medium on some root system properties of Burrin class seedlings

Growth Medium	Root Length cm	Roots No	Tubers No	Fresh Weight g	Dry Weight g
Loam	7.33	9.33	1.33	0.270	10.03
Peat moss	8.33	10.33	1.33	0.230	0.025
Loam+Peat moss	8.66	11.66	2.33	0.530	0.035
Loam + Perlite	12.33	12.33	3.33	0.600	0.064
Peat moss+Perlite	13.33	14.33	3.66	0.660	0.068
LSD	0.486	0.595	0.486	0.023	0.003

Table 3: The effect of nodes number on some shoot system properties of Burrin class seedlings

Nodes No	Height cm	Branches No	Leaves No	Fresh Weight g	Dry Weight g
5	10.33	2.33	8.66	0.380	0.041
6	12.00	3.33	10.33	0.480	0.051
7	12.00	2.66	11.66	0.660	0.071
8	14.00	3.00	15.33	0.760	0.075
9	17.33	4.33	15.33	0.860	0.078
LSD	0.595	0.643	0.595	0.01114	0.00103

Table 4: The effect of nodes number on some root system properties of Burrin class seedlings

Nodes No.	Root Length cm	Roots No	Tubers No	Fresh Weight g	Dry Weight g
5	10.66	6.66	2.33	0.160	0.021
6	12.33	7.66	2.33	0.240	0.022
7	11.66	7.66	3.33	0.350	0.041
8	11.33	8.66	3.66	0.460	0.061
9	12.33	8.00	3.66	0.610	0.072
LSD	NS	0.486	0.595	0.032	0.002

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