BRIEF COMMUNICATION

# Effect of potassium on potato microtuber production *in vitro*

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## Abstract

The role of potassium nutrition in microtuber production was investigated in two potato cultivars belonging to different maturity groups. Alterations were made in Murashige and Skoog (MS) medium to obtain seven concentrations of potassium (10, 15, 20, 25, 30, 35 and 40 mM), and their effects were studied on microtuber number, microtuber mass and harvest index. In late cultivar Kufri Sindhuri, an increase in potassium concentration beyond 25 mM decreased the number of microtubers. Whereas, potassium did not show any inhibitory effect on microtuber number in early cultivar Kufri Ashoka. Potassium showed promoting effect on microtuber mass in both the cultivars. Maximum microtuber mass and harvest index were observed when the medium was supplemented with 40 mM potassium. Therefore, large size potato microtubers amenable to direct field planting can be induced in MS medium containing 40 mM potassium.

*Additional key words*: micropropagation, mineral nutrition, *Solanum tuberosum* L.

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The potato (*Solanum tuberosum* L.) plant tuberizes *in vitro* as a result of the changing balance of endogenous growth regulators brought about by manipulating the chemical and physical culture conditions. Combined with meristem culture, this technology has been used for disease-free seed potato production in many countries (Wang and Hu 1982, Estrada *et al.* 1986). However, one of the major limitations of the technology is the small size of the microtubers. Small microtubers are more vulnerable to storage damage (Naik and Sarkar 1997), and difficult for direct field

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planting (Jones 1988). Several substances, preferably growth regulators have been investigated to increase microtuber size (Palmer and Smith 1969, Pelacho and Mingo-Castel 1991, Chandra *et al.* 1992). However, except for nitrogen (Wang and Hu 1985, Garner and Blake 1989), little attention has been paid to mineral nutrition. Tuberization in potato plants *in vivo* is affected by a number of mineral elements; notably potassium which increases tuber yields by improving the size of tubers (Sharma and Arora 1987). The present study was undertaken to determine if potassium nutrition affects microtuber production during cytokinin-induced *in vitro* tuberization in potato.

The experiment was carried out with two potato cultivars: Kufri Ashoka (early cultivar) which produces small number of large microtubers, and Kufri Sindhuri (late cultivar) which produces many small microtubers. These two cultivars were selected due to the microtuber size differences.

Test tube plantlets of these cultivars were obtained from the pathogen tested *in vitro* collection of the Central Potato Research Institute, Shimla (India). These plantlets were multiplied and maintained *in vitro* as described earlier (Sarkar *et al.* 1997). The experiment was carried out with subcultured nodal explants (7 - 8 nodes) in 25 × 150 mm culture tubes containing 10 $cm^3$ of microtuber induction medium [MS (Murashige and Skoog 1962) medium supplemented with 8 % saccharose and 44.38 μM BA]. Alterations in MS macronutrients were made to obtain seven different concentrations of total potassium (10, 15, 20, 25, 30, 35, and 40 mM) while keeping the concentrations of other macronutrients constant (Table 1). The culture tubes were closed with polypropylene closures and incubated in the dark at 20 °C. After 60 d, number of microtubers per g of biomass, average microtuber mass and harvest index, *i.e.* the ratio of microtuber yield to total biomass were recorded. The experiment was conducted in a factorial completely randomized design (7 × 2) with five replications, and repeated twice. Each replication was comprised of 5 culture tubes. Data were pooled over experiments, and analyses of variance and correlations were computed following Gomez and Gomez (1984).

Table 1. Media composition in potassium nutrition experiment.

| Salts [mg $dm^{-3}$][a] | Potassium concentration [mM] | | | | | | |
|---|---|---|---|---|---|---|---|
| | 10 | 15 | 20[b] | 25 | 30 | 35 | 40 |
| $KNO_3$ | 884 | 1390 | 1900 | 1900 | 1900 | 1900 | 1900 |
| $Ca(NO_3)_2 . 4H_2O$ | 707 | 595 | - | - | - | - | - |
| $NaNO_3$ | 344 | - | - | - | - | - | - |
| $CaCl_2 . 2H_2O$ | - | 70 | 440 | 440 | 440 | 440 | 440 |
| $K_2SO_4$ | - | - | - | 216 | 434 | 652 | 870 |
| KCl | - | - | - | 185 | 371 | 558 | 744 |

[a] - other nutrients are as in Murashige and Skoog (1962) medium, [b] - MS basal salt mixture

The early cultivar (Kufri Ashoka) produced 3 - 5 large microtubers, whereas the maincrop cultivar (Kufri Sindhuri) produced 7 - 12 small microtubers per g of biomass

(Table 2). In Kufri Sindhuri, microtuber number declined significantly with increasing potassium concentration beyond 25 mM. In contrast, potassium did not show any inhibitory effect on microtuber number in Kufri Ashoka. Our result is consistent with the normal effect of potassium in the field where it decreases the tuber number in cultivars which produce small size tubers (Sharma and Arora 1987). Potassium showed promoting effect on microtuber mass in both the cultivars: in Kufri Sindhuri, microtuber mass did not increase up to 35 mM concentration, and increased significantly at 40 mM, and microtuber mass increased significantly at 25 mM and higher potassium concentration in Kufri Ashoka (Table 2). This pattern is in agreement with the normal behaviour of these cultivars in the field where rapid-bulking early cultivars producing large size tubers are more responsive to potassium than late ones producing predominantly small size tubers (Sharma and Sharma 1990). Harvest index measured the extent of partitioning of biomass into microtubers. The promoting effect of potassium on harvest index was observed in both the genotypes (Table 2). At potassium concentration 40 mM, the harvest index 0.465 was observed in Kufri Sindhuri, whereas it was 0.676 in Kufri Ashoka. Higher harvest index in Kufri Ashoka was due to higher microtuber size.

Table 2. Effect of potassium on microtuber production in two potato genotypes.

| Potassium [mM] | Kufri Sindhuri microtuber number [$g^{-1}$(biomass)] | microtuber mass [mg] | harvest index [g(tubers) $g^{-1}$(biomass)] | Kufri Ashoka microtuber number [$g^{-1}$(biomass)] | microtuber mass [mg] | harvest index [g(tubers) $g^{-1}$(biomass)] |
|---|---|---|---|---|---|---|
| 10 | 11.5 | 26.2 | 0.297 | 4.5 | 97.8 | 0.429 |
| 15 | 10.5 | 27.6 | 0.283 | 4.3 | 101.3 | 0.438 |
| 20 | 10.4 | 30.4 | 0.312 | 4.8 | 112.9 | 0.519 |
| 25 | 10.6 | 26.5 | 0.275 | 3.7 | 136.4 | 0.505 |
| 30 | 8.2 | 25.5 | 0.206 | 4.1 | 126.8 | 0.513 |
| 35 | 7.9 | 23.8 | 0.192 | 4.3 | 151.5 | 0.635 |
| 40 | 7.7 | 59.7 | 0.465 | 3.3 | 211.5 | 0.676 |
| $LSD_{0.05}$ | 1.5 | 24.9 | 0.144 | 1.5 | 24.9 | 0.144 |

The analyses of variance showed that potassium had significant effects on all the microtuber characteristics studied. The differences among genotypes were also statistically significant for all these characters. Genotype × potassium interaction was significant for number of microtubers per g biomass and average microtuber mass. This suggested that the effect of potassium on number of microtubers per g biomass and average microtuber mass was not consistent over the two genotypes tested. However, no genotype × potassium interaction was observed for harvest index, indicating that the genotypes had similar response to potassium nutrition in respect of this character.

During microtuber production reserves from plantlets are partitioned into microtubers. Therefore, the initial availability of reserves in the plantlets determines the production potential of microtubers *in vitro* (Garner and Blake 1989). In the present study, healthy and vital plantlets of cv. Kufri Ashoka having more reserves produced bigger microtubers than weak plantlets of cv. Kufri Sindhuri with less available reserves.

Correlation was studied to establish relationship between potassium nutrition and microtuber characteristics. In cv. Kufri Sindhuri, potassium nutrition correlated negatively with microtuber number ($r$ = -0.93**), and did not correlate significantly with average microtuber mass and harvest index. On the contrary, no significant correlation was observed between potassium nutrition and microtuber number in cv. Kufri Ashoka. Potassium correlated positively with average microtuber mass ($r$ = 0.90**) and harvest index ($r$ = 0.93**) in cv. Kufri Ashoka. The results further showed that there was significant negative correlation between microtuber number and average microtuber mass ($r$ = 0.81*) in cv. Kufri Ashoka. In both cultivars, significant positive correlation was observed between average microtuber mass and harvest index. The differential relationship between potassium nutrition and microtuber characteristics in two cultivars may be due to their different maturity levels and varied response to microtuber production *in vitro*. The late cultivar Kufri Sindhuri produces more number of small microtubers; as a result, the effect of potassium was more prominent on microtuber number than on microtuber size *vis-a-vis* average microtuber mass. Similarly, the early cultivar Kufri Ashoka produces fewer number of large microtubers due to which the effect of potassium was more prominent on microtuber size (average microtuber mass) than on microtuber number. This can further be substantiated by the fact that there is negative relationship between microtuber number and microtuber mass in early cv. Kufri Ashoka, but not in late cv. Kufri Sindhuri.

For commercial seed potato production, microtuber size is more important than microtuber number, because small size microtubers are more sensitive to storage loss, and difficult for direct field planting (Jones 1988). MS medium enriched with high nitrogen (60 mM) is extensively used for potato microtuber production. It has been reported that reduced total nitrogen in MS medium caused a decline in the size of microtubers (Garner and Blake 1989), and no substantial improvement in microtuber size occurred when this medium was supplemented with more than 60 mM total nitrogen (Wang and Hu 1985). The present study demonstrated that an increased potassium concentration (40 mM) in MS medium gave rise to large microtubers. More than twofold increase in microtuber size was observed in this medium.

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