EFFECT OF METHOD OF PLANTING AND PLANTLET DENSITY ON POTATO MINI-TUBER PRODUCTION

Ashwani K Sharma¹, Vinod Kumar¹ and EP Venkatasalam²

ABSTRACT: An experiment was carried out at Central Potato Research Station, Kufri (Shimla) to find out the suitable method of planting the potato micro-plants with appropriate plant density for obtaining optimum number and size of mini-tubers. Three week old micro-plants of potato cultivar Kufri Himalini were planted in two different methods viz. flat bed and ridge-furrow system in combination with two plantlet densities, viz. 33 and 50 hills per m², achieved by planting at two spacings viz. 30 x 10 cm and 20 x 10 cm respectively. Two plantlets were planted per hill. Higher number and yield of mini-tubers were obtained under flat bed (232.6 and 2.23 kg/m² respectively) than ridge –furrow method (221.4 and 1.85 kg/m² respectively). Higher plant density (20 x 10 cm) resulted in more number of mini-tubers (237.7/m²) than low density (216.2/m²). Plant density did not influence the yield of mini-tubers significantly. Planting at low density (30 x 10 cm) was better in improving the size of mini-tubers and reducing the proportion of <3g mini-tubers over higher density (20 x 10 cm). Flat bed method of planting was also superior to ridge-furrow method in reducing the proportion of extremely small sized (<3g) mini-tubers.

KEYWORDS: Flat bed, micro-plants, mini-tuber, plant density, plantlets, potato, ridge-furrow

INTRODUCTION

In-vitro propagated plantlets are commonly used in potato seed production as a source of healthy propagation material. Producing mini-tubers from in vitro plantlets allows a faster multiplication in seed production and reduces the number of field generations needed (Ranalli, 1997). Among the various techniques available, direct planting of in vitro generated plantlets (micro-plants) in soil medium under aphid proof net/ poly-houses is a well established method for the production of potato mini-tubers in the hills as well as in plains (Sharma et al., 2013; Kumar et al., 2011a). Ahloowalia (1994) has also reported direct transplanting of in vitro plantlets in soil media as a rapid and efficient method of producing potato mini-tubers which is a well adopted practice world-wide (Venkatasalam et al., 2011). The objective of this phase of seed production system is to produce as many mini-tubers above a certain minimum size per in vitro plantlet as possible (Struijk, 2007); and as early as possible (Hosseini et al., 2011).

For the rapid multiplication of elite planting material, potato mini-tuber production during the autumn season in addition to Kharif season has been found successful in high hills of north western Himalaya (Sharma et al., 2013). The laboratory procedures to produce in vitro plantlets are well established; however technology for production of mini-tubers using such plantlets is not standardized. (Kumar et al., 2011a). Keeping this in view, an attempt was made to evaluate two different methods of planting the plantlets at two plant densities in the high hills of north-western Himalaya for improving the rate of multiplication as well as the size of mini-tubers produced.

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MATERIALS AND METHODS

The experiment was conducted in a factorial randomized block design with three replications per treatment at Central Potato Research Station, Kufri (Fagu unit), Shimla, 2700 m above mean sea level during the autumn season (mid August - December) of 2009 and 2010. Micro-plants were planted under the protected structure (poly-house) with no provision for the heating or cooling. Soil media consisted of soil: sand: farmyard manure in 2:1:1. Fertilizer mixture consisting of nitrogen (N), phosphorus (P$_2$O$_5$) and potash (K$_2$O) in the form of calcium ammonium nitrate, single super phosphate and muriate of potash, respectively was applied @ 50 kg each/ ha in the soil 4-5 days before planting. The same soil media mixed with fertilizers was kept aside for top filling the beds in flat bed method at the time of earthing up in ridge-furrow method.

Prior to planting, 3-week old micro-plants were hardened by keeping the test tubes inside the poly-house for 10 days. Before planting, micro-plants were taken out from the test tubes and after washing off the adhering growth media, the longer adventitious roots were trimmed off slightly. Two plantlets were planted per hill on the initially prepared flat beds in both the methods of planting. Keeping the beds flat or to convert to ridge-furrows was performed at the time of earthing up. Planting of micro-plants of potato variety Kufri Himalini was done on 19-20 August at 30 x 10 cm and 20 x 10 cm spacing in 2.0 x 2.4 m beds per replication. A light irrigation was given before and after the planting of micro-plants. Thereafter, the crop was irrigated according to its requirement. After 21 days of planting, another dose of nitrogen (10 kg/ha) was top dressed through calcium ammonium nitrate followed by earthing up or top filling as per treatment. To fulfill the requirement of earthing up for tuberization in flat bed method of planting, the already kept soil media was used for filling up the beds for raising their level to the height of ridges. Haulms were cut 90 days after planting (DAP) and harvesting was done 15 days after the cutting of haulms. Data were collected on per cent establishment of micro-plants (20 DAP), height, number of shoots, compound leaves (60 DAP) and haulms weight per plant (90 DAP) as well as on number and yields of total and graded mini-tubers at harvesting. Ground cover (%) was estimated after 60 days of planting with the help of a 50 x 50 cm grid with 100 equal compartments at two locations in each plot (Burstall and Harris, 1983). The average of two years data was analyzed statistically by applying the technique of analysis of variance (ANOVA). Mean values were calculated and separated using F-test at 5% level of significance.

RESULTS AND DISCUSSION

Per cent establishment

Establishment of micro-plants was affected significantly due to plantlet density but not due to the method of planting (Table 1). Establishment was better at low plantlet density (30 x 10 cm) than the higher (20 x 10 cm). Comparatively low establishment of plantlets at higher plantlet density might be due to increased competition among the plants for space and other nutrients resulting in mortality of some of the plantlets. Interaction between the method of planting and plantlet density was found significant for the establishment of micro-plants. Among all the treatment combinations, planting in flat bed at 30 x 10 cm spacing resulted in maximum establishment (99.7%) of micro-plants (Table 1). However, >93% establishment of the micro-plants under both
Table 1. Effect of method of planting and plant density on establishment of micro-plants and plant height in potato cv. Kufri Himalini.

<table>
<thead>
<tr>
<th>Method of planting</th>
<th>% Establishment (20 days after planting)</th>
<th>Plant height (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30 x 10</td>
<td>20 x 10</td>
</tr>
<tr>
<td>Flat bed</td>
<td>99.7</td>
<td>91.3</td>
</tr>
<tr>
<td>Ridge-furrow</td>
<td>95.4</td>
<td>95.4</td>
</tr>
<tr>
<td>Mean</td>
<td>97.6</td>
<td>93.4</td>
</tr>
</tbody>
</table>

CD (0.05)

Planting method (P) N.S. N.S.
Density (D) 2.3 3.6
P × D 3.3 N.S.

the systems of planting can be attributed to the favourable climatic conditions on account of prevailing high relative humidity with the ongoing rainy season during August. Better establishment of micro-plants during the rainy season in high hills has already been reported by Sharma et al., 2010.

Plant vigour

Plant height and weight of haulms per plant were influenced significantly by the plant density but were not affected by the method of planting (Tables 1 and 3). Low plant density (30 x 10 cm spacing) resulted in significantly more height and weight of haulms per plant than closer planting at 20 x 10 cm. Kumar et al. (2012) have also reported more height at wider inter-row spacing of 45cm in potato plants raised from in vitro plantlets. Number of shoots and compound leaves per plant were not affected by the method of planting; however, wider plant spacing (30 x 10 cm) resulted in significantly higher number of compound leaves per plant over closer spacing (Table 2).

Though with flat bed method; plant height, compound leaves and haulms weight per plant were slightly higher over the ridge-furrow method but the differences were statistically non-significant. Per cent ground cover at 60 days crop stage was found to be similar with either of the planting method as well as with plant density. Increased height and compound leaves per plant at low plant density might be due to the better plant growth on account of availability of more space and nutrients in comparison to the higher density planting (Singh et al., 1997;

Table 2. Effect of method of planting the plantlets and plant density on number of shoots and compound leaves per plant.

<table>
<thead>
<tr>
<th>Method of planting</th>
<th>No. of shoots/ plant</th>
<th>Compound leaves/ plant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30 x 10</td>
<td>20 x 10</td>
</tr>
<tr>
<td>Flat bed</td>
<td>2.7</td>
<td>2.3</td>
</tr>
<tr>
<td>Ridge-furrow</td>
<td>2.8</td>
<td>2.4</td>
</tr>
<tr>
<td>Mean</td>
<td>2.7</td>
<td>2.3</td>
</tr>
</tbody>
</table>

CD (0.05)

Planting method (P) N.S. N.S.
Density (D) N.S. 3.4
P × D N.S. N.S.
Effect of method of planting and density on mini-tuber production

Table 3. Effect of method of planting and plant density on per cent ground cover and weight of haulms per plant.

<table>
<thead>
<tr>
<th>Method of planting</th>
<th>Ground cover (%) 60 DAP</th>
<th>Haulms wt./ plant (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30 x 10</td>
<td>20 x 10</td>
</tr>
<tr>
<td>Flat bed</td>
<td>99.8</td>
<td>99.2</td>
</tr>
<tr>
<td>Ridge-furrow</td>
<td>97.2</td>
<td>98.5</td>
</tr>
<tr>
<td>Mean</td>
<td>98.5</td>
<td>98.8</td>
</tr>
</tbody>
</table>

CD (0.05)

Planting method (P) N.S. N.S.
Density (D) N.S. 8.8
P x D N.S. N.S.

Number and yield of mini-tubers

Number and yield of mini-tubers were affected significantly with the method of planting (Table 4). Flat bed method of planting resulted in significantly higher number and yield of mini-tubers over the ridge furrow method. Planting the plantlets at closer spacing (20 x 10 cm) resulted in significantly higher number of mini-tubers per m² but not the yields over the wider (30 x 10 cm) spacing (Table 4). Increase in number of mini-tubers at higher plant density might be due to the corresponding higher number of stems available per unit area on account of more number of plantlets planted. More number of tubers per unit area with increasing plant population has been reported to occur on account of more number of stems per unit area in conventionally grown potato (Kumar

Table 4. Effect of method of planting and plant density on the number and yield of potato mini-tubers/m².

<table>
<thead>
<tr>
<th>Method of planting</th>
<th>No. of mini-tuber / m²</th>
<th>Yield of mini-tuber (kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30 x 10</td>
<td>20 x 10</td>
</tr>
<tr>
<td>Flat bed</td>
<td>224.2</td>
<td>241.0</td>
</tr>
<tr>
<td>Ridge-furrow</td>
<td>208.2</td>
<td>234.5</td>
</tr>
<tr>
<td>Mean</td>
<td>216.2</td>
<td>237.7</td>
</tr>
</tbody>
</table>

CD (0.05)

Planting method (P) 0.3 N.S.
Density (D) N.S. 7.9
P x D N.S. N.S.
et al., 2011b; Kushwah and Singh, 2008; Malik et al., 2000 and Zamil et al., 2010) as well as in the mini-tubers raised from in vitro plantlets (Kumar et al., 2012). Non significant differences in the yield of mini-tubers in spite of significantly higher number of mini-tubers at closer spacing can be attributed to the small size of mini-tubers obtained over low plant density. Better number and yield of mini-tubers with flat bed method of planting can be attributed to the comparatively more space available for the growth of underground plant parts (mainly the stolon and tuber forming sites) on account of covering of whole intra-row spaces with soil media in comparison to the ridge and furrow method.

**Proportion of different grades of mini-tubers**

Proportions of different grades of mini-tubers were also significantly affected by the method of planting as well as with the plant density. Large size mini-tubers (>20g) were significantly higher with flat bed method, whereas, 10-20g mini-tubers were almost same under both the methods of planting (Fig. 1a and b). Low plant density (30 x 10 cm) resulted in significantly higher proportions of large (>20g and 10-20g) mini-tubers over the higher density (20 x 10 cm). However, reverse was true with the proportion of 3-10g mini-tubers, which were found to be higher at high plant density (20 x 10 cm) and were not affected due to the method of planting (Fig. 1a-b). Extremely small sized mini-tubers (<3g) were affected significantly by both method of planting as well as plant density and were significantly higher in ridge–furrow method of planting at high plant density. Comparatively higher proportions of large sized mini-tubers obtained at low plant density and vice-versa can be attributed to the increasing competition between plants for space and nutrients coupled with higher number of mini-tubers obtained per unit area at high plant density.

**CONCLUSIONS**

The results reveal that for getting maximum number and yield of mini-tubers
with better size (>3g), micro-plants should be planted in the flat bed method of planting at low plantlet density (30 x 10 cm). It will significantly improve the number of >20g mini-tubers while reducing the proportions of extremely small sized (<3g) mini-tubers without much compromise on the total number of mini-tubers per unit area. Planting of plantlets at high density (20 x 10 cm) results in more number of mini-tubers but of smaller grades (<10g). The flat bed method though cumbersome than ridge-furrow method, is definitely superior to the other method of planting the micro-plants.

**LITERATURE CITED**


Kushwah VS (1989) Effect of different levels of nitrogen and planting density on production of seed potato (*Solanum tuberosum*). *Indian J Agri Sci* 59(9): 561-65


MS received: 31 August 2013; Accepted: 12 May 2014