In vitro multiplication of Gymnema sylvestre R.Br. – An important medicinal plant

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The objective of this study was to develop a rapid system for regenerating shoots from mature nodal explants of Gymnema sylvestre, an useful antidiabetic medicinal plant. Single node stem explants were inoculated on MS media containing different combinations of 6-benzylaminopurine (BAP) or kinetin with naphthaleneacetic acid (NAA). Maximum number of shoots (7 per explant) were observed on the medium containing BAP (5 mg/l) and NAA (0.2 mg/l). Regenerated shoots were rooted on MS half-strength medium without supplementing any growth regulator.

Gymnema sylvestre R.Br. is a valuable medicinal plant belonging to the family Asclepiadaceae, and distributed over most parts of India and Africa. It is well recognized in traditional medicine as a remedy for diabetes mellitus, stomachic and diuretic. The plant is popularly known as ‘gurmar’ for its distinctive property of temporarily destroying the taste of sweetness. The complex mixture of the active principles, named gymnemic acids were isolated from Gymnema leaves. Recently, the plant has been recognized by natural products industry in North America and Europe and a number of commercial, over-the-counter herbal products are now available that contain varying amounts of Gymnema. Hence, it is felt that there is a great need for cultivation of this important medicinal plant.

Gymnema is propagated by seed germination. One of the constraints in this conventional propagation is the very short span of seed viability. No alternative mode of multiplication is available to propagate and to conserve genetic stock of this useful plant. Tissue culture offers an effective alternative method for rapid multiplication of desirable clones. Relatively fewer studies have been published on the mass in vitro clonal propagation of some milk weeds like Tylophora, Hemidesmus, Asclepias which described the use of adventitious shoot regeneration. Micropropagation by axillary bud proliferation has proved to be the most reliable method for large-scale production of many forest and medicinal plants. The present investigation was undertaken with the aim to optimize in vitro conditions for mass multiplication of this medicinal plant having potential antidiabetic properties.

Small tender twigs were collected from 5 to 6-year old wild grown mature plants, cut into 1–1.5 cm nodal segments and used as explants for the induction of multiple shoots. Explants were washed thoroughly under running tap water for 15 min and treated with a surfactant Tween-20 (two drops per 100 ml solution). Later they were surface-sterilized with 1% fungicide (w/v) (carbendazim) for 30 min, followed by rinsing in 1% mercuric chloride (w/v) for 5 min and washed thrice with sterile distilled water. Under a laminar flow, cabinet explants were inoculated aseptically on Murashige and Skoog (MS) medium supplemented with various concentrations of cytokinins, kinetin and 6-benzylaminopurine (BAP), and auxins indoleacetic acid (IAA) and naphthaleneacetic acid (NAA) alone or in combinations. Media were adjusted to pH 5.7–5.8 and 0.8% (w/v) agar (CDH, Mumbai) was added before autoclaving at

Figure 1. a. Formation of multiple shoots from mature nodal explant on MS medium with 5 mg/l BAP + 0.2 mg/l NAA; b. Elongation of multiple shoots on 0.2 mg/l BAP + 0.2 mg/l NAA; c. Rooting of in vitro initiated shoot on auxin-free 1/2 strength MS basal medium; d. Potted in vitro raised plantlet after six weeks.

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CURRENT SCIENCE, VOL. 75, NO. 8, 25 OCTOBER 1998
Table 1. Effect of different PGR in MS medium on induction of multiple shoots from mature nodal explants of Gymnema sylvestre. Observations after 10 weeks

<table>
<thead>
<tr>
<th>Plant growth regulator (mg/l)</th>
<th>Frequency of shoot regeneration (%)</th>
<th>Mean number of shoots/explant</th>
<th>Mean length of the shoot (cm)</th>
<th>Basal callus</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAP</td>
<td>Kin</td>
<td>NAA</td>
<td>83.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.6&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>70.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.0&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>1.0</td>
<td>-</td>
<td>-</td>
<td>46.4&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.0&lt;sup&gt;cd&lt;/sup&gt;</td>
</tr>
<tr>
<td>1.0</td>
<td>-</td>
<td>0.2</td>
<td>52.4&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.2&lt;sup&gt;de&lt;/sup&gt;</td>
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<tr>
<td>1.0</td>
<td>0.5</td>
<td>0.2</td>
<td>55.4&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1.0&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>-</td>
<td>0.5</td>
<td>0.2</td>
<td>30.3&lt;sup&gt;e&lt;/sup&gt;</td>
<td>1.0&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>-</td>
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<td>0.2</td>
<td>32.1&lt;sup&gt;e&lt;/sup&gt;</td>
<td>1.6&lt;sup&gt;de&lt;/sup&gt;</td>
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<td>0.2</td>
<td>47.3&lt;sup&gt;f&lt;/sup&gt;</td>
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<td>-</td>
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<td>72.3&lt;sup&gt;e&lt;/sup&gt;</td>
<td>5.4&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>4.3&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>5.0</td>
<td>-</td>
<td>0.2</td>
<td>70.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.4&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Values represented in the table are the mean of 20 replicates.

Means values followed by the same letter are not significantly different at P ≤ 0.05 (Student–Newman–Keuls’s test).

Number of (+) signs indicates the degree of callusing.

Table 2. Rooting efficiency of in vitro raised shoots of Gymnema sylvestre in MS medium. Observations: After six weeks

<table>
<thead>
<tr>
<th>MS medium</th>
<th>Frequency of root regeneration (%)</th>
<th>Mean no. of roots</th>
<th>Mean length of the root (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-strength</td>
<td>46.0 ± 0.7</td>
<td>7.6 ± 0.3</td>
<td>2.3 ± 0.4</td>
</tr>
<tr>
<td>Half-strength</td>
<td>74.2 ± 0.4</td>
<td>28.5 ± 0.5</td>
<td>5.6 ± 0.7</td>
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<tr>
<td>Quarter-strength</td>
<td>52.6 ± 0.9</td>
<td>11.4 ± 0.6</td>
<td>3.5 ± 0.5</td>
</tr>
</tbody>
</table>

Values represented above are the mean of 20 replicates.

1.06 kg/cm² pressure for 15 min. After inoculation in test tubes (25 × 150 mm), cultures were maintained at 25 ± 2°C under 16 h daily illumination with fluorescent light (15 μE m⁻² s⁻¹). In all experiments 25 replicates were used and each experiment was repeated at least three times.

Isozyme (peroxidase) analysis was performed by macerating 1 g leaf material collected from mature parent plants and 1½-year-old tissue culture raised plants, growing in the same environment. Leaf tissue was macerated in a pre-chilled mortar by adding 3 ml of 0.1M phosphate buffer (pH 7). Extract was centrifuged at 18,000 g for 15 min at 4°C. The supernatant was used as an enzyme extract. SDS-PAGE was performed using 12% polyacrylamide gels. 8 μg of protein was loaded in each slot. Proteins were separated by supplying a constant voltage of 200 V and 30 amp at 4°C, for 5 h. Gels were incubated in a staining solution containing benzidine (2.08 g), acetic acid (18 ml), 3% hydrogen peroxide (100 ml) and water (80 ml). When the blue-coloured bands appeared, the reaction was arrested by immersing the gel in 300 ml of 7% acetic acid solution for 10 min.

Preliminary studies proved that nodal explants on BAP with IAA combination responded better than those on BAP with IAA. Induction of multiple shoots was achieved from axillary regions with BAP and NAA, 5–6 weeks after inoculation with an average of 7 shoots per explant. Among all the concentrations tested, the best response was noticed with 5 mg/l BAP + 0.2 mg/l NAA. Explants inoculated at higher concentrations of BAP (more than 5 mg/l) alone or in combination with NAA produced clumps of highly-reduced shoots with smaller leaves. Patnai and Debata found a similar response in Hemidesmus indicus, where such abnormal shoots were grown normally when subcultured on low concentrations of BAP. However, in the present study these shoots did not survive even after subculturing on to the medium containing low concentrations of BAP or GA<sub>3</sub>. While multiple shoots originated from leaf axil, the stem portion below the node formed callus in many treatments (Table 1). Similar observations were made in other plants also. In the present study, kinetin at different concentrations did not improve the number of proliferating shoots as reported by Purohit and Dave. Shoot length also did not improve significantly when kinetin was added to the medium. After 7–8 weeks, when regenerated shoots attained a length of more than 3 cm, they were excised and planted on full-strength and half-strength MS basal medium with and without supplementing various auxins (IAA, IBA and NAA). In cultures where the shoots were inoculated on auxin-free half-strength MS basal medium, root primordia emerged from the shoot base 15–20 days after implantation and subsequently developed into roots without basal callus (Table 2). Nevertheless when auxins were added to the medium, callus was formed from the shoot base, which did not favour root formation.

For acclimatization, plantlets were removed from rooting medium 8 weeks after root initiation, and

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Direct shoot multiplication is preferable for generating true-to-type plants than callus regeneration, where possibilities of chromosomal variations are high. This report helps to multiply elite genotypes of this useful medicinal plant.


ACKNOWLEDGEMENTS. P.S.R. is highly grateful to UGC for providing financial assistance in the form of senior research fellowship.

Received 17 February 1998; revised accepted 11 August 1998