EXPLANTS MODULATES GROWTH CHARACTERISTICS OF IN –VIVO PROPOGATED CHRYSANTHEMUM CULTIVARS

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ABSTRACT

Three different explants, herbaceous cuttings (HC), Soft wood cuttings (SWC) and Semi hard wood cuttings (SHWC), were collected from stems of seven chrysanthemum (Chrysanthemum morifolium) cultivars that successfully developed roots. These cultivars were collected from Capital Development Authority (CDA), Islamabad, and grown at Faculty of Agriculture, Rawalakot, Azad Kashmir, Pakistan, during 2006-2007, as stock plant. Plants produced through HC gave better performance for overall growth characteristics and survival percentage compared to the plants produced by SWC and SHWC. In general SWC also gave better survival percentages than SHWC. Various cultivars propagated through cuttings, exhibited variability in overall growth and floral characteristics. Anemone yellow, Spider Red and Korean Hybrid Yellow proved successful cultivars with 100% survival rate of plantlets. Anemone Yellow, Red Spider and Spider Yellow, produced more tillers plant1. Korean Hybrid produced more branches, and leaves. Anemone Yellow and Korean Hybrid Yellow produced more flowers plant1. Use of HC, SWC and SHWC proved as an easier and useful method for multiplication of chrysanthemum cultivars.

Key Words: Propagation, stem cuttings, Growth responses


INTRODUCTION

The autumn flowering chrysanthemum (Chrysanthemum morifolium) has no rivals for beauty, versatility and even economy. It belongs to family Compositae and genus Chrysanthemum. It is a hardy perennial plant. Its stem is mostly erect and leaves are opposite. The centre of disk consists of many more individual flowers and florets. All of the named varieties of chrysanthemum have come from 165 species in the genus Chrysanthemum (Fischer and Hapsen, 1977). Chrysanthemum was cultivated in China about 500 B.C. and cultivated varieties were introduced from China to Japan in about A.D.800, where they were further developed by selection and cross-fertilization (Devier and Geneve, 1997). Chrysanthemum from Asia was introduced to Holland in 1688 but did not survive there. Cultivated varieties next reached Europe in 1789, then these were brought from China to France and England in 1795 (Megumi and Saneyuki, 2000).

In United States Pyrethr in is extracted from chrysanthemum, spending millions of dollars to fulfil its demand. Chrysanthemum is a medicinal plant and tea made from leaves is useful to cure bad cold, indigestion and diarrhea. Dried flowers are useful to induce menstrual flow and bring about abortion, to treat intestinal worms and indigestion (Kazuhiko et al., 2005). Clonally propagated chrysanthemum plants proved superior for quality and early maturity compared to stock plants (Ishan Ilahi et al., 2007). Adventitious bud and then root development is a good technique for development of plants in chrysanthemum (Zalewska et al. 2007). The ability of chrysanthemum cuttings to regenerate varies with species, cultivars, part taken, age and method used for propagation. (Ahmad and Abida, 2003). Variation in root formation has been observed by various workers for different cultivars. Stoltz (1968) reported that considerable variation occurs in root formation when cuttings were taken from various parts grown under different conditions.

It is difficult to say which part is most suitable for commercial propagation of chrysanthemum cultivars. Different cultivars gave variable responses to the parts used for multiplications (Druege et al., 2007). Therefore, these studies were undertaken to select most suitable plant material (explant) and cheaper way for commercial propagation of chrysanthemum cultivars.
MATERIALS AND METHODS

For these studies stock plants of seven cultivars, were collected from Capital Development Authority (CDA) Nursery, Check Shazad, Islamabad and grown in pots at Faculty of Agriculture, Rawalakot, Azad Kashmir, (Pakistan), during May 2006-2007, to find out most suitable plant material (explants) and cheaper method of propagation for important commercial cultivars of chrysanthemum. The varieties were Spider Red, Spider Yellow, Anemone Yellow, Pompon Single, Korean Hybrid Yellow, Single Red and Reflex Yellow. Uniform healthy cuttings (explants), five cm in length were first planted in polyethylene bags and then shifted in bed. The explants (cuttings type) used as treatments were: T1. Herbaceous cuttings (HC), T2. Soft wood cuttings (SWC) and T3. Semi hard wood cutting (SHWC). The experiment was laid out according to bi-factorial randomized complete block design (RCBD). There were seven cultivars (factor A), three cutting types (factor B) that were considered as treatment, with three replications. One cutting was grown into each polyethylene tube -1 and 10 tubes were considered as one replication. Proper rooting environment was provided by using mixture of sand, compost (saw dust, shredded bark and leaves) and soil in the pots, with the ratio of 1:2:1. No, bottom heat was used. To avoid sun drying and other stresses, these tubes containing explants were shifted under shade and kept there for 25 days. Then tubes were shifted to greenhouse under partial light conditions for 10 days. Cultural practices were carried out uniformly throughout the experiments. Cuttings were thoroughly irrigated with sprinkler to compensate the water loss. After successful development of rooting, plantlets were shifted in the field. Weeding and hoeing was done time-by-time, to keep the bed free from weeds. Data were collected by adopting following procedure.

Data on survival percentages were collected by counting the survived plantlets in each replication. Information on number of days to sprouting were obtained by observing the sprouting date of each plant for each replication. Number of tillers plant⁻¹ was obtained by counting plant for each replication. Information on number of branches plant⁻¹ was collected by counting the number of primary branches plant⁻¹ in each replication. Number of leaves plant⁻¹ was recorded by counting the total number of leaves for each plant. Plant height (cm) was measured by measuring the plant height of each replication. Height of the plants was measured from soil surface to the tip of the terminal branches. Number of days to flower bud formation was obtained by counting the days up to formation of flower bud. Number of flower buds and flower plant⁻¹ was obtained by counting the total for each replication. Data collected were statistically analyzed for analysis of variance and results exhibiting significant differences were subjected to LSD test for comparison of their means (Steel et al., 1997).

RESULTS AND DISCUSSIONS

Survival percentages

Results in table I showed that cultivars Spider Red, Anemone Yellow and Korean Hybrid Yellow, gained maximum survival percentage (100) whereas, minimum survival (44.4 %) was obtained by Reflex Yellow. Herbaceous cuttings (HC), presented maximum survival (97.6) compared to other cutting types while, Semi hard wood cuttings (SHWC), exhibited minimum survival percentage (78.5) (Table-II).

These results could be justify because the leaves affected rooting similar to that of buds and the endogenous growth substances like auxins proved their worth in root formation. Moreover a lower ratio between auxin and cytokinins produced more roots in cuttings (Ruiter, 1993). So, HC that exhibited more survival percentage contained more auxin that proved helpful in root initiation and development and better survival of the plantlets, because of more root formation. Results of various scientists agreed that survival percentages are affected by endogenous auxin. Higher concentration of endogenous IAA enhanced more root formation in apple root stock (Alveraz et al., 1989). It can be concluded that leaves and auxins greatly affected the root formation. The cuttings with more leaves and auxins produced more roots. The HC, presented higher survival percentage because of more leaves and endogenous auxin contents while SHWC, exhibited lower survival percentages that might be presence of minimum leaves and auxin contents.

Number of days to sprouting

Observation of table I showed that Anemone Yellow utilized maximum days (8.1) to sprouting compared to Reflex Yellow that took minimum time to sprouting (5.5). SWC required maximum days (7.8) compared to other cutting type while HC, sprouted with in less days (6.5) (Table-II).

This parameter was probably affected by environment, nutritional status and plant hormones. Phenolic compound as caffeic acid, catechol and chlorogenic acid interacts with auxin to induce root initiation (Hackett,
1970). Auxin inducing earlier root formation was accompanied by increasing level of putrescence (Burtin, 1990). The cuttings that produced roots in minimum days actually retained mentioned factors that interact and proved helpful in formation of roots in cuttings.

**Number of tillers plant⁻¹**

Korean Hybrid Yellow produced maximum number of tillers (4.3) plant⁻¹ whereas Reflex Yellow gained the lowest number of tillers plant⁻¹ (2.0) (Table I). Plants produced from SWC, presented maximum number of tillers (3.7) compared to other cuttings while SHW, produced plants with minimum tillers (3.4) (Table II). Non significant differences were found between these all types of cuttings material under study.

Number of tillers was affected by different factors such as genetic composition, environment and nutrition. Tillers plant⁻¹ was under the control of over dominance type of gene action. Both dominance as well as additive genetic variance was important for tillers plant⁻¹ (Shah and Khan, 1971). Tillers of the plant affected by nutritional status of the plant and parts used for propagation. Proper nutrients increased the number of tillers (Moore et al., 1972).

**Number of branches plant⁻¹**

Results on number of branches showed that Korean Hybrid Yellow produced maximum branches (33.0) whereas Reflex Yellow presented minimum branches (11.7) (Table I). HC developed plants that obtained maximum branches (25.3) compared to SHWC, that produced comparatively lower number of branches (14.4) (Table II). Growth of plant is affected by many physiological factors including gibberellins, auxins and cytokinins other than nutrition. Pinching is a common practice to improve the number of branches, especially in chrysanthemum. Most obvious and spectacular effect of gibberellins is the increase in number and growth of shoots (Hansen, 1976). Higher cytokinin found helpful in development of more shoots. Levels of endogenous auxins and cytokinins appear to control the altered morphology of shoot (Steponkus and Hogan, 1967).

**Number of leaves plant⁻¹**

Results (Table I) showed that Anemone Yellow developed maximum of leaves (107.9) while Reflex Yellow presented minimum leaves (25.1) without significant difference in comparison with Korean Hybrid Yellow (106.0). Results given in Table II showed that HC, produced plants with maximum number of leaves (76.6) compared to other treatments while SHWC, produced plants with minimum leaves (52.4). All phases of plant growth are interrelated and interdependent. Number of leaves depends on initials or primordial developed by the cultivars and type of cuttings. Variability in number of leaves was genetically controlled (Larsen and Persson, 1999).

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Survival (%)</th>
<th>Days to sprouting (n)</th>
<th>Tillers plant⁻¹ (n)</th>
<th>Branches plant⁻¹ (n)</th>
<th>Leaves plant⁻¹ (n)</th>
<th>Plant height (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spider Red</td>
<td>100.0 a</td>
<td>7.2 ab</td>
<td>3.8 ab</td>
<td>17.5 c</td>
<td>51.0 d</td>
<td>47.1 a</td>
</tr>
<tr>
<td>Spider Yellow</td>
<td>94.4 a</td>
<td>7.7 ab</td>
<td>4.0 ab</td>
<td>18.3 c</td>
<td>49.5 d</td>
<td>26.4 c</td>
</tr>
<tr>
<td>Anemone Yellow</td>
<td>100.0 a</td>
<td>8.1 a</td>
<td>3.8 ab</td>
<td>16.1 cd</td>
<td>107. a</td>
<td>17.7 d</td>
</tr>
<tr>
<td>Pompon Single</td>
<td>94.4 a</td>
<td>7.6 ab</td>
<td>3.2 b</td>
<td>25.6 b</td>
<td>64.2 b</td>
<td>35.0 b</td>
</tr>
<tr>
<td>Korean Hybrid Yellow</td>
<td>100.0 a</td>
<td>7.1 b</td>
<td>4.3 a</td>
<td>33.0 a</td>
<td>106. a</td>
<td>46.7 a</td>
</tr>
<tr>
<td>Single Red</td>
<td>94.4 a</td>
<td>7.1 b</td>
<td>3.6 ab</td>
<td>15.3 cd</td>
<td>57.3 c</td>
<td>27.6 c</td>
</tr>
<tr>
<td>Reflex Yellow</td>
<td>44.4 b</td>
<td>5.5 c</td>
<td>2.0 c</td>
<td>11.7 d</td>
<td>25.1 e</td>
<td>14.1 e</td>
</tr>
</tbody>
</table>

In each column, means sharing same letter do not differ significantly.

**Plant height**

Results on plant height (Table I) showed that Korean Hybrid Yellow produced taller plants (46.7 cm) compared to other cultivars whereas Reflex Yellow gained minimum plant height (14.1 cm). Plants produced from HC, obtained maximum plant height (42.7 cm) compared to other cutting types while plants developed from SHWC, obtained minimum plant height (20.7 cm) (Table II).

It is possible to suppose that plant height was affected by endogenous plant hormones. In addition to auxin, endogenous gibberellins also played a very crucial role in stem elongation (Bradley and Crane, 1970). Hormones produced in apical parts moved to the plant body in downward direction where they performed special functions as elongation of stem (Balouch, 1994). It was observed that stem extension in many ornamentals was related to the
concentration of auxin produced inside the plant. Endogenous auxin level in terminal stem cuttings of *Chrysanthemum morifolium* promoted rooting and later on stems elongation. (Leshem and Schwarz, 1968; Li *et al.*, 2000). It was concluded that auxin played important role in cell elongation and plant height. Auxins are synthesized in terminal portion and higher concentrations present in HC and SWC that developed plants compared to other material used for propagation. Another factor that affected plant height was the genetic behavior. Non additive type of gene action was more predominant as compared to additive type of gene action for plant height (Shakoori *et al.*, 1979).

### Table-II  Effect of cutting type on vegetative characteristics of chrysanthemum cultivars

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Survival (%)</th>
<th>Days to sprouting (n)</th>
<th>Tillers plant$^1$ (n)</th>
<th>Branches plant$^1$ (n)</th>
<th>Leaves plant$^1$ (n)</th>
<th>Plant height (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herbaceous cuttings (HC)</td>
<td>97.6 a</td>
<td>6.5 b</td>
<td>3.5 ab</td>
<td>25.3 a</td>
<td>76.6 a</td>
<td>42.7 a</td>
</tr>
<tr>
<td>Soft wood cuttings (SWC)</td>
<td>92.8 a</td>
<td>7.8 a</td>
<td>3.7 a</td>
<td>19.1 b</td>
<td>68.5 b</td>
<td>28.5 b</td>
</tr>
<tr>
<td>Semi hard woodcuttings (SHWC)</td>
<td>78.5 b</td>
<td>7.2 a</td>
<td>3.4 ab</td>
<td>14.4 c</td>
<td>52.4 c</td>
<td>20.7 c</td>
</tr>
</tbody>
</table>

In each column, means sharing same letter do not differ significantly.

### Number of days to flower bud formation

Korean Hybrid Yellow required maximum days (79.2) to flower bud formation whereas Reflex Yellow required minimum days (27.3) (Table III). HC, produced plants that required maximum days to flower bud formation (68.5) compared to other cuttings type whereas plants produced by SHWC, took minimum days (52.6) to flower bud formation (Table IV). Gibberellins and other growth substances terminated the rest period of buds. One of the dramatic effects of GA on plants was their response by early flowering (Devier and Geneve, 1997). By providing proper nutrition one can gain early development of flower buds (Moore *et al.*, 1972).

### Table-III  Effect of cultivar factor on reproductive characteristics of chrysanthemum cultivars

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Days to flower bud formation (n)</th>
<th>Flower buds plant$^1$ (n)</th>
<th>Flowers plant$^1$ (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spider Red</td>
<td>66.7 c</td>
<td>14.7 d</td>
<td>14.7 d</td>
</tr>
<tr>
<td>Spider Yellow</td>
<td>71.0 b</td>
<td>16.4 d</td>
<td>15.8 d</td>
</tr>
<tr>
<td>Anemone Yellow</td>
<td>61.3 d</td>
<td>87.4 a</td>
<td>86.2 a</td>
</tr>
<tr>
<td>Pompon Single</td>
<td>58.6 e</td>
<td>41.6 c</td>
<td>41.6 c</td>
</tr>
<tr>
<td>Korean Hybrid yellow</td>
<td>79.2 a</td>
<td>74.3 b</td>
<td>74.3 b</td>
</tr>
<tr>
<td>Single Red</td>
<td>53.0 f</td>
<td>17.0 d</td>
<td>16.8 d</td>
</tr>
<tr>
<td>Reflex Yellow</td>
<td>27.3 g</td>
<td>3.8 e</td>
<td>3.4 e</td>
</tr>
</tbody>
</table>

In each column, means sharing same letter do not differ significantly.

### Number of flower buds plant$^1$

Anemone Yellow produced higher number of flower buds (87.4) plant$^1$ compared to other cultivars whereas Reflex Yellow developed minimum flower buds (3.8) plant$^1$ (Table III). HC, produced plants that developed higher number of buds (49.5) compared to other cuttings type. SHWC, developed plants, that obtained minimum flower buds (24.7) (Table-IV).

### Table-IV  Effect of cutting type on reproductive characteristics of chrysanthemum cultivars

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Days to flower bud formation (n)</th>
<th>Flower buds$^1$ (n)</th>
<th>Flowers plant$^1$ (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herbaceous cuttings (HC)</td>
<td>68.5 a</td>
<td>49.5 a</td>
<td>49.1 a</td>
</tr>
<tr>
<td>Soft wood cuttings (SWC)</td>
<td>57.6 b</td>
<td>35.1 b</td>
<td>34.9 b</td>
</tr>
<tr>
<td>Semi hard wood cuttings (SHWC)</td>
<td>52.6 c</td>
<td>24.7 c</td>
<td>24.5 c</td>
</tr>
</tbody>
</table>

In each column, means sharing same letter do not differ significantly.

Endogenous auxins, gibberellins and cytokinins content played a role in flower bud development. Balouch (1994) reported that growth of auxiliary buds in roses and chrysanthemum was accelerated by hampering the activity of natural bud inhibiting agents. Apparently, sufficient cytokinins and auxin must exist before a bud is able to develop. The cultivars/ species, that normally do not form buds or seldom do so, developed profuse bud formation with cytokinins treatment (Leshem and Schwarz, 1968). Kinetin, initiated bud primodia on root segments of convolvulus. A large number of buds are produced in several moss spp. with high cytokinin level (Steponkus and...
Hogan, 1967). Above results showed that production of buds greatly affected by auxins and cytokinins and plants parts with higher level of auxin and cytokinin developed more buds.

**Number of flowers plant**

Results, on number of flowers plant showed that cultivar Anemone Yellow produced maximum flowers per plant (86.2) as compared to other cultivars while Reflex Yellow developed minimum flowers (3.4) plant (Table III). HC, produced more flowers (49.1) compared to other cuttings. SHWC, produced plants that later on developed minimum flowers (24.5) plant (Table IV).

Number of flowers is directly proportional to the number of flower buds. When there was higher number of buds obviously there were more number of flowers or vice a versa. In addition hormones like gibberellins, anthesins, auxins and photoperiodism affected flower development in various plants. Higher levels of gibberellins and anthesins must be present in plant before flowering. The practical use of day length has its economic value and was evident in the florist industry (Cecilia and Larsen, 1994)

**CONCLUSION AND RECOMMENDATIONS**

Three different explants, Herbaceous cuttings (HC), Soft Wood Cuttings (SWC) and Semi Hard Wood Cuttings (SHWC) taken from the stems of seven chrysanthemum (Chrysanthemum morifolium) cultivars and developed roots. Various cultivars propagated through different explants (cuttings), exhibited variability in overall growth and floral characteristics. Anemone yellow, Spider Red and Korean Hybrid Yellow proved successful cultivars with 100% survival rate of plantlets. Anemone Yellow, Red Spider and Spider Yellow also produced more tillers plant . Anemone Yellow developed maximum (107.9), leaves and flowers (86.22) plant . Out of three explants, HC (herbaceous cuttings) proved more successful than SWC (soft wood cuttings) and SHWC (semi hard wood cuttings) for multiplication of chrysanthemum cultivars. Hence, recommended for general propagation of chrysanthemum. This study showed that Korean Hybrid Yellow, Spider Red and Anemone Yellow excelled other cultivars in overall growth characteristics.

**REFERENCES**


