Research Article

Effect of NAA and IAA on the Rooting of *Chrysanthemum morifolium* Propagated by Tip Cuttings

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Abstract | *Chrysanthemum morifolium* L. cultivators in Pakistan have frequently detected that poor root cuttings of chrysanthemum caused poor anchorage of roots that results in shipping losses of these pot plants. Optimum concentration of appropriate auxins is used to promote effective rooting. Completely randomized design (CRD) is adopted and it consisted of five treatments including control and different concentration of both auxins viz. 1-Naphthalene acetic acid (50 mg/L,100 mg/L) and Indole-3-acetic acid (100 mg/L, 200 mg/L) on tip cuttings of chrysanthemum. In this experiment, 15 pots of 9-inch diameter were used which were filled with silt, leaf mould and well rotten farmyard manure (1:1:1). Three cuttings in each pot and a total of 45 cuttings were planted. Cuttings of each treatment were dipped for 3 minutes in respective solution before planting. Uprooting was done after 60 days of plantation the cuttings. NAA with 100 mg/L proved best treatments that produced maximum root length, number of roots, dry and fresh weights of roots, number of sprouted buds, number of leaves, leaves fresh weight and dry leaves weight as compared to other treatments and control. This data suggested that NAA can be successfully used to increase root and shoot parameters in chrysanthemum propagated by means of tip cuttings.

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Introduction

Chrysanthemum morifolium L. (Chrysanthemum) commonly known as golden flower or autumn queen or gul-e-daudi. From more than 2000 years, it has been cultivated as cut flower. It is world's second most significant floriculture crop next to rose (Kalia, 2015). Chrysanthemum is the important genus of family Asteraceae. It is native to China. Globally, Chrysanthemum is a very famous flowering crop. It is valued as landscape plant as well as potted plant (Oladipupo *et al.*, 2014). In many countries it is cultivated as a cut flower crop for commercial purposes (Baskaran *et al.*, 2016). Now a day it is very famous in

the international and national trade for worshipping and for making garlands (Mamta and Ajit, 2014). The bioactive compounds in chrysanthemum are being used in drug development process (Chae, 2016). Due to low in calories, chrysanthemum tea is also excellent for overweight people. Chrysanthemum tea taken with meals helps in digestion, particularly in the case of oleaginous and fatty foods (Lin and Harnly, 2010).

The new plantation of chrysanthemum comes on flowering in autumn months and blooming in early winter (Baskaran *et al.*, 2016). Vegetative propagation is commonly used to produce best and true to type plants in chrysanthemum (Liao *et al.*, 2010). The key methods of propagation are *in vitro* culture, cutting and seeding (Waseem *et al.*, 2009). According to Waseem *et al.* (2011) suckers are used for multiplication of chrysanthemum plants. The rate of suckers production from mother stock is very low and it cannot fulfill the current demands of chrysanthemum plants. Therefore, for the mass clonal production of different plant species, the chief method is propagation via stem cuttings. Some internal factors i.e. hormonal balance and nutrition as well as external factors i.e. humidity, light and temperature played vital role in organogenesis of roots from the cuttings (Kollarova *et al.*, 2005). The enhancement of rooting in chrysanthemums by exogenous application of auxin has already been reported in literature (Hartmann *et al.*, 2002). Generally, the requirement of auxin concentration increases with woodiness or age of plant. Therefore, softwood or early aged plants required lesser concentration of auxin in comparison to woody cuttings (Hartmann *et al.*, 2002). Cutting after 20 days or at the time of excision, the endogenous IAA contents in chrysanthemum stock plants are closely related (Weigel *et al.*, 1984). In terms of root number, total dry weight, fresh weight of shoot and root, shoot dry weight the required concentration of NAA is 500 mg/L; while for stem height, nod number, total fresh weight and leaf number the required concentration of NAA is 125 mg/L and in terms of highest root height and root dry weight NAA 125 mg/L were proved better (Rahimi *et al.*, 2016).

Exogenous application of both rooting hormones NAA and IAA had a noticeable effect on the root and shoot parameters of *Dalbergia sissoo* (Omar and Khudhur, 2015). IAA is more effective than NAA on root development and growth (Ahmad, 2011). Among different plant species, the concentration and type of auxins differ as well as response of auxins also depends on genotype of plant (Guo *et al.*, 2009). This study aimed at determining the effect of NAA and IAA concentrations for propagating chrysanthemum through tip cuttings.

Materials and Methods

An experiment was performed in Department of Horticulture, Bahauddin Zakariya University Multan in 2018. It consisted of five treatments in completely randomized design (CRD). Each treatment was replicated thrice and three cuttings per replication were planted. The treatments were as follows:

T_o: Distilled water
T_1: 50 mg/L NAA
T_2: 100 mg/L NAA
T_3: 100 mg/L IAA
T_4: 200 mg/L IAA

Tip cuttings were obtained in the last week of September 2018 from the well grown chrysanthemum in the Botanical garden of B. Z. University. Cuttings were dipped in solution for 3 minutes. 9 inches pots were filled with garden compost (i.e. leaf-manure 30%, farmyard manure 10% and clay 60%), In each pot 3 cuttings were planted and watered immediately. Plants were watered after every three days of interval during the experimental period. After 60 days of plantation of the cuttings plants were harvested. Before harvesting plants were irrigated so that seedlings could be uprooted without root damage. After that seedlings were harvested and separated into shoots and roots. Roots and shoots lengths were measured by measuring tape. Fresh weights of root and shoot were recorded immediately after harvest. Then they were put in the oven at 70 °C for 48 h to measure dry weights after complete desiccation. Weight of each seedling was recorded by 4 digit electrical balance. In these seedlings number of leaves and number of shoots were also counted from each replicate and then average number of leaves and shoots were calculated.

Statistical analysis

All the data obtained was analyzed by using ANOVA (analysis of variance). Means of treatments were compared by using LSD (Least Significant Difference) at significance level of 5%. The software (Statistic 8.1) was used for analysis.

Table 1: *Analysis of variance for number of roots, root length, fresh root weight, dry root weight, number of sprouted buds, number of leaves, fresh leaves weight and dry leaves weight of chrysanthemum affected by NAA and IAA. Source Degree of freedom. Sum of square means of square F valve probability.*

Source	Number of roots	Root length (cm)	Fresh roots weight (g)	Dry roots weight (g)	Number of sprouted buds	Number of leaves	Fresh leaves weight (g)	Dry leaves weight (g)
Treatment	0.0144*	0.054*	0.128	0.331	0.238	0.004**	0.017**	0.023**

** = Significant (P<0.05); ** = highly significant (P<0.01).*

Results and Discussion

Shoot parameters

Shoot parameters like number of sprouted buds, number of leaves, fresh leaves weight and dry leaves weight showed significant differences when treated with NAA and IAA (Table 1). Our data indicated that maximum number of sprouted buds, number of leaves, fresh and dry weight leaves weight were observed highest in tip cuttings treated with NAA at 100 mg/L while the lowest values for all these parameters were recorded in control (Figures 1 and 2).

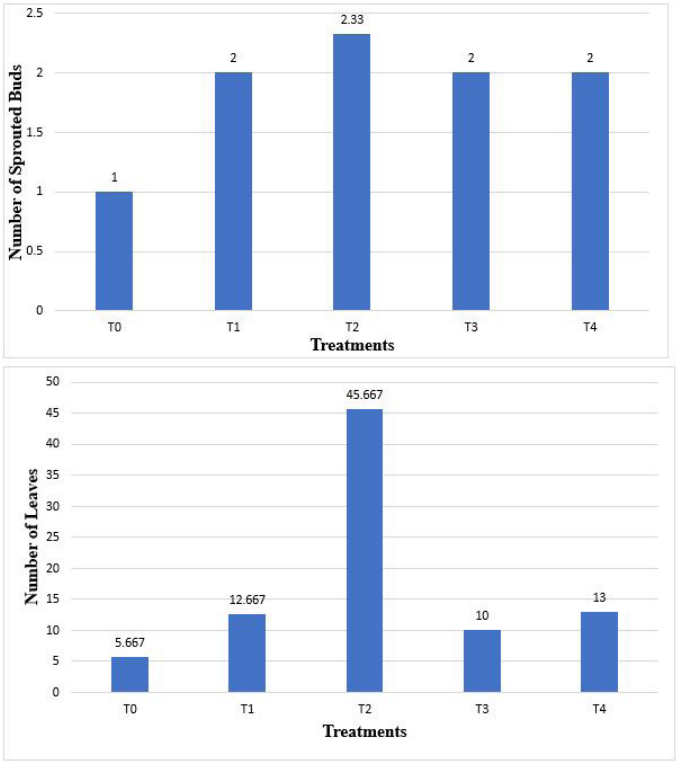

Figure 1: *Effect of different concentrations of NAA and IAA on number of sprouted buds and number of leaves of tip cuttings of chrysanthemum.*

Root parameters

Root parameters were significantly affected by NAA and IAA treatments (Table 1). Various concentrations of IAA and NAA showed noticeable effects on the root parameters. Highest number of roots, root length, fresh weight of roots and root dry weight was found when chrysanthemum cuttings were treated with 100 mg/L NAA solution while the control showed lowest values (Figures 3 and 4).

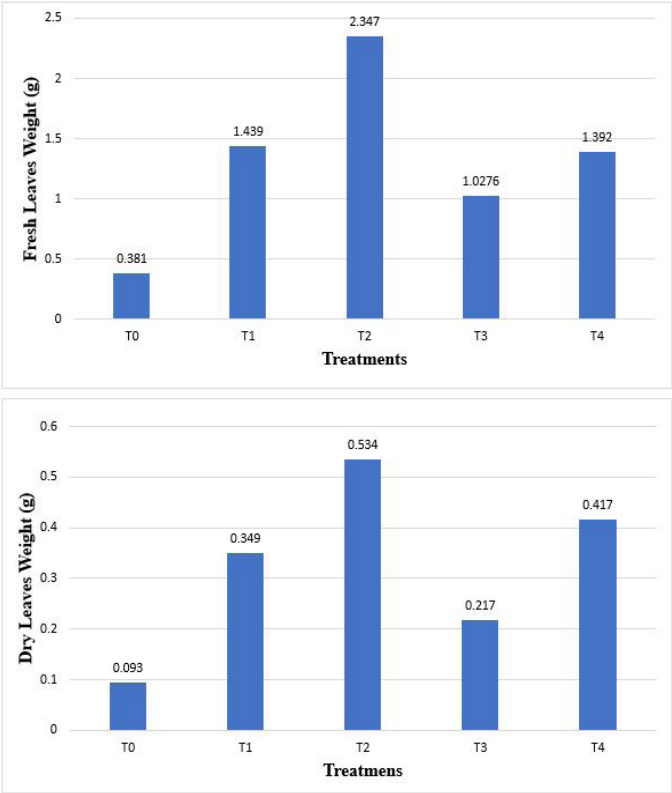

Figure 2: *Effect of different concentrations of NAA and IAA on fresh and dry weight of leaves of tip cuttings of chrysanthemum.*

Auxin among the plant growth regulators has the capability to promote the root growth (Ahmad, 2011). There was significant increase in length and number of roots, fresh and dry weights of root with the increase in duration of dipping in 100 mg/L NAA at 60 days after plantation (Sao and Verma, 2021). However, treatment with100 mg/L NAA for 3 minutes dipping duration indicated higher values of all above root and shoot parameters in the cuttings. The results in this study were similar with Kumar *et al.* (2014). NAA and IAA were used as root promoters. NAA was more effective to stimulate rooting of cuttings (Ahmad, 2011) which strongly support our results. All levels of NAA promoted growth in all parameters, however the maximum number of leaves, number

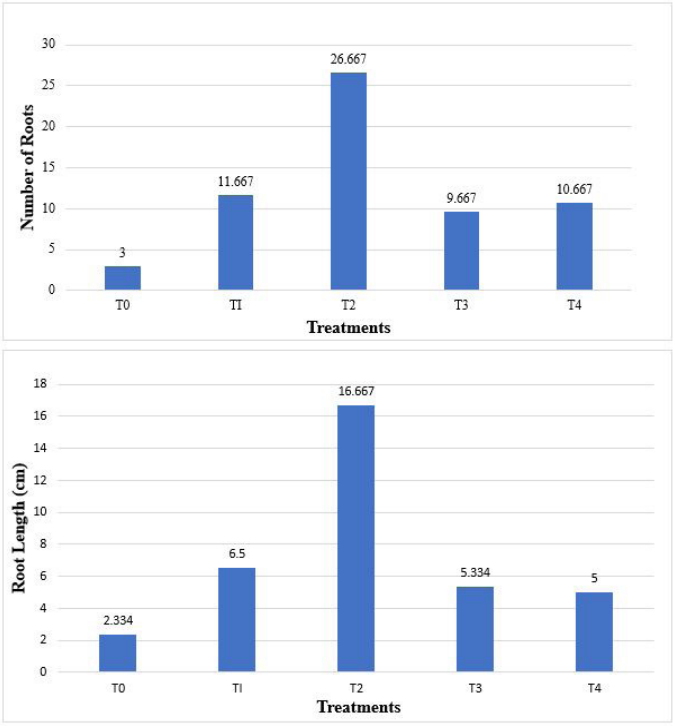

Figure 3: *Effect of different concentrations of NAA and IAA on number of roots and root length of tip cuttings of chrysant.*

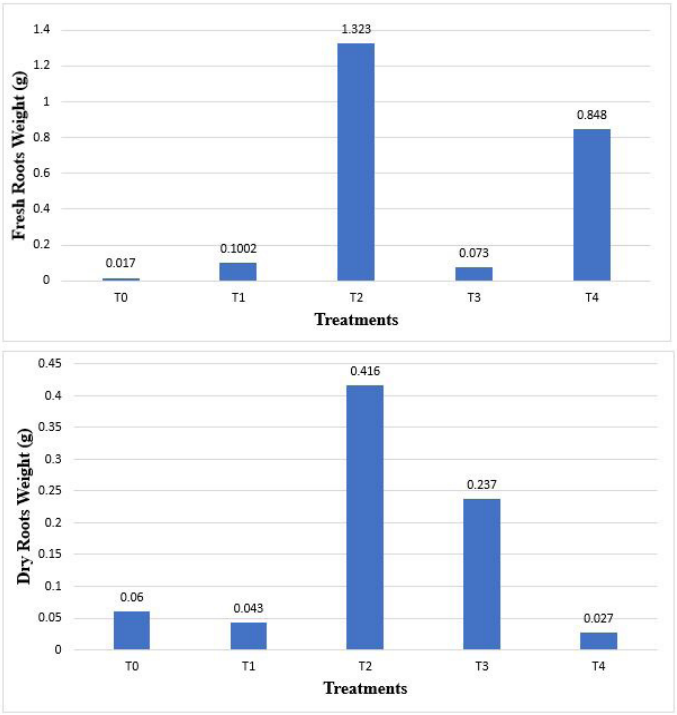

Figure 4: *Effect of different concentrations of NAA and IAA on fresh and dry weight of roots of tip cuttings of chrysanthemum.*

of sprouted buds, fresh and dry weight of leaves was found at 100 mgL^{-1} NAA than at 50 mgL^{-1}. The plant cell walls are composed of lignin, protein and cellulose. Therefore, it is very hard and affects expansion of cell, division of cell and growth. Axial elongation may be promoted by NAA in special tissue such as shoot. Our results were strongly supported with Ranpise *et al.* (2004), Khan *et al.* (2006); Singh *et al.* (2012); Mohana *et al.* (2014), Gehlot *et al.* (2014) and Prince *et al.* (2017).

Conclusions and Recommendations

Among different NAA and IAA concentration, it is concluded that 100 mg/L NAA concentration showed the best results for various root and shoot parameters in chrysanthemum when propagated by means of tip cutting. Hence NAA of 100 mgL^{-1} could be recommended for treatment of tip cuttings in chrysanthemum for better root and shoot attributes

Novelty Statement

Chrysanthemum morifolium L. being an important floriculture crop in Pakistan have frequently detected poor root that caused poor anchorage of roots that results in shipping losses of these pot plants. This study proved that auxins can be used to promote effective rooting.

Author's Contribution

Anwar ul Haq: Performed the experiments.
Maqsooda Parveen: Did statistical analysis.
Shehzadi Saima: Performed the experiments and wrote the manuscript.
Khalid Masood Ahmad: Critically analysed the manuscript.

Conflict of interest
The authors have declared no conflict of interest.

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