ABSTRACT

Dianthus caryophyllus L. is a beautiful l flower of Caryophyllaceae family that is planted in pots, borders and beds to beautify the area. It is the third most demanded cut flower globally due to its shape, colors and long vase life. Along with aesthetic value it also has a very significant role in medicinal, cosmetic and perfume industry. Its demand is increasing worldwide. Carnation needs both macro and micro-nutrients for its proper growth and to produce high quality cut flowers. Boron and zinc plays an important role in the maintenance of physiological attributes of the plant and carnation is very sensitive to their availability. But in arid and semi-arid areas of the world soil lack proper amount of these nutrients especially in Pakistan. Unavailability of B and Zn leads to stunted plant growth, reduced yield and poor shelf life of carnation. Foliar application of Zinc and Boron can be done to minimize the issues related to growth and post-harvest quality of carnation. The experiment will be conducted in Experimental Area, Department of Horticulture, PMAS-Arid Agricultural Rawalpindi. Foliar application of two micro-nutrients at the rate of Boon (Boric acid) @ 7.5 ppm, 12.5 ppm, 17.5 ppm, 22.5ppm, Zinc (Zinc Sulphate) @ 500 ppm, 750 ppm, 1000 ppm, 1250 ppm and followed by control will be done on different growth stages. The research will be laid out using CRD. Data will be collected (for morphological and physiological parameters) and analyzed by MSTAT-C.LSD test to check the significance of results.

INTRODUCTION

Carnation (*Dianthus caryophyllus L.*) is a beautiful ornamental flower of Caryophyllaceae family. It is native to Mediterranean region and is under cultivation by man for about 2000 years (Ali *et al.,* 2008). In sixteenth century its cultivation spread to

the gardens of Italy, France, Germany, Holland and England where a lot of improvement work was done on breeding and development of new cultivars. It has wide range of varieties classified as annual, biennial and perennial but mostly only perennials are liked to be cultivated worldwide. (Salehi, 2006; Mir *et al*., 2007; Khalighi, 2008; El-Naggar, 2009). There are about 280 species of Carnation that are known but only few are in cultivation and have grayish green to bluish green, succulent, kneeled and five nerved leaves on shiny and hardy stems that can grow upto 90 cm long. Carnation flowers throughout the year and either have one terminal or several lateral flowers per stem with multiple colors ranging from pink, red, purple, salmon, white and yellow. Flowers are available in different sizes with spray or standard shape and have a sweet fragrance (Dole and Wilkins, 2005; Singh, 2006).

Carnation is one of the most important commercial cut flower and is ranked as number three in international cut flower industry after rose and chrysanthemum (Sangita, 2008). Due to its vase life quality it is widely used in bouquets, flower arrangements, corsages specially on the occasions of Mother's Day and wedding ceremonies to express love, beauty, respect, enthrallment and to wish luck. Perpetual flowering Carnation is widely grown as commercial cut flower due to its hardy nature (Singh, 2006; Mir et al., 2007; Kanwar and Kumar, 2009). It is also an important plant to be used in landscape designs because of its stimulating beauty and effervescent colors that help to enhance the beauty of the existing landscape. It is the most commonly grown in pots and is best suited for borders, bedding, edgings in the gardens. Commercial production of Carnation is a profitable business due to its increasing demand and use in landscape industry globally (Radojevic et al., 2007).

Carnation also has a vital role in medicinal industry and is in use from last 2000 years. In Europe carnation tea is used to treat nausea, nervousness and to relieve stress. It contains substances that can be used to treat inflammations, swellings and hormonal imbalance. Petals are very useful to treat kidney and bladder diseases. Along with medicinal uses petals are also used to make some beauty products like skin moisturizers that are used to treat dry and cracked skin around the lips. Oil extracted from the flower contains benzyl salicylate, methyl salicylate, phenylethyl alcohol, benzyl benzoate and eugenol and that oil is used in perfume industry. France and Netherland are the major oil extracting countries on commercial scale. Carnation pickle and carnation tonic wine is also prepared from carnation (Roberts, 2000; Singh, 2006).

Major carnation producing country is Netherland followed by Spain, Kenya, Columbia, Israel, Ceylon, Canary Islands, Australia, USA, Chile and South Africa. Europe is the leading producer of carnation due to its agro-climatic conditions that support the production in open fields in less time and cost (Singh, 2006). In Pakistan floriculture business in under development but there is a great potential for the production and export of flowers to neighboring countries. Main floricultural crops include rose, gladiolus, carnation and day lilies that are mainly produced in Patoki and are exported to the other cities on daily basis. Punjab is the leading producer with 8,700 acre area under floriculture crops followed by Sindh, Balochistan and KPK (Rafiq, 2015).

Carnation can be grown via seeds and cuttings under greenhouse or in open field conditions according to the type and requirement of the variety to give flowers in spring. Standard carnation successfully grows under cool climate, whereas spray type grows

well under warm temperatures, therefore selection of variety is a very keen step in cultivation. Generally it is a long day plant and needs 16 hours of light for early flowering, intense color and good flower size. It requires 18^{o}C-24^{o}C day temperature and 10^{o}C-15^{o}C night temperature respectively during the growing season. It thrives best in well-drained sandy to loamy soils with 6-6.5 pH .Fertilizer application is very much important for the quality production of carnation. They need around 20:20:10 g/m^{2} of N, P, K after three weeks of planting (Walls, 1982; Singh, 2006).

Ornamental flowering crops need the application of both macro and micro nutrients for their healthy growth and quality production with good yield. Along with N, P, K carnation also needs application of micro-nutrients including Ca, Mg, Fe, B, Mn, Cu and Zn. In the absence of these micronutrients especially Zn and B carnation faces physiological disorders which result in poor quality and reduced yield (Singh, 2006; Ahmad *et al*., 2010). Application of zinc and boron should be ensured at optimum concentration required by the plant through foliar or soil application to avoid physiological disordes. Application of nutrients through foliar spray is more efficient technique then soil application because it helps to reduce fertilizer loss by leaching and alleviates ground water pollution (Naggar, 2009).

Boron has a very important role in the growth and development of plant as it helps to maintain stability of cell membranes and plasma membranes, improves fruit setting and production of perfect flowers (Cakmak and Romheld, 1997; Perica *et al*., 2001). It also plays an important role in the development and elongation of roots, promote cell division and controls ethylene production (Ahmadnia *et al*., 2013). Its application on carnation also showed positive effects on vegetative and reproductive

growth which in return also improved post-harvest quality of cut flower by increasing its vase life (Singh *et al.*, 2013; Qureshi *et al*., 2015)

Zinc is equally important for the growth of plant as boron. It helps in the production of chlorophyll, carbohydrates, starch and promotes the integrity of cell membrane which ultimately promotes good and healthy growth of the plant (Kumar, 2000; Khosa *et al*., 2011). Zinc also improves morphological attributes of the plant and its application on carnation can increase number of leaves and branches, stalk length, yield and most importantly vase life of the cut flower (Mir *et al*., 2007; Khalifa *et al.*, 2011)

Total area of Pakistan is 79.6 million hectares and 88% of this total area lies under arid and semi-arid climatic conditions. Deficiency of zinc and boron in the soil of these areas is the major hindrance for the proper growth and development of carnation and has a great impact on its physiology which results in splitting of calyx, abnormal opening of flower buds, poor plant growth, reduced flower yield and vase life (Singh, 2006; Ahmad *et al*., 2010; Anjum *et al.*, 2010). To solve the issue foliar application of Zn and B at optimum concentration level at various growth stages of carnation can be an effective way to promote early flowering, good plant height, chlorophyll content, increased plant height, good yield and good shelf life. (Mir *et al*., 2007; Kocabas and Kaplan,2009; Usman *et al*., 2015)

Objectives

- To evaluate influence of Zn and B on growth of Carnation**.**
- To determine the effect of Zn and B on post-harvest quality of Carnation.

REVIEW OF LITERATURE

Carnation (*Dianthus caryophyllus L.*) is the member of Caryophyllaceae family and is widely cultivated for its aesthetic, medicinal and culinary uses. It is also very famous for its use in perfume industry due to its sweet fragrance (Roberts, 2000; Ali et al., 2008; Stern, 2015). It is the third most desired cut flower globally and has great demand (Sangita, 2008). Micro-nutrients play very important role in its good quality production especially Zn and B are to essential nutrients for its growth. Foliar application of Zinc and Boron helps carnation to improve its growth and produce good quantity of high quality flowers with improved shelf life (Sharaf and Naggar, 2003).

Nowadays production of flowers around the world is the most increasing activity. Rise in the production is due to increasing demand of people for beautiful and captivating ornamental crops to add life and increase aesthetic value of their surrounding areas. In this regard there is a huge demand for rose, chrysanthemum and carnation which are used as cut flower in flower arrangements or grown in lawns to make a refreshing environment. Comparative to the production of rose and chrysanthemum, carnation is also an important flower and is the third most desired cut flower globally with great demand. Carnation is mainly used as a cut flower because of its wonderful keeping quality and shelf life (Sangita, 2008; Qureshi *et al*., 2015).

Carnation can be grown through seeds and cutting in greenhouse, glasshouse or in open fileds. It is a long day loving plant and in order to get early flowering it must be exposed to at least 16 hours of light. Like all other floriculture crops it also needs maintenance or cultural practices of weeding, hoeing, irrigation etc. Fertilizer application is the important step to maintain its growth and yield. It needs both macro

and micro-nutrients for its healthy growth and development and is very sensitive to the deficiency of boron and zinc (Walls, 1982; Singh, 2006).

Problem of zinc and boron deficiency is very common in arid and semi-arid areas of the world because soils contain less organic matter and plant nutrition is dependent upon the external application by man. Especially in Pakistan where more than 80% of the area is under arid conditions carnation faces many physiological problems like abnormal opening of flower buds, poor plant growth, reduced flower yield and vase life. Foliar application of boron and zinc is an effective way to fulfill the nutritional requirement of carnation with less fertilizer loss (Naggar, 2009; Ahmad *et al*., 2010)Study showed plants absorb boron in the form of boric acid and under high pH Boron affects several functions in plants such as, flowering, fruiting, cell division, water relationships and the movement of hormones, transport of sugars, synthesis of cell wall, IAA, RNA, pollen germination and the growth of the pollen tube, and regulates opening of stomata, this will improve the overall quality and shelf life of carnation cut flowers as well (Singh *et al.*, 2013).

It has been observed that the keeping quality of carnation can be improved by applying different concentrations of Boron ranging from 0, 5, 10, 15, and 20 ppm using foliar application. The results showed improvement in number of parameters e.g. plant height, number of leaf pairs, number of flowers, girth, diameter of flower, and dry matter contents of carnation plant at 15ppm (Qureshi *et al*., 2015)

Response of carnation plant to phosphorus and boron foliar fertilization was studied. Foliar application of P_2O_5 alone or in combination with different levels of B stimulated the length, diameter and dry weight of stem, number and dry weight of leaves

per branch as well as enhanced flowering time, number, size and dry weight of flower per plant at 200 mg P_2O_5 per liter plus 50 mg B per liter (Sharaf and El-Naggar, 2003).

Foliar application of boric acid also improved the postharvest quality and shelf life of cut carnation cv. 'Nelson'. Four different levels of boric acid ranging from 0, 100, 200, and 300 mg/l respectively were applied which resulted in the maximum vase life, degree brix and protein level of petals and also the least fresh weight loss (Ahmadnia *et al.*, 2013)

Boron is not only involved in the growth and development of plant but also help to develop stress resistance in plants. Spraying of plants at the flowering stage with a mixture of 20 mg/L boric acid and 100mg/L zinc sulphate markedly increased heat and drought resistance during the period of moisture stress (Khodzhaev and Stesnyagina, 1983).

Postharvest management of flowers is very difficult in order to store flowers as long as possible in a good quality for the purpose of export. A study was conducted to examine the performance of postharvest life of peony cultivar 'Karl Rosenfield' employing different four treatments using water, Barocal® with water, Barocal® with sucrose 100 g/L of water. Cut flowers were observed for different parameters for about 25 days including stem curvature, floral diameter, vase life and stem weight. These treatments increased the vase life and quality with no significant difference in stem curvature and other parameters (Lopez *et al.*, 2012).

Zinc is equally important as boron in the quality production of carnation and other flowers. A study showed that application of Zinc on carnation effects different growth patterns revealing the effect of zinc on vegetative processes. Acording to the

results 800 ppm plants showed the best result with height (75.12cm), number of leaves per plant (301.98), number of branches per plant (28.60), length of branches (51.73cm), number of flowers per plant (40.86), diameter of flowers (6.88cm) days taken to first flower bud appearance, first flower bud opening, duration of flowering 97.80, 8.86 and 42.86 days respectively. (Mir *et al.*, 2007

A scientific study on the effect of foliar application of Zn, Ca, and B at different concentration levels on gladiolus indicated the positive increase in vegetative growth and size of spike of flower. Results showed that 0.5% Zn concentration was best to improve the keeping quality and yield of flower (Katiyar *et al.*, 2012)

Foliar spraying of zinc and boron also effected the multiplication of bulbs, flower characteristics, and nutrients content of leaves and flowers. Application of zinc as zinc sulphate at concentration levels of 0.0, 1.5, 3.0 and 4.5 g/l and boron as boric acid at concentration levels of 0, 5, 10 and 20 ppm showed increased flower characteristics, shelf life and quality. The most ideal and effective results were noticed with Zn at 4.5g/l along with the B at 20 ppm (Khalifa *et al.*, 2011).

Both pre and post-harvest quality of carnation needs attention to meet the demand of people. Application of Boron and Zinc at the rate of 6-8 mg kg^{-1} and 2-3 mg kg^{-1} respectively, induced the flowering with good color, petal size, quality, and vase life. Zinc and Boron also improved growth, production rate, vase quality and antioxidant activities of the gladiolus flowers (Saeed, 2013).

MATERIALS AND METHODS

Experimental Site

The experiment on *Dianthus caryophyllus L*. will be conducted at the

Experimental Area, Department of Horticulture; PMAS-Aid Agriculture University Rawalpindi, during the year 2015-2016. Carnation will be planted in pots with 3 treatments of Zinc and 3 treatments of Boron followed by control treatment, and will be laid out randomly. *Dianthus caryophyllus L*. will be established through seeds and irrigation will be done with help of sprinkler. Various concentrations of Zinc and Boron will be given (Table 1). General soil properties for example soil form, organic matter (OM), soil pH and electrical conductivity (EC) will be calculated before planting carnation seeds from soil science laboratory of PMAS-Arid Agriculture University Rawalpindi.

Growth parameters

1. **Stalk length (cm)**

   Stalk length will be measured with the help of wooden scale.

2. **Leaf area (cm^2)**

   Leaf area will be calculated by the help of leaf area meter (ADC-AM 100).

3. **Plant height (cm)**

   Plant height will be measured with the help of wooden scale from the bottom to the top of the plant.

4. **Days to flower bud formation (days)**

   Visual observation will be used to count number of days taken from planting to appearance of flower buds.

5. **Number of flowers**

   Number of flowers will be calculated manually.

Table 1 Concentration of Micro-Nutrients (mg)

Treatments	Concentration of Micro-Nutrients
T_0	Distilled Water
	Boron
T_1	7.5 ppm
T_2	12.5 ppm
T_3	17.5 ppm
T_4	22.5 ppm
	Zinc
T_5	500 ppm
T_6	750 ppm
T_7	1000 ppm
T_8	1250 ppm

6. **Diameter of flower buds (mm)**

Diameter of flower buds will be measured with electronic digital caliper (MC 01010259).

7. **Fresh weight of flowers (g)**

Fresh weight of flowers will be calculated by the help of digital weighing (DC 1-12 V-300 mA).

8. **Dry weight of flowers (g)**

Dry weight of flowers will be calculated by the help of digital weighing (DC 1-12 V-300 mA) after drying the plants sample in dry oven

9. **Diameter of flower stems (mm)**

Diameter of stem will be measured with the help of electronic digital caliper (MC-01010259).

10. **Days to bud opening stage (days)**

Visual observation will be used to count number of days taken from planting to the opening of buds.

11. **Number of Leaf Pairs**

Number of leaf pairs will be calculated manually.

12. **Vase life (days)**

Vase life will be counted from the opening to the fading, wilting and shattering of flowers.

Physiological Parameter

13. **Chlorophyll content of leaves**

Chlorophyll content of leaves will be measured with the help of

chlorophyll meter. (SPAD Chlorophyll Meter).

STATISTICAL ANALYSIS

The research will be laid out using CRD. Data will be collected (for morphological and physiological parameters) and analyzed by MSTAT-C. LSD test to check the results.

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