CARNATION (*Dianthas caryophyllus*) PLANT RESPONSES TO NITROGEN FERTILIZATION

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Abstract

A pots experiment was conducted in a greenhouse at the Experimental Station of King Faisal University, Al-Hassa, Saudi Arabia in 1995 and 1996 to determine the effect of nitrogen fertilization on vegetative growth, flowering and nitrogen partitioning in carnation plants. Carnation plants were grown in pots on 6 Oct. 1995 and 8 Oct. 1996. The pots are large plastic cans contain 130 liters of soil each. The soil consists of 10% silt, 40% sand and 50% peat moss. Carnation plants were grown with nitrogen from urea at rates of 0.0, 1.0, 2.0 and 3.0 g N/plant (pot). All nitrogen treatments enhanced vegetative growth and total nitrogen in the different plant tissues. Nitrogen fertilization delayed flowering but increased the number of flower/plant and flower diameter. However, nitrogen fertilizer at 1.0 and 2.0 g N/Pant produced the optimum floral number and size in carnation plants.

Introduction

Nitrogen is often the most limiting nutrient for plant growth, development and achievement of yield potential. Nitrogen affects the vegetative growth of plants more than any other nutrient. However, soil variability and unpredictable environment during the growing season and variable demands by the plant in respect to physiological stages of growth, available N in the rooting zone is the most difficult nutrient to manage in a soil fertilization system (7). Soil and fertilizer management must be designed to furnish a continuous supply of available N and adequate plant growth factors for producing high plant growth and quality (3). Carnation plants are the most frequently grown floral plants in Al-Hassa region of Saudi Arabia on a sandy loam soil and irrigated with slightly saline water and receiving no fertilization. Reasons for lower flower production and shorter flowering period are increased grassy weeds and decreased fertilizer efficiency. The present study was conducted to determine the effect of N fertilization on vegetative growth, nitrogen partitioning and production of flowers of carnation plants.

Materials and Methods

Carnation stem cuttings were made from the second or third internode of ramets of a nondormant clone. The cuttings were treated with Rootone F, planted in a 3:1 mixture of sterilized vermiculite and perlite, and irrigated with a nutrient solution containing 8mM NH_4NO_3, 2mM $CaSO_4$, 2mM $MgSO_4$, 1mM K_2SO_4, 1 mM K_2HPO_4 , 4 μM $COCl_2$, 1 ml/liter of a micronutrient solution and 18.7 mg / liter of sequestrene 138 Fe iron chelate. After sufficient roots had formed (approximately 3 weeks), the rooted cuttings were transplanted into pots under greenhouse conditions at Al-Hassa, Saudi Arabia. During the experimental periods greenhouse temperatures generally ranged between 12 ^oC to 35 ^oC. Photosynthetically active radiation (PAR) at midday inside the greenhouse was approximately 1500 μmol/m^2 /se. The pots contain 130 liters of soil The soil consist of 10% silt, 40% sand and 50% peatmoss, positioned in the ground to give a 40 cm row spacing.

A randomized, complete block design was used, with three replications of each treatment. Nitrogen treatments (0.0, 1.0, 2.0 and 3.0 g N/plant were applied 6 weeks from transplanting and continued for 6 weeks (once a week). Prior to transplanting, recommended doses of phosphatic and potassic fertilizers were added to each pot. Plant variables were measured and observed on three plant samples for each pot. Plants were sampled at the end of the experimental period for developmental stage, plant height, number of branches, number of leaves, leaf area index (LAI) (green leaf blade area per unit ground area), leaf area duration (LAD) which calculated as the average leaf area index between two sampling periods divided by growth period (week)), number of flowers, flower diameter, dry weight of tops and flowers, leaf chlorophyll concentration and plant parts total nitrogen. The chlorophyll content (mg/g fresh weight) was determiend at flowering by the procedure of (2). A Beckman (Model L) spectrophotometer was used to measure the chlorophyll content. Leaf area was determined at flowering by a photoelectric planimeter (Hayashi Denko Automatic Area Meter Model AAM-5). Sampled plants were gently pulled from the soil so that the roots remained with the plant and were carefully

washed to remove soil. The plants were separated into roots, stems and leaves dried at 70^{o}C and weighed for dry matter and nitrogen determination. The nitrogen content was determined by the micro-kjeldahl method (1).

The data of each variable were analyzed by the analysis of variance (8). Mean comparisons were determined using Duncan's New Multiple Range Test (5).

Results and Discussion

Growth of carnation plants was significantly stimulated by each increment of fertilizer nitrogen (Table 1). Plant height response was greatest for plants at 3.0 g N/Plant which were about twice as high as those grown in the control pots (Table 1) as an average of both seasons. Plants of the 1.0 and 2.0 g N/Plant also appeared significantly taller than the control. Apparently, plants grown in the 3.0 g N/Plant were more elongated and had wider, thinner leaves, resulting in a lower mass per unit volume than plants receiving lower nitrogen levels. No lodging was noted during the 2-year experimental period.

The plants received 3.0 g N/Plant produced two to three more in number of branches per plant at physiological maturity than did those receiving no nitrogen (Table 1). The control (0.0 g N/Plant) treatment had a 87% greater leaf area index (Table 1) than the control. Another important parameter, leaf area duration, reflects the ability of the plants to maintain green leaf area on a given unit of land throughout the life of the plant. Consequently, LAD reveals not only the growth in leaf area but also the maintenance of green leaf area over time, i.e., leaf senescence on the plant. The fertilized plants consistently had greater LAD than did the control (Table 1). The plants had the ability to remain green (Table 2) and supposed physiologically active, late in their development when receiving nitrogen fertilizer (Table 2).

Table (1) Comparison of nitrogen treatment effects on vegetative traits of carnation plant (two seasons average)

Nitrogen g N/Plant	Plant height(cm)	Branches /plant (no.)	Leaves /plant (no.)	LAI	LAD week
0	58.6c	4.2c	127.1c	2.3b	1.5a
1.0	62.2b	8.4b	220.2b	3.4a	0.9b
2.0	68.7b	9.5b	241.7b	3.8a	0.7b
3.0	86.9a	14.8a	330.3a	4.3a	0.4b
c.v.%	8.6	13.1	12.6	11.7	7.3

Means within a column not followed by the same letter are significantly different (P<0.05) according to Duncan's New Multiple Range Test.

Averaged over two years, the plants received 3.0 g N/Plant had a 36% greater chlorophyll content (Table 2) than the control, but significant differences were not found between the three nitrogen fertilizer treatments. Ireland and Yeats (6) studied the pattern of chlorophyll accumulation in sorghum and found a positive correlation (r = 0.54) between chlorophyll content and growth. Our data support this line where chlorophyll content has been found to increase with increased fertilizer nitrogen and resulted in the highest dry matter production.

Table (2) Comparison of nitrogen treatment effects on chlorophyll and total nitrogen content of carnation plants (two growh periods average)

Nitrogen gN/Plant	Chlorophyll content	Total Nitrogen		
		Roots	Leaves	Stems
	mg/g fresh wt		----------mg/g dry wt.----------	
0	2.63b	18.6b	28.8c	25.8b
1.0	3.04a	21.7ab	34.8b	32.1a
2.0	3.14a	25.9a	37.9b	32.5a
3.0	3.58a	27.9a	45.6a	34.1a
c.v.%	7.2	15.1	7.3	12.6

Means within a column not followed by the same letter are significantly different (P<0.05) by Duncan's Multiple Range Test.

Since the nitrogen fertilized treatments had higher chlorophyll contents for longer periods of time, larger leaf area indices and longer leaf area duration than the control. It is speculated that treatments receiving nitrogen fertilizer possess a greater photosynthetic capacity and possible greater flower productivity. Since carnation plants in nitrogen fertilized pots remain physiologically active during the late stages of growth, this characteristic may also contribute to the overall utilization of carnation plants in home gardens. The variability of the data in this study points to a complex situation in which a large number of genetically controlled , physiological factors are coupled with a multitude of environmental influences.

The fertilized carnation plants maintained a high nitrogen concentration (Table 2) throughout the experimental period in the roots, leaves and stems. The effect of nitrogen treatments on nitrogen accumulation in roots, leaves and stems during the reproductive development of carnation plants was related to morphological, as well as physiological, changes. Nitrogen concentration among nitrogen treatments varied from 18.6 to 27.9 mg/g in roots, 28.8 to 45.6 mg/g in leaves and from 25.8 to 34.1 mg/g in stems. The levels of N accumulation in roots and stems were lower than the leaves in association with their advent in flowers (Table 2). This indicated the expected shift in allocation of N production during flowering (9 and 10).

Carnation plants exposed to high nitrogen level surpassed that of lower level treatments in flowers per plant (Table 3). Furthermore, the average plant dry weight in the control treatment was only 58 % of the average plant dry weight under high nitrogen fertilizer conditions (Table 3).

Flowering curves for plants in the 12 g N/m^2 and the control are striking different. Plant exposed to no nitrogen fertilizer reached their flowering peaks approximately 36 days after flowering. Flowering intensity then dropped sharply and remained comparatively low until the end of the experiment. Conversely, plants in the 12 g N/m^2 (3 g N / plant) treatment continued to flower profusely throughut most of the experimental period.

Table (3) Comparison of nitrogen treatment effects on carnation plant floral characteristics (two seasons average)

Nitrogen g N/Plant	Days to flowering	Flowers /plant (no.)	Flower diameter (cm)	Dry weight flower g/plant	tops
0	69b	15.2c	3.17c	0.45c	9.76d
1.0	72a	27.5b	5.25ab	1.98b	11.47c
2.0	74a	29.2b	5.65a	2.02a	15.42b
3.0	76a	36.5a	4.89b	1.93c	16.78a
c.v.%	13.1	12.9	19.8	16.1	18.4

Means within a column not followed by the same letter are significantly different ($P<0.05$) according to Duncan's New Multiple Range Test.

Plants receiving nitrogen treatments had much greater reproductive efficiency than those in the control treatment. The plants produced 27.5, 29.2 and 36.5 flower per plant on the average (1, 2 and 3 gN/plant), respectively), while plants under no nitrogen treatment produced only 15.2 flowers/plant (Table 3). Economically, the flower producer is interested in flower yield. The application of high nitrogen dose produced an aveage of 36.5 of flowers plant^{-1}. Nitrogen stressed plants produced 15.2 flowers/ plant or approximately 41.6 of that produced under 12 g N/m^2 conditions. Flower diameter was higher with the addition of 2.0 g N/plant (Table 3).

Comparing the average flower dry weight/plant to the average dry weight of the plant tops provides another appraisal of reproductive efficiency (3). The flower weight was only 4.6% of the plant's top weight the control treatment plants, but 11.7% of the dry weight of plants grown under high nitrogen level. This resulted primarily from smaller flower number/plant, and small size of the flowers. From the experiments we concluded that: 1-nitrogen fertilizer should be applied before transplanting or during the early plant growth stages that nitrogen uptake and carnation plant growth will be enahnced markedly. 2- the addition of nitrogen fertilizer above that needed for optimum plant growth causes a greater proportion of the photosynthate to be used for excess top growth at the expense of floral growth. 3- for maximum economy in carnation production, nitrogen fertilizer should be applied at transplanting or during the early plant growth stages at 1 and 2g N/pot for optimum plant growth and floral production.

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استجابة نبات القرنفل للتسميد النيتروجيني

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الملخص :

لقد تم تصميم تجربه أصص لدراسة تأثير التسميد الازوتى على النمو الخضرى والزهرى القرنفل بالبيوت المحمية بمحطة التجارب بجامعة الملك فيصـل بالاحساء. فى هذه الدراسة زرعت النباتات فى موسمين زراعيين ١٩٩٥ و ١٩٩٦ وذلك فى أصص كبيرة الحجم يحتوى كل منها على ١٣٠ لتر من التربه (١٠ % طمى، ٤٠% رمل و ٥٠ % بيت موس) و كانت المسافه بين النباتات ٤٠سم و تم التسميد باليوريا بمعدل صفر ١، ٢، ٣ جرام نيتروجين/ نبات أوضحت النتائج أن كل معاملات النيتروجين قد شجعت النمو الخضرى كما لوحظ أن التسميد النيتروجيني يؤخر التزهير بينما يزيد من عدد الأزهار/ نبات وكذلك قطر الزهرة. و كانت أفضل النتائج فيما يخص عدد الأزهار و حجمها لنبات القرنـفل عندما استخدم التسميد بمعدل ١ و ٢ جم نيتروجين/نبات.