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Effect of different Nitrogen levels on the growth of Chrysanthemum cultivars

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Abstract

Effect of different nitrogen levels on the growth of Chrysanthemum cultivars" was determined at Horticulture farm, The University of Agriculture, Peshawar during spring 2014. The experiment was laid out in Randomized Complete Block Design (RCBD) having split plot arrangement with three replications. Four levels of nitrogen (0, 50, 100 and 150 kg ha^{-1}) and four cultivars of Chrysanthemum (Candy Floss, Lillian Jackson, Elizabeth Lawson and Harry Revill) were used during the study. Both cultivars and nitrogen levels were significantly different among most of the growth parameters. Among nitrogen levels, the maximum number of days to sprouting of lateral shoot (20.89) was observed in control treatment. Maximum growth rate week^{-1} (4.88 cm), number of lateral shoots plant^{-1} (43.73), number of leaves plant^{-1} (205.96), leaf area (17.35 cm^2), number of roots plant^{-1} (55.07), root length (15.63 cm) and root diameter (4.87 mm) was recorded at 150 kg N ha^{-1}. In case of cultivars, maximum number of days to sprouting of lateral shoot (19.94) was recorded in cultivar Candy Floss. The maximum growth rate week^{-1} (5.09 cm), number of lateral shoots plant^{-1}(42.62), number of leaves plant^{-1} (192.71), leaf area (17.15 cm^2), number of roots plant^{-1} (52.74), root length (16.05 cm) and root diameter (5.04 mm) was observed in cultivar Elizabeth Lawson. It was concluded that the best performance were recorded at 150 kg N ha^{-1} in cultivar Elizabeth Lawson. Hence cultivar Elizabeth Lawson is recommended to be grown for good growth at 150 kg N ha^{-1} in Peshawar region.

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Introduction

Chrysanthemum (*Chrysanthemum morifolium* L.) belongs to family Asteraceae (Arore, 1990). This name is derived from Greek word where 'crysos' means golden and 'anthos' means flower (Kessler, 1996). It is called so because most primitive flowers having suchcolor. Carolus Linnaeus, a Swedish naturalist who is also known as the father of modern taxonomy, was the founder of this name. It is also called mums or Chrysanths. Chrysanthemum was originated in China (Crater, 1992). Its cultivation began in China about 2500 years ago and arrived in Europe in seventeen Century. There are 150 to 200 known species of Chrysanthemum. Genus Chrysanthemum includes 37 species of plants from Eastern Asia. In many countries including United States and Japan, it is the most popular flower (Verma *et al.,* 2012). Chrysanthemum is the second most famous cut flower after rose and prevails over the cut flower market (Spaargaren, 2002). It is commonly grown floricultural crop in the world. In Japan, Chrysanthemum contributes 35 percent of the total cut flower production (Boase, 1997). Japan imported 90 percent of cut chrysanthemum from china (Chen, 2005). It is very useful landscape plant in Florida, because of suitable cultivars and extendable flowering period up to 10 months (Wilfret and Raulston, 1973). Chrysanthemum is hermaphrodite, self-pollinated and short day plant. It is greatly affected by light and temperature. It requires long days for vegetative growth and short days to initiate flower. It is hardy plant and tolerates cool temperature. It is a pot plant (Kessler, 1996) and yellow, white and various shade of pink are its famous colors (Gokongwei, 2009).

Chrysanthemum has a variety of medicinal uses. Stem and flower extracts is used for various medicinal purposes like anti-HIV-1, (Hu *et al.*, 1994 and Collins *et al.*, 1997). Its flower syrup is effective against headaches, sore throat and constipation. The extract of flower is used for lowering the cholesterol level and high blood pressure and also used as a cleaner for liver and blood. It is used forfluid deficiency in eyes and treating of spots around the eyes. It is also used for skin softness in cosmetics (Navale *et al.,* 2010). Nitrogen is very crucial for growth and development of plant because it has an important role in photosynthesis. Nitrogen has greater impact on photosynthetic pigment and the formation of enzymes which contributes in carbon cycle. Adequate supply of nitrogen plays a key role in vegetative and reproductive growth (Lawlor, 2002). Nitrogen fertilization is very important because Nitrogen deficiency decreases the leaf area which results in catching of less sun light for photosynthesis. Increasing level of Nitrogen up to 180 kg per ha result inmaximum nodes, number of shoots, number of leaves and leaf area in China aster (Maheshwar, 1997).African orange marigold result in maximum number of leaves, number of shoots and leaf area by the application of150 kg N and 60 kg K2O per ha.Gaillardia result in maximum number of shoots, number of leaves and leaf area by increasing the nitrogen levelfrom 50 to 100 kg ha^{-1}.(Hugar, 1997).Nitrogen improves the vegetative and reproductive growth of Zinnia Cultivar Meteor (khan *et al.,*2004). Chrysanthemum results in premier plant height, number of shoots, number of leaves per plant and leaf area when fertilized with 150 kgN/ha (John *et al.*, 1991). Nitrogen improve the vegetative and floral characteristics of (*Zinnia elegans*) Cultivar Meteor (khan *et al.,* 2004). Successful Chrysanthemum production depends on environmental condition and proper nutrition.It is one of the most famous blooming plant grown all year round (Macz *et al.*, 2001). It is a heavy feeder of nitrogen fertilizer and requires high amount of nitrogen in the first seven weeks but it should be decreased in last three to four weeks of flowering (Yoon *et al.*, 2000). Nitrogen is very essential for the bio synthesis of enzymes in the leaves of Chrysanthemum for the production of bio mass (Liu *et al.*, 2010). Chrysanthemum need less amount of phosphorus than nitrogen (Li *et al.,* 2009). Nitrogen should be applied at 200 kg ha^{-1} for the best vegetative growth of Chrysanthemum. Maximum yield of chrysanthemum can be obtained by the application of Nitrogen and phosphrous20gm^{-2} (Beniwal*et al.,* 2006). Maximum plant height, plant spread and maximum number of branches can be obtained when chrysanthemum is fertilized with 40g N + 20g P_2O_5 m^{-2}. Nitrogen 45gm^{-2}along with phosphorus 45gm^{-2}Significant increase plant height and plant spread in chrysanthemum (Singhlodhi and Tiwari, 1993).In hydroponic production of chrysanthemum, Nitrogen increase leaf area and plant height (Haun g*et al.,* 1997). Nitrogen at the rate of 1000ppm is essential to reduce disease problems, water contamination and to enhance the chrysanthemum production and postharvest performance (Crater, 1992). Optimum level of nitrogen accelerates vegetative and reproductive growth (Lawlor, 2002). Although a lot of work on nitrogen has been done. But due to different genetic make up of cultivars and the importance of nitrogen for the growth,of chrysanthemum, no work has been conducted so far on cultivars response to nitrogen. Therefore the present research work has been conducted keeping in view the following aims and objectives.

1. To find out best level of nitrogen for better growth and flowering of chrysanthemum.

2. To recommend suitable cultivar of chrysanthemum for the agro climatic condition of Peshawar region.

Materials and methods

An investigation entitled "effects of different nitrogen levels on the growth of Chrysanthemum cultivars were studied at Horticulture Farm, The University of Agriculture Peshawar, Khyber-Pakhtunkhawa during 2012. The experiment was consist of Four levels of nitrogen(0, 50, 100, 150 kg/ha) and four chrysanthemum cultivars (Candy Floss, Lillian Jackson, Elizebath Lawson and Harry Revill). The investigation was bedded in (RCBD) and split plot arrangement with two factors. Nitrogen levels wereassigned to the main plot and cultivars wereassigned to the sub plot. The investigation was replicated three times with 16 treatments. Plant spacing was 45 cm and row spacing was 75 cm. The size of each main plot was 3 × 4.5 =13.5 m². The total area of the experimental field was 162 m². Planting was performed on raised bed and all cultural practices were carried out during the experiment.

Treatments Details:

Factor A (Main plot) Nitrogen levels	Factor B (Sub plot) Chrysanthemum cultivars
N0 = 0 Kg N/ha	C1= Candy Floss
N1= 50 Kg N/ha	C2= Lillian Jackson
N2=100 Kg N/ha	C3=Elizabeth Lawson
N3= 150 Kg N/ ha	C4=Harry Revill

1) Field preparation

The field was ploughed will before the installation of the experiment. The plot was kept clean by removing the unwanted plants. The field was leveled and silt was added according to the requirement.

2) Transplanting

Healthy suckers which have no hard woody portion were selected and separated from the pots and were transplanted on the beds up to the level as it was in the pots.

3) Fertilizer application

Recommended dose of NPK was applied to the field. Phosphorus and potassium was assigned to the whole field uniformly as a single dose while Nitrogen was assigned to the field inparts. The first dosage wasutilized at transplanting time and the second was assigned at three weeks interval.

4) Irrigation

First irrigation was practiced after the transplanting of suckers. Later on the plants were irrigated according to their need and environmental conditions.

5) Pinching

The suckers were pinched uniformly before transplanting. The top portion withtwo to three small leaves was removed to encourage the growth of lateral branches.

6) Hoeing and weeding

The experimental plot was kept clean and soft and all the unwanted plants were removed regularly.

Results and discussions

Days to sprouting of lateral shoots

The analyzing of the data expressed that cultivars and nitrogen levels had significantly influenced days to opening of lateral shoots (Table-1). Whereas therewas no impact on interaction between nitrogen and cultivars. The average data for nitrogen levels demonstrated that maximum number of days to sprouting of lateral shoots (20.89) was observed in the control treatment closely followed by (18.84) at 50 kg N ha^{1}. While the minimum number of days to sprouting (15.40) was noticed at 150 kg N ha^{1}. Consering cultivars the mean data showed that the maximum number of days to sprouting of lateral shoots (19.94) was recorded in cultivar Candy Floss closely followed by (18.90) in cultivar Harry Revill. Whereas the minimum number of days to sprouting of lateral shoots (16.28) was recorded in the cultivar Lillian Jackson. Chrysanthemum is a heavy feeder of nitrogen and in the first 5-6 weeks, it require a high amount of nitrogen to encourage the sprouting of lateral bubs Yoon *et al.* (2000). This statement is also in agreement Singh *et al.* (2000) they reported that high level of nitrogen in the early growth stage, improve the sprouting of lateral buds.

Table 1. Days to sprouting of lateral shoot of chrysanthemum as affected by nitrogen levels and cultivars.

Nitrogen Levels					
Cultivars	0	50	100	150	Mean
Candy floss	22.73	20.92	19.08	17.05	19.05a
Lilian Jackson	20.67	17.86	17.17	15.03	17.68b
Elizabeth Lawson	19.06	16.91	15.70	13.45	16.28c
Harry revill	21.09	19.67	18.75	16.06	18.90ab
Mean	20.89a	18.84b	17.67b	15.40c	

LSD value for Nitrogen at 0.05% level of probability = 1.77. LSD value for cultivars at 0.05% level of probability= 1.26. LSD value for interaction at 0.05% level of probability = 2.52. Means followed by same letters are not significantly different by using LSD at 0.05% (upper case) level of significance.

Table 2. Growth rate (cm) week^{-1} of lateral shoots as affected by nitrogen levels and cultivars.

Nitrogen kg/ha					
Cultivars	0	50	100	150	Mean
Candy Floss	2.73	2.93	3.88	3.96	3.38c
Lilian Jackson	3.74	4.05	4.81	4.99	4.39b
Elizabeth Lawson	4.37	4.48	5.57	5.94	5.09a
Harry Revill	2.90	3.03	4.50	4.63	3.77c
Mean	3.43b	3.62b	4.69a	4.88a	

LSD value for Nitrogen at 0.05% level of probability = 0.65. LSD value for cultivars at 0.05% level of probability= 0.60. LSD value for interaction at 0.05% level of probability = 1.20. Means followed by same letters are not significantly different by using LSD at 0.05% (upper case) level of significance.

Growth rate of lateral shoots (cm) week^{-1}

It is cleared from the analyzing data that cultivars as well as nitrogen levels significantly influenced the growth rate of lateral shoots (Table-2).However the interaction was non effective. The average data pertaining to nitrogen levels indicated that the maximum growth rate of lateral shoots (4.88cm) observed at 150 kg N ha^{-1} closely followed by (4.69cm) at 100 kg N ha^{-1}. Whereas leastgrowth rate of lateral shoots (3.43cm) was recorded in the control treatment. Nitrogen showed positive relation with the growth rate of lateral shoots. On the other hand the mean values for cultivars indicated that the maximum growth rate of lateral shoots (5.09cm) was observed inElizabeth Lawson closely followed by (4.39cm) in cultivar Lillian Jackson. While the minimum growth rate of lateral shoots (3.38cm) was recorded in cultivar Candy Floss. Proper dose of nitrogen is responsible to encourage vegetative growth. These outcomes resemblance with the statement of John *et al.* (1991) revealed that, increasing nitrogen level from 50 to 150 kg ha^{1}, enhanced the growth rate in Zinnia. These findings are also in conformity with Khan *et al.* (2004) who reported maximum growth at higher level of nitrogen as compared to control treatment.

Table 3. Number of lateral shoots plant^{-1}as affected by nitrogen levels and cultivars.

Nitrogen kg/ha					
Cultivars	0	50	100	150	Mean
Candy Floss	31	34.15	35.12	37.85	34.53c
Lillian Jackson	32.33	38.20	41.17	45.52	39.31b
Elizabeth Lawson	35.05	40.07	45.06	50.27	42.62a
Harry Revill	31.72	34.11	37.19	41.28	36.08b
Mean	32.53d	36.63c	39.64b	43.73a	

LSD value for Nitrogen at 0.05% level of probability = 2.97. LSD value for cultivars at 0.05% level of probability= 1.80. LSD value for interaction at 0.05% level of probability = 3.60. Means followed by same letters are not significantly different by using LSD at 0.05% (upper case) level of significance.

Table 4. Number of leaves plant^{-1} as influenced by nitrogen levels and cultivars.

Nitrogen kg/ha					
Cultivars	0	50	100	150	Mean
Candy Floss	149.67	167.25	172.08	184.07	168.27d
Lilian Jackson	166.69	175.31	180.71	213.37	184.02b
Elizabeth Lawson	172.90	177.09	184.14	236.69	192.71a
Harry Revill	157.31	171.42	181.69	189.72	175.03c
Mean	161.64c	172.77b	179.65b	205.96a	

LSD value for Nitrogen at 0.05% level of probability = 7.94. LSD value for cultivars at 0.05% level of probability= 5.72. LSD value for interaction at 0.05% level of probability = 11.44. Means followed by same letters are not significantly different by using LSD at 0.05% (upper case) level of significance.

Number of lateral shoots plant^{-1}

The data expressed that cultivars and nitrogen levels had significantly influencedthe number of lateral shoots and the interaction among nitrogen and cultivar was non-effective (Table 3).

The average data viewing nitrogen levels suggested that the highest number of lateral shoots plant^{-1} (43.73) was achieved by treating nitrogen at the rate of 150 kg ha^{1} closely followed by (39.64) at 100 kg N ha^{-1}. However lowestnumber of lateral shoots plant^{-1} (32.53) was obtained from the control treatment. Whereas the mean data pertaining to cultivars represented that maximum number of lateral shoots plant^{-1} (42.62) was recorded in cultivar Elizabeth Lawson closely followed by (39.31) in cultivar Lillian Jackson. However the minimum number of lateral shoots plant^{-1} (34.53) was obtained from cultivar Candy Floss. High supply of nitrogen to the roots is responsible to stimulate and export cytokine to the shoots. The increased cytokines caused the lateral buds to sprout which result in more number of cuttings.

These lines are in agreement with Rachayanavar (1987) who recorded maximum number of lateral shoots at high level of nitrogen in the same plant. This statement is also in conformity with Avari (1993) who stated that increasing level result in maximum number of lateral shoots. Joshi *et al.* (2013) also reported the same results in the same plant.

Table 5. Leaf area (cm^2) as effected by nitrogen levels and cultivars.

	Nitrogen kg/ha				
Cultivars	0	50	100	150	Mean
Candy Floss	12.78	13.91	15.02	15.77	14.37b
Lilian Jackson	13.73	14.80	16.88	17.84	15.81ab
Elizabeth Lawson	14.51	16.33	18.02	19.74	17.15a
Harry Revill	13.34	14.47	15.43	16.07	14.83b
Mean	13.59d	14.88c	16.34b	17.35a	

LSD value for Nitrogen at 0.05% level of probability = 0.73. LSD value for cultivars at 0.05% level of probability= 1.45. LSD value for interaction at 0.05% level of probability = 2.90. Means followed by same letters are not significantly different by using LSD at 0.05% (upper case) level of significance.

Table 6. Number of rootsplant^{-1}as affected by nitrogen levels and cultivars.

	Nitrogen kg/ha				
Cultivars	0	50	100	150	Mean
Candy Floss	40.68	47.40	52.50	55.07	48.91c
Lilian Jackson	42.74	50.97	53.72	56.40	50.96ab
Elizabeth Lawson	45.80	52.53	54.87	57.78	52.74a
Harry Revill	41.79	49.43	53.30	54.66	49.80bc
Mean	42.75c	50.08b	52.50a	55.07a	

LSD value for Nitrogen at 0.05% level of probability = 2.68. LSD value for cultivars at 0.05% level of probability= 1.92. LSD value for interaction at 0.05% level of probability = 3.84. Means followed by.

Number of leaves plant^{-1}

Analyzing data demonstrated that nitrogen and cultivar significantly impact leaves number plant^{-1} and the interaction between them was also significant (Table 4). The average data concerning nitrogen levels expressed that the premier number of leaves plant^{-1} (205.96) was achieved by the application of 150 kg N ha^1 followed by (179.65) at 100 kg N ha^1. However the minimum number of leaves plant^{-1} (161.64) was obtained from the control treatment. While the mean data for cultivars revealed that the maximum number of leaves plant^{-1} (192.71) was obtained from cultivar Elizabeth Lawson followed by (184.02) from Lillian Jackson whereas the minimum number of leaves plant^{-1} was achieved from cultivar Candy Floss. Similarly mean values for interaction showed that the maximum number of leaves plant^{-1} (236.69) was obtained from cultivar Elizabeth Lawson treated with 150 kg N ha^1 while the minimum number of leaves plant^{-1} (149.67) was observed in cultivar Candy Floss with control treatment. Nitrogen is an important constituent of nucleotide and plays a crucial role in the energy metabolism hence it controls the growth of plant during vegetative stage Bergmann (1992). These results are in lines with Dorageero *et al.* (2012) who recorded maximum number of leaves at 150 kg N ha^1 in the same plant. John *et al.* (1991) also reported maximum number of leaves with increasing nitrogen level.

Table 7. Root length (cm) as influenced by nitrogen levels and cultivars.

Nitrogen kg/ha					
Cultivars	0	50	100	150	Mean
Candy Floss	10.45	12.70	12.91	13.85	12.48c
Lilian Jackson	12.24	14.01	14.32	16.15	14.18b
Elizabeth Lawson	14.03	15.07	17.05	18.07	16.05a
Harry Revill	11.54	13.30	13.61	14.44	13.22bc
Mean	12.07c	13.77b	14.47ab	15.63a	

LSD value for Nitrogen at 0.05% level of probability = 1.47. LSD value for cultivars at 0.05% level of probability= 1.13. LSD value for interaction at 0.05% level of probability = 2.26. Means followed by same letters are not significantly different by using LSD at 0.05% (upper case) level of significance.

Leaf area (cm^2)

The data expressed that nitrogen levels had significantly impact while the interaction among the two was non effective (Table 5). The average data pertaining to nitrogen levels revealed that the maximumleaf area (17.35cm^2) was noticed by treating the plants with 150 kg N ha^1 closely followed by (16.34cm^2) at 100 kg N ha^{-1}. While the minimum leaf area (13.59cm^2) was noticed in control treatment. However the mean data regarding to cultivars indicated that maximum leaf area (17.15cm^2) was observed in cultivar Elizabeth Lawson followed by (15.81cm^2) in cultivar Lillian Jackson. While the minimum leaf area (14.37cm^2) was observed in cultivar Candy Floss. Nitrogen as a part of amino acid, proteins, chlorophyll and also a crucial part of protoplasm Schuch *et al.* (1998). Nitrogen takes part in energy metabolism Bergmann. (1992). These statement are in agreement with Joshi *et al.* (2013) who reported that increasing nitrogen level, enhanced cell division in Chrysanthemum which results in maximum leaf area. These findings are also in lines with Khan *et al.* (2004) who observed maximum leaf area at higher nitrogen level in Zinnia.

Table 8. Root diameter (mm) as affected by nitrogen levels and cultivars.

	Nitrogen kg/ha				
Cultivars	0	50	100	150	Mean
Candy Floss	3.63	3.93	4.15	4.58	4.07
Lilian Jackson	4.40	4.37	4.72	4.97	4.61
Elizabeth Lawson	4.67	4.74	5.23	5.50	5.04
Harry Revill	4.18	3.98	4.53	4.44	4.28
Mean	4.22	4.26	4.66	4.87	

Number of roots plant^{-1}

Nitrogen and cultivars significantly influenced the number of roots plant^{-1}whereas the interaction between the two factors was non-effective (Table 6). The average data concerning to nitrogen levels indicated that maximum the number of roots plant^{-1} (55.07) was observed by treating the plants with 150 kg ha^1 closely followed by (52.50) at 100 kg N ha^{-1}. While the least number of roots plant^{-1} (42.75) was observed in the control treatment. While the mean value pertaining to cultivars revealed that the maximum roots number plant^{-1} (52.74) was observed in cultivar Elizabeth Lawson closely followed by (50.96) in cultivar Lillian Jackson. Whereas the least roots number plant^{-1} (48.91) was noticed in cultivar Candy Floss. Optimal level of nitrogen increases the number of roots to balance the root and shoot ratio and to regulate the nutrient and water supply for the abundant foliage Belgaonkar *et al.* (1996). These results are in agreement with Shafi*et al.* (2001) worked on gaillardia, who stated that nitrogen augmenting the number of roots but it negatively affected the number of roots per plant beyond the critical value.

Root length (cm)

Analyzing data demonstrated that nitrogen and cultivars significantly influenced the root length whereas the interaction among nitrogen and cultivars was non effective (Table 7). The average data regarding to nitrogen levels revealed that the maximum root length (15.63cm) was noticed at 150 kg N ha^1 closely followed by (14.47cm) at 100 kg N ha^{-1}. Whereas the lowest root length (12.07cm) was observed in the control treatment. While the mean data about cultivars indicated that the maximum root length (16.05cm) was noticed in cultivar Elizabeth Lawson closely followed by (14.18cm) in cultivar Lillian Jackson. Whereas the minimum root length (12.48cm) was noticed in cultivar Candy Floss. Nitrogen is crucial for root growth and elongation and its deficiency will influence the assimilation of other nutrients (Alam and Naqvi, 2003). These finding are also in lines with Khan *et al.*2007. They reported that suitable dose of nitrogen result in premier root length.

Root diameter (mm)

It is evident from the analyzing data that nitrogen and cultivars had non-significant effect on the root diameter of chrysanthemum (Table 8). The mean data relating to nitrogen levels indicated that the premierroot diameter (4.87mm) was observed at 150 kg N ha^{-1} closely followed by (4.66mm) at 100 kg N ha^{-1}. Whereas the smallest root diameter (4.22mm)was noticed in the control treatment. Whereas the mean value for cultivars represent that the premier root diameter (5.04mm) was observed in cultivar Elizabeth Lawson closely followed by (4.61mm) in cultivar Lillian Jackson. While the smallest root diameter (4.07mm) was observed in cultivarCandy Floss. While the interaction values revealed that the premier root diameter (5.50mm) was recorded in cultivar Elizabeth Lawson by treating it with 150 kg N ha^{1}. Although the smallest root diameter (3.63mm) was observed in cultivar Candy Floss with control condition. The interaction among nitrogen and cultivar was non-significant.

Conclusions

On the basis of current research study, it is concluded that superior performance was observed when 150 kg N ha^{-1} for cultivar Elizabeth Lawson under the agro climatic condition of Peshawar.

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