EFFECT OF NITROGEN AND PHOSPHORUS APPLICATION ON GROWTH AND FLOWERING OF ZINNIA (*Zinnia elegans*) var. BENARY′S GIANT MIX.

Abdul Kareem A. J. Mohammad Saeed

Department of Horticulture and Landscaping, Agriculture College, Diyala University, Iraq.

Email: kareemmohammad56@yahoo.com

ABSTRACT

An experiment was conducted to study the impact of adding different levels of nitrogen and phosphorus in growth and flowering of Zinnia (*Zinnia elegans*) var. Benary′s Giant Mix. The study included addition of four levels of nitrogen 0, 125, 175 and 225 $kg.ha^{-1}$ and four levels of phosphorus 0, 125, 175 and 225 $kg.ha^{-1}$, with a constant level of Potassium (125 $kg.ha^{-1}$) for each treatment. Full dose of phosphorous and potassium along with half dose of nitrogen was applied to the soil pots during the process of transplanting. The remaining half dose of nitrogen was given at 30 days after transplanting. The results can be summarized as follows.

It was noted that each increase in the level of nitrogen have led to an increase in plant height and the content of N and P in leaves. Treatment with 175 $kg.ha^{-1}$ of nitrogen was superior on increasing number of leaves, leaf area, number of branches, dry weight of shoots, number of flowers, early flowering, flower diameter, flower dry weight and vase life .

Each increase in the level of phosphorous has led to an increase in plant height and the content of N and P in leaves. Treatment with 125 $kg.ha^{-1}$ of phosphorous was superior on increasing number of leaves, leaf area, number of branches, dry weight of shoots, number of flowers, early flowering, flower diameter, flower dry weight and vase life.

The interaction effect between nitrogen and phosphorus was significant in vegetative growth and flowering qualities, as was observed that with each increase in the level of nitrogen with a constant level of phosphorus, there was an increase in plant height and content of N and P in leaves. Treatment with combination 225:225 $kg.ha^{-1}$ (N3P3) gave highest plants and an increase in content of N and P in leaves, while treatment with combination 175:125 $kg.ha^{-1}$ (N2P1) was superior on increasing number of leaves, leaf area, number of branches, dry weight of shoots, number of flowers, early flowering, flower diameter, flower dry weight and vase life .

Keywords: *Zinnia elegans*, nitrogen, phosphorus, vegetative growth, flowering.

INTRODUCTION

Zinnia elegans is the most famous annuals summer plants in Iraq. Common species are grown in gardens increasingly in dry sunny places (Sultan et al., 1992). Zinnia genus includes more than 20 species of annuals and perennials which belong to the family Asteraceae. Mexico is the homeland of this plant (Baloch, 2010). Zinnia stem covered with coarse hair with sitting opposite oval leaves. Flowers in inflorescence with various shapes and colors. Single and half double inflorescence varieties are grown in gardens basins either double are preferred in commercial harvest (Al-Chalabi and Al-Khayat, 2013). Zinnia is a favorite to the owners of the gardens for many generations and this attention led to the development of hundreds of various forms and sizes ranging from dwarf to giant, dwarf of them used in rock gardens, basins of flowers, pots, hanging baskets and as plants filler, while the longer ones used in the production of cut flowers (Kessler, 2008).

Nutrition plays an essential role in the improvement of vegetative growth and flower yield of annual flowering crops as in others. They are known to respond well to the application of nutrients. Proper supply of nutrients particularly that of major ones influence not only crop growth, but also yield and quality are largely dependent upon it. However, the individual effect of any of these nutrients cannot be a comprehensive result of its own. Their individual effects are always mutually influenced by the dosages of the others and hence, have to be studied in combination. This fact is true with all essential elements, even though some of them are generally required in lesser quantities (Pimple et al., 2006). Many studies have pointed to the role of nitrogen and phosphorus in improving vegetative growth and flowering for many ornamental plants. Acharya and Dashora (2004) reported that application of 200 $kg.ha^{-1}$ each of nitrogen and phosphorus produced the maximum height of the plant and the largest number of branches, earlier flowers with maximum diameter. The maximum number of flowers was recorded with 150 kg N ha^{-1} and 200 kg P ha^{-1} in African marigold cv. Pusa Basanti Gainda. Baboo et al.(2005) observed that the tallest plants with maximum number of leaves, diameter and spread were produced by the plants receiving 300 kg N and 200 kg P_2O_5 ha^{-1} in African marigold. Application of N at 300 $kg.ha^{-1}$ recorded the highest length of flower stalk, number of flowers per plant, size of flower head, weight flowers per plant and flower yield per ha. All these parameters except stalk length were on par with those recorded at 200 kg N per ha. Application of Phosphorus at 200 $kg.ha^{-1}$ recorded the highest values of number of flowers per plant, size of flower head, weight of flowers per plant and flower yield per ha. Application of nitrogen at 200 $kg.ha^{-1}$ and 100 kg P_2O_5 ha^{-1} produced maximum plant height, number of primary and secondary branches per plant, plant spread and number of leaves per plant, in addition to a significant increase in fresh and dry weight of flowers, flowering duration, number of flowers per plant and harvest flowers (Sharma et al., 2006).

MATERIALS AND METHODS

This study was carried out in one of baghdad's municipality nurseries in the year 2013, Zinnia seeds (var. Benary's Giant Mix) which obtained from local market were planted in 10/3/2013, the plants were transferred to 25 cm pots contained 5 kg of sandy loam soil after two months,table (1) shows some of the physical and chemical characteristics of the culture soil. The study included addition of four levels of nitrogen supplier of urea (N 46%) which is N0 (0 kg.ha^{1}), N1 (125 kg.ha^{1}), N2 (175 kg.ha^{1}) and N3 (225 kg.ha^{1}), and addition of four levels of phosphorus supplier of mono superphosphate (P_2O_5 18%) which is P0 (0 kg.ha^{1}), P1 (125 kg.ha^{1}), P2 (175 kg.ha^{1}) and P3 (225 kg.ha^{1}), with a constant level of Potassium (125 kg.ha^{1}) for each treatment. The amount of fertilizer has been weighted according to each combination of the treatments mentioned above. Full dose of phosphorous and potassium along with half dose of nitrogen was applied to the soil pots during the process of transplanting. The remaining half dose of nitrogen was given at 30 days after transplanting.

The Experiment measures had been taken at the full bloom stage. It included the vegetative growth qualities like plant height, number of leaves per plant, number of branches (main and secondary) per plant, leaf area per plant, dry weight of shoots, the content of nitrogen and phosphorus in leaves, and flowering growth qualities like number of flowers per plant, the date of flowering, flower diameter, flower dry weight and vase life. To determine the content of nitrogen and phosphorus in the leaves, samples of leaves was collected at the beginning of flowering and the amount of nitrogen was measured by Microkjeldahl as described by Tandon (1993), and phosphorus by spectrophotometer using a standard curve (AOAC, 1984).

Table (1): Some of the chemical and physical characteristics of the culture soil.

The character	The value	The unit
pH	٧.٢٠	-
EC	٣.٨٣	dS.m^{-1}
Available N	41	mg.kg^{-1}
Available P	٥٢	mg.kg^{-1}
Available K	٢١١	mg.kg^{-1}
Organic matter	٢.٥٠	%
Soil Separation		
Sand	٦٣٠	g.kg^{-1}
Clay	٢٨٠	g.kg^{-1}
Silt	٤٦	g.kg^{-1}
Soil structure	Sandy Loam	

Table (2): Number of treatments, their symbols and fertilizer combination.

Number of treatments	Fertilizer combination	Symbols	Unit
1	0: 0: 125	N0 P0 K	$Kg.ha^{1}$
2	0: 125: 125	N0 P1 K	
3	0: 175: 125	N0 P2 K	
4	0: 225: 125	N0 P3 K	
5	125: 0: 125	N1 P0 K	
6	125: 125: 125	N1 P1 K	
7	125: 175: 125	N1 P2 K	
8	125: 225: 125	N1 P3 K	
9	175: 0: 125	N2 P0 K	
10	175: 125: 125	N2 P1 K	
11	175: 175: 125	N2 P2 K	
12	175: 225: 125	N2 P3 K	
13	225: 0: 125	N3 P0 K	
14	225: 125: 125	N3 P1 K	
15	225: 175: 125	N3 P2 K	
16	225: 225: 125	N3 P3 K	

The experiment had been conducted as a factorial 4×4 on the RCBD design with three replicates and three pots for each one, table (2) shows the number of treatments, their symbols and fertilizer combination used in the experiment. The data were analyzed according to the statistical program GenStat. Averages were compared using the less significant difference LSD test at the level of probability 0.05 (Al-Rawi and Mohammed, 2000).

RESULTS

1. Effect of nitrogen, phosphorus, and their interaction in vegetative growth qualities of Zinnia elegans var. Benary′s Giant Mix.

The data on various growth parameters, i.e. plant height, number of leaves, leaf area, number of branches, and dry weight of shoots, nitrogen and phosphorus content in leaves are tabulated in table 3-6.

Each increase in the level of nitrogen and phosphorus has led to an increase in plant height. Significant differences existed in the plant height due to nitrogen, phosphorus as well as their interaction. Maximum plant height was recorded by N3 (105.78 cm), P3 (103.81 cm) and N3P3 (111.19 cm). N3 was on par with N2 with a plant height of 103.68 cm, but significantly superior to N1 and N0. Also P3 was on par with P2 which recorded a plant height of 101.80 cm, but significantly superior to P1 and P0. Among the interactions, N3P3 was on par with the treatment combinations of N3P2 and N2P3 N2P2, N1P3 and significantly superior to the rest of the combinations.

There were significant differences with respect to number of leaves per plant due to nitrogen, phosphorus as well as their interaction. Maximum number of leaves was recorded by N2 (206.64), P1 (202.62) and N2P1 (217.18). N2 was on par with N3 having 204.09 leaves per plant, but significantly superior to N1 and N0. P1 was significantly superior to the rest of the treatments. Among the interactions, N2P1 was on par with the treatment combination N3P1 (215.66 leaves per plant) but significantly superior to the rest of the combinations.

Table (3): Effect of nitrogen, phosphorus, and their interaction in plant height and number of leaves per plant of *Zinnia elegans* var. Benary's Giant Mix.

Treatment	Plant height (cm)					Number of leaves per plant				
	P0	P1	P2	P3	Mean	P0	P1	P2	P3	Mean
N0	78.00	84.38	87.55	89.33	84.82	١٥٣.٦	١٧٦.٠	164.96	175.59	167.55
N1	92.70	100.04	103.68	105.73	100.54	190.52	201.58	181.99	198.23	193.08
N2	95.64	103.17	106.91	109.01	103.68	207.04	217.18	202.12	200.23	206.64
N3	97.60	105.26	109.06	111.19	105.78	200.36	215.66	193.45	206.90	204.09
Mean	90.99	98.21	101.80	103.81	98.71	١٨٧.٨	202.62	185.63	195.24	192.84
L.S.D 0.05										
N	3.06					4.19				
P	2.90					3.96				
N×P	5.71					7.41				

The effect of nitrogen, phosphorus levels as well as their interaction was found to be significant on leaf area per plant. Maximum leaf area was recorded by N2 (3199.6 cm^2), P1 (3207.0 cm^2) and N2P1 (3390.0 cm^2). N3 significantly superior to the rest of the treatments, and minimum leaf area per plant (2869.7 cm^2) being recorded by N0. P1 was significantly superior to the rest of the treatments. Among the interactions, the treatment combination N2P1 was significantly superior to N3P1 (3288.9 cm^2) and the rest of combinations.

There were significant differences on number of branches per plant due to nitrogen, phosphorus as well as their interaction. Maximum number of branches was recorded by N2 (32.57), P1 (31.30) and N2P1 (35.28). N2 was significantly superior to the rest of the treatments. P1 was significantly superior to the rest of the treatments. Among the interactions, N2P1 was on par with the treatment combination N2P2 (34.09 branches per plant) but significantly superior to the rest of the combinations.

Table (4): Effect of nitrogen, phosphorus, and their interaction in leaves area and number of branches per plant of *Zinnia elegans* var. Benary's Giant Mix.

Treatment	Leaf area per plant (cm^2)					Number of branches per plant				
	P0	P1	P2	P3	Mean	P0	P1	P2	P3	Mean
N0	2762.1	2953.1	2843.7	2919.9	2869.7	١٨.٦٥	٢٦.٠٠	16.99	19.95	20.40
N1	2926.5	3196.1	2994.6	3070.5	3046.9	24.92	29.28	23.33	25.90	25.86
N2	3108.2	3390.0	3167.1	3132.9	3199.6	28.92	35.28	34.09	32.01	32.58
N3	3054.9	3288.9	2983.8	3068.3	3099.0	30.23	34.66	27.05	28.61	30.14
Mean	2962.9	3207.0	2997.3	3047.9	3053.8	٢٥.٦٨	32.30	25.36	26.62	27.23
L.S.D 0.05										
N	37.88					1.57				
P	37.72					1.42				
N×P	66.78					2.29				

The results showed that the effect of nitrogen, phosphorus levels as well as their interaction was found to be significant on the dry weight of shoots. Largest dry weight was recorded by N2 (46.60 g), P1 (46.33 g) and N2P1 (48.73 g). N2 was significantly superior to the rest of the treatments. P1 was significantly superior to the rest of the treatments. Among the interactions, the treatment combination N2P1 was significantly superior to the rest of combinations, fig. 1.

Table (5): Effect of nitrogen, phosphorus, and their interaction in Dry weight of shoots (g) of *Zinnia elegans* var. Benary's Giant Mix.

Treatment	Dry weight of shoots (g)				
	P0	P1	P2	P3	Mean
N0	٤٠.٣٦	٤٢.٩٥	٤١.٠٩	٤٢.٤٢	٣١.٧١
N1	٤٣.٣٠	٤٦.٠٤	٤٣.٢٨	٤٤.٦٠	٤٤.٣١
N2	٤٥.٧٨	٤٨.٧٣	٤٥.٩١	٤٥.٩٨	٤٦.٦٠
N3	٤٥.٤٦	٤٧.٦١	٤٣.٥٦	٤٤.٨٤	٤٥.٣٧
Mean	٤٣.٧١	٤٦.٣٣	٤٣.٤٦	٤٤.٤٦	44.49
L.S.D 0.05					
N	٠.٥١				
P	٠.٤٦				
N×P	٠.٩٣				

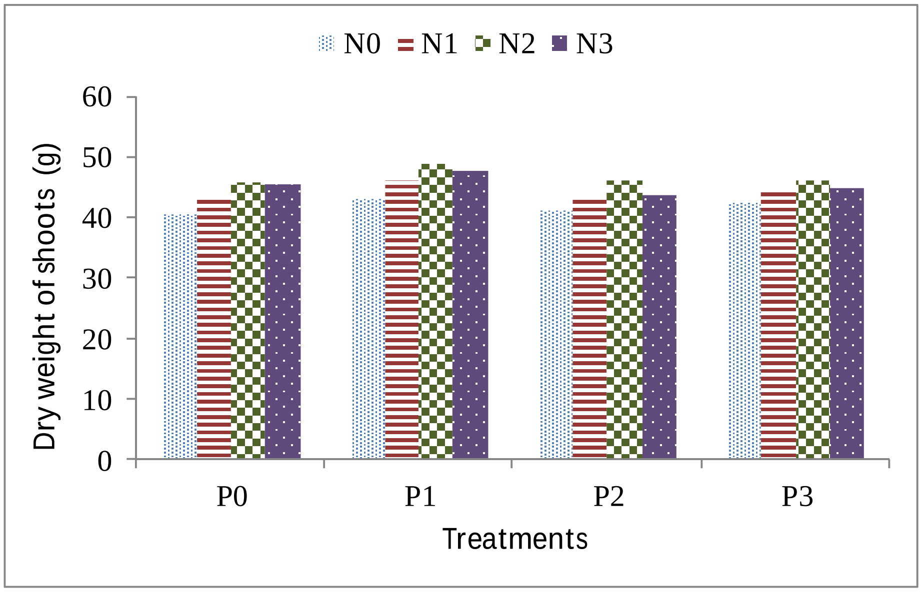

Fig. (1): Effect of nitrogen, phosphorus, and their interaction in dry weight of shoots of *Zinnia elegans* var. Benary's Giant Mix.

Nitrogen content differed significantly by varying the doses of nitrogen, phosphorus and their interactions in the leaves. Maximum content of nitrogen in leaf was recorded by the treatment of N3 (3.97%), P1 (3.40%) and N3P3 (4.07%). N3 was followed by N2 (3.89%) and minimum nitrogen content in the leaves (2.29%) being recorded by N0. P1 was significantly superior to the rest of the treatments. Among the interactions, the treatment combination N3P3 was significantly superior to the rest of combinations.

Table (6): Effect of nitrogen, phosphorus, and their interaction in Content of nitrogen and phosphorus in leaves of *Zinnia elegans* var. Benary's Giant Mix.

Treatment	Content of nitrogen in leaves (%)					Content of phosphorus in leaves (%)				
	P0	P1	P2	P3	Mean	P0	P1	P2	P3	Mean
N0	٢.٠٣	٢.٢١	٢.٣٧	٢.٥٤	٢.٢٩	٠.٢٤	٠.٢٤	٠.٢٦	٠.٣٠	٠.٢٦
N1	٢.٦٠	٢.٧٩	٢.٨٨	٢.٩٣	٢.٨٠	٠.٢٩	٠.٣٣	٠.٣٤	٠.٣٤	٠.٣٣
N2	٣.٦٣	٣.٩٠	٣.٩٨	٤.٠٥	٣.٨٩	٠.٤٣	٠.٤٦	٠.٤٧	٠.٤٨	٠.٤٦
N3	٣.٨١	٤.٠٠	٤.٠٢	٤.٠٧	٣.٩٧	٠.٤٥	٠.٤٧	٠.٤٨	٠.٤٩	٠.٤٧
Mean	٣.٠٢	٣.٢٣	٣.٣١	٣.٤٠	3.24	٠.٣٥	٠.٣٨	٠.٣٩	٠.٤٠	0.38
L.S.D 0.05										
N	٠.٣٠					٠.١١				
P	٠.١١					٠.٠٤				
N×P	٠.٦٠					٠.٢١				

There were significant differences in phosphorus content among the various doses of nitrogen, phosphorus and their interactions in the leaves. Maximum content of phosphorus in leaf was observed by the treatment of N3 (0.46%), P3 (0.40%) and by the combination N3P3 (0.49%). N3 level was on par with N2 (0.46%). The combination N3P3 was on par with lower levels till N3P1 (0.47%) but significantly superior to still lower doses.

2. **Effect of nitrogen, phosphorus, and their interaction in flowering growth qualities of *Zinnia elegans* var. Benary′s Giant Mix.**

The results on various flowering parameters i.e. number of flowers per plant, flowering date, flower diameter, dry weight of flower, and the vase life are tabulated in table 7-9.

The effect of different levels of nitrogen, phosphorus and their interactions was found to be significant on number of flowers per plant. N2 level recorded the highest number of flowers per plant (32.52) which was significantly superior to N3 (26.14) and the rest of the treatments whereas, among phosphorus doses, P1 level was the best with 32.13 flowers per plant. Among the interactions, the treatment combination of N2P1 recorded the highest number of flowers per plant (39.31) and significantly superior to the rest of combinations.

Flowering date was varied significantly among the different levels of nitrogen, phosphorus and their interactions. N2 level took the least number of days for flowering date (51.83 days) which was significantly earlier to N3 (54.33 days) whereas, among phosphorus doses, P1 level was the earliest (51.92 days) for flowering date. Among the interactions, the treatment combination of N2P1 (51.00 days) was the earliest for flowering date. N2P1 was on par with the treatment combinations of N1P1 and N2P2 and significantly superior to the rest of the combinations.

Table (7): Effect of nitrogen, phosphorus, and their interaction in number of flowers per plant and flowering date of *Zinnia elegans* var. Benary′s Giant Mix.

Treatment	number of flowers per plant					flowering date (day)				
	P0	P1	P2	P3	Mean	P0	P1	P2	P3	Mean
N0	١٤.٣٩	٢٥.٠٣	٢٠.١٣	١٨.٩٠	١٩.٦١	٥٣.٦٧	٥٢.٠٠	٥٢.٣٣	٥٤.٣٣	٥٣.٠٨
N1	١٨.٩٤	٣٠.٦٠	٢٤.٧٢	٢٤.٢٥	٢٤.٦٣	٥٣.٣٣	٥١.٣٣	٥١.٦٧	٥٢.٦٧	٥٢.٣٥
N2	٢٧.٦٧	٣٩.٣١	٢٥.٢٧	٢٧.٨٤	٣٢.٥٢	٥٢.٣٣	٥١.٠٠	٥١.٣٣	٥٢.٦٧	٥١.٨٣
N3	٢٣.٢٥	٣٣.٥٩	٢٤.٣٩	٢٣.٣٥	٢٦.١٤	٥٤.٦٧	٥٣.٣٣	٥٤.٠٠	٥٥.٣٣	٥٤.٣٣
Mean	٢١.٠٦	٣٢.١٣	٢٦.١٣	٢٣.٥٨	25.73	٥٣.٥٠	٥١.٩٢	٥٢.٤٣	٥٣.٧٥	52.90
L.S.D 0.05										
N	١.٤٢					٠.٢٩				
P	١.٣٣					٠.٢٣				
N×P	٢.٦٩					٠.٤١				

There were significant differences in the flower diameter values among the different levels of nitrogen, phosphorus and their interactions. The largest flowers were obtained by the treatments N2 (8.53 cm), P1 (8.36 cm) and their combination N2P1 (9.27 cm). N2 was significantly superior to the rest of the treatments. P1 was significantly superior to the rest of the treatments. Among the interactions, the treatment combination N2P1 was significantly superior to the rest of combinations.

Table (8): Effect of nitrogen, phosphorus, and their interaction in flower diameter and dry weight of flower of *Zinnia elegans* var. Benary's Giant Mix.

Treatment	flower diameter (cm)					dry weight of flower (g)				
	P0	P1	P2	P3	Mean	P0	P1	P2	P3	Mean
N0	٦.٧٣	٧.٦١	٧.٢١	٦.٩٢	٧.١٢	١.٨٧	٢.٧٦	٢.٣٥	٢.٢٥	٢.٣١
N1	٧.٥٨	٨.٣٥	٧.٨٨	٧.٥٩	٧.٨٥	٢.٢٥	٣.٢٢	٢.٧٣	٢.٦٩	٢.٧٢
N2	٧.٨٦	٩.٢٧	٨.٧٣	٨.٢٧	٨.٥٣	٢.٩٨	٣.٩٥	٣.٦١	٢.٩٩	٣.٣٨
N3	٨.٣٢	٨.٢٣	٧.٧٧	٧.٤٤	٧.٩٤	٢.٦١	٣.٤٧	٢.٧٠	٢.٦٢	٢.٨٥
Mean	٧.٦٢	٨.٣٦	٧.٩٠	٧.٥٦	7.86	٢.٤٣	٣.٣٥	٢.٨٥	٢.٦٤	2.82
L.S.D 0.05										
N	٠.١٤					٠.١٠				
P	٠.١١					٠.٠٩				
N×P	٠.٢٧					٠.١٦				

Table (9): Effect of nitrogen, phosphorus, and their interaction in vase life (day) of *Zinnia elegans* var. Benary's Giant Mix.

Treatment	vase life (day)				
	P0	P1	P2	P3	Mean
N0	٥.٤٠	٨.١٠	٧.٣٠	٦.٧٠	٦.٨٨
N1	٦.٩٠	٨.٧٠	٧.٨٠	٧.٩٠	٧.٨٣
N2	٨.٨٠	١١.١٠	١٠.٠٠	٩.٢٠	٩.٧٨
N3	٨.٦٠	٩.٦٠	٨.٦٠	٧.٨٠	٨.٦٥
Mean	٧.٤٣	٩.٣٨	٨.٤٣	٧.٩٠	8.29
L.S.D 0.05					
N	٠.٢١				
P	٠.٢٠				
N×P	٠.٥٧				

The results showed that the effect of nitrogen, phosphorus levels as well as their interaction was found to be significant on the dry weight of the flower. Largest dry weight was recorded by N2 (3.38 g), P1 (3.35 g) and N2P1 (3.95 g). N2 was significantly superior to the rest of the treatments. P1 was significantly superior to the rest of the treatments. Among the interactions, the treatment combination N2P1 was significantly superior to the rest of combinations.

The effect of nitrogen and phosphorus levels and their interactions was found to be significant on vase life of Zinnia flowers. The highest vase life was recorded by N2 (9.78 days), P1 (9.38 days) and N2P1 combination (11.10 days), fig. 2.

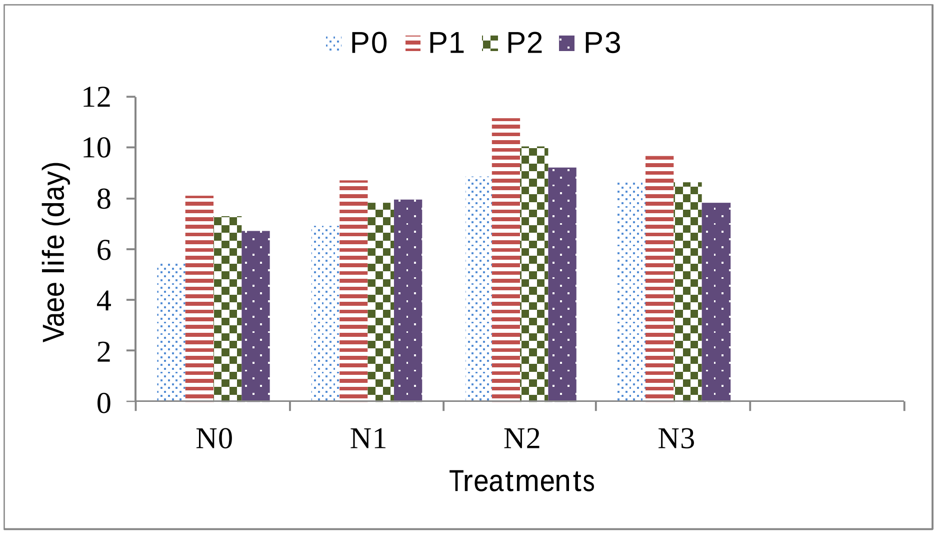

Fig. (2): Effect of nitrogen, phosphorus, and their interaction in vase life of *Zinnia elegans* var. Benary's Giant Mix.

DISCUSSION

The results show that each increase in nitrogen level has led to an increase in plant height and the content of N and P in the leaves. The highest increase in number of leaves per plant, number of branches per plant, leaf area, and dry weight of shoots have been recorded at the nitrogen level of 175 kg.ha^{-1}, However, a decrease in these qualities have been observed when increasing the dose of nitrogen for this level. The downward trend in the number of branches per plant when increasing the nitrogen level for a certain level is consistent with what Hugar (1997) found in *Gaillardia pulchella*, while the trend towards low dry weight when increasing the nitrogen level for a certain level is consistent with what Sonawane (2008) found in China aster plants. The increase in plant height, number of branches per plant, and leaf area may be due to the availability of these key nutrients, which lead to better growth due to increased cell division and elongation and therefore increase the efficiency of photosynthesis process (Verma et al., 2011). The increase in the number of leaves per plant may return to the increase in plant height and number of branches (table 3) and this increase will lead to more production of vegetative buds and eventually more leaves. On the other hand, the number of leaves in the control plants was a little, which may be due to the absence of nitrogen, which is working on the development of vegetative buds (Javid et al., 2005). When nitrogen level increase, the nutrient uptake increases also contributing to the increase in photosynthesis process and increase cellular materials represented in the leaves, and the increasing number of leaves improves the size of photosynthesis tissue, leading to accelerating the growth of the main stem and increase the number of branches which contributes to increase the number of flowers per plant (Belorker et al., 1992).

The decrease in the number of flowers per plant when increasing the level of nitrogen from 175 $kg.ha^{-1}$ may be due to stimulate the dominance of terminal bud growth without allowing axillary buds to produce side branches (Pimple et al., 2006). The maximum vase life of flowers was recorded in flowers produced from plants treated with 175 $kg.ha^{-1}$ of nitrogen and can be attributed to dry weight increase of the flower at this level (table 4), so the such flowers can remain fresh for a longer time and this is consistent with what Monish et al. (2008) found in China aster plants.

It was noted that each increase in the level of phosphorus has led to an increase in plant height, but the highest increase in number of leaves per plant and number of branches per plant have been recorded in plants receiving 125 $kg.ha^{-1}$ of phosphorus, a decrease was observed in the qualities listed above when increasing the level of phosphorus for more of this level. This trend in lower growth at increasing the level of phosphorus for a certain level is consistent with what Hugar (1997) found in *Gaillardia pulchella* plants. Phosphorus level of 125 $kg.ha^{-1}$ caused significant increase in leaf area and this increase may be due to the role of phosphorus to supply the plant with energy in the form of ATP in the stages of photosynthesis process and thus increase their efficiency (Mullen, 2013). Increase the number of flowers per plant as a result of treatment with phosphorus may be due to the role of phosphorus in the formation of ATP compounds, which used in most of the energy processes in the plant such as nutrient uptake and photosynthesis and thus increase the assimilation materials and converts to the production of flowers (Alkurdi, 2014).

The effect of interaction between nitrogen and phosphorus was significant in vegetative growth qualities, as was observed that with each increase in the level of nitrogen with a constant level of phosphorus there was an increase in plant height, also a similar effect observed for phosphorus. The highest number of leaves, branches, leaf area and dry weight of shoots recorded at the combination 175:125 $kg.ha^{-1}$ (N2P1), followed by combinations

225:125 kg.ha^{-1} (N3P1) and 175:175 kg.ha^{-1} (N2P2). Increase in leaf area may be due to the role of nitrogen to assist in increase vegetative growth by increasing the size of the leave and the cells and eventually increase leaf area. Also, the availability of nitrogen and phosphorus in this combination may have been led to the best growth of roots and increased their physiological activity to absorb water and other nutrients (Hadimani, 2003). The effect of interaction between nitrogen and phosphorus was significant in flowering growth qualities, as plants treated with 175:125 kg.ha^{-1} (N2P1) led to improve all floral qualities. Increase the number of flowers per plant and flower diameter as a result of addition of nitrogen and phosphorus may be due to that these elements have led to increase in plant height, number of leaves, number of branches and leaf area (table 4), and thus enhance the photosynthetic material which lead to increase the number of flowers and the formation of large flowers. The early flowering may be due to the early time of the completion of vegetative growth as a result of balanced nutrition and also provide enough food to produce flowers earlier (Sajid and Amin, 2014). The addition of nitrogen and phosphorus were encouraged to improve the vegetative growth primarily, which led to more of carbohydrates and proteins available, which may be reflected later in improving the floral qualities. In addition, these nutrients can stimulate growth by stimulating cell division and synthesis of organic food (Taha, 2012). Results of this study show that the best vegetative growth and floral qualities of *Zinnia elegans* var. Benary's Giant Mix was achieved when adding nitrogen and phosphorus at the combination of 175:125 kg.ha^{-1} (N2P1).

REFERENCES

Acharya, M.M. and Dashora, L.K. (2004). Response of graded levels of nitrogen and phosphorus on vegetative growth and flowering in African marigold. J. Orn. Hort., 7(2): 179-183.

Al-Chalabi, Sami Kareem and Nasreen Khalil Al-Khayat. 2013. Ornamentals in Iraq. University House of Printing, Publishing & translation - Baghdad University. Iraq.

Alkurdi, Maryam I.S. (2014). Impact of Nitrogen and Phosphorus efficiency on the growth and flowering of Helichrysum bractum. Journal of Agriculture and Veterinary Science. (7) 2 Ver. II, PP 07-12.

Al-Rawi, Khashee Mahmoud, Khalaf Allah Abdul Aziz Mohammed .2000. Design and Analysis of Agricultural Experiments. House Books of Printing and Publishing, College of Agriculture and forests, University of Mosul. Iraq.

Al-Sultan, Salem Mohammed, Talal Mahmood Al- Chalabi and Mohammed Dawood Al-Sawaf. 1992. Ornamental. Ministry of Higher Education and Scientific Research. Mosul. Iraq.

Association of Official Analytical Chemists (AOAC). (1984). Official methods of analysis of the AOAC. 14th ed. AOAC, Washington, DC.

Baboo, R., Ahmad, N. and Singh, D. (2005). Growth and flowering of African marigold (*Tagetes erecta* Linn.) as affected by nitrogen and phosphorus under varying intra-row spacings. J. Ornamental Hort., 8(4): 312-313.

Baloch, Q.B., Chacha, Q.I. and Panhwar, U.I. (2010). Effect of NP fertilizers on the growth and flower production of Zinnia (*Zinnia elegans* L.). Journal of Agricultural Technology. Vol. 6(1): 193-200.

Belorkar, P.V., B.N. Patel, V.J. Golliwar and A.J. Kothare. (1992). Effect of nitrogen and spacing on growth, flowering and yield of African marigold. J. Soils and Crops, 2: 62–4

Gnyandev, B. (2006). Effect of pinching, plant nutrition and growth retardants on seed yield, quality and storage studies in China aster (*Callistephus chinensis* (L.) Nees.). M.Sc. (Agri.) Thesis, Univ. Agril. Sci., Dharwad, Karnataka (India).

Hadimani, S. (2003). Effect of different levels of potassium and their split application on yield, quality and nutrient uptake by potato (*Solanum tuberosum* L.). M.Sc. (Agri.) thesis. Univ. of Agric. Sci., Dharwad.

Hugar, A.H. (1997). Influence of spacing, nitrogen and growth regulators on growth, flower yield and seed yield in gaillardia (*Gaillardia pulchella* var Picta Fougar). Ph.D. thesis, Univ. of Agric. Sci., Dharwad.

Javid, Q.A., N.A. Abbasi, N. Saleem, I.A. Hafiz and A.L. Mughal. (2005). Effect of NPK Fertilizer on Performance of Zinnia (*Zinnia elegans*) Wirlyging Shade. Int. J. Agri. Biol., 7(3): 471-473.

Kessler. (2008). Green house production of bedding plant Zinnias. Albama Cooperative Extension System pp. 1-3.

Monish, M., Umrao, V.K., Tyagi, A.K. and Meena, A.M. (2008). Effect of nitrogen and phosphorus levels on growth, flowering and yield of China aster. Agric. Sci. Digest, 28(2): 97-100.

Mullen, R. (2013). The Importance of Phosphorus for Crop Production. Agriviews. PotashCorp/PCS Sales.

Pimple, A.G., S.R. Dalal, D.R. Nandre, S.M. Ghawade and Swarupa Utgikar. (2006). Yield and quality of gerbera influenced by N & P levels under poly house conditions. Internet J. agric. Sci., 2(2): 320-321.

Sajid, M., N. Amin. (2014). Effect of various combinations of nitrogen, phosphorus and potash on enhancing the flowering time in Chrysanthemum (*Chrysanthemum morifolium*). International Journal of Biosciences. Vol. 4, No. 10, p. 99-108.

Sharma, D.P., Manisha, P. and Gupta, N., (2006). Influence of nitrogen, phosphorus and pinching on vegetative growth and floral attributes in African marigold (*Tagetes erecta* Linn.), J. Ornamental Hort., 9(1): 25-28.

Sonawane, S., Dabke, D.J., Dodake, S.B., Rathod, P.K. and Salvi, V.G. (2008). Effect of different levels of N, P and FYM on yield and quality of China aster (*Callistephus chinensis* L.) in lateritic soil of Konkan. J. Soils and Crops., 18(1): 130-134.

Taha, Ragaa A. (2012). Effect of Some Soil Types and Some Commercial Foliar Fertilizers on Growth, Flowering, Bulb Productivity and Chemical Composition of Iris Plants. Journal of Horticultural Science & Ornamental Plants. 4 (2): 221-226.

Tandon, H.L.S. (1993). Agronomic evaluation and calibration of soil tests In: Proc. FADINAP Regional Workshop on Cooperation in Soil Testing for Asia and the Pacific. pp. 89-100.

Verma, S.K., Angadi S.G., Patil V.S., Mokashi A.N., Mathad J.C., Mummigatti U.V. (2011). Growth, yield and quality of chrysanthemum (*Chrysanthemum morifolium* Ramat.) cv. Raja as influenced by integrated nutrient management. Karnataka Journal of Agricultural Sciences. 24(5): 681-683.