Growth and Yield of Onion Alum cepa L. as Influenced by Nitrogen and Phosphorus Fertilizers Levels

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ABSTRACT

In order to investigate the effects of different rates of nitrogen and phosphorus fertilizers on growth and yield of onion under semi-arid condition. Two field experiment was conducted during 2013/2014 and 2014/2015 seasons to study four rates of nitrogen fertilizer i.e. 72, 120, 168 and 216 kg N/ha and four rates of phosphorus fertilizer i.e. 37, 74, 111 and 148 P_2O_5/ha. The results clearly revealed that Highest nitrogen fertilizer rates (216 kg/ha) produced the highest values of foliage height, number of leaves/plant, foliage fresh weight, Bulbing ratio, bulb diameter and length, bulb weight, total fresh bulb weight, marketable bulb yield and TSS% in both seasons. It could be stated that increasing nitrogen fertilizer rates from 72 kg N/ha to 216 kg N/ha significantly increased foliage height, number of leaves/plant, foliage fresh weight, Bulbing ratio, bulb diameter and length, bulb weight, total fresh bulb weight, marketable bulb yield and TSS% by 4.76, 12.27, 15.9, 18.38, 15.23,11.23, 8.73, 10.21, 10.13 and 6.35 %, respectively as an average of both seasons. The results indicated that increasing phosphorus fertilizer rates from 37 kg P2O5/ha to 148 kg P2O5/ha markedly increased foliage height, number of leaves/plant, foliage fresh weight, Bulbing ratio, bulb diameter and length, bulb weight, total fresh bulb weight, marketable bulb yield and TSS% in both seasons. It could be noticed that increasing phosphorus fertilizer rates from 37 kg P2O5/ha to 148 kg P2O5/ha significantly increased number of leaves/plant, foliage fresh weight, Bulbing ratio, bulb diameter and length, bulb weight and total fresh bulb weight by 4.9, 4.14, 9.41, 4.37, 3.93,3.07 and 3.1 %, respectively as an average of both seasons. It could be concluded that the highest foliage fresh weight and bulb weight were produced by application of the highest rates from nitrogen fertilizer rate (216 kg N/ha) and phosphorus rate (148 kg P2O5/ha).

Keywords: *Nitrogen, Phosphorus fertilizer rates, Total fresh bulb, Marketable bulb yield.*

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1. INTRODUCTION

Onion *Allium cepa* L. is one of the important vegetable and field crop in Egypt. It is one of the most important crops used for local consumption and also as exportation commodity Onions are most susceptible than most crop plants in extracting nutrients, especially the immobile types, because of their shallow and unbranched root system; hence they require and often respond well to addition of fertilizers Major factors contributing to such depletion are soil erosion, fixation of phosphorus (P) and leaching in respect of nitrogen (N) and potassium (K); the problem is further accelerated by deleterious land use practices resulting from high population pressure. Plants require a variety of elements for growth and development of which N and K are the most important of the essential nutrients to plants because they are required in large quantities. The deficiency of these elements is manifested in the detrimental effects on the growth and development of the plants.

Balanced use of fertilizer especially nitrogen and phosphorus could result in an increased bulb yield of onions [1, 2]. This study agreement with Brewester [3] and Serensen and Grevsen [4] who reported that too much N promoted excessive vegetative growth and delayed maturity. Abdissa, et al. [5] showed that, application of N fertilizer significantly increased plant height in onion compared to the control due to the synthesis of amino acids and form proteins and make up metabolic processes required for plant growth, while P fertilization and its interaction with N did not. Generally, Messele [6] obtained that at the same results. However, the optimum level of N, P fertilizer application gave the maximum yield of onion varieties, and productivity could be increased through optimum of fertilizers Shaheen, et al. [7]. Soleymani and Shahrajabian [8] stated that foliage fresh weight, bulbing ratio, plant height, weight of bulb, total yield, favorite yield, total percentage of dry matter and nitrate in bulb was significantly influenced by cultivars and the maximum values of these traits were resulted from CLSAKHT cultivar. Also showed that N had significant influence on bulb diameter, weight average of bulb, total yield. Tekalign, et al. [9] showed that regardless of the rate, N fertilization decreased bulb dry matter content by about 4% over the control and was also observed that not significantly affected by P fertilization and the lack of response may be due to the availability of adequate amount of P (16.02 ppm) in the soil. Therefore, the objectives of this research was aimed to study performance of both nitrogen and phosphorus rates on growth and yield of onion.

2. MATERIAL AND METHODS

Two field experiments were conducted in extension field at Awish El-Hagar village, during two seasons of 2013/2014 and 2014/2015. The objectives of this investigation were aimed to study the effect of nitrogen and fertilizer rates on growth, yield and bulbs quality of onion C.v. Giza Red. Onion seed cultivars were obtained from Onion Research Section, ARC, Egypt. The experiments were carried out in strip-plot design with four replications. The vertical plots were occupied with four nitrogen fertilizer rates i.e. 72, 120, 168, 216 kg N/ha. The horizontal plots were allocated with four phosphorus fertilizer rates i.e. 37, 74, 111, 148 kg P2O5/ha. The amount of nitrogen fertilizers was splitted into two portions, one half being applied one month after transplanting time before the first irrigation and the remaining portion was applied before the second irrigation, 60 days from transplanting. While the amounts of phosphorus fertilizer rates were added at soil preparation directly before ridging.

The soil of the experimental sites was clayey, pH was 7.87 and 8.00, available nitrogen was 40.12 and 51.33 ppm, available phosphate was 3.36 and 3.44 ppm and exchangeable potassium was 299.1 and 305.2 ppm in first and second seasons, respectively. Each plot area was 10.5 m2, which consisted of 5 ridges, each of 3.5 m in length and 60 cm in width. The preceding crop was maize (Zea mays L.) in both seasons. Onion seeds were hand drilled in the nursery bed on 11th and 10th October in the first and second seasons, respectively. Seedlings of nearly sixty days old when they usually were 25 cm in height were pulled tied and moved to the permanent land for transplanting on

12th and 13th December in the first and second seasons, respectively. Other cultural practices were carried out in the same manner prevailing in the region.

After 120 days from transplanting, ten plants were selected at random from every sub-plot to record plant height, number of leaves/plant, foliage fresh weight per plant and bulbing ratio. At harvest time, ten guarded plants were chosen at random from the outer ridges of each plot to determine the following characters: bulb length and diameter (cm), bulb weight (g) and total soluble solids (TSS) in bulbs (%). Total bulbs yield (t/ha) and marketable bulbs yield (t/ha) were determined by harvesting the two middles rows per plot in kg and then converted to t/ha. Marketable yield of each plot were placed in common burlap bags and kept under normal storage conditions.

All obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the split-plot design to each experiment (row spacing), then combined analysis was done between row spacing trails as published by Gomez and Gomez [10] by using "MSTAT-C" computer software package. Least significant of difference (LSD) method was used to test the differences between treatment means at 5 % level of probability as described by Snedecor and Cochran [11].

3. RESULTS AND DISCUSSION

3.1. A. Nitrogen Fertilizer Rate Effects

The results presented in Tables (1 and 2) clearly indicated that nitrogen fertilizer rates significantly affected foliage height, number of leaves/plant, foliage fresh weight, Bulbing ratio, bulb diameter and length, bulb weight, total fresh bulb weight, marketable bulb yield and TSS% in both 2013/2014 and 2014/2015 seasons. Results revealed that increasing nitrogen fertilizer rates from 72 kg N/ha to 216 kg N/ha markedly increased foliage height, number of leaves/plant, foliage fresh weight, Bulbing ratio, bulb diameter and length, bulb weight, total fresh bulb weight, marketable bulb yield and TSS%. Highest nitrogen fertilizer rates (216 kg/ha) produced the highest values of foliage height, number of leaves/plant, foliage fresh weight, Bulbing ratio, bulb diameter and length, bulb weight, total fresh bulb weight, marketable bulb yield and TSS% in both seasons. The corresponding data were 73.0, 10.3, 225.75, 5.4, 7.77, 5.54, 1515.59, 39.520, 31.98 and 11.61, respectively in the first season, and 73.9, 11.2, 226.66, 5.48, 7.85, 5.67, 152.43, 39.600,32.200 and 11.7, respectively in the second season. However, the lowest values of foliage height, number of leaves/plant, foliage fresh weight, Bulbing ratio, bulb diameter and length, bulb weight, total fresh bulb weight, marketable bulb yield and TSS% were recorded from fertilization at 72 kg N/ha. It could be stated that increasing nitrogen fertilizer rates from 72 kg N/ha to 216 kg N/ha significantly increased foliage height, number of leaves/plant, foliage fresh weight, Bulbing ratio, bulb diameter and length, bulb weight, total fresh bulb weight, marketable bulb yield and TSS% by 4.76, 12.27, 15.9, 18.38, 15.23,11.23, 8.73, 10.21, 10.13 and 6.35 %, respectively as an average of both seasons. The reasons for increase in plant height under N application might be due to the increased vegetative growth with increasing N and this could be due to increase in N supply leads utilization of carbohydrate to form protoplasm and more cells to enhance growth Simon, et al. [12]. Large quantities of N fertilizers may be required to obtain high yields of quality onion bulbs, but large amount of N may also remain in the soil after harvest. Generally, the amount of N applied and onion crop responses to N vary from place to place. The increase in yield might be due to applying nitrogen, improving the vegetative growth and increase in net assimilation rate and accelerating the photosythates in storage organs of bulbs resulting in an increased diameter and weight of the bulb. Similar results are reported by several investigators such as Aliyu, et al. [13]; Soleymani and Shahrajabian [8]; Tekalign, et al. [9]; Kamble and Kathmale [14] and Messele [6].

B. Phosphorus Fertilizer Rate Effects

Concerning to the effect of phosphorus fertilizer rates, the results in Tables (1 and 2) clearly revealed that phosphorus fertilizer rates significantly affected foliage height, number of leaves/plant, foliage fresh weight, Bulbing ratio, bulb diameter and length, bulb weight, total fresh bulb weight, marketable bulb yield and TSS% in both 2013/2014 and 2014/2015 seasons. The results indicated that increasing phosphorus fertilizer rates from 37 kg P2O5/ha to 148 kg P2O5/ha markedly increased foliage height, number of leaves/plant, foliage fresh weight, Bulbing ratio, bulb diameter and length, bulb weight, total fresh bulb weight, marketable bulb yield and TSS% in both seasons. Highest phosphorus fertilizer rates (148 kg P2O5/ha) produced the highest values of foliage height, number of leaves/plant, foliage fresh weight, Bulbing ratio, bulb diameter and length, bulb weight, total fresh bulb weight, marketable bulb yield and TSS% in both seasons. The corresponding data were 71.6, 9.8, 212.0, 4.83, 7.42,5.43,145.2, 146.93, 38.340, 31.020 and 11.34, respectively in the first season, and 72.8, 10.6, 212.97, 4.89, 7.47, 5.52, 146.93, 38.34, 31.020 and 11.43, respectively in the second season. However, the lowest values of foliage height, number of leaves/plant, foliage fresh weight, Bulbing ratio, bulb diameter and length, bulb weight, total fresh bulb weight, marketable bulb yield and TSS% were recorded from fertilization at 37 kg P2O5/ha. It could be noticed that increasing phosphorus fertilizer rates from 37 kg P2O5/ha to 148 kg P2O5/ha significantly increased number of leaves/plant, foliage fresh weight, Bulbing ratio, bulb diameter and length, bulb weight and total fresh bulb weight by 4.9, 4.14, 9.41, 4.37, 3.93,3.07 and 3.1 %, respectively as an average of both seasons. Most of the P present in soils is in unavailable forms and added soluble forms of P are quickly fixed by many soils. Thus, available P levels must be supplemented in most soils by adding chemical fertilizers. Phosphorus is essential for root development and when the availability is limited, plant growth is usually reduced. The movement of P in soils is very low and its uptake generally depends on the concentration gradient and diffusion in the soil near the roots.

Table-1. Mean of foliage height (cm), No. of leaves/plant, foliage fresh weight, Bulbing ratio and Bulb diameter (cm) as affected by nitrogen and phosphorus fertilizer rates during 2014/2015 and 2015/2016 seasons.

Treatments	Foliage height (cm)		No. of leaves/plant		Foliage fresh weight		Bulbing ratio		Bulb diameter (cm)	
	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015
A. Nitrogen fertilizer rates:										
72 kg N/ha	69.5	70.4	8.7	9.3	189.92	190.72	3.91	3.98	6.60	6.65
120 kg N/ha	70.6	71.8	9.2	9.9	198.48	199.47	4.35	4.41	7.11	7.16
168 kg N/ha	71.7	72.9	9.8	10.7	215.90	216.81	4.80	4.86	7.53	7.62
216 kg N/ha	73.0	73.9	10.3	11.2	225.75	226.66	5.40	5.48	7.77	7.85
F-test	*	*	*	*	*	*	*	*	*	*
L.S.D. 5%	0.6	0.3	0.3	0.3	1.05	0.88	0.13	0.06	0.12	0.08
B. Phosphorus fertilize rates:										
37 kg P2O5/ha	70.6	71.7	9.3	10.1	203.22	204.12	4.40	4.48	7.10	7.17
74 kg P2O5/ha	71.0	72.1	9.4	10.2	206.21	207.02	4.54	4.62	7.19	7.28
111 kg P2O5/ha	71.4	72.4	9.6	10.4	208.63	209.54	4.70	4.75	7.31	7.37
148 kg P2O5/ha	71.6	72.8	9.8	10.6	212.00	212.97	4.83	4.89	7.42	7.47
F-test	*	*	*	*	*	*	*	*	*	*
L.S.D. 5%	0.2	0.2	0.2	0.1	0.49	0.42	0.06	0.06	0.06	0.05
Interaction AXB										
F-test	N.S.	N.S.	N.S.	N.S.	*	*	N.S.	N.S.	N.S.	N.S.

N. S. = Not significant, *= significant at 5%

Table-2. Mean bulb length (cm), bulb weight (g), total fresh bulb yield/ha, marketable bulb t/ha and T.S.S% as affected by nitrogen and phosphorus fertilizer rates during 2014/2015 and 2015/2016 seasons.

Treatments	Bulb length (cm)		Bulb weight (g)		Total fresh bulb yield t/ha		Marketable bulb t/ha		T.S.S%	
	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015
A. Nitrogen fertilizer rates:										
72 kg N/ha	4.95	5.00	138.31	139.15	35.320	35.700	28.740	28.939	10.87	10.96
120 kg N/ha	5.30	5.33	139.75	140.68	37.480	37.500	29.880	29.981	11.12	11.22
168 kg N/ha	5.47	5.57	143.95	144.77	38.400	38.599	30.761	31.001	11.33	11.44
216 kg N/ha	5.54	5.67	151.59	152.43	39.520	39.600	31.980	32.201	11.61	11.70
F-test	*	*	*	*	*	*	*	*	*	*
L.S.D. 5%	0.11	0.11	0.45	0.29	0.326	0.330	0.362	0.276	0.03	0.03
B. Phosphorus fertilize rates:										
37 kg P2O5/ha	5.22	5.31	141.15	142.02	37.241	37.382	29.861	30.101	11.13	11.22
74 kg P2O5/ha	5.26	5.35	142.95	143.78	37.519	37.620	30.130	30.444	11.19	11.29
111 kg P2O5/ha	5.37	5.44	144.33	145.19	37.960	38.081	30.499	30.619	11.27	11.37
148 kg P2O5/ha	5.43	5.52	145.20	146.93	38.261	38.340	30.900	31.020	11.34	11.43
F-test	*	*	*	*	*	*	*	*	*	*
L.S.D. 5%	0.06	0.05	0.28	0.28	0.149	0.149	0.185	0.175	0.02	0.02
Interaction AXB										
F-test	N.S.	N.S.	*	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

N. S. = Not significant, *= significant at 5%

Similar concussion was reported by Aliyu, et al. [13]; Boyhan, et al. [15]; Soleymani and Shahrajabian [8]; Simon, et al. [12] and Messele [6].

C. Interaction Effects

Concerning to the interaction between nitrogen and phosphorus fertilizer rates on foliage fresh height, number of leaves/plant, bulb ratio, bulb diameter, bulb length, total fresh bulb yield/ha, marketable bulb yield/ha and TSS% did not reach to the degree of significance in foliage fresh height, bulb ratio, total fresh bulb yield/ha, marketable bulb yield/ha and TSS%.

Results presented in Tables (1 and 2) clearly showed that the interaction between nitrogen and phosphorus fertilizer rates significantly affected the number of leaves/plant, bulb length in the first season only and the same interaction significantly affected significantly affected forage fresh weight and bulb weight in both studied seasons. The results illustrated in Fig 1 and 2 clearly showed that the interaction between nitrogen and phosphorus fertilizer rates significantly affected the number of foliage fresh weight and bulb weight in the first season. It could be noticed that the highest foliage fresh weight (231.26 g/plant) and bulb weight (9154.73 g/bulb) were produced by application of the highest rates from nitrogen fertilizer rate (216 kg N/ha) and highest phosphorus rate (148 kg P2O5/ha). Whilst, the lowest amount of phosphorus fertilizer rate leaves/plant, foliage fresh weight, bulb length and bulb weight in the first season.

Regarding to the effect of the interaction between nitrogen and fertilizer rates on foliage fresh weight and bulb weight in the second season, the results in Figs. 3 and 4 clearly illustrated that foliage fresh weight and bulb weight significantly affected by this interaction in the second season. The results clearly showed that higher values of

foliage fresh weight (232.16 g/plant) and bulb weight (155.63 g/bulb) were obtained from adding highest nitrogen fertilizer rate (216 kg/ha) and highest phosphorus fertilizer rate (148 kg P_2O_5/ha) in the second season. Whilst, the lowest values of foliage fresh weight and bulb weight were produced from the lowest rate of nitrogen (72 kg/ha) and phosphorus (37 kg P_2O_5/ha) rate in the second season. A similar conclusion was reported by Simon, et al. [12] and Messele [6].

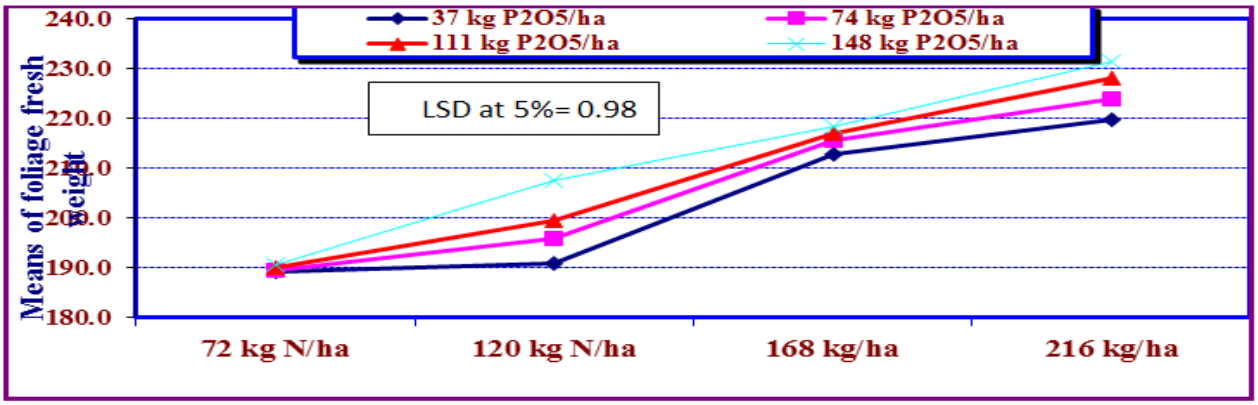

Fig-1. Means of foliage fresh weight as affected by the interaction between nitrogen and phosphorus fertilizer rates during 2013/2014 season.
*= significant at 5%

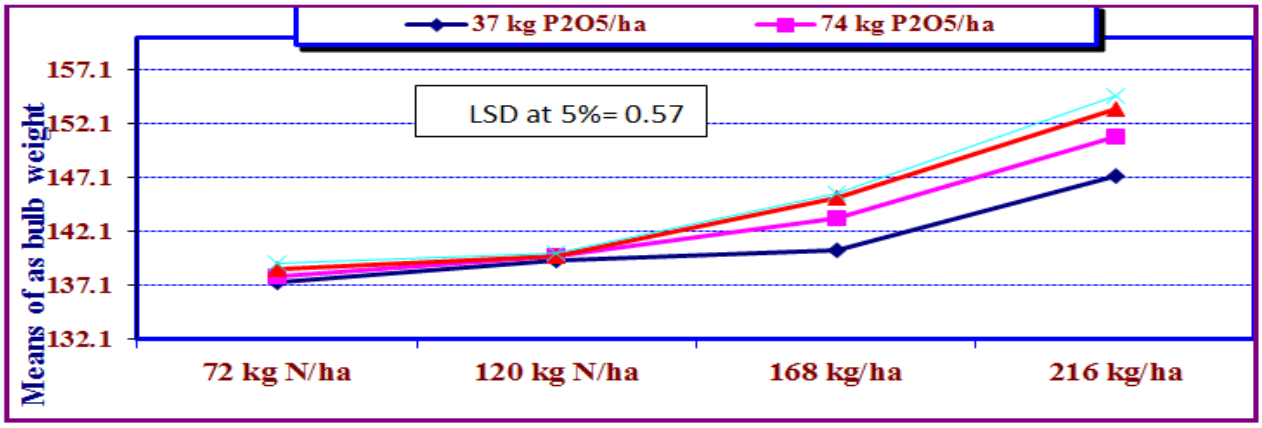

Fig-2. Means of as bulb weight as affected by the interaction between nitrogen and phosphorus fertilizer rates during 2013/2014 season.
*= significant at 5%

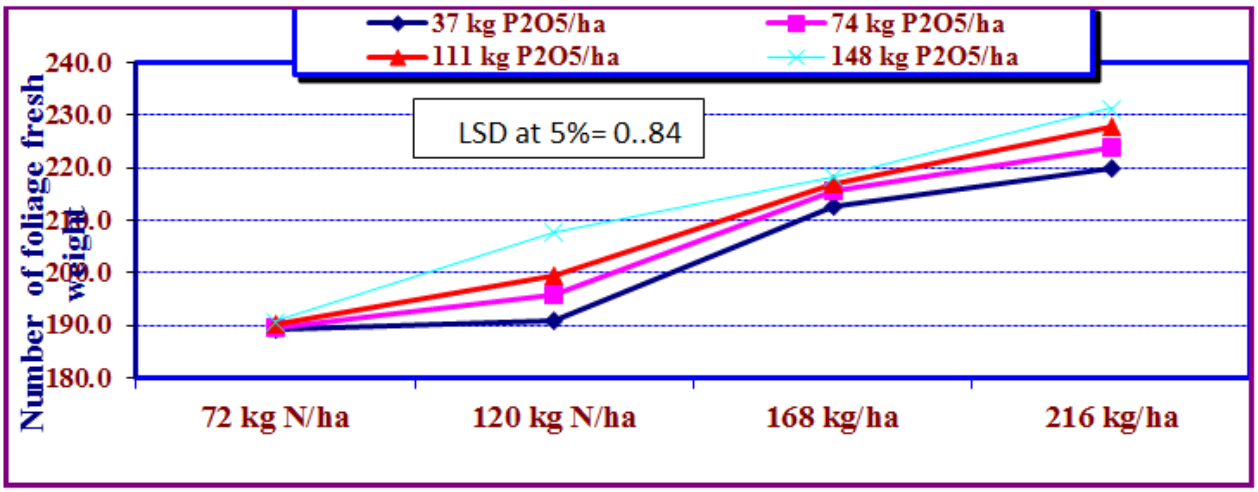

Fig-3. Number of foliage fresh weight as affected by the interaction between nitrogen and phosphorus fertilizer rates during 2014/2015 season.
*= significant at 5%:

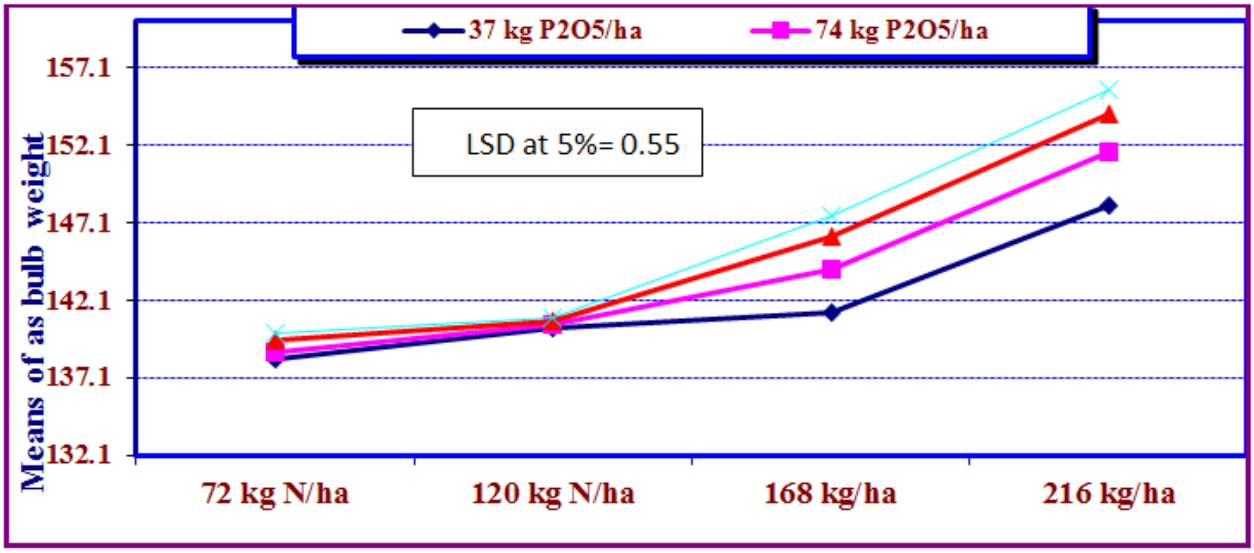

Fig-4. Means of as bulb weight as affected by the interaction between nitrogen and phosphorus fertilizer rates during 2014/2015 season.
*= significant at 5%

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