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Full Length Research Paper

Effect of organic manure sources and NPK fertilizer on yield and water productivity of onion (*Allium cepa* L.)

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This study was carried out to maximize the fertilization efficiency of onion (*Allium cepa* L.) under two organic manures that improved soils retain ability to water. Field wintered experiments were carried out in Production Station in Nubaria, Behera Governorate, Egypt during two successive growing seasons (2014 and 2015). The organic fertilizers were farm yard manure and chicken manure. Chemical fertilizer NPK was added as a percentage from recommended dose (0, 25, 50, 75%). Farm yard manure (FYM) and chicken manure (ChM) were applied during soil preparation at rates 15 and 5 ton fed^{-1}. Based on the obtained results yield of onion bulbs, wither FYM or ChM with 50 % of recommended NPK had highly significant effect on all studied parameters. To achieve a high production potential of onion, appropriate reasonable amount of the organic manure enriched with 50 % NPK should be maintained during the entire growing season. High yields of bulbs in ChM followed by FYM confirm supplementary NPK under experimental conditions. Differences in bulb yields between 50 and 75 % from recommended NPK treatments indicate that high and reliable yields of onion grown from seed in the region could be achieved only under ChM or FYM. The values of consumed irrigation water were 420 mm that could be recommended as a good platform for onion growers in the region in terms of maximum yield and optimum utilization of NPK mineral fertilizer. The mathematical relations between NPK fertilizer application rates from recommended doses versus onion yield and WCP were plotted and the obtained regression equations were positively and highly significant at 1 % level, which represents that any increase in NPK fertilizer by unite (25%) faced by increase in both onion yield and WUE. Also, the previous relations was linear and could be used to maximize the expected yield by application different ratios of NPK. Regression equations between fresh and dry weight of both leaf and bulb were estimated and both equation were highly and positive significant liner for leaf and polynomial after bulb fresh and dry weight.

Keywords: Organic manure, Chicken manure, NPK fertilizer, onion, growth characters, yield components.

INTRODUCTION

Regarding to the production mass and importance, onion is one of the major export and a high cash value crop in Egypt. Inadequate management practices, insufficient amount of both organic and inorganic fertilizers during the growing season and inappropriate irrigation quantity applied to onions. In arid and semiarid areas, irrigation may supply all of the crops water needs. Onions are

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considered as shallow-rooted crop(Greenwood et al., 1982)who reported that 90% of the root system of the onion plant was concentrated at the top 40 cm of soil. So, it is necessary to keep top soil moisten that needed for plants (Abdel-Hady et al., 2011). Controlling of the applied irrigation water is one of the most important factor that affect directly on the yield that could be applied through scheduling irrigation (Al-Jamal et al., 1999). If shortage of readily available soil water is eliminated and the technological and biological characteristics of the crop are taken into account, it is possible to achieve high and stable yields of irrigated onions, at the level of 40 t ha^{-1} or higher (Halim and Ener, 2001),who added that the advantages of high pre-irrigation soil moisture and frequent irrigations, using drip irrigation in the production of onions under arid climatic conditions in Turkey.

Moursy et al. (2007) found that application of 190.4 kg N/ha gave significantly increased in onion yield, bulb diameter and TSS content as compared with using nitrogen at rate of 95.2 kg N/ha. Yaso et al. (2007) revealed that increasing mineral nitrogen levels led to significant increases on plant height, number of leaves, average bulb weight, marketable and total bulbs yield, and total soluble solid of onion. These effects were obtained with using 214.2 kg N/ha.

Many factors can affect the amount of needed in any particular vegetable crop. These include plant, soil, cultural and environmental factors (Jones et al., 1984). Pelter et al. (2004) recorded an onion ET of 597 mm when irrigated by drip-irrigation system at Columbia Basin, Washington State, USA. Olalla et al. (2004) reported the water requirements of onion (Albacete, Spain) producing an optimum yield of75 t ha^{-1}(30 ton fed^{-1}) was 662 mm of water under drip irrigation with water productive value 27 kg m^{-3} irrigation water.

Water crop productivity mostly depending on the amount of water applied and its distribution. Furthermore, Sarkar et al., (2008) stated that irrigation water use efficiency coefficients provide a more realistic assessment of the efficacy of irrigation. Many studies have been conducted to determine the water use efficiency characteristics of onion crops in different climate and soil conditions under different irrigation systems (Al-Jamal et al., 2001;Bekele and Tilahun, 2007).

Magdi et al., (2009)reported that the yield and quality of onion were significantly influenced by fertilizer types. The highest yield of onion bulbs was obtained by the application of chicken manure (ChM) in both investigated seasons comparing with animal manure and mineral fertilizers. Additionally, application of ChM increased onions dry matter, weight of individual bulb and bulb diameter. Incorporating manure into a field will help to reduce water and wind erosion by improving soil structure (Hermanson, 1996) who stated that ChM contained a broader range of nutrients than most commercial fertilizers. This may be due to a large portion of the plant nutrients initially ingested by the animals and chicken. Generally 80% of the phosphorus, 90% of the potassium and 75 %of the nitrogen are still present in the manure.

Mineral fertilizers are considered to be an important source of major and minor elements in crop production. Continuous application of mineral fertilizers may adversely affect soil chemical composition, nutrient imbalance, soil degradation and crop yield (Ojeniyi, 2000).

Soleymani and Shahrajabian (2012) revealed that the maximum bulb diameter, bulb height, weight of bulb, total yield and favorite yield was related to application of 200 kg N/ha, and there were no significant differences between 200 or 300 kg N/ha. Whereas, Tekalign et al. (2012) found that nitrogen fertilization decreased bulb dry matter content by about 4% over the control. Bulb storability study for eight weeks at ambient condition indicated that highest level of N or P fertilizer caused highest cumulative weight loss. Bulb dry matter content and rotting percentage were not significantly affected by P fertilization.

The aim of the work was to study the effect of different source organic manure and rate of NPK applied on the onion yield and water use.

MATERIALS AND METHODS

Field trials were conducted in two successive seasons 2014 and 2015 in the Research and Production Station, National Research Centre, Nubaria region, Behera Governorate, Egypt.

The soil of the experimental site is loamy sand and having pH 7.8, EC 2.34 dSm-1, CaCO3 4.2 % and field capacity 17.2 %.Farm yard manure (FYM) and chicken manure (ChM) were applied during soil preparation at rates 15 and 5 ton fed^{-1}.

Examined soil was analyzed after Rebecca (2004) and the values were 1.78, 0.624, 3.3, 0.6, 4, 11; FYM2.86, 0.483, 2.4, 0.4, 3; 8 and ChM4.2 0.342 3.9 0.2 2 9 for N, P, K%, Fe, Zn and Mn (ppm), respectively

The experiments included onion cultivar (*Allium cepa* L. Giza 20). The onions were grown using commercial weed and pest management practices typical. Seedlings of the onion cv. Giza 20 were transplanted on November 20thin both seasons. Treatment plot consisted of 3 lateral lines, 35 m long and 0.9 m between the rows and 0.3m among the drippers. Onion seedlings were planted on 4 rows in both side of drip line 7 cm apart with plant density 28 plant per square meter.

Onion handily yielded at 25th March in both seasons and plants were collected in groups to dry for 10 days then onion yield components were took place. The following parameters were recorded using 20 randomly sampled bulbs: plant height (cm), no. of leaves per plant, weight of individual bulbs (g), bulb diameter (cm). Additionally, fresh and dry matter of onion leaf and onion bulb were determined.

Water crop productivity of onions yield was estimated from the following equation:

$WCP_{kg/\ irrigation\ m^3}$ = Total onion yield / consumed irrigation water

where WCP is water crop productivity

Data reported for yield and yield components of onion plant were assessed by analyses of variance (ANOVA) after Dospekhov (1984)and Fisher's LSD test was used for any significant differences at the $P< 0.05$ levels between the means. All the analyses were conducted using software package SAS 2001. The relationship among some estimated characteristics were evaluated using regression analysis.

RESULTS AND DISCUSSION

Onion plant growth characters under investigation of onion such as plant height (cm), no. of leaves per plant, weight of individual bulbs (g), bulb diameter (cm) and as affected by farm yard manure (FYM) and chicken manure (ChM) and rate of recommended NPK were represented in table (1). The resulted data mentioned that the highest values were recorded at FYM at 50 % from NPK, except for fresh /dry ratio of leaf and bulb that were found at ChM at 50 % NPK. The obtained results showed that NPK fertilizer at 50% from recommended doses under both FYM and ChM except at last 75 % was the highest one followed by 50 % NPK for plant height, leaves no per plant and onion bulb diameter. Regarding to the impact of applied organic manure (OM) sources, ChM was superior than FYM on the previous onion plant characters, except for bulb diameter the opposite was true with rate of change 5, 11and -3 % as compared with FYM, respectively.

For the above mentioned onion plant characters , 50 % of Recommended NPK had a positive effect on improving those characters, except bulb diameter where 75 % NPK followed by 50 % there no significant differences among them . also, the rate of increase were 19, 35, 32; 9, 26, 26; 2, 7, 10 for 25, 50 and 75 % of NPK as compared with control one for the previous onion plant characters.

Yield components such as fresh and dry weight of leaf and bulb were affected by OMs applied and contribution of NPK %. The values of fresh and dry weight of leaf and bulb were improved progressively under ChM more than FYM, while increasing application of NPK % associated with increasing of all studied plant characters. So, the highest values were attained at ChM (75 % NPK, except bulb diameter) and FYM (50 %NPK). In addition, ChM had a promotive effect on the last plant characters with increasing percentage 9, 16; 6, 9 % for fresh and dry weight of leaf and onion bulb, respectively.

With respect to the impact of NPK % application, data on hand noticed that increasing of NPK rate had a positive effect on the fresh and dry weight of leaf and bulb with rate of change 50, 103, 115; 8, 42, 61; 14, 24, 18; 15, 22, 234 % as compared with untreated plot in same sequences. It could estimate the ratio between fresh /dry weight of the leaf and onion bulb (Table 1), that were affected by of the two studied factors. Results revealed that the highest ratios were attained after 50 % NPK and 25 % NPK under FYM and ChM, respectively. Meanwhile, FYM had a promotive effect FW/DW for leaf than ChM whereas the opposite was true in case of onion bulb. Increasing FW/DW ratio often pointed out to plant health and it ability to maximize onion yield production.

This results was in harmony with Kandil et al., (2013), who found that Giza 20, Giza Red and Texas Early Yellow Grano X Giza 20 cultivars were significantly better in most of the studied characters in both seasons. they added that mineral fertilization of onion with 214.2 kg N + 71.4 kg P_2O_5 + 57.1 kg K_2O/ha (85.7 N, 28.6 P_2O_5, 22.8 K_2O kg/fed, in same sequences) surpassed other studied fertilization treatments and resulted in highest values of most studied characters in both seasons. The purpose of application OM not only supply plants by its needs from nutrients but also improves soil hydrophysical properties. It is worthy to mention same amount of water that applying during the growing season to clear the role of the two types of the used OMs.

The onion yield production as affected by the main studied factors that was significantly in higher NPK % than used OMs. That described mainly on the base of main effect of NPK. The highest onion yield was produced after 75 % NPK under both OMs used where ChM more pronounced effect than FYM, but without significantly differences. Also, data mentioned that increasing NPK % from 0 to 75 % associated with increasing onion yield with percentage rate 10, 22 and 27 % for 25, 50 and 75 % of NPK relative to the control (0% NPK). Whereas, increasing NPK % by application unite (25 %) increased yield by about 12 % (from 25 to 50 % NPK) and 5% (from 50 to 75%). these finding agreed with those obtained by (Olalla et al. 2004).

The following equations is a regression state that represents the relation between onion yield from side and types of organic manure. It could conclude that the relation is linear, positive and highly significant at 1 % level with both organic manure used.

$Y_{FYM} = 1.745x + 17.97 R^2 = 0.9839$

$Y_{ChM} = 1.383x + 13.46 R^2 = 0.9516$

From the above mentioned, results noticed that 50 % NPK and mostly FYM was the preferable choose that could play an important role not only in crop production but also improving soil hydrophysical properties especial water retained and water intake rate under new reclaimed soils.

With respect to onion water productivity, the total amount of the irrigation consumed during onion growing season. The onion was consumed 420.6 mm.

Regarding to the onion crop productivity, it is ranged from 19.72 to 24.75 and from 19.58 to 25.06 kg/ m3 irrigation water for 0 to 75 % NPK under FYM and ChM,

Table 1: Effect of organic manure source and rate of NPK on the some growth characters and yield water productivity of onion (mean of two seasons)

	NPK %	Plant height(cm)	No. of leaves	Bulb D (cm)	Leaf FW g	Bulb FW g	Leaf DW g/plant	Bulb DW	Leaf F/D	Bulb F/D
FYM	0	57.1	7.8	2.9	52.9	189.8	16.7	143.5	3.2	1.3
	25	61.8	8.2	2.5	69.5	220.2	17.2	175.7	4.0	1.3
	50	79.3	10.8	2.9	134.5	246.5	26.5	203.2	5.1	1.2
	75	67.7	10.1	2.9	111.8	238.3	26.8	208.2	4.2	1.1
	Mean	**66.5**	**9.2**	**2.8**	**92.2**	**223.7**	**21.8**	**182.6**	**4.1**	**1.2**
ChM	0	55.1	9.0	2.5	62.1	220.2	20.2	183.8	3.1	1.2
	25	71.1	10.3	2.8	103.2	245.6	22.5	199.2	4.6	1.2
	50	72.6	10.5	2.7	109.0	263.1	26.1	196.4	4.2	1.3
	75	80.9	11.2	2.9	136.7	247.2	32.5	198.0	4.2	1.2
	Mean	**69.9**	**10.2**	**2.7**	**102.8**	**244.0**	**25.3**	**194.4**	**4.0**	**1.3**
LSD at 5%	OM	1.2	0.8	0.03	2.3	6.7	1.4	3.8	0.02	0.02
	NPK %	1.5	0.9	0.04	2.7	8.1	1.6	4.5	0.03	0.03
	Interaction	1.6	1.1	0.05	2.8	8.3	1.7	4.7	0.04	0.04

FYM: farm yard manure, ChM: chicken manure, OM: organic manure FW: fresh weight, DW:dry weight

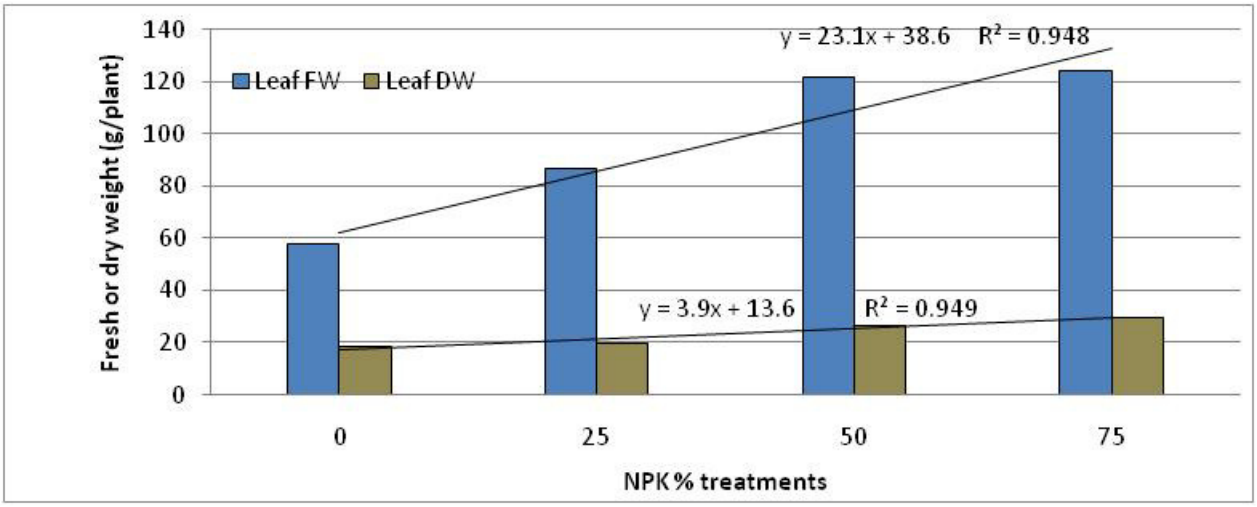


Figure 1: Onion yield and water crop productivity (WCP) as affected by NPK% and used organic manures

respectively. So, the highest values were recorded after using 75 % NPK under both OMs applied. Where the rate of increase was 2% if ChM compared with FYM. But NPK was more effective on improving onion crop productivity values that combined with increasing NPK %from 0 to 75 % with rate of increase 10, 2; 27 for 25, 50; 75 % of NPK as compared with control (0% NPK). In view of point, Fatideh and Asil (2012) reported that using nitrogen at level of 150 kg/ha produced higher bulbs and dry matter yield. Meanwhile, bulb size and weight were decreased with decrease in amount of nitrogen, whereas, Salem (2012) concluded that fertilization onion plants with 50 % NPK + 50 % FYM and spraying with Agrispon + EM increased onion yield over the control (100 % NPK without foliar applications) and improved bulbs quality. Hence, this treatment is recommended where the mineral fertilization is reduced to 50 % and this in turn decreases the environment pollution and production costs. Also, Abdelhady (2005) and Ebtisamet al (2013) reported that application of organic manure not only improves soil structure, but also can modified soil ability to retain more water that encourage root development and leads to encourage growth.

The mathematical relations between NPK fertilizer application rates from recommended doses versus onion yield and WCP were plotted in Figure (3). One can notice that the regression equations were positively and highly significant at 1 % level that is mean that any increase in

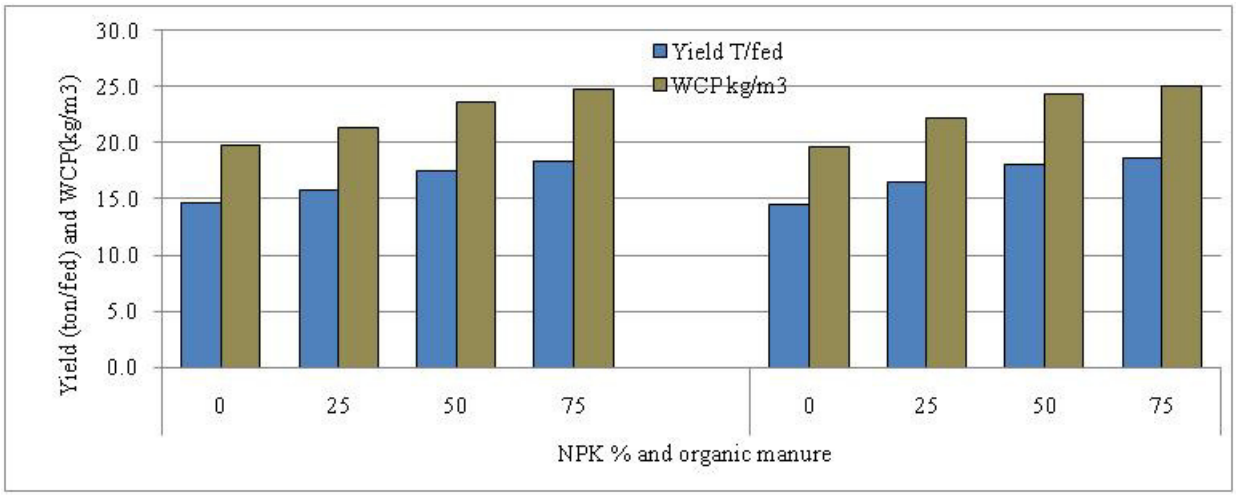


Figure 2: Onion yield and water crop productivity (WCP) as affected by NPK% and used organic manures

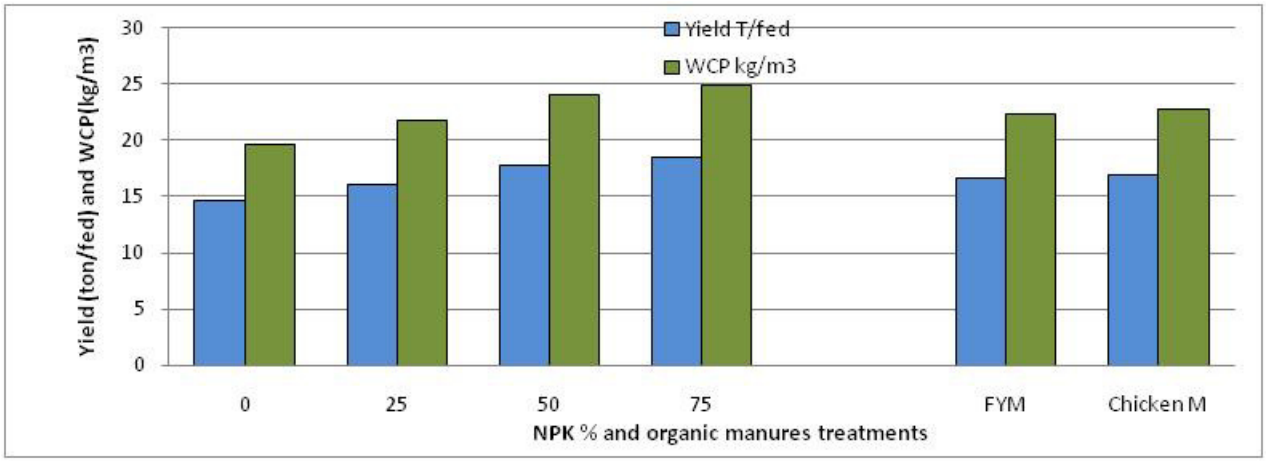
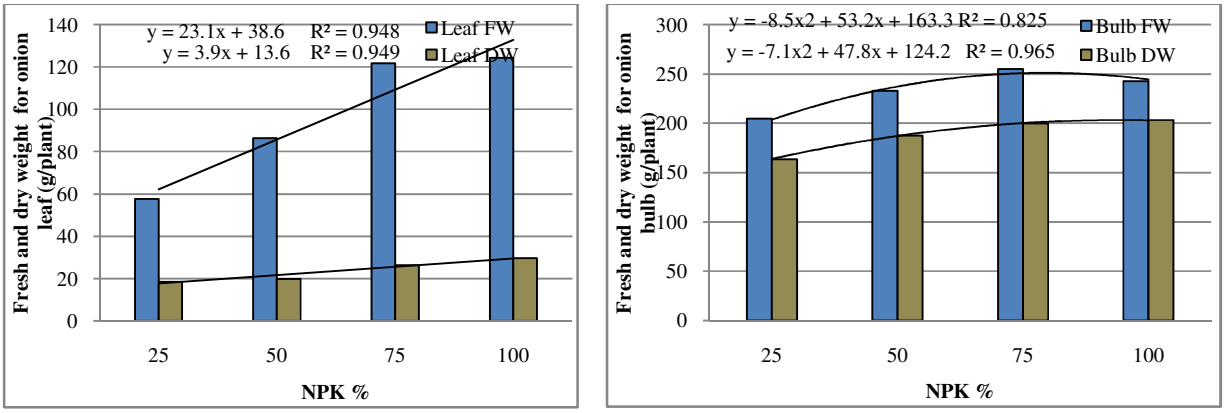


Figure 3: Onion yield and water crop productivity (WCP) as affected by NPK% and used organic manures

NPK fertilizer by unite (25%) faced by increase in both onion yield and WUE. Also, the previous relations was linear and could be used to maximize the expected yield by application different ratios of NPK .

Figure (4) illustrate the regression equations between fresh and dry weight of both leaf (A) and bulb (B). it could concluded that both equation were highly and positive significant liner for leaf and polynomial after bulb fresh and dry weight. This means, that it could useful to use NPK till the curve go down (50 % NPK) then stopped fertilizer application in case of bulb. but in case of fresh and dry weight of leaf pointed out that the maximum NPK % was



A B

Figure 3: Fresh and dry weight for onion leaf (A) and fresh and dry weight of onion bulb (B) as affected by NPK% .

50 % that fulfill the equation . It is clear that 50 % NPK is the best one and any increase more than 50 % lead to reduction in both ChM tends to be high in N and P, while farm yard manure (FYM) tends to be high in potassium. Nutrient availability, however, is determined by the manure handling system, as well as by climate and soil characteristics (IAEA, 2008). However, Yassen and Khalid (2009) showed that all organic fertilizer treatments; i.e. mixture of farmyard manure and chicken manure overcame the control treatment (recommended NPK) improved vegetative growth characters, essential oil, some of the main constituents of essential oil and NPK contents. In same view of point Dina et al. (2010) showed that highest number of exportable green onion plants was obtained from chicken manure treatment.

CONCLUSIONS

The obtained results of the effect of different organic manures and percentage of the NPK on plant growth characters and yield of onion bulbs, it was concluded that FYM or ChM with 50 % of recommended NPK had highly significant effect on all studied parameters. To achieve a high production potential of onion, appropriate reasonable amount of the organic manure enriched with 50 % NPK should be maintained during the entire growing season. High yields of bulbs in ChM followed by FYM confirm supplementary NPK under experimental conditions. Differences in bulb yields between 50 and 75 % from recommended NPK treatments indicate that high and reliable yields of onion grown from seed in the region could be achieved only under ChM or FYM. The values of consumed irrigation water were420 mm that could be recommended as a good platform for onion growers in the region in terms of maximum yield and optimum utilization of NPK mineral fertilizer.

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