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Effect of Organic and Mineral Nitrogen Fertilizers on Growth, Productivity and Bulb Quality of Garlic Plants Grown under Sandy Soil Conditions

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THIS experiment was carried out during the winter seasons of 2018/2019 and 2019/2020 at El-Khattara Experimental Farm, Faculty of Agriculture, Zagazig University,Sharkia Governorate, Egypt, to study the effect of vermicompost, botanical compost and mineral nitrogen fertilizers on growth, productivity and bulb quality of garlic.The treatments were arranged in a randomized complete block design with three replicates. Results showed that fertilizing garlic plants with 3 ton/feddan of vermicompost+20 m^3/feddan of botanical compost+100% of recommended mineral nitrogen increased plant height, leaf number, neck and bulb diameters, bulbing ratio, bulb weight, number of cloves/bulb, dry weight of bulb and leaves, total dry weight/plant and total yield/feddan. Also, this treatment led also to an increment of N, P and K contents in leaves, bulb and plant, total protein and dry matter contents, while the lowest value of nitrate content in cloves was obtained by using vermicompost at 3 ton/feddan+ botanical compost at 20 m^3/feddan in both seasons of the study.

Keywords: Garlic plants, Vermicompost, Botanical compost, Mineral nitrogen, Growth, Bulb

Introduction

Garlic (*Allium sativum* L.) is one of the most important bulb vegetable crops grown in Egypt for local consumption in food, processing and exportation. It is used as a seasoning in many foods or in the medicinal purposes. This plant is one of the oldest cultivated crops, while it was mentioned in the Holy Quran and it is one of the most highest-revenue cash crops. Egypt ranks the fourth in the world in garlic production after China, India and Bangladesh and Egyptian garlic exports reached 18,784 tons (Egyptian ministry of agriculture, 2021). Garlic is exported to Arab countries, European countries and Russia. Therefore, increasing garlic yield and improving bulb quality are essential aims for growers and consumers as well as exportation companies.

Mineral nitrogen using worldwide enhances the soil quality and thus helps in agricultural practices and it is necessary for plant enzyme function, protoplasm formation, amino acid and protein synthesis, and cell division, however excessive inorganic fertilizers are tended to be accumulated various types of radio nuclides and heavy metals which may be caused groundwater pollution and serious damages to the plant growth. Also, these toxic components enter to the food chain and affect the soil micro-organisms and the health of the consumers of these plants (Savci, 2012). In the same regards, increasing soil nitrogen application resulted in the accumulation of nitrates and nitrites in the plant tissue to unhealthy levels (Wang et al., 2002 and Shao-ting et al., 2007).

Organic manure improves the physical, chemical, and biological qualities of soil, reduces the C:N ratio, raises humic acid content, and delivers nutrients to plants in a readily available form, resulting in increased productivity and reduced environmental dangers (Pare et al., 2000). Many authors showed that fertilizing

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garlic plants with organic fertilizer gave the best growth, yield and bulb quality (Hassan, 2015, Zaghloul et al., 2016 and Badal et al., 2019).

Vermicompost are produced from organic wastes through interactions between microorganisms and earthworms. It is a nutritive "organic fertilizer" rich in different nutrients such as nitrates, phosphates and exchangeable calcium and soluble potassium, manganese and zinc (Pathma and Sakthivel, 2012), and it also contains large amounts of plant hormones (auxin, gibberellin and cytokinin), vitamins, enzymes like amylase, lipase, cellulase and chitinase which continue to break down organic matter in the soil (to release the nutrients and make it available to the plant roots) even after they have been excreted (Gupta, 2005, Tharmaraj et al., 2011).

In addition, vermicompost increased microbial diversity and populations, and soil fertility, as well as improved the moisture-holding capacity of soils, and increased the soil cation exchange capacity (Suparno et al., 2013, Yadav and Garg 2019). Owing to vermicompost application, the highest vegetative growth, productivity and best quality were recorded as reported by Suthar (2009), Verma et al. (2013), Golmohammadzadeh et al. (2015), Patidar et al. (2017), Acharya and Kumar (2018),Fikru and Fikreyohannes (2019), Kumar et al. (2019) and Meena et al. (2019) on garlic plants. Furthermore, Degwale et al. (2016) found that application of 5 t ha^{-1} of vermicompost alone or combined with application of 46 kg N ha^{-1} plus 92 kg P_2O_5 ha^{-1} led to the maximum vegetative growth, yield and quality of the garlic crop.

Therefore, this research was conducted to study the influence of mineral nitrogen and organic manure (vermicompost and botanical compost) on growth, productivity and bulb quality of garlic grown under sandy soil conditions.

Materials and Methods

This experiment was carried out during the winter growing seasons of 2018/2019 and 2019/2020 at El-Khattara Experimental Farm, Faculty of Agriculture, Zagazig University,Sharkia Governorate, Egypt, to study the effect of organic and mineral nitrogen fertilizers on growth, productivity and bulb quality of garlic plants grown under newly reclaimed sandy soil conditions. The experimental soil was sandy in texture, which had 0.33% organic matter, 7.94 pH, 1.97 mmhos/cm EC, 13.20 available N, 10.18 available P and 50.28 available K as ppm (average of two seasons). The physical, chemical and biological analysis of organic fertilizers are presented in Table1.

TABLE 1. Physical, chemiecal and biological analysis of organic fertilizers (average of two seasons).

Organic fertilizers analysis	Vermicompost[1]	Botanical compost[2]
Weight of m^3/(kg)	710	600
Organic matter (%)	32.33	35.20
C/N ratio	13.20:1	20:1
Total nitrogen (%)	1.50	0.91
Total phosphorus (%)	0.70	0.52
Total potassium (%)	1.10	0.85
Fe (ppm)	785	609
Mn (ppm)	139	198
Cu (ppm)	14.0	28.02
Zn (ppm)	40.0	135
Pb (ppm)	9.0	15.7

[1]The source of vermicompost was Central Laboratory for Agricultural climate, Giza, Egypt.
[2]The source of botanical compost was Egyland Company, El-Salhia City.

The experiment included seven treatments as follows:

- Botanical compost at 20 m^3/fed. + 100 % of mineral nitrogen.
- Vermicompost at 3 ton/fed. + botanical compost at 20 m^3/fed. + 100 % of mineral nitrogen.
- Vermicompost at 3 ton/fed. + botanical compost at 20 m^3/fed. + 50 % of mineral nitrogen.
- Vermicompost at 3 ton/fed. + botanical compost at 15 m^3/fed. + 100 % of mineral nitrogen.
- Vermicompost at 3 ton/fed. + botanical compost at 15 m^3/fed. + 50 % of mineral nitrogen.
- Vermicompost at 3 ton/fed. + 100 % of mineral nitrogen.
- Vermicompost at 3 ton/fed. + botanical compost at 20 m^3/fed.

These treatments were arranged in a randomized complete block design with three replicates. Garlic cloves of Sids-40 cultivar were selected for uniformity in shape and size. Cloves were planted at the distance of 10 cm a part in both sides of the dripper line on the first week of October in both seasons. The experimental unit area was 10.8 m^2. It contained 3 drip irrigated rows with 6 m length and 60 cm in width with three dripper lines per row. One dripper line was used for the samples to measure vegetative growth parameters and the other dripper lines (second and third dripper lines) were used for bulb yield and quality determination. The required quantities of vermicompost and botanical compost were applied and incorporated into the top 15 cm layer of the experimental soil before planting.

One third of mineral nitrogen in the form of ammonium sulphate (20.6% N) was added during experimental soil preparation and the rest amounts were added at four portions as soil application under drip irrigation system by one-month interval beginning one month after planting (the recommended dose of mineral nitrogen was 120 kg). All plots received the recommended dose of P and K at the rates 90 kg P_2O_5/fed. and 120 kg K_2O/fed. in the form of calcium superphosphate (15.5% P_2O_5) and potassium sulphate (50% K_2O), respectively. One third of potassium sulphate and all calcium superphosphate were added during the experimental soil preparation, while the two third of K_2O was added at four portions as soil application by one-month interval beginning one month after planting. The other normal agricultural practices for growing garlic were carried out as commonly followed in the district.

Data Recorded

Vegetative Growth Parameters

A random sample of ten plants from each experimental block was taken at 120 days after planting date and the following parameters were recorded: plant height (cm), number of leaves/plant and both neck and bulb diameter (cm) as well as bulbing ratio measured according to Mann (1952). Afterwards, different plant parts were separated and oven dried at 70 ^{o}C for 48 hours, and the dry weight of roots, bulb and leaves as well as the total dry weight/plant were recorded.

N, P and K Contents

Dried represented samples of bulb and leaves of all treatments were finely ground and wet digested. Then, N, P and K contents were determined according to the methods described by AOAC (1995) and N, P and K contents in leaves and bulb as well as total of N, P and K contents per plant were calculated.

Yield and Its Components

As plants reached the proper maturity stage (after 190 days), all block bulbs were harvested, weighed and the following data were recorded: average bulb diameter, bulb weight and total yield/fed. A random sample of 10 bulbs from each block was taken to determine the average number of cloves/bulb.

Bulb Quality at Harvesting

Evaluation of bulb quality was done just after harvesting, the evaluation implicated determination characteristics of bulb tissues of total carbohydrate (%) according to the method described by Dubois et al. (1956), and total protein was calculated by multiplying total nitrogen x 6.25. Nitrate content was determined according to the methods described by Cafado et al. (1975). Dry matter (%) was recorded by drying one hundred grams of the grated mixture at 105°C till a constant weight.

Statistical Analysis

All data obtained were statistically analyzed using the Statistix 9.0 program and means of the treatments were separated using least significant differences (L.S.D.) at 0.05 level of probability according to the procedures reported by Snedecor and Cochran (1980).

Results and Discussion

Vegetative Growth Parameters

It is clear from the data in Table 2 that vermicompost (VC), botanical compost (BC) and mineral nitrogen (MN) added in combination had a significant effect on plant height, number of leaves/plant, neck and bulb diameter at 120 days after sowing date in both seasons.

TABLE 2. Effect of organic and mineral nitrogen fertilizers on some vegetative growth parameters of garlic plants at 120 days after sowing date during both seasons.

Treatments	Plant height (cm)	Number of leaves/ plant	Neck diameter (cm)	Bulb diameter (cm)	Bulbing ratio
2018/2019 season					
BC at 20 m^3/fed.+ 100 % MN	89.66	12.00	1.86	4.13	0.450
VC at 3 ton/fed. + BC at 20 m^3/fed.+ 100 % MN	94.00	12.66	2.20	4.36	0.500
VC at 3 ton/fed. + BC at 20 m^3/fed.+ 50 % MN	87.66	11.00	1.90	3.66	0.440
VC at 3 ton/fed. + BC at 15 m^3/fed. + 100 % MN	92.00	12.33	2.00	4.25	0.470
VC at 3 ton/fed. + BC at 15 m^3/fed. +50 % MN	86.50	11.00	1.60	3.56	0.449
VC at 3 ton/fed. + 100 % MN	89.33	12.00	1.83	3.93	0.470
VC at 3 ton/fed. + BC at 20 m^3/fed.	87.33	11.00	1.73	4.23	0.410
LSD at 0.05 level	**1.34**	**0.89**	**0.15**	**0.16**	**0.033**
2019/2020 season					
BC at 20 m^3/fed.+ 100 % MN	86.00	11.50	1.53	3.66	0.420
VC at 3 ton/fed. + BC at 20 m^3/fed.+ 100 % MN	89.66	12.66	1.70	4.06	0.420
VC at 3 ton/fed. + BC at 20 m^3/fed.+ 50 % MN	88.66	12.00	1.60	3.86	0.410
VC at 3 ton/fed. + BC at 15 m^3/fed. + 100 % MN	89.50	12.33	1.66	4.00	0.420
VC at 3 ton/fed. + BC at 15 m^3/fed. +50 % MN	87.33	11.00	1.50	3.40	0.440
VC at 3 ton/fed. + 100 % MN	86.66	10.66	1.60	3.66	0.440
VC at 3 ton/fed. + BC at 20 m^3/fed.	88.33	11.33	1.63	3.53	0.460
LSD at 0.05 level	**2.23**	**1.00**	**NS**	**0.26**	**0.013**

VC = vermicompost, BC= botanical compost and MN= mineral nitrogen.

Data also indicated that fertilizing garlic plants grown in sandy soil with 3 ton/fed. VC+20 m^3/fed. BC+100 % MN gave the tallest garlic plant and the highest leaves number, neck and bulb diameter as well as bulbing ratio in both seasons compared with the other treatments, except for bulbing ratio in the second season, followed by 3 ton/fed. VC+ 15 m^3/fed. BC+100 % MN in this respect.

The improvement in vegetative growth of garlic plant might be attributed to the application of vermicompost, botanical compost and mineral nitrogen. Vermicompost or botanical compost are a good sources of organic matter, would have improved the physico-chemical properties of the soil, and it also, contains large amounts of plant growth stimulants, vitamins, enzymes like amylase, lipase, cellulase and chitinase which continue to break down organic matter in the soil (Suparno et al., 2013, Yadav and Garg 2019). In addition, vermicompost contains humus-like compounds and beneficial active microorganisms (Perucci, 1992), and also it contains a good range of nutrient availability such as calcium, magnesium, zinc and manganese (Surindra, 2009). Also, the stimulative effect of nitrogen element on growth characters may be due to the major role of nitrogen on protein and nucleic acids synthesis and protoplasm formation.That's in role induce cell division and initiate meristematic activity for producing more tissues and organs (Najm et al., 2012). In addition, application of vermicompost and N fertilizers provided adequate nitrogen which is associated with high photosynthetic activity and vigorous vegetative growth (Pariari and Khan, 2013).

Furthermore, Verma et al. (2013) reported that combined application of organic and inorganic fertilizers provided plants with all essential elements required for better plant growth and development. Also, Fikru and Fikreyohannes (2019) and Kumar et al. (2019) obtained the similar conclusion with garlic plants. In addition, Degwale et al. (2016) found that N from vermicompost as well as the inorganic N application is one of the important building blocks of amino acids ($-NH_2$), where they linked together to form proteins and make up metabolic processes required for plant growth. Also, Reddy and Reddy (2005) reported that the bulb diameter of onion was increased significantly with increasing levels of vermicompost and nitrogen fertilizers. From the other side,Suthar (2009),Patidar et al.(2017) and Acharya and Kumar(2018) reported that application of vermicompost enhancing growth of garlic plant.

Dry Weight

Data shown in Table 3, showed that VC and BC in combination with MN had a significant effect on dry weight of leaves, bulb and total dry weight of plant at 120 days after sowing date in both seasons, but did not reflected any significant effect on dry weight or roots in both seasons.

Moreover, it is obvious from the data that fertilization of garlic plants with 3 ton/fed. of VC+20 m^3/fed. of BC + 100 % of MN significantly increased dry weight of leaves, bulb and total dry weight/plant in both seasons, followed by 3 ton/fed. of VC+15 m^3/fed. of BC+100 % of MN. Fertilizing with 3 ton/fed. of VC+BC at 20 m^3/fed. came in the third rank in both seasons. While, fertilization of garlic plants with 3 ton/fed. of VC+BC at 15 m^3/fed. + 50 % of MN recorded the minimum dry weight of leaves, bulb, roots and total dry weight of plant at 120 days after sowing date in both seasons of 2018/2019 and 2019/2020.

In this regard, it could be concluded that the superiority of the dry weight of different garlic plant parts by application of organic manure and nitrogen fertilizers might be attributed to the increase in photosynthetic capacity to which the number of leaves per plant could be are liable index with application of orgnaic manure and mineral nitrogen fertilizers. In addition, such added fertilizers to garlic plants promoting the physiological, biochemical and metabolic processes, which in turn increased the accumulation of the dry matter content in the plant. Also, Juan et al. (2006) reported that vermicompost increased the bulb dry weight due to the accumulation of non-structural carbohydrates whose distribution patterns change, thus favoring the metabolism of fructan precursors and accumulating as scorodose. Patidar et al. (2017) reported that application of 50 kg sulphur and 4.0 ton of vermicompost/ha. recorded significantly a higher dry weight of garlic bulb.On the other hand, nitrogen element plays an important role in the enzyme activity which reflects more products needed for plant growth. Abou El-Magd et al. (2014) and Golmohammadzadeh et al. (2015) found that increasing of nitrogen fertilizer significantly increased dry weight of different plant organs of garlic plant.

N, P and K Contents

It is clear from data presented that there were significant differences among all fertilization treatments which tested on N, P and K contents in bulb and leaves as well as in garlic plants harvested at 120 days after sowing date in both seasons (Tables 4 and 5).

TABLE 3. Effect of organic and mineral nitrogen fertilizers on dry weight of different garlic plant parts at 120 days after sowing date during both seasons.

Treatments	Dry weight of roots (g)	Dry weight of bulb (g)	Dry weight of leaves (g)	Total dry weight (g/ plant)
	2018/2019 season			
BC at 20 m^3/fed.+ 100 % MN	0.84	5.54	11.94	18.32
VC at 3 ton/fed. + BC at 20 m^3/fed.+ 100 % MN	1.64	7.08	13.16	21.88
VC at 3 ton/fed. + BC at 20 m^3/fed.+ 50 % MN	1.00	4.92	11.32	17.24
VC at 3 ton/fed. + BC at 15 m^3/fed. + 100 % MN	1.24	7.08	11.84	20.16
VC at 3 ton/fed. + BC at 15 m^3/fed. +50 % MN	1.00	3.64	8.96	13.60
VC at 3 ton/fed. + 100 % MN	1.08	5.96	10.60	17.64
VC at 3 ton/fed. + BC at 20 m^3/fed.	1.00	4.80	11.24	17.04
LSD at 0.05 level	**0.16**	**0.72**	**0.83**	**1.56**
	2019/2020 season			
BC at 20 m^3/fed.+ 100 % MN	1.08	4.72	8.56	14.36
VC at 3 ton/fed. + BC at 20 m^3/fed.+ 100 % MN	1.40	5.00	10.16	16.56
VC at 3 ton/fed. + BC at 20 m^3/fed.+ 50 % MN	1.32	4.04	9.48	14.84
VC at 3 ton/fed. + BC at 15 m^3/fed. + 100 % MN	1.08	4.72	10.04	15.84
VC at 3 ton/fed. + BC at 15 m^3/fed. +50 % MN	0.64	3.88	8.36	12.88
VC at 3 ton/fed. + 100 % MN	1.16	4.76	9.64	15.56
VC at 3 ton/fed. + BC at 20 m^3/fed.	1.20	4.52	8.88	14.60
LSD at 0.05 level	**0.21**	**0.33**	**0.32**	**0.91**

VC = vermicompost, BC= botanical compost and MN= mineral nitrogen.

TABLE 4. Effect of organic and mineral nitrogen fertilizers on N, P and K contents in bulb and leaves of garlic plants at 120 days after sowing date during both seasons.

Treatments	Bulb contents (mg/g. dry weight)			Leaves contents (mg/g. dry weight)		
	N	P	K	N	P	K
2018/2019 season						
BC at 20 m^3/fed.+ 100 % MN	112.46	18.39	103.04	345.07	30.92	317.60
VC at 3 ton/fed. + BC at 20 m^3/fed.+ 100 % MN	167.09	24.14	145.85	423.75	35.14	386.90
VC at 3 ton/fed. + BC at 20 m^3/fed.+ 50 % MN	102.83	16.58	96.43	336.20	29.77	312.43
VC at 3 ton/fed. + BC at 15 m^3/fed. + 100 % MN	152.22	24.21	138.06	361.12	31.49	330.34
VC at 3 ton/fed. + BC at 15 m^3/fed. +50 % MN	58.97	11.25	52.05	199.81	19.44	195.33
VC at 3 ton/fed. +100 % MN	122.18	20.20	116.22	309.52	27.98	253.34
VC at 3 ton/fed. + BC at 20 m^3/fed.	92.16	15.46	80.16	291.12	28.21	257.40
LSD at 0.05 level	**4.70**	**1.43**	**4.18**	**8.74**	**2.15**	**8.35**
2019/2020 season						
BC at 20 m^3/fed.+ 100 % MN	94.40	15.39	87.79	243.10	21.74	228.55
VC at 3 ton/fed. + BC at 20 m^3/fed.+ 100 % MN	116.50	17.10	106.00	322.07	27.13	293.62
VC at 3 ton/fed. + BC at 20 m^3/fed.+ 50 % MN	85.24	13.66	63.43	285.35	24.84	212.35
VC at 3 ton/fed. + BC at 15 m^3/fed. + 100 % MN	106.20	16.14	97.70	306.22	26.81	282.12
VC at 3 ton/fed. + BC at 15 m^3/fed. +50 % MN	66.74	11.80	59.36	228.23	18.48	188.10
VC at 3 ton/fed. + 100 % MN	97.10	15.66	92.34	280.52	24.77	267.03
VC at 3 ton/fed. + BC at 20 m^3/fed.	81.81	14.83	75.48	229.10	22.73	211.34
LSD at 0.05 level	**2.95**	**0.76**	**2.30**	**4.18**	**1.43**	**8.30**

VC = vermicompost, BC= botanical compost and MN= mineral nitrogen.

TABLE 5. Effect of organic and mineral nitrogen fertilizers on N, P and K contents in garlic plant at 120 days after sowing date during both seasons.

Treatments	Plant contents (mg/g. dry weight)		
	N	**P**	**K**
	2018/2019 season		
BC at 20 m^3/fed.+ 100 % MN	457.53	49.32	420.64
VC at 3 ton/fed. + BC at 20 m^3/fed.+ 100 % MN	590.84	59.28	532.75
VC at 3 ton/fed. + BC at 20 m^3/fed.+ 50 % MN	439.03	46.35	408.86
VC at 3 ton/fed. + BC at 15 m^3/fed. + 100 % MN	513.34	55.71	468.40
VC at 3 ton/fed. + BC at 15 m^3/fed. +50 % MN	258.78	30.69	247.38
VC at 3 ton/fed. + 100 % MN	431.70	48.19	369.56
VC at 3 ton/fed. + BC at 20 m^3/fed.	383.28	43.67	337.56
LSD at 0.05 level	**20.84**	**2.68**	**13.44**
	2019/2020 season		
BC at 20 m^3/fed.+ 100 % MN	337.50	37.13	316.34
VC at 3 ton/fed. + BC at 20 m^3/fed.+ 100 % MN	438.57	44.23	399.62
VC at 3 ton/fed. + BC at 20 m^3/fed.+ 50 % MN	370.59	38.49	275.78
VC at 3 ton/fed. + BC at 15 m^3/fed. + 100 % MN	412.42	42.95	379.83
VC at 3 ton/fed. + BC at 15 m^3/fed. +50 % MN	294.96	30.27	247.46
VC at 3 ton/fed. + 100 % MN	377.63	40.44	359.37
VC at 3 ton/fed. + BC at 20 m^3/fed.	310.92	37.56	286.83
LSD at 0.05 level	**25.55**	**2.68**	**10.75**

VC = vermicompost, BC= botanical compost and MN= mineral nitrogen.

Data also showed that fertilization garlic plants grown in sandy soil with 3 ton/fed. of VC+ 20 m^3/fed. of BC combined with 100 % of MN gave the highest values of N, P and K contents in bulb, leaves and garlic plants in both seasons, followed by treatment of 3 ton/fed. of VC +15 m^3/fed. of BC+100 % MN after 120 days from sowing date in both seasons. While, the lowest values of N, P and K contents were recorded by those garlic plants which received 3 ton/fed. of VC+15 m^3/fed. of BC combined with 50 % MN of the recommended dose or 3 ton/fed. of VC+ 20 m^3/fed. of BC combined with 50 % of MN in both seasons of 2018/2019 and 2019/2020.

Organic fertilizers (vermicompost or botanical compost) are good source for organic matter which acts as a storehouse of all plant nutrients and contributed nutrients availability in absorbable form towards the balanced nutrition of the crop. In addition, the increment of minerals content in the tissues of garlic plant as a result of increasing the level of nitrogen fertilizer might be attributed to the stimulating effect on plant growth and dry matter accumulation which in turn led to increase N, P and K contents. Also, Atiyeh et al. (2000) reported that the process of vermicompost enhances the microbial enzyme activity which helps in degradation of waste material into stabilized organic manure. It also increases the basal respiration, total organic C and biomass C. Plants will readily uptake the nutrients from vermicompost in the form of soluble potassium, phosphorous, calcium, magnesium and other beneficial minerals. In the same line, El-Dissoky and Gahwash (2018) came to the similar results, they found that fertilizing garlic plants with mineral nitrogen and compost were the best for increasing N, P and K contents in garlic plants.

Yields and its Components

Results shown in Table 6 indicated that fertilizing garlic plants with 3 ton/fed. of VC+ 20 m^3/fed. of BC combined with 100 % of MN significantly increased the average bulb diameter, bulb weight, number of cloves/ bulb as well as total yield per feddan. However, no significant differences were detected with the treatment of fertilizing garlic plants with 3 ton/fed. of VC+ 15 m^3/fed. of BC combined with 100 % of MN on all yield components, except for the number of cloves/ bulb in both seasons. On the other hand, the lowest total yield was obtained with those garlic plants which fertilized by 3 ton/fed. of VC+ 15 m^3/fed. of BC combined with 50 % of MN.

This means that fertilizing garlic plants with 3 ton/fed. of VC+20 m^3/fed. of BC + 100 % of MN recorded the highest buld yield of 9.312 and 9.249 ton/fed. while, fertilizing with 3 ton/fed. of VC+15 m^3/fed. of BC + 50 % of MN recorded the lowest bulb yield of 7.403 and 7.042 ton /fed. in the 1st and 2nd seasons, respectively. The increase in bulb yield with organic manure treatments attributed to overall increase in plant growth characters as discussed. These organic sources beside supplying of N, P and K nutrients also convert unavailable form of nutrients into an available form to facilitate the plants to absorb the nutrients.

Application of organic sources promoted also the growth and activity of beneficial microorganisms in the soil particularly in the rizosphere (Yadav et al., 2013). The healthy growth of plants might lead to a higher rate of photosynthesis and carbohydrate accumulation (Mohd et al., 2011), which resulted into increasing the size of bulbs as indicated by bulb diameter and the average bulb weight and ultimately overall yield enhancement of garlic plants.

In addiotion, the availability of nitrogen is of prime importance for plant growth as it is a major and indispensable constituent of protein and nucleic acid molecules formation. An adequate supply of nitrogen is associated with vigorous vegetative growth. In this regard, Suthar (2009) reported that the combination of vermicompost with chemical fertilizer increasing the budget of essential soil micronutrients and boosting microbial population, which ultimately promotes the plant growth and production.

Also, Hore et al. (2014) found that growth and more efficient use of available inputs finally leading to higher productivity. The obtained results are in accordance with those reported by Kumar et al. (2013) and Badal et al. (2019) who found that combined application of organic manure with mineral fertilizers increased the yield attributes and finally the total bulb yield in garlic. Later on, it was also supported by the findings of Shinde et al. (2013) on onion. On the other hand, the increase in bulbs productivity with application of organic or mineral nitrogen were in conformity with the earlier findings of Verma et al. (2013), Golmohammadzadeh et al. (2015), Hassan (2015), Degwale et al. (2016), Patidar et al. (2017) and El-Metwaly et al. (2021).

Bulb Quality

Results in Table 7 evidently showed that fertilizing garlic plants with different rates and sources of nitrogen had a significant effect on total protein, nitrate content in bulb and dry matter accumulation, but had no significant effect on total carbohydrates in cloves. These findings were similar in both seasons of the study.

TABLE 6. Effect of organic and mineral nitrogen fertilizers on bulb yield and its components of garlic plant at 120 days after sowing date during both seasons.

Treatments	Bulb diameter (cm)	Bulb weight (g)	Number of cloves/bulb	Total yield (ton/feddan)
2018/2019 season				
BC at 20 m^3/fed.+ 100 % MN	5.76	61.29	36.00	8.480
VC at 3 ton/fed. + BC at 20 m^3/fed.+ 100 % MN	6.94	67.23	38.33	9.312
VC at 3 ton/fed. + BC at 20 m^3/fed.+ 50 % MN	5.93	56.37	34.66	7.691
VC at 3 ton/fed. + BC at 15 m^3/fed. + 100 % MN	6.88	66.01	37.33	9.141
VC at 3 ton/fed. + BC at 15 m^3/fed. +50 % MN	4.93	55.74	31.16	7.403
VC at 3 ton/fed. + 100 % MN	5.63	59.74	34.16	8.263
VC at 3 ton/fed. + BC at 20 m^3/fed.	5.06	57.73	31.33	7.682
LSD at 0.05 level	**0.67**	**1.53**	**0.78**	**0.322**
2019/2020 season				
BC at 20 m^3/fed.+ 100 % MN	5.87	63.80	36.33	8.732
VC at 3 ton/fed. + BC at 20 m^3/fed.+ 100 % MN	6.53	66.07	40.16	9.249
VC at 3 ton/fed. + BC at 20 m^3/fed.+ 50 % MN	5.84	54.95	35.30	7.693
VC at 3 ton/fed. + BC at 15 m^3/fed. + 100 % MN	6.46	65.88	36.16	9.223
VC at 3 ton/fed. + BC at 15 m^3/fed. +50 % MN	5.10	51.73	33.00	7.042
VC at 3 ton/fed. + 100 % MN	5.84	62.45	37.50	8.543
VC at 3 ton/fed. + BC at 20 m^3/fed.	5.44	52.40	34.83	7.236
LSD at 0.05 level	**0.29**	**2.01**	**0.89**	**0.672**

VC = vermicompost, BC= botanical compost and MN= mineral nitrogen.

TABLE 7. Effect of organic and mineral nitrogen fertilizers on garlic bulb quality at harvesting time during both seasons.

Treatments	Total protein (%)	Total carbohydrates (%)	Nitrate content(mg/ kg DW)	Dry matter (%)
2018/ 2019 season				
BC at 20 m^3/fed.+ 100 % MN	11.25	47.94	225.77	36.10
VC at 3 ton/fed. + BC at 20 m^3/fed.+ 100 % MN	12.19	48.37	223.01	38.91
VC at 3 ton/fed. + BC at 20 m^3/fed.+ 50 % MN	11.75	47.27	205.16	38.00
VC at 3 ton/fed. + BC at 15 m^3/fed. + 100 % MN	13.13	48.54	222.75	39.13
VC at 3 ton/fed. + BC at 15 m^3/fed. +50 % MN	10.38	48.52	204.51	38.23
VC at 3 ton/fed. + 100 % MN	11.44	48.47	205.00	38.20
VC at 3 ton/fed. + BC at 20 m^3/fed.	9.56	48.04	200.61	38.16
LSD at 0.05 level	**0.84**	**NS**	**3.46**	**0.73**
2019/2020 season				
BC at 20 m^3/fed.+ 100 % MN	11.00	47.99	225.84	37.90
VC at 3 ton/fed. + BC at 20 m^3/fed.+ 100 % MN	12.19	48.45	223.14	38.80
VC at 3 ton/fed. + BC at 20 m^3/fed.+ 50 % MN	11.94	47.30	205.16	38.60
VC at 3 ton/fed. + BC at 15 m^3/fed. + 100 % MN	12.88	48.57	222.81	39.06
VC at 3 ton/fed. + BC at 15 m^3/fed. +50 % MN	10.38	48.48	204.69	38.73
VC at 3 ton/fed. + 100 % MN	11.38	48.60	205.10	38.26
VC at 3 ton/fed. + BC at 20 m^3/fed.	9.50	47.99	202.68	37.00
LSD at 0.05 level	**0.80**	**NS**	**2.11**	**0.84**

VC = vermicompost, BC= botanical compost and MN= mineral nitrogen.

It is clear also that fertilizing garlic plants with 3 ton/fed. of VC+15m^3/fed. of BC+100 % MN of the recommended dose gave the highest value of total protein and dry matter contents in both seasons compared with other treatments, while, the lowest value of nitrate content in garlic cloves was obtained by treatment of 3 ton/fed. of VC + BC at 20 m^3/fed. in both seasons. The improvement in garlic quality may be due to increased vegetative growth and greater accumulation of substrates which ultimately increased the quality of bulb through desirable enzymatic changes taking place during growth. The similar results have been reported by Yadav et al. (2017) and Kumar et al. (2019). In addition, Mahmoud et al. (2000) found that organic manure or and NPK treatments showed a significant increase of N, P and K in onion bulbs and Degwale et al. (2016) reported that, 5 t ha^{-1} vermicompost alone or combined with 46 N + 92 P_2O_5 (kg/ha.) resulted in the highest garlic crop quality.

Conclusion

From the previous results, it is clear that fertilizing garlic plants with 3 ton/fed. of vermicompost + 20 m^3/fed. of botanical compost combined with 100 % of mineral nitrogen of recommended dose improved vegetative growth parameters of garlic plants, and it increased total dry weight/plant, N, P and K contents as well as yield and its components, while the lowest value of nitrate content in cloves was obtained by using vermicompost at 3 ton/fed. + botanical compost at 20 m^3/fed.

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Conflict of interest

The authors declare that there is no conflict of interest.

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تأثير الأسمدة العضوية والنيتروجين المعدني على نمو، إنتاجية وجودة أبصال نباتات الثوم النامية تحت ظروف التربه الرمليه

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أجريت تجربة حقلية خلال موسمي شتاء ٢٠١٩/٢٠١٨ و ٢٠٢٠/٢٠١٩ بمزرعة الخطارة التجريبية - كلية الزراعة - جامعة الزقازيق - محافظة الشرقية - مصر. لدراسة تأثير أستخدام الفيرميكمبوست، الكمبوست النباتي والنيتروجين المعدني على النمو، الإنتاجية وجودة أبصال الثوم المزروع تحت ظروف التربه الرملية. وقد صممت التجربة فى تصميم القطاعات كاملة العشوائية من ٣ مكرارات. اظهرت النتائج المتحصل عليها أن تسميد نباتات الثوم ب ٣ طن/ فدان فيرميكمبوست +٢٠ م ٣ / فدان كمبوست نباتى + ١٠٠٪ النيتروجين المعدني من المعدلات الموصى بها أدى إلى زيادة كل من طول النبات ، عدد الأوراق ، قطر العنق والبصلة وكذلك نسبة التبصيل ، الوزن الجاف لكل من الأوراق والأبصال والوزن الجاف الكلى للنبات. كما أدت هذه المعاملة إلى زيادة المحتوى من النتروجين ،الفوسفوروالبوتاسيوم فى كل من الأبصال والأوراق ، وكذلك النبات ، وزيادة وزن البصلة ، عدد الفصوص / البصلة ، المحصول الكلي من الأبصال للفدان، محتوى البروتين الكلي والمادة الجافة. فى حين تم الحصول على أقل قيمة لمحتوى النترات في الفصوص عن طريق معاملة التسميد بمعدل ٣ طن / فدان فيرميكمبوست + ٢٠ م ٣ / فدان كمبوست نباتى في كلا الموسمين.