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Effect of Different Levels of Nitrogen and Phosphorus Fertilizer in Combination with Botanical Compost on Growth and Yield of Okra (*Abelmoschus esculentus* L.) under Sandy Soil Conditions in Egypt

[1]Ahmed A.M. Mohsen and [2]Mohamed K. Abdel-Fattah
[1]Department of Horticulture, Faculty of Agriculture, Zagazig University, Egypt
[2]Department of Soil Science, Faculty of Agriculture, Zagazig University, Egypt

Corresponding Author: Mohamed K. Abdel-Fattah, Department of Soil Science, Faculty of Agriculture, Zagazig University, Egypt

ABSTRACT

A field experiment was conducted on a sandy soil at El-Khattara Experimental Farm, Faculty of Agriculture, Zagazig University, Sharkia Governorate, Egypt during two successive summer seasons of 2013 and 2014. It aims to assess the response to nitrogen and phosphorus fertilizer rates with or without botanical compost regarding growth and yield of okra (*Abelmoschus esculentus* L.) as well as other attributes. The experiment was carried out under drip irrigation system. The treatments consisted of 14 treatments, which were the combination between two botanical compost (without compost and with compost) and seven levels of nitrogen and phosphorus fertilizer (Unfertilized soil, 80 kg N fed^{-1}+45 kg P fed^{-1}, 80 kg N fed^{-1}+60 kg P fed^{-1}, 80 kg N fed^{-1}+75 kg P fed^{-1}, 100 kg N fed^{-1}+45 kg P fed^{-1}, 100 kg N fed^{-1}+60 kg P fed^{-1} and 100 kg N fed^{-1}+75 kg P fed^{-1}). These treatments were arranged in split plot system in a randomized complete block design with three replications. The botanical compost were randomly arranged in the main plot and N+P were distributed in sub plots. The results showed that application of different levels of nitrogen plus phosphorus fertilizer combined with or without compost; significantly ($p<0.05$) influenced the growth, yield and other attributes of okra plants. Application of 100 kg N fed^{-1}+75 kg P fed^{-1} with or without compost to okra plants gave the highest values of plant growth, yield and quality in the two studied seasons. In addition, results showed that application of botanical compost led to increase the yield and NPK uptake by okra plant. This study suggests that okra response to different levels of nitrogen and phosphorus combined with or without botanical compost under sandy soil in Egypt.

Key words: Okra, nitrogen, phosphorus, compost, sandy soil, Egypt

INTRODUCTION

Sandy soils are characterized by less than 18 % clay and more than 68 % sand in the first 100 cm of the solum. In the World Reference Base (WRB) soil classification system (ISSS Working Group R.B., 1998), sandy soils may occur in the following Reference Soil Groups: Arenosols, Regosols, Leptosols and Fluvisols. Sandy soils are characterized by a lack of structure or it is weakly development. On the sandy soil, in the field and in the laboratory (on cores originating from the same horizons), showed very small shrinkage: bulk volume variation was only 0.05%. When they dried, the sandy soils develop only very few thin cracks organized in a loose network. The poor shrinkage properties of these soils are related to the low clay content and the high proportion of low activity clays of many tropical sandy soils. Sandy soils are often dry, nutrient deficient and fast draining. It has little (or no) ability to transport water from deeper layers through capillary transport. The nutrient and water-holding capacity of sandy soils can be improved through adding organic material. On other hand, sandy soil have good aeration because air gets in easily, good drainage, because water moves easily through them, they are easy to cultivate and warm up quickly in spring.

Okra (*Abelmoschus esculentus* L.) is one of the important vegetable crops in tropical and sub-tropical regions. In Egypt, it is one of the most popular vegetables and considered a valuable source of calcium, iron and vitamins. It has been grown for its edible pods which can be used as fresh, canned, frozen, or dried food. Okra is a flowering plant in the mallow family *Malvaceae*, originating from tropical and sub-tropical Africa and is natural to West Africa (Tindall, 1983). It was formerly considered a species of Hibiscus, but it is now classified in the genus *Abelmoschus*. Okra grows in all types of soils and thrives best in a moist, friable, well-drained soil (Kochhar, 1986). The plant is tolerant to drought stress (Majanbu *et al*., 1985); however, irrigation water supplementary is necessary for a satisfactory production (Okunade *et al*., 2008). The approximate nutrient content of the edible okra pods is as follows: water, 88%, protein 2.1% m, fat 0.2%, carbohydrate 8.0%, fibre 1.7% and ash 0.2% (Tindall, 1983). However, the nutritional quality of okra can be influenced by the application of organic fertilizers, such as liquid seaweed, with the following composition (as dry weight basis), according to Zodape *et al*. (2008): carbohydrate, 7.39%, protein 28.04% and dietary fiber 35.55%. The oil content in the seeds could be as high as that in poultry eggs and soybeans (Akinfasoye and Nwanguma, 2005).

Okra requires nutrients such as nitrogen, phosphorus, potassium, calcium, sodium and sulfur for fertility maintenance and crop production. These nutrients are specific in function and must be supplied to plants at the right time and at the right quantity. Lack of sufficient amounts of these nutrients resulted in poor performance of the crop growth and led to low yield (Shukla and Nalk, 1993). The use of organic manure especially poultry dropping and ruminant dung for crop production has helped to improved agricultural practice in West Africa countries. Organic manure helps to improve the physical condition of soil and provide adequate amount of necessary nutrients in the soil for good productivity. Organic fertilizer plays a vital role as a major contributor of plant nutrients. It also acts as a storehouse for cation exchange capacity and as a buffering agent against undesirable pH fluctuation (Adepetu and Corey, 1976). Okra responds well to the dressing of organic and inorganic manure. Palm *et al*. (1997) gave the importance of organic and inorganic fertilizer as essential tools for okra production. Okra can also be given combination of organic and inorganic fertilizers to improve the fruit yield and to supply balance nutrient to the crop. Use of proper doses of fertilizer is one of the most important ways of better production of okra and phosphorus fertilizer has a great effect in this respect (Yogesh and Aora, 2001). The objectives of this study was to determine the optimum level of both nitrogen and phosphorus with or without botanical compost for maximizing plant growth, fruit yield and improved okra pods quality under sandy soil conditions in Egypt.

MATERIALS AND METHODS

A field experiment was conducted on a sandy soil at El-Khattara Experimental Farm, Faculty of Agriculture, Zagazig University, Sharkia Governorate, Egypt during two successive summer seasons of 2013 and 2014. It aims to assess the response of okra plants (*Abelmoschus esculentus* L) to nitrogen and phosphorus levels with or without botanical compost regarding growth, yield and other attributes. Physicochemical characteristics of the investigated soils are presented in Table 1 (average 2 seasons). Soil was analyzed according to the methods described by USDA (1954). This experiment was carried out under the drip irrigation system.

The treatments consisted of 14 treatments, which were the combination between two botanical compost (without compost and with compost) and seven levels of nitrogen and phosphorus fertilizer (Unfertilized soil, 80 kg N fed^{-1}+45 kg P fed^{-1}, 80 kg N fed^{-1}+60 kg P fed^{-1}, 80 kg N fed^{-1}+75 kg P fed^{-1}, 100 kg N fed^{-1}+45 kg P fed^{-1}, 100 kg N fed^{-1}+60 kg P fed^{-1} and 100 kg N fed^{-1}+75 kg P fed^{-1}). These treatments were arranged in split plot system in a randomized complete block design with three replications. The botanical compost were randomly arranged in the main plot and N+P were distributed in sub plots. Seeds of okra cv. Dokki 2 were sown in 1st May in the both seasons. The area of experimental units was 5 m^2. It contained two lines each of 5 length and 0.5 m width. The distance between plants was 25 cm on one side of dripper lines.

Application rate of botanical compost was 20 Mg fed^{-1} and the characteristics of compost are shown in Table 2. Ammonium sulfate (205 g N kg^{-1}) and ordinary super phosphate (75 g P kg^{-1}) were used as sources of N and P mineral fertilizers, respectively. The former mineral fertilizers were added as soil application. Different doses of P fertilizer as well as compost were added during soil preparation. All experimental units received one third of the recommended amount of potassium sulfate (415 g K kg^{-1}) and one third of N used levels were added during soil preparation. The two third of K fertilizer was added at 30 and 45 days after sowing. In addition, the two thirds of N rates were added in five equal portions every two weeks beginning at 15 days after sowing as soil application. The other normal agriculture practices for growing okra plants were followed.

Table 1: Physicochemical characteristics of the experimental soil site

Property	Studied soil
Texture class	Sand
Organic matter (g kg^{-1})	6.30
EC and pH	
EC (dS m^{-1}) [soil extract1:2.5]	0.45
pH [soil suspension 1:2.5]	7.98
Soluble ions (mmolc L^{-1})	
Na^+	1.12
K^+	0.27
Ca^{2+}	1.17
Mg^{2+}	0.54
Cl^-	0.89
HCO_3^-	1.01
$SO_4^=$	1.20

Table 2: Physicochemical characteristics of botanical compost

Property	Compost
Moisture (%)	23.00
pH	6.87
EC (dS m^{-1}) (Compost extract 1:10)	4.57
Total N (%)	1.00
N-NH_4 (ppm)	67.00
N-NO_3 (ppm)	17.00
Organic matter (%)	30.50
Organic carbon (%)	14.79
Ash (%)	74.50
C/N Ratio	1:14.79
Total P-P_2O_5 (%)	0.73
Total K-K_2O (%)	1.03

A random sample of two plants from each experimental unit was taken at 60 days after sowing to measure plant height, number of branches and number of leaves. Different plant parts, i.e., roots, stems, branches and leaves were dried at 70°C until constant weight and dry weight were recorded. The dried plant parts were wet digested using a mixture of $HClO_4$ and H_2SO_4 for determining N, P and K (Piper, 1950). Okra pods were harvested every three days and yield and its attributes were recorded. Pod sample from the third harvest were oven dried at 70°C and finely ground them wet digested as previously mentioned in plant chemical analysis according to Piper (1950) and N, P and K percentage in pods were determined and calculated as dry weight basis.

Statistical analysis: The obtained data were statistically analyzed using the SAS program and LSD test at the 5% level of probability was used to compare the treatments means according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Results presented in Table 3 shows the effect of different studied treatments on plants height, branches No., leaves No. and dry weight of okra plants in 2 tested seasons at 60 days from sowing. Data show that application of N and P fertilization at different levels with or without botanical

Table 3: Effect of compost and nitrogen combined with phosphors on plant growth of okra plants at 60 days from sowing during 2013 and 2014 seasons

	1st season (2013)					2nd season (2014)				
T and C	Plant height (cm)	Branches No.	Leaves No.	DW/P (g)	DWR (g)	Plant height (cm)	Branches No.	Leaves No.	DW/P (g)	DWR (g)
Effect of interaction between T and C										
C0										
T1	43.50	5.00	20.75	19.54	4.98	44.00	5.75	22.75	20.48	4.95
T2	48.90	6.50	23.00	21.79	6.12	50.00	7.50	27.00	22.33	6.14
T3	52.13	7.25	25.50	24.36	7.71	53.75	9.00	28.50	24.95	7.75
T4	53.25	7.75	28.00	27.06	8.65	54.25	9.25	29.25	27.84	8.70
T5	57.25	10.00	29.50	29.24	9.89	60.25	10.50	30.00	29.79	9.69
T6	59.25	10.75	30.00	33.36	11.73	63.75	11.75	32.75	33.77	11.75
T7	61.75	11.50	34.75	37.12	13.73	65.25	12.25	36.00	36.99	13.84
C1										
T1	48.50	6.50	22.25	20.38	5.86	49.50	7.50	25.75	20.79	5.72
T2	51.00	6.75	25.00	23.41	6.35	52.00	8.00	27.75	23.97	6.40
T3	52.50	7.75	26.50	26.13	8.41	53.50	8.50	29.00	27.01	8.53
T4	55.25	8.75	28.50	27.83	8.90	56.25	10.00	29.50	28.87	8.93
T5	58.50	10.25	29.50	29.75	10.15	61.25	10.75	32.00	30.27	10.20
T6	61.25	11.00	32.25	34.22	12.78	64.50	12.00	33.75	34.85	12.72
T7	62.50	11.50	35.75	38.85	19.81	66.00	13.00	39.00	39.29	19.92
Effect of (C)										
C0	53.72	8.39	27.36	27.49	8.97	55.89	9.43	29.46	28.02	8.97
C1	55.64	8.93	28.54	28.65	10.32	57.57	9.96	30.96	29.29	10.35
Effect of (T)										
T1	46.00	5.75	21.50	19.96	5.42	46.75	6.63	24.25	20.64	5.34
T2	49.95	6.63	24.00	22.60	6.24	51.00	7.75	27.38	23.15	6.27
T3	52.32	7.50	26.00	25.24	8.06	53.63	8.75	28.75	25.97	8.14
T4	54.25	8.25	28.25	27.44	8.78	55.25	9.63	29.38	28.36	8.82
T5	57.88	10.13	29.50	29.49	10.02	60.75	10.63	31.00	30.03	9.95
T6	60.25	10.88	31.13	33.79	12.26	64.13	11.88	33.25	34.31	12.24
T7	62.13	11.50	35.25	37.98	16.77	65.63	12.63	37.50	38.14	16.88
$LSD_{0.05}$										
A	2.26	1.19	1.81	0.43	1.30	1.49	0.81	0.83	0.35	0.28
B	1.21	ns	0.97	0.23	0.69	0.80	0.43	0.45	0.19	0.15
AB	ns	ns	ns	0.613	1.84	2.11	ns	1.18	0.50	0.40

T1: Untreated soil, T2: 80 kg N fed^{-1}+45 kg P fed^{-1}, T3: 80 kg N fed^{-1}+60 kg P fed^{-1}, T4: 80 kg N fed^{-1}+75 kg P fed^{-1}, T5: 100 kg N fed^{-1}+ 45 kg P fed^{-1}, T6: 100 kg N fed^{-1}+60 kg P fed^{-1}, T7: 100 kg N fed^{-1}+75 kg P fed^{-1}, C0: Without compost, C1: With compost, DW/P: Dry weight per plant and DWR: Dry weight of roots compost significantly increased plants height, branches No. leaves No. shoots and roots dry weight of okra plants as compared to unfertilized plots (control) in the two seasons.

Respecting the effect of compost, data shows that fertilization of okra plants with compost at 20 Mg fed^{-1} significantly increased plants height, branches No., leaves No., shoots and roots dry weight of okra plants in both seasons except number of branches in the 1st season. Regarding N+P effect, the obtained results illustrated that N+P at different rates significantly increased plants height as well as branches No., leaves No. and dry weight of okra plants in 2 tested seasons at 60 days from sowing. Fertilization with N+P at 100+75 kg fed^{-1} gave the highest values of former attributes with no significant with N+P at 100+60 kg fed^{-1} with respect to plant height and number of branches per plant in both seasons. Concerning the effect of interaction between compost and N+P, data indicated that the interaction between compost and N+P reflect significant effect on dry weight per plant and dry weight of roots in both seasons and plant height and number of leaves in the 2nd season, but did not reflect significant effect on plant height, number of branches in both seasons and plant height and number of branches in the 1st season. The highest values in this respect were recorded with treatments T7+C1, while the lowest one was obtained in the unfertilized plants. The increased in plants height, branches No., leaves No., shoots and roots dry weight of okra were 30.40, 56.52, 41.96, 49.70 and 74.86% in the first season, respectively and 33.33, 55.77, 41.67, 47.87 and 75.15% in the second season, respectively.

Data in Table 4 show that the different levels of nitrogen plus phosphors as well as compost caused a positive significant effect on N, P and K uptake after 60 days from sowing. Compost at 20 Mg fed^{-1} increased K uptake per plant in both seasons and N uptake per plant in the 1st season. N+P at different rates had significant effect on N, P and K uptake by plants. The N+P at 100+75 kg fed^{-1} increased N, P and K uptake by plants compared to other treatments and control. The interaction between compost and N+P had no significant effect on N, P and K uptake by plants except N uptake in the 1st season. The highest values of N, P and K total uptake per plant were 979.44, 167.18 and 995.13 mg $plant^{-1}$ and 982.05, 196.35 and 943.76 mg $plant^{-1}$ in the first and second seasons, respectively, were obtained with T7 combined with botanical compost. However, un-treated plants showed the lowest values in this respect.

Data in Table 5 show effect of different treatments on yield and its components of okra. Data indicated that the total yield fed^{-1} of okra plants followed a rather similar pattern as that of the former parameters. All fertilizer supplied to okra plant increased total yield compared with untreated one. Data shows that Compost application had no significant effect on yield and its components, except yield per plant, yield per plot and total yield per fed in 1st seasons. Fertilization of okra plants with N+P at different rates reflect significant effect on yield and its components except average fruit weight in the 2nd season. Generally, N+P at 100+60 or at 100+75 kg fed^{-1} significantly increased number of fruits per plant, yield per plant, yield per plot and total yield per fed. The increases in total yield were about 59.35, 71.28% for N+P at 100+60 kg fed^{-1} and 67.70 and 74.53% for N+P at 100+75 kg fed^{-1} in the 1st and 2nd seasons, respectively.

Concerning the effect of interaction between compost and N+P, data shows that the interaction between compost and N+P had significant effect on yield and its components of okra in 1st season except average fruits weight. In the 1st season, the interaction between compost at 20 Mg fed^{-1} and N+P at 100+60 kg fed^{-1} or 100+75 kg fed^{-1} increased fruit number per plant, yield per plant, yield per plot and total yield per fed with no significant differences with zero compost and N+P at 100+60 or at N+P at 100+75 kg fed^{-1}. The increases in total yield were about 84.78 and 92.21% for the interaction between compost at 20 Mg fed^{-1} and N+P at 100+60 kg fed^{-1} and the interaction

Table 4: Effect of compost and nitrogen combined with phosphors on NPK uptake by okra plants at 60 days from sowing during 2013 and 2014 seasons

	1st season (2013)			2nd season (2014)		
T and C	N uptake (mg plant^{-1})	P uptake (mg plant^{-1})	K uptake (mg plant^{-1})	N uptake (mg plant^{-1})	P uptake (mg plant^{-1})	K uptake (mg plant^{-1})
Effect of interaction between (T) and (C)						
C0						
T1	242.12	31.25	283.17	286.53	40.90	307.21
T2	315.75	45.64	339.95	334.89	44.60	357.20
T3	370.35	63.91	411.73	398.22	74.74	423.97
T4	462.71	83.90	492.49	500.97	83.46	473.06
T5	534.97	99.63	593.60	565.77	119.07	537.09
T6	720.41	126.90	743.98	743.05	135.19	675.61
T7	909.33	152.17	876.06	850.58	184.93	850.69
C1						
T1	269.01	38.75	309.77	291.00	41.55	311.79
T2	348.90	58.54	379.41	359.11	47.56	383.17
T3	425.91	70.45	449.42	459.00	80.98	459.07
T4	498.07	89.03	536.98	519.60	86.48	519.64
T5	592.03	107.10	642.60	604.02	121.01	574.81
T6	793.90	133.46	773.42	799.97	138.91	766.50
T7	979.44	167.18	995.13	982.05	196.35	942.76
Effect of (C)						
C0	507.95	86.20	534.43	525.72	97.55[a]	517.83
C1	558.18	94.93	583.82	573.54	101.83[a]	565.39
Effect of (T)						
T1	255.56	35.00	296.47	288.77	41.23[d]	309.50
T2	332.33	52.09	359.68	347.00	46.08[d]	370.18
T3	398.13	67.18	430.57	428.61	77.86[c]	441.52
T4	480.39	86.46	514.73	510.29	84.97[c]	496.35
T5	563.50	103.37	618.10	584.89	120.04[b]	555.95
T6	757.16	130.18	758.70	771.51	137.05[b]	721.06
T7	944.39	159.67	935.59	916.31	190.64[a]	896.72
LSD0.05						
A	36.60	42.10	65.50	117.40	30.80	80.60
B	19.60	ns	35.00	ns	ns	43.10
AB	51.80	ns	ns	ns	ns	ns

T1: Untreated soil, T2: 80 kg N fed^{-1}+45 kg P fed^{-1}, T3: 80 kg N fed^{-1}+60 kg P fed^{-1}, T4: 80 kg N fed^{-1}+75 kg P fed^{-1}, T5: 100 kg N fed^{-1}+45 kg P fed^{-1}, T6: 100 kg N fed^{-1}+60 kg P fed^{-1}, T7: 100 kg N fed^{-1}+75 kg P fed^{-1}, C0: Without compost, C1: With compost

between compost at 20 Mg fed^{-1} and N+P at 100+75 kg fed^{-1}1 78.08 and 89.86% for the interaction between zero compost and N+P at 100+60 kg fed^{-1} and the interaction between zero compost and N+P at 100+75 kg fed^{-1}, respectively over the control in the 1st season.

Results presented in Table 6 shows effect of different treatments on chemical composition of okra pods in the two tested seasons. Data shows that application of N and P fertilization at different rates with or without compost significantly increased N, P and K concentrations of okra pods as compared to untreated in the two seasons. The highest values of N, P and K concentrations in okra pods were 2.78, 0.49 and 2.89% in the first season, respectively and 2.89, 0.51 and 2.87% in the second seasons, were obtained with T7 combined with and without botanical compost with no significant differences between them, except K% in pods in the second season.

The data presented in Table 3, 4, 5 and 6 cleared also that the tested treatments could be arranged in the following order regarding the effect of the main effect on plant growth characters, NPK uptake, yield and pods chemical composition in two seasons T7+C1>T7+C0>T6+C1>T6+C0>T5+C1>T5+C0>T4+C1>T4+C0>T3+C1>T3+C0>T2+C1>T2+C0>T1+C1>T1+C0. In addition, it was observed from the results that application of botanical compost also had a significant influence on the previously mentioned trails in two seasons.

Table 5: Effect of compost and nitrogen combined with phosphors on yield and its components of okra during 2013 and 2014 seasons

		1st season (2013)						2nd season (2014)					
C	T	Fruit No.	Yield (g plot^{-1})	Yield (ton fed^{-1})	Fruit weight average	Yield g/plant	Relative +/-in yield	Fruit No.	Yield (g plot^{-1})	Yield (ton fed^{-1})	Fruit weight average	Yield g/plant	Relative +/-in yield
C0	T1	590	1379.97	2.32	2.34	69.00	0.00	598	1397.47	2.35	2.34	69.87	0.00
	T2	712	1929.96	3.24	2.71	96.50	39.86	723	1984.96	3.33	2.75	99.25	42.04
	T3	841	2059.96	3.46	2.45	103.00	49.28	856	2102.46	3.53	2.46	105.12	50.45
	T4	884	2089.96	3.51	2.37	104.50	51.45	896	2194.96	3.69	2.45	109.75	57.07
	T5	959	2224.96	3.74	2.32	111.25	61.23	979	2417.45	4.06	2.47	120.87	72.99
	T6	987	2457.45	4.13	2.49	122.87	78.08	1044	2624.95	4.41	2.52	131.25	87.84
	T7	1194	2619.95	4.40	2.195	131.00	89.86	1073	2667.45	4.48	2.49	133.37	90.88
C1	T1	624	1762.46	2.96	2.83	88.12	27.72	631	1674.97	2.81	2.66	83.75	19.86
	T2	731	1992.46	3.35	2.73	99.62	44.38	753	2077.46	3.49	2.76	103.87	48.66
	T3	853	2064.96	3.47	2.42	103.25	49.64	866	2164.96	3.64	2.50	108.25	54.92
	T4	905	2094.96	3.52	2.32	104.75	51.81	915	2292.45	3.85	2.51	114.62	64.04
	T5	972	2389.95	4.02	2.46	119.50	73.19	1001	2492.45	4.19	2.49	124.62	78.35
	T6	1087	2549.95	4.28	2.35	127.50	84.78	1032	2637.45	4.43	2.56	131.87	88.73
	T7	1087	2652.45	4.46	2.44	132.62	92.21	1061	2694.95	4.53	2.54	134.75	92.84
C0		880	2108.89	3.54	2.41	105.44	0.00	881	2198.53	3.69	2.49	109.93	0.00
C1		894	2215.31	3.72	2.50	110.77	5.05	894	2290.67	3.85	2.57	114.53	4.19
	T1	601	1571.22	2.64	2.58	78.56	0.00	615	1536.22	2.58	2.50	76.81	0.00
	T2	722	1961.21	3.29	2.72	98.06	24.82	738	2031.21	3.41	2.75	101.56	32.22
	T3	847	2062.46	3.46	2.44	103.12	31.26	861	2133.71	3.58	2.48	106.69	38.89
	T4	894	2092.46	3.52	2.34	104.62	33.17	906	2243.71	3.77	2.48	112.19	46.05
	T5	965	2307.45	3.88	2.39	115.37	46.86	990	2454.95	4.12	2.48	122.75	59.80
	T6	1037	2503.70	4.21	2.42	125.18	59.35	1038	2631.20	4.42	2.54	131.56	71.28
	T7	1140	2636.20	4.43	2.32	131.81	67.78	1067	2681.20	4.50	2.51	134.06	74.53
$LSD_{0.05}$	A	46.519	139.716	0.234	0.229	6.985		45.026	307.370	0.516	0.229	15.368	
	B	24.866	74.681	0.125	0.123	3.734		24.067	164.296	0.276	0.123	8.215	
	AB	65.788	197.588	0.331	0.324	9.879		ns	ns	ns	ns	ns	

T1: Untreated soil, T2: 80 kg N fed^{-1}+45 kg P fed^{-1}, T3: 80 kg N fed^{-1}+60 kg P fed^{-1}, T4: 80 kg N fed^{-1}+75 kg P fed^{-1}, T5: 100 kg N fed^{-1}+45 kg P fed^{-1}, T6: 100 kg N fed^{-1}+60 kg P fed^{-1}, T7: 100 kg N fed^{-1}+75 kg P fed^{-1}, C0: Without compost, C1: With compost

Table 6: Effect of compost and nitrogen combined with phosphors on pod chemical composition of okra during 2013 and 2014 seasons

	1st season 2013			2nd season 2014		
	N	P	K	N	P	K
T and C	(%)					
Effect of interaction between (T) and (C)						
C0						
T1	1.34	0.19	1.51	1.39	0.18	1.56
T2	1.43	0.23	1.62	1.46	0.22	1.62
T3	1.65	0.26	1.76	1.62	0.49	1.72
T4	1.87	0.31	1.86	1.73	0.32	1.93
T5	2.16	0.38	2.12	1.99	0.36	2.31
T6	2.43	0.41	2.46	2.45	0.39	2.56
T7	2.68	0.45	2.75	2.75	0.48	2.73
C1						
T1	1.39	0.21	1.56	1.43	0.20	1.59
T2	1.56	0.25	1.64	1.57	0.25	1.66
T3	1.76	0.29	1.82	1.69	0.29	1.85
T4	1.98	0.34	1.92	1.85	0.34	2.19
T5	2.32	0.39	2.33	2.23	0.37	2.46
T6	2.56	0.43	2.62	2.59	0.43	2.69
T7	2.78	0.49	2.89	2.89	0.51	2.87
Effect of (C)						
C0	1.94	0.32	2.01	1.91	0.35	2.06
C1	2.05	0.34	2.11	2.04	0.34	2.19
Effect of (T)						
T1	1.37	0.20	1.54	1.41	0.19	1.58
T2	1.50	0.24	1.63	1.52	0.24	1.64
T3	1.71	0.28	1.79	1.66	0.39	1.79
T4	1.93	0.33	1.89	1.79	0.33	2.06
T5	2.24	0.39	2.23	2.11	0.37	2.39
T6	2.50	0.42	2.54	2.52	0.41	2.63
T7	2.73	0.47	2.82	2.82	0.50	2.80
$LSD_{0.05}$						
A	0.134	0.064	0.115	0.124	ns	0.056
B	0.072	ns	0.061	0.066	ns	0.030
AB	ns	ns	ns	ns	ns	0.079

T1: Untreated soil, T2: 80 kg N fed^{-1}+45 kg P fed^{-1}, T3: 80 kg N fed^{-1}+60 kg P fed^{-1}, T4: 80 kg N fed^{-1}+75 kg P fed^{-1}, T5: 100 kg N fed^{-1}+45 kg P fed^{-1}, T6: 100 kg N fed^{-1}+60 kg P fed^{-1}, T7: 100 kg N fed^{-1}+75 kg P fed^{-1}, C0: Without compost, C1: With compost

Regarding discussion the former results, several workers have reported linear increase in green pod yield of okra with the application of N from 56 to 150 kg N ha^{-1} (Hooda *et al.*, 1980; Mani and Ramanathan, 1980; Majanbu *et al.*, 1985; Singh, 1995). Phosphorus fertilization can influence fruiting and fruit development of okra. Phosphorus is called the "Key to life" because it is directly involved in most living process. It is a key constituent of ATP and has a vital role in energy transformation in plants as well as in various physiological processes (Shivasankeb *et al.*, 1982). Phosphorus helps in nutrients uptake by promoting root growth and thereby ensuring a good pod yield through the increase in total dry weight/plant (Sharma and Yadev, 1997; Rai, 1982). Phosphorus deficiency results in poor root development, poor pod setting and subsequently reduces yield (Jain *et al.*, 1990). Many researchers reported the effect of phosphorus application on green pod yield of okra (Gupta *et al.*, 1981; Mohanta, 1998; Sadat, 2000). The higher dose of N might have enhanced cell division and formation of more tissues resulting in luxuriant vegetative growth and thereby increased plant height, Sultana (2002) and Meyer and Anderson (1970) reported similar result. Majanbu *et al.* (1985) observed that plant height was enhanced by N fertilizer up to 100 kg N ha^{-1}. Singh *et al.* (1998) stated that application of 90 kg N ha^{-1} increased plant height by 14.03% compared with control. Mohanta (1998) and Gupta *et al.* (1981) observed that plant height of okra increased with the increase in P application up to 60 kg P_2O_5 ha^{-1} this finding is a disagree with our finding. On the other hand, Majanbu *et al*. (1985) did not observe any effect due to phosphorus application on growth and yield of okra plants.

Previous results can be attributed to the important role played by nitrogen and phosphorus within the plant and the role of compost in the soil. In simple terms, nitrogen promotes plant growth. It is associated with vegetative growth. It's a part of every protein in the plant, so it's required for virtually every process, from growing new leaves to defending against pests. Nitrogen is a part of the chlorophyll molecule, which gives plants their green color and it involved in creating food for the plant through photosynthesis. Lack of nitrogen shows up as general yellowing (chlorosis) of the plant. Because nitrogen can move around in the plant, older growth often yellows more than the new growth. Phosphorus is involved in metabolic processes responsible for transferring energy from one point to another in the plant. It's also critical in root development and flowering. Because phosphorus moves slowly through the soil, it's important to work it into the soil, where the roots need it. Using compost in the soil is beneficial in many ways; improves the soil structure, porosity and density, thus creating a better plant root environment, improves water holding capacity, thus reducing water loss and leaching in sandy soils, supplies a variety of macro and micronutrients, supplies significant quantities of organic matter, improves cation exchange capacity of soils and growing media, thus improving their ability to hold nutrients for plant use, supplies beneficial microorganisms to soils and growing media and compost can greatly enhance the physical structure of soil.

CONCLUSIONS

The results showed that application of different levels of nitrogen plus phosphorus fertilizer combined with or without botanical compost, significantly enhanced plant growth and yield and its components of okra plants compared to control. Application of 100 kg N fed^{-1}+75 kg P fed^{-1} with or without botanical compost gave in the most cases the highest growth and total yield. It also improved pod quality in two seasons. In addition, results showed also that application of compost led to increase the total yield and NPK uptake by okra plants.

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