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Impact of foliar spraying of urea or liquid manure under different nitrogen sources on productivity and chemical composition of leaves of cotton

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Tow field experiments were carried at Sids, Agriculture Research Station, Beni-Suef Governorate, ARC, Egypt in 2017 and 2018 seasons to evaluate the effect substitute half recommended nitrogen with foliar spraying of liquid manure or urea for three nitrogen fertilizer forms, i.e., ammonia gas (82% N), urea (46.5% N) and ammonium nitrate (33.5% N) on cotton growth (plant height, first fruiting branches, number of fruiting branche/plant, number of green branches/plant and total bolls/plant), yield components (number of plants ha^{-1}, number of open bolls/plant, boll weight and seed cotton yield/plant) and yield parameters (seed index, lint percentage and seed cotton yield ha^{-1}) as well as some chemical composition of cotton leaves, i.e., N%, P%, K%, chlorophyll A and B and caroteniods. The experiment design was factorial in complete randomized blocks with four replications. The results indicate that all studied growth parameters, yield and yield components, chemical composition, except lint percentage were significantly affected by nitrogen sources, where the highest values were obtained under ammonia gas followed by ammonium nitrate fertilizers, while urea fertilizer gave the lowest ones. Combined foliar spraying of liquid manure with half of recommended nitrogen rate (84 kg N ha^{-1}), statistically gave cotton productivity equal to those due to full recommended nitrogen rate (167 kg N ha^{-1}), followed by combined foliar spraying of 2% urea solution with half recommended nitrogen rate (84 kg N ha^{-1}) . Where fed cotton plant with half recommended rate of nitrogen only exhibited the lowest values of cotton productivity and chemical composition of cotton leaves. The treatments of ammonia gas at rate of 167 kg N ha^{-1} or 84 kg N ha^{-1} + foliar spraying of liquid manure gave the highest values of cotton productivity, while the plants received 84 kg N ha^{-1} only produced the lowest ones.

Keywords: Foliar fertilizer, inorganic fertilizer sources, Cotton productivity and chemical composition of cotton leaves.

INTRODUCTION

Cotton (Gossypium barbadense L.) is the most popular natural fiber for clothing and textile products, accounting for approximately 25% of tool fiber use (USDA, 2017). It is known in Egypt as the "White Gold ". Egyptian cotton fibers are preferred around the world due to its fine and excellent properties that make it softer and stronger at the same time (Mehasen et al., 2012). Both seed cotton yield and fiber quality of cotton are important factors in determining a farmer's profit. Raising cotton productivity and quality can be performed during careful management in every production stage, including field management practices as planting date, fertilization and irrigation.

Fertilization is the important factor affected cotton growth, yield and quality. Nitrogen represents a vital element in all biological processes in plant life, synthesis of chlorophyll molecule, protein synthesis and nucleic acid formation, plant growth, productivity (Elayan et al., 2018; Bekele, 2018)

Many enzymes are proteinaceous; consequently, N plays an important function in many metabolic reactions. Also, it is involved in cell walls structure (Fageria, 2006; Delwar et al., 2000; Haward et al., 2001) investigated that high nitrogen treatment stimulates growth. Many investigators stated that the adequate nitrogen level is needed for maximum seeds of cotton yield such as (Singh 2015; Sui et al., 2017; Abd El-Hady, 2019). The effectiveness of inorganic nitrogen sources on agronomic growth is mainly due to its effect on soil reaction and nutrients availability. Some manures leave on acid residue in the soil, others are of basis, and still others seemingly have no influence on soil pH (Tisdale and Nelson, 1975; Hassanein, 1996). Crops adsorbed nitrogen in form of NO_3^- (nitrate) or NH_4^+ (ammonium), but NO_3^- is the preferred form in flooding or an aerobic condition (Absalam et al., 2011; Fageria, 2006) stated that plants supplied with equal doses of NH_4^+ and NO_3^- grew equally as those which fertilized with a single level of nitrogen. Foliar of nitrogen as urea has the benefits of low expenses and fast vegetation response (Oosterhuis, 1999). The efficiency of foliar feeding is higher than soil application under some conditions such as drought and water stress (Ahmad, 2013). Foliar nitrogen application of cotton as partial supplementation to soil fertilization is particularly efficient method due to the ability of leaves to absorption nutritious through its cuticle (Bondada et al., 1997). In addition, (Oosterhuis et al., 1989) explain the efficiency of foliar feeding of cotton crops to the fast translocation of nutrients to the bolls, making it more effective than soil application. Many workers stated the benefits of foliar nitrogen to cotton, such as (Bondata et al., 1999; Kawakami et al., 2010). Effectiveness of nitrogen form was varied in different species and is related to the concentration same as soil reaction, the capacity of buffer and other nutrient contents in the soil. It has been recognized that ammonium absorbed faster than nitrate ions, which involved more energy needs to assimilate NO_3^- in comparison with NH_4^+ (20 ATP), same as O_2 needed for NO_3^- absorption. (Absalam et al., 2011). In Egypt, many nitrogen fertilizer forms were used as ammonium sulphate, ammonium nitrate and urea, same as ammonia gas by injected in the soil before sowing using especial apparatus (Abd El-Hafeez et al., 2013). Siam *et al* (2008) stated that the superiority of ammonia gas than the other nitrogen forms is mainly due to the addition of ammonia gas under the soil surface into suitable depth save it from loss.

Several workers have studied the differential impact of NO_3^- and NH_4^+ on growth (Britto and Kronzucker, 2002). Tan et al., (2000) reported that NH_4^+ in roots near the absorption in cell vacuoles, while NO_3^- can be accumulated without any toxic effects and translocated into shoots (Andrews, 1986). Smolen and Sady (2009) noticed that fertilization with ammonium increased absorption of metals from the roots as compared to those treated with nitrate (Smolen and Sady, 2009).

Environment-friendly organic manures storage, translocation and application had stimulation effect on soil fertility and reduce the expenses of using chemical fertilizer. Farmyard manure contains somewhat suitable amounts of macron and micronutrients and may provide significant savings from chemical manures (Chadwick and Laws, 2002). Combined chemical fertilizers with manure may deceased the fertilization expenses and increased crop production same as provide environmental production. It could be applied the organic manure as liquid form (Chambers et al., 2001) indicated that, the amount and time of liquid manure application can easily be adjusted at different plant growth phases. The liquid manure includes, fungi, protozoa, microorganisms, bacteria, mineral compounds, organic and inorganic acids (Al-Kahal et al., 2009). Many investigators reported the beneficial effect of liquid manure on plant growth such as (Arancon et al., 2007; Hargreaves et al., 2008; Zewail and Ahmed, 2015).

The goal of this study was to investigate the importance use three N fertilizer sources; i.e., ammonia gas, urea and ammonium nitrate, either alone or in combination with 2% foliar spraying of urea or liquid manure, on cotton growth, chemical composition of cotton leaves, yield and yield components.

MATERIALS AND METHODS

The experiment was conducted at the Farm of the Agricultural Research Satiation, Beni-Suef Governorate, ARC, Egypt during 2017 and 2018 seasons to evaluate the using of foliar spraying of urea or added liquid manure to substitute 50% from full recommended rate of three sources of chemical fertilizers. In this study, a complete randomized blocks design with four replications was used. The treatments were: -

1- Nitrogen fertilizer sources, i.e., ammonia gas at (82% N), urea at (46.5% N) and ammonium nitrate (33.5% N).

2- Methods and levels of application, i.e., full recommended nitrogen level (167 kg ha^{-1}), half recommended nitrogen dose 84 kg ha^{-1}, 84 kg ha^{-1} + foliar sparing of liquid manure twice and half of recommended nitrogen level + foliar sparing of 2% urea solution twice.

Soils of experiment were clay in texture, having pH of 8.0 and 8.1, electrical conductivity in extracted soil paste of 1.2 and 1.4 dSm^{-1} soil organic matter of 1.2 and 1.3%, and calcium carbonate of 1.1 and 1.2% same as soil available N, P and K of 21 and 20; 16 and 18; and 165 and 181 ugg^{-1} in the two seasons, respectively according to (A.O.A.C, 1980). Liquid farmyard manure was prepared by but 40 kg farmyard manure in a barrel, and then the barrel was topped off with top water (1:5 w/v). The mixture was ferment for a week in ambient temperatures, where, mixture stirred once every day. The supernatant of the watery manure was applied twice, as foliar sparing before second and third irrigation at rate of 1 liter per 1.5 m² area. The liquid manure used in the experiments contain about 1.95 and 1.81 N, 0.58 and 0.51 P, 2.12 and 2.00 K, and 0.62 and 0.67% Mg in the two growing seasons, respectively according to (A.O.A.C, 1980).

Ammonia gas (82% N) were injected directly into 15% moisture soil moisture (15 cm depth) with 30 cm spacing between points of injection, while urea (46.5% N) or ammonium nitrate (33.5% N) were used at 2 equal doses, after thinning and at 15 days later. The foliar sparing of 2% urea at rate of (950 L ha^{-1}) was done, one at beginning of flowering and after two weeks later. The preceding crops were maize in both seasons.

Cotton seeds, variety Giza 95 were sown on 7 and 10 April in the two seasons, respectively. Experimental area was 13.5 m² (3×4.5m) inclusive five ridges. Each ridge was 4.5m long, 0.65m wide of the hills and 0.30m a part between crops in one side of the ridge. Hills were thinned after three weeks, from sowing to two crops. Phosphorus fertilizer as superphosphate (15.5% P_2O_5) at dose of 55 Kg P_2O_5 ha^{-1} was added before planting. Also, potassium fertilizer as potassium sulphate, 48% kg K_2O (57 kg K_2O ha^{-1}) were added before the second irrigation. Other cultural practices were done as recommended for cotton in district.

Ten representative plants from two inner ridges of each plots were taken randomly at harvest to measure the these characters, growth parameters (plant height, first fruiting branches, number of bolls and number of fruiting branches), yield components (total number of open bolls, boll weight, and number of plants ha^{-1}) and yields (lint percentage, seed index and seed cotton yield kentar ha^{-1}). Also, index leaves samples from each plot were taken at random from the top fourth node leaves at 15 days after full flowering phase to determine; N, P and K concentration by the method (A.O.A.C. 1980), chlorophyll (A), and (B) according to (Arnon, 1949) and carotenoids according to (Rolbelem, 1957).

The obtained data were subjected to proper statistical analysis according the method described by Sendecor and Cochran (1980). The significant of differences (L.S.D.) at 0.05 level of probability.

RESULTS AND DISCUSSION

Growth parameters

Data in table 1 show that growth parameters of cotton plants were significantly affected by nitrogen sources, levels and method of application. The highest values of plant height, number of green branches per plant, number of fruiting branches per plant and number of total bolls per plant were obtained under added full dose of nitrogen fertilizer as ammonia gas, followed by ammonium nitrate fertilizers, while urea fertilizer gave the lowest one . On the other hand, first fruiting branches did not respond to nitrogen fertilizer sources. The increasing percentages of plant height as well as number of fruiting branches, number of green branches and number of total bolls per plant due to ammonia gas fertilizer were 0.7, 2.8, 9.0% when compared with urea fertilizer in the first season, respectively. Same trends were obtained in the second season. The superiority of ammonia gas over urea and ammonium nitrate may be due to continuous and slow release of nitrogen beginning of cotton planting (Abd El-Hafeez et al., 2013).These data are in harmony with those collected by (Ismail et al., 1996; Siam et al., 2008). On the other hand, the reduction in cotton growth due to urea fertilizer is mainly due to the hydrolysis of urea was more fast than other nitrogen sources resulted in more nitrogen loss by leaching. As for foliar sparing, the data in table 1 clearly indicate that, irrespective of nitrogen sources mixed 84 kg N ha^{-1} with foliar sparing of both liquid manure or 2% urea enhanced all studied growth parameters of cotton when compared with added 84 kg N ha^{-1} only. The increment of cotton growth caused by foliar spraying of liquid manure is more than foliar spraying of 2% urea solution, but the different between then in not reached to the significance values. The relative increasing of plant height, number of fruiting branches/plant, number of green branches/plant and total bolls/plant due to mixed 84 kg N ha^{-1} with foliar sparing with liquid manure reached to 2.3, 2.1, 8.7 and 15.7% over added 84 kg N ha^{-1} only in the first season, respectively. Similar trends were obtained in the second season. It is worthy to notice that substitute half of the recommended nitrogen dose by foliar sparing of liquid manure or urea solution gave statistically values of cotton growth parameters equal to those under the full recommended nitrogen dose. The beneficial effect of liquid manure may be attributed to it include: active microorganisms, primarily bacteria, micro-organisms, fungi and some microbial bio-products (Al-Kahal et al., 2009). Moreover, (Hargreaves et al., 2008) stated that liquid manure enhancing vegetation status and promoting vegetation growth. These results are in agreement with Sadik et al., (2009) for maize and Zewail and Ahmed (2015) for cotton.

Foliar sparing of cotton of nitrogen as a supplement to soil fertilization increased the ability of the leaf to absorb nutrients through the cuticle (Bondada et al., 1997; Bondada et al., 1999)

The data clearly show that all studied cotton growth parameters did not affect by the interaction between the two factors, which means that each factor was insignificantly acting independently. In general, the best values of cotton growth were obtained under the treatment of the full recommended rate of nitrogen (167 kg N h^{-1}) or the half-recommended rate of nitrogen (84 kg N h^{-1}) combined with foliar spraying of liquid manure or foliar spraying of 2% urea solution. Whereas, half recommended nitrogen dose (84 kg N h^{-1}) gave the lowest values of cotton growth parameters.

Yield components

Analysis of variance show that nitrogen sources increased significantly cotton yield components, namely, number of plant ha^{-1}, number of open bolls/plant, boll weight and seeds of cotton yield/plant (Table, 2), except number of plant ha^{-1} which did not affect by nitrogen forms. Ammonia gas had more effect on yield components followed by ammonium nitrate and urea. Injected ammonia gas yielded number of open bolls/plant, boll weight and seeds of cotton yield/plant surpassed that due to urea by about 2.0, 0.9 and 8.4% in the first season, respectively. Similar trend was collected in the second season. It is obvious to notice that, the differences between the effect of ammonia gas and ammonium nitrate manures are not significant in both growing seasons. The superiority of NH_4^+ containing fertilizer, whether ammonia or ammonium nitrate in plants is due to release of protons (H^+), which consequently decreased of pH in rooting zone (Bolan et al., 1991). In addition, (Xin et al., 2011) reported that nitrogen sources increased chlorophyll contents, photosynthetic assimilation, enzyme activities of rubisco and the photorespiration. Guo et al., (2002) found that plant fed with NH_4^+ had higher stomatal conductance and transpiration rate. Moreover, ammonium treatment increased acidification of rhizosphere and promote acquisition in crops (Thomson et al., 1993). The data are similar to those obtained by (Absalam et al., 2011) for cotton crops, (Borgognonea et al. 2012) for tomato crops and (Abd El-Hafeez et al., 2013).

The data in Table (2) show that yield components of cotton were affected significantly by methods and levels of N treatment, except number of plants ha^{-1}. Statistically, mixed 84 kg N ha^{-1} with foliar spraying of liquid manure or foliar spraying of urea solution gave yield components parameters of cotton equal to those yielded under 163 kg N ha^{-1}. Whereas, fed cotton plants with 84 kg N ha^{-1} only gave the lowest values of cotton yields attributes in both seasons. The promotive effect of liquid manure is mainly due to liquid manure contains a large and diverse community of microbes, humic acids and other nutrients that enhance plant growth and enhance the uptake of nutrients by plants (Glik, 2012). The beneficial effect of foliar spraying of 2% urea solution on cotton yield components is mainly due to foliar spraying of urea to leaves restored both normal chlorophyll content and normal somatal in plant resulted in increasing growth and yield attributes (Amanullah et al., 2010). Also, (Bondada et al., 1997) indicated that foliar N fertilization of cotton is particularly effected method due to the ability of leaves to absorb nutrients, and rapid translocation of these nutrients to the bolls (Oosterhuis et al., (1989).These results are in line with those of Zewail and Ahmed (2015) for liquid manure and Kawakami et al., (2010) for urea solution.

Table (1) Impact of foliar sparing of liquid manure and urea under different N sources on cotton growth parameters.

Treatments		Plant height (cm)		First fruiting branches		No. of fruiting branches / plant		No. of green / branches plant		No. of total bolls /plant	
Sources	Methods and levels	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Ammonia gas	167 kg N h $^{-1}$	126.5	141.1	8.2	7.8	14.8	16.1	2.8	2.8	26.6	26.5
	84 kg N h $^{-1}$	125.2	138.5	8.5	8.1	14.4	15.5	2.4	2.1	22.5	22.5
	84 kg N h $^{-1}$ + liquid manure	126.4	141.1	8.2	7.8	14.7	16.0	2.6	2.7	26.2	25.3
	84 kg N h $^{-1}$ + 2% urea	125.0	138.6	8.3	8.0	14.3	15.6	2.5	2.3	25.2	25.3
Mean		125.3	139.8	8.3	7.9	14.6	15.8	2.6	2.5	25.1	25.2
Urea	167 kg N h $^{-1}$	125.6	135.1	8.2	8.1	14.5	15.8	2.5	2.5	24.4	24.3
	84 kg N h $^{-1}$	122.7	129.8	8.4	7.9	14.1	15.2	2.2	2.0	20.5	20.4
	84 kg N h $^{-1}$ + liquid manure	125.5	134.7	8.3	8.0	14.4	15.6	2.4	2.5	24.1	24.2
	84 kg N h $^{-1}$ + 2% urea	124.9	132.1	8.3	8.0	14.2	15.5	2.3	2.1	21.8	21.7
Mean		124.7	132.9	8.3	8.0	14.3	15.5	2.4	2.3	22.7	22.7
Ammonium nitrate	167 kg N h $^{-1}$	125.9	136.3	8.2	7.8	14.7	15.9	2.7	2.6	25.2	25.1
	84 kg N h $^{-1}$	123.1	131.5	8.6	8.1	14.3	15.4	2.3	2.1	21.8	21.7
	84 Kg N h $^{-1}$ + liquid manure	125.4	135.7	8.2	7.8	14.6	15.6	2.5	2.5	24.7	24.6
	84 kg N h $^{-1}$ + 2% urea	125.2	133.6	8.4	7.9	14.4	15.5	2.4	2.3	23.1	23.1
Mean		124.9	134.3	8.4	7.9	14.5	15.6	2.5	2.4	23.7	25.6
Mean of method and levels	167 kg N h $^{-1}$	126.0	137.5	8.2	7.8	14.7	15.9	2.7	2.6	25.4	25.3
	84 kg N h $^{-1}$	123.0	133.3	8.5	8.1	14.3	15.4	2.3	2.1	21.6	21.5
	84 kg N h $^{-1}$ + liquid manure	125.8	137.2	8.2	7.8	14.6	15.9	2.5	2.5	25.0	25.1
	84 kg N h $^{-1}$ + 2% urea	125.0	134.8	8.3	8.0	14.3	15.5	2.4	2.2	24.4	23.4
L.S. D. at 0.05	A	1.16	1.03	NS	NS	0.06	0.04	0.12	0.12	1.06	1.14
	B	1.37	1.29	0.13	0.23	0.17	0.13	0.15	0.13	1.17	1.25
	AB	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2; Impact of foliar spraying of liquid manure and urea under different nitrogen sources on yield components.

Treatments		Number of Plants ha^{-1}		Number of open bolls /plants		Seed cotton yield /plant (g)		Boll weight (g)	
Sources	Methods and levels	2017	2018	2017	2018	2017	2018	2017	2018
Ammonia gas	167 kg N h $^{-1}$	100964	100835	21.7	19.2	49.41	44.32	2.29	2.31
	84 kg N h $^{-1}$	101003	101006	19.2	17.5	35.93	33.11	1.87	1.89
	84 kg N h $^{-1}$+ liquid manure	101236	101138	21.7	19.1	48.23	42.79	2.21	2.24
	84 kg N h $^{-1}$ +2% urea	101351	101117	21.6	18.9	46.47	40.11	2.15	2.16
Mean		101139	101024	21.5	18.7	45.01	40.08	2.13	2.15
Urea	167 kg N h $^{-1}$	100776	100716	20.0	18.2	45.27	41.52	2.26	2.28
	84 kg N h $^{-1}$	101215	101216	18.1	16.3	33.29	30.13	1.83	1.85
	84 kg N h $^{-1}$+ liquid manure	100853	100692	20.2	18.1	44.01	39.93	2.18	2.20
	84 kg N h $^{-1}$ +2% urea	101067	101213	20.1	17.9	43.45	39.01	2.16	2.18
Mean		100978	100959	19.6	17.6	41.51	37.65	2.11	2.13
Ammonium nitrate	167 kg N h $^{-1}$	100561	100603	20.8	18.9	47.40	43.27	2.28	2.29
	84 kg N h $^{-1}$	100857	100812	18.6	16.8	34.52	31.52	1.86	1.88
	84 kg N h $^{-1}$+ liquid manure	101019	101039	20.7	18.7	45.58	41.82	2.20	2.23
	84 Kg N h $^{-1}$ +2% urea	101236	101338	20.5	18.3	43.67	39.56	2.13	2.16
Mean		100918	100963	20.2	18.2	42.79	39.04	2.12	2.14
Mean of method and levels	167 kg N h $^{-1}$	100767	100738	20.8	18.8	47.36	43.04	2.28	2.29
	84 kg N h $^{-1}$	101025	101011	18.6	16.9	34.58	31.59	1.85	1.87
	84 kg N h $^{-1}$+ liquid manure	101036	100956	20.9	18.6	45.94	41.51	2.20	2.22
	84 kg N h $^{-1}$ +2% urea	101218	101223	20.7	18.4	44.53	39.56	2.15	2.17
L.S. D. at 0.05	A	NS	NS	0.9	0.8	3.05	2.17	0.15	0.16
	B	NS	NS	0.4	0.5	3.97	4.80	0.18	0.17
	AB	NS	NS	NS	NS	NS	NS	NS	NS

Interaction data clearly show that, cotton yield components did not respond to the interaction between the two studied factors In general, the highest values of cotton yield components were collected for the plants supplied with the full recommended rat of nitrogen (167 kg ha^{-1}) or the plants fertilized with half nitrogen recommended rate (84 kg N ha^{-1}) when combined with twice foliar spraying whether liquid manure or urea solution. Whereas the cotton plants received only half recommended rate of nitrogen (84 kg N ha^{-1} exhibited the lowest values of cotton yield components.

Cotton yields

The results in Table (3) show that seeds index and seeds of cotton yield were affected significantly by the different nitrogen sources in the two growing seasons with the highest values obtained by ammonia gas, while lint percentage did not affect. The increment of seeds index and seeds of cotton yield caused by ammonia gas reached to 4.2 and 11.0% over urea in 1st season, respectively. In the 2st season the increases were 4.8 and 7.0% in the abovementioned respect. The superiority of the effect of ammonia gas on cotton yields parameters than other sources is mainly due to the stimulation effect of ammonia gas on growth parameters and yields component of cotton as mentioned before (Tables 1 and 2). These data agree with those collected by (Abd El-Hafeez et al., 2013; Ahmed et al., 2017).

With respect to methods and levels of application, the data in the same tables reveal that seeds index, lint percentage and seeds of cotton yield were significantly responded to the methods and levels of nitrogen application. It could be arranged these effects on the abovementioned yield parameters on the descending order as follow: 167 kg N ha^{-1} > 84 kg N ha^{-1} + foliar spraying of liquid manure > 84 kg N ha^{-1} + foliar spraying of urea solution >84 kg N ha^{-1}. It's worthy to notice that the different among the effect of 167 kg N ha^{-1}, 84 kg N ha^{-1} + foliar spraying of liquid manure and 84 kg N ha^{-1} + foliar spraying of urea solution did not reach to the significant values. The positive effects of combined liquid manure or urea solution with half recommended dose of nitrogen is mainly attributed to its promoted effects on both yield components and growth of cotton as discussed earlier (Table 1 and 2). These data are in agreement with (Al-Kahal et al., 2009) for liquid manure and (Kawakami et al 2010) for urea solution.

As for the interaction between treatments, the data show that yield parameters did not respond to the interaction between nitrogen sources, and its methods and levels. In general, the highest seeds index and seeds of cotton yield were collected under the treatments of 167 kg ha^{-1} as ammonia gas or 84 kg N ha^{-1} as ammonia gas + foliar spraing of liquid manure or urea solution.

Chemical composition

The data in table (4 and 5) show the effect of nitrogen sources same as methods and levels of application on some chemical composition, i.e., N, P and K concentration and chlorophyll (A) and (B) and caroteniods levels in cotton. The results indicate that ammonia gas fertilizer yielded the highest values of the studied chemical composition of cotton leaves followed by ammonium nitrate fertilizer, while the lowest values were recorded for urea fertilizer. This increment could be explained by the enhancing effect of ammonia gas fertilizer on cotton growth (table 1), consequently enhanced its ability to absorption the nutrients. Also, in this concern, (Thomson et al., 1993) reported that the plants supplied with NH_4^+ contains higher concentration of nutrient as compared to plants treated with other nitrogen sources, they added that ammonium added to plants resulted in acidification of rhizosphere and enhanced nutrient absorption, in turn increased chlorophyll A and B and caroteniods, where nitrogen is constituent of chlorophyll molecule. The obtained results are in accordance with (Ahmed et al., 2017).

Considering the methods and levels of nitrogen fertilization, the data clearly indicate that chemical composition of cotton leaves were affected significantly by levels and methods of nitrogen treatment. The highest values of nitrogen content were recorded under fed cotton plants with 167 kg N ha^{-1}, while 84 kg N ha^{-1} exhibited the lowest one. The treatment with 84 kg N ha^{-1} + foliar spraying of liquid manure gave the highest values of P, K, chlorophyll A and B and carotenids contents, whereas the plants treated with the half-recommended nitrogen dose gave the lowest ones. The chemical composition stimulation of cotton leaves by increasing nitrogen concentration could be due to the increasing in root hairs, chemical changes in rhizosphere and physiological (Baligar et al., 2001).

Table 3; Impact of foliar spraying of liquid manure and urea under different nitrogen sources on seeds index and lint percentage and cotton yield.

Treatments		Seeds index (g)		Lint percentage (%)		Seeds of cotton yield kentar ha^{-1}	
Sources	Methods and levels	2017	2018	2017	2018	2017	2018
Ammonia gas	167 kg N h $^{-1}$	10.46	10.48	42.53	42.41	31.52	28.26
	84 kg N h $^{-1}$	9.85	9.72	41.36	41.28	23.01	21.01
	84 kg N h $^{-1}$ + liquid manure	10.40	10.46	42.41	42.38	31.43	28.15
	84 kg N h $^{-1}$ + 2% urea	10.36	10.41	42.40	42.39	31.39	28.07
Mean		10.27	10.27	42.18	42.12	29.34	26.37
Urea	167 kg N h $^{-1}$	10.11	10.05	42.55	42.45	28.43	26.53
	84 kg N h $^{-1}$	9.43	9.35	41.39	41.30	21.22	19.28
	84 kg N h $^{-1}$ + liquid manure	9.99	9.96	42.52	42.47	28.75	26.43
	84 kg Nh $^{-1}$ + 2% urea	9.91	9.83	42.47	42.46	28.70	26.32
Mean		9.86	9.80	42.23	42.17	26.88	24.64
Ammonium nitrate	167 kg N h $^{-1}$	10.21	10.15	42.49	42.44	30.33	27.59
	84 kg N h $^{-1}$	9.65	9.53	41.31	41.32	22.21	20.05
	84 kg N h $^{-1}$ + liquid manure	10.20	10.11	42.50	42.43	30.18	27.43
	84 kg N h $^{-1}$ + 2% urea	10.16	9.96	42.48	42.45	30.10	27.36
Mean		10.06	9.94	42.20	42.16	28.21	25.61
Mean of method and levels	167 kg N h $^{-1}$	10.26	10.23	42.52	42.43	30.23	27.46
	84 kg N h $^{-1}$	9.64	9.53	41.35	41.30	22.15	20.11
	84 kg N h $^{-1}$ + liquid manure	10.20	10.18	42.48	42.43	30.12	27.34
	84 kg N h $^{-1}$ + 2% urea	10.14	10.07	42.45	42.43	30.06	27.25
L.S. D. at 0.05	A	0.08	0.09	NS	NS	0.65	0.66
	B	0.18	0.19	0.23	0.25	0.72	0.79
	AB	NS	NS	NS	NS	0.85	0.89

Table 4; Effect of foliar spraying of liquid manure and urea under different nitrogen sources on N, P and K concentration in cotton leaves.

Treatments		N %		P %		K %	
Sources	Methods and levels	2017	2018	2017	2018	2017	2018
Ammonia gas	167 kg N h ⁻¹	3.11	3.02	0.37	0.38	2.91	2.89
	84 kg N h ⁻¹	2.32	2.29	0.36	0.38	2.74	2.71
	84 kg N h ⁻¹ + liquid manure	2.26	2.50	0.44	0.45	2.95	2.93
	84 kg N h ⁻¹ + 2% urea	2.89	2.81	0.36	0.39	2.75	2.71
Mean		2.72	2.66	0.38	0.40	2.84	2.81
Urea	167 kg N h ⁻¹	2.62	2.57	0.33	0.34	2.68	2.65
	84 kg N h ⁻¹	2.13	2.06	0.33	0.34	2.69	2.67
	84 kg N h ⁻¹ + liquid manure	2.25	2.12	0.39	0.40	2.78	2.75
	84 kg N h ⁻¹ + 2% urea	2.55	2.50	0.33	0.35	2.68	2.64
Mean		2.39	2.31	0.35	0.36	2.71	2.68
Ammonium nitrate	167 kg N h ⁻¹	2.81	2.74	0.35	0.36	2.86	2.83
	84 kg N h ⁻¹	2.25	2.17	0.35	0.36	2.71	2.67
	84 kg N h ⁻¹ + liquid manure	2.33	2.28	0.42	0.44	2.90	2.82
	84 kg N h ⁻¹ + 2% urea	2.69	2.61	0.35	0.36	2.72	2.69
Mean		2.52	2.45	0.37	0.38	2.80	2.75
Mean of method and levels	167 kg N h ⁻¹	2.85	2.78	0.35	0.36	2.82	2.79
	84 kg N h ⁻¹	2.23	2.17	0.35	0.36	2.71	2.68
	84 kg N h ⁻¹ + liquid manure	2.38	2.30	0.42	0.43	2.88	2.83
	84 kg N h ⁻¹ + 2% urea	2.71	2.64	0.35	0.37	2.72	2.68
L.S. D. at 0.05	A	0.05	0.07	0.02	0.03	0.07	0.08
	B	0.06	0.08	0.03	0.03	0.08	0.06
	AB	NS	NS	NS	NS	NS	NS

Table 5;Impact of foliar spraying of liquid manure and urea under different nitrogen sources on pigments contents in cotton leaves.

Treatments		Chlorophyll A mgg^{-1} Dw		Chlorophyll B mgg^{-1} Dw		Careteniods mgg^{-1} Dw	
Sources	Methods and levels	2017	2018	2017	2018	2017	2018
Ammonia gas	167 kg N h^{-1}	3.21	3.26	2.80	2.83	0.71	0.73
	84 kg N h^{-1}	3.01	3.07	2.72	2.74	0.62	0.63
	84 Kg N h^{-1} + liquid manure	3.35	3.38	2.93	2.96	0.76	0.78
	84 Kg N h^{-1} + 2% urea	3.35	3.37	2.91	2.95	0.74	0.76
	Mean	**3.23**	**3.27**	**2.84**	**2.87**	**0.71**	**0.73**
Urea	167 kg N h^{-1}	3.17	3.20	2.70	2.72	0.65	0.66
	84 kg N h^{-1}	2.90	2.94	2.58	2.61	0.54	0.56
	84 kg N h^{-1} + liquid manure	3.30	3.34	2.75	2.77	0.70	0.73
	84 kg N h^{-1} + 2% urea	3.30	3.34	2.73	2.75	0.68	0.70
	Mean	**3.17**	**3.21**	**2.69**	**2.71**	**0.64**	**0.66**
Ammonium nitrate	167 kg N h^{-1}	3.19	3.24	2.74	2.76	0.68	0.70
	84 kg N h^{-1}	2.96	2.97	2.63	2.66	0.57	0.60
	84 kg N h^{-1} + liquid manure	3.33	3.36	2.83	2.86	0.73	0.76
	84 kg N h^{-1} + 2% urea	3.33	3.35	2.80	2.83	0.70	0.73
	Mean	**3.20**	**3.23**	**2.75**	**2.78**	**0.67**	**0.70**
Mean of method and levels	167 kg N h^{-1}	3.19	3.23	2.75	2.74	0.68	0.70
	84 kg N h^{-1}	2.96	2.99	2.64	2.67	0.58	0.60
	84 kg N h^{-1} + liquid manure	3.33	3.36	2.84	2.86	0.73	0.76
	84 kg N h^{-1} + 2% urea	3.33	3.35	2.81	2.84	0.71	0.73
L.S.D. at 0.05	A	0.04	0.05	0.06	0.05	0.02	0.02
	B	0.06	0.07	0.05	0.06	0.03	0.04
	AB	NS	NS	NS	NS	NS	NS

However, the positive effect of the treatment include liquid manure on chemical composition of cotton leaves may be due to the beneficial effects of organic manure on minerals absorption and increase photosynthesis in cotton leaves (Zewail and Ahmed, 2015). These results are in accordance with (Wilkinson et al., 2000; Bekele, 2018) for nitrogen levels, and (Lithourgidis et al., 2007; Yolcu et al., 2010) for liquid manure.

With regard to the interaction effect, the data clearly show that the chemical composition of cotton leaves did not respond to the interaction between nitrogen sources and its methods and levels of application. In general, the highest values of chemical content in cotton leaves were collected under the treatment of nitrogen at the full recommended rate or under the treatment of half recommended dose of nitrogen + foliar spraying of liquid manure. Whereas, the plants treated with half recommended dose of nitrogen only exerted the lowest values of chemical composition of cotton leaves.

CONCLUSION

In this study, it was observed that mixed the half-recommended rate of nitrogen with foliar spraying of liquid manure or 2% urea solution gave cotton productivity, statistically equal to those yielded under the trogon recommended rate. This means the possibility of save about 84 kg N ha^{-1} by foliar spraying of liquid manure or 2% urea solution twice at beginning of flowering and month later.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

Abd El-Hafeez and Ibrahim designed and performed the experiments and also wrote the manuscript. All authors read and approved the final version.

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