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Effects of Chicken Manure and Nitrogenous Fertilizer on Growth,Yield and Yield Components of Okra (*Abelmoschus esculentus* (L.) Monech) under rainfed conditions

Atif H. Naim and Nahed M. Abker

Abstract— A field experiment was conducted during rainy season 2015 at experimental farm of the Faculty of Agricultural and Environmental Sciences, University of Gadraif in Sudan. The aim of the present study was to investigate the effects of different sources of fertilizers (i.e. organic and inorganic) on the performance of okra under rainfed conditions of Gadarif State in Sudan. The experiment contained eight treatments, two levels of organic fertilizer; with and without application of chicken manure and four levels of nitrogenous fertilizers (urea) donated as 0N (control), 1N (80kgN/fed), 2N (160 kg/fed), 3N (240 kg N/fed). These treatments were allocated in factorial arrangement according to randomized completely block block design (RCBD) with three replications. The results revealed significant differences among the treatments in all growth and yield parameters. The application of organic fertilizer (chicken manure) substaintially increased growth and improved yield of okra comparing with the sole application of the chemical fertilizer (urea). Moreover increasing nitrogen rate significantly increased growth and yield of okra up to 2N (160 kg N/fed) but the highest rate of nitrogen (240 kg N/fed) substantially recorded lower averages of all parameters compared with 2N rate (160 kg N/fed) in sole application of urea and in combination with chicken manure. The combination of 2t/ha chicken manure and 2N rate (160 kg N/fed) significantly increased all growth and yield attributes of okra crop under rainfed conditions of Sudan.

Index Terms— *Abelmoschus esculentus*, Chicken manure, Growth, organic fertilizer; Nitrogenous fertilizer, Yield, Okra;

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1 INTRODUCTION

Okra, *Abelmoschus esculentus* (L.) Moench, is a leafy vegetable grown both in tropical and subtropical regions of the world [1]. In the Middle East it is known as bamia and lady's finger in England. It is an erect herbaceous annual crop species belongs to the family Malvaceae [2].

In the Sudan, okra is extensively grown especially where there is irrigation facilities [3]. The crop is one of the most popular vegetables and its association with the native food in the different regions of the country create a great stable demand for it [3]. The immature tender pods are used in stews or cut into slices, sundried, then ground as a powder and used as a favourite Sudanese dish called "Weika".

Similarly, the older immature pods which start to develop fiber are also cut into slices, sundried, ground and cooked. Even the young leaves are used as a vegetable and also may be dried [3]. In other countries the pods are used in stews and soups. According to [4], the immature fruits and leaves of *Abelmoschus esculentus* are used in soup as a thickener because it represents a rich source of vitamins and minerals. Okra is recommended for consumption by World Health Organization due to its ability to fight diseases. Okra has been found to be a rich source of vitamins A (retinol) and C (ascorpic acid), calcium, thiamine and riboflavin. It is also rich in iron and is used as a medicine in the treatment of the peptic ulcer.

The application of organic and inorganic fertilizers results in yield increase of cultivated crops. Recently, the modern subsistence and commercial farming systems depend on synthetic chemical fertilizers due to readily application, rapid absorption and utilization by the crop[5]. Unfortunately, in the long-run the continuous application of these fertilizers causes deterioration in soil physical proprieties such as soil structure which leads to accelerated soil erosion, salinity and soil deterioration. Moreover, the high cost of chemical fertilizers in developing countries leads to an increase in production costs which resulted in a substantial reduction in profit of crops production. The high prices and insufficient quantities of agricultural commodities which resulted from increasing fertilizer prices represent a potential problem and challenge for food security in these countries [6]. On the other hand, chemical fertilizers constitute few minerals which dissolve rapidly in damp soils and provide the plant with high doses of these minerals [7].

Animal manures has been used successfully in sustainable agriculture [5]. The most important manure among organic residues is chicken manure because it contains high concentration of nitrogen and other essential elements [5], [8]. Chicken manure as an organic amendment provides soil with other nutrients and improve the physical and chemical prosperities of the marginal and deteriorated soils in arid and semi-arid regions [9]. The organic matter in chicken manure conserve soil moisture by increasing water holding capacity. Nutrients contained in chicken manure are released more slowly and are stored for a long time in the soil, thereby ensuring a long beneficial residual effect [10]. The Economic Commission for Africa [11] reported that tropical soils are

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adversely affected by suboptimal soil fertility and erosion, causing a deterioration of the nutrient status and changes in soil organism populations. [12] asserted that inorganic fertilizers can improve crop yields and soil pH, total nutrient content, and nutrient availability, but their use is limited due to scarcity, high cost, nutrient imbalance and soil acidity.

Proper application and management of organic manures and nitrogenous fertilizers leads to about 50 to 60 % increases in field crop production [13]. Several studies revealed the importance of chemical and organic fertilizers as important resources for crop production and restores essential nutrients depleted due to intensive cropping practices. However, there is lack of research to investigate impact of combine application of nitrogen fertilizer and chicken manure on okra crop. This research was therefore designed with an objective to find out suitable N level in combination with chicken manure in order to increase okra productivity for nitrogen deficient clayey soils under rain-fed conditions of Gadarif State in Sudan. .

2 Materials and Methods

2.1 Description of the Experimental Site

A Field experiment was conducted during rainy season 2015 at the Research and Teaching Farm of the Faculty of Agricultural and Environmental Sciences, University of Gadarif. The experimental site is located within latitude 14°02 'N of the Equator and longitude 35°28 'E of Greenwich. Its average altitude is 600 m a.s.l. The experiment was conducted in semi-arid climatic conditions with an aridity index ranging from 0.2 to 0.4 [14]. The annual rainfall is less than 500 mm in the northern part of Gadarif State; however, the rainfall is erratic and concentrated in only few months of the year mainly from May to October. According to [15], the average temperature of this region varies between a mean minimum of 22°C in winter and a mean maximum of 37°C in summer. The study area receives the highest temperature between April and May. During such times, the hottest day can go up to 40–42°C [15]. The most prominent types of the soil in the studied area are heavy dark cracking clays in which the clay content is very high, amounting 70 to 80 per cent [16]. Monmorillonite is the common clay type in the area, its and content varies between 47 and 75 per cent. Cracks can be 3 to 10 cm wide and can be as deep as 2 m during the dry season. Cation exchange capacity ranges from 50 to 100 mg 100 g^{-1} with calcium constituting more than half of the exchangeable cations [16]. Soil pH is near neutrality in general with 1 to 3 per cent free carbonates. Nitrogen content is low and ranges from 0.05 to 0.15 percent [16]. Generally, the soils have low to moderate amounts of phosphorous content [16]. The concentration of potassium ranges from 400 to 600 ppm, which is considered as an adequate amount [17], [16]. Land use system in the area is dominated by agricultural activities such as sorghum and sesame cultivation, livestock rearing and forestation [16].

2.2 Land Preparation

The experimental site was disc ploughed, disc harrowed to crush clods and levelled out to maintain a well leveled seed bed and then followed by ridging up to 0.7m between ridges which were oriented in a north-south direction. Individual plot size was 4×3 meters consisting of 3 ridges of 3 meters in length.

2.3 Treatments and Design

The experiment was carried out in a factorial arrangements using randomized complete block design (RCBD) with three replicates. Treatments includes two levels of Chicken manure (with chicken manure and without chicken manure) and four rates of Nitrogen fertilizers in kg per feddan were 0, 80, 160, and 240 designated as ON, 1N, 2N and 3N, respectively.

2.4 Cultural Practices

2.4.1 Fertilization

The type of manure used was chicken manure, which was collected from a poultry farm in Gadarif. The fertilizer was applied on 15/7/2015 during the rainy season. The organic fertilizer was broadcasted manually on the bottom of the ridges mixed with soil and distributed equally to the entire plot using a hand hoe.

2.4.2 Sowing Date and Seeding Rate

Sowing was done manually on one side of the ridge (eastern side of ridge) and it was carried out on August, 5th. The seed rate applied was 12 kg/ha. Three to four seeds per holes and thinned latter to two plants per hole.

2.4.3 Weeding

Weeding was practiced twice during the growing period 18 and 35 days from sowing.

2.5 Growth parameters

2.5.1 Plant height (cm)

The height of the plant was measured using a meter ruler from the plant base to the terminal bud. The five tagged plants from each plot were measured and the mean height was taken to represent each replicate plant height which measured after 4, 6 and 8, 10 weeks after planting (WAP).

2.5.2 Number of leaves per plant

This parameter was measured after 4,6, 8 and 10 weeks after planting (WAP) by counting all leaves of the five randomly tagged plants. The mean number of leaves per plant for each treatment was recorded.

2.5.3 Leaf area (cm^2)

Leaf area measurements were taken at 4,6,8,10 weeks after planting (WAP) by measuring the length of median lobe of each individual leaf on the tagged plants and applying the following formula [16]:

$$Y = 115 X - 150$$

Where:

Y= leaf area (cm2)

X= length of median lobe (cm)

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The area of all leaves on a plant were added up to give leaf area per plant.

2.5.4 Dry Matter Accumulation

For determination of dry matter yield or partitioning, 3 plants per plot (destructive sampling) were uprooted at the end of the experiment. The destructive samples of leaves, stems and roots of each plant were oven dried at 75OC for 24 hours until constant weight was reached. Then the dried samples were weighed using sensitive digital balance. The average of each treatment was calculated.

2.6 Yield and Yield Components

For determination of fruit yield, five plants were selected randomly and tagged from the 1st and 3rd ridges of each individual plot during the study period. Harvesting of fruit commenced when the fruits snapped easily and reached market size. Harvesting of fruit continue every week (three pickings) until when the crop is no longer producing economic fruits. The following parameters were studied: number of pods per plant and pod fresh weight.

2.6.1 Number of pods per plant

At harvesting (three picking), when the fruits reached the physiological maturity, the number of pods in each one of the tagged plants were counted and then the average was calculated for each replicate to represent the mean number of pods for all treatments.

2.6.2 Pods Fresh Weight per plant

At physiological maturity phase at three consecutive pickings, the pods from each tagged plants were taken to the laboratory to measure the fresh weight using an electronic balance (PGW 4502e), max: 4500g and readability: 0.01g.

2.6.3 Final Fruit Yield (t/ha)

At the end of the experiment, the pods of plants were harvested in unit area (1m^2) in the middile off each plot. Then the fresh weight of collected pods per area were weighed by using a balance. Then, the equivalent yield in t/ha were calculated and the average of final yield for each treatment was calculated.

2.7 Statistical analysis

Analysis of variance (ANOVA) appropriate for split-split plot design was used according to [19] by using SPSS (version 15) software. Means of each trait for different treatments were compared according to the least significant difference (LSD) method at p≤0.05. Excell software was used to draw figures.

3 Results

3.1 Plant Height (cm)

The results showed significant ($p < 0.05$) differences in okra plant height amongst the treatments (Table 1). Incresing nitrogen fertilizer dose significantly ($p < 0.05$) increased plant height up to 2N (160 kgN/fed) and then significantly ($p < 0.05$) decresed height with increasing the dose to 3N (240 kg/fed) at all treatments regardless of application of organic fertilizer (chicken manure). The highest plant height were obtained from plots provided with 2t/ha chicken manure + 2N (160 kg/fed), while the lowest plant height was recorded for plots in the control treatment at all sampling occation (Table 1). Application of chicken manure fertilizer signifinatly ($p < 0.05$) increased the plant height of okra at all growth sampling time (Fig.1).

TABLE 1. Effect of chicken manure and nitrogen fertilizer on plant height of okra crop during the rainy season 2015.

Treatments	Plant Height (cm)			
	4 WAP	6 WAP	8 WAP	10 WAP
2 t/ha of Chm + 0N	25.27cd	32.43c	53.23b	62.97d
2 t/ha of Chm + 1N	29.90b	38.23bc	63.17a	74.43c
2 t/ha of Chm + 2N	39.30a	46.47a	67.73a	82.10b
2 t/ha of Chm + 3N	31.93b	36.37b	62.18a	95.13a
0 N (control)	23.42d	25.30c	42.03c	52.10e
1N	27.58bc	31.83bc	44.40c	62.07d
2 N	36.73a	40.10b	52.43b	72.33c
3 N	29.57bc	32.57bc	48.53b	64.64d
LSD (ρ ≤ 0.05)	4.86	7.73	6.81	3.90

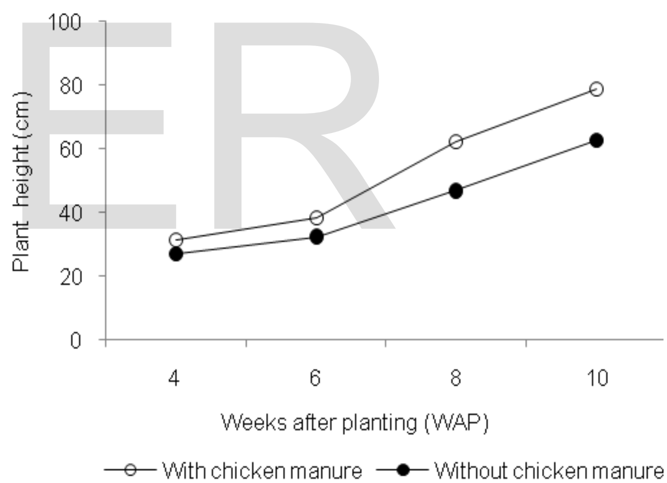

Fig.1. Effect of chicken manure fertilizer on plant height of okra crop during rainy season 2015.

3.2 Number of leaves per plant

The average number of leaves per plant was significantly ($p < 0.05$) different across all treatments. Incresing nitrogen fertilizer rate in combination with chicken manure significantly ($p < 0.05$) increased number of leaves per plant of okra from control treatment (0N) up to 160 kg/fed (2N) but the highest rate of nitrogen in combination with chicken manure significantly ($p < 0.05$) decreased number of leaves per plant (Table 2). The sole application of nitrogen fertilizer significantly increased the number of leaves per plant up to 2N (160 kg/fed) and then decreased with increasing nitrogen rate to 3N (240 kg/fed) as shown in Table 2. The highest number of leaves per plant was recorded for plants provided by 2t/ha chicken manure in combination with 2 N (160

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kg/fed), while the control treatment recorded the lowest number of leaves per plant (Table 2). Application of organic fertilizer significantly increased the average number of leaves per plant at all sampling occasions(Fig.2).

TABLE 2. EFFECT OF CHICKEN MANURE AND NITROGEN FERTILIZER ON NUMBER OF LEVES PER PLANT OF OKRA CROP DURING THE RAINY SEASON 2015.

Treatments	Average number of leaves per plant			
	4 WAP	6 WAP	8 WAP	10 WAP
2 t/ha of Chm + 0N	24.80de	26.53cd	28.37d	30.20d
2 t/ha of Chm + 1N	28.63bc	32.10b	34.40b	36.13b
2 t/ha of Chm + 2N	32.03a	36.57a	38.47a	39.93a
2 t/ha of Chm + 3N	29.33ab	33.23b	34.77b	36.60b
ON	17.17g	21.57f	23.13e	24.80e
1N	22.10f	24.57e	26.03d	27.63d
2 N	26.40cd	29.20c	31.30c	33.00c
3 N	22.57ef	26.07de	27.93d	29.43d
LSD (ρ ≤ 0.05)	2.56	2.77	2.71	2.62

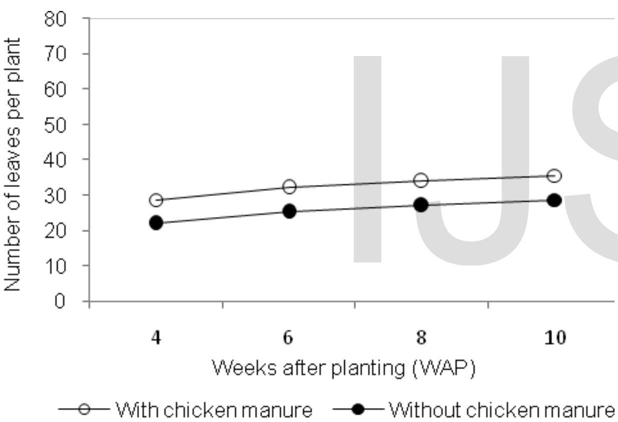

Fig.2. Effect of chicken manure fertilizer on number of leaves per plant of okra crop during season 2015.

3.3 Leaf Area (cm^2)

Significant ($p < 0.05$) differences were recorded in leaf area (LA) among treatments (Table 3). At all sampling occasions, the highest leaf area was obtained from the combination of 2t/ha chicken manure with 160 kg N/fed (Table 3), while the control treatment obtained the lowest leaf area. Increasing nitrogen rate significantly ($p < 0.05$) increased leaf area of okra plant up to 160 kg/fed but the highest rate of N (240 kg/fed) significantly ($p < 0.05$) decreased leaf area in sole application and in combination with chicken manure (Table 3). The application of chicken manure significantly increased leaf area of okra plant at all sampling periods (Fig.3).

TABLE 3. EFFECT OF CHICKEN MANURE AND NITROGEN FERTILIZER ON LEAF AREA PER PLANT OF OKRA CROP DURING THE RAINY SEASON 2015.

Treatments	Average leaf area (cm^2)			
	4 WAP	6 WAP	8 WAP	10 WAP
2 t/ha of Chm + 0N	250.32c	287.73c	320.64c	368.74
2 t/ha of Chm + 1N	262.64b	296.41c	335.63b	380.86bc
2 t/ha of Chm + 2N	278.53a	330.32a	351.33a	410.55a
2 t/ha of Chm + 3N	265.45b	310.55b	341.24ab	396.54a
0 N (control)	210.36f	235.56e	287.66e	324.53e
1N	230.34e	243.57e	304.57d	345.72d
2 N	240.63d	255.94d	333.73b	367.71c
3 N	233.72de	240.23e	317.82c	350.80d
LSD (ρ ≤ 0.05)	8.22	9.60	10.63	15.21

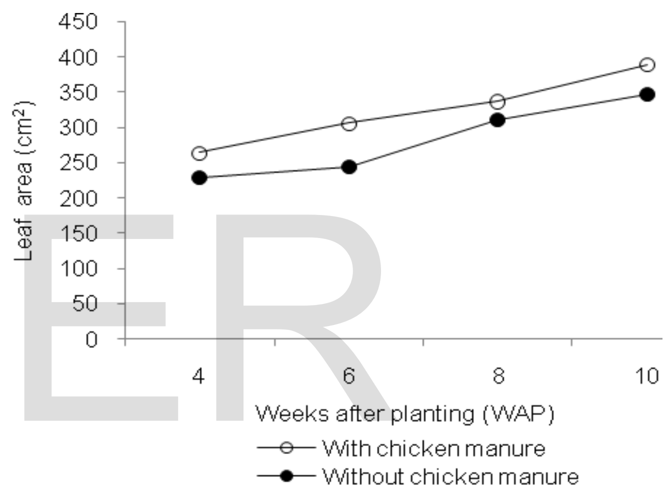

Fig.3. Effect of chicken manure fertilizer on leaf area (cm^2) of okra crop during rainy season 2015.

3.4 Dry Matter Yield (g)

Results of the present study revealed significant ($p < 0.05$) differences among the treatments on dry matter yield and portioning of okra plant (Table 4 and 5). The combination between chicken manure and nitrogen fertilizer significantly increased dry matter accumulation in shoot and root compared with the sole application of chemical fertilizer (nitrogen in form of urea) treatments and the control treatment (Table 4 and 5). The highest shoot and root dry matter was obtained by the combination of 2t/ha chicken manure and 2N treatment, while the lowest shoot dry matter was recorded for plants which received the control treatment (no fertilizer) as shown in Table 4 and Table 5. The sole application of chemIncreasing nitrogen up to 2N rate significantly increased the dry matter yield of shoot and root dry matter at all growth duration (Table 4 & 5). The results of this study showed significant ($p < 0.05$) increase in shoot dry matter portioning at all sampling occations. The results also indicated that the root dry matter was progressively increased by appling chen manure fertilizer at all sampling occasions.

TABLE 4. EFFECT OF CHICKEN MANURE AND NITROGEN FERTILIZER ON SHOOT DRY MATTER YIELD (G) OF OKRA CROP DURING THE RAINY SEASON 2015.

Treatments	Shoot dry weight (g)			
	4 WAP	6 WAP	8 WAP	10 WAP
2 t/ha of Chm + 0N	4.67d	6.03d	13.33d	22.17d
2 t/ha of Chm + 1N	6.40c	7.53c	15.63c	24.47c
2 t/ha of Chm + 2N	9.87a	11.50a	20.77a	32.87a
2 t/ha of Chm + 3N	7.30b	9.00b	17.30b	27.83b
ON	3.80e	4.80e	9.93f	15.93f
1N	5.00d	5.87d	12.03e	20.37e
2N	7.67b	9.03b	16.30bc	24.63c
3N	6.37c	7.37c	12.83de	20.20e
LSD (ρ ≤ 0.05)	0.86	0.78	1.15	0.87

TABLE 5. EFFECT OF CHICKEN MANURE AND NITROGEN FERTILIZER ON ROOT DRY MATTER YIELD (G) OF OKRA CROP DURING THE RAINY SEASON 2015.

Treatments	Average number of leaves per plant			
	4 WAP	6 WAP	8 WAP	10 WAP
2 t/ha of Chm + 0N	24.80de	26.53cd	28.37d	30.20d
2 t/ha of Chm + 1N	28.63bc	32.10b	34.40b	36.13b
2 t/ha of Chm + 2N	32.03a	36.57a	38.47a	39.93a
2 t/ha of Chm + 3N	29.33ab	33.23b	34.77b	36.60b
ON	17.17g	21.57f	23.13e	24.80e
1N	22.10f	24.57e	26.03d	27.63d
2 N	26.40cd	29.20c	31.30c	33.00c
3 N	22.57ef	26.07de	27.93d	29.43d
LSD (ρ ≤ 0.05)	2.56	2.77	2.71	2.62

3.5 Number of pods per plant

Both fertilizers (organic in form of chicken manure and inorganic in form of urea) have significant effects (P<0.05) on the average nmber of pods per plant of okra plant during the growing season 2015 (Table 6). Means average number of pods in the three pickings was produced by the combination of 2t/ha chicken mature and 2 N rate of urea fertilizer followed by the combination of 2 t/ha chicken manure and 3N in the first and second picking but in the third picking application of 2N without chicken manure recorded the second highest number of pods per plant.

TABLE 6. EFFECT OF CHICKEN MANURE AND NITROGEN FERTILIZER ON NUMBER OF PODS PER PLANT OF OKRA CROP DURING THE RAINY SEASON 2015.

Treatments	Average number of pods per plant		
	First pick	Second pick	Third pick
2 t/ha of Chm + 0N	2.40c	6.63c	16.47de
2 t/ha of Chm + 1N	3.20b	8.00b	18.27d
2 t/ha of Chm + 2N	5.33a	9.33a	34.73a
2 t/ha of Chm + 3N	4.00b	7.03bc	21.97c
0 N (control)	1.80d	5.00d	12.73f
1N	2.33c	5.53d	16.20e
2 N	3.67b	6.07c	24.93b
3 N	3.20b	6.77c	17.53de
LSD (ρ ≤ 0.05)	0.88	1.07	2.01

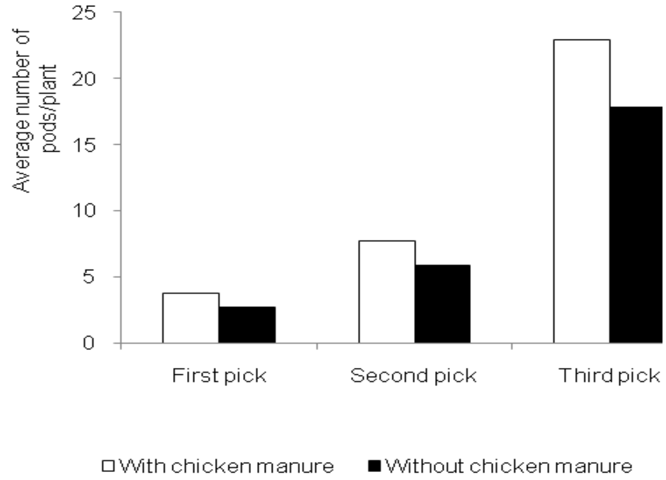

Fig.6 Effect of chicken manure fertilizer on number of pods per plant of okra during season 2015.

The minimum number of pods per plant was recorded for the control treatment (without fertilizers) at all pickings (Table 6).Application of chicken manure significantly (P<0.05) increased the average number of pods per plant compared with control treatment (without chicken manure) at all growth durations of this study (Fig.6).

3.6 Pods Fresh Weight per plant

The effects of chicken manure and nitrogen fertilizer on podweight per plant of okra during 2015and 2015 rainy seasons are shown in Table 7. The results in both tseasons showed that application of poultry manure had significant influence on pod weight (Fig) . Increase in nitrogen fertilizer from the control (0N) to (2N) 160 kg N/ fed significantly increased fruit weight per plant at all pickings occasion except in the second picking, further increase to 240 kg N/fed gave pod weight that were statistically similar in the first two pickings. Surprisingly, in the third pickings, application of 2N (160 kg N/fed) scored the highest pod fresh weight (Fig. 7). The interactions between the chicken manure and nitrogen fertilizer treatments was significant (Table 7).

TABLE 7. EFFECT OF CHICKEN MANURE AND NITROGEN FERTILIZER ON PODS FRESH WEIGHT PER PLANT OF OKRA CROP DURING THE RAINY SEASON 2015.

Treatments	Average number of pods per plant		
	First pick	Second pick	Third pick
2 t/ha of Chm + 0N	45.38c	67.16bc	140.99e
2 t/ha of Chm + 1N	73.73b	99.23ab	193.26d
2 t/ha of Chm + 2N	144.08a	130.31a	582.79a
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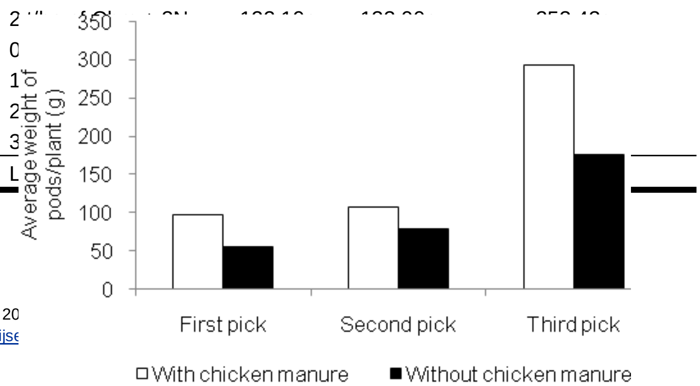

Fig.7 Effect of chicken manure fertilizer on weight of pods per plant of okra crop during rainy season 2015.

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The integrated combination of 2t/ha chickmanure and 2N treatment gave the highest pod weight per plant at all pickings (Table 7).

3.7 Final Fruit Yield

Analysis of variance and mean separation of the present study as shown in table (8) revealed significant differences between the treatments in the final fruit yield of okra plant. Increasing nitrogen rate from control (0N) to 160 kg N/fed significantly increased the final fruit yield of okra. The highest rate of nitrogen decreased the final pod weigh comparing with the 2N treatment (Table8). Combination of chicken manure with inorganic fertilizer (nitrogen in form of urea) significa increased the final pod weight of okra compared with the control and the sole application of nitrogen fertilizer (Table 8). The highest final fruit yield (6.73 t/ha) was obtained by the application of 2t/ha chicken manure combined with 2N (380.95 kg /ha) treatment while the lowest final yield (1.73 t/ha) was obtained by the control treatment (table 8). Application of chicken manure significantly increased the final pod yield per unit area (4.8 t/ha) compared with the control treatment (without chicken manure which obtained low final pod weight per unit area (2.4 t/ha) as shown in Fig.8.

TABLE 8. EFFECT OF CHICKEN MANURE AND NITROGEN FERTILIZER ON AVERAGE AVERAGE FINAL YIELD (T/HA) OF OKRA PLANT UNDER RAIN-FED CONDITIONS OF GADARIF STATE, SUDAN DURING SEASON 2015.

Treatments	Average final yield (t/ha)
2 t/ha of Chm + 0N	3.72d
2 t/ha of Chm + 1N	4.47b
2 t/ha of Chm + 2N	6.73a
2 t/ha of Chm + 3N	4.20c
0 N (control)	1.73h
1N	2.37g
2 N	2.93e
3 N	2.45f
LSD (ρ ≤ 0.05)	0.07

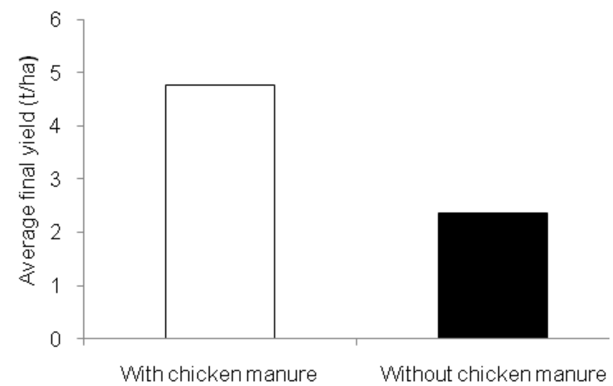

Fig.8 Effect of chicken manure fertilizer on average final yield per plant of okra crop during rainy season 2015

4. DISCUSSION

The present study investigate effects of organic fertilizer in form of chicken manure and chemical nitrogenous fertilizer (urea) in some growth attributes, yield and yield components. The results revealed postitive effect of organic and inorganic fertilizer in improving performance of okra crop under rainfed conditions of Sudan.The findings of this study was in harmony with previous studies on the response of okra to in-organic fertilize [20], [12]. The application of N and or NPK led to significant increase in the growth and yield of okra [20]. However, the inorganic fertilizer (chicken manure) in this study significantly increased the growth parameters and outyielded the application of nitrogenous fertilizer. Some researchers [21], [22] reported that some of plant nutrients, when added to the soil in the inorganic form have low efficiency when comparing to the effect of inorganic fertilizers. under organic useful for soil improvement and environment conservation [23].

The increase in all growth parameters,fresh pod weight, number of pods, final yield of okra due to chicken manure application could be attributed to easy solubilization effect of released plant nutrient leading to improved nutrient status and water holding capacity of the soil. The results obtained were in agreement with the findings of [24] in turmeric (*Curcuma longa*). Two researchers [25] studied the effect of chicken manure on okra crop (*A. esculentus*) and reported that higher yield. response of crops due to organic manure application could be attributed to improved physical and biological properties of the soil resulting in better supply of nutrients to the plants. In this study, interactions and combinations between nitrogen fertilizer and chicken manure recorded a significant increase in yield and yield component of okra plant. The nutrient use efficiency of crops tends to be better with mix of manure and inorganic fertilizers. Nutrients seemed more available to okra plant with the mixes than the organic materials alone, a similar trend of response had been earlier observed with other crops such as maize (*Zea mays*) [26] and with sorghum (*Sorghum bichlor* L.) [27]. Superisingly, in the present study the combination of chicken manure with the highest rate of nitrogen significantly decreased all growth parameters, dry matter partitioning and yield of okra plant compared with chicken maure and moderate dose of nitrogen. Previous studies stated that application of manure with high N content from inorganic fertilizer has been reported to cause reduction in fruits yield [28]. A significant response in final pod yield (ton/ha) to chickenmanure observed in the present is in agreement with the findings of [29], [24] that higher yield respon se due to organic manure is ascribed to the movement in physical and biological properties of soil resulted in better supply of nutrients that led to good crop yield. The reason for increased in yield could also be attributed to the solubilization effect of the major essential nutrients with addition of chicken manure thereby resulting to increased uptake of N, P and K [30].

5 Conclusion

The present study revealed responsive effects of okra plant to both organic and inorganic fertilizers. Application of chicken manure substantially increased growth and yield of okra plant under rainfed conditions of Sudan. Moreover combination of 2t/ha chicken manure with 160 kg/fed nitrogen in form of urea recorded the highest parameters of growth and yield of okra and therefore this treatment is strongly recommended for okra growers in Gadarif State of Sudan under rainfed conditions.

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