Original Research Article

Effect of Different Levels of Nitrogen and Filter mud on Tomato Vegetative Growth Yield and Yield Components

ABSTRACT

Aim: This study aimed to evaluate the effect of different levels of nitrogen and filter mud cake applications on vegetative growth and yield on tomato cultivar "Castle Rock".

Place and Duration of Study: Field experiments were conducted during two successive winter seasons 2015/2016 and 2016/2017 at the experimental farm, Faculty of Agriculture and Natural Resources, University of Bakht Al Ruda, Ed Duiem, Sudan.

Methodology: Treatments included three Nitrogen levels (0, 43 and 86 kg N/ ha) and three filter mud levels (0, 2 and 4 ton/ ha). Urea (46%N) was used as source of nitrogen and applied after fifteen days from sowing. Filter mud Cake was applied one month before sowing. The treatments were arranged in a randomized complete block design with three replications.

Results: Results showed significant differences among N treatments in tomato vegetative growth, yield and yield components. The 86 kg N/ ha showed the highest vegetative growth yield and yield components compared to control. The filter mud application at both rates showed significant increase in the most vegetative growth parameters, yield and yield components compared to the control. The combination of N and filter mud resulted in significant increase in vegetative growth and yield components, the highest values were obtained by application of 86 kg/ha combined with 4 ton filter mud /ha.

Conclusion: Considering the present study it can be concluded that the application of 86 kg/ha combined with 4 ton filter mud /ha is the best level in terms of maximum vegetative growth, yield and yield components of Castle Rock tomato cultivar.

Keywords: Filter mud; nitrogen; fertilization; tomato; growth, yield; Sudan.

1. INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) belongs to the family *Solanaceae* and is one of the most widely consumed and popular vegetables in the world. Its popularly comes from the fact that it can be eaten fresh or in multiple of processed forms. Recently, the consumption of tomatoes has been associated with prevention of several diseases [1; 2]. The tomato total world production is 161.7 million metric tons [3]. In Sudan the annual production of tomato is 423,500 tons. The main production areas are Gezira, south Blue Nile, Kassala, and Khartoum States [4].

Industrial by-products in agriculture becomes use to enhanced the productivity of agricultural land and save the environment from its degradation through their disposal in the nearby area

of the industries [5]. One of these important organic wastes is filter mud which is a by-product of sugar cane industry containing oxides of Si, Ca, P, Mg and K [6]. Recently, the high cost of fertilizers and concerns about environmental hazard have promoted incentives for studying the recycling of the large quantities of organic residues produced as by- products of the sugar industry. It is produced in large volumes (30-40kg/t of crushed cane) [7].

The usefulness of organic sources to meet the nutrient requisite of crop is not as assured as mineral fertilizers, but the joint employ of chemical fertilizers along with different organic sources is capable of enhancing soil quality and higher crop productivity on long- term basis [8]. Highest productivity of crops in sustainable way with no deteriorating the soil and other natural resources could be accomplished only by applying proper combination of various organic manures and inorganic fertilizers [9]. Therefore, this research conducted to study the effect of different levels of filters mud and Nitrogen on the vegetative growth, yield and yield components of tomato (Castle Rock) under field conditions.

2. MATERIALS AND METHODS

Field experiments were conducted during the two successive winter seasons of 2015/16 and 2016/17 on the research farm of the Faculty of Agriculture and Natural Resources, University of Bakht ALruda, Ed-Duiem, Sudan (longitude 32^{o} 20^{-} E, latitude 13^{o} 39^{-} N). The area allotted for the experiment was disc ploughed**,** harrowed**,** leveled and made into a meter apart**.** The experimental units were equipped with a distance of 2 m for length and 1 m for the width. The tomato seeds (Castle Rock) were sown manually in two sits of ridge in 3 – 2 cm deep holes**.** Spacing between holes was 50 cm**.** Seed rate was 5 seeds / hole**.** The seed were sown on 17 of November and 25 of November for the first and second seasons, respectively**.** Irrigation started directly after sowing, and continued for every 7- 10 days interval**.** All cultural practices were done as recommended. Three Nitrogen levels (0, 43 and 86 kg N/ha) applied at 15 days after sowing and three levels of filter mud cake (0, 2, and 4 t/ha) applied one month before sowing giving a total of 9 treatments. Urea (46%N) was used as source of nitrogen. Treatments were arranged in a randomized complete block design (RCBD) with three replications.

Four plants were randomly selected from each plot for growth parameters and yield components measurement and the following parameters were measured: number of leaves/plant, number of primary branches/plant, plant height (cm), stem girth (cm), fruit diameter (cm), fruit length (cm), fruit weight (gm), fruits weight per plant and total yield (t/ha).

Data were subjected to analysis of variance using M-Stat. C computer program. Means separation were done according to Duncan's Multiple Range Test (DMRT).

3. RESULTS AND DISCUSSION

3.1. Vegetative growth

The main effects of different nitrogen levels on vegetative growth parameters of tomato at 50% flowering during season 2015/2016 and 2016/2017 are shown in Table 1. Treatments showed significant differences in plant height and number of leaves in the two seasons. Application of 187 N kg/ha showed the highest values in all parameters at the two seasons. These results are in agreement with those reported by Elizabeth and John [10] and Oyinlola and Jinadu [11] who reported that tomato responded significantly to applied N rates. Along the same lines, Tswanya and Olaniyi [12], who found that as increase of N rates resulted in an increase in plant height and number of leaves. These findings confirmed the importance and contribution of N to the growth of the vegetative in tomato crop.

The main effects of different filter mud levels on tomato vegetative growth parameters at 50% flowering during seasons 2015/16 and 2016/17 are presented in Tables 3. Filter mud application showed significant differences in plant height, number of primary branches and number of leaves during 2015/2016 and plant height primary and number of leaves during season 2016/17. The highest values in all parameters were obtained with application of 4 (t/h) filter mad during the two seasons. These findings are in line with the findings of Abdelhalim [13] who reported that filter mud application had beneficial effects on the performance of tomatoes. These findings are also, in line with finding obtained by Kumar and Chopra [14] that worked in eggplant and reported positive correlation between vegetative growth and different treatments of the filter mud.

The growth response of tomato to filter mud in this trial could be attributed to increased organic matter, nitrogen, and possibly other nutrients released from the incorporated filter mud. Soil amendment by filter mud is also thought to help in plant establishment by providing a suitable rooting environment by the improvement in soil structure, aeration, water retention and nutrient availability.

The interaction effects of different nitrogen and filter mud levels on tomato vegetative growth parameters at 50% flowering during seasons 2015/2016 and 2016/2017 are shown in Tables 3. There were significant differences in plant height and number of leaves in the two seasons. The highest values of these parameters were obtained with application of 187 kg N /ha and 4 ton filter mud / ha. In this study, application of N and filter mud fertilizer enhances growth of tomato. Tomato growth increases as expressed by the increases observed in plant height and number of leaves. The higher response of tomato to the growth might be due to the availability of essential elements from inorganic fertilizer. This observation is in agreement with that of Isah *et. al*., [15] who reported that application of green manure and NPK fertilizer increased the vegetative growth of tomato. These findings are in line with the findings of

Table 1: The main effects of different nitrogen levels on vegetative growth parameters of tomato at 50% flowering during season 2015/2016 and 2016/2017

	Season 2015/2016				Season 2016/2017			
Nitrogen (kg/ha)	**Plant height (cm)**	**No of primary branches**	**No of leaves**	**Stem girth (cm)**	**Plant height (cm)**	**No of primary branches**	**No of leaves**	**Stem girth (cm)**
0	34.59 b	7	71 c	3.61	34.71b	7	75c	3.78 a
43	38.21 a	7	78 b	3.67	38.99 a	7	81b	3.83a
86	39.46 a	8	91 a	3.70	40.86 a	8	90a	4.11a
CV (%)	12.21	10.80	13.72	9.42	7.06	16.42	20.27	15.58
Sig.	*	NS	**	NS	**	NS	*	NS

Means within columns followed by the same letter (s) are not significantly different ($P < 0.05$)

*, ** and NS indicate significance at $P \leq 0.05$, 0.01 and not significant, respectively.

Table 2: The main effects of different filter mud levels on tomato vegetative growth parameters at 50% flowering during seasons 2015/2016 and 2016/2017.

	Season 2015/2016				Season 2016/2017			
Filter mud (ton/ha)	**Plant height (cm)**	**No of primary branches**	**No of leaves**	**Stem girth (cm)**	**Plant height (cm)**	**No of primary branches**	**No of leaves**	**Stem girth (cm)**
0	33.6c	6 c	66 c	3.3	34.7b	7	75c	3.4
2	37.4b	7 b	77b	3.5	39.0 a	7	81b	3.9
4	41.2 a	8 a	97 a	4.1	40.7 a	8	90a	4.4
CV (%)	12.21	10.80	13.72	9.42	7.06	16.42	20.27	15.58
Sig.	**	*	**	NS	**	NS	**	NS

Means within columns followed by the same letter (s) are not significantly different (P < 0.05)
*, ** and NS indicate significance at P≤0.05, 0.01 and not significant, respectively.

Table 3: Interaction effects of different nitrogen and filter mud levels on tomato vegetative growth parameters at 50% flowering during seasons 2015/2016 and 2016/2017

Treatment		Season 2015/2016				Season 2016/2017			
Nitrogen (Kg/ha)	Filter mud (t/ha)	Plant height (cm)	No of primary branches	No of leaves	Stem girth (cm)	Plant height (cm)	No of primary branches	No of leaves	Stem girth (cm)
	0	29.5e	6	61f	3	29.8e	7	60d	3
0	**2**	35.7cd	7	79d	4	37.5cd	7	78c	4
	4	38.6bc	9	97b	4	43.5a	9	87b	4
	0	36.8bcd	7	76d	3	35.9d	7	75c	3
43	**2**	38.5bc	8	61f	3	35.7 d	7.	87b	4
	4	39.3b	9	86c	4	38.7bc	7	107a	5
86	**0**	34.6d	6	90 c	3	36.4cd	8	59d	3
	2	38.0bc	7	67e	4	40.5b	6	75c	3
	4	45.8a	8	107a	4	45.7a	9	109a	4
CV (%)		12.21	10.80	13.72	9.42	7.06	16.42	20.27	15.58
Sig.		*	NS	*	NS	*	NS	*	NS

Means within columns followed by the same letter (s) are not significantly different (P < 0.05)

*, ** and NS indicate significance at P≤0.05, 0.01 and not significant, respectively.

Tonfack *et. al*., [16] who found that combined application of organic and inorganic fertilizers on two tomato varieties significantly improved plant growth. Along the same lines, Nawaz *et. al*., [17] who found that application of sugarcane processing by-product compost supplements with inorganic fertilizer markedly increased the growth parameters of sugarcane.

3.2.1. Yield and yield components:

The main effects of different nitrogen levels on yield and yield components on tomato during seasons 2015/2016 and 2016/2017 are shown in Table 4.

Tomato yields are highly responsive to the application of nitrogen Anderson *et al*., [18]. Nutrient requirement of the tomato is an important factor if large quantities of high quality fruits are to be produced effectively and efficiently annually. Nitrogen fertilizer levels increase total marketable yields [19].

In the current study application of N showed significant differences on number of days from flowering to maturity, fruit weight, fruit weight/plant and total yield in the two seasons. These parameters increased with increasing rate of urea. The highest values of all the parameters were observed in plots treated with 187 Kg/ha N compared to control treatment. These findings are in agreement with those reported by Ogundare *et. al*., [20] who found that fruit weight, number of fruits and fruit yield increased with increasing rate of urea in tomato. Along the same lines, Samaila *et. al*., [21] reported that the highest mean of fruit weight and fruit yield were obtained at 90 kg N ha^{-1}. These results are also, in conformity with those obtained by Oloye *et. al*., [22] who reported that Roma variety recorded a relatively better fruit yield under nitrogen treatment.

The main effects different of filter mud levels on yield and yield components on tomato during seasons 2015/2016 and 2016/2017 are shown in Table 5. Application of different levels of filter mud revealed significant differences in fruit length, fruit weight, fruit weight/ plant and total yield. Application of 4 ton/ha reveled the highest values in all these parameters at the two seasons. These results are in line with the findings of Abdelhalim[3] who worked on tomato and found that the application of filter mud resulted in a significantly increased marketable yield. Also, Ibrahim and Fadni [23] found that application of organic manure significantly increased tomato yield, Hassan *et. al*.,[24] worked on dill and found that application of filter mud increased fruit yield /plant and total yield. Similarly, Kumar and Chopra [14] worked on eggplant and found the crop yield/plant was positively correlated with sugarcane press mud treatments.

Interaction effects of different nitrogen and filter mud levels on yield and yield components on tomato during seasons 2015/2016 and 2016/2017 are shown in table 6.

Application of N and filter mud combination showed significant differences in number of days from flowering to maturity, fruit weight, fruit weight/ plant and total yield at the first season and fruit weight, fruit weight/ plant and total yield at the second season. The highest values of these parameters were obtained with application of 86 kg N/ ha in combination with 4 ton filter mud/ha. Ayoola and Adeniyan [25] reported that nutrients from mineral fertilizers enhance the

Table 4: The main effects of different nitrogen levels on yield and yield components on tomato during seasons 2015/2016 and 2016/2017

Nitrogen (kg/ha)	Season 2015/2016					Season 2016/2017				
	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Fruit weight/ plant (g)	Total yield (ton/ ha)	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Fruit weight / plant (g)	Total yield (ton/ ha)
0	4.3	4.2	39.86b	540.4c	20.6 b	3.8	4.3	37.72c	549.1c	21.9c
43	4.4	4.2	40.22b	585.7b	22.5 a	4.3	4.1	41.8 b	610.3b	24.2b
86	4.2	4.0	45.89a	596.9a	22.8a	4.3	4.5	42.7 a	628.6a	25.2a
C.V	7.81	6.82	9.32	7.94	9.51	7.39	11.1 9	13.00	7.94	**14.57**
Sig.	NS	NS	*	**	**	NS	NS	*	**	**

Means within columns followed by the same letter (s) are not significantly different (P < 0.05)

*, ** and NS indicate significance at P≤0.05, 0.01 and not significant, respectively.

Table 5: The main effects different of filter mud levels on yield and yield components on tomato during seasons 2015/2016 and 2016/2017

Filter mud (t/ha)	Season 2015/2016					Season 2016/2017				
	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Fruit weight/ plant (g)	Total yield (t/ ha)	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Fruit weight / plant (g)	Total yield (t/ ha)
0	3.9c	4.23	40.61b	533.6 c	20.98b	3.9 b	3.82	37.72 b	549.1c	21.36c
2	4.4b	4.37	41.88a b	595.2b	20.95b	4.2 ab	4.01	42. 78 a	610.3b	24.05b
4	4.6a	4.16	43.48a	659.2 a	23.97a	4.8 a	4.53	42. 88a	628.6a	25.94a
C.V	7.81	11.19	9.32	12.24	9.51	7.39	11.19	9.32	7.94	14.57
Sig.	**	NS	*	**	*	**	NS	**	**	**

Means within columns followed by the same letter (s) are not significantly different ($P < 0.05$)

*, ** and NS indicate significance at $P \leq 0.05$, 0.01 and not significant, respectively.

Table 5: **Interaction effects of different nitrogen and filter mud levels on yield and yield components on tomato during seasons 2015/2016 and 2016/2017**

Treatment		Season 2015/2016					Season 2016/2017				
N(Kg/ha)	Fliter mud (t/ha)	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Fruit weight/ plant (g)	Total yield (t/ ha)	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Fruit weight/ plant (g)	Total yield (t/ ha)
0	0	4.0	3.7	38.1e	481.8d	19.0 D	3.933a	3.900	32.83fe	481.3h	19.267d
	2	4.1	4.0	40.5df	560.9c	22.0cd	4.167a	3.967	34.67f	554.3f	22.183c
	4	4.8	4.7	43.1c	579.7c	22.0b	4.583a	4.967	38.67c	611.7d	22.483c
43	0	4.0	3.9	40.6df	591.8c	22.7b	4.200a	4.200	37.06c	587.7e	22.530c
	2	4.4	4.0	44.8bc	552.9c	22.0b	4.167a	4.433	43.67b	611.3d	23.213b
	4	4.8	4.5	45b	611.3b	23.2b	4.733a	4.933	47.90Ab	679.3b	24.877a
86	0	3.8	3.8	37.6ef	535.4cd	21.2bc	3.867a	3.767	35.97df	531.7g	21.270cd
	2	4.5	3.9	41.2d	617.4b	22.3b	4.200a	4.067	43.03 b	620.0c	24.487a
	4	4.1	4.3	46.7a	637.4a	24.4a	4.400a	4.467	48.33 A	686.7a	24.857a
C.V		7.81	6.82	13	12.24	9.51	7.39	13.00	11.19	7.94	8.71
Sig.		NS	NS	*	*	*	NS	NS	**	*	*

Means within columns followed by the same letter (s) are not significantly different (P < 0.05)

*, ** and NS indicate significance at P≤0.05, 0.01 and not significant, respectively

establishment of crops, while those from mineralization of organic manure promoted yield when both fertilizers were combined. These results are in line with the findings of Islam *et. al*., [26] who worked on tomato and found that application of combination of organic and in organic fertilizers showed significant increased in tomato yield. Also, Arif *et*. *al*., [27] reported that combined application of organic manures and inorganic fertilizers improve the growth and yield of rice.

4. Conclusion

Results of this study showed that vegetative growth and yield and yield components were significantly increased with application of different nitrogen and filter mud levels. Application of 86 kg/ha combined with 4 ton filter mud /ha is the best level in terms of maximum vegetative growth, yield and yield components of Castle Rock tomato cultivar.

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