International Journal of Plant & Soil Science

21(5): 1-8, 2018; Article no.IJPSS.35135
ISSN: 2320-7035

Mutagenic Effect of Carboxylic Acid on the Growth and Yield of Two Varieties of Pepper Grown in Mubi, Adamawa State

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Authors' contributions

This work was carried out in collaboration between all authors. Author BPM designed the study and wrote the first draft of the manuscript. Author SJ performed the statistical analysis and wrote the protocol. Author GFA carried out the field work. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2018/35135
Editor(s):
(1) Abhishek Naik, Technology Development Department - Vegetable Crops, United Phosphorus Limited -Advanta, Kolkata, India
(2) Omer Kilic, Bingol University, Turkey.
Reviewers:
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Complete Peer review History: http://www.sciencedomain.org/review-history/23420

Original Research Article

Received 29th June 2017
Accepted 6th September 2017
Published 4th March 2018

ABSTRACT

The effect of carboxylic acid on the growth and yield of two varieties of pepper grown in Mubi, Adamawa State was investigated in this study was investigated after treatment with carboxylic acid. Two different cultivars of pepper *Capsicum annum* (sweet and hot) were obtained from Mubi Main Market. Five different concentrations were prepared on weight basis, viz. 0.001%, 0.002%, 0.003%, 0.004% and 0.005 respectively. The control treatment used was distilled water. The seeds were subjected to varying concentrations of the five different carboxylic acid concentrations (0.001-

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0.005) for 6 hours. The treated seed were then washed in running tap water to remove excess chemicals from the seed. They were planted, Complete Randomized Design method was adopted with five replicates for each concentration was carried out; all cultural practices observed and data collected on stem height, stem girth, number of flowers, number of leaves, leave area etc. ANOVA was used to analyze the data. Results showed that increased in carboxylic acid concentration brought about increase in all agronomical characters in both sweet and hot pepper except in stem girth where there was no statistical difference. However, more generations need to raised and molecular analysis carried out to ascertain the effects at the molecular level of treatment.

Keywords: Sweet pepper; hot pepper; mubi; mutation.

1. INTRODUCTION

Capsicum is an excellent source of vitamin A, B, C, and E and also rich in minerals like molybdenum, potassium, manganese and thiamines. β carotenoids and vitamin C and A are powerful antioxidants that destroy free radicals and B and E. The total antioxidant is completed by phenolic compound, which occurs in pepper in connection with sugar [1].

In Nigeria pepper occupies the third place of importance among cultivated vegetable [2,3]. The pepper is used as pungent spice for flavouring stew, soup and sauce. It is a rich resource of vitamin A and C [1]. It has both nutritive and medicinal values; hence it is used by the food manufacturing industries for the seasoning of processed food. It is also used by the pharmaceutical industries in the preparation of the stimulant and counter irritant balms for external application [4]. Mutation induction offers significant increase in crop production. [5]: and the possibility of inducing desired attributes that either cannot be found in nature or has been lost during evaluation. Treatment with mutagens alters genes or break chromosomes [6]. Induced mutations have been used to improve a wide variety of crops with different reproductive systems and at different ploidy levels [7]. The main aim of this study is therefore to find out the mutagenic effects of different carboxylic acid concentrations on two varieties of pepper grown in Mubi, Nigeria.

2. MATERIALS AND METHODS

2.1 Study Area

The study area is Mubi. Mubi is located in the North Eastern part of Nigeria between latitude 10' 14'N and 10' 18' N of the equator and longitude 13' 14' E and 13º 19'E of the Greenwich meridian. The area has tropical climate with an average temperature of 32ºC and lies within the Sudan savannah vegetation zone in Nigeria. The area has an average relative humidity from 28%-45% and annual rainfall of about 1056 mm [8].

2.2 Collection of Seeds

Two different cultivars of pepper *Capsicum annum* were obtained from Mubi Main Market. The cultivars include sweet pepper and hot pepper.

2.3 Soil Collection and Field Study

Top sandy loam soil (0-10 cm) was collected for use in the present study from an area measuring 50 m x 50 marked on a fallow land. The soil was sun dried to constant weight, and thereafter, 5kg of soil was measured into palm nursery poly bags of 30cm in height and 15cm in diameter. These were perforated at the bottom. The bags were placed in the screen house at a spacing of 60cm x 30cm, as proposed by [9]. They were left for one week before made ready for sowing of seeds.

The soil was measured into 50 polybags for the two cultivars, with five (6) replicates for each carboxylic concentration. The polybags was labeled based on the concentrations with masking tape.

2.4 Preparation of Mutagenic Solution

Five different carboxylic acid concentrations were prepared on weight basis, viz. 0.001%, 0.002%, 0.003%, 0.004% and 0.005 respectively. The control used was distilled water.

2.5 Pre-treatment of Seed with Carboxylic Acid

The seeds were subjected to varying concentrations of the five different carboxylic acid concentrations (0.001-0.005) for 6 hours. The

treated seed were then washed for about 5 minutes in running tap water to remove excess chemicals from the seed.

2.6 Germination Study

The treated seeds were sown in petri dishes containing cotton wool soaked in distilled water and germination was observed. The seed were observed daily until maximum germination was attained on the 7th day after sowing (DAS).

2.7 Sowing

The other set of pre-soaked seed were sown directly into the soil. Planting was done in the evening, just beyond sunset following the methods of [10]. Seed were sown at the rate of 5 seeds per hole and at a depth of 2 cm.

2.8 Experimental Design

The experimental design chosen was Complete Randomized Block Design (CRBD) following assumption of homogeneity of the experimental plot in use with each treatment consisted of 5 replicates. The treatments include five levels of carboxylic acid. The treatments bags were properly labeled according to a given treatment name and replicate number.

2.9 Parameters Considered

Plant height, Number of leaves per plant, Number of flowers per plant, Number of fruit per plant, Weight of 10 fresh fruits, Weight of 10 dry fruits.

2.10 Data Analysis

The data collected was subjected to Analysis of variance (ANOVA) using the SPSS version 17.

3. RESULTS

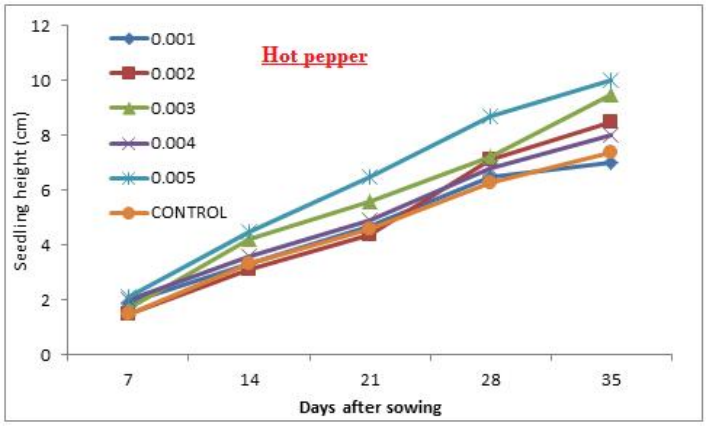
Fig. 1a and 1b.shows the effect of carboxylic acid on plant height for both hot and sweet pepper.

The seedling height of the hot pepper plant was measured on 7-dayly basis. At the 0.001 conc., seedling height (SH) was 1.9 cm on the 7th day (Fig. 1a). This increased gradually to 7 cm at the 35th day. When compared with SH of plants in 0.003 conc., increase in height over this period was 1.7 – 9.5 cm. increase in plant height in the control was from 1.5 cm at 7 days after sowing to 7.4 cm at the 35th day. Results also showed that sweet pepper plant was 1.7 cm in height at 7 days for 0.001 conc. and 1.9 cm for 0.004 conc (Fig. 1b). However, at 35 days plant height ranged from 8.2 – 10.0 cm.

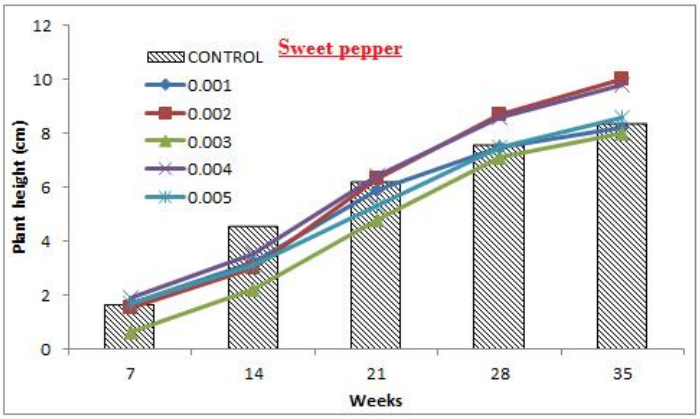
Stem girth of the hot pepper variety as presented (Fig. 2a.) showed relatively no statistical difference between values presented. Generally stem girth ranged from 0.1 - 0.9 cm within a 30-day period.

Stem girth of the sweet pepper variety as presented (Fig. 2) showed relatively no statistical difference between values presented. Generally stem girth ranged from 0.9 – 1.6 cm within a 35-day period.

Table 1 shows the Mean leaf area per week for the hot pepper variety under experimental condition.

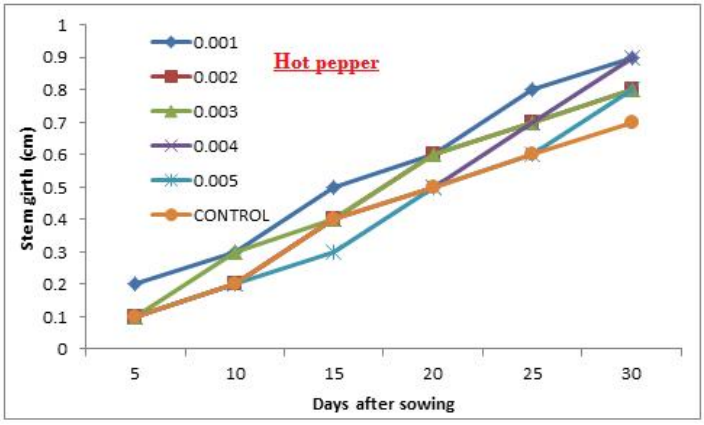


(1a)

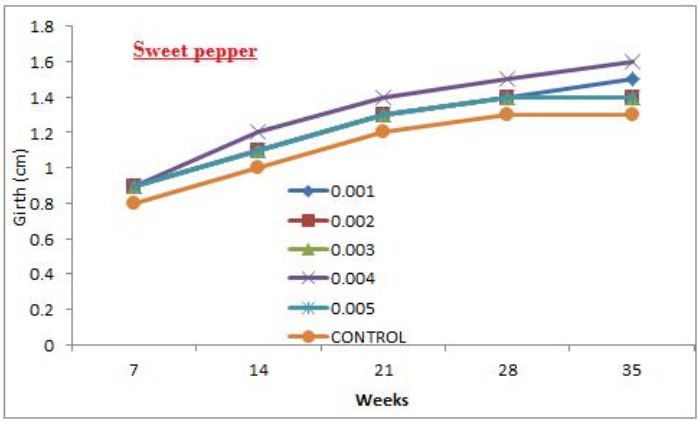


(1b)

Fig. 1. Seedling height for both (a) hot and (b) sweet pepper varieties



(2a)



(2b)

Fig. 2a and 2b. Shows the effect of carboxylic acid concentrations on stem girth for hot and sweet pepper

Leaf area increased from 26.115 cm² at day 4 in 0.001 conc. to 94.019 cm^2 8 weeks after planting. This represented a 1.22 cm^2day^{-1} daily rate in leaf area increase (Table 1). Similarly, rate of increase in leaf area was 1.51 cm^2day^{-1} in 0.002 conc. and 1.07 cm^2day^{-1} in the control. Leaf area (Fig. 3) increased from 30.2 – 107.03 cm^2 in 0.002 conc. over a 9 week period in sweet variety, compared to 1451 – 91.61 cm^2 as change range in the control.

Number of leaves has been presented on Fig. 4. Results show that mean values of leaf number of hot variety increasing from 9 leaves per variety at 4^{th} week to 30 leaves on the 12^{th} week. Number of leaves per variety (sweet) as presented (Fig. 4b) shows an increase from 9 to 28 leaves per variety in 8 weeks and in 0.001 conc. Similarly, increase in leaves from 11 – 31 was recorded in 0.003 conc., compared to the control (10 – 29).

As presented (Fig. 5), number of flowers per hot pepper plant ranged from 11 – 24 in the experiment. There were 16 flowers per sweet variety in the plants treated with 0.001, 0.002, and 0.004 conc. of solutions, compared to 19 in the control. There were 21 flowers in 0.005 conc.

4. DISCUSSION

The effects of carboxylic acid concentrations on the growth and yield parameters of both hot and Sweet pepper has been investigated.

From Fig. 1a, there was increase in stem height with increased carboxylic acid concentrations in both sweet and hot pepper when compared with the control. This agrees with work done by [11]: working on Cowpea and [12]: who affirmed that increasing the concentrations of the mutagens led to decreases shoot length in Sesame seeds. It could be concluded that carboxylic acid at higher concentrations could be used as mutagenic agent for increase in morphological features in some plants [13].

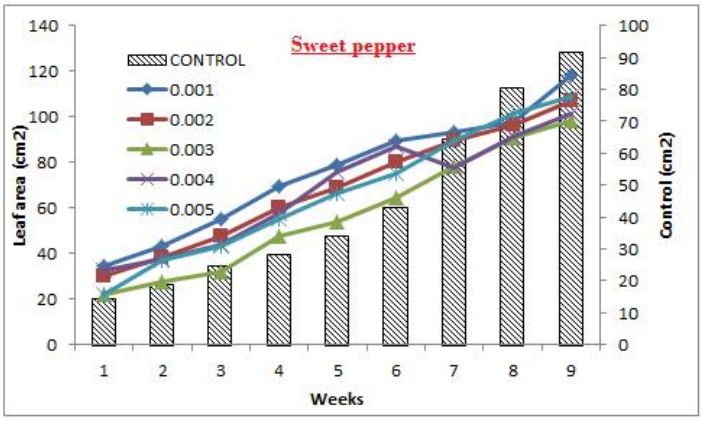


Fig. 3. Average leaf area per plant under experimental condition

Table 1. Mean leaf area per week

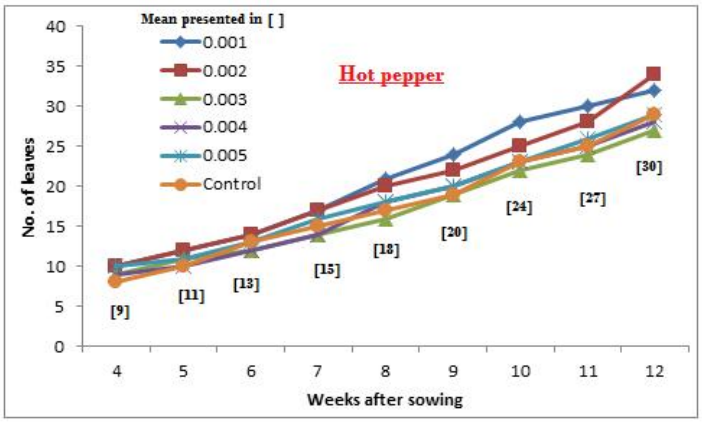
Conc.	Weeks after sowing									Rate of increase in leaf area (cm^2day^{-1})
	4	5	6	7	8	9	10	11	12	
	Mean leaf area (cm^2)									
0.001	26.115	33.22	39.026	43.236	52.35	65.361	77.774	83.358	94.019	1.22
0.002	34.266	53.67	65.672	76.878	87.69	95.099	105.11	113.41	118.21	1.51
0.003	49.649	58.35	67.871	77.983	88.49	97.199	105.51	110.43	116.35	1.19
0.004	44.04	53.35	66.864	75.6784	87.69	99.11	108.81	117.83	123.18	1.42
0.005	39.242	45.84	56.654	68.957	83.47	95.875	105.49	113.39	119.19	1.43
Control	18.722	27.65	32.6725	41.05	58.66	62.346	68.657	73.658	78.728	1.07
Mean	*35.339*	*45.347*	*54.793*	*63.963*	*76.39*	*85.831*	*95.225*	*102.012*	*108.27*	*1.31*

There was however no change in the stem girth in both sweet and hot pepper varieties at all carboxylic acid concentrations Fig. 2a and 2b when compared with the control. This suggests that there was no biochemical reaction that takes place in the girth of the plant as a result of the presence of the carboxylic acid at all concentrations. This agrees with report by [14].

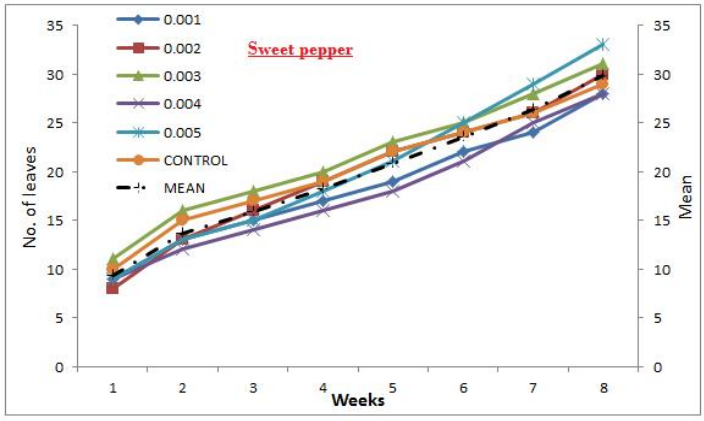
From Table 1, there was sharp increase in the leaf area as carboxylic acid increases in both pepper varieties. This was similar to the study in cowpea, where IAA significantly increased the agronomic characters [15]. Increase in concentration of carboxylic acid solution led to increase in number of leaves in both hot and sweet pepper at 12 (WAP). This agrees with work done by [10].

At lower concentrations (0.001) sharp increase in the number of leaves was observed from 9 to 28 leaves in 8 weeks (Fig. 3) compared to the control. Also, 0.03 carboxylic concentration recorded increase in leaf number compared to the control. This agrees with work done by [11] working on cowpea who reported that lower concentrations of sodium azide triggered increase in number of leaves.

Lower concentrations of carboxylic acid concentrations (0.001) and (0.002) led to gradual reduction in the number of days to flower in both varieties (Fig. 4a and 4b) compared to the control which disagrees with work done by [11] and that of [10] working with rice who reported that lower doses of sodium azide tends to reduce the number of days to flowering in rice.

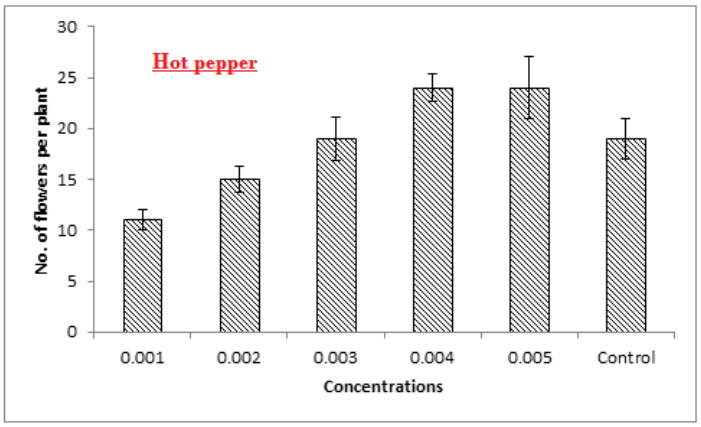


(4a)

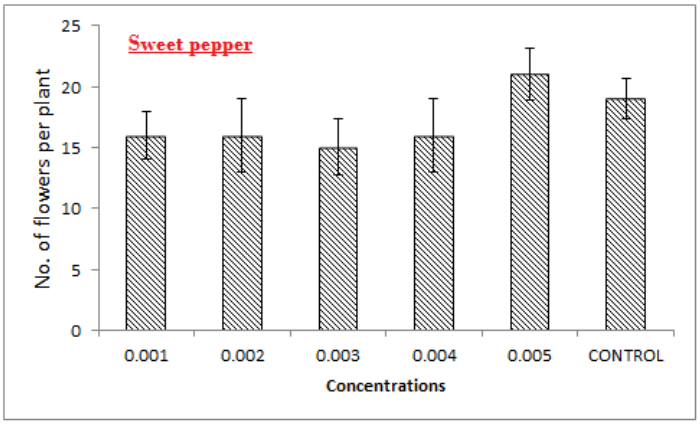


(4b)

Fig. 4a and 4b. Shows the effect of carboxylic acid concentrations on number of leaves for both cultivar



(5a)



(5b)

Fig. 5a and 5b. Shows effect of carboxylic acid concentrations on number of flowers per variety under experimental condition

5. CONCLUSION

In conclusion from the results obtained, carboxylic acid at lower concentrations has greatly influenced the agronomic features of both pepper varieties positively. At those concentrations, agronomical characters has been triggered and enhanced compared to the control. This indicates that carboxylic acid could be used as mutagenic agent at various concentrations for crop improvement. However, further generations should be raised so as to find pure lines.

6. RECOMMENDATION

1. It is recommended that further study should be carried out for 5 or 6 generations to get pure breeding line and new variety.
2. Gene sequences/molecular study should be done to ascertain the degree of mutation at the molecular level.

COMPETING INTERESTS

Authors have declared that no competing interests exist

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