International Journal of Research in Agronomy 2024; 7(3): 71-75

International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; 7(3): 71-75
Received: 02-12-2023
Accepted: 06-01-2024

S Celsia
Research Scholar, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu, India

S Babu
Associate Professor, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

A Karthikeyan
Assistant Professor, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

K Dhanasekaran
Professor, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu, India

Corresponding Author:
S Celsia
Research Scholar, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu, India

Monitoring the effect of different application rates of plant growth regulators in altering the canopy of hybrid cotton (*Gossypium hirsutum* L.)

S Celsia, S Babu, A Karthikeyan and K Dhanasekaran

DOI: https://doi.org/10.33545/2618060X.2024.v7.i3b.380

Abstract
A field experiment was conducted during *Rabi* season of 2023 to determine the efficacy of plant growth regulators on cotton plant architect (*Gossypium hirsutum* L.). The experiment was conducted at the Experimental farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Cuddalore district of Tamil Nadu in randomized block design and replicated thrice. The experiment consists of eight treatments *viz*., T_1 - mepiquat chloride 5% w/w @ 0.6 ml L^{-1} of water, T_2 - mepiquat chloride 5% w/w @ 1.2 ml L^{-1} of water, T_3 - chlormequat chloride 50% SL @ 1.5 ml L^{-1} of water, T_4 - chlormequat chloride 50% SL @ 3 ml L^{-1} of water, T_5 - cyclanilide 2.10% w/w + mepiquat chloride 8.40% w/w SC @ 0.6 ml L^{-1} of water, T_6 - cyclanilide 2.10% w/w + mepiquat chloride 8.40% w/w SC @ 1.2 ml L^{-1} of water, T_7 - nipping @ 80 DAS, T_8 - untreated check. The results indicated that among the different PGR practices tested, application of chlormequat chloride 50% SL @ 3 ml L^{-1} of water at 60 and 80 DAS (T_4) significantly exerted a beneficial result in growth characters *viz*., plant height, dry matter production, growth oriented analysis *viz*., number of main stem nodes $plant^{-1}$, length of top fourth and fifth internodes, height-to-node ratio, growth analysis *viz*., LAI, and chlorophyll content in leaf. Number of monopodial branches $plant^{-1}$ did not show any significant response with plant growth regulators application.

Keywords: Cotton, PGR, Chlormequat chloride

Introduction
Cotton (*Gossypium hirsutum* L.) is one of the most important fiber crops in the world. It is referred to as the "King of fibres" and, because of its continued prominence in India's economy, is also known as "White Gold." The industrial and agricultural economies both rely heavily on cotton. It has long been acknowledged that cotton is a cornerstone of India's agricultural economy's non-food crops (Sharma, 2015) [16]. It has additionally been titled "friendly fibre" due to its employment and foreign exchange gains.

About 71 per cent of the world cotton production comes from China, India, USA and 64 per cent from Brazil. At global level, India holds first in the world cotton area occupies 40 per cent of about 130 lakh hectares and second in production (52 lakh bales) under cotton cultivation, the productivity keeps fluctuating owing to monsoon and other factors and contribute just 21 per cent of the global cotton production which is much less than world's average productivity. In terms of average productivity, India is among the lowest with 400 kg ha^{-1} (ICAC, 2023) [5]. Maharashtra is the leading cotton cultivating state with an area of 42.29 lakh ha, production of 81.85 lakh bales and 329 kg ha^{-1} productivity (AICRP, 2023) [1]. In Tamil Nadu, cotton is cultivated in an area of 1.56 lakh ha with a production of 3.56 lakh bales and the average productivity of 388 kg ha^{-1} (AICRP, 2023) [1]. The major cotton-producing districts in Tamil Nadu are Perambalur, Salem, Trichy, Dharmapuri, Krishnagiri, Ariyalur, Coimbatore, Madurai and Cuddalore.

Cotton production has numerous obstacles in the 21st century. The increasing global population and the depletion of arable land have resulted in a substantial increase in demand for more cotton production (Deshmukh *et al*., 2023) [2]. Despite there are several possible reasons for the yield loss, one in particular has to be emphasized *i.e.* altering the crop canopy by modifying the shape of the plants ought to boost productivity and assist the country in meeting its needs.

Under optimum growing conditions, as a result of maximizing the inputs for the cotton production particularly nitrogen and irrigation water, plants often become excessively tall and vegetative (Nichols *et al.*, 2003) [13]. Excessive vegetative growth occurs at the expense of reproductive growth and a large fraction of squares and small bolls on the lower sympodia may shed and result in late maturity and often a low yielding crop. The plant must have a balance between vegetative and reproductive growth, where there is enough vegetative growth to provide adequate carbohydrate supply for fruit development (Kerby *et al.*, 1997) [7]. Over growth or dense growth would block the solar radiation to the lower parts of the plant which adversely effects on seed cotton yield (Lamas, 2001) [10]. Because of the shadowing effect created by the enormous canopy and rapid branch growth, fruit and leaves become detained, resulting in a low yield (Zhao and Oosterhuis, 2000) [21].

Plant architecture is managed through various approaches like genetic, agronomic, plant growth regulating chemicals and physical trimming. Cotton can be topped manually, mechanically or chemically, and both manual and mechanical topping are considered to be physical forms of topping. Manual topping is time consuming and laborious, while mechanical topping often causes too much damage to the cotton plants and bolls. The next way to alter plant growth and partitioning is by applying plant growth regulator *i.e.*, chemical topping (Zhou and Oosterhuis, 2000) [21]. The desire to control plant growth while at the same time, increasing yield has led to interest in plant growth regulators (PGRs).

The plant growth regulators such as mepiquat chloride (MC) and chlormequat chloride (CCC) are extensively used to control the overgrowth of cotton. However, there have been erratic results among different studies on the response of cotton yield to chemical topping ranging from positive (Kerby, 1985) [6] to negative (Zhou and Oosterhuis, 2000; Ren *et al*., 2013) [21, 15]. The size of the plant, its age, and the environment determine the rate and choice of application of PGR. For stressed cotton, growth-inhibiting PGRs are not advised.

Some chemicals are mixed with primary PGRs to perform various physiological functions and suppress vegetative growth (Thomas *et al*., 2007) [19]. Availability of information on the performance of mepiquat chloride mixed with cyclanilide is very limited in cotton crop. An agronomic tactic for achieving large yields can be the manipulation of cotton plant architecture using growth hormones or plant growth regulators (Souza and Rosolem, 2007) [17]. Focusing on these points by keeping these in view the scope of canopy management in modern production systems, the present study was proposed to study the effect of different application rates of plant growth regulators in altering the canopy of hybrid cotton (*Gossypium hirsutum* L.)

Materials and Methods

To check out the effect of different plant growth regulators on cotton crop, a field experiment was carried out at Experimental farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Cuddalore district of Tamil Nadu ($11^0$24' N latitude $79^0$44'E longitude and altitude of + 5.79 m) during the "*Rabi*" season of 2023. Experimental soil was clay loam with pH 7.1 and EC 0.53 dSm^{-1}, containing 193 kg ha^{-1} available nitrogen (low), 20 kg ha^{-1} available phosphorus (medium), and 287 kg ha^{-1} available potassium (high). The experimental field area comes under the North Eastern Agro-Climatic Zone of Tamil Nadu with a prevailed mean maximum and minimum temperature of 33.6ºC and 21.8ºC with a relative humidity of 74.6 per cent, respectively and the rainfall was 295 mm in 16 rainy days during the experimental period.

The hybrid cotton RCH 578 BG II (Rasi Neo) with a duration of 140 to 160 days was raised at spacing of 90 x 60 cm with three replications in a randomized block design (RBD). The plant growth regulators evaluated in this study included: T_1 - mepiquat chloride 5% w/w @ 0.6 ml L^{-1} of water, T_2 - mepiquat chloride 5% w/w @ 1.2 ml L^{-1} of water, T_3 - chlormequat chloride 50% SL @ 1.5 ml L^{-1} of water, T_4 - chlormequat chloride 50% SL @ 3 ml L^{-1} of water, T_5 - cyclanilide 2.10% w/w + mepiquat chloride 8.40% w/w SC @ 0.6 ml L^{-1} of water, T_6 - cyclanilide 2.10% w/w + mepiquat chloride 8.40% w/w SC @ 1.2 ml L^{-1} of water, T_7 - nipping @ 80 DAS and T_8 - untreated check was included for comparision purposes. Plant growth regulator applications were initiated at 60 DAS with the second application made at 80 DAS. An additional treatment consisting of nipping at 80 DAS was included.

Biometric observation of growth, growth oriented analysis and physiological characters *viz*., plant height, dry matter production, number of monopodial branches $plant^{-1}$, number of main stem nodes $plant^{-1}$, length of top fourth and fifth internodes $plant^{-1}$, height-to-node ratio, leaf area index and chlorophyll content in leaves (SPAD- readings). Plant height data from five plants per plot was collected prior to the first and second applications at (40 DAS), peak flowering stage (75 DAS), boll development stage (100 DAS) and at harvest stage. The collected plant samples at 75, 100 DAS and at harvest for estimating DMP were chopped, initially sun-dried and then oven dried at 80°C $\pm$ 5ºC for 72 hours till concordant values of weight were obtained. The weight was measured using an electronic balance and expressed in kg ha^{-1}. The length and breadth of the third leaf were measured from the top of the plant and multiplied with number of leaves and the adjustment factor 0.78 to arrive at total leaf area $plant^{-1}$ on 40, 75, 100 DAS. The number of monopodial branches $plant^{-1}$ was counted from the randomly tagged five plants in each plot at first picking and mean worked out and expressed as number $plant^{-1}$. In addition, total number of main stem nodes $plant^{-1}$ was counted from the first true leaf node above the cotyledons until reaching the uppermost unfurled leaf at 40, 75 and 100 DAS. The length of the top fourth and fifth internodes from the terminal point of plant was measured by using measuring tape at 40, 75 and 100 DAS. Height-to-Node Ratio (HNR) = Plant height (in.) / number of main stem nodes $plant^{-1}$ was recorded at 40 and 75 DAS. Chlorophyll content of leaves at 40, 75 and 100 DAS was recorded as described by (Peng *et al.*, 1993) [22] using the chlorophyll meter (SPAD- 502, Soil Plant analysis Development Section, Minolta Camera Co. Ltd., Japan). The readings were recorded on the upper most fully expanded leaf in between the leaf margin and the midrib of five SPAD readings from five randomly chosen plants at different growth stages. The average values were worked out and taken as the final value and expressed as SPAD readings. The estimated data were analyzed as per the procedure outlined by Gomez and Gomez (1991) [23] and critical difference was worked out at 5% probability level for significant results.

Results and Discussion

Effect of plant growth regulators on growth characters of hybrid cotton

Applying chlormequat chloride at 3.0 ml L^{-1} of water (T_4) significantly affects most of the growth characters of hybrid cotton (Table 1). The plant growth regulators were significantly registered the maximum reduction in plant height (89.65 cm), and showed highest value in dry matter production (5112 kg ha^{-1}) and number of monopodial branches plant^{-1} (2.36) was found non-significant by the application of chlormequat chloride at 3.0 ml L^{-1} of water (T_4). This could be because of the chlormequat chloride, which inhibits the growth of the GA-producing fungus *Gibberella fujikuroi* by preventing it from producing CPP-synthase, which lowers GA concentrations. It also reduces plant height by increasing friction between cells and interfering with their ability to replicate and elongate. These results are coincidence with the findings of Wankhade *et al*. (2002) [20]. Better architectural plants emerged as a result of CCC's reduction of endogenous gibberellic acid metabolism and signalling, which leads plants to grow more compact. Because there is less foliage, this may have improved sunlight penetration in the canopy. These results are in close conformity with the study of (Kumar *et al*., 2005) [9].

Cotton yield depends not only on total dry matter production but also on its distribution into reproductive parts. Despite the shorter plant height, DMP has grown due to higher chlorophyll content and thicker leaves. Similar inferences were documented by Mateus *et al*. (2004) [11]. Dry matter accumulated less fast later in crop growth, which could have been brought on by a drop in source activity, which would have prevented as much dry matter from accumulating in the stem and leaf. These results closely matched those of Rajni and Deol (2011) [11], who found that whereas DMA by the fruiting bodies continued to exhibit an increase from 90 DAS onwards till maturity, DMA by the leaves showed a reduction from 120 DAS onwards. Souza and Rosolem (2007) [17], in contrast, reported a decrease in the DMP with an increase in the concentration of CCC.

Number of monopodial branches plant^{-1} was found to be non-significant by the application of various plant growth regulators. Reduced lateral monopodial shoots develop before sympodial fruiting branches, which causes blooming to begin earlier.

Effect of plant growth regulators on physiological characters of hybrid cotton

Leaf area index indicates the ratio of leaf area of the plant to the ground area occupied by the individual plant. The amount of source that will eventually be accessible for translocation to sink is determined, as is the total absorbing area available to cotton plants. Among the various PGRs tested, applying chlormequat chloride at 3.0 ml L^{-1} of water (T_4) significantly reduced the LAI (2.94 and 1.19) and showed increase in chlorophyll content (45.32 and 42.71) of hybrid cotton (Table 2). The blockage of leaf expansion by CCC may be the cause of the reduction in LAI. By hampering the leaf expansion, CCC application lending plants a more compact architecture. Early boll retention and more photosynthates being divided towards the sink may have decreased cotton's ability to produce new leaves, which would have decreased leaf area and leaf area index (LAI). These findings are in line with the works reported by Stewart (2005) [18].

Chlorophyll content determines the photosynthetic capacity of the cotton which directly influence the rate of photosynthesis, dry matter production and yield. The application of chlormequat chloride has been identified as the cause of the increase in chlorophyll content. This may have resulted in larger leaf blades, which in turn may have contributed to the rise in chlorophyll content and produced dark green leaves that remain photosynthetically active for an extended period. This is in corroboration with the results of Gobi and Karthikraja (2019) [4] and (Dharani *et al*., 2022) [3].

Effect of plant growth regulators on growth oriented analysis of hybrid cotton

By the imposement of different plant growth regulators, application of chlormequat chloride at 3.0 ml L^{-1} of water (T_4) reduced the growth-oriented analysis of hybrid cotton (Table 3). The least values of number of main stem nodes plant^{-1} (12.54 and 14.07), length of top fourth and fifth internodes (4.02 and 2.34) and height-to-node ratio (2.03 and 1.74) were obtained at different growth stages. The practicing of different plant growth regulators altered the number of main stem nodes and internodal distance. By suppressing cell elongation and reducing internode length,application of chlormequat chloride limits GA biosynthesis and promotes photosynthesis transport towards reproductive sinks (bolls), resulting in a compact plant structure. The cause for the short internodal length could be this. These results endorsed with Kumar *et al*. (2005) [9]. Further, chlormequat chloride reduces the node number as reported by Mondino *et al*. (2004) [12]. Fewer main stem nodes and reduced plant heights were the primary contributing factors to the decreased height-to-node ratio, as evidenced by the explanation for the decline. The same trend was observed by Kiran hiremath (2021) [8].

Table 1: Effect of plant growth regulators on plant height (cm), dry matter production (kg ha^{-1}), number of monopodial branches plant^{-1} at different stages of hybrid cotton

Treatments	Plant height (cm)	Dry matter production (kg ha^{-1})	Number of monopodial branches plant^{-1}
T_1 - Mepiquat chloride 5% w/w @ 0.6 ml L^{-1} on 60 and 80 DAS	124.30	3672.33	2.52
T_2 - Mepiquat chloride 5% w/w @ 1.2ml L^{-1} on 60 and 80 DAS	106.40	4228.05	2.44
T_3 - Chlormequat chloride 50%SL @ 1.5ml/ on 60 and 80 DAS	96.98	4556.27	2.40
T_4 - Chlormequat chloride 50%SL @ 3ml L^{-1} on 60 and 80 DAS	89.65	5112.12	2.36
T_5 - Cyclanilide 2.10% w/w + Mepiquat chloride 8.40% w/w SC @ 0.6 ml L^{-1} on 60 and 80 DAS	127.80	3640.46	2.54
T_6 - Cyclanilide 2.10% w/w + Mepiquat chloride 8.40% w/w SC @ 1.2 ml L^{-1} on 60 and 80 DAS	112.50	3958.00	2.49
T_7 - Nipping at 80 DAS	130.00	3635.17	2.55
T_8 - Untreated check	151.80	3111.00	2.59
S.Ed	2.75	42.35	0.015
CD (p=0.05)	5.89	90.64	NS

Table 2: Effect of plant growth regulators on leaf area index and Chlorophyll content (SPAD readings) at different stages of hybrid cotton

Treatments	Leaf Area Index		Chlorophyll content (SPAD readings)	
	75 DAS	100 DAS	75 DAS	100 DAS
T_1 - Mepiquat chloride 5% w/w @ 0.6 ml L^{-1} on 60 and 80 DAS	3.21	2.58	40.92	37.35
T_2 - Mepiquat chloride 5% w/w @ 1.2ml L^{-1} on 60 and 80 DAS	3.10	2.42	42.66	40.17
T_3 - Chlormequat chloride 50%SL @ 1.5ml/ on 60 and 80 DAS	3.08	2.39	44.47	41.93
T_4 - Chlormequat chloride 50%SL @ 3ml L^{-1} on 60 and 80 DAS	2.94	1.19	45.32	42.71
T_5 - Cyclanilide 2.10% w/w + Mepiquat chloride 8.40% w/w SC @ 0.6 ml L^{-1} on 60 and 80 DAS	3.36	2.73	40.87	37.33
T_6 - Cyclanilide 2.10% w/w + Mepiquat chloride 8.40% w/w SC @ 1.2 ml L^{-1} on 60 and 80 DAS	3.11	2.43	41.37	39.52
T_7 - Nipping at 80 DAS	3.53	2.88	40.81	37.31
T_8 - Untreated check	3.66	3.03	37.58	34.02
S.Ed	0.05	0.07	0.13	0.29
CD (p=0.05)	0.1	0.14	0.28	0.62

Table 3: Effect of plant growth regulators on number of main stem nodes plant^{-1}, length of top fourth and fifth internode (in.) and height-to-node-ratio (in.) at different stages of hybrid cotton

Treatments	Number of main stem nodes plant^{-1}		length of top fourth and fifth internode (in.)		height-to-node-ratio (in.)	
	75 DAS	100 DAS	75 DAS	100 DAS	40 DAS	75 DAS
T_1 - Mepiquat chloride 5% w/w @ 0.6 ml L^{-1} on 60 and 80 DAS	15.84	18.78	4.66	3.54	2.35	2.15
T_2 - Mepiquat chloride 5% w/w @ 1.2ml L^{-1} on 60 and 80 DAS	14.73	17.88	4.28	2.69	2.16	2.04
T_3 - Chlormequat chloride 50%SL @ 1.5ml/ on 60 and 80 DAS	13.75	16.02	4.17	2.51	2.15	1.93
T_4 - Chlormequat chloride 50%SL @ 3ml L^{-1} on 60 and 80 DAS	12.54	14.07	4.02	2.34	2.03	1.74
T_5 - Cyclanilide 2.10% w/w + Mepiquat chloride 8.40% w/w SC @ 0.6 ml L^{-1} on 60 and 80 DAS	15.86	18.80	4.68	3.57	2.38	2.16
T_6 - Cyclanilide 2.10% w/w + Mepiquat chloride 8.40% w/w SC @ 1.2 ml L^{-1} on 60 and 80 DAS	15.77	17.95	4.47	2.87	2.25	2.08
T_7 - Nipping at 80 DAS	15.87	18.82	4.68	3.59	2.40	2.18
T_8 - Untreated check	15.92	18.98	6.92	5.88	2.45	2.52
S.Ed	0.02	0.03	0.05	0.074	0.033	0.014
CD (p=0.05)	0.04	0.06	0.10	0.16	NS	0.03

From the field experimental results, it could be concluded that chlormequat chloride 50% SL @ 3 ml L^{-1} of water at 60 and 80 DAS (T_4) significantly registered better modification of crop growth and development of hybrid cotton. Thus, altering the vegetative characters of crop thereby increased the gross return, net return and benefit-cost ratio be a most technically and economically viable canopy management practices for maximizing the production and productivity of "*Rabi"* hybrid cotton.

Conclusion
In conclusion, the application of chlormequat chloride at 3.0 ml L^{-1} of water significantly influenced various growth and physiological characters of hybrid cotton. It notably reduced plant height, increased dry matter production, and altered architectural traits by inhibiting gibberellic acid biosynthesis, as supported by previous studies. Despite the shorter stature, enhanced chlorophyll content and thicker leaves contributed to increased dry matter accumulation. The reduction in leaf area index may be attributed to inhibited leaf expansion, resulting in a more compact plant architecture and early boll retention. Additionally, chlormequat chloride application led to a decrease in growth oriented parameters such as main stem nodes and internodal length, promoting photosynthates transport towards reproductive sinks. These findings underscore the significant impact of plant growth regulators, particularly chlormequat chloride, on enhancing cotton growth and productivity, emphasizing its potential for agricultural application.

Reference

1. AICRP. ICAR-All India Co-ordinated Research Project on Cotton-Annual Report (2022-23); 2023; A-1 to A-4.
2. Deshmukh SB, Rathod TH, Nemade PW, Deshmukh DT, Kharche VK. SuvarnaShubhra (AKH-09-5): A promising American cotton variety for sustainable cotton production under rainfed situation for Central Zone of India. Biological Forum - An International Journal. 2023;15(9):798-804.
3. Dharani K, Ravichandran V, Anandakumar S, Sritharan N, Sakthivel N. Impact of Growth Retardant and Defoliant on Morpho-physiological Traits and Yield Improvement in Cotton. International Journal of Plant & Soil Science. 2022;34:635-644.
4. Gobi R, Karthikraja M. Agronomic approaches to improve growth and yield of sesame (*Sesamum indicum* L.). Multilogic Science. 2019;8:30-32.
5. International Cotton Advisory Committee (ICAC). Global warming and cotton production - Part 2. ICAC Recorder. 2023;27(1):9-13.
6. Kerby TA. Cotton response to mepiquat chloride. Agronomy Journal. 1985;78:907-912.
7. Kerby TA, Plant RE, Horrocks RD. Height to node ratio as an index of early season cotton growth. Journal of Production Agriculture. 1997;10:80-83.
8. Hiremath KN, Pawar C, Nawalagatti M, Patil RS. Effect of plant growth regulators on biophysical, biochemical traits and productivity in Bt cotton. Journal of Farm Science. 2021;34(4):386-389.
9. Kumar KAK, Patil BC, Chetti MB. Effect of plant growth regulators on physiological components of yield in hybrid cotton. Indian Journal of Plant Physiology. 2005;10:187-190.
10. Lamas FM. Comparative study of mepiquat chloride and

chlormequat chloride application in cotton. Pesquisa Agropecuária Brasileira. 2001;36:265-272.
11. Mateus GP, Lima EV, Rosolem CA. Mepiquat chloride loss by simulated rain. Pesquisa Agropecuária Brasileira. 2004;39:631-636.
12. Mondino MH, Peterlin OA, Garay F. Response of late-planted cotton to the application of a growth regulator (chlorocholine chloride, Cycocel 75). Experimental Agriculture. 2004;40(3):381-387.
13. Nichols SP, Snipes CE, Jones MA. Evaluation of row spacing and mepiquat chloride in cotton. Journal of Cotton Science. 2003;7:148-155.
14. Rajni, Deol JS, Brar AS. Effect of chemical defoliation on boll opening percentage, yield and quality parameters of Bt Cotton (*Gossypium hirsutum*). Indian Journal of Agronomy. 2011;56(1):74-77.
15. Ren X, Zhang L, Du MW, Evers JB, Werf W, Tiana X, *et al*. Managing mepiquat chloride and plant density for optimal yield and quality of cotton. Field Crop Research. 2013;149:1-10.
16. Sharma A. Growth and variability in area, production and yield of cotton crop. International Journal of Agriculture Innovations & Research. 2015;4(3):2319-1473.
17. Souza FS, Rosolem CA. Rainfall intensity and mepiquat chloride persistence in cotton. Scientia Agricola. 2007;64:125-130.
18. Stewart S. Suggested guidelines for plant growth regulator use on Louisiana cotton. Louisiana Cooperative Extension Service Publication Number; c2005, 2918.
19. Thomas WE, Everman WJ, Collins JR, Koger CH, Wilcut JW. Rain-free requirements and physiological properties of cotton plant growth regulators. Pesticide Biology and Physiology. 2007;88:247-251.
20. Wankhade ST, Turkhede AB, Katkar RN, Sakhare BA, Solanke VM. Effect of concentration and time of application of growth regulators on yield and growth of cotton under drip irrigation. PKV Research Journal. 2002;26:127-129.
21. Zhao D, Oosterhuis DM. Pix plus and Mepiquat Chloride effects on physiology, growth, and yield of cotton. Journal of Plant Growth and Regulation. 2000;19:415-422.
22. Peng CK, Mietus J, Hausdorff JM, Havlin S, Stanley HE, Goldberger AL. Long-range anticorrelations and non-Gaussian behavior of the heartbeat. Physical review letters. 1993 Mar 1;70(9):1343.
23. Pavlostathis SG, Giraldo-Gomez E. Kinetics of anaerobic treatment. Water science and technology. 1991 Oct 1;24(8):35-59.