Int. J. Agricult. Stat. Sci. Vol. 14, Supplement 1, pp. 319-325, 2018 *ISSN : 0973-1903*

ORIGINAL ARTICLE

COTTON CULTIVARS RESPONSE TO MEPIQUAT CHLORIDE (PIX)

Ola Sami Hasab* and Muwafaq A. Al-Naqeeb

Department of Field Crops, College of Agricultural Engineering, University of Baghdad, Iraq
E-mail : ollasami85@gmail.com

Abstract : A field experiment was conducted at the research station of Field Crops Department, College of Agricultural Engineering, University of Baghdad, AL-Jaderyah for the two summer seasons 2016 and 2017, to investigate the growth and yield of different responses of three cotton cultivars to the concentrations of Mepiquate chloride (pix). The study included the effect of two factors : the cultivars (Lashata, coker 310 and AL-Tammem) which represented the main plots, and the second factor is spraying pix in concentration (0.5, 1 and 1.5) Lha^{-1}, in addition to control treatment (without spraying pix) which represented the minor plots. The Randomized complete block design (RCBD) was conducted with split - plot design in three replications. The results shows significant differences between cultivars in most studied characters. As coker 310 cultivars exceeded by giving highest average in number of sympodia and number of open bolls which reflected on increasing seed cotton yield (3950.5 and 3135.1) $kgha^{-1}$, cotton lint yield. No significant effect was indicated of growth retardant (pix) in bolls weight. The interaction between the treatments of the plants of coker 310 cultivars sprayed with pix in concentration of 1.5 Lha^{-1} gave highest average in number of sympodia. Number of open bolls and seed cotton yield reached (4121.3 and 3349.0) $kg.ha^{-1}$ and the cotton lint yield, while the interaction between the treatment of AL-Ta¢meem unsprayed with pix gave highest average in shedding percentage (37.28 and 36.65) % while no significant effect was indicated for the interaction between the cultivars and pix concentration in bolls weight for both seasons 2016 and 2017 respectively. We concluded that there was differences in the response among cultivars when sprayed with (pix) and the best results was at the high concentration of the growth retardant when compared with control treatment.

Key words: Number of sympodia, The shedding percentage, Seed cotton yield, The earliness percentage.

1. Introduction

Cotton plants (*Gossypiumhirsutum* L.) is considered one of the perennial plants of unlimited growth and of mass vegetation which reflects on fibers production, this because of prostration, flowers shedding and new bolls as a result of light lack because of the shadow of vegetative growth on the bolls that were formed in the middle and bottom parts of plant. This undesirable growth makes the harvesting process whether manually or chemically to difficult and will delay the opening of ripen bolls. These factors together led to yield decrease. In order to overcome these problems and to advance cotton cultivation in Iraq it is necessary to use plant growth retardants such as Mapiquate chloride by spraying on vegetative parts in order to determine plant shape and organize physiological balance between vegetative and fruit growth and increase plants interception to drought and high temperature and also to reduce flowers and shedding percentage and improving yield, further more continuing in finding out cultivars of high productivity. The results of AL-Majedi (2004) when studied seven cotton cultivars (Marsoomy 1, Ashur, Abu-Ghraib 3, coker 310, Lashata, Kafur, Rabee 122 and Back coat 189) indicated significant differences in the average number of sympodia as coker 310 cultivars exceeded significantly in most characters compared with other cultivars. The results of Askar (2015) when studied five cotton cultivars (Coker 310, Marsoomy 1, Lashata, Ashur 1 and Abu-Ghraib 5) indicated the exceeding of coker 310 in the average of the number of open bolls, seed cotton yield and cotton lint yield by giving highest average in these results reached (8.93 $boll.plant^{-1}$, 1437.00 $kgha^{-1}$ and 439.13 $kgha^{-1}$) respectively, also coker 310 was exceeding in giving low fall average of (33.37%) compared with other

Author for correspondence ***Received*** *July 19, 2018* ***Revised*** *October 10, 2018* ***Accepted*** *October 30, 2018*

cultivars which gave lower results in each character. The studies indicated an effect of growth retardant Mapiquate chloride in the character of growth and yield of cotton plants. Shekar *et al.* (2015) indicated an increase in number of sympodia and seed cotton yield when sprayed with (pix) as adding 0.2 ml Lt^{-1} gave highest average in these characters. Madi (2016) indicated significant differences between pix concentrations (50, 100 and 150) $mlha^{-1}$ in the average of the number of sympodia, percentage of shedding percentage, as the treatment of adding 150 $mlha^{-1}$ gave highest average in this character and lowest fall percentage compared with other treatments. Yasmeen *et al.* (2016) indicated significant differences between pix levels in: the number of sympodia, adding 90 $gmha^{-1}$ gave highest average (15.40 branch $plant^{-1}$) compared with control treatment (without spraying) respectively. Echer and Rosolem (2017) mentioned that adding pix in concentration of 22.5 $gmha^{-1}$ caused increase in cotton lint yield and decreased the percentage of shedding percentage which gave an average of (2139.2 $kgha^{-1}$ and 40.25%) and (31.69) respectively. Sabale *et al.* (2017) mentioned that adding Mapiquate chloride had a significant effect on number of open bolls and cotton lint yield, adding 200 gm ha^{-1} of pix gave highest average 30 boll $plant^{-1}$ and 2312.1 $kgha^{-1}$ compared with control treatment (without spraying pix) which gave lowest average 17 boll $plant^{-1}$ and 41682.5 $kgha^{-1}$. A study by Vistro *et al.* (2017) indicated an effect of adding pix in the number of open bolls as adding 1500 ml^{-1} gave highest average of 30.12 boll $plant^{-1}$ compared with control treatment (without spraying Mapiquate chloride) which gave lowest average of 25.13 boll $plant^{-1}$. This research was conducted to investigate the affection and response of cotton plants by different concentrations of pix.

2. Materials and Methods

A field experiment was conducted in the research station of Field Crops Dept., College of Agricultural Engineering, University of Baghdad in AL-Jaderyah in the two summer seasons 2016 and 2017 in clay loam soil. The experiment aimed at investigating the different response in growth and yield of three cotton cultivars for spraying with Mapiquate chloride (pix). The research land was prepared by plowing vertically twice by using mold board plow, and smoothed by disc arrow, then the canals were ditched, the Triflan herbicide was sprayed (44%) in concentration of 1.25 $lt.ha^{-1}$ after plowing to combat weeds and the herbicide was mixed with soil by using disc harrow [AL-Juboory (2003)]. The two experiments conducted the randomized complete block design (RCBD) with split - plot design with three replications for each experiment, the area of miner plots was (3m × 2.25m) included four lines the length of each line was 3m, the distance between each line was 0.75 cm and the distance between each hill was 0.25 ml [AL-Khalidy (2004)] leaving a space of 1.5m between the plots in order to avoid affection between nearby plots. The cultivation was made on 8/4/2016 and 10/4/2017 in the cultivars (Lashata, coker 310 and AL-Tammem) in a rate of 2-3 seeds in each hill at a depth of 3 cm. The thinning was made after two weeks from emergence leaving two plants in each hill. Phosphorus was added in the form of super phosphate (P20%) when the land was prepared for cultivation in average of 100kg.p ha^{-1} [Mohammed (2012)], while nitrogen was added in the form of urea (N 46%) in average of 200 $kg.ha^{-1}$ by two parallel captures the first was at thinning and the second after 30 days from the first capture. The study included investigating the effect of two factors: the first factor included the cultivars (Lashata, coker 310 and AL-Tammem) which occupied the main plots, the second factor was the concentration of pix (0.5, 1.5 and 1) Lha^{-1} in addition to control treatment (without spraying pix) occupied the minor plots. The yield of middle lines was harvested for each experimental unit after the exclusion of terminal hills, the first harvest was made when 60% of bolls were opened on 18-19/9/2016 and 20-21/9/2017. The second harvest was made after one month from the first harvest. Ten plants were selected randomly from each plot in the middle lines at harvesting in order to measure some growth characters as follows:

(number of sympodia $plant^{-1}$, The shedding percentage, number of open bolls $plant^{-1}$, boll weight (gm), seed cotton yield $kgha^{-1}$, lint cotton yield $kgha^{-1}$, after collecting and classifying the data of studied characters for both seasons and the data was analyzed statistically by using Genestat program and the arithmetical rates were contrasted by using little significant difference (L.S.D) with significant level of 5% [Steel and Torrie (1980)].

3. Results and Discussion

Number of sympodia

The results of Tables 1 & 2 indicated significant effect of cultivars and concentration of growth retardant (pix) ad interaction between them in the average of number of sympodia for both seasons 2016 and 2017. The cultivars coker 310 was exceeded by giving highest

average in this character of 18.42 and 18.27 branch plant^{-1} while the cultivars Lashata achieved lowest average of 15.41 and 16.27 branch plant^{-1} and didn't differ significantly from AL-Tammem cultivars for both seasons respectively. These results agreed with AL-Majedy (2004) who indicated differences in number of sympodia in different cultivars and this considered is normal according to the cultivars. The results of Tables 1 and 2 indicated that the increased concentration of pix led to significant increase in the average of number of sympodia, the plants sprayed with pix in concentration of 1.5 Lha^{-1} gave highest average in this character reached 17.65 and 18.59 branch plant^{-1} and didn't differ significantly from the concentration (1 Lha^{-1}), while control treatment gave lowest average in this character of 14.86 and 15.01 branch plant^{-1} for both seasons respectively. This increase due to the role of pix in reducing the level and inhibition of dominant tip and therefore stimulating branches growth and increased their number by inhibition of oxen transfer in plant tissue. This may cause increase in the rate of cytokinins to oxen which significantly affected stimulation of nodes growth and branches formation, the process of producing branched is related to the phenomenon off dominant tip which was controlled by hormones especially oxen, here inters the role of pix which played as anti-oxen through reducing the average of amino acid Tryptohan that was considered a main material in the biological building of oxen and therefore increased efficiency and activeness of both enzymes (Oxidase-IAA and peroxidase) which played on reducing oxen levels in plant tissue, and therefore affected dominant tip and giving a chance to lateralnodes to grow and increased number of sympodia. This result agreed with Yasmeen *et al.* (2016) who indicated the role of (pix) in increasing number of sympodia. The results of the previous tables indicated significant effect of interaction between cultivars and concentration of pix for both seasons, as the plant of coker 310 cultivars that sprayed with 1.5 Lha^{-1} gave highest average in number of sympodia of 14.39 and 19.28 branch.plant^{-1} whereas the plants of Lashata unsprayed with pix gave lowest average in this character of 13.29 and 13.85 branch plant^{-1} for both seasons respectively.

Table 1: Number of sympodia branch plant^{-1} under effect culativars and concentration of pix in the season 2016.

Cultivars	Concentration pix (L ha^{-1})				Means
	0	0.5	1	1.5	
Lashata	13.29	15.85	16.16	16.35	15.41
Coker 310	16	18.4	19.19	19.39	18.24
AL-Tameem	15.31	16.24	16.76	17.23	16.38
LSD 0.05	0.78				0.65
Means	14.86	16.83	17.37	17.65	
LSD 0.05	0.40				

The shedding percentage

Table 2 : Number of sympodia branch plant^{-1} under effect culativars and concentration of pix in the season 2017.

Cultivars	Concentration pix (L ha^{-1})				Means
	0	0.5	1	1.5	
Lashata	13.85	15.91	17.64	17.70	16.27
Coker 310	16.34	18.30	19.17	19.28	18.27
AL-Tameem	14.84	17.72	18.57	18.80	17.48
LSD 0.05	0.53				
Means	15.01	17.31	18.46	18.59	
LSD 0.05	0.28				

The results of Tables 3 and 4 indicated significant effect of the cultivars and pix concentration and interaction between them in the shedding percentage for both seasons. AL-Tameem cultivars gave highest average in shedding percentage of 33.16 and 34.46% which differed significantly from the cultivars (coker 310 and Lashata), while coker 310 achieved lowest average in shedding percentage of 29.59 and 30.96% for both seasons. This result agreed with the results of AL-Naqeeb (1997) who indicated differences in the shedding percentage in the cultivars (Lashata, coker 310 and AL-Tameem) in the shedding percentage. The results of the two tables indicated significant difference between pix concentrations and shedding percentage in cotton plants. The plants which sprayed with the concentration 1.5 Lha^{-1} recorded the lowest average in this character of 28.40 and 32.21% and didn't differ significantly from other concentrations whereas the control treatment (without spraying pix) recorded the highest average in this character of 34.39 and 35.49% for both seasons respectively. The decreased shedding percentage due to the role of pix which worked on regulating plant shape by reducing vegetative growth and let the vegetation opened which helped in the entrance of a great amount of light for longer time to the lower part of plant especially in day and hours of

night which as a result increased photosynthesis and also increased assimilation which therefore reduced competition between bolls and prevented shedding percentage. These results agreed with the results of Madi (2016), Echer and Rosolem (2017) who indicated significant effect of pix in the percentage of shedding percentage in cotton plants. The results of Tables 3 and 4 show significant interaction between cultivars and pix concentrations in the average of the shedding percentage. The plant cultivars coker 310 sprayed with concentration of 1.5 Lha^{-1} recorded the lowest value in interaction of 26.62 and 28.28% whereas the plants of cultivars AL-Tameem unsprayed with pix (control treatment) recorded highest average of interaction reached 37.28 and 45.49% for both seasons respectively.

The number of opened bolls

Table 3: Shedding percentage under effect culativars and concentration of pix in the season 2016.

Cultivars	Concentration pix (L ha^{-1})				Means
	0	0.5	1	1.5	
Lashata	32.70	31.45	31.38	28.78	31.08
Coker 310	33.19	29.86	28.71	26.62	29.59
AL-Tameem	37.28	33.39	31.84	29.80	33.16
LSD 0.05	1.05				0.75
Means	34.39	31.68	30.64	28.40	
LSD 0.05	0.60				

Table 4: Shedding percentage under effect culativars and concentration of pix in the season 2017.

Cultivars	Concentration pix (L ha^{-1})				Means
	0	0.5	1	1.5	
Lashata	34.32	34.26	34.32	30.00	32.75
Coker 310	35.51	30.15	29.91	28.28	30.96
AL-Tameem	36.65	32.00	30.84	38.35	34.46
LSD 0.05	0.95				0.86
Means	35.49	32.12	31.07	32.21	
LSD 0.05	0.43				

Tables 5 and 6 indicated significant effect of cultivars effect and concentration of pix and their interaction in the number of opened bolls for both seasons as coker 301 cultivars was exceeded in giving highest average in the number of opened bolls reached 11.88 and 11.46 boll $plant^{-1}$ and didn't differ significantly from AL-Tameem, whereas Lashata cultivars gave lowest average in this character reached 10.71 and 10.36 boll$plant^{-1}$ for both seasons 2016 and 2017. The increase in the number of opened bolls may be due to the genetic contraction between cultivars. From the results of table it was shown that there was a significant effect of pix in the average number of opened bolls as the plants sprayed with a concentration of 1.5 Lha^{-1} gave highest average in this character reached 12.53 and 12.16 boll.$plant^{-1}$ which differed significantly from the concentration (0.5 and 1) Lha^{-1}, whereas the plants of control treatment (without spraying pix) recorded lowest average in this character of 9.27 and 9.00 boll $plant^{-1}$ for both seasons. This increase may be due to the role of pix in changing and regulating plants shape, so the vegetation will be opened for longer time or closed slowly which helped in improving the climate for cotton plants through the entrance of sunlight to the lower parts of the plant and increasing the pressure from inside. So the air circulation movement and the reduced moisture caused drought in the outer coverage of bolls and its maturation. This will reflect on increasing the number of opened bolls. These results agree with Sabale *et al*. (2017) and Vistro *et al*. (2017) who indicated the effect of pix in the number of opened bolls. From the results of the mentioned tables, we concluded significant interaction between cultivars and concentrations of pix in the average of this character for both seasons respectively. As the plants of coker 310 cultivars that sprayed with the regrowth retardant pix in a concentration of 1.5Lha^{-1} recorded highest average in this character reached 12.99 and 12.40 boll $plant^{-1}$, whereas unsprayed plants of Lashata cultivars in control treatment recorded lowest average in this character reached 8.38 and 8.12 boll $plant^{-1}$

Boll weight

From the results of Tables 7 and 8 no significant effect was indicated for cultivars and concentration of pix and their interaction in the average of boll weight during both seasons of 2016 and 2017. From the results

Table 5: Number of open boll $plant^{-1}$ under effect culativars and concentration of pix in the season 2016.

Cultivars	Concentration pix (L ha^{-1})				Means
	0	0.5	1	1.5	
Lashata	8.38	10.68	11.36	12.45	10.71
Coker 310	9.90	11.88	12.76	12.99	11.88
AL-Tameem	9.95	11.52	12.34	12.15	11.39
LSD 0.05	0.57				0.54
Means	9.27	11.36	12.15	12.53	
LSD 0.05	0.24				

of Tables 9 and 10 we concluded that the addition of pix resulted in increasing the average of bolls weight but this increase didn't reach significance. These results were similar to the results of Iqbal and Islam (2007). The results of the two tables indicated no significant interaction between cultivars treatments and the concentration of pix for both seasons. This may be due because the effect of each factor was independent in its effect from the other factor.

Table 6: Number of open boll plant^{-1} under effect culativars and concentration of pix in the season 2017.

Cultivars	Concentration pix (L ha^{-1})				Means
	0	0.5	1	1.5	
Lashata	8.12	10.48	11.15	11.69	10.36
Coker 310	9.49	11.64	12.34	12.40	11.46
AL-Tameem	9.40	11.40	12.00	12.39	11.29
LSD 0.05	0.25				0.23
Means	9.00	11.17	11.83	12.16	
LSD 0.05	0.11				

Seed cotton yield

The results of the Tables 9 and 10 indicated significant effect of cultivars and concentration of pix and their interaction on the average of seed cotton yield for both seasons 2016 and 2017. As the cultivars coker 310 recorded highest average in this character reached 3950.5 and 3135.1 kgha^{-1} followed by AL-Tammem cultivars which recorded highest average reached 3481.5 and 2981.8kgha^{-1}, whereas Lashata cultivars recorded lowest average in this character reached 3125.6 and 2794.2 kgha^{-1} for both seasons respectively. These results may be due to the difference between cultivars in the number of opened bolls (Tables 7 & 8). Also this concentration in seed cotton yield may be due to the genetic effect. These results agreed with Askar (2015). The results of Tables 11&12 indicated significant effect of the concentration of pix in the average of seed cotton yield, so the plants sprayed with pix in concentration of 1.5 Lha^{-1} achieved highest average in this character reached 3679.7 and 3157.2 kgha^{-1} whereas unsprayed plants (control treatment) gave lowest average in this character of 3289.9 and 2738.0 for both seasons respectively. The reason of this increase may be due to the significant increase in the number of opened bolls (Tables 7 & 8). This result agreed with the results of Shekar *et al.* (2015). The results of Tables 13 & 14 show significant interaction between the study factors of both seasons respectively, as the plants of cultivars coker 310 that sprayed with concentration of 1.5 Lha^{-1} gave highest average in this character of 4121.3 and 3345.0 kgha^{-1} whereas the unsprayed plants of Lashata cultivars (control treatment) gave lowest average in this character of 2806.9 and 2478.3 kgha^{-1} for both seasons 2016 and 2017.

Table 7: Boll weight gm plant^{-1} under effect culativars and concentration of pix in the season 2016.

Cultivars	Concentration pix (L ha^{-1})				Means
	0	0.5	1	1.5	
Lashata	3.16	2.71	2.70	2.55	2.78
Coker 310	3.52	3.11	2.99	2.98	3.15
AL-Tameem	3.32	2.85	2.68	2.75	2.90
LSD 0.05	N.S				N.S
Means	3.33	2.89	2.79	2.76	
LSD 0.05	N.S				

Table 8: Boll weight gmplant^{-1} under effect culativars and concentration of pix in the season 2017.

Cultivars	Concentration pix (L ha^{-1})				Means
	0	0.5	1	1.5	
Lashata	2.88	2.44	2.50	2.45	2.56
Coker 310	2.90	2.52	2.35	2.34	2.52
AL-Tameem	2.82	2.45	2.39	2.32	2.49
LSD 0.05	N.S				N.S
Means	2.86	2.47	2.41	2.37	
LSD 0.05	N.S				

Lint cotton yield

The Tables 11 & 12 indicated significant effect for cultivars and concentration of pix and their interaction in the average of cotton lint yield for both seasons 2016 and 2017. From the results of the two tables we

Table 9 : Seed cotton yield Kg h^{-1} under effect culativars and concentration of pix in the season 2016.

Cultivars	Concentration pix (L ha^{-1})				Means
	0	0.5	1	1.5	
Lashata	2806.9	3079.2	3251.2	3365.2	3125.6
Coker 310	3694.3	3932.0	4054.5	4121.3	3950.5
AL-Tameem	3368.6	3488.2	3516.7	3552.5	3481.5
LSD 0.05	53.89				36.05
Means	3289.9	3499.8	3607.5	3679.7	
LSD 0.05	31.45				

concluded exceedance of coker 310 cultivars in giving highest average in this character of 1342.7 and 1035.0

Table 10: Seed cotton yield kgha^{-1} under effect culativars and concentration of pix in the season 2017.

Cultivars	Concentration pix (L ha^{-1})				Means
	0	0.5	1	1.5	
Lashata	2478.3	2710.5	2954.2	3033.8	2794.2
Coker 310	2919.2	3117.7	3154.6	3349.0	3135.1
AL-Tameem	2816.4	2960.6	3061.3	3088.8	2981.8
LSD 0.05	50.34				33.63
Means	2738.0	2929.6	3056.7	3157.2	
LSD 0.05	29.39				

kaha^{-1} whereas it didn't differ from AL-Tameem cultivars, while Lashata cultivars gave lowest average in this character of 1038.9 and 897.8 kgha^{-1} for both seasons respectively. This may be due to the exceedance of coker 310 cultivars in the average of the number of opened bolls (Tables 7 & 8). The concentration of pix significantly affected the average of cotton lint yield for both seasons as shown in Tables 11 and 12 as the plants that sprayed with a concentration of 1.5 Lha^{-1} recorded highest average in this character of 1257.3 and 1056.7 kgha^{-1} and didn't differ significantly from the concentration 1 Lha^{-1} in the first seasons only, while the plants of control treatment (without spraying pix) recorded lowest average in this character of 1063.8 and 855.9 kgha^{-1} for both seasons respectively. This may be due to the role of pix in increasing the number of opened bolls (Tables 7 & 8). This result agreed with the results of Echer and Rosolem (2017). The results of Tables 7 and 8 indicated significant interaction between cultivars and concentration of pix in the average of cotton lint yield for both seasons 2016 and 2017, as the plants of coker 310 cultivars that sprayed with pix in concentration of 1.5 Lha^{-1} achieved highest value of interaction in this character reached 1440.0 and 1159.0 kgha^{-1}, while the unsprayed plants of Lashata cultivars (control treatment) achieved lowest average in this character of 903.5 and 768.27 kgha^{-1}.

Acknowledgements

Authors thankfully appreciates the comments of the referee which improved much the earlier version of this manuscript.

Table 11: Lint cotton yield kgha^{-1} under effect culativars and concentration of pix in the season 2016.

Cultivars	Concentration pix (L ha^{-1})				Means
	0	0.5	1	1.5	
Lashata	903.5	1039.2	1102	1110.5	1038.9
Coker 310	1199.9	1329.8	1401.2	1440.0	1342.7
AL-Tameem	1088.0	1177.3	1195.7	1221.3	1170.6
LSD 0.05	49.02				32.76
Means	1063.8	1182.1	1233.0	1257.3	
LSD 0.05	28.62				

Table 12: Lint cotton yield kgha^{-1} under effect culativars and concentration of pix in the season 2017.

Cultivars	Concentration pix (L ha^{-1})				Means
	0	0.5	1	1.5	
Lashata	768.3	875.5	959.2	988.4	897.8
Coker 310	919.8	1008.3	1053.0	1159.0	1035.0
AL-Tameem	879.6	947.4	1002.6	1022.7	963.1
LSD 0.05	39.18				26.16
Means	855.9	943.7	1004.9	1056.7	
LSD 0.05	22.88				

References

AL-Douri, O.N.A. and M.A.A. AL-Janabi (2013). Effect of plant densities in field properties of some upland cotton. *Tikrit Univ. J. Agric. Sci*, **13(1)**, 181-190.

Al-Juboory, B.A.K. (2003). *Weed Science*. Ministry of Higher Education and Scientific Research, Univ. of Baghdad. pp.509.

AL-Khalidy, R.A A. (2004). Effect of Weed Control and Plant Spacing on Yield & Yield Components of Cotton (*Gossypium hirsutum* L.). *M. Sc. Thesis*, Coll. of Agric., Univ. of Baghdad. pp.65

AL-Majedi, L.I.M. (2004). Estimating Genetic Parameters and Path Coefficient Analysis in Some Varieties of Cotton (*Gossypium hirsutum* L.). *Ph.D. Dissertation*, Coll. of Agric., Univ. of Baghdad. pp.178.

Al-Naqeeb, M.Abd. (1997). Effect of chlormequat (cycocel) on growth and yield of cotton (*Gossypium hirsutum* L.). *M.Sc.Thesis*, Coll. of Agric., Univ. of Baghdad.pp.108.

Al-Satori, H.K.S. (2012). Response of cotton (*Gossypium hirsutum* L.) to different Levels of nitrogen fertilizer, irrigation depth and plant density. *Ph.D Thesis*, Dept. of Field Crop Sci., Coll. of Agric., Univ. of Al-Anbar.

Echer, F.R. and C.A. Rosolem (2017). Plant growth regulation: A method for fine-tuning mepiquat chloride rates in cotton. *Pesa. Agro. Pec. Trop. Goiania*, **47(3)**, 286-295.

Iqbal, M.K. Hayat and N.U. Islam (2007). Cotton response to mepiquat chloride and nitrogen under ultra narrow plant spacing. *Asian. J. of Plant Sci.*, **6(1)**, 87-92.

Madi, A.H.A. (2016). Response of Eygyptian cotton to mepiquat chloride application under different plant spacings. *Egypyt. G. Agron.*, **38(1)**, 99-116.

Mohammed, H.A. (2012). Effect of phosphate fertilization and foliar application of zinc on growth and yield of cotton (*Gossypium hirsutum* L.). *M.Sc. Thesis*, Coll. of Agric., Univ. of Baghdad. pp.82.

Sabale, S.S., G.R. Lahane and S.J. Dhakulkar (2017). Effect of various plant growth regulator on growth and yield of cotton (*Gossypium hirsutum* L.). *Int.Curr. Microbiol. App. Sci.*, **6(11)**, 978-989.

Shekar, K., M.V. Ramana and S.R.Kumari (2015). Response of hybrid cotton to chloro mepiquat chloride and detopping. *J. Cotton Res. Dev.* **29(1)**, 84-86.

Steel, R.G.D. and J.H. Torrie (1980). *Principles of Statistics*. McGraw-Hill Book Co. Inc. New York. USA. pp. 485.

Vistro, R., O.I. Chachar, S.D. Chachar, A. Laghari, S.Vistro and I. Kumbhar (2017). Impact of plant growth regulators on the growth and yield of cotton. *Inter. J. of Agric. Technology*,**13(3)**, 353-362.

Yasmeen, A., M. Arif, N. Hussain, W.M. Alik and I. Qadir (2016). Morphological growth and yield response cotton to exogenous application of natural growth promoter and syhthetic growth retardant. *Inter. J. Agric and Biol.*, **15(8)**, 1109-1121.