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EVALUATION OF APICAL PINCHING, HUMIC ACID AND PLASTIC MULCH ON DIFFERENT CHARACTERS OF OKRA (*ABELMOSCHUS ESCULANTUS* L.)

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Abstract

This experiment was aimed to test the effect of apical pinching, humic acid and plastic mulch on different growth parameters of okra. The results showed that pinching 2 was superior over the pinching 1 in fruit number and total yield in 2016 and 2017 seasons. Application of humic acid significantly increased all traits in two study seasons. It was also noticed that plastic mulch significantly increased all studied traits in both seasons. The interaction between pinching and humic acid were characterized by the upper values of most detected traits. The interaction between pinching 2 and clear mulch caused an increase in most characteristics in both of the study seasons. The combination treatment between humic acid at 20ml.$L^{-1}$and clear mulch had significant effect in most parameters, while the combination between 40ml.L^{-1} and clear mulch gave the highest rate of nitrogen %, phosphorus % and potassium % in 2017 only. The combination among pinching, humic acid and plastic mulch significantly enhanced all studied traits in both the season (2016 and 2017).

Key words: Pinching, Humic acid, Plastic mulch, Okra.

Introduction

Okra is one of the major vegetable plants in Iraq and Kurdistan especially during summer season. Okra is grown for its unripe fruit/capsule which can be utilized as fresh fruit/capsule, which are consumed in several meals after being cooked, canned or dried in order to be used in winter, or may be frozen as supplement to the soups (Akanbi, 2002). Okra (*Abelmoschus esculentus* L.) is a member of Malvaceae family and is a rich source of protein, carbohydrate, minerals, fats and vitamins that can be vastly used in human diet (Matloob *et al*., 1989). Apical pinching also known as topping is one of the techniques employed to enhance vegetative growth and yield. Pinching involves the removal of the apical bud of a stem to encourage development of lateral branches. Pinching affects the growth of plants in height as auxin (plant hormone responsible for elongation/ growth) are redirected to other buds to induce lateral shoot and pinching provides wider surface area for bigger photosynthetic activities which is turn enhance other growth characteristics and yield (Kumar *et al*., 2014). This increases the potential fruit points on the plant thereby increasing the number of fruit produced per plant (Marie *et al*, 2007).

Humic acid directly affect the vegetative growth, absorption of N, Ca, Mg, P and K by plant (Vanitha & Mohandass, 2014). Humic acid which has hormone like activity not only enhancing plant growth and nutrient uptake but also improve stress tolerance. The importance of humic acid is not limited to their function as a reservoir of mineral nutrients of plant (Yildirim, 2007). It is formed through the biological and chemical humification of plant and through the biological activates of microorganisms (Anon., 2010). Nadia *et al*., 2015 found that humic acid had a significant increasing effect on the N, P, K, fruits number, fruit weight and yield per hectare. (Haider *et al*., 2017). In conclusion it was noticed that using 20 kg/ha of humic acid significantly increased fruit weight and yield.

Plastic mulch (polyethylene) is used in vegetable production in Kurdistan. The use of mulching in agriculture has enhanced dramatically in the past two decades in all over the word. This enhance is because it availability when applied in the field, such as increase soil temperature, enhances moisture conservation, reduces weed problems, reduction of certain insect pests, earliness, increase yields, improve quality and result to more operative use of soil nutrients (Hatami *et al*., 2012 & Mutetwa & Mtaita, 2014). Clear plastic provide an even warm soil climate and sunlight compared to black plastic, but require the use of additional technique to control weeds. Kumara & Dey, 2011 stated that plastic mulch enhanced root growth through higher nutrient uptake which promoted growth and development. Tavossi *et al*., (2015) suggested that clear plastic had the highest yield, longest crop growth cycle and the longer fruit production period as compared to non-mulching.

This experiment was aimed to limit the influence of pinching, humic acid and plastic mulch on some mineral nutrient and pod yield traits of okra (Clemson cv.) in two study seasons, viz., 2016, 2017.

Materials and Methods

This study was carried out at the field of Agriculture College, Duhok University, Iraq during 2016 and 2017. The ground was ploughed twice, and then it was divided into rows. Three seeds per hole were sown on April 20th 2016 and 2017, thinning was done after 15 days of sowing when the seedling had 2-3 true leaves. Two pinching (pinching 1 after 4 leaves and pinching 2 after 7 leaves), three levels of humic acid (0, 20 and 40ml.L^{-1}) and four plastic mulches (without, black, clear and blue) were utilized in this experiment. Plastic mulch was added before seed sowing, humic acid was utilized 3 times within 15 days interval at the stage of 3-4 true leaves.

This study consisted of 24 treatments (two pinching type, three levels of humic acid and four plastic mulch) implicated in a factorial experiment with a Randomized Compete Blok Design (RCBD). Each treatment was replicated three times every plot 3.2 meter long and 130 cm wide. Each unit was two rows, the distance between the plants to plant was 40 cm with row to row distance of 65 cm and each replicate consisted of sixteen plants of okra. The collected data subjected to analysis variance and means separated through Duncan Multiple Range Test at the alpha level of 5%. Furthermore, the data were analyzed statistically using SAS program (SAS, 2007).

Experimental measurements were as follows:

Mineral nutrients concentration in leaves

a. Nitrogen % in leaves: Nitrogen percentage was determined according to Kjeldahl modified method using Microkjeldahl instrument (Anon., 2000).

b. Phosphorus % in leaves: The phosphorus percentage was evaluated according to colorimetric method by using spectrometer (Matt, 1970)

c. Potassium % in leaves: Potassium percentage was determined according to flame method using flam photometer instrument (Al-Sahaf, 1989).

Yield characteristics

a. Number of fruits /plant: The number of pods per plant was estimated from each experimental unit, beginning from the first harvest and lasted to the end of the growing season (40 harvests).

b. Average fruit weight (g): Average weight of fruit was obtained by weighing the fruit of each experimental unit at any given harvest then divided by the fruit number in each experimental unit.

c. Yield (ton/hectare): The rate of the total yield was measured by estimating the yield of the plants for each experimental unit and then converted in to the yield per hectare.

Results

The results in Table 1 revealed that pinching had no significant effect on nitrogen percentage at both study seasons. Application of 20ml.L^{-1} humic acid was the most effective treatment in 2016 and 2017 seasons, which gave the highest nitrogen percentage of 1.87% and 1.99%, respectively. Clear mulch significantly increased leaf nitrogen% and gave the maximum of 1.93% in 2016 and 2.03% in 2017 as compared to other treatments.

The interaction of pinching and humic acid was not significant for leaf nitrogen percentage in 2016 season, whereas in 2017 season (pinching1 and 20ml.L^{-1} of humic acid) were superior over the all treatments. The interact between pinching and plastic mulch, had a significant effect on nitrogen percentage in both study seasons, the most operative treatment was through (pinching 2 and clear mulch) in 2016 season, while in 2017 season the best interaction treatment was (pinching 1 and clear mulch). The interaction between (humic acid and mulching) was a significant for nitrogen percentage in (2016 and 2017). The combination between (20 ml.L^{-1}humic acid and clear mulch) appeared to be the most effective treatment in 2016, which gave maximum leaf nitrogen of 1.97%, while in 2017 the best combination was 40ml.L^{-1}humic acid and clear mulch) which gave the highest leaf nitrogen (2.08%).

The combination among (pinching, humic acid and plastic mulch), was superior to the combination among (pinching 1, 20ml.L^{-1}humic acid grown under clear mulch) as it gave the highest rate (1.99%) in2016 season, whereas the results obtained from 2017 season displayed that the (pinching 1, 20 ml.L^{-1}humic acid grown under black mulch) gave more nitrogen (2.15%).

It is clear from Table 2, that in the 2016 season pinching effect was not significant, while in 2017 season the highest phosphorus percentage was observed with pinching 1. Using Humic acid enhanced the phosphorus percentage in bot hseasons, especially at 20 ml.L^{-1} in 2016 season and 40 ml.L^{-1} in 2017 season. Data reported in the same table show that plant grown under clear mulch gave the highest phosphorus percentage in 2016 and 2017 seasons measured 0.354 and 0.418, respectively.

The better interactions occurred between (pinching1and 20ml.L^{-1}humic acid) in first season (2016) which gave (0.379%), whereas, the best interactions in second season (2017) were obtained between (pinching 1and 40ml.L^{-1}humic acid) which gave (0.465%). Concerning the interplay between pinching and humic acid, the data clearly showed that it had no significant effect on phosphorus percentage in leaves in 2016 season, whereas pinching 2 with clear mulch resulted in a higher phosphorus % in 2017 seasons. The interplay through humic acid and plastic mulch, showed that(20 ml.L^{-1} and clear mulch) resulted in better nitrogen (0.387%) in 2016 season. while in 2017 season, the best interaction was (40 ml.L^{-1} with clear mulch) which gave the higher nitrogen (0.451%).

The interaction among pinching, humic acid and plastic mulch on the phosphorus percentage, the data reveal a significant effect from the combination among (pinching 1, 20 ml.L^{-1}humic acid and black mulch) in 2016 season however, in the 2017 season (pinching 1, 40 ml.L^{-1}humic acid and clear mulch) gave the best phosphorus %.

In both seasons there were no significant effects of pinching on leaf potassium percentage (Table 3) and 20 ml. L^{-1} humicacid recorded the maximum value of leaf potassium (0.96%) in 2016 season, while in 2017 season the maximum value (1.04%) was obtained with 40 ml.L^{-1}. The recorded data showed that in 2016 and 2017 okra plants with different mulching particularly at clear mulch produced a higher significant leaf potassium percentage of 0.97% in 2016 and 1.13% in 2017.

Results indicated that the interaction between (pinching 2 and 20 ml.L^{-1}humic acid) significantly affected leaf potassium% in season 2016 and (pinching 2 with 40 ml.L^{-1}) in season 2017. The interaction between (pinching 1 and clear mulch) gave the highest significant leaf potassium (0.98%) in first season, whereas in second season (pinching 2 and clear mulch) gave the highest significant leaf potassium (1.13%). Humic acid at 20 ml.L^{-1} and clear mulch gave the maximum value (1.04%) in 2016 season, while in 2017 season the maximum value (1.15%)was noticed between (40 ml.L^{-1}humic acid and clear mulch).

The interaction among (pinching 2 with 20 ml.L^{-1}humic acid and clear mulch) was the most potent treatment which gave the highest leaf potassium% (1.13), results in 2017 season displayed that the interaction among (pinching 2 with 40 ml.L^{-1}humic acid and clear mulch) gave the highest leaf potassium% (1.21).

Table 1. Effect of pinching, humic acid and plastic mulch on nitrogen % in leaves of okra plant cv. Clemson in 2016 and 2017 seasons.

Pinching	Humic acid ml/l	Plastic mulch				P*H	Effect of pinching
		Without	Black	Clear	Blue		
2016							
	0	1.56 bc	1.73 a-c	1.80 a-c	1.82 a-c	1.73a	
P1	20	1.79 a-c	1.86 a-c	1.99 a	1.82 a-c	1.87 a	1.82 a
	40	1.84 a-c	1.82 a-c	1.94 a	1.82 a-c	1.85 a	
	0	1.48 c	1.77 a-c	1.98 a	1.82 a-c	1.76 a	
P2	20	1.82 a-c	1.84 a-c	1.94 a	1.87 ab	1.87 a	1.82 a
	40	1.75 a-c	1.86 a-c	1.92 ab	1.82 a-c	1.84 a	
Effect of plastic mulch		1.70 b	1.81 ab	1.93 a	1.83 ab	**Effect of humic acid**	
P*M	P1	1.73 bc	1.80 a-c	1.91 ab	1.82 a-c		
	P2	1.68 c	1.82 a-c	1.95 a	1.84 a-c		
	0.0	1.52 b	1.75 a	1.89 a	1.82 a	1.74 b	
H*M	20.0	1.80 a	1.85 a	1.97 a	1.85 a	1.87 a	
	40.0	1.79 a	1.84 a	1.93 a	1.82 a	1.85 ab	
2017							
	0	1.70de	2.03a-c	1.96a-d	1.78c-e	1.87b	
P1	20	2.07a-c	2.15a	2.04a-c	2.12ab	2.09a	1.95a
	40	1.89a-d	1.83b-e	2.10ab	1.78c-e	1.90b	
	0	1.59e	1.98a-d	2.12ab	1.96a-d	1.91b	
P2	20	1.96a-d	1.86a-e	1.93a-d	1.82b-e	1.89b	1.94a
	40	2.00a-d	2.03a-c	2.05a-c	1.96a-d	2.01ab	
Effect of plastic mulch		1.87c	1.98ab	2.03a	1.90bc	**Effect of humic acid**	
P*M	P1	1.88ab	2.00ab	2.04a	1.89ab		
	P2	1.85b	1.96ab	2.03a	1.91ab		
	0	1.64b	2.01a	2.04a	1.87a	1.89b	
H*M	20	2.01a	2.00a	1.98a	1.97a	1.99a	
	40	1.95a	1.93a	2.08a	1.87a	1.96ab	

Table 2. Effect of pinching, humic acid and plastic mulch on phosphorus% in leaves of okra plant cv. Clemson in 2016 and 2017 seasons.

Pinching	Humic acid ml/l	Plastic mulch				T*H	Effect of Pinching
		without	Black	Clear	Blue		
2016							
	0	0.256 c	0.321 a-c	0.298 a-c	0.337 a-c	0.303 c	
P1	20	0.375 a	0.392 a	0.384 a	0.364 ab	0.379 a	0.337 a
	40	0.307 a-c	0.302 a-c	0.358 ab	0.344 a-c	0.328 bc	
	0	0.272 bc	0.322 a-c	0.342 a-c	0.358 ab	0.324 bc	
P2	20	0.335 a-c	0.345 a-c	0.390 a	0.325 a-c	0.349 ab	0.340 a
	40	0.348 a-c	0.319 a-c	0.351 a-c	0.376 a	0.349 ab	
Effect of plastic mulch		0.316 b	0.333 ab	0.354 a	0.351 a	**Effect of humic acid**	
P*M	P1	0.313 a	0.338 a	0.347 a	0.348 a		
	P2	0.318 a	0.328 a	0.361 a	0.353 a		
	0	0.264 c	0.321 bc	0.320 bc	0.348 ab	0.313 b	
H*M	20	0.355 ab	0.368 ab	0.387 a	0.345 ab	0.364 a	
	40	0.328 ab	0.310 bc	0.355 ab	0.360 ab	0.338 ab	
2017							
	0	0.289g	0.310fg	0.375d-f	0.361d-g	0.333d	
P1	20	0.426a-d	0.424a-d	0.397c-e	0.411a-e	0.414b	0.404a
	40	0.415a-d	0.463a-c	0.495a	0.489ab	0.465a	
	0	0.325e-g	0.325e-g	0.419a-d	0.377c-f	0.361cd	
P2	20	0.388c-f	0.412a-e	0.416a-d	0.400c-e	0.404b	0.383b
	40	0.405b-e	0.344d-g	0.406b-e	0.381c-f	0.384bc	
Effect of plastic mulch		0.375b	0.379b	0.418a	0.403ab	**Effect of humic acid**	
P*M	P1	0.376a-c	0.399a-c	0.422a	0.420a		
	P2	0.373bc	0.360c	0.414ab	0.386a-c		
	0	0.307c	0.317c	0.397ab	0.369b	0.347b	
H*M	20	0.407ab	0.418ab	0.406ab	0.405ab	0.409a	
	40	0.410ab	0.403ab	0.451a	0.435a	0.425a	

Table 3. Effect of pinching, humic acid and plastic mulch on potassium% in leaves of okra plant cv. Clemson in 2016 and 2017 seasons.

Pinching	Humic acid ml. L^{-1}	Plastic mulch				P*H	Effect of pinching
		Without	Black	Clear	Blue		
2016							
P1	0	0.75 gh	0.95 b-e	1.09 ab	0.97 b-e	0.94 ab	0.91 a
	20	0.99 a-d	0.91 c-f	0.95 b-e	0.83 e-h	0.92 b	
	40	0.77 f-h	0.96 b-d	0.89 c-h	0.86 c-h	0.87 b	
P2	0	0.74 h	0.83 d-h	0.94 b-e	1.01 a-c	0.88 b	0.94 a
	20	0.94 b-e	1.00 a-c	1.13 a	0.94 b-e	1.00 a	
	40	0.90 c-g	1.09 ab	0.85 c-h	0.85 c-h	0.92 b	
Effect of plastic mulch		0.85 c	0.96 ab	0.97 a	0.911 b		
P*M	P1	0.84 c	0.94 ab	0.98 a	0.89 bc	**Effect of humic acid**	
	P2	0.86 bc	0.98 a	0.97 a	0.94 ab		
H*M	0	0.74 f	0.89 b-e	1.01 a	0.99 ab	0.91 b	
	20	0.97 a-c	0.96 a-d	1.04 a	0.89 c-e	0.96 a	
	40	0.83 ef	1.02 a	0.87 c-e	0.86 c-e	0.90 b	
2017							
P1	0	0.78 h	0.99 c-f	1.12	0.98 c-f	0.97 b	1.00 a
	20	0.87 f-h	1.02 b-e	1.15 ab	0.99 c-f	1.01 ab	
	40	0.93 e-g	1.01 c-f	1.10 a-c	1.02 b-e	1.02 ab	
P2	0	0.80 gh	0.90 e-h	1.10 a-c	1.02 b-e	0.96 b	1.02 a
	20	1.06 b-d	0.94 d-f	1.07 a-d	1.10 a-c	1.04 a	
	40	0.93 d-g	1.12 a-c	1.21 a	1.01 c-f	1.07 a	
Effect of plastic mulch		0.90 c	1.00 b	1.13 a	1.02 b		
P*M	P1	0.86 d	1.01 b	1.12 a	1.00 bc	**Effect of humic acid**	
	P2	0.93 cd	0.99 cd	1.13 a	1.04 b		
H*M	0	0.79 f	0.94 e	1.11 ab	1.00 c-e	0.96 b	
	20	0.97 de	0.98 c-e	1.11 ab	1.04 b-d	1.03 a	
	40	0.93 e	1.06 a-c	1.15 a	1.02 c-e	1.04 a	

Table 4 showed that pinching 2 was superior in comparison to pinching 1 at both the study seasons. Application of humic acid led to a significant increment in fruit number in (2016 and 2017). Using plastic mulch led to increase fruit number, particularly clear mulch (182.28 in 2016 season and 208.09 in 2017 season).

Regarding the interaction of pinching 2 and 20 ml.L^{-1}humicacid yielded better fruit number in season 2016, while the combination between (pinching 2 and 40 ml.L^{-1}humic acid) gave the highest fruit number /plant in 2017 season. As for the interaction between pinching and mulching in concerned, the largest number of fruit resulted from (pinching 2 with clear mulch) which gave (188.68 t in 2016 season and 220.73 in 2017 season). The most influential interaction treatment between humic acid and plastic mulch observed from using humic acid at 20 ml.L^{-1} with clear mulch at (2016 and 2017) seasons.

The combination of three factors had a significant effect on the number of fruits /plant. The better combination realized among (pinching 2, 20ml.$L^{-1}$and clear mulch) at both study seasons resulting in (211.94 and 239.99), respectively.

Referring to fruit weight, it was revealed that pinching had no significant effect on this trait in 2016, while in 2017 seasons pinching 2 gave highest significant rate (Table 5). In both study seasons, there was a significant effect of humic acid especially 20 ml.L^{-1} resulted increased fruit weight (7.82g in 2016 and 7.36 g in 2017). Application mulching, in 2016 season the highest fruit weight (7.75 g) was obtained from using clear mulch, whereas in 2017 seasons there was no significant effect on fruit weight.

The combination between (pinching 1 and 20 ml.L^{-1} humicacid) gave the maximum fruit weight in 2016, while in 2017 pinching 2 and 20 ml.L^{-1}gave the highest value. Whereas the interaction between pinching 1 and clear mulch gave the better fruit weight in 2016 season, while in 2017 season the best interaction was noticed between pinching 2 and black mulch. The interact between (20.ml.L^{-1}humic acid and clear mulch) reason preferable increasing of pod weight in 2016 season, whereas in 2017 there was no significant effect on fruit weight.

The maximal combination occurred among (pinching 2 with 40 ml.L^{-1}humic acid and without mulch in 2016 season measured (8.37 g), while in 2017 season displayed that the interaction between pinching 2, 20 ml.L^{-1}humic acid and blue mulch measured as 7.56 g.

Table 4. Effect of pinching, humic acid and plastic mulch on fruit numbers of okra plant cv. Clemson in 2016 and 2017 seasons.

Pinching	Humic acid ml. L^{-1}	Plastic mulch				P*H	Effect of pinching
		Without	Black	Clear	Blue		
2016							
	0	132.33l	147.94h-l	158.28d-k	152.17f-l	147.68d	
P1	20	141.70j-l	146.33i-l	189.17b	154.83e-l	158.01e	157.14b
	40	156.17e-k	159.73c-j	180.17b-d	166.83b-i	165.73bc	
	0	136.26kl	164.00c-j	172.50b-g	189.72b	165.62bc	
P2	20	150.25g-l	177.17b-e	211.94a	170.70b-h	177.52a	172.94a
	40	169.55b-h	174.00bf	181.61bc	177.61b-e	175.69ab	
Effect of plastic mulch		147.71c	161.53b	182.28a	168.64b		
P*m	P1	143.40d	151.34cd	175.87b	157.94c	**Effect of humic acid**	
	P2	152.02cd	171.72b	188.68a	179.34ab		
	0	134.30f	155.97de	165.39cd	170.94b-d	156.65b	
h*m	20	145.98ef	161.75cd	200.56a	162.77cd	167.76a	
	40	162.86ed	166.87b-d	180.89b	172.22bc	170.71a	
2017							
	0	146.32 i	207.47 b-d	201.44 b-e	191.28 c-f	186.63 bc	
P1	20	158.49 g-i	183.39 d-g	195.99 c-e	184.71 d-h	180.65 bc	181.85 b
	40	161.49 f-i	181.18 d-h	188.91 c-g	181.52 d-h	178.28 c	
	0	151.65 hi	177.66 d-h	193.99 c-e	173.76 e-i	174.27 c	
P2	20	170.19 e-i	173.10 e-i	239.99 a	188.91 c-g	193.05 ab	190.39 a
	40	180.64 d-h	191.52 c-f	228.21 ab	215.03 a-c	203.85 a	
Effect of plastic mulch		161.46 c	185.72 b	208.09 a	189.20 b		
P*M	P1	155.43 d	190.68 b	195.45 b	185.84 b	**Effect of humic acid**	
	P2	167.49 cd	180.76 bc	220.73 a	192.57 b		
	0	148.99 f	192.57 bc	197.72 a-c	182.52 c-e	180.45 b	
H*M	20	164.34 ef	178.25 c-e	217.99 a	186.81 cd	186.85 ab	
	40	171.07 de	186.35 cd	208.56 ab	198.28 a-c	191.06 a	

Table 5. Effect of pinching, humic acid and plastic mulch on pod weight (g) of okra plant cv. Clemson in (2016, 2017) seasons.

Pinching	Humic acid ml/l	Plastic mulch				P*H	Effect of pinching
		Without	Black	Clear	Blue		
2016							
	0	6.90 ef	7.12 d-f	7.46 b-f	7.69 a-d	7.29 d	
P1	20	7.62 b-d	7.73 a-d	8.35 a	8.17 ab	7.97 a	7.61 a
	40	7.38 c-f	7.84 a-c	7.72 a-d	7.34 c-f	7.57 b-d	
	0	6.89 f	7.12 d-f	7.56 b-e	8.01 a-c	7.40 cd	
P2	20	7.53 b-f	7.64 b-d	7.80 a-d	7.69 a-d	7.67 a-c	7.60 a
	40	8.37 a	7.48 b-f	7.59 b-e	7.52 b-f	7.74 ab	
Effect of plastic mulch		7.45 b	7.49 b	7.75 a	7.74 a		
P*M	P1	7.30 c	7.56 a-c	7.84 a	7.73 ab	Effect of Humic acid	
	P2	7.60 a-c	7.41 bc	7.65 a-c	7.74 ab		
	0	6.89 e	7.12 de	7.51 b-d	7.85 a-c	7.34 b	
H*M	20	7.58 bc	7.69 a-c	8.08 a	7.93 ab	7.82 a	
	40	7.87 a-c	7.66 a-c	7.65 a-c	7.43 cd	7.65 a	
2017							
	0	6.58 d	6.47 d	6.89 b-d	6.75 cd	6.67 b	
P1	20	7.36 a-c	7.28 a-c	7.01a-d	7.27 a-c	7.23 a	7.04b
	40	7.05 a-d	7.26 a-c	7.47 ab	7.09 a-c	7.22 a	
	0	7.43 ab	7.49 ab	7.28 a-c	7.26 a-c	7.36 a	
P2	20	7.49 ab	7.48 ab	7.44 ab	7.56 a	7.49 a	7.40a
	40	7.42 ab	7.40 ab	7.31 a-c	7.29 a-c	7.36 a	
Effect of plastic mulch		7.22 a	7.23 a	7.23 a	7.20 a		
P*M	P1	7.00 b	7.00 b	7.12 ab	7.04 b	Effect of Humic acid	
	P2	7.44 a	7.46 a	7.34ab	7.37 ab		
	0	7.01 a	6.98 a	7.09 a	7.00 a	7.02b	
H*M	20	7.42 a	7.38 a	7.22 a	7.41 a	7.36a	
	40	7.23 a	7.33 a	7.39 a	7.19 a	7.29a	

Table 6. Effect of pinching, humic acid andplastic mulch total yield (t/ha) of okra plant cv. Clemson in (2016, 2017) seasons.

Pinching	Humic acid ml/l	Plastic mulch				P*H	Effect of Pinching
		Without	Black	Clear	Blue		
2016							
P1	0	30.80 l	35.54 j-l	39.82 e-j	39.60 e-j	36.44 c	40.44 b
	20	36.44 i-l	38.24 g-j	52.46 ab	42.76 d-i	42.47 b	
	40	38.92 f-j	42.42 d-i	46.99 b-d	41.32 d-j	42.41 b	
P2	0	31.70 kl	39.48 e-j	44.34 d-h	51.22 a-c	41.68 b	44.53 a
	20	37.79 h-k	45.92 c-e	55.97 a	44.56 d-g	46.06 a	
	40	47.83 b-d	44.00 d-h	46.48 b-d	45.13 c-f	45.86 a	
Effect of plastic mulch		37.25 d	40.93 c	47.67 a	44.10 b		
T*M	P1	35.39 d	38.73 c	46.42 a	41.23 bc	**Effect of humic acid**	
	P2	39.11 c	43.13 b	48.93 a	46.97 a		
H*M	0	31.25 e	37.51 d	42.08 c	45.41 bc	39.06 b	
	20	37.12 d	42.08 c	54.21 a	43.66 bc	44.27 a	
	40	43.38 bc	43.21 bc	46.73 b	43.22 bc	44.14 a	
2017							
T1	0	32.60 f	45.45 b-e	46.82 b-e	43.74 b-e	42.15 b	43.27 b
	20	39.47 c-f	44.81 b-e	46.42 b-e	45.47 b-e	44.04 b	
	40	38.53 d-f	44.65 b-e	47.71 b-d	43.56 c-e	43.61 b	
T2	0	38.13 ef	45.17 b-e	47.84 bc	42.61c-e	43.44 b	47.71 a
	20	43.20 c-e	43.83 b-e	60.40 a	48.32 bc	48.94 a	
	40	45.33 b-e	48.05	56.78 a	52.85 ab	50.75 a	
Effect of plastic mulch		39.54 c	45.33 b	51.00 a	46.09 b		
P*M	P1	36.87 d	44.97 bc	46.98 bc	44.25 bc	**Effect of humic acid**	
	P2	42.22 c	45.68 bc	55.01 a	47.93 b		
H*M	0	35.37 e	45.31 cd	47.33 b-d	43.17 cd	42.80 b	
	20	41.34 d	44.32 cd	53.41 a	46.89 b-d	46.49 a	
	40	41.93 cd	46.35 b-d	52.24 ab	48.21 a-c	47.18 a	

Table 6 showed that pinching, humic acid and mulching had a significant effect on the yield in both study seasons (2016 and 2017).

For the effect of the combination, the higher value was obtained through the pinching 2 and 20 and 40 ml.L^{-1}humic acid in both seasons. Whereas, the most operative combination treatment between pinching and plastic mulch observed between (pinching 2 and clear mulch) which gave (48.93 t/ha in 2016 and 55.01 t/ha in 2017). The maximum interaction between humic acid and mulching was obtained between (20.0 ml.$L^{-1}$and clear mulch) which gave (54.21 t/ha in 2016 and 53.41t/ha in 2017).

The combination of the three factors significantly affected this trait. The higher interaction occurred among pinching 2, 20 ml.L^{-1}humic acid grown under clear mulch in both study seasons (55.97t/ha and 60.40 t/ha), respectively.

Discussion

The mineral nutrients traits were significantly influenced by pinching, humic acid and plastic mulch in both study seasons (Tables 1, 2, 3). This might be due to pinching effect of apical buds which resulted in production of more leaves per plant and leaf development for efficient photosynthetic activities to take place, these findings are in affirmity with those of Abed Al-Hussain & Muhammed, 2016. As alrrady referred to Tables 1, 2 and 3, humic acid significantly improved nitrogen, phosphorus and potassium percentage, this increment might be due to stimulatory effect of humic acid that has been directly correlated with enhancing uptake of macronutrients, such as nitrogen, phosphorus, potassium and micronutrients. Humic substances enhances the uptake of minerals through the stimulation of microbiological activity as reported by Day *et al*., 2000. Or might be due to the impact of humic acid which expanded cell membrane permeability, photosynthesis, respiration, oxygen and phosphorous uptake and root cell development as reported by Fahramand *et al*., 2014, which are supportiveof our findings. Some other scientists have reported that that the utilization of humic acid significantly increased nitrogen, phosphorus and potassium percentage in leaves (Osman & Rady, 2012 and Barakat *et al*., 2015).

The increase in nitrogen% might be due to the fact that greater moisture content in rhizosphere under mulching lead to faster solubility of nutrients and promoting optimum hydrothermal regimes for better root

growth (Table 1), causing more exploitation/extraction of nitrogen from soil as reported by Choudhary, 2011. In Table 2 and 3, Phosphorus and potassium percentage was higher in plant mulched which may be due to accumulation of more organic matter. Plastic mulch enhanced soil temperature reason to restricted co_2 evolution and soil moisture from soil surface. Increased temperature of soil solution the nutrient concentration like P and K also increased in the root zone as evidenced by Eissa, 2002.

The higher yield under the impact of pinching may be because of best growth parameters which resulted in considerable enhancement in yield parameters like fruit number and lastly reflected into yield (Tables 4- 6). In addition significantly more of primary and secondary branches number carrying more fruit number under pinching treatment as reported by Tripathi *et al*., 2013 and our findings are in agreement with the result of Kabir, 2010. Detailed explanation that pinching of okra plant significantly effect on fruit number and fruit yield is provided by Aliyu *et al*., 2015. The data displayed in same tables demonstrated that humic acid had critical impact on fruit number and yield per plant in 2016 and 2017 seasons, this expansion was probably because of humic acid which affected the respiration operation, amino acids, the amount of sugar and nitrate accumulation and made the plants resistant against diseases and viruses and increment fruit number per plants as was explained by Unlu *et al*., 2011. Also these results were in agreement with (Kumar *et al*., 2015 and Haider *et al*., 2017), they noticed that humic acid increased number of fruits per plant and yield.

The increased yield under plastic mulch in Tables 4-6 may be to the effect of polyethylene treatments on vegetative growth parameters, as well as on availability and uptake of both water and nutrients which reflected on enhancing sufficient assimilation area and consequently, increased fruit weight and yield (Moursi, 2003). Mulching is an effective method of manipulating crop growing environment to increase yield and improve product by controlling weed growth, reducing soil erosion, increase soil temperature, conservation soil moisture and improving soil structure and enhancing organic matter (Awodoyin & Ogunyemi, 2005). The higher fruit yield under mulch may also be ascribed to reduced nutrient losses due to weed control and improved hydrothermal regimes of soil (Singh, 2005). This reflect to produce more yield. Our results were in agreement with those results obtained with (Rajablariani *et al*., 2012).

Conclusion

In light of the results it is concluded that utilizing of pinching, humic acid and plastic mulch increase most traits in Okra. Pinching improved yield traits. Humic aid and plastic mulch enhanced mineral nutrients and yield parameters.

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