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EFFECT OF TOPPING, HUMIC ACID, MULCHING COLOR AND THEIR INTERACTIONS ON VEGETATIVE GROWTH AND SEED YIELD OF OKRA (*Abelmoschus esculentus* L.)

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ABSTRACT

This study was carried out during 2016 growing season at the vegetative research farm of the College of Agriculture, Duhok University, Kurdistan region on okra plants, to study the effect of topping (after 4 leaves and 7 leaves), three levels of humic acid (0, 20 and 40 m.l-^{1}) and four mulching color (without mulch, black mulch, clear mulch and blue mulch) on okra (Clemson). The results showed that topping after 7 leaves significantly increased branch numbers, leaf area and dry pod . Humic acid at 40 m.l^{-1} significantly increased leaf area, dry pod and seed weight, while humic acid at concentration 20 m.l^{-1} increased number of seeds. Mulching significantly enhanced all studied traits. The interactions between topping after 7 leaves and 20 m.l^{-1} humic acid significantly increased brunch number, leaf area and seed number. The dual interaction between a topping after 7 leaves and clear mulch significantly enhanced brunch numbers, leaf area and dry pod. And the interactions between humic acid and mulching significantly increased most characteristics. The interactions between topping, humic acid and mulching caused positive significant differences in all vegetative and seed characteristics.

KEY WORDS: *Okra, Humic acid, mulching, Clemson*

INTRODUCTION

Okra (*Abelmoschus esculentus* L.) is a popular vegetable crop grown for domestic consumption in the tropical and sub- tropical countries of the word. It is one of the most widely known and utilized of the family malvaceae (Naveed *et al*. 2009). The seed is the prime factor that determines the qualitative and quantitative characteristics of the crop that is going to be harvested later on. The seeds nutritional composition of okra include protein, oil, carbohydrate and calcium, magnesium, iron and phosphorus (Omotosho and Shittu, 2008). Topping is a very common practice to breaking the apical dominance in some of the vegetable crops like okra for enhanced lateral buds thereby increase the potential poding area (Gujar and Srivastava,1972). (Sajjan *et al*. ,2002) showed that in apical bud pinching resulted significantly higher processed seed yield (1078 kg. ha^{-1}),while seed yield was lowest in the control (586.7 kg. ha^{-1}).

Humic acid is one of the most important components of bio-liquid complex that influence plant growth by modifying the physiology of plants and by improving chemical, biological and physical properties of soil (Elayaraja *et al*., 2010). Humic acid essentially helps the movement of micronutrients from soil to plant, (Stumpe *et al*., 2000) stated that the positive effect of humic acid on the yield capacity of soil consist of many components. Other researcher found out the foliar spray of humic acid encourages nutrient uptake, plant growth, yield and quality (El-Nemr *et al*., 2012). Also (Saruhan *et al*., 2011) have reported that foliar application of humic acid caused the highest 1000 seed weight. Mulching practices have been used in vegetable production for better growth and yield of most horticultural crops. Moreover, the importance of mulch on its effectiveness in the soil runoff, control of weed growth, enhances conservation of soil moisture compaction by rain drops and temperature regulation(Aniekwe, 2002). Mulches also promote crop development, early yield and increased yields as observed by (Adekalu *et al*., 2008). The aim of this study is to determine the effect of topping, humic acid, different mulching color and their interactions on growth and seed yield of okra plant.

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MATRIALS AND METHODS

This experiment was carried out during 2016 growing season, at the vegetable research farm, College of Agriculture, Duhok University, on okra (Clemson), Seed of okra were sown on 20 April 2016 in the farm, and planted on 40 cm between plants and 65 cm between rows.

A completely randomized block design (RCBD) was used in this experiment. Each experimental unit consisted of eight plants with three replication. The factors undertaken in this study were two time (T1,T2) of topping (topping after 4 leaves and 7 leaves), three concentrations of Humic acid (0, 20 and 40 $m.l^{-1}$) and four mulching color (without mulching, black mulch, clear mulch and blue mulch). All plants in this study received regular agricultural and horticultural practices that were usually carried out in the vegetable crops farm. Mulching was done before planting, Humic acid spraying were applied three times within fifteen days intervals, starting after 4 true leaves stage. Data were analyzed by using S A S program (SAS, 2001).

For data collection five plants were randomly selected from each experimental unit. For vegetative characteristics data collected were on branches number $plant^{-1}$ and leaf area (cm^2) of okra plants and for seed properties such as number of dry pod $plant^{-1}$, seed weight (g. $pods^{-1}$) and seed number pod^{-1}.

RESULTS AND DISCUSSIONS

Table (1) revealed that topping (2) was significantly dominated over topping (1) in number of branches (7.06 $plant^{-1}$). The effect of humic acid had no significant effects on this trait. Plants grown under clear mulch had a significant increase in the number of branches (7.25 $plant^{-1}$) as compared with without mulching.

Concerning the effect of interactions between each two factors, Topping (2) and 20 $m.l^{-1}$ humic acid were superior over all treatments. In case of the interactions between topping and mulching, the highest number of branches was obtained between topping (2) and clear mulch. The interactions between humic acid and mulching, the data clearly showed that spraying of humic acid at 20 $m.l^{-1}$ with clear mulch resulted in a higher numbers of branches.

Referring to the triple interactions, the superior interactions was noticed between topping (2) with 20 $m.l^{-1}$ humic acid and clear mulch.

Table (1): Effect of topping, humic acid, mulching color and their interactions on number of branches. $plant^{-1}$ of okra plant.

Toping	Humic acid m.l-1	Mulching				T*H	Toping
		Without	**Black**	**clear**	**Blue**		
T1	0.0	4.84 d	6.22 a-d	6.89 a-c	7.34 a-c	6.33 b	6.59 b
	20.0	6.47 a-d	6.51 a-c	7.50 a-c	6.09 b-d	6.64 ab	
	40.0	6.63 a-c	7.72 ab	6.46 a-d	6.43 a-d	6.81 ab	
T2	0.0	5.97 cd	6.40 a-c	7.81 ab	7.17 a-c	6.84 ab	7.06 a
	20.0	6.40 a-d	7.30 a-c	7.85 a	7.55 a-c	7.28 a	
	40.0	7.83 a	6.63 a-c	7.00 a-c	6.77 a-c	7.06 ab	
Mulching		6.36 b	6.80 ab	7.25 a	6.89 ab	Humic	
T*M	T1	5.98 b	6.82 ab	6.95 a	6.62 ab		
	T2	6.73 ab	6.78 ab	7.55 a	7.16 a		
H*M	0.0	5.41 c	6.31 bc	7.35 ab	7.25 ab	6.58 a	
	20.0	6.43 bc	6.91 ab	7.68 a	6.82 ab	6.96 a	
	40.0	7.23 ab	7.18 ab	6.73 ab	6.60 ab	6.93 a	

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Mean with a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple at 0.05 level.

Table (2) indicates that topping (2) was significantly dominated over the topping (1) in branchs number plant^{-1}. For the effect of Humic acid, the results show that there was an increase in leaf area by increasing the concentration of Humic acid. Mulching color significantly increased the leaf area particularly clear mulch as compared to without mulch.

In case of interactions, the best interactions were observed between topping (2) and humic acid at 20 m.l^{-1}. As for the interaction between topping (2) with clear mulch gave the highest leaf area (299.81 cm^2). Otherwise, the maximum interaction between humic acid and mulching was noised from spraying of humic acid 0 m.l^{-1} and clear mulch 304.21 cm^2.

The interaction of the three factors had significantly affected the leaf area. The superior treatment noticed between topping (2) with 20 m.l^{-1} and blue mulch measured in 304.98 cm^2

The tables above concluded results are close in conformity with the finding of (Vasudevan *et al*., 2008, Sudarshan, 2004; Jhon and Paul, 1995) in different vegetables and ornamental plants. Vasudevan *et al*., 2008) reported that the maximum number of branches were noted in plants topping at 30 days after sowing. It is also shown that topping plant enhanced in branch production increased young leaf production in okra (Olasantan and Salau, 2008).The increase in leaf area in table 2 may be due to the direct effect of humic acid depending on the biochemical action on cell wall, mainly hormonal, membrane or cytoplasm, acting in manner similar to plant growth substances (Chen *et al*., 2004) Accordingly, (Kaya *et al*., 2005) agricultural humic substances are reputed to drought tolerance , enhance nutrient uptake and overall plant performance resulting in increasing leaf area.

Table (2): Effect of topping, Humic acid, mulching color and their interactions on leaf area (cm^2) of okra plant.

Topping	Humic acid m.l^{-1}	Mulching				T*B	Topping
		Without	**Black**	**Clear**	**Blue**		
T1	0.0	232.34 e	267.02 b-d	304.15 ab	292.33 a-c	273.96 b	279.51 b
	20.0	264.25 c-e	270.39 a-d	292.76 a-c	279.52 a-d	276.73 b	
	40.0	284.95 a-c	280.35 a-d	301.79 ab	284.32 a-c	287.85 ab	
T2	0.0	246.74 de	287.15 a-c	304.26 ab	295.64 a-c	283.45 ab	291.78 a
	20.0	288.78 a-c	293.24 a-c	301.04 a-c	304.98 a	297.01 a	
	40.0	289.14 a-c	299.23 a-c	294.13 a-c	297.01 a-c	294.88 a	
Mulching		267.70 c	282.90 b	299.69 a	292.30 ab	Humic	
T*M	T1	260.51 d	272.59 cd	299.57 a	285.39 a-c		
	T2	274.89 b-d	293.21 ab	299.81 a	299.21 a		
H*M	**0.0**	**239.54 c**	**277.09 b**	**304.21 a**	**293.99 ab**	**278.71 b**	
	20.0	**276.52 b**	**281.82 ab**	**296.90 ab**	**292.25 ab**	**286.87 ab**	
	40.0	**287.05 ab**	**289.79 ab**	**297.96 ab**	**290.66 ab**	**291.37 a**	

Mean with a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple at 0.05 level.

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The improvement on vegetative growth in table (1 &2) because to that plastic mulches improve moisture conservation and availability, which ultimately leads to improvement in plant growth. Have reported that improvement in growth characters as a result of using mulch might be due to the enhancement in photosynthesis and other metabolic activities (parmar *et al*., 2013). Higher soil temperature and soil moisture content under plastic mulch improve the pant microclimate leading to early growth and development. The availability of moisture and extended retention of moisture also lead to higher uptake of nutrients for plants proper growth and development, resulted in higher growth of plant as compared to soil without mulches (Atif, 2014).

Data presented in table (3) shows that topping (2) caused significant increase in number of dry pod 25.54 plant^{-1} as compared with topping (1) 24.21 plant^{-1}. The results showed that spraying humic acid caused positive significant differences in number of dry pod. For the mulching factor effect, it also clear and blue mulching that significantly enhanced number of dry fruit 27.09 and 25.23 plant^{-1} respectively.

In case of interaction between two factors (topping and humic acid), the highest value was recorded in plant topping (2) and spraying humic acid at 40 m.l^{-1}. The interactions between topping and mulching recorded the maximum number of dry pod 27.93 plant^{-1} in topping (2) planted under clear mulch. The same results were obtained from interactions between humic acid and mulching and the superiority was for spraying 20 m.l^{-1} humic acid with clear mulch.

Data in table (3) also showed that the interactions between the three factors increased number of dry pod/plant and topping (2) spray with 20 m.l^{-1} of humic acid and planted under clear mulch had the highest value 30.30 plant^{-1} as compared with other treatments.

Table (3): Effect of Topping, Humic acid, Mulching color and their interactions on number of dry pod plant^{-1} of okra plant.

Topping	Humic acid m.l^{-1}	Mulching				T*H	Topping
		Without	**Black**	**Clear**	**Blue**		
T1	0.0	18.50 g	21.30 e-g	27.00 a-d	23.67 c-f	22.62 c	24.21 b
	20.0	23.74 c-f	24.39 b-e	25.56 b-e	23.25 c-f	24.24 bc	
	40.0	25.53 b-e	24.92 b-e	26.22 a-d	26.50 a-d	25.79 ab	
T2	0.0	19.67 fg	24.28 b-e	25.66 b-e	27.00 a-d	24.15 bc	25.54 a
	20.0	24.00 b-f	22.89 d-f	30.30 a	26.10 a-d	25.82 ab	
	40.0	28.66 ab	25.23 b-e	27.83 a-c	24.83 b-e	26.64 a	
Mulching		23.35 c	23.84 bc	27.09 a	25.23 b	Humic	
T*M	T1	22.59 d	23.54 cd	26.26 ab	24.47 b-d		
	T2	24.11 b-d	24.14 b-d	27.93 a	25.98 a-c		
H*M	0.0	19.08 f	22.79 e	26.33 a-d	25.33 a-e	23.38 b	
	20.0	23.87 c-e	23.64 de	27.93 a	24.68 b-e	25.03 a	
	40.0	27.10 ab	25.08 a-e	27.03 a-c	25.67 a-e	26.22 a	

Mean with a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple at 0.05 level.

It can be noticed from table (4) that there are no significant effects of topping on seed weight g^{-1}. whereas; humic acid at concentration 40 m.l^{-1} caused significant increases in comparison with the untreated plants. For the effect of mulching,

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the results show that using blue mulch there was an increase in the seed weight g^{-1}.

Concerning the dual interactions, the interactions between topping (1) and 40 $m.l^{-1}$ humic acid resulted in higher seed weight 3.97 g^{-1}. on the other hand, the interactions between topping (2) and blue mulch gave the highest seed weight 3.83 g^{-1}.whereas, the best interactions between humic acid and mulching was recorded 4.33 g^{-1} from spraying humic acid at 40 $m.l^{-1}$with blue mulch.

As for the interactions between three factors, the maximum interactions occurred between topping (1) with 40 $m.l^{-1}$ humic acid and blue mulch 4.42 g^{-1}.

Table (4): Effect of Topping, Humic acid, Mulching color and their interactions on seed weight g pot^{-1} of okra plant.

Topping	Humic acid $m.l^{-1}$	Mulching				T*H	Topping
		Without	**Black**	**Clear**	**Blue**		
T1	0.0	3.04 c-e	2.95 c-e	3.35 a-e	2.97 c-e	3.08 d	3.58 a
	20.0	3.57 a-d	3.88 a-d	3.82 a-d	3.57 a-c	3.71 a-c	
	40.0	4.07 a-c	3.30 a-e	4.08 a-c	4.42 a	3.97 a	
T2	0.0	2.33 e	3.60 a-d	3.03 c-e	3.94 a-c	3.23 cd	3.41 a
	20.0	3.32 a-e	2.70 de	3.68 a-c	3.30 a-e	3.25 b-d	
	40.0	3.57 a-d	3.13 b-e	4.08 a-c	4.25 ab	3.76 ab	
Mulching		3.32 b	3.26 b	3.68 ab	3.74 a	Humic	
T*M	T1	3.56 a-c	3.38 a-c	3.75 ab	3.65 a-c		
	T2	3.07 c	3.14 bc	3.60 a-c	3.83 a		
H*M	0.0	2.69 d	3.28 cd	3.19 cd	3.45 b-d	3.15 b	
	20.0	3.44 b-d	3.29 b-d	3.75 a-c	3.43 b-d	3.48 b	
	40.0	3.82 a-c	3.22 cd	4.08 ab	4.33 a	3.86 a	

Mean with a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple at 0.05 level.

It is clear from table (5) that there was no significant effect between two toppings. Spraying of humic acid at concentration 20 and 40 $m.l^{-1}$ caused a significant increase in the seed number pod^{-1} 83.26 and 82.08 respectively as compared with those of the untreated plants 75.97. The plants grown under all mulching color significantly increased seed number and the color blue gave high seed number 83.98.

The effect of interactions between each two factors, the best interactions resulted from topping (2) with 20 $m.l^{-1}$ humic acid 83.68. In case of the interactions between topping and mulching, the maximum interactions was obtained between topping (2) with blue mulch 86.74. However, the best interactions between humic acid and mulching was obtained from spraying of 20 $m.l^{-1}$ humic acid with blue mulch 90.61seed number.

The superior triple interactions was found between topping (2) with 20 $m.l^{-1}$ humic acid and clear mulch which recorded 95.33 seed number.

Journal of University of Duhok., Vol. 20, No.1 (Agri. and Vet. Sciences), Pp 41-49, 2017

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Tabl (5): Effect of Topping, Humic acid, mulching color and their interactions on Seed number pot^{-1} of okra plant.

Topping	Humic acid m.l^{-1}	Mulching				T*H	Topping
		Without	Black	Clear	Blue		
T1	0.0	64.00 h	87.33 a-d	76.27 b-h	70.67 e-h	74.57 b	79.76 a
	20.0	88.33 a-c	69.83 f-h	84.34 a-f	88.83 a-c	82.83 ab	
	40.0	77.00 b-h	87.00 a-d	79.33 a-h	84.17 a-f	81.88 ab	
T2	0.0	65.33 gh	88.33 a-c	74.47 c-h	81.33 a-g	77.37 ab	81. 11 a
	20.0	71.50 d-h	75.50 c-h	95.33 a	92.38 ab	83.68 a	
	40.0	77.67 b-h	81.83 a-f	83.17 a-f	86.50 a-d	82.29 ab	
Mulching		73.97 b	81.64 a	82.15 a	83.98 a	Humic	
T*M	T1	76.44 ab	81.39 ab	79.98 ab	81.22 ab		
	T2	71.50 b	81.89 ab	84.32 a	86.74 a		
H*M	0.0	64.67 e	87.83 a-c	75.37 c-e	76.00 c-e	75.97 b	
	20.0	79.92 a-d	72.67 de	89.84 ab	90.61 a	83.26 a	
	40.0	77.33 b-d	84.42 a-d	81.25 a-d	85.33 a-d	82.08 a	

Mean with a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple at 0.05 level.

The results in table (3, 4 &5) may interpreted that apical bud topping increase the metabolites supplied by leaves as a result of strong carbohydrate sinks furnished by developing pods (Kittock and Fry, 1977), or/and, topping enhanced the lateral branches of plants to carry more pods (Omer *et al*.,1997). Revealed that apical bud topping significantly improved the seed weight per pod and seed yield per pod compared to control in okra (Venkata Reddy *et al*., 1997). (Singh et al., 2002) stated that topping of okra plant producer maximum number of seeds per pod compared to that of pods taken from without topping plants. For the effect of humic acid in increasing number of dry fruit, seed weight and seed yield per pod in table (3, 4 & 5) these results are in agreement with those obtained by (Karakurt *et al*., 2009) who obtained that humic acid enhanced nutrient uptake, vegetative growth, yield and quality in a number of plant species.(Kirn *et al*., 2010) who indicated in their results that humic acid significantly increased yield when applied with full recommended fertilizer in okra.

Mulching leads to the increase in the number of dry fruit, seed weight per pod and seed number per pods which might be due to increased photosynthetically active radiation, increased biochemical activities in the soil, less nutrient loss through leaching, reduction of evaporation leading to higher soil moisture content, reduction in weed growth, optimum root zone temperature and better nutrient availability to the plant for overall increase in crop yield. Similar result were also observed by (Jimenez *et al*.,2011 and Kapoor, 2012)

CONCLUSION

From these results, it can be concluded that topping, humic acid and mulching color leads to the enhancement of vegetative growth and seed yield. Furthermore the dual interactions among the

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tested factors was a positive effect in improving these traits.

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Journal of University of Duhok., Vol. 20, No.1 (Agri. and Vet. Sciences), Pp 41-49, 2017

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پوختە

ئەف ڤەکولینە هاتە بجهئینان ل سالا **2016** ل زەڤیێن چاندنێ **/** کولیژا چاندنێ**/**زانکویا دهوك**/**دەڤەرا کوردستانێ ل سەر بامیێ ژبو تاقیکرنا کارتێکرنا برینا سەرێ رووەکی **(**بشتی **4** بەلگا و**7** بەلگا**)** وسێ تیراتیێن جودا ژ ترشێ هیومیکی **(0، 20، 40** مل**/**لتر **)** وچار جورێن رەنگا ورەنگ بێن نایلونی **(**نەهاتیە نخافتن، روهن، رەش، شین**)** ل سەر بامیێ جورێ **(**کلامسون**)** ئەنجاما دیارکر کو برینا سەرێ روەکی بشتی **7** بەلگا زێدەکرنەکا جیاواز هەبو لسەر ژمارا چەقا وروبەرێ بەلگا وبامیێت هشك**.** ترشێ هیومیکی **40** مل**/**لتر زێدەکرنەکا جیاواز هەبو لسەر روبەرێ بەلگا وبامیێت هشك وکێشەیا توفی، ترشێ هیومیکی **20** مل**/**لتر ژمارا توڤی زێدەکر**.** نخافتنێ جیاوازیا پێش جاڤ هەبو ل سەر هە می سالوخەتان **.**لێکدان دناڤبەرا برینا سەری روەکی بشتی **7** بەلگا و**20**مل**/**لتر ترشێ هیومیکی زێدەکرنەکا جیاواز هەبو ل سەر ژمارا چەقا وروبەرێ بەلگا وژمارا توڤی**.** لێکدانێن دوو قولی دناڤبەرا برینا سەرێ رووەکی بشتی **7** بەلگا ونایلونێ روهن جیاوازیا بێش جاڤ هەبو ل سەر ژمارا چەقا وروبەرێ بەلگا وبامیێت هشك**.** لێکدان دناڤبەرا ترشێ هیومیکی ونخافتنێ زێدەکرنەکا جیاواز هەبو ل سەر زوربەی سالوخەتان**.** لێکدان دناڤبەرا برینا سەرێ روەکی وترشێ هیومیکی و نخافتنێ زێدەکرنەکا ئە رێنی هەبو ل هەمی سالوخەتێن کەسکاتیێ وتوڤی**.**

تأثير قرط القمة النامية وحامض الهيومييك والتغطية بالبلاستيك الملون والتداخل بينهما على نمو وحاصل البذور لنبات الباميا (***Abelmoschus esculentus* L.**)

الخلاصة

اجريت هذه الدراسة خلال موسم النمو **2016** في حقل الخضراوات التابع لكلية الزراعة **/**جامعة دهوك **/**منطقة كوردستان على نبات الباميا لدراسة تاثير قرط القمة النامية **(**بعد **4** اوراق ،**7** اوراق**)** وثلاث مستويات من حامض الهيوميك **(0، 20، 40** مل**/**لتر**)** واربع الوان من التغطية بالبلاستيك **(**بدون تغطية، شفاف، اسود، ازرق**)** على نبات الباميا **(**كلامسون**).** اظهرت النتائج بان قرط القمة النامية بعد **7** اوراق ادى الى زيادة معنوية في عدد الفروع والمساحة الورقية والثمار الجافة. حامض الهيوميك **40** مل**/**لتر ادى الى زيادة معنوية في المساحة الورقية والثمار الجافة ووزن البذور، حامض الهيوميك **20**مل**/**لتر ادى الى زيادة عدد البذور . التغطية شجع معنويا جميع الصفات المدروسة. التداخل بين قرط القمة النامية بعد **7** اوراق و **20** مل**/**لتر من حامض الهيوميك ادى الى زيادة معنوية في عدد الفروع والمساحة الورقية وعدد البذور. التداخل الثنائي بين قرط القمة النامية بعد **7** اوراق و البلاستيك الشفاف شجع معنويا عدد الفروع والمساحة الورقية والثمار الجافة. والتداخل بين حامض الهيوميك والتغطية ادى الى زيادة معنوية في معضم الصفات. التداخل بين قرط القمة النامية وحامض الهيوميك والتغطية سبب اختلافات معنوية موجبة في جميع صفات النمو الخضري والبذري.

كارتێکرنا برینا سەرێ رووەکی وترشێ هیومیکی ونخافتنا نایلونێن رەنطا ورەنط و تێکەلکرنا وان ل سالوخەتێن کەسکاتیێ وبەرهەمێ توظێ بامیێ **(*Abelmoschus esculentus* L.)**