Impact of seed soaking by Salicylic Acid, Biozyme application, and covering on Okra (*Abelmoschus esculentus* L.) germination and yield.

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Abstract:

The study carried out during (April to October 2020) at two different locations in Sulaimani governorate, the first location was the Agricultural nursery in Tasluja (back to nature), and the second at the vegetable farmer in Dukan, the study determines the response of an okra variety and the effect of salicylic acid on the growth and germination of seeds and foliar application with biozyme as well as the use of temporary vegetation covering on growth, yield and seed quality. Then the two locations were compared in quantitative and qualitative appearances of the local okra production, and their interactions on yield and its growth characteristics and the quantitative and qualitative of the local okra crop. This study was designed as a factorial according to a randomized complete block design (R.C.B.D.) with three replicates and (54 experimental units). An experiment was conducted to find out the effect of the vital properties of local okra seeds obtained directly in Sulaymaniyah during the season from (2020). The seeds were soaked for 4 hours in three different concentrations (0 ppm, 75 ppm and 150 ppm)) of salicylic acid with distilled water to achieve a higher germination, Biozyme foliar application at three levels (0 $ml.l^{-1}$, 0.75 $ml.l^{-1}$ and 1.5 $ml.l^{-1}$), and covering on okra yield quality in green shade-net house. The results indicated that salicylic acid treatment led to significant effect on seed germination and yield.

The interaction among locations, covering, salicylic acid and biozyme foliar application, significantly ($P<0.05$) effected positively on pod weight (4.829 g), Yield Per Hectare (9.491 ton/ hectare), number of seeds per pod (78.467) and seed weight per pod (68.000 g).

Keywords: Okra, salicylic acid, biozyme, covering, seed quality

Introduction:

Okra (*Abelmoschus esculentus* L. Moench.) is a vegetable crop that belongs to the Malvaceae family (1). Okra has a deep root system, smooth, striped seeds that range in color from dark green to dark brown, and is a valuable vegetable crop grown in tropical and sub-tropical regions around the world (2, 3, 4). Gumbo originated in Ethiopia (5), and by the 12th century, it had spread across North Africa, the Mediterranean, Arabia, and India (6). The majority of suitable land has been cultivated, and expanding into new areas to increase okra production as a staple food in most countries is both feasible and desirable. It's a common crop in India because it's easy to grow, and it's highly adaptable to different climates and humidity levels. Okra is extremely vulnerable to cold temperatures, resulting in thin plants with poor ability to produce leaves and flowers, as well as irregular pods that are reduced in quantity and quality. According to (7) global food production would need to increase by 38 percent by 2025 and 57 percent by 2050. Because of its medicinal nature, dietary fibers, and distinct seed protein in both lysine and tryptophan amino acids, okra has been dubbed "the ideal villager's vegetable" in Africa accounts for more than 75% of okra produced , but the average productivity in region is very low (2.5 t/ha) compared to East (6.2 t/ha) and North Africa (8.8 t/ha) (8).

Germination is a crucial phase in the growth of plants because it prepares the seedling for installation, adaptation to the climate, and productivity (9). Plant bio stimulants such as plant and algae extracts generally fall within one of these categories i.e. hormone-containing products, micronutrients based products, amino acid-containing products, and

humic acid-containing products (10, 11), Plant bio-stimulants are used to treat crops in a commercial setting in view of their ability to increase growth rates, increase stress tolerance, increase the photosynthetic rate (12, 13) ,one endogenous plant hormone, salicylic acid (SA), is essential to plant growth and growth, has demonstrated many key plant functions and can alter the plants' physiological conduct (14), However, SA has been shown to influence a wide range of plant processes, including seed germination and fruit yield (15, 16). Exogenous salicylic acid or indole acetic acid (IAA) has an impact on endogenous levels of soaked grains, as well as germination and maize development, at various concentrations. The study showed that pre-soaking maize seeds absorbed less seed soaked in IAA than SA in various solutions like SA on their intrinsic content in soaking seeds (17). There has been substantial speculation that phenolic in general act as regulators of plant growth (18, 19). Salicylic acid is a plant growth regulator that greatly enhances a plant's bioproductivity. It has a beneficial impact on a variety of vegetable and ornamental plants (20, 12).

Shading is an easy, non-chemical, and low-cost alternative to plastic polyethylene for growing and developing plants in hot weather (21). Under cover, the plant's response to sunlight can be more effective. Since shading has a major impact on plant textures and the percentage of chlorophyll in the leaves, a combination of shading and plant management is needed to improve crop productivity and quality. As a result, the sun It reaches the Shade net house at a lower rate than in the open field, resulting in a more favorable climate for the crop inside the tunnel. Furthermore, under the green and white strips shade net house, growth parameters such as plant height, number of branches, leaf area, and stem diameter were significantly increased, studied by (22). The aim of this study was to improve germination and the quality of the okra seeds and the quality and quantity of the yields.

Materials and Methods:

The experimental period was conducted during (March to October 2020) at two different locations in Sulaimani governorate, Kurdistan Region-Iraq. The first location, in the agricultural field in Tasluja, by 20 km from center with (longitute:45,2474053. latitute:355901740), the second location, Dukan Region of Sulaymaniyah/Iraq by 70.77 km from center with (longitude: 44. 985734.latitude 35.887146) during season 2020. The climate of the study area is classified as semi-arid region, hot and dry in summer and cold in winter (23).

Experimental Design and Treatments

The experiments in both were arranged in a randomized complete block design with three replications. The ground is divided into two longitudinal halves, half of which are covered by a shad net (tunnels) to Knowing the comparison of germination of seeds, plants growth, yield and seed yield between cover plants and uncover plants, the other half was left clear of the shade net cover**.** Shading was performed on May 12, 2020 and the tunnel cover was removed on June 30 after transplantation , and then the plant feeding programs were randomly arranged with biozyme foliar application at different concentrations (0, 0.75 ml.l^{-1} and 1.5 ml.l^{-1}) done three times, the first Biozyme application was done 3 weeks after transplanting, and repeated every 15 days after the last application during the period, were plants spray early in the morning or late in the evening, to avoid burns of leaves of plants. In this study we will use three factors and their interactions between two location Sulaymaniyah (S) and Dukan (D) as follows:

Factor 1: Soak okra seeds with different concentrations of salicylic acid (0, 75 ppm and 150 ppm) (for 4 hr.)

Factor 2: Biozyme (foliar application) with 3 concentration (0, 0.75 ml. l^{-1} and 1.5 ml.l^{-1}) and spraying the seedlings two weeks after transplanting, 3 times between them 15days.

Factor 3: Covering (covering and without covering), and then the interaction between two locations Sulaymaniyah (S) and Dukan (D) covering (C) and non-covering (NC) ,

 ISSN 2072-3875

salicylic acid (S) and biozyme (B) treatments was taken.

Germination process:

Germination process was performed according to (24), cultivation of okra seeds in bags began after they were treated with salicylic acid at different concentrations (0, 75, 150) ppm, with the use of distilled water on April 6, 2020, then the seeds germinated three days after sowing at a temperature of 12-22 ºc, time was calculated after 10 days between the initial and maximum emergence.

After a perfectly random design the experiment with three replicates was done. Visible radical seeds were regarded as germinated. Dates for germination counts have been recorded daily after the seedling assessment technique provided in the manual of the Association of official seed analysis (25).

At the end of the experiment the final percentage of germination was calculated.

Mean germination time (MGT) was derived by the (26).

$$1\text{- } MGT\ (0\ ppm) = \frac{\sum Dn}{\sum n} = 6.227$$

Were *n* is the number of germinated seeds on day *D*, the number of days counted from the started of germination.

The time required for germination T50 was determined based on the modified formula by (27).

$$2\text{- } T50\ (0ppm) = ti + \frac{\left(\frac{N}{2} - ni\right)(tj - ti)}{nj - ni} = 303.727$$

Were *N* is the final number of emerged seeds and *ni*, *nj* are the cumulative number of seeds germinated by adjacent seed count at times *ti* and *tj* respectively, when

$ni < N/2 < nj$.

Germination index (GI) was calculated according to the following formula given by

Association of official seed analysis (28).

$$3\text{- GI (0ppm)} = \frac{\text{Nº of germinated seeds}}{\text{Days of first count}} = \frac{\text{Nº of germinated seeds}}{\text{Days of first count}} = 14.346$$

On the 7-day following planting, germination energy (GE) was recorded. It is the % of germinating seeds seven days after planting in comparison with the total seeds.

Characteristic Of Quantitative Yield

Data Collection

Data collection began 25 days after transplanting the seedlings for a period of 16 weeks. The investigations included data related plant growth and seed yield of local variety okra plant, and a comparison between the two locations of Tasluja and Dukan. Using both salicylic acid and Biozyme, cover plants and without covering in both locations. The cultivar was studied in addition to salicylic acid for seeds by soaking them for 4 hours with distilled water and spraying the seedlings after 3 weeks with Biosyme as a foliar spray for treated and untreated plants season 2020. Fresh okra fruits were harvested manually from the immature fruit of the okra plant in the early morning, fruits were harvested three times a week, leaving a stalk of 2-3 cm attached to the pods, and the following parameters were measured:

Pod Weight (g)

The average weight of the pods was obtained as shown below:

Average pod weight (g) = yield of exp. unit (g)/Number of pods of the exp. unit

Yield Per Hectare (ton / hectare)

The total yield was measured by calculating the plant yield for each experimental unit, then the crop was converted in hectares to tons.

Seed Character

Okra fruit contains many seeds, so twenty pods for each experimental unit were taken

 ISSN 2072-3875

without harvest until the end of the season before shattering stage occurs, the seeds of okra may spread up to 2-3 meters.

Number of Seed Per Pod

The number of seeds per pods from twenty pods in each experimental unit was randomly counted and the mean was measured.

Weight of 1000 seed (g)

The average seed weight was obtained from one hundred seeds and then multiplied by ten in each experimental unit for covering and without cover and then the mean was measured.

Statistical Analysis

Statistical analysis of data and comparison of arithmetic averages for evaluated by use one-way analysis of variance (ANOVA). Transactions according were separated by the Duncan test at a level P-value of 0.05 (29) Duncan test is a new multiple range test procedures of the Statistical Analysis System (30).

Results and Discussion:

Germination was observed in the seeds treated with (75 ppm and 150 ppm) and the lowest germination percentage was observed in control.

Table 1: Effect of salicylic acid on seed okra germination

Factors	0 ppm	75 ppm	150 ppm
MGT	6.226 a	7.069 a	6.414 a
T50	303.727 b	189.084 c	421.643 a
GI	14.348 a	14.673 a	14.558 a
GE (7 days)	223.667 c	296.000 a	260.000 b

Different letter in same row means significant differences (P<0.05).

The germination effect of priming the seeds was positive. In table 1, the results showed no significant difference ($p > 0.05$) in MGT & GI among different levels of the hormonal priming when the seed socked at concentrations (0, 75, 150) ppm of salicylic acid for four hours. (31) reported that the mean germination time and germination index was increased in okra seed treating with salicylic acid solution, this is may be due to that the treatment of seeds enhances antioxidants' enzymes such as ascorbate and glutathione in seeds and reduces lipid peroxidation during germination, and increasing germination percentages may be the result of dormancy in fresh seeds after treatment with SA, these findings agree with (32) for the average time required for the maximum germination T50 of a seed lot and can have the same time units used for germination calculation. The highest germination percentage at time to reach 50% germination (T50) was observed in concentration (150 ppm) of SA treatments for four hours caused gradual increases was 421.643 compared with the other concentrations which showed lower values. Seed soaking at concentration (75 & 150) ppm increased germination energy (GE 7 days) compared with control. The reason for this rise may be increasing cell division within the seedling roots and shooting apex that caused plant growth to increase and treatments with salicylic acid maintain cytokinine and IAA in plant tissues, which increase cell division within the apical meristem. These findings were also consistent with the results mentioned by (33, 34).

Pod Weight (g)

The results data reveled in table (2) that the tetra interaction among locations, covering, salicylic acid and biozyme foliar application, significantly (P<0.05) effected on pod weight (g) in both locations, the highest value (4.829

 ISSN 2072-3875

g) was obtained from okra plant that non-covering in Dukan location when the seeds treated with salicylic acid at (75 ppm) and treated with biozyme at (0.75 ml.l-1) concentration (DNC*S1*B0), while in okra plant from Sulaymaniyah with non-covering when the seeds treated with (75 ppm) and spray okra plants with biozyme at (0.75 ml.l-1) concentration (SNC*S1*B1) recorded the lowest pod weight (3.848 g).

Results of tri-interaction among locations, covering and salicylic acid, show in table (2) indicated that in okra plant from Dukan location treated with non-covering and the seeds treated with 75 ppm of salicylic acid (DNC*S1) was the most significant effective treatment which gave pod weight of (4.699 g). Results obtained Okra plant from Sulaymaniyah with non-covering and the seeds treated at (0 ppm) concentration (SNC*S0) which gave the lowest pod weight (4.029 g).

Concerning the tri interaction among locations, covering and biozyme foliar application results, indicated that effect was significant on pod weight (g), the highest value (4.551 g) was noticed from the Okra plant in Dukan location with non-covering and spray okra plants with biozyme at (1.5 ml.l-1) concentration (DNC*B2), while Okra plant in Sulaymaniyah with covering and plants treated with biozyme foliar application at (0.75 ml.l-1) concentration (SNC*B1) gave the lowest pod weight, which was (665.778 g).

The interaction between locations and covering results, displayed that there were significant ($P<0.05$) effects on pod weight, the maximum value (4.479 g) recorded in Okra plant from Dukan location with non-covering (DNC), whereas okra plant from Sulaymaniyah with covering (SC) obtained the lowest pod weight (4.052 g).

The results in the same table showed that there were no significant ($P>0.05$) differences in pod weight when the seeds are treated with salicylic acid at different concentrations. The results in table (2) illustrated that the pod weight of okra plants spraying with biozyme non-affect significantly ($P>0.05$).

In both locations, showed that there were no significant ($P>0.05$) differences in pod weight between covering and non-covering.

Results in the same table demonstrated that, Dukan location gave the best value of pod weight compared to Sulaymaniyah location.

Yield (ton / hectare)

Results in table (3) indicated that the tetra interaction among locations, covering, salicylic acid and biozyme foliar application significantly affected yield per hectare. The highest value (9.491 ton/ hectare) was obtained in Okra plant from Dukan location with non-covering and seeds treated at (75 ppm) of salicylic acid and biozyme foliar application at (0 ml.l-1) concentration (DNC*S1*B0), whereas in Okra plant from Sulaymaniyah with covering and seeds treated with (0 ppm) salicylic acid and biozyme foliar application at (1.5 ml.l-1) concentration (SC*S0*B2) gave the lowest value (2.832 ton/ hectare).

Tabulated data declare that in both locations, the tri interaction among locations, covering and salicylic acid significantly affected yield per hectare, the highest significant value (8.814 ton/ hectare) recorded in Okra plant from Dukan with non-covering when seeds treated with salicylic acid at (75 ppm) concentration (DNC*S1), whereas the Okra plant from Sulaymaniyah with covering and salicylic acid at (75 ppm) concentration (SC*S1) gave the lowest significant yield per hectare, which was (3.930 ton/ hectare).

Concerning the tri-interaction among location, covering and biozyme, the effect was significant ($P<0.05$) in increasing of yield per hectare. The highest value (8.574 ton/ hectare) was noticed in Okra plant from Dukan location with non-covering and spray okra plants with biozyme foliar application at (1.5 ml.l-1) concentration (DNC*B2), nevertheless the lowest value was obtained in Okra plant from Sulaymaniyah, covering when the okra plants treated with biozyme at (1.5 ml.l-1)

 ISSN 2072-3875

concentration (SC*B2) which was (3.468 ton/ hectare).

For the interaction between locations and covering, the results shows that the Okra plant from Dukan with non-covering (DNC) gave the highest significant value (8.425 ton/ hectare), whereas the Okra plant from Sulaymaniyah and covering (SC) gave the lowest on yield per hectare was (4.016 ton/ hectare).

Results in table (3) indicated that there was no significant ($P>0.05$) effect on yield per hectare when the seeds treated with salicylic acid at different concentration However, biozyme foliar application for okra plants had no significant ($P>0.05$) effect on yield per hectare.

The recorded data in table (3) demonstrated that there was significance ($P<0.05$) effect of covering and non-covering for both locations on yield per hectare, okra plants grown under non-covering gave the highest value (7.048 ton/ hectare) compared with covering.

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Table (2): Impact of Seed Soaking by salicylic acid, Biozyme Foliar Application and Covering Okra plant on the Pod Weight (g)

Treatments						Average of Salicylic acid effect	Average of covering	total Average of covering	
location	Type of covering	Salicylic acid	Biozyme						
			B0	B1	B2				
Dukan	Covering	S0	4.365 a-f	4.637 a-d	4.702 ab	4.568 ab	4.445 a	Covering	4.249 a
		S1	4.547 a-f	4.411 a-f	4.138 a-f	4.365 a-c			
		S2	4.258 a-f	4.481 a-f	4.468 a-f	4.402 a-c			
	Average of Biozyme		4.390 a	4.510 a	4.436 a				
	Non covering	S0	4.455 a-f	4.285 a-f	4.471 a-f	4.404 a-c	4.479 a		
		S1	4.580 a-f	4.829 a	4.688 a-c	4.699 a			
		S2	4.116 a-f	4.398 a-f	4.492 a-f	4.335 a-c			
	Average of Biozyme		4.384 a	4.504 a	4.551 a	Average of Dukan effect		4.462 a	
Sulaimani	Covering	S0	4.207 a-f	3.960 c-f	3.936 d-f	4.034 c	4.052 b	Non covering	4.292 a
		S1	4.408 a-f	3.939 d-f	3.894 f	4.080 c			
		S2	4.250 a-f	3.976 b-f	3.900 ef	4.042 c			
	Average of Biozyme		4.288 ab	3.958 bc	3.910 c				
	Non covering	S0	4.147 a-f	3.965 c-f	3.974 b-f	4.029 c	4.105 b		
		S1	4.287 a-f	3.848 f	3.953 d-f	4.029 c			
		S2	4.279 a-f	3.863 f	4.627 a-e	4.256 bc			
	Average of Biozyme		4.238 a-c	3.892 c	4.185 a-c	Average of Sulaimani effect		4.078 b	
Total Average of Biozyme effect			B0			B1	B2		
			4.325 a			4.216 a	4.270 a		
Total Average of Salicylic acid effect			S0			S1	S2		
			4.259 a			4.293 a	4.259 a		

The averages with identical letters (same cells color) are not significantly different (P> 0.05) between them

ISSN 2072-3875

The results in the same table showed that Okra plant from Dukan location gave the best value (6.975 ton/ hectare) compared with the data Okra plant from Sulaymaniyah location on yield per hectare. Biozyme increases the effectiveness of photosynthesis because the symbiotic coexistence between the plant and biozyme helps to absorb nutrients, which increases the growth of the plant (35). This was led to an increase in the weight of pod and plant yield, which is a reflection on the increase of the total yield. Biozyme increased pod weight and yield per hectare when the plants at triple interaction with location, covering and biozyme at high concentration through the formation of more epidermis cells and cell enlargement. The present study supports the findings of (36), this application of Biozyme increases fruit number per plant in tomato by assuring the rapid absorption of plant nutrients by improving the fruit environment and activating the development of larger and quality fruit (37).

The higher concentration of Biozyme of over control gave higher yield, whose yield depends on production of high number of fruits, responded more to biozyme application in the open field, because dependent variable exhibits a highly significant and positive relationship (38, 39, 40) could be caused by an auxin presence (NAA) that encourages the cell proliferation and cell extension and leads to an increase in fruit sink strength. On the other hand, the increasing influence of biozyme on the availability of nutrients and the role of potassium in the plant nutrition can be linked to this increase in plant growth. For the non-covering factors that significantly enhanced yield per hectare compared with covering. This may be due to the fact that okra is one of the plants requiring high temperatures, covering reduced sunlight, delaying flowering and fruit production even after vegetation was removed, significant differences were observed in the number of pods per plant after treating plants with biozyme. The effect of the growing regulators incorporated in the foliar fertilize, this may be due to that biozyme observed rise in okra pod weight results were expected since biozyme is a complex of three growth stimulants (IAA, GA3 and zeatin). (41, 36) observed a mean increase in fruit, weight, chilli and tomato diameters plant in application of biozyme as foliar fertilizer. Early fruit development important for the production of large-size fruits include high amounts of cytokinins (42, 43), gibberellic acid (44), and auxin (45, 46) the partition of photosynthesis into fruit of biozyme treated plants could have changed these plant growth regulators.

Increasing the yield of okra after being treated with biozyme varies according to the location and cover, and that described by(47) which found that after treating tomato with a foliar fertilizer have shown increasing in production and yield, in the case of covering and open failed, it was explained that non-covering gave the best value in terms of yield. Relatively high minimum temperatures during the fruiting period, may favor the ripening of the pod. The harvest season is the optimum temperature for fruit set, Earlier investigations showed that pepper pollen at low temperatures become sterile (48). In the meantime, GA3 encourages other development and raises the amount of sustainable pollen. the plants where treated with three factors, location covering and both concentrations of Biozyme significantly increased the number of fruits in okra plants Biozyme at 0.75 $ml.l^{-1}$ produced the highest fruit weight, yield per hectare whereas 1.5 $ml.\ l^{-1}$ gave the highest value in these cultivar. Although the nutrient value of fruits is higher for consumers, a high return for farmers is even more vital. Similarly, the ascorbic acid growth in pepper fruits by the use of NAA and GA3 in (49, 50) respectively was detected. Extension of the 5–6-week cover time negative affected the growth properties of okra plants. the fruit yield may decrease due to the lack of sufficient sunlight reaching the plants and may lead to a delay in flowering and failure to pollination (51). In this study, plant coverage period was affected by yield levels and pod weight, which is exactly contrary with the results of (52), who reported that the cover length of melon does not affect fruit yields substantially and fruit weight. The table (3) showed a significant

 ISSN 2072-3875

increase in yield per hectare when plants grow in open field were (7.048 ton/ha). The open field temperature is observed to be higher compared to the shade net. non covering led to increase the average pod weight of okra and the share of marketable yield in the total yield.
The highest production of okra was found in open field compared to shade net house. Since it provides unsuitable temperature for crop growth and development (53, 54, 55). So, the sun light in the covering or shade net house is less inside the house outside compared to. So, we have a good environment in the shade net house for cultivation. Morning and evening, the light intensity is decreased. This might be due to green color decreases the crop temperature. However, the study conducted by (56) found a 30% drop in the yield of pumpkin by covering, compared to non-cover cultivation.These effects of these foliar fertilizers may be due to their multi-nutrient content, which improved the growth properties of okra plants after absorption from the leaf tissues and consequently raised the yields of okra. Foliar fertilization not only increases plant development characteristics, crop yields and plant nutrient consumption (57) but also improves crop nutrient efficiency (58).
Increasing the yield of okra after being treated with biozyme varies according to the location and cover. Increased yield of okra, tomato and wheat (59) as reported foliar application of liquid fertilizer extracted from seaweed. The foliar fertilization method is therefore regarded as a strategy of environmental fertilization. Reduced floral drop and fruit growth may be related to delay of abscission (cytokinins and auxin effects) by preserving the loss of pectin material in the middle lamella (60) and improving tolerance to water as well as nutrient stress (61). A clear effect was observed with salicylic acid, which increased the yield characteristics at Dukan location, and this is the result of the temperature of the environment and the soil. Soaking of okra seed with SA significantly improved growth and yield characters, both in control with distilled water and treatment condition. The increase in yields results from improved vegetative growth features, which led to the efficiency of the photosynthesis process being increased as a result of an increase in plant height and the number of leaves per plant and the increase in the amount of carbohydrates produced and transferred to the flowers during the growing period this is consistent with (62).

 ISSN 2072-3875

Table (3): Impact of Seed Soaking by salicylic acid, Biozyme Foliar Application and Covering Okra plant on the Yield Per Hectare (ton / hectare)

Treatments						Average of Salicylic acid effect	Average of covering	total Average of covering	
location	Type of covering	Salicylic acid	Biozyme						
			B0	B1	B2				
Dukan	Covering	S0	5.933 c-i	5.905 c-i	5.109 e-j	5.649 b	5.525 b	Covering	4.770 b
		S1	5.148 e-j	4.347 g-j	5.975 c-i	5.157 bc			
		S2	4.597 g-j	6.537 b-g	6.171 c-h	5.769 b			
	Average of Biozyme		5.226 b-d	5.596 bc	5.752 bc				
	Non covering	S0	8.801 ab	8.238 a-d	8.380 a-c	8.473 a	8.425 a		
		S1	9.491 a	8.810 ab	8.141 a-d	8.814 a			
		S2	7.162 a-f	7601.847 a-e	9.201 a	7.988 a			
	Average of Biozyme		8.485 a	8.217 a	8.574 a	Average of Dukan effect		6.975 a	
Sulaimani	Covering	S0	4.363 g-j	4.778 f-j	2.832 j	3.991 c	4.016 c	Non covering	7.048 a
		S1	3.656 h-j	4.618 g-j	3.516 ij	3.930 c			
		S2	4.026 g-j	4.299 g-j	4.056 g-j	4.127 c			
	Average of Biozyme		4.015 de	4.565 c-e	3.468 e				
	Non covering	S0	5.783 d-i	5.908 c-i	5.311 e-j	5.667 b	5.671 b		
		S1	6.047 c-i	6.302 c-g	5.214 e-j	5.854 b			
		S2	5.378 e-i	6.278 c-g	4.819 f-j	5.492 b			
	Average of Biozyme		5.736 bc	6.163 b	5.115 b-d	Average of Sulaimani effect		4.843 b	
Total Average of Biozyme effect			B0			B1	B2		
			5.865 a			6.135 a	5.727 a		
Total Average of Salicylic acid effect			S0			S1	S2		
			5.945 a			5.939 a	5.844 a		

The averages with identical letters (same cells color) are not significantly different (P> 0.05) between them.

ISSN 2072-3875

Results of location, covering and biozyme interaction had a direct effect on the yield per hectare of okra plants (8.574 ton⁄ hectare). However, favorable influence on the fruit of the chili was also detected. Maximum fruit yield of 9.77t ha-• was recorded with treatment T4. (63, 64) showed dramatically higher chili and bell pepper yields by biozyme applications. The data presented in table (2) showed that biozyme at over control concentration had significant effect on pod weight, it is assumed that this significant increase is due to the effect on the respiration process, accumulated nitrates, resistance and growth of plant pods to viruses and diseases (65), or may lead to a higher pod weight due to a good physiological effect and hormone activity as a result of plant cell metabolism, photo synthesis and raising the leaf chlorophyll and nitrogen content (66).

Seed Character

Number of Seeds Per Pod

Results in table (4) illustrated the number of seeds per pod, the tetra- interaction among locations, covering, salicylic acid and biozyme effect significantly ($P<0.05$) on the number of seeds per pod. Okra plant From Sulaymaniyah location with covering when the seeds treated with (0 ppm) salicylic acid and (0 ml.l-1) biozyme foliar application (SC*S0*B0) gave the highest value was recorded (78.467), while the lowest value was recorded in Okra plant from Dukan location with covering when the seeds treated with salicylic acid at (150 ppm) concentration and sprayed plants at (0 ml.l-1) biozyme (DC*S2*B0), which was (57.833).

Tabulated data showed that the tri-interaction among location, covering and salicylic acid effect significantly ($P<0.05$) on the number of seeds per pod, Okra plant in Dukan location with non-covering and the seeds treatment with (0 ppm) salicylic acid (DNC*S0) gave the highest value (74.389), while the lowest value was recorded in Okra plant from Sulaymaniyah with non-covering and seeds that treated with (0 ppm) salicylic acid (SNC*S0) (65.989).

Results in table (4) revealed that, the tri-interaction among Location, covering and biozyme, significantly ($P<0.05$) increase the number of seeds per pod, Okra plant from Sulaymaniyah location with covering and biozyme foliar application at (0 ml.l-1) (SC*B0) (74.700), whereas the number of seeds per pod decrease dramatically in Okra plant from Dukan location at (0 ml.l-1) biozyme concentration (DC*B0) was recorded (66.322).

It's clear from same table, the interaction between locations and covering no significant ($P>0.05$) effect on the number of seeds per pod.

The results in the same table showed that there was no significant ($P>0.05$) difference on the number of seeds per pod, when the seeds treating with salicylic acid at different concentration on number of seeds per pod.

Regarding in the same table showed that when the okra plants treated with biozyme liquid as a foliar spray there were no significant effect ($P>0.05$) on the number of seeds per pod.

The results obtained from the present study revealed that the covering and non-covering for both locations had no significant effect ($P>0.05$) on the number of seeds per pod. The results in the same table showed that location no significant ($P>0.05$) effecting on the number of seeds per pod.

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Table (4): Impact of Seed Soaking by salicylic acid, Biozyme Foliar Application and Covering Okra plant on the Number of Seeds Per Pod

Treatments						Average of Salicylic acid effect	Average of covering	total Average of covering	
location	Type of covering	Salicylic acid	Biozyme						
			B0	B1	B2				
Dukan	Covering	S0	74.433 ab	69.667 ab	69.633 ab	71.244 a	68.644 a	Covering	698.667 a
		S1	66.700 ab	63.000 ab	71.833 ab	67.178 a			
		S2	57.833 b	72.367 ab	72.333 ab	67.511 a			
	Average of Biozyme		66.322 a	68.344 a	71.267 a				
	Non covering	S0	76.767 a	70.400 ab	76.000 a	74.389 a	72.615 a		
		S1	74.533 ab	68.133 ab	72.967 ab	71.878 a			
		S2	70.333 ab	72.267 ab	72.133 ab	71.578 a			
	Average of Biozyme		73.878 a	70.267 a	73.700 a	Average of Dukan effect		70.630 a	
Sulaimani	Covering	S0	78.467 a	67.533 ab	63.567 ab	69.856 a	71.089 a	Non covering	701.444 a
		S1	76.600 a	73.867 ab	71.500 ab	73.989 a			
		S2	69.033 ab	73.000 ab	66.233 ab	69.422 a			
	Average of Biozyme		74.700 a	71.467 a	67.100 a				
	Non covering	S0	61.600 ab	66.433 ab	69.933 ab	65.989 a	67.674 a		
		S1	69.600 ab	69.933 ab	68.900 ab	69.478 a			
		S2	69.733 ab	68.367 ab	64.567 ab	67.556 a			
	Average of Biozyme		66.978 a	68.244 a	67.800 a	Average of Sulaimani effect		69.382 a	
Total Average of Biozyme effect			B0			B1	B2		
			70.469 a			69.581 a	69.967 a		
Total Average of Salicylic acid effect			S0			S1	S2		
			70.369 a			70.631 a	69.017 a		

The averages with identical letters (same cells color) are not significantly different (P> 0.05) between them.

ISSN 2072-3875

Weight of 1000 seed (g):

The data in table (5) reveals that the tetra-interaction among locations, covering, salicylic acid and biozyme had a significant ($P<0.05$) effect on the seed weight per pod. The results indicated that okra plant in Sulaymaniyah with non-covering, when the seeds treated with salicylic acid at (75 ppm) concentration and biozyme foliar application at (0.75 ml.l-1) concentration (SNC*S1*B1) gave the highest value (68.000 g), while the lowest value significantly decreased sharply in the seed weight per pod, was obtained from Okra plant in Dukan location with non-covering which were seeds treated with (75 ppm) of salicylic acid and (1.5 ml.l-1) with biozyme (DNC*S1*B2) it was (48.000 g).

In the same table indicated that the tri-interaction among locations, covering and salicylic acid significantly ($P<0.05$) affected on the seed weight, the highest value (65.444 g) was recorded in okra plant from Sulaymaniyah location with non-covering when the okra seeds treated with salicylic acid at (75 ppm) (SNC*S1), while the lowest value recorded in okra plant from Dukan with non-covering and the seeds treated with salicylic acid at (75 ppm) (DNC*S1), it was (55.778 g).

The data in table (5) concerning the tri-interaction among locations, covering and biozyme foliar application, significantly ($P<0.05$) affected on the seed weight per pod, okra plant in Sulaymaniyah location with non-covering and plants were treating with (0.75 ml.l-1) of biozyme (SNC*B1) recorded highest value(66.222 g). However, the lowest value recorded in okra plant from Dukan location with non-covering when okra plants treated with (0.75 ml. l-1) of biozyme (DNC*B1) (56.778 g).

In the same table the data showed that the interaction between location and covering significantly ($P<0.05$) effected on the seed weight per pod, okra plant in Sulaymaniyah location and non-covering (SNC) gave the highest value (64.407 g), whereas the lowest value obtained from okra plant in Dukan location and non-covering of plants (DNC), it was (59.296 g).

Results in table (5) illustrated that there were no significant ($P>0.05$) differences on the seed weight per pod when okra seeds treating with salicylic acid at different concentration.

On the other hand, the results in the same table showed that when okra plants sprayed with biozyme at different concentration no significant ($P>0.05$) effect on the seed weight per pod.

Regarding the results, it indicated that there were no significant ($P>0.05$) differences on the seed weight per pod between covering and non-covering.

The results presence in the same table showed that the best value was obtained from Okra plant in Sulaymaniyah location (63.444 g) compared to Dukan location.

Results of tetra interaction (location, covering, salicylic and biozyme) indicated that the interaction (SC*S0*B0) was the most significant efficient treatment as it gave the highest value (78.467) that showed in table (4). Significantly, the highest value of this parameter was obtained from the tri-interaction (SC*B0) which was (74.700).

The improvement of the performance of the covering plants was attributed to a larger number of branches carrying more pods (67), a higher photosynthesis rating, accumulated more photosynthesis leading to improved pod count and seed per pod. The number of seeds ranged between (57.833 to 78.467) per pod may be attributed to diversion of photosynthetic and metabolites producer by leaves to strong carbohydrate (68). Number of pods is dependent on the seeds producing signal molecules that regulate cellular division and expansion. Auxin is a candidate for the signal molecules one of the biozyme components (69). Biozyme contains cytokinins which could also have encouraged cell division, boosted sink activity to enhance fruit growth in competition with resources and hence improve fruit production (70). The results in table (4-5) showed that the tetra interaction among (location, covering,

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salicylic acid and biozyme) demonstrated that, the use of biozyme as foliar spray on okra plants reduces dramatically the number of seeds whereas seed weight increases considerably over control (36) were found contrary results in tomato plants.

More branches to carry more pods (67), salicylic acid and biozyme, increased photosynthetic rate, accumulation of more photosynthetic results, better pod dry number and the number of seeds, led to a larger rates for photosynthesis On plants sprayed with biozyme, the lowest number of seeds (57.833) was recorded at (0 $ml.l^{-1}$) concentration of biozyme, the correlation matrix of all independent variables contributing to the okra shows an important connection. Though there was no significant improvement of number of seeds per pod and seed weight when the plants treated with biozyme, these observations on the yield characteristics of okra in this study could be attributed to the synergistic effect of gibberellin, IAA, and cytokinin.

The interaction among three factors increased the number of seeds per pod in Sulaymaniyah location the plants grow under covering when the plants treated with biozyme at (0 ml. l^{-1}). However, the seed weight increased at the same location in open failed with treating plants with biozyme at (0.75 $ml.l^{-1}$). The differences between number of seed and seed weight were significant between the control and biozyme treatments. The larger seed numbers in the Biozyme control plants could be attributed to photosynthesis in fruit development, which would eventually support seed development.

Seed composition will lead to greater seed production through the shift of components of photosynthesis from vegetative to reproductive organs (72).

Biozymes at the control levels lead to increase the plant height and number of leaves to appear with good physiological effects, including effects of the plant cell metabolism and increased leaf chlorophyll levels (73). The application of biozyme at different concentration not significant differences on the number of seed and seed weight per plant, these results are contrary to the researchers' findings (74, 75). The covering and non-covering of plants had no substantial effect on the seed per pod. It can be owing to the maximum pod size containing more seeds. Similar findings were observed by (76, 77). Due to maximum seed size and per pod of seed, a relation exists between the number of seeds per pod and the weight of the seeds. Similar findings have been achieved (78, 79).

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Table (5): Impact of Seed Soaking by salicylic acid, Biozyme Foliar Application and Covering Okra plant on weight of 1000 seed (g)

Treatments						Average of Salicylic acid effect	Average of covering	total Average of covering	
location	Type of covering	Salicylic acid	Biozyme						
			B0	B1	B2				
Dukan	Covering	S0	58.333 b-d	63.000 a-c	62.000 a-d	61.111 a-c	59.741 b	Covering	61.111 a
		S1	59.667 a-d	58.000 b-d	59.667 a-d	59.111 cd			
		S2	56.000 cd	59.667 a-d	61.333 a-d	59.000 cd			
	Average of Biozyme		58.000 cd	60.222 b-d	61.000 b-d				
	Non covering	S0	63.000 a-c	53.333 de	64.000 a-c	60.111 b-d	59.296 b		
		S1	60.333 a-d	59.000 a-d	48.000 e	55.778 d			
		S2	65.667 ab	58.000 b-d	62.333 a-d	62.000 a-c			
	Average of Biozyme		63.000 a-c	56.778 d	58.111 cd	Average of Dukan effect		59.519 b	
Sulaimani	Covering	S0	67.333 ab	60.000 a-d	62.333 a-d	63.222 a-c	62.481 a	Non covering	61.852 a
		S1	60.333 a-d	64.667 a-c	63.667 a-c	62.889 a-c			
		S2	61.333 a-d	62.667 a-c	60.000 a-d	61.333 a-c			
	Average of Biozyme		63.000 a-c	62.444 a-c	62.000 a-c				
	Non covering	S0	65.000 a-c	65.667 ab	64.000 a-c	64.889 ab	64.407 a		
		S1	63.000 a-c	68.000 a	65.333 ab	65.444 a			
		S2	65.000 a-c	65.000 a-c	58.667 b-d	62.889 a-c			
	Average of Biozyme		64.333 ab	66.222 a	62.667 a-c	Average of Sulaimani effect		63.444 a	
Total Average of Biozyme effect			B0			B1	B2		
			62.083 a			61.417 a	60.944 a		
Total Average of Salicylic acid effect			S0			S1	S2		
			62.333 a			60.806 a	61.306 a		

The averages with identical letters (same cells color) are not significantly different (P> 0.05) between them.

ISSN 2072-3875

Conclusion

According to the results obtained from this study, the following could be concluded:

1. Seed priming at various doses of salicylic acid promote germination and seed growth in okra seeds.
2. It is evident that the application of Shading, plant bio stimulants significantly improved plant growth, fruit set, and yield. So, it can be concluded that spray not only gave more yield to the farmers but also improve the fruit quality.

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 ISSN 2072-3875