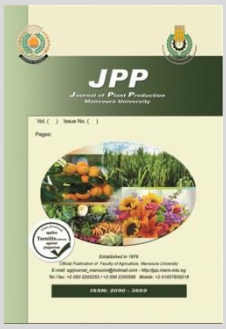
Journal of Plant Production

Journal homepage & Available online at: www.jpp.journals.ekb.eg

Effect of Spraying with Salicylic Acid and Bacterial Inoculation on Yield and Yield Components of some Soybean Cultivars under El-Minia Governorate Conditions

Eman M. Taha [1] ; S. A. Mokadem [1]; G. A. Abd El-Hafez [2] and Hagar M. Abdel Naeem[2]*

[1]Agron. Dep. Fac. Agric., Minia univ., Egypt)
[2]Field Crops Institute Agric., Res., Center, Egypt.



ABSTRACT

Two field experiments were conducted out at the experimental farm of Malawi Agricultural Research station, Minia Governorate, Egypt during two seasons of 2021 and 2022 to study the effect of salicylic acid, inoculation with *Bradyrhizobium japonicum* bacteria on yield and yield components of some soybean (*Glycine max* L. Merrill.) cultivars. The obtained results summarized as follows: Data results that salicylic acid sprayed at 50 ppm produced the highest values of yield components (plant height, branches number/plant, height of the first pod, number of fruitful / main stem, number of pods/plants, number of seeds/pod, seed index, seed yield/plant), yield characters (seed yield/fed., straw yield/fed, harvest index% and land use efficiency (LUE) and seed chemical content (seed oil percentage, oil yield/fed., seed crude protein percentage and protein yield/fed. in both seasons. The lowest values obtained by salicylic acid sprayed at 0 ppm concentration in both seasons. The highest values of the mentioned traits from bacterial inoculation in the two seasons. Soybean cultivar Giza111 gave the highest values of the studied characters, followed by Giza 22 cultivar in both seasons. The highest values of the characters under study obtained from Giza 111 cultivar with salicylic acid sprayed at 50 ppm under inoculation, while the lowest one obtained by Giza 21 cultivar with 0 ppm salicylic acid under inoculation treatment in both seasons.

Keywords: Soybean; Salicylic; Inoculation; Cultivars; Productivity.

INTRODUCTION

Soybean is the most important grain legume of the world, which contributes significantly to edible oil protein concentrate for animal feed, food uses and various industrial Products. The increase of soybean area as a summer crop to face the great demand for edible oil and poultry feed is very difficult because of competition either between cotton or corn and rice, therefore, it is necessary to increase the productivity per unit area of soybean. this goal can be achieved by cultivating a high yielding cultivar with application of the best package from agricultural practices optimum levels of several factors. Among these factors, which effect growth and productivity plants of soybean are foliar with salicylic acid and inoculation by *Bradyrhizobium japonicum*. The optimum levels of those factors varied widely according to different varieties.

Several investigators studied the effect of Salicylic acid on yield and yield components of soybean. Hegazi and El-Shraiy (2007) found that SA increased plant height and shoots. Salicylic acid (SA) is the most effecting soybean growth, yield and yield components, because it considered as a natural plant hormone, it has many effects on the growth of plant (Khan *et al.,* 2010). Ali and Mohamed (2013) Showed that (SA) had a significant effect on all studied traits and produced the highest seed yield. Alyemeni (2014) recorded that SA treatment resulted in a significant increase of growth and yield. The result of El-Shafey (2017) and Estaji and Niknam (2020) showed that application of salicylic acid had significant effect on growth parameters, seed yield components and seed oil quality. Uppalige and Nagaboanalli (2018) showed that foliar applied (SA) significantly improved protein and oil yield, Also the yield and quality of soybean. Calvin and Siregar (2019) found that SA spraying on soybean increased number of pod/plant.

Concerning the effect of inoculation by *Bradyrhizobium japonicum* on yield and its components, Badran (2003) found that the highest values of seed, straw, protein, and oil yields/fed were obtained by applying rhizobium inoculation. Mohamed (2008) resulted that bacterial inoculation produced the highs seed yield/fed., seed oil percentage, straw yield/fed., biological yield/fed. Shiri *et al.* (2012) recorded that inoculation of seed by *Bradyrhizobium japonicum* improves soybean yield and yield components. Abd El-Kader (2015) reported that inoculation had a significant effect on soybean growth, plant height, number of branches/plant, leaf area/plant, leaf area index. Also, the highest values of number of pods/plant, number of seeds /plant, seed index and the greatest values of seed, straw and biological yields/fed., harvest index and land use efficiency were recorded for inoculation. Omari *et al.* (2022) confirmed that inoculation soybean with bacterial improves yield and yield attributes.

Significant differences between soybean cultivars for plant height and first pod height, number of branches/plant, number of pod and seed/plant, seed weight /plant and 100 seed weight (Eisa *et al.,* 2002). Abd El-Hafez and Abo El-Soud (2007) found superiority of Giza 111 cultivar for increasing growth, yield and its components, seed and straw yield /fed, plant height, branches number and number of pods

* Corresponding author.
E-mail address: hagarmoubarak282@gmail.com
DOI: 10.21608/jpp.2024.283255.1328

per plant, seed weight /plant and 100 seed weight. Mohamed (2008) resulted that plant of Giza 111 and the Giza 22 cultivar carried the highest number of seeds/plant, biological yield/fed., seed yield. /fed. and straw yield/fed., also he reported that Giza 111 gave the highest values of yield and its components. Zohri (2024) reported that Giza 111 gave the highest values of yield.

MATERIALS AND METHODS

Two field experiments were conducted at the experimental farm of Malawi Agriculture Research Station, Minia Governorate, Egypt during two seasons of 2021 and 2022 to study, the effect of salicylic acid, inoculation with *Bradyrhizobium japonicum* bacteria on yield and its components of some soybean cultivars under Minia Governorate conditions.

Clay loam soil having a PH of 7.6, total N content of 25%, Extractable P and K of 5.62 and 287 ppm, respectively used for the experiments.

The design of the experiments was split-split plot with three replicates. The main-plots will devoted to salicylic acid (sprayed with water as control treatment, 50 ppm and 100 ppm) and the sub-plots were assigned to the inoculation with *Bradyrhizobium japonicum*, while soybean cultivars (Giza 21, Giza 22 and Giza 111) were randomly located in sub-sub plots. Each experimental plot consisted of five ridges of 3.5 m in long and 60 cm apart, occupying an area of 10.5 m^2 (1/400 fed.). The soybean plants were foliar sprayed with salicylic acid (SA) concentration when 5 to 10% of the plants had one flower. Each plot receives one liter of salicylic acid solution, the control plants were sprayed with water only. The inoculation process was done for seeds of soybean before sowing. All cultural practices of soybean were done as recommended in the region.

The studied characters:

Yield components: At harvest time, five plants were selected at random from the third and fourth ridges of each plots to determine the following characters; plant height (cm); number of branches/plant; height of the first node (cm); number of fruitful nodes (clusters) per main stem; number of pods/plant; number of seeds/pod; seed index (g) (weight of 100 seed) and seed yield/plant.

Yield: At harvest, all plants of the third and fourth ridges from each plot were harvested to estimate the following characters: 1- Seed yield (ton/fed.); 2- Straw yield (ton/fed.); 3- Harvesting index; 4- Land use efficiency (L.U.E) kg seeds day according to the following equation:

$$LUE = \frac{\text{Seed yield/fed}}{\text{Number of days from sowing to maturity}}$$

Seed chemical contents:

1- Seed oil percentage: For determination seed oil percentage, the Soxhelt continuous extraction apparatus with petroleum ether as an organic solvent was used according to A.O.A.C (1995).

2- Oil yield/fed (kg): It was calculated by multiplying seed oil percentage by seed yield/fed (kg).

3- Seed crude protein percentage: Total nitrogen was determined using improved Kjeldahl's method of A.O.A.C (1995).

4- Protein yield/fed (kg): It was calculated by multiplying seed protein percentage by seed yield/fed (kg).

All data recorded in both seasons were subjected to proper statistical analysis according to procedures outlined by Snedecor and Cochran (1981). The differences among treatment means were compared using Least Significant of Differences Test (LSD) at level of 5% probability.

RESULTS AND DISCUSSION

Yield components:

Data presented in (Tables 1-8) show the average values of plant height, number of branches/plant, height of the first pod, number of fruitful nod/main stem, number of pods/plant, number of seeds/pod, seed index (100 seed weight) and seed yield/plant, respectively as affected by spraying salicylic acid (SA) on soybean plants in 2021 and 2022 seasons.

Data cleared that all studied characters were significantly affected by spraying salicylic acid. Results showed that spraying (SA) gave the greatest values for all the mentioned traits of yield components, compared to control treatment (0 ppm), except height of the first pod., in both seasons. The highest values obtained by using concentrations of 50 ppm cell salicylic acid followed by 100 ppm treatment, except height of the first pod per plant, which this height was progressively increased with decreased salicylic acid concentration, these results were true in both Seasons.

These obtained results by spraying (SA) may be due to stimulation effect of salicylic acid in enhancing some physiological and biochemical aspect or increasing N, P, K and Ca content, activity in antioxidant enzymes and glutathione content, which revealed increasing in growth rate and yield components.

Concerning the highest first pod from ground, it was obtained from salicylic acid sprayed at 0 ppm (control) with comparison the nearest first pod from ground for (SA) sprayed at 50 or 100 ppm. Such results might be due to length of the plant. Similar results obtained by Khan et al., (2010), Ali and Mohamed (2013) and Estaji and Niknam (2020).

Inoculation with *Bradyrhizobium japonicum* significantly affected all characters of yield components (Table 1-8) in both seasons. The highest values which obtained by bacterial inoculation compared with un inoculation treatment (control. Such effect may be attributed to the role of inoculation by *Bradyrhizobuim japonicum* on fixed nitrogen, which soybean plants have a more tendency to form their vegetative growth, consequently yield components. These results are in accordance with those obtained by Badran (2003), Abd El-Kader (2015) and Omari *et al.* (2022).

Cultivars of soybean significantly affected all studied traits of yield components in both season (Tables 1-8). These significant differences between varieties may be due the growth habit of each genotype of soybean varieties G.111 cultivar surpassed the other cultivars i.e. Giza 21 and Giza 22., this fact may be attributed to the results obtained affirm the fact that Giza 111cultivar is the superior of the new released soybean cultivar because of its stronger and larger root system that reflected on its characters under study. These results are in general agreement with those obtained by Eisa *et al.,* (2002), Abd El-Hafez and Abd El-Soud (2002) and Zohri (2024).

Table 1. Effect of spraying by salicylic acid, bacterial inoculation, cultivars and their interactions on plant height in 2021 and 2022 seasons.

S.A spraying (A)	Inoculation (B)	Cultivars (C)							
		Giza 21	Giza 22	Giza111	Mean of A	Giza 21	Giza 22	Giza111	Mean of A
		2021				2022			
0.0 ppm	un inoculation	100.000	90.000	108.400	99.467	111.667	110.067	120.000	113.911
	Inoculation	102.333	89.333	110.667	100.778	120.000	115.000	120.000	118.333
Mean		101.167	89.667	109.533	100.122	115.833	112.533	120.000	116.122
50 ppm	un inoculation	115.333	93.333	112.333	107.000	125.000	108.333	115.000	116.111
	Inoculation	110.000	110.000	115.733	111.911	128.333	116.733	120.000	121.689
Mean		112.667	101.667	114.033	109.456	126.667	112.533	117.500	118.900
100 ppm	un inoculation	91.333	125.000	115.000	110.444	125.000	121.667	98.333	115.000
	Inoculation	104.667	95.000	116.667	105.444	110.667	126.667	105.000	114.111
Mean		98.000	110.000	115.833	107.944	117.833	124.167	101.667	114.556
Mean of (C)		103.944	100.444	113.133	105.841	120.111	116.411	113.056	116.526
Mean of (B)	b1	102.222	102.778	111.911	105.637	120.556	113.356	111.111	115.007
	b2	105.667	98.111	114.356	106.044	119.667	119.467	115.000	118.044
LSD 5%	A	6.252					7.971		
	B	3.793					4.014		
	C	3.806					5.687		
	AB	7.789					9.365		
	AC	24.443					42.774		
	BC	10.436					14.640		
	ABC	19.647					39.706		

Table 2. Effect of spraying by salicylic acid, bacterial inoculation, cultivars and their interactions on number of branches in 2021 and 2022 seasons.

S.A spraying (A)	Inoculation (B)	Cultivars (C)							
		Giza 21	Giza 22	Giza111	Mean of A	Giza21	Giza 22	Giza111	Mean of A
		2021				2022			
0.0 ppm	un inoculation	1.733	1.433	3.000	2.056	2.067	2.100	2.400	2.189
	inoculation	1.300	1.200	3.067	1.856	2.933	2.867	3.833	3.211
Mean		1.517	1.317	3.033	1.956	2.500	2.483	3.117	2.700
50 ppm	un inoculation	2.367	2.633	1.500	2.167	2.300	2.533	2.067	2.300
	inoculation	2.600	3.067	3.833	3.167	3.600	4.167	5.433	4.400
Mean		2.483	2.850	2.667	2.667	2.950	3.350	3.750	3.350
100 ppm	un inoculation	1.967	2.733	2.800	2.500	2.967	2.967	2.167	2.700
	inoculation	2.733	1.733	2.300	2.256	4.067	4.100	3.867	4.011
Mean		2.350	2.233	2.550	2.378	3.517	3.533	3.017	3.356
Mean of (C)		2.117	2.133	2.750	2.333	2.989	3.122	3.294	3.135
Mean of (B)	b1	2.022	2.267	2.433	2.241	2.444	2.533	2.211	2.396
	b2	2.211	2.000	3.067	2.426	3.533	3.711	4.378	3.874
LSD 5%	A	0.612					0.780		
	B	0.292					0.523		
	C	0.566					0.882		
	AB	0.709					1.254		
	AC	0.293					0.842		
	BC	0.099					0.284		
	ABC	0.359					0.905		

Table 3. Effect of spraying by salicylic acid, bacterial inoculation, cultivars and their interactions on height of the first pod (cm) in 2021 and 2022 seasons.

S.A s praying(A)	Inoculation (B)	Cultivars (C)							
		Giza 21	Giza 22	Giza111	Mean of A	Giza21	Giza 22	Giza111	Mean of A
		2021				2022			
0.0 ppm	un inoculation	3.300	4.300	3.500	3.700	4.267	5.900	5.700	5.289
	inoculation	6.767	4.067	5.300	5.378	5.733	5.200	4.733	5.222
Mean		5.033	4.183	4.400	4.539	5.000	5.550	5.217	5.256
50 ppm	un inoculation	4.967	4.100	4.300	4.456	4.067	5.300	4.733	4.700
	inoculation	2.933	3.633	4.000	3.522	3.500	3.833	4.067	3.800
Mean		3.950	3.863	4.150	3.989	3.783	4.567	4.400	4.250
100 ppm	un inoculation	4.433	5.200	3.767	4.467	2.600	2.400	2.967	2.656
	inoculation	4.433	4.633	3.967	4.344	4.567	4.733	4.967	4.756
Mean		4.433	4.917	3.867	4.406	3.583	3.567	3.967	3.706
Mean of (C)		4.472	4.322	4.139	4.311	4.122	4.561	4.528	4.404
Mean of (B)	b1	4.233	4.533	3.856	4.207	3.644	4.533	4.467	4.215
	b2	4.711	4.111	4.422	4.415	4.600	4.589	4.589	4.593
LSD 5%	A	0.503					1.452		
	B	0.746					0.898		
	C	0.610					0.739		
	AB	1.284					1.821		
	AC	0.534					1.231		
	BC	0.363					0.527		
	ABC	0.512					0.822		

Table 4. Effect of spraying by salicylic acid, bacterial inoculation, cultivars and their interactions on number of fruitful nodes (clusters) per main stem in 2021 and 2022 seasons.

S.A spraying (A)	Inoculation (B)	Cultivars (C)							
		Giza 21	Giza 22	Giza111	Mean of A	Giza21	Giza 22	Giza111	Mean of A
		2021				2022			
0.0 ppm	un inoculation	14.533	17.533	19.333	17.133	15.300	16.867	19.633	17.267
	Inoculation	16.733	17.200	27.500	20.478	24.933	21.700	27.000	24.544
Mean		15.633	17.367	23.417	18.806	20.117	19.283	23.317	20.906
50 ppm	un inoculation	22.833	18.533	21.500	20.956	27.433	23.233	24.233	24.967
	Inoculation	20.833	21.200	24.433	22.156	27.133	35.167	37.400	33.233
Mean		21.833	19.867	22.967	21.556	27.283	29.200	30.817	29.100
100 ppm	un inoculation	19.333	17.567	20.500	19.133	23.767	17.133	21.933	20.944
	Inoculation	22.533	20.533	22.867	21.978	26.633	34.467	32.100	31.067
Mean		20.933	19.050	21.683	20.556	25.200	25.800	27.017	26.006
Mean of (C)		19.467	18.761	22.689	20.306	24.200	24.761	27.050	25.337
Mean of (B)	b1	18.900	17.878	20.444	19.074	22.167	19.078	21.933	21.059
	b2	20.033	19.644	24.933	21.537	26.233	30.444	32.167	29.615
LSD 5%	A	0.876					3.339		
	B	1.268					1.330		
	C	1.385					2.596		
	AB	1.783					3.714		
	AC	0.891					7.852		
	BC	1.226					2.066		
	ABC	2.162					7.855		

Table 5. Effect of spraying by salicylic acid, bacterial inoculation, cultivars and their interactions on number of pods/plants in 2021 and 2022 seasons.

S.A spraying(A)	Inoculation (B)	Cultivars (C)							
		Giza 21	Giza 22	Giza111	Mean of A	Giza 21	Giza 22	Giza111	Mean of A
		2021				2022			
0.0 ppm	un inoculation	46.067	75.400	94.300	71.922	51.667	76.000	92.833	73.500
	Inoculation	85.233	111.400	103.833	100.156	91.100	109.800	107.567	102.822
Mean		65.650	93.400	99.067	86.039	71.383	92.900	100.200	88.161
50 ppm	un inoculation	86.300	98.300	104.067	96.222	83.633	101.233	105.167	96.678
	Inoculation	118.767	125.600	127.100	123.822	120.700	126.167	129.833	125.567
Mean		102.533	111.950	115.583	110.022	102.167	113.700	117.500	111.122
100 ppm	un inoculation	58.700	89.900	98.967	82.522	55.900	89.467	100.233	81.867
	Inoculation	82.833	106.367	94.000	94.400	83.367	107.733	94.667	95.256
Mean		70.767	98.133	96.483	88.461	69.633	98.600	97.450	88.561
Mean of (C)		79.650	101.161	103.711	94.841	81.061	101.733	105.050	95.948
Mean of (B)	b1	63.689	87.867	99.111	83.556	63.733	88.900	99.411	84.015
	b2	95.611	114.456	108.311	106.126	98.389	114.567	110.689	107.881
LSD 5%	A	3.699					2.856		
	B	3.032					1.816		
	C	3.132					2.679		
	AB	5.242					3.620		
	AC	10.117					6.422		
	BC	6.782					3.088		
	ABC	12.122					8.209		

Table 6. Effect of spraying by salicylic acid, bacterial inoculation, cultivars and their interactions on number of seeds/pods in 2021 and 2022 seasons.

S.A spraying(A)	Inoculation (B)	Cultivars (C)							
		Giza 21	Giza 22	Giza111	Mean of A	Giza21	Giza 22	Giza111	Mean of A
		2021				2022			
0.0 ppm	un inoculation	1.398	1.513	1.590	1.500	1.317	1.523	1.600	1.480
	Inoculation	1.583	1.623	1.677	1.628	1.620	1.640	1.690	1.650
Mean		1.490	1.568	1.633	1.564	1.468	1.582	1.645	1.565
50 ppm	un inoculation	1.707	1.680	1.733	1.707	1.713	1.707	1.720	1.713
	Inoculation	1.807	1.843	1.887	1.846	1.807	1.863	1.893	1.854
Mean		1.757	1.762	1.810	1.776	1.760	1.785	1.807	1.784
100 ppm	un inoculation	1.397	1.553	1.623	1.524	1.407	1.560	1.650	1.539
	Inoculation	1.637	1.700	1.730	1.689	1.697	1.727	1.743	1.722
Mean		1.517	1.627	1.677	1.607	1.552	1.643	1.697	1.631
Mean of (C)		1.588	1.652	1.707	1.649	1.593	1.670	1.716	1.660
Mean of (B)	b1	1.500	1.582	1.649	1.577	1.479	1.597	1.657	1.577
	b2	1.676	1.722	1.764	1.721	1.708	1.743	1.776	1.742
LSD 5%	A	0.016					0.013		
	B	0.015					0.012		
	C	0.019					0.014		
	AB	0.025					0.020		
	AC	N. S					N. S		
	BC	N. S					N. S		
	ABC	N. S					N. S		

Table 7. Effect of spraying by salicylic acid, bacterial inoculation, cultivars and their interactions on seed index in grains (100.seed/weight) in 2021 and 2022 seasons.

S.A spraying (A)	Inoculation (B)	Cultivars (C)							
		Giza 21	Giza 22	Giza111	Mean of A	Giza21	Giza 22	Giza111	Mean of A
		2021				2022			
0.0 ppm	un inoculation	15.333	16.100	16.367	15.933	15.433	16.133	16.533	16.033
	Inoculation	16.000	16.400	16.667	16.356	16.533	16.733	16.933	16.733
Mean		15.667	16.250	16.517	16.144	15.983	16.433	16.733	16.383
50 ppm	un inoculation	17.633	18.100	18.233	17.989	17.700	18.200	18.633	18.178
	Inoculation	18.400	18.700	18.833	18.644	18.700	18.867	19.200	18.922
Mean		18.017	18.400	18.533	18.317	18.200	18.533	18.917	18.550
100 ppm	un inoculation	15.767	16.100	16.367	16.078	15.900	16.333	16.667	16.300
	Inoculation	17.267	17.700	17.833	17.600	17.100	17.900	17.633	17.544
Mean		16.517	16.900	17.100	16.839	16.500	17.117	17.150	16.922
Mean of (C)		16.733	17.183	17.383	17.100	16.894	17.361	17.600	17.285
Mean of (B)	b1	16.244	16.767	16.989	16.667	16.344	16.889	17.278	16.837
	b2	17.222	17.600	17.778	17.533	17.444	17.833	17.922	17.733
LSD 5%	A	0.166					0.231		
	B	0.078					0.071		
	C	0.179					0.139		
	AB	0.191					0.246		
	AC	0.024					0.033		
	BC	0.008					0.006		
	ABC	0.034					0.024		

Table 8. Effect of spraying by salicylic acid, bacterial inoculation, cultivars and their interactions on seed yield/plant (g) in grains in 2021 and 2022 seasons.

S.A spraying (A)	Inoculation (B)	Cultivars (C)							
		Giza 21	Giza 22	Giza111	Mean of A	Giza21	Giza 22	Giza111	Mean of A
		2021				2022			
0.0 ppm	un inoculation	15.800	15.833	16.667	16.100	15.333	15.933	16.467	15.911
	Inoculation	18.333	18.833	18.900	18.689	18.333	18.900	19.233	18.822
Mean		17.067	17.333	17.783	17.394	16.833	17.417	17.850	17.367
50 ppm	un inoculation	18.433	18.567	18.900	18.633	17.700	18.967	19.267	18.644
	Inoculation	21.333	22.033	25.333	22.900	22.133	22.233	23.700	22.689
Mean		19.883	20.300	22.117	20.767	19.917	20.600	21.483	20.667
100 ppm	un inoculation	17.400	17.733	18.667	17.933	16.300	16.800	17.800	16.967
	Inoculation	19.567	19.300	20.467	19.778	19.233	19.867	20.267	19.789
Mean		18.483	18.517	19.567	18.856	17.767	18.333	19.033	18.378
Mean of (C)		18.478	18.717	19.822	19.006	18.172	18.783	19.456	18.804
Mean of (B)	b1	17.211	17.378	18.078	17.556	16.444	17.233	17.844	17.174
	b2	19.744	20.056	21.567	20.456	19.900	20.333	21.067	20.433
LSD 5%	A	0.544					0.343		
	B	0.466					0.328		
	C	0.648					0.409		
	AB	0.788					0.528		
	AC	0.275					0.110		
	BC	0.195					0.089		
	ABC	0.466					0.189		

Yield:

The data presented in (Tables 9-12) showed the effect of salicylic acid (SA), inoculation by *Bradyrhizobium japonicum*, cultivars and their interactions on the yield of soybean in 2021 and 2022 seasons.

It is clear that spraying salicylic acid had a significant effect on seed yield/fed., straw yield/fed., harvest index and land use efficiency (LUE).

Salicylic acid sprayed at 50 ppm produced the highest values for the mentioned traits, while 0 ppm (control) gave the lowest one in both seasons. These results confirm the fact that salicylic acid prevailed throughout the growing season result the most vigor growth tallest plants seed and yield/plant, consequently the highest yield of seed and straw, harvest index and land use efficiency (LUE). The present findings are in agreement with Alyemeni (2014).

Resulted showed in (Tables 9-12) cleared that inoculation soybean plants with *Bradyrhizobium japonicum* revealed significant effect on traits of the yield in both seasons. Inoculation has a destructive effect on nodule formation and nitrogen fixation that happened inside active nodule. The nitrogen fixed inside the active nodules has necessary restricted inside plant tissue especially at pods and seed set stage. Add to this inoculation gave the highest values of plant height, branches number/plant, seed yield/plant and seed index, which reflected on yield characters. Similar result obtained by Khan *et al.* (2010) and El-Shafey (2017).

Regarding the effect of cultivars under this study, it is clear that the cultivars have significant effect on characters of yield (Tables 9-12) in both seasons. Giza 111 cultivar gave the highest values and followed by Giza 22, while Giza 21 resulted the lowest values in the two growing seasons. These results may be attributed to different growth habits that are governed by genetically factors in those three soybean varieties produced the highest values of yield components such as seed yield/plant, which reflected on yield traits. Similar results obtained by Abd El-Hafez (2007) and Mohamed (2008).

Table 9. Effect of spraying by salicylic acid, bacterial inoculation, cultivars and their interactions on seed yield (ton/fed) in 2021 and 2022 seasons.

S.A spraying (A)	Inoculation (B)	Cultivars (C)							
		Giza 21	Giza 22	Giza111	Mean of A	Giza21	Giza 22	Giza111	Mean of A
		2021				2022			
0.0 ppm	un inoculation	1.503	1.473	1.557	1.511	1.447	1.427	1.510	1.461
	Inoculation	1.713	1.667	1.733	1.704	1.713	1.730	1.817	1.753
Mean		1.608	1.570	1.645	1.608	1.580	1.578	1.663	1.607
50 ppm	un inoculation	1.647	1.683	1.703	1.678	1.597	1.660	1.687	1.648
	Inoculation	2.107	2.213	2.320	2.213	2.080	2.100	2.253	2.144
Mean		1.877	1.948	2.012	1.946	1.838	1.880	1.970	1.896
100 ppm	un inoculation	1.630	1.650	1.740	1.673	1.587	1.620	1.700	1.636
	Inoculation	1.847	1.843	1.900	1.863	1.837	1.823	1.857	1.839
Mean		1.738	1.747	1.820	1.768	1.712	1.722	1.778	1.737
Mean of (C)		1.741	1.755	1.826	1.774	1.710	1.727	1.804	1.747
Mean of (B)	b1	1.593	1.602	1.667	1.621	1.543	1.569	1.632	1.581
	b2	1.889	1.908	1.984	1.927	1.877	1.884	1.976	1.912
LSD 5%	A	0.037					0.049		
	B	0.049					0.032		
	C	0.037					0.042		
	AB	0.071					0.063		
	AC	0.001					0.002		
	BC	0.002					0.001		
	ABC	0.002					0.002		

Table 10. Effect of spraying by salicylic acid, bacterial inoculation, cultivars and their interactions on strow yield (ton/fed).

S.A spraying (A)	Inoculation (B)	Cultivars (C)							
		Giza 21	Giza 22	Giza111	Mean of A	Giza21	Giza 22	Giza111	Mean of A
		2021				2022			
0.0 ppm	un inoculation	1.547	1.473	1.687	1.569	2.113	2.067	2.367	2.182
	Inoculation	1.647	1.640	1.773	1.687	2.020	1.993	1.940	1.984
Mean		1.597	1.557	1.730	1.628	2.067	2.030	2.153	2.083
50 ppm	un inoculation	1.700	1.653	1.747	1.700	2.040	1.960	2.020	2.007
	Inoculation	2.007	2.087	2.207	2.100	1.807	1.960	1.833	1.867
Mean		1.853	1.870	1.977	1.900	1.923	1.960	1.927	1.937
100 ppm	un inoculation	1.553	1.423	1.747	1.574	2.107	2.300	2.333	2.247
	Inoculation	1.780	1.693	2.020	1.831	2.133	2.253	2.020	2.136
Mean		1.667	1.558	1.883	1.703	2.120	2.277	2.177	2.191
Mean of (C)		1.706	1.662	1.863	1.744	2.037	2.089	2.086	2.070
Mean of (B)	b1	1.600	1.517	1.727	1.614	2.087	2.109	2.240	2.145
	b2	1.811	1.807	2.000	1.873	1.987	2.069	1.931	1.996
LSD 5%	A	0.047					0.080		
	B	0.036					0.048		
	C	0.061					0.095		
	AB	0.065					0.099		
	AC	0.002					0.006		
	BC	0.001					0.003		
	ABC	0.004					0.010		

Table 11. Effect of spraying by salicylic acid, bacterial inoculation, cultivars and their interactions on harvest index.

S.A spraying (A)	Inoculation (B)	Cultivars (C)							
		Giza 21	Giza 22	Giza111	Mean of A	Giza21	Giza 22	Giza111	Mean of A
		2021				2022			
0.0 ppm	un inoculation	49.303	50.000	47.989	49.097	40.675	40.985	38.943	40.201
	Inoculation	51.015	50.412	49.457	50.294	45.887	46.457	48.355	46.900
Mean		50.159	50.206	48.723	49.696	43.281	43.721	43.649	43.550
50 ppm	un inoculation	49.197	50.450	49.383	49.677	43.907	45.863	45.520	45.097
	Inoculation	51.225	51.501	51.247	51.324	53.512	51.707	55.163	53.460
Mean		50.211	50.976	50.315	50.500	48.710	48.785	50.341	49.279
100 ppm	un inoculation	51.209	53.750	49.893	51.618	42.965	41.324	42.166	42.152
	Inoculation	50.924	52.125	48.466	50.505	46.265	44.826	47.985	46.358
Mean		51.067	52.938	49.179	51.061	44.615	43.075	45.076	44.255
Mean of (C)		50.479	51.373	49.406	50.419	45.535	45.194	46.355	45.695
Mean of (B)	b1	49.903	51.400	49.088	50.131	42.516	42.724	42.210	42.483
	b2	51.054	51.346	49.723	50.708	48.555	47.663	50.501	48.906
LSD 5%	A	1.062					0.931		
	B	0.944					0.659		
	C	0.880					1.393		
	AB	1.570					1.232		
	AC	0.824					0.961		
	BC	0.621					0.543		
	ABC	0.984					2.011		

Table 12. Effect of spraying by salicylic acid, bacterial inoculation, cultivars and their interactions on land use efficiency.

S.A spraying (A)	Inoculation (B)	Cultivars (C)							
		Giza 21	Giza 22	Giza111	Mean of A	Giza21	Giza 22	Giza111	Mean of A
		2021				2022			
0.0 ppm	un inoculation	12.396	12.242	12.898	12.512	12.121	12.199	12.723	12.348
	Inoculation	14.238	13.814	14.365	14.139	14.440	14.459	15.309	14.736
Mean		13.317	13.028	13.631	13.326	13.281	13.329	14.016	13.542
50 ppm	un inoculation	13.686	14.185	14.435	14.102	13.492	14.148	14.294	13.978
	Inoculation	17.604	18.702	19.385	18.564	17.726	17.900	19.205	18.277
Mean		15.645	16.444	16.910	16.333	15.609	16.024	16.749	16.128
100 ppm	un inoculation	13.704	13.943	14.502	14.050	13.561	13.805	14.490	13.952
	Inoculation	15.566	15.624	16.148	15.779	15.608	15.407	15.823	15.613
Mean		14.635	14.784	15.325	14.915	14.585	14.606	15.156	14.782
Mean of (C)		14.533	14.752	15.289	14.858	14.491	14.653	15.307	14.817
Mean of (B)	b1	13.262	13.457	13.945	13.555	13.058	13.384	13.836	13.426
	b2	15.803	16.047	16.633	16.161	15.925	15.922	16.779	16.209
LSD 5%	A	0.313					0.455		
	B	0.381					0.275		
	C	0.308					0.353		
	AB	0.561					0.566		
	AC	0.080					0.145		
	BC	0.094					0.064		
	ABC	0.122					0.151		

Seed chemical contents:

Salicylic acid spraying had a significant effect on seed chemical contents of soybean seeds i.e. seed oil percentage, seed oil yield /fed., seed protein percentage and seed protein yield/fed. in both seasons. (Table 13-16).

Results presented show that the highest values of the mentioned traits recorded from salicylic acid sprayed at 50 ppm, while salicylic acid at 0 ppm concentration gave the lowest one in both seasons. These results might be attributed to the better effect of salicylic acid at 50 ppm during growth period, which in turn on produced more metabolites accumulated in plants including fats and protein. This trend is in consistence with that reported by Uppalige and Nagabovanalli (2018). Seed chemical content was significantly affected by bacterial inoculation in both seasons (Table 13-16). Inoculation treatment by *Bradyrhizobium japonicum* attained to highest physiological balance inside plant tissues and led to the highest seed extraction and attaining the highest oil and protein percentage in soybean seed as a consequence. These results are in harmony with those recovered by Abd El-Kader (2015) and Omari *et al.,* (2022). The results in (Tables 13-16) indicated a significant effect by studied varieties on seed oil, seed protein, yield of seed oil and seed protein in both seasons. This may be due to the previous results of seed yield/fed. and the seed content of oil and protein percentage, which recorded by this treatment. These findings are in agreement with recorded by Abd El-Kader (2015) and Zohri (2024).

Concerning the interaction between the three studied factors, it is obviously that all interactions were have significant effect on all studied characters, expect on number of seeds/pod in both seasons. In general, plants of soybean Giza 111 cultivar with salicylic acid sprayed at 50 ppm under the addition bacterial inoculation produced the greatest values of studied characters in both seasons.

Table 13. Effect of spraying by salicylic acid, bacterial inoculation, cultivars and their interactions on seed oil percentage in 2021 and 2022 seasons.

S.A spraying (A)	Inoculation (B)	Cultivars (C)							
		Giza 21	Giza 22	Giza111	Mean of A	Giza21	Giza 22	Giza111	Mean of A
		2021				2022			
0.0 ppm	un inoculation	19.553	17.540	19.390	18.828	18.090	19.220	19.177	18.829
	Inoculation	20.147	17.957	20.450	19.518	19.247	19.453	20.050	19.583
Mean		19.850	17.748	19.920	19.173	18.668	19.337	19.613	19.206
50 ppm	un inoculation	18.247	19.307	20.110	19.221	19.393	19.747	19.847	19.662
	Inoculation	19.800	19.867	20.363	20.010	20.650	20.797	21.177	20.874
Mean		19.023	19.587	20.237	19.616	20.022	20.272	20.512	20.268
100 ppm	un inoculation	20.240	20.087	19.623	19.983	19.463	19.467	19.810	19.580
	Inoculation	20.230	18.560	18.620	19.137	20.627	20.657	19.690	20.324
Mean		20.235	19.323	19.122	19.560	20.045	20.062	19.750	19.952
Mean of (C)		19.703	18.886	19.759	19.449	19.578	19.890	19.958	19.809
Mean of (B)	b1	19.347	18.978	19.708	19.344	18.982	19.478	19.611	19.357
	b2	20.059	18.794	19.811	19.555	20.174	20.302	20.306	20.261
LSD 5%	A	0.339					0.784		
	B	0.512					0.475		
	C	0.521					0.417		
	AB	0.713					0.976		
	AC	0.130					0.364		
	BC	0.192					0.152		
	ABC	0.311					0.254		

Table 14. Effect of spraying by salicylic acid, bacterial inoculation, cultivars and their interactions on oil yield per feddan(kg) in 2021 and 2022 seasons.

S.A spraying (A)	inoculation (B)	Cultivars (C)							
		Giza 21	Giza 22	Giza111	Mean of A	Giza 21	Giza 22	Giza111	Mean of A
		2021				2022			
0.0 ppm	un inoculation	293.521	259.308	302.183	285.004	262.240	274.271	289.583	275.365
	Inoculation	345.114	299.662	354.388	333.055	329.632	336.553	364.026	343.403
Mean		319.317	279.485	328.286	309.029	295.936	305.142	326.805	309.384
50 ppm	un inoculation	300.440	324.920	342.590	322.650	309.823	327.694	334.750	324.089
	Inoculation	416.750	439.858	472.374	442.994	429.404	436.490	477.173	447.689
Mean		358.595	382.389	407.482	382.822	369.613	382.092	405.961	385.889
100 ppm	un inoculation	329.824	331.807	341.227	334.286	308.478	315.424	336.715	320.206
	Inoculation	373.700	341.918	353.903	356.506	379.093	376.609	36.588	373.846
Mean		351.762	336.862	347.563	345.396	343.785	346.016	351.277	347.026
Mean of (C)		343.225	332.912	361.110	345.749	336.445	344.507	361.347	347.433
Mean of (B)	b1	307.928	305.345	328.667	313.980	293..514	305.796	320.349	306.553
	b2	378.521	360.479	393.554	377.518	379.376	383.217	402.346	388.313
LSD 5%	A	94.48					11.12		
	B	16.31					11.08		
	C	12.49					11.66		
	AB	22.10					17.55		
	AC	89.72					10.49		
	BC	16.84					91.62		
	ABC	19.75					16.13		

Table 15. Effect of spraying by salicylic acid, bacterial inoculation, cultivars and their interactions on seed crude protein percentage in 2021 and 2022 seasons.

S.A spraying (A)	Inoculation (B)	Cultivars (C)							
		Giza 21	Giza 22	Giza111	Mean of A	Giza21	Giza 22	Giza111	Mean of A
		2021				2022			
0.0 ppm	un inoculation	30.667	29.000	28.667	29.444	31.333	29.333	30.333	30.333
	Inoculation	31.000	31.667	31.000	31.222	29.333	30.333	32.667	30.778
Mean		30.833	30.333	29.833	30.333	30.333	29.833	31.500	30.556
50 ppm	un inoculation	31.000	31.333	31.333	31.222	30.667	30.333	31.000	30.667
	Inoculation	32.667	32.667	33.667	33.000	32.667	32.667	34.000	33.111
Mean		31.833	32.000	32.500	32.111	31.667	31.500	32.500	31.889
100 ppm	un inoculation	29.000	30.000	30.333	29.778	30.000	30.000	30.667	30.222
	Inoculation	32.000	31.667	33.000	32.222	31.333	31.667	31.667	31.556
Mean		30.500	30.833	31.667	31.000	30.667	30.833	31.167	30.889
Mean of (C)		31.057	31.056	31.333	31.148	30.889	30.722	31.722	31.111
Mean of (B)	b1	30.222	30.111	30.111	30.148	30.667	29.889	30.667	30.407
	b2	31.889	32.000	32.556	32.148	31.111	31.556	32.778	31.815
LSD 5%	A	1.053					0.804		
	B	0.703					0.712		
	C	0.823					0.950		
	AB	1.360					1.186		
	AC	0.783					0.596		
	BC	0.394					0.441		
	ABC	0.833					1.008		

Table 16. Effect of spraying by salicylic acid, bacterial inoculation, cultivars and their interactions on protein yield per feddan (kg) in 2021 and 2022 seasons.

S.A spraying (A)	Inoculation (B)	Cultivars (C)							
		Giza 21	Giza 22	Giza111	Mean of A	Giza 21	Giza 22	Giza111	Mean of A
		2021				2022			
0.0 ppm	un inoculation	460.766	427.333	446.066	444.722	453.533	418.666	459.100	443.766
	Inoculation	530.966	527.133	537.133	531.744	502.133	524.500	592.933	539.855
Mean		499.586	477.233	491.600	488.233	477.833	471.583	526.016	491.811
50 ppm	un inoculation	510.200	527.733	533.733	523.888	489.133	503.633	522.966	505.244
	Inoculation	688.200	722.266	780.400	730.288	679.466	686.333	766.333	710.711
Mean		599.200	625.000	657.066	627.088	584.300	594.983	644.650	607.977
100 ppm	un inoculation	472.433	495.200	527.500	498.377	476.000	486.433	521.300	494.577
	Inoculation	591.033	583.833	627.166	600.677	574.800	577.333	588.633	580.255
Mean		531.733	539.511	577.333	549.527	525.400	531.883	554.966	537.416
Mean of (C)		542.266	547.250	575.334	554.950	529.177	532.816	575.211	545.735
Mean of (B)	b1	481.133	483.422	502.433	488.996	472.888	469.577	501.122	481.196
	b2	603.409	611.077	648.233	620.903	585.466	596.055	649.300	610.274
LSD 5%	A	15.46					28.48		
	B	15.09					16.37		
	C	16.06					20.13		
	AB	24.09					34.83		
	AC	20.13					54.42		
	BC	17.09					22.10		
	ABC	30.56					50.96		

In the other hand Giza 21 or Giza 22 with salicylic acid sprayed at 0 ppm (control) under the un-inoculation gave the lowest values in both seasons. The results of the interaction revealed the superiority of Giza111 with salicylic acid at 50 ppm under the bacterial inoculation that make available better conditions to plants at the critical growth stage and affirm the importance of adding bacterial inoculation that surly enhance biological growth to both plants and nodules and hence attaining the highest values of studied characters.

REFERENCES

A.O. A. C. (1995). Official methods of analysis (16th ed.). Washington, DC, USA; Association of Official Analytical Chemists, Washington.

Abd El-Hafez, G.A. and Abo El-Soud, A. (2007). Response of two soybean cultivars to different levels organic fertilizer (Compost). Journal of Agricultural Chemistry and Biotechnology, 32, 8575-8588.

Abd El-Kader, A.A.M. (2015). Response of some soybean cultivars to inoculation with *Bradyrhizobium Japonicum a*nd nitrogen fertilization. M.Sc. Thesis, Agron. Egypt. Minia J. of Agric. Res. & Develop. 35(2): 195-205.

Ali, E. and Mahmoud, A. (2013). Effect of Foliar Spray by Different Salicylic Acid and Zinc Concentrations on Seed Yield and Yield Components of Mung bean in Sandy Soil. Asian Journal of Crop Science, 5, 33-40.

Alyemeni, M., Hayat, Q., Wijaya, L. and Hayat, S. (2014). Effect of Salicylic Acid on the Growth, Photosynthetic Efficiency and Enzyme Activities of Leguminous Plant under Cadmium Stress. Notulae Botanicae Horti Agrobotanici Cluj-Napoca, 42.

Badran, M.M. (2003). Effect of nitrogenous and prophetic fertilization on some economical characters of soybean Crawford cultivar under calcareous soil conditions. Egyptian Journal of Agricultural Research, 81(2): 433-440.

Calvin, R.I., Damanik L. and Siregar, A.M. (2019). Growth and production of soybean (*Glycine max* L. Merrill) varieties in response to waterlogging at vegetative (V5) growth phase by application of gibberellic acid and salicylic acid. IOP Conf. Ser.: Earth Environ. Sci. 260 012143.

Eisa, M.S., Abd El-Maksoud, H. H. and Al-Assily, Kh. A. (2002). Growth and yield of some soybean varieties as affected by imposing to dated irrigation. Arab Univ. J of Agric. Sci., Ain Shams Univ., Cairo, 10(2): 659-639.

El-Shafey, A. (2017). Response of soybean to water stress conditions and foliar application with salicylic and ascorbic acids. Zagazig Journal of Agricultural Research, 44, 1-22.

Estaji,A and Niknam,F. (2020). Foliar salicylic acid spraying effect' on growth, seed oil content, and physiology of drought-stressed S*ilybum marianum* L. plant, Agricultural Water Management, 234, (C).

Hegazi, A. M., and El-Shraiy, A. M. (2007). Impact of Salicylic Acid and Paclobutrazol Exogenous Application on the Growth, Yield and Nodule Formation of Common Bean. *Australian Journal* of Basic and Applied Sciences, 1(4): 834-840, ISSN 1991-8178.

Khan, Nafees., Shabina, Syeed., Masood, Asim., Nazar, Rahat., Iqbal, Noushina. (2010): Application of Salicylic Acid Increases Contents of Nutrients and Antioxidative Metabolism in Mungbean and Alleviates Adverse Effects of Salinity Stress. International Journal of Plant Biology. 1. 10.4081/pb.2010.e1.

Mohamed, F. G. (2008). Response of some new soybean varieties to sowing date, inoculation and nitrogen fertilization. Ph.D. Thesis, Agron. Dept., Fac. Agric., Minia Univ., Egypt.

Omari, R., Yuan, K., Anh, T., Reckling, M., Halwani, M., Egamberdieva, D., . . . Kimura, S. (2022). Enhanced Soybean Productivity by Inoculation with Indigenous Bradyrhizobium Strains in Agroecological Conditions of Northeast Germany. Frontiers in Plant Science, 12, 14.

Shiri, M. and Raey, Y.., Ghassemi-Golezani, K. and Aliasgharzad, N. (2012). Influence of *Bradyrhizobium japonicum* and phosphate solubilising bacteria on soybean yield at different levels of nitrogen and phosphorus. Int J Agron Plant Prod 3:544-549. International journal of Agronomy and Plant Production. 3. 544-549.

Snedecor and Cochran (1981). Statistical Methods Seventh Ed. Iowa State Univ. press, Ames, Iowa, USA.

Uppalige, S., and Nagabovanalli, P. (2018). Effect of Foliar Application of Silicic Acid on Soybean Yield and Seed Quality under Field Conditions. Journal of the Indian Society of Soil Science, 66, 406.

Zohri, M.O. (2024). Evaluation of growth, yield and its attributes of some soybean cultivars as affected by irrigation intervals and planting methods. M.Sc. Thesis, Agron. Dept., Fac. Agric., Minia Univ., Egypt.

تاثير الرش بحمض الساليسيليك والتلقيح البكتيري علي النمو والمحصول ومكوناته لبعض أصناف فول الصويا تحت ظروف محافظة المنيا

ايمان محمد طه[1]، شكري عبدالسلام مقدم[1] ، جمال عبدالعزيز عبدالحافظ[2] و هاجر مبارك محمد عبدالنعيم[2]

[1]قسم المحاصيل – كلية الزراعة – جامعة المنيا

[2]معهد البحوث الزراعية – الجيزة - مصر

الملخص

أجريت الدراسة بالمزرعة البحثية لمحطة البحوث الزراعية بملوي ، المنيا، مصر خلال موسمي2021، 2022، صممت التجربة فى تصميم القطع المنشقة مرتين فى ثلاث مكررات حيث استخدم تركيزين من الرش بحمض الساليسيليك 50 ،100 جزء في المليون مقارنة مع الكنترول، التلقيح البكتيري مع *Bradyrhizobium japonicum* مقارنة مع الكنترول مع استخدام ثلاثة أصناف من فول الصويا (جيزة 21 ، جيزة 22 ، جيزة 111). أدى الرش بحمض الساليسيليك بتركيز 50 جزء في المليون الي الحصول علي اعلي القيم لجميع الصفات تحت الدراسة (طول النبات - عدد الافرع بالنبات – ارتفاع اول قرن – عدد العناقيد الثمرية علي الساق الرئيسي – عدد القرون علي النبات – عدد البذور للقرن – دليل البذور – محصول بذور النبات - محصول البذور للفدان – محصول القش للفدان – دليل الحصاد – كفاءة استخدام الأرض - النسبة المئوية للزيت في البذور – النسبة المئوية للبروتين في البذور – محصول الزيت للفدان – محصول البروتين للفدان) ، بينما اقل القيم تم الحصول عليها من المعاملة الكنترول فى كلا الموسمين. ادت المعاملة بالتلقيح البكتيري الي الحصول علي اعلي القيم للصفات السابق ذكرها في موسمي الزراعة. تفوق الصنف جيزة 111 يليه الصنف جيزة 22 في تحقيق اعلي القيم للصفات تحت الدراسة في موسمي التجربة. أوضحت النتائج معنوية التاثير بين جميع التفاعلات بين العوامل تحت الدراسة علي جميع الصفات فيما عدا صفة عدد البذور للقرن وذلك في موسمي التجربة. اعطي الرش بحمض الساليسيليك بتركيز 50 جزء في المليون علي نباتات صنف جيزة 111 مع التلقيح البكتيري اعلي القيم للصفات تحت الدراسة بينما اعطي الصنف جيزة 21 بدون تلقيح بكتيري ورش بحمض الساليسيليك اقل القيم في موسمي التجربة تحت ظروف محافظة المنيا.

الكلمات الداله : فول الصويا، الساليسيليك، التلقيح البكتيرى، الأصناف، المحصول، الجودة