

## ARTICLE / INVESTIGACIÓN

# Role of Salicylic acid in stay green, growth and yield of two purposes maize hybrid

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**Abstract:** An experiment was conducted at Al- Hamidhia Research Fields, Faculty of Agriculture / Al- Anbar University in North Ramadi city to study the levels of salicylic acid 0, 200 and 400 mg. L<sup>-1</sup> and fifteen genotypes (5 inbred lines + 10 hybrids) of maize. A randomized complete block design was used in a slit table arrangement; thus, the main treatments are for salicylic spray, and the secondary tables are for genotypes (inbred lines and hybrids). Three replications were made to produce two-purpose hybrids (grain and forage yield) by introducing some inbred lines and maize hybrids grown by the semi-co-breeding program. Results have shown the dominance of hybrid BK104× Zm6 giving the highest product of leaves staying green that reached 222.1g and 8.9 leaves, successively in the spring season. In comparison, the hybrid Inb-27× BK104 has dominated in the fall season, giving yield and leaves stay green as 247.01g and 9.45 leaves successively. The reason for these hybrids dominance returned to their dominance with grains numbered a row, grain weight and dominance of salicylic acid concentration 400 mg.L<sup>-1</sup> for both seasons, giving the highest yield as 179.10 and 177.33g and didn't differ significantly from salicylic acid concentration 200 mg.L<sup>-1</sup>. The interaction treatments were significant for all the traits, except the trait of 300 grains weight for the spring season. So, we recommend using 200 mg.L<sup>-1</sup> concentration of salicylic acid and the dominant hybrids in yield for both seasons.

**Key words:** AS, Inbred lines, Diallel crops, plant growth regulator, grains yield, grain weight.

## Introduction

Maize (*Zea mays* L.) is considered the life vein for many human communities, and the grain yield increase is the goal of plant breeders in general, especially for maize breeders. The quality and quantity of plant production generally, and farm crops specifically depend on their genetic material nature and growth environment, as well as the value of their interaction that could be managed through the growth factors management to suit the farmer's goal. Despite the global increase of maize that reached about 1670 million tons annually in 2020, the need for more production is still necessary because of the increased uses of maize with the tremendous increase in population<sup>1</sup>.

In Iraq, the total area cultured with this crop for 2020 is about 13.95 thousand hectares, with an average productivity of 4.5 tons.hect<sup>-1</sup>. The reason for low productivity compared to global productivity is maybe the farmer's carefree to culture highly productive genotypes seeds, especially the dominant single hybrids that adapt to local environmental conditions due to the high expense of imported hybrids seeds, the absence of modern techniques and weakness of soil and crop maintenance services because of the limited support of agricultural section. Hybridization and selection are the essential bases of maize improvement and generate a broad genetic framework that helps breeders to exploit genetic storage in different breeding programs. In addition to genetic prospecting techniques and variable parameters for their study to increase their production efficiency per unit area and improve their specific traits<sup>2-4</sup>.

Salicylic is a phenolic compound and an important plant hormone that regulates ion absorption, hormonal balance, division rate, flower induction, stomata motion and photosynthesis<sup>5</sup>. It has important physiologic roles in enhancing plant growth and increasing the efficiency of photosynthesis and flowering<sup>6</sup>. It improves plant tolerance via activating the un-enzymatic antioxidants as superoxide demonize, catalase and prior oxidase enzymes<sup>7</sup>. The external salicylic effect on plants depends on many factors like the used dosage, plant type where the regulator is used, plant growth stage and salicylic way of addition, and of the reasons that cause productivity decrease in not fulling the grains that urge using salicylic, which the main feature is delaying leaves aging and increases photosynthesis activity; thus, it prolongs the grains fulling period that reflects on increasing grains yield<sup>8</sup>, also delaying plant aging could happen by ethylene prohibition, increasing enzymes activity, increased division of meristematic root cells and keeping chloroplasts safe of degradation because of free roots; thus, it activates the production of the antioxidants for their effect on cells free roots<sup>9</sup>.

Salicylic acid alone is insufficient to raise crop productivity unless it is gathered with an efficient genetic enhancer.

The study aims to produce dual-purpose hybrids (grain and fodder yield) by introducing a group of maize inbred lines and hybrids resulting from half diallel cross program.

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## Materials and methods

Experiments were done in the farms of Al- Hamidhiya Research Station of the College of Agriculture / Al- Anbar University to the north of Ramadi City, which lies on latitude 33° 27' 10.8" N to the north and longitude 43° 23' .2.4" E to the east with collected mixed texture in two seasons: spring and fall 2021. All the culturing operations like spading, softening and leveling were done. The soil was then fertilized with dap in an average of 300 kg.hec<sup>-1</sup>. On soil preparation, urea fertilizer was added with 46% nitrogen at a rate 300 kg.hec<sup>-1</sup> on two loads: the first when plant height reached 30cm and the second before the inflorescences germinated. In all seasons, weed control was made after culturing and before germination with brobonite herbicide<sup>11</sup>. all the crop service operations were made, like irrigation, grassing, spading and weed control.

In the spring and fall seasons of 2021, an experiment was done among the individual hybrids in the company of parental inbred lines; so, the number of genotypes included in the control experiment is ten derived hybrids + 5 parental inbred lines = 15 genotypes and three salicylic level (0, 200, 400) mg.L<sup>-1</sup> using the randomized complete block design in slit boards arrangement; so, the primary treatment is for salicylic spray and secondary boards for genotypes (inbred lines and hybrids) in three replications.

### Salicylic Acid Preparation

A standard solution of salicylic acid (SA) weighing 1000 mg was prepared to a concentration of 1000 mg l<sup>-1</sup> then resolved in several ethyl alcohol drops, and later the size was completed with distilled water to prepare 200 mg.L<sup>-1</sup>. After that, two groups of concentrations (200 and 400) mg.L<sup>-1</sup> are prepared and sprayed on the shoot system 30 days after culture, and the second spray is two weeks after the first. So, the first spray was made in the early morning for complete wetting, while the control plants were sprayed with distilled water only.

### Studied Traits

- Days of Silks emergence (day):

Counted for the period from planting to silks emergence in 50% of plants per experiment unit.

- Leaf Area (cm<sup>2</sup>): counted from the square length of the leaf that lies under the central tip leaf crossed with constant (0.75)

- Row Grains Number. It was determined by counting the rows in the primary ear at the harvest stage on a sample of five plants taken from the middle of each experimental unit.

- Stay Green by counting the number of green leaves at maturity above the upper ear.

- 300 Grains weight (gm): 300 grains were counted, then the final weight was corrected based on the ideal water content

- Plant Grain Yield (g): by the average weight of five plants' yield.

### Statistical Analysis

Statistical analysis was made for each trait using the randomized complete block design (RCBD) according to slit boards arrangement; the comparison was made between the average genotypes using the least significant difference (LSD) at a likelihood level 5%.

## Results

### Days from culture to 50% Ear Flowering

Statistical analysis results in a table (2) showed significant differences among the average concentrations of salicylic acid and genotypes (parents and their co-hybrids) for both seasons and the cooperative interaction of both study factors of 50% ear flowering trait for both spring and fall seasons. The plants of two inbred lines 3 and 4 lasted the shortest duration of ear flowering at 62.00 and 62.09 days, successively, while parent 5 lasted the most prolonged period of ear flowering at 63.78 days for the spring season. In return to the fall season, inbred line 1 and 2 required the shortest number of days to reach the stage of 50% ear flowering, 59.37 and 59.42 days, successively, while the inbred line 3 plants needed the longest time to get this stage as 61.31 days. This would indicate that hybrids have tended to early flowering compared to their parents; so, the co-crossing 1X3 of the spring season has lasted the least duration of ear flowering as 59.10 days, which has differed significantly with seven hybrids and the longest days number to reach flowering has been made by hybrid 4X3 as 62.77 days. During the fall season, the cooperative hybrid 3X2 lasted the shortest duration of ear flowering at 55.42 days and didn't differ significantly from the two cooperative hybrids. Also, the hybrid 5X1 lasted 58.35 days, indicating the general tendency of hybrids for early ear flowering. These results agreed with (12,13) when they referred to significant differences among genotypes in the trait of days number from culture to 50% ear flowering. The same table results also refer to the dominance of plants cultured with 400 salicylic in ear flowering to give a shorter number of days as 61.11 and 56.95 days for spring and fall seasons, successively, which, in turn, differed significantly from 200 mg.L<sup>-1</sup> concentration for both seasons successively as 62.26 and 58.26 with the difference in trait mean values for spraying concentrations 400 mg.L<sup>-1</sup> of salicylic acid for both seasons to give the lowest flowering duration in days number. The decrease of days number from culture to 50% ear flowering with spray concentrations 400 mg.L<sup>-1</sup> salicylic acid and the early appearance of ear node is attributed to its role in increasing the Auxin content that acts vitally to increase photosynthetic products and so the plant nutrients to gain excessive sac-

Seq.	Inbred line Name	Source
1.	<b>BK 116</b>	Locally derived 106 research
2.	<b>Zm 6</b>	Locally derived
3.	<b>ABS 6</b>	Locally derived
4.	<b>BK 104</b>	Locally derived 106 research
5.	<b>Inb-27</b>	Locally derived

**Table 1.** Pure inbred lines of maize, brought by the supervisor doctor, have been used and input in a semi-diallel-crosse program according to the second model of (10).

Genotypes	Spring Season				Fall Season			
	Salicylic Concentrations mg.L <sup>-1</sup>				Salicylic Concentrations mg.L <sup>-1</sup>			
	0	200	400	Average	0	200	400	Average
1	64.77	64.66	61.66	63.70	60.11	59.68	58.47	59.42
2	64.66	63.66	62.66	63.66	60.57	60.20	57.33	59.37
3	62.33	63.35	60.33	62.00	63.27	62.33	58.33	61.31
4	63.47	62.66	60.14	62.09	62.09	60.53	59.16	60.60
5	64.00	64.70	62.66	63.78	60.80	60.15	60.20	60.38
2×1	61.21	59.82	58.33	59.79	58.37	57.25	55.98	57.20
3×1	60.92	58.73	57.66	59.10	57.29	56.25	56.07	56.53
4×1	61.33	62.33	61.11	61.59	57.46	55.15	55.13	55.91
5×1	62.66	62.66	61.33	62.22	58.33	59.01	57.70	58.35
3×2	60.81	59.84	60.66	60.44	57.33	55.10	53.84	55.42
4×2	62.21	62.69	60.66	61.85	58.47	57.97	56.51	57.65
5×2	63.61	63.00	61.66	62.75	57.23	57.67	56.49	57.13
4×3	62.33	63.57	62.40	62.77	58.78	58.18	56.30	57.75
5×3	61.00	60.33	62.66	61.33	57.98	57.55	56.80	57.44
5×4	61.66	61.85	62.66	62.06	57.96	56.90	56.00	56.95
Average	62.46	62.26	61.11		59.07	58.26	56.95	
LSD 5%	salicylic	0.94			1.50			
	Genotypes	1.02			1.27			
	Interaction	1.84			2.41			

**Table 2.** Effect of Salicylic Concentrations, their Hybrids and Interaction on Average ear Flowering (Day) for Spring and Fall Seasons 2021.

charides ready to support shoot system growth and cause late flowering, this result agrees with what's found by (14), who suggested that the plants sprayed with salicylic acid would early reach ear flowering. The interaction between spray treatments with salicylic and genotypes concentration has a significant effect; the same table shows the dominance of 2X1 hybrid plant cultured in 400 salicylic concentration with an average rate of 58.33 in the spring season with no difference from two cooperative hybrids. Still, in the fall season, the hybrid 4X1 plants cultured with 400 mg.L<sup>-1</sup> salicylic have last the least ear flowering time at 55.13 days and didn't differ significantly from the five cooperative hybrids.

#### Leaf Area (cm<sup>2</sup>)

The statistical analysis results of table (3) showed significant differences among the level concentrations of salicylic acid and genotypes (parents and their cooperative hybrids) for both seasons and the co-interference of both study factors in leaf area traits for seasons spring and fall. Inbred line 2 plants have given the highest average value of this trait as 4967cm<sup>2</sup>, which has not differed significantly from parents 3 and 4, while parent 1 made the lowest trait average value of 4467cm<sup>2</sup> for the spring season. While in the fall season, inbred line 3 produced the highest middle leaf area at 5724cm<sup>2</sup> with no significant difference from inbred line 2. The least value has been made by inbred line 5 plants as 4722cm<sup>2</sup>; the hybrids resulting from co-crossing had a tremendously considerable effect, so they exceeded parents in this trait, and the cooperative hybrid 4X1 achieved the highest average value as 5966 and 6425cm<sup>2</sup>, successively for both culture seasons. The reason behind that

is the nature of genes each genetic enhancer carries that reflect their difference in average leaf width and height and leaves number in addition to the length of vegetable growth duration. These results have come similar to what's obtained by Abdulhamed. *et al.*, 2021, when indicated significant differences among genotypes in the traits of leaf area and carbon assimilation maintenance during the growth time. From the same table, it is noticed the dominance of plants cultured with 400 mg.L<sup>-1</sup> salicylic for leaf area cm<sup>2</sup> gave the highest average value as 5480 and 5513cm<sup>2</sup> day for spring and fall seasons successively, with no significant difference from 200 mg.L<sup>-1</sup> for both seasons. Perhaps the reason for the leaf area cm<sup>2</sup> increase in spray concentrations 400 mg.L<sup>-1</sup> salicylic acid is its role in increasing Auxin content, which plays an essential role in increasing photosynthesis products and thus increases the plant nutrients to gain excessive saccharides ready to support the shoot system growth, leading to late flowering. This result meets the one obtained by (15,16), who referred to an increase in each of CO<sub>2</sub> assimilation and photosynthesis, and this photosynthesis support would increase cellular juice production in middle lamella that saves suitable water content in the leaf, leading to better growth configured with increased leaf area. In return to salicylic and genotypes spray interaction, it's noticed in the same table that in the spring season, the hybrid 5X3 cultured in 400 mg.L<sup>-1</sup> dominated to reach 6562cm<sup>2</sup>, so it didn't differ significantly from some cooperative hybrid, while in the fall season, the plants of hybrid 4X1 cultured in 400 mg.L<sup>-1</sup> salicylic has made the highest value as 6639cm<sup>2</sup> and didn't differ significantly with 3 cooperative hybrids. This result agreed with what was obtained by (17) when they

Genotypes	Spring Season				Fall Season			
	Salicylic Concentrations mg.L <sup>-1</sup>				Salicylic Concentrations mg.L <sup>-1</sup>			
	0	200	400	Average	0	200	400	Average
1	4341	4577	4482	4467	4637	4942	5086	4888
2	5282	5312	4307	4967	5167	5661	5760	5529
3	5490	4748	4186	4808	5485	5701	5985	5724
4	5198	4464	4638	4767	5340	4945	4968	5084
5	4310	4712	4853	4625	4585	5200	4382	4722
2×1	5314	5243	5764	5441	5003	5354	5779	5379
3×1	5291	5503	5729	5508	5333	5767	5707	5602
4×1	5797	5963	6139	5966	6352	6285	6639	6425
5×1	5301	5628	5838	5589	6240	5634	5580	5818
3×2	5315	5605	5694	5538	6084	6128	5713	5975
4×2	5529	5607	5761	5633	5439	5659	5179	5426
5×2	5273	5514	5994	5594	5216	5020	5485	5240
4×3	5591	5828	6318	5913	5097	5290	5561	5316
5×3	5426	5732	6562	5907	4996	5467	5518	5327
5×4	4926	5673	5937	5512	5558	4919	5361	5279
Average	5226	5341	5480		5369	5465	5513	
LSD 5%	salicylic	172.5			85.6			
	Genotypes	209.2			263.5			
	Interaction	371.4			445.0			

**Table 3.** Effect of Salicylic Concentrations, their Hybrids and Interaction on Average Leaf Area (cm<sup>2</sup>) for Spring and Fall Seasons 2021.

used salicylic acid at concentrations 0 and 200ppm leaf spray on maize in two stages the first after two weeks and the second after three weeks of germination, to obtain dominated leaf area.

### Stay Green

The statistical analysis results of table (4) referred to the presence of significant differences among the average concentrations of salicylic acid and genotypes (parents and their cooperative hybrids) for both seasons and the co-interference of both study factors for the trait of leave stay significant duration for spring and fall seasons. The plants of inbred lines 1 and 2 have the highest average value of the attribute at 7.36, which didn't differ significantly from the three inbred lines. In contrast, parent one has given the lowest duration of this trait as 6.35 for the spring season. While in the fall season, inbred line 5 achieved the highest value of 7.4, while inbred line 1 plants gave the lowest duration of 6.31, while the hybrids resulted from co-crossing for the spring season, the cooperative combination 4X2 provided the highest rate of 8.90 and didn't differ significantly from hybrid 3X2. The cooperative hybrid 5X3 gives the least duration, 6.96. but in the fall season, the hybrid 5X4 made 9.45 and didn't differ significantly from 4 cooperative hybrids. Had obtained similar results when they referred to significant differences in genotypes for the trait of leaves staying green. It's noticed from the same table results the dominance of plants cultured in 400 salicylic concentration in this trait, giving the highest value as 8.28 and 8.22 for

spring and fall seasons successively, and it differed significantly with concentrations of 0 and 200 mg.L<sup>-1</sup> for both seasons. The table shows the difference of average trait values for spray concentrations 400 mg.L<sup>-1</sup> salicylic for two seasons, giving the most extended duration of leaves staying green. This trait probably increased due to spray concentrations of 400 mg.L<sup>-1</sup> salicylic. This result agrees with (18,19), who suggested that the plants sprayed with salicylic acid.

While for the interaction among the spray treatments of salicylic and genotypes for the spring season, the same table stated the dominance of hybrid 4X2 with a value of 8.90 that differed significantly with five hybrids this season. While for the fall season, the plants of hybrid 5X4, cultured in 400 mg.L<sup>-1</sup> salicylic, have made the highest trait interference as 10.13, which differed significantly from the other hybrids in this season.

### Grains Number a R

Results of statistical analysis in the table (5) refer to significant differences among the concentrations of salicylic and genotypes (parents and their cooperative parents and their cooperative hybrids) and the co-interference of both study factors for the trait of grains number a row in two seasons. Genotypes have significantly differentiated among themselves, so inbred line 1 has the highest average value of 26.49, which differed considerably from the other inbred lines. In contrast, inbred line 3 has the most negligible average value of 24.71 for the spring season. While in the fall season, inbred line 2 has the highest average value of

Genotypes	Spring Season				Fall Season			
	Salicylic Concentrations mg.L <sup>-1</sup>				Salicylic Concentrations mg.L <sup>-1</sup>			
	0	200	400	Average	0	200	400	Average
1	5.73	6.33	6.98	6.35	6.00	6.20	6.73	6.31
2	7.09	7.26	7.73	7.36	5.73	6.53	6.93	6.40
3	6.40	7.24	7.46	7.03	5.50	6.67	6.86	6.34
4	6.40	7.07	8.53	7.33	6.26	6.52	6.91	6.56
5	6.39	7.20	7.60	7.06	6.40	7.50	8.33	7.41
2×1	7.26	8.20	9.20	8.22	7.66	8.93	9.13	8.57
3×1	7.31	7.66	9.06	8.01	8.10	7.26	8.26	7.87
4×1	7.66	8.00	8.46	8.04	6.80	7.73	8.44	7.65
5×1	8.20	8.60	8.62	8.47	7.66	7.90	8.40	7.99
3×2	8.10	8.60	8.78	8.49	7.73	7.90	8.62	8.08
4×2	8.26	9.01	9.44	8.90	8.80	9.40	9.71	9.30
5×2	7.46	8.13	8.26	7.95	8.00	8.50	8.90	8.46
4×3	6.56	7.20	7.82	7.19	5.40	7.10	7.83	6.77
5×3	6.30	7.00	7.58	6.96	6.10	7.76	8.17	7.34
5×4	8.01	8.23	8.72	8.32	8.60	9.64	10.13	9.45
Average	7.14	6.33	8.28		6.98	7.70	8.22	
LSD 5%	salicylic	0.22			1.19			
	Genotypes	0.46			1.47			
	Interaction	0.79			4.08			

**Table 4.** Effect of Salicylic Concentrations, their Hybrids and Interaction on Average Leaves Stay Green for Spring and Fall Seasons 2021.

27.97, with no significant difference from inbred line 1, whereas the most negligible average value was made by inbred line 5 at 24.17. In return, hybrids produced by inbred lines could exceed the hybrid 4X2 giving the highest average value of this trait as 40.37 in the spring season.

In contrast, the hybrid 5X2 gave the most negligible value of grains number a row as 35.10, which differed significantly from the other cooperative hybrids. While in the fall season, the co-hybrid 2X1 gave the highest trait value of 37.82 and the least average value was given by hybrid 3X1 (29.48), the reason for this difference in row grains number could be the presence of differences in oval number that later transformed to grains to reflect this on inheritance and increase of grains number, compared to its generation of dominant hybrids, and these results have agreed with both of (20) who referred to significant differences among genotypes in row grains number. It's noticed from the same table results, the considerable effect of salicylic addition in different concentrations on row grains number, figured by the salicylic increase in two seasons above; so, the plants cultured in concentration 400 mg.L<sup>-1</sup> salicylic have dominated in this trait, giving the highest average value as 33.60 and 32.15 for spring and fall seasons successively with no significant difference from spraying concentrations 200 mg.L<sup>-1</sup> for the fall season only, compared with the control treatment that gave 32.64 and 30.69 for spring and fall seasons, successively, when he used salicylic acid in different concentrations. The leaf plant spraying a plant leads to early plant flowering and increases the average plant flower number that reflects, in turn, on the number of the grain produced later.

### 300 Grains weight (g)

Statistical analysis results in table (6) showed significant differences among the concentrations of salicylic acid and genotypes (parents and their co-hybrids) for spring and fall seasons and the co-interference of both study factors for 300 grains weight in the spring season. The plants of the inbred line (4) have made the highest value of 300 grains weight trait as 78.82g and didn't differ significantly from the other inbred lines, while inbred line 1 made the lowest value of 76.46g for the spring season. While in the fall season, inbred line 5 produced the highest average value, 85.53g, which differed significantly from other parental inbred lines. The most negligible average value was made by inbred line 2 plants at 72.15g. The cooperative hybrid 4X2 in the spring season made the highest average value at 97.89g, which didn't differ significantly from some combinations. The most negligible average value was created by hybrid 5X3 as 74.97g. while in the fall season, the co-hybrid 4X2 made the highest value of this trait at 99.99g with no significant difference from some co-hybrid, hybrid 3X1 has produced the lowest average value of this value at 81.94g, indicating that hybrids have exceeded their parents in this trait. Grain weight is one of the most critical crop components where the degree of grain fulfilling, bulk and specific density. The reason for hybrids' dominance in this trait is maybe the early flowering and plant leaf area. This result agrees with Sharif *et al.*, 2020 who stated that the genetic nature affects this trait. The results of the same table also refer to the dominance of plants cultured in 400 mg.L<sup>-1</sup> concentration salicylic in this trait; so, it gave the highest average value as 84.26g. for the spring season and didn't

Genotypes	Spring Season				Fall Season			
	Salicylic Concentrations mg.L <sup>-1</sup>				Salicylic Concentrations mg.L <sup>-1</sup>			
	0	200	400	Average	0	200	400	Average
1	26.15	26.86	27.80	26.94	27.73	25.73	25.66	26.37
2	25.40	25.53	25.93	25.62	26.53	28.46	28.93	27.97
3	24.20	25.06	24.86	24.71	24.00	25.33	26.06	25.13
4	23.20	23.73	23.46	23.46	23.33	23.86	23.68	23.62
5	24.53	24.60	25.60	24.91	23.13	24.73	24.64	24.17
2×1	33.00	37.93	38.40	36.44	37.33	37.73	38.40	37.82
3×1	36.77	35.26	36.23	36.08	28.26	29.73	30.46	29.48
4×1	38.66	37.40	37.96	38.00	29.00	31.13	33.20	31.11
5×1	37.50	37.53	39.06	38.03	33.20	34.13	35.20	34.17
3×2	38.00	38.30	39.00	38.43	30.40	33.20	32.86	32.15
4×2	40.10	40.50	40.50	40.37	37.26	37.16	36.53	36.98
5×2	35.00	35.00	35.30	35.10	36.53	38.13	35.73	36.80
4×3	36.60	36.80	36.56	36.65	32.66	33.20	34.33	33.40
5×3	35.00	36.46	36.62	36.03	35.46	36.73	37.00	36.40
5×4	35.46	36.00	36.77	36.07	35.60	37.90	39.60	37.70
Average	32.64	33.13	33.60		30.69	31.81	32.15	
LSD 5%	salicylic	0.43			1.10			
	Genotypes	1.03			0.93			
	Interaction	1.75			1.77			

**Table 5.** Effect of Salicylic Concentrations, their Hybrids and Interaction on Average Grains Number a Row for spring and fall Seasons 2021.

differ significantly from 200 mg.L<sup>-1</sup> concentration, while the most negligible value was made by 0 mg.L<sup>-1</sup> as 42.34g. also, the average trait values have varied for interaction between genotypes and salicylic acid spray levels for the spring season; so, the plants of hybrid 4X2 cultured gave 97.93g with no significant difference from 6 co-hybrids. While in the fall season, there weren't significant differences between genotypes and salicylic acid spray levels. The increase in this trait is, perhaps, because the leaf support of maize with salicylic acid has improved most of the vegetative growth indicators and thus reflected in grains' weight. This result has agreed with each of (21).

The reason is that spraying salicylic acid concentration of 150 mg.L<sup>-1</sup> has supported the increase of products of photosynthesis in vegetative growth traits of maize sugary yields, certainly the leaf area increase; so, crop salicylic acid spraying operation has decreased high temperatures and abortion during inoculation and fertilization to increase the weight and number of grains in the tip.

These results agree with the results, and the cause is that salicylic acid concentration 150 mg.L<sup>-1</sup> has dominated in plant height and leaf area, the evidence is significantly 500 grains.

#### Plant Yield (g)

Grain yield is considered the final result of growth and

evolution processes connected complicatedly with its essential components (tip grains number and grain weight), which are affected by genetic and environmental factors and their interaction. The statistical analysis results in table (7) refer to significant differences among the average values of salicylic acid and genotypes (parents and their co-hybrids) and the co-interference of study two factors for individual plant yield traits for both seasons. Table (7) states the variance of genotypes significantly among themselves; so, inbred line (3) gave the highest average value of 128.2g with no significant difference from stain 2, while inbred line 1 gave the most negligible average value (111.4g) for the spring season. For the fall season, inbred line 5 gave the highest average value of 126.95g, and parent bequeathed their variance to their co-hybrids; so, in the spring season, the co-hybrid 2X4 dominated, giving the highest average value of plant grains yield trait as 222.1g with no significant difference with co-hybrids 2X3 and 1X5. In the fall season, the co-hybrid 4X5 made the highest value of trait as 247.01g. the reason for these hybrids' dominance and abundant yield is the crop components' dominance. These differences among inbred lines and their hybrids reflect the genetic differences and their dominance in one or more crop components (grains number, row grains number and 300 grains weight). (22-24) had obtained close results when they referred to significant differences among genotypes in

Genotypes	Spring season				Fall season			
	Salicylic Concentrations mg.L <sup>-1</sup>				Salicylic Concentrations mg.L <sup>-1</sup>			
	0	200	400	Average	0	200	400	Average
1	76.00	75.93	77.53	76.49	75.00	75.15	75.67	75.27
2	75.60	75.60	79.67	76.96	69.74	72.88	73.83	72.15
3	76.63	80.60	78.27	78.50	69.83	73.41	73.67	72.30
4	80.20	77.67	78.60	78.82	80.17	81.83	83.67	81.89
5	78.91	76.87	79.54	78.44	83.50	86.75	86.33	85.53
2×1	78.40	78.48	79.84	78.91	96.38	94.37	98.33	96.36
3×1	87.64	88.40	88.60	88.21	79.83	83.00	83.00	81.94
4×1	86.53	93.82	88.70	89.68	88.33	92.58	90.50	90.47
5×1	95.04	96.74	95.87	95.88	93.83	90.33	88.67	90.94
3×2	81.44	81.71	87.69	83.61	79.83	82.01	84.00	81.95
4×2	96.97	97.93	98.76	97.89	98.87	100.10	101.00	99.99
5×2	81.30	90.07	90.31	87.23	85.42	86.33	90.50	87.42
4×3	79.10	80.24	79.93	79.76	88.42	88.50	90.67	89.19
5×3	79.70	72.44	72.77	74.97	90.33	92.83	96.00	93.06
5×4	81.60	85.20	87.76	84.85	97.75	98.52	100.45	98.91
Average	82.34	83.45	84.26		85.15	86.57	87.75	
<b>LSD 5%</b>	salicylic	1.29			2.02			
	Genotypes	2.74			2.66			
	Interaction	4.68			NS			

**Table 6.** Effect of Salicylic Concentrations, their Hybrids and Interaction on Average (300) Grains Weight (g) for Spring and Fall Seasons 2021.

individual plant yield. It's noticed from the same table results in the considerable effect of adding salicylic in different concentrations on individual plant yield, figured with the increase of average grains yield with increased salicylic concentrations in both study seasons; so, the plants cultured with 400 mg.L<sup>-1</sup> salicylic have dominated with individual plant yield, giving average yield as 179.10 and 177.13g for the two seasons, spring and fall, successively, and they didn't differ significantly with spray concentrations 220 mg.L<sup>-1</sup>, compared with the control treatment that reached 164.69 and 169.26g for spring and fall seasons, successively. This yield increase could be attributed to the positive effect of salicylic growth regulator to raise photosynthesis efficiency, plant growth enhancement, dry matter accumulation increase, and thus increasing grains production rate and salicylic impact to increase grains number through transporting synthetic products from source to sink. These results have come supporting to what's found by (8), who suggested that maize grains yield would increase by salicylic acid spray.

Genotypes have significantly responded to salicylic

spray, so the co-hybrid 2X4 has exploited salicylic spray concentrations through a yield of 222.1g at spray treatment 400 mg.L<sup>-1</sup> salicylic, with no significant difference from 11 co-hybrids in the spring season. In contrast, for the fall season, co-hybrid 4X5 exploited spraying at a concentration of 400 mg.L<sup>-1</sup> salicylic with high efficiency, when it made the highest value of co-interference with a yield of 254.67g. these results have met the results of past studies done by (25).

This was because of many factors like plant capacity to store assimilating materials because of salicylic acid that provides assimilating products during the fulfilling grain time, increased readiness of nutrients for the plant, their absorption and then increasing vegetative growth and metabolic processes and photosynthetic products and then increasing the yield that reflected positively on grains yield increase.

Due to the application of salicylic acid treatments that supported catalase and peroxidase content and phenols accumulation and photosynthesis efficiency and reduced hydrogen peroxide content in plants with salicylic acid increased concentration (26) to increase grains weight.

Genotypes	Spring season				Fall season			
	Salicylic Concentrations mg.L <sup>-1</sup>				Salicylic Concentrations mg.L <sup>-1</sup>			
	0	200	400	Average	0	200	400	Average
1	109.7	103.5	120.9	111.4	108.33	110.67	113.97	110.99
2	114.3	119.1	122.3	118.6	122.62	126.72	131.50	126.95
3	126.3	128.0	130.3	128.2	100.00	103.16	108.71	103.96
4	107.4	112.7	115.5	111.9	94.67	100.55	102.41	99.21
5	101.3	109.6	111.6	107.5	110.68	113.67	115.93	113.43
2×1	177.8	190.5	197.1	188.5	218.91	221.00	231.36	223.76
3×1	198.8	200.9	207.4	202.4	173.33	178.70	184.52	178.85
4×1	186.8	198.7	203.0	196.2	165.33	172.67	176.92	171.64
5×1	204.8	209.7	214.9	209.8	197.67	206.97	215.18	206.61
3×2	209.6	212.2	215.7	212.5	180.67	186.67	195.49	187.61
4×2	218.2	219.3	228.7	222.1	223.67	231.37	236.33	230.46
5×2	191.1	204.1	221.8	205.7	214.69	224.67	160.83	200.06
4×3	151.4	172.9	208.1	177.5	180.33	192.00	204.47	192.27
5×3	168.6	170.1	176.3	171.7	207.33	218.50	224.61	216.82
5×4	203.6	208.4	213.3	208.4	240.67	245.70	254.67	247.01
Average	164.60	170.60	179.10		169.26	175.53	177.13	
LSD 5%	salicylic	10.31			5.43			
	Genotypes	12.77			6.34			
	Interaction	22.62			11.32			

**Table 7.** Effect of Salicylic Concentrations, their Hybrids and Interaction on Average Individual Plant Yield (g) for Spring and Fall Seasons 2021.

## Conclusions

We can conclude from previously mentioned information that parent ABS6 for the spring season and parent 6Zm for the fall season is the best parent because of the high number of row grains number and plant grains yield, and they could be invested to produce various hybrids and classes. The crossing (BK104× Zm6) for the spring season and crossing (Inb-27× BK104) for the fall season is the best crossings for giving a high plant grains yield (222.1 and 247.01 g.plant<sup>-1</sup>), and a number for leaves stay green (8.9 and 9.45 leaves) for spring and fall seasons, successively. In the time that concentration 200 mg.L<sup>-1</sup> was featured, giving the highest yield for both seasons, and the hybrids featured with high yield and duration of leaves stay green could be invested to produce another hybrid or double purpose structural class that could be used for grains and making fodder plant.

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