



Effect Of Salicylic Acid And Benzyl Adenine On Growth Performance Of Three Cold Turf Grass Mixtures

Yousif Ali Abdulrahman¹

Hailan Mohammed Ahmed¹

¹ Department of Horticulture, College of Agricultural Engineering Sciences, University of Dohuk.

*Corresponding Author: yousif.abdulrahman@uod.ac

Received: 07/07/2025

Revised: 19/08/2025

Accepted: 17/09/2025

Published: 02/12/2025

ABSTRACT

The study was conducted in the nursery of the Horticulture Department, College of Agricultural Engineering Sciences, Duhok University, Iraq, during the period from 01 September 2024 to 01 June 2025 for the fall season to investigate the response of three cold turf grass seeds mixtures included (1, 2 and 3) to two concentrations of Salicylic acid (0 and 10 mg L⁻¹) was spray every month after germination of seeds and different concentrations of benzyl adenine (0, 100 and 200 mg l⁻¹) was spray two times. The experiment was performed by using Factorial Experiment Randomized Complete Block design with three factors and three replications. The results explained that the spray turf grass mixture with 10 mg L⁻¹ of salicylic acid had a significant effect on plant density (210.19 plants 100 cm⁻²), mowing number (2.67), cumulative dry weight of vegetative growth (25.20 g) and percentage of carbohydrates in clipping yield (0.88%). The foliar sprayed of turf grasses mixture with benzyl adenine (BA) at 200 mg L⁻¹ significantly superior than control and 100 mg L⁻¹ in total carbohydrates in clipping yield (0.89%), whereas results at concentration of 100 mg L⁻¹ of BA caused significant increase in plant density (208.39 plants 100 cm⁻²) as comparison with other concentration. As for turf grass mixtures noticed that mixture 1 was significantly superior to two other mixtures in the pant density (218.78 plant 100 cm⁻², leaf area (2.64 cm²), cumulative dry weight of vegetative growth (24.92 g) and root depth (21.03 cm), while mixture 3 was significantly superior to other mixture in total carbohydrates in clipping yield (0.91).

Keywords: Cold season grass, Seeds mixture, Salicylic acid, benzyl adenine.

Copyright © 2025. This is an open-access article distributed under the Creative Commons Attribution License.

INTRODUCTION

The cultivation of a seeds mixture of different species or cultivars instead one species and these mixes often give satisfactory results as the cultivation of one species cannot continue throughout the year in giving the desired color, and the choice of species for use in blends. The selection of species for use in blends is dependent on a variety of factors, including tolerance to environmental conditions such as light or shade, high or low temperatures, excessive irrigation or drought, etc., or selection based on the nature of the species growth, such as the formation of rhizomes or stems stalking or growth in the form of bundles upright growth or creeping, or selection based on the life cycle [1 and 2]. [3] mentioned that when it is intended to stabilize turf grasses using seed mixtures, it is preferable to use a mixture consisting of *Poa pratensis* L. seeds at a rate of 85% (based on weight) with *Lolium perenne* L. and at a rate of 15%, especially when desired obtaining quick coverage of the place to be planted with turf grass.

Salicylic acid is considered a non-enzymatic growth regulator that plays an important role in increasing plant resistance to various conditions and activating some important antioxidant enzymes [4]. Salicylic acid (SA) is due to a wide range of plant phenols obtained from many plant sources and the starting compound for salicylic acid for its production inside plants is cinnamonic acid [5 and 6] and it is one of the plant hormones because of its physiological roles in the growth of plants and the absorption of ions where it affects the movement of stomata and the production of ethylene [7 and 8]. It also works to accelerate the formation of chlorophyll and carotene pigments, accelerate photosynthesis and increase the activity of some important enzymes [9]. Salicylic acid has received the attention of scientists and researchers due to its link with the defense systems inside the plant against the stresses to which the plant is exposed, particularly under conditions of salt stress, by reducing the production of oxidative systems and reducing the damage caused by these free oxygen radicals [10].

Benzyl adenine (BA) which belongs to the cytokinin group, and is one of the most widely used and common cytokinin

compounds because of its high bioactivity, persistence and long term storage potential [11]. Benzyl adenine has recently been used as one of other sources that can maintain or increase the quality of various ornamental plants [12]. Applications of benzyl adenine have been shown to have effects on many other physiological and developmental processes. Benzyl adenine can improve propagule yield of ornamental grasses propagated by divisions. Benzyl adenine (BA) promoted branching of many dicotyledonous species [13, 14, 15, 16 and 17] and hosta (*Hosta spp.*), a monocotyledonous species [18], and BA applications increased tillering in turf grasses [19 and 20].

The research aimed to investigate the response of three cold turf grasses seeds mixtures performance growth to different concentrations of salicylic acid and benzyl adenine.

Materials and Methods

This study was carried out for the period from 01 September 2024 to 01 June 2025 for the fall season in Horticulture Department nursery/College of Agriculture Engineering Sciences. The experiment was conducted to study the response of three cold turf grass seeds mixtures included mixtures as shown in (Table 1) to two concentrations of Salicylic acid (0 and 10 mg L⁻¹) was spray every month after germination of seeds and different concentrations of benzyl adenine (0, 100 and 200 mg l⁻¹) was spray two times intervals (first spray in fall season 15/10/2024 and second spray in spring season 15/4/2025). The experiment was performed by using Factorial Experiment Randomized Complete Block design with three factors; each treatment was replicated three times. The data has been analyzed by using computer through the SAS program, and means comparison was done by Duncan's Multiple Ranges Test under 5% which was claimed by [20]. The seeds were sown in plastic pots with dimensions 1 × 1 m and depth 40 cm were filled with loam media with addition 1 liter of peat moss and 1 liter of perlite as experimental unit. The soil were sterilized with Kriptanol-SL fungicide with concentration of 2 ml L⁻¹ at a rate 8 ml m⁻² avoid to infection the soil with fungal diseases [21], then the seed mixtures were sown by hand in the pots at the rates shown in (Table 2) and has practical coverage with thin layer of soil and then the soil of pots pressed by hand.

The study parameters are plant density (number of plants 100 cm⁻²), color degree, which measured monthly by using card colors and given a measure degrees of color from (1-9): 1- yellow 3 – green yellowing 5- light green 7- normal green 9- dark green, cumulative dry weight of vegetative growth (g) according to following equation: cumulative dry weight = dry weight of the first mowing product (1) + dry weight of the second product (2) + ...x of dry weight of mowing clipping, roots depth (cm), cumulative dry weight of roots (g) and total carbohydrates (% in dry matter of clippings).

Table (1). Mixtures of seeds

Mixtures	Mixtures No.	Genera	Cultivars	Seeds ratio
Water saver	1	<i>Lolium perenne</i>	Barlancia	10%
		<i>Festuca arundinacea</i>	Barnoble	44%
		<i>Festuca arundinacea</i>	Baronesse	36%
		<i>Poa pratensis</i>	Baranello	10%
		<i>Lolium perenne</i>	Barlancia	25%
RPR	2	<i>Lolium perenne</i>	Barolando	25%
		<i>Lolium perenne</i>	Barlibro	35%
		<i>Lolium perenne</i>	Barprrium	15%

Resilient blue	3	<i>Poa pratensis</i>	Barimpala	15%
		<i>Poa pratensis</i>	Barserati	15%
		<i>Lolium perenne</i>	Amiata	10%
		<i>Lolium perenne</i>	Barprrium	15%
		<i>Festuca rubra comutata</i>	Staybo	15%
		<i>Festuca rubra rubra</i>	Barchip	15%
		<i>Festuca trachyphyla</i>	Hardtop	15%

Table (2). Germination percent (%), germination rate (days), number of seeds per gram and seeding rate (g.m⁻²) of used seed mixtures.

Mixtures	Germination percent (%)	Germination rate (days)	Number of seeds per gram	Seeding rate (g m ⁻²)
1	80	17	287	40
2	88	6	564	30
3	84	14	797	35

Results and Discussions

1. Plant density (plant 100 cm⁻²)

The results in Table (3) clarified that salicylic acid (SA) had a significant effect on the plant density of turf grass mixtures, the spray turf grass with 10 mg L⁻¹ gave significantly higher plants density in experimental units reached (210.19) plants 100 cm⁻² while the least significant density 190.82 plants 100 cm⁻² was for control treatment (0 mg L⁻¹). Although there was a significant difference between plants sprayed with 100, 200 mg L⁻¹, and unsprayed with benzyl adenine (BA), the highest density of plants 208.39 plants 100 cm⁻² were obtained from those sprayed with 100 mg L⁻¹, while the least value (190.90) plants 100 cm⁻² was those sprayed with 200 mg L⁻¹. Also, significant were shown among the Turf grass mixture in this trait, where the mixture 1 gave the highest values. (218.78) plants 100 cm² followed by mixture 2 (213.67) plants 100 cm⁻² was significantly superior to the 3 mixture 169.06 plants 100 cm². Generally, the triple interaction among SA, BA and turf grass mixtures had a significant effect on the plant density and the highest value 265.67 plants 100 cm² was for mixture 2 that were sprayed with 10 mgL⁻¹ of SA without BA and the least value (153.67) plant 100 cm² was for mixture 3 sprayed with 10 mgL⁻¹ of SA and 200 mgL⁻¹ of BA.

Table (3). Effect of Salicylic acid and Benzyl adenine concentrations on the plant density (plant/100 cm²) of three turf grasses seeds mixture.

Salicylic acid (mg L ⁻¹)	Benzyl adenine (mg L ¹)	Turf grass seeds mixtures			Salicylic acid mean	Benzyl adenine mean
		1	2	3		
0	0	222.33 c	158.33 gh	169.33 fg	190.82 b	202.22 b
	100	187.33 de	227.67 c	172.00 fg		
	200	198.33 d	194.67 d	187.33 de		
10	0	220.00 c	265.67 a	177.67 ef	210.19 a	208.39 a
	100	261.33 ab	247.67 b	154.33 h		
	200	223.33 c	188.00 de	153.67 h		
Turf grass mixtures mean		218.78 a	213.67 a	169.06 b		

Means with same letter for each factor and interactions are not significantly different at 5% level based on Duncan Multiple Range Test.

2. Leaf area (cm²)

The data in Table (4) indicated that there were no significant differences obtained among values of leaf area in different uses of SA and BA concentrations. On the other hand, there were significant differences among different turf grass mixtures in leaf area and the higher leaf area (2.64 and 2.59 cm²) were for 1 and 2 mixtures respectively, while least area 1.41 cm² was for mixture 2. The interaction among SA, BA concentrations and turf grass mixtures had a significant effect on leaf area, the highest leaf area (3.60 cm²) was obtained when spraying mixture 1 with 100 mg L⁻¹ of BA without SA.

Table (4). Effect of Salicylic acid and Benzyl adenine concentrations on the leaf area (cm²) of three turf grasses seeds mixture.

Salicylic acid (mg L ⁻¹)	Benzyl adenine (mg L ⁻¹)	Turf grass seeds mixtures			Salicylic acid mean	Benzyl adenine mean
		1	2	3		
0	0	2.60 b	1.57 c	2.61 b	2.30 a	
	100	3.60 a	1.53 c	2.41 b		
	200	2.25 b	1.38 c	2.70 b		
10	0	2.59 b	1.11 c	2.85 b	2.13 a	2.22 a
	100	2.47 b	1.34 c	2.47 b		2.30 a
	200	2.33 b	1.52 c	2.51 b		2.11 a
Turf grass mixtures mean		2.64 a	1.41 b	2.59 a		

3. Mowing numbers

The results in Table (5) showed that the SA had appeared a significant effect in the number of mowing for turf grass mixtures, the largest number of mowing (2.67) was recorded for turf grass sprayed with 10 mg L⁻¹ of SA as compared with unsprayed turf grass (2.37), but both of BA and turf grass mixtures had not appear any significant effect on the number of mowing. The triple interactions among the factors indicated that unsprayed mixture 2 plants with SA and BA, and sprayed same mixture with 10 mg L⁻¹ of SA and 200 mg L⁻¹ of BA gave the highest number of mowing (3.00) which significantly outperformed the other interactions, while the lowest number of mowing (2.00) was recorded for the mixture 1 plants sprayed with 200 mg L⁻¹ of BA without spray with SA.

Table (5). Effect of Salicylic acid and Benzyl adenine concentrations on the mowing numbers of three turf grasses seeds mixture.

Salicylic acid (mg L ⁻¹)	Benzyl adenine (mg L ⁻¹)	Turf grass seeds mixtures			Salicylic acid mean	Benzyl adenine mean
		1	2	3		
0	0	2.00 b	3.00 a	2.00 b	2.37 b	
	100	2.33 ab	2.67 ab	2.33 ab		
	200	2.00 b	2.33 ab	2.67 ab		
10	0	2.67 ab	2.67 ab	2.67 ab	2.67 a	2.50 a
	100	2.67 ab	2.67 ab	2.67 ab		2.56 a
	200	2.67 ab	3.00 a	2.33 ab		2.50 a
Turf grass mixtures mean		2.39 a	2.72 a	2.44 a		

4. Cumulative dry weight of clipping yield (g)

The results shown in Table (6) that the SA had a significant effect on the cumulative dry weight of turf grass vegetative growth. The spraying of turf grass mixtures with 10 mg L⁻¹ of SA gave significantly high cumulative dry weight of vegetative growth (25.20 g) in comparison with control treatment (22.65 g). Although the cumulative dry weight of vegetative growth was increased with the increasing of BA but the differences between these values were not significant. A significant variation in cumulative dry weight of vegetative growth was noticed among the different turf grass mixtures, the highest weight (24.98 g) was for mixture 1 whereas the lowest values were for rest mixtures. As for the triple interaction among the studied factors in this experiment, it was significant; the high cumulative dry weight (27.63 g) was obtained from mixture 1 treated with 200 mg L⁻¹ of BA without spray of SA.

Table (6). Effect of Salicylic acid and Benzyl adenine concentrations on the cumulative dry weight of clipping yield (g) of three turf grasses seeds mixture.

Salicylic acid (mg L ⁻¹)	Benzyl adenine (mg L ¹)	Turf grass seeds mixtures			Salicylic acid mean	Benzyl adenine mean
		1	2	3		
0	0	26.82 ab	22.92 d-f	24.66 a-e	22.65 b	
	100	26.13 a-c	25.51 a-d	23.50 c-f		
	200	27.63 a	26.87 ab	22.71 d-f		
10	0	22.73 d-f	21.00 f	21.93 ef	25.20 a	23.35 a
	100	23.74 c-f	24.48 b-e	22.78 d-f		24.36 a
	200	22.45 d-f	21.97 ef	22.79 d-f		24.07 a
Turf grass mixtures mean		24.92 a	23.79 b	23.06 b		

5. Roots depth (cm)

The results in Table (7) clarified that alone of SA and BA had not significant effect on the root depth of turf grass mixtures A significant variation in roots depth was also noticed among different turf grass mixtures and the highest depth (21.03 cm) was recorded in mixture 1 which was superior significantly to other mixtures. As for the interactions effect among the three studied factors in this experiment, it was significant, the high roots depth (22.07 cm) obtained from sprayed mixture 1 with 200 mg L⁻¹ of BA without SA while the least depths (18.80 cm) was for non-sprayed of mixture 3 with SA and treated with same concentration of BA.

Table (7). Effect of Salicylic acid and Benzyl adenine concentrations on the roots depth (cm) of three turf grasses seeds mixture.

Salicylic acid (mg L ⁻¹)	Benzyl adenine (mg L ¹)	Turf grass seeds mixtures			Salicylic acid mean	Benzyl adenine mean
		1	2	3		
0	0	21.00 a-c	19.10 cd	19.53 b-d	20.39 a	
	100	20.87 a-d	20.73 a-d	21.40 ab		
	200	22.07 a	20.00 a-d	18.80 d		
10	0	20.53 a-d	19.90 a-d	20.23 a-d	20.45 a	20.05 a
	100	21.60 ab	19.90 a-d	20.47 a-d		20.83 a
	200	20.13 a-d	20.73 a-d	20.57 a-d		20.38 a
Turf grass mixtures mean		21.03 a	20.06 b	20.17 b		

6. Roots dry weight (g 100 cm⁻²)

The results in Table (8) clarified that salicylic acid (SA), benzyl adenine (BA) and different turf grass mixtures had not any significant effect on the dry weight of turf grass mixtures roots. Generally, the triple interaction among SA, BA and turf grass mixtures had a significant effect on dry weight of turf grass mixtures roots and the highest value (9.99 g) was for mixture 2 that were sprayed with 10 mg L⁻¹ of SA and 200 mg L⁻¹ of BA and the least value (6.41 g) was for mixture 1 sprayed with the same concentration of SA and BA.

Table (8). Effect of Salicylic acid and Benzyl adenine concentrations on the roots dry weight (g 100 cm⁻²) of three turf grasses seeds mixture.

Salicylic acid (mg L ⁻¹)	Benzyl adenine (mg L ¹)	Turf grass seeds mixtures			Salicylic acid mean	Benzyl adenine mean
		1	2	3		
0	0	7.31 cd	6.78 cd	7.07 cd	7.42 a	
	100	7.66 b-d	6.67 cd	7.16 cd		
	200	6.62 cd	8.63 b	6.70 cd		
10	0	8.58 b	6.65 cd	7.07 cd	7.18 a	7.24 a
	100	6.80 cd	6.44 d	7.89 bc		7.10 a
	200	6.41 d	9.99 a	6.94 cd		7.55 a
Turf grass mixtures mean		7.23 a	7.53 a	7.14 a		

7. Total carbohydrates in leaves (%)

It can be seen from Table (9) that SA had significant effect on the total carbohydrates percentage of different turf grass mixture, the spray turf grass mixture with 10 mg L⁻¹ of SA gave significantly higher percentage (0.88%) than control treatment (0.82%). By increasing BA concentrations led to a significant increase in the total carbohydrates percentage in turf grass mixture reached to 0.89%, 0.86% and 0.81 for 200, 100 and 0 mg L⁻¹ of BA respectively. Also significant differences appeared among turf grass mixture in its content of carbohydrates; the highest value (0.91%) was for resilient blue mixture while the least value 0.82 and 0.83% were for mixture 2 and 3 respectively. On other hand, the results of interaction among factors studied in this experiment indicated a significantly higher percentage of total carbohydrates (1.31%) were found in unsprayed mixture 3 with SA and BA, while these values decreased to (0.52%) in same mixture sprayed with 10 mg L⁻¹ of SA without BA.

Table (9). Effect of Salicylic acid and Benzyl adenine concentrations on the total carbohydrates in leaves (%) of three turf grasses seeds mixture.

Salicylic acid (mg L ⁻¹)	Benzyl adenine (mg L ⁻¹)	Turf grass seeds mixtures			Salicylic acid mean	Benzyl adenine mean
		1	2	3		
0	0	0.96 cd	1.31 a	0.83 ef	0.82 b	
	100	0.81 f	0.66 hi	0.71gh		
	200	0.59 ij	0.75 fg	0.80 f		
10	0	0.75 fg	0.52 j	0.80 f	0.88 a	0.81 b
	100	0.89 de	0.62 i	1.19 b		0.86 a
	200	0.98 c	1.03 c	1.16 b		0.89 a
Turf grass mixtures mean		0.83 b	0.82 b	0.91 a		

It can be shown in Tables (3, 5, 6, and 9) during the study that the spray turf grass mixture with 10 mg L⁻¹ of salicylic acid had a significant effect on plant density, mowing number, cumulative dry weight of vegetative growth and percentage of carbohydrates in clipping yield, these results agree with [23] indicated that the SA significantly increased photosynthesis and growth in wheat and mung bean, also agree with what was presented by [24] were conducted study in order to investigate the morphological and physiological responses of vetiver grass (*Chrysopogon zizanioides* L. Roberty), to salicylic acid application at concentrations (0, 1 and 2 mili Molar) Salicylic acid applied 2 mili Molar through foliar spray weekly had a better result and plants in this treatment had higher shoot dry weight and proline. Also, the results are similar to those reported by [25] show that 0.5 mM SA enhanced dry weight of root, shoot and nodule in chickpea. These results may be attributed to the role of salicylic acid, which is important in improving physiological processes and thus increasing the plant ability to absorb water and nutrients, which in turn improves plant growth. Or the results may be show the positive role of salicylic acid in increasing vegetative growth characteristics in line with the increase in concentrations. This may be due to the role played by salicylic acid in cell division and elongation due to the interaction between auxin and phenol [26]. Or the treatment with salicylic acid works to stimulate the plant to produce hormones such as auxin and cytokinin and prevent their oxidation [27 and 28]. The increase in vegetative growth may be attributed to the role of salicylic acid in maintaining the levels of auxins in plant tissues, which play a role in the continuation of cell division and elongation [29]. The reason for the increase in the number of buds is due to the effect of salicylic acid, salicylic acid plays a vital role in the regulation of physiological and chemical processes in plants which lead to an increase in the number of buds in the plant [30].

Results in Table (3) clarified that the concentration 100 mg L⁻¹ of BA caused significant increase in plant density as comparison with other concentration, whereas results in Table (9) refer that the sprayed plants with 200 mg L⁻¹ of benzyl adenine (BA) was significantly superior than control and 100 mg L⁻¹ in total carbohydrates in clipping yield. These findings are consistent with those reported by [31] carried out an experiment to study the effects of benzyl adenine on the morphological behavior of Asiatic lilies. that the plants treated with BA @ 150 ppm had the largest basal stem diameter (18.06), the shortest plant height (36.72 cm), leaf length (7.11 cm), and leaf number (29.33). also agree with [32] showed in their study on the effect of benzyl adenine on the content of non-total structural carbohydrates and water-soluble carbohydrates of tall fescue leaves (*Festuca arundinacea* Scherb.) that application of 50 µM benzyl adenine significantly improved photosynthesis and reduced further starch degradation and its conversion to fructose, glucose and sucrose, thereby preserving the plant's carbohydrate resources.. Benzyl adenine is one of the most effective synthetic growth regulators than any other natural cytokinin [33] such as zeatin and kinetin because it has a benzene ring in the side chain linked to the double bond in the side chain [34], affects the activation of enzymes necessary for vital reactions and increases the construction of chlorophyll and proteins, thus delaying the aging of leaves and increasing the transfer of nutrients to the active tissues and their metabolism [35]. Application of

benzyl adenine have been shown to have effects on many other physiological and developmental processes, including leaf senescence, leaf chlorosis, delaying senescence of cutCarnation by inhibiting ethylene biosynthesis [36], nutrient of mobilization, apical dominance, the formation and activity shoot apical meristems [37].

The results in Tables (3, 4, 6 and 7) showed that water saver mixture was significantly superior to other mixtures in the pant density, leaf area, cumulative dry weight of vegetative growth and root depth. While resilient blue mixture was significantly superior to other mixture in total carbohydrates in clipping yield as in Table (12). It is evident from the above Tables that there are clear significant differences in the response and growth of the different mixtures. The variations between the mixtures can be explained either by the mixtures containing different types in their quality and quantity, which led to their genetic variation and thus the occurrence of variation in their performance and growth in general. Selecting different species and mixtures of species is one of the keys to maintaining turf grasses; this is because some species persist due to their capacity to grow in low light conditions, while others do so due to their tolerance to high or low heat and others due to their resistance to disease. One of the most crucial elements in keeping grass intact is weed control [38]. These results agree with [39] concluded in study of various mixtures of cool-season grass seeds on the characteristics of garden lawns in South Africa that the mixture consisting of 50% red fescue (*Festuca rubra* var. Harld) and 50% perennial ryegrass (*Lolium perenne* L. cv. citadel) produced the highest plant height, plant density, dry weight of the clipping yield. This result is consistent with what [40] found when they studied the compatibility of Kentucky bluegrass (KB), perennial ryegrass (PR), and tall fescue (TF) for planting as mixtures in Mexico State, they found that the mixture consisting of Kentucky bluegrass and tall fescue or tall fescue alone was of high quality and gave the highest values for plant density compared to the other two mixtures. The reason for the superiority of the mixture 1 can be attributed to the fact that this mixture contains a large percentage of tall fescue seeds, which is 80%, compared to the other two mixtures, which contained a lower percentage of this grass seeds. It is considered a cool-season grass, as it is characterized by its high ability to grow vigorously and produce a large group of leaves that enables it to adapt under poor environmental conditions such as high humidity, severe drought, and lack of nutrients, thus producing a dense turf, while the mixture 2 contains a large percentage, which is 100%, of perennial ryegrass seeds. The mixture 3 contains 25% perennial ryegrass seeds, 30% poa grass seeds, and 45% red grass seeds, which cannot survive and withstand high temperatures unless sufficient water is available, they cannot survive for a long time, so they produce a weak and distant turf [41 and 42].

Conclusions

This research concluded that the salicylic acid at concentration 10 mg L⁻¹ had a significant effect on plant density, mowing number, cumulative dry weight of vegetative growth and percentage of carbohydrates in clipping yield. Spray turf grass with benzyl adenine (BA) at 200 mg L⁻¹ significantly superior than control and 100 mg L⁻¹ in total carbohydrates in clipping yield of turf grass mixtures, whereas results at concentration of 100 mg L⁻¹ of BA caused significant increase in plant density as comparison with other concentrations. As for turf grass mixtures noticed that mixture 1 was significantly superior to other mixtures in the pant density, leaf area, cumulative dry weight of vegetative growth, root depth and percentage of total carbohydrates in clipping yield, while mixture 3 was significantly superior to other mixture in total carbohydrates in clipping yield. The interactions among the studied factors indicate that the spray of mixture 1 with 10 mg L⁻¹ of salicylic acid (SA) and 200 mg L⁻¹ of benzyl adenine (BA) resulted in a significant increase in cumulative dry weight of vegetative growth and root dry weight. Wears the spray of mixture 1 with 200 mg L⁻¹ of BA without SA resulted significant increase in cumulative dry weight of vegetative growth, roots depth and decrease mowing numbers. From the results of this study, we recommend use salicylic acid at concentration 10 mg L⁻¹ and BA with mixture 3 to benefit from them in obtaining a good turf grass mixture and to improve its growth and performance.

References

- [1].Day, T. R. (2006). Intermountain west native and adapted grass species and their management for turf grass applications. A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in plant sci. Montana state university, Bozeman, Montana.
- [2].Dong, L., Xiong, L., Sun, X., Shah, S., Guo, Z., Zhao, X., & Chen, Y. (2022). Morphophysiological Responses of two cool-season turfgrasses with different shade tolerances. *Agronomy*, 12(4), 959.
- [3].Bughara, S. S. (2004). Establishing a new lawn using seed. Michigan State University Extension Bulletin E-2910, P. 1-6. (Web site at: <http://web2.msu.edu/bulletins/intro.cfm>).
- [4].Kadiogula, A., Saruham, A, and Terezi, R. (2011). The reactions between antioxidant enzyme and chlorophyll fluorescence parameters in common bean cultivars differing in sensitivity to drought stress. *Russian. J. Plant Physio*, 58(1): 60-68.
- [5].Al-Taey, D. K. A. (2009). Effect of spraying acetyl salicylic acid to reduce the damaging effects of salt water

- stress on orange plants (*Citrus sinensis* L.). *Journal of Kerbala University*. 7 (2):192-202.
- [6]. Aljalaly, S.S., Al-Mentafji, H. N. H, and AlArzawazi, A. L. A. (2018). The effect of salicylic acid, fertilizer NPK Zn and water stress on the pepper plant, *Capsicum annuum* L. c *Int. J. Agricult. Stat. Sci.* 14(2):705- 712.
- [7]. AL-Taey, D. K. A. and Saadoon, A. H. (2014). Effect of treatment of Salicylic acid and water Salinity on the Growth and Nitrate Accumulation with nitrate reductase activity in the Leaves of Spinach, *Spencia oleracea* L. *Journal of Babylon University, Pure and Applied Sciences*; 3 (22): 1188-1203.
- [8]. AL-Obaidy, B. S. J., Al-Joboory, W, and Al-Esawi, J. S. E. (2020). Effect of bio-fertilizer and salicylic acid on dry weight and leaf content of some nutrient elements of fenugreek plant under saline stress. *Int. J. Agricult. Stat. Sci.*; 16(Supp1):11935-1940. Available:<https://connectjournals.com/03899.2020.16.19358>.
- [9]. Hayat, S. and Ahmad, A. (2007). Salicylic acid biosynthesis, metabolism and physiological role in plants. Springer Netherland. 1-14.
- [10]. Lateef, M. A., Noori, A. M., Saleh, Y. M., Al-Taey, D. K. A. (2021). The effect of foliar spraying with salicylic acid and calcium chloride on the growth, yield and storage traits of two strawberry cultivars, *Fragaria* × *Ananassa* Duch. – *International Journal of Agricultural and Statistical Science*, 17(2):611–615.
- [11]. Carey, D. J. (2008). The Effect of Benzyladenine on Ornamental Crops. M.Sc. Thesis, Faculty of North Carolina State University, Raleigh, North Caroline, USA.
- [12]. Han, S. S. (2001) Benzyl adenine and Gibberellins improve postharvest quality of cut Asiatic and Oriental lilies. *Hort. Sci.*, 36(4): 741 – 475.
- [13]. Carpenter, W. J. (1975). Foam sprays of plant growth regulating chemicals on rose shoot development at cutback. *Hort Science* 10:605–606.
- [14]. Emongor, V. E., Mutunga, C .M. M. and Chweya, J. A. (2004). Effect of benzyl adenine on growth and flower yield of chamomile plants. *Trop. Agr.* 81:1–6.
- [15]. Latimer, J. and Freeborn, J. (2008). Enhance branching of echinacea with PGRs. *Greenhouse Product News* 18: 24–28.
- [16]. Little, C. H. A. (1985). Increasing lateral shoot production in balsam fir Christmas trees with cytokinin application. *Hort Science*, 20:713–714.
- [17]. Padhye, S., Runkle, E., Olrich, M. and L. Reinbold. (2008). Improving branching and postharvest quality. *Greenhouse Product News* 8:36–42.
- [18]. Keever, G. J. (1994). BA-induced offset formation in hosta. *J. Environ. Hort.* 12: 36–39.
- [19]. Erwin, E. H. and Koski. A. J. (1998). Growth responses of *Lolium perenne* L. 741. RESEARCHREPORTS to trinexapac-ethyl. *Hort Science* 33: 1200–1202.
- [20]. Erwin, E. H., Ok, C.H., Fresenburg, B. S., and Dunn, J. H. (2002). Trinexapac-ethyl restricts shoot growth and prolongs stand density of ‘Meyer’ zoysiagrass fairway under shade. *HortScience* 37:502–505.
- [21]. SAS. (2001). Statistical Analysis System. SAS Institute Inc., Cary, Nc. USA.
- [22]. Hassan, W. A. and Ramadan, N. A. (1992). The effectiveness of Basamed, Benlate and Ridomil G-5 (G-5%) pesticides in controlling seedling death in greenhouses. *Journal of Education and Science*, Vol. (12), No. (2): 112-120.
- [23]. Khan, M. I. R., Asgher, M., and Khan, N. A. (2014). Alleviation of salt-induced photosynthesis and growth inhibition by salicylic acid involves glycinebetaine and ethylene in mung bean (*Vigna radiata* L.). *Plant Physiol. Biochem.* 80, 67–74. doi: 10.1016/j.plaphy.2014.03.026
- [24]. Safari, M., Arghavani, M. and Kheiri, A. (2018). Effect of salicylic acid on morphological and physiological characteristics of vetiver grass under water deficit stress conditions. *Journal of Crop Improvement*, Volume (19) Issue (3), P. 591-603. <https://doi.org/10.22059/jci.2017.60464>
- [25]. Kaur, H., Hussain, S. J., Kaur, G., Poor, P., Alamri, S., Siddiqui, M. H. (2022). Salicylic acid improves nitrogen fixation, growth, yield and antioxidant defence mechanisms in chickpea genotypes under salt stress. *J. Plant Growth Regul.* doi: 10.1007/s00344-022-10592-7.
- [26]. Padmapriya S. and Chezhiyan N. (2002). Influence of Gibberellic acid and certain other chemicals on flowering character of chrysanthemum cultivars-1. *South Indian Hort.* 50(4/6):437-443.
- [27]. Sardoei, A., Fahraji, S. and Ghasemi, H. (2014). Effect of salicylic acid on rooting of poinsettia (*Euphorbia pulcherrima* L.). *International J. advan. Bio. Biomed. Res.*, 2 (6): 1883-1886.
- [28]. Ram, A. Verma, P., and Gadi, A. (2014). Effect of floride and salicylic acid and on seedling growth and biochemical and parameters of watermelon (*Citrullus lanatus*) .*Res. Report. Fluoride*, 47(1): 49 55.
- [29]. Sakhabutdinova, A. R., Farkhutdinova, D. R, Bezrukova, M. V. and Shakirova, F. M. (2003). Salicylic acid prevents the damaging action of stress factors on wheat plants. *Bulg. J, Plant Physiol*, 1, 314-319.
- [30]. El-Tayeb, M. A. (2005). Response of barley grains to the interactive effect of salinity and salicylic acid. *Plant Growth Regul.* 45:215224.

- [31]. Jayshree, N., Chandrashekar, S. Y., Hemla Naik, B., Hanumantharaya, L., Ganapathi, M. (2020). Influence of benzyl adenine and gibberellic acid on morphological behavior of Asiatic lily. *International Journal of Chemical Studies*. 8(5): 028-031.
- [32]. Zahra, R., Gh., Mostafa, Kh. S. and Sadegh, A. (2020). Effects of 6-Benzyladenine on total nonstructural carbohydrates and water-soluble carbohydrates of tall fescue leaves subjected to drought stress. *J. of Plant Production Research*, [Volume 27, Issue 2](#), P. 215-231. [10.22069/jopp.2020.17173.2576](#).
- [33]. Al-Hamdany, M.H.S. (2012). Effect of some organic compounds on vegetative growth, yield, and quality characteristics olive (*Olea europaea* L.) cv. Bashika. Ph. D. Thesis, Department of Horticulture and Landscape, Col-lege of Agriculture and Forestry -University of Mosul, Iraq.
- [34]. Saleh, M. M. S. (1991). Physiology of plant growth regulators, first addition, Uni-versity of Salah Al-ddin. Iraq.
- [35]. Mohammed, A. K. (1985). Plant Physiology. University of Mosul Press. Mosul –Iraq.
- [36]. Cook, D., Rasche, M. and Eisinger, W. (1985). Regulation of ethylene biosynthesis and action in cut carnation flower senescence by cytokinins. *J. Amer. Soc. Hort. Sci.*, 110, 24 27.
- [37]. Waterland, N. L., Finer, J. J. and Jones, M. L. (2010). Benzyl adenine and Gibberellic Acid Application Prevents Absciscic Acid-induced Leaf Chlorosis in Pansy and Viola. *Hort. Sci.*, 45(6):925—933.
- [38]. Stier, J. C. (1999). Growing grass in shade. Cooperative extension publishing of the University of Wisconsin, A. 3700, P. 1-6.
- [39]. Misiha, A. (1991). Effect of cool season turf grass seed mixture on lawn characteristics. Bulletin of faculty of agriculture, university of Cairo, Egypt, Vol. 42, No. 2, P. 401-414. (Abst.).
- [40]. Hunt, K. L. and Dunn, J. H. (1993). Compatibility of Kentucky blue grass and Perennial rye grass with Tall fescue in transition zone turf grass mixtures. *Agron J.* 85: 211-215.
- [41]. Powell, A. J. Jr. (2000). Selecting the right grass for your Kentucky lawn. University of Kentucky, College of Agric., AGR-S2, P. 1-4. <https://agris.fao.org/agris/search/search.do?recordID=US7760617>
- [42]. Al-Qaee, T. M. and Noah, F. (2004). Green turf grasses and sports fields. Faculty of Agriculture, Alexandria University, Egypt.

تأثير حامض السالسيك والبنزيل ادنين في اداء نمو ثلاث خلطات من حشائش مسطحات الموسم البارد

هيلان محمد احمد¹

يوسف علي عبدالرحمن¹

قسم البستنة، كلية علوم الهندسة الزراعية، جامعة دهوك، دهوك، العراق.

الخلاصة

اجريت البحث في مشتل قسم البستنة – كلية علوم الهندسة الزراعية – جامعة دهوك – العراق خلال الفترة من 1 ايلول 2024 لغاية 1- حزيران 2025 للموسم الخريفي لبحث استجابة ثلاث خلطات من بذور المسطحات الخضراء الشتوية والتي تضمنت (1، 2 و 3) للرش بتركيزين من حامض السالسيك (0 و 10 ملغم لتر⁻¹) كل شهر بعد انبات البذور و تراكيز مختلفة من البنزيل ادنين (0، 100 و 200 ملغم لتر⁻¹) قد رشت مرتين خلال فترة التجربة. اجريت الدراسة باستخدام تصميم القطاعات العشوائية الكاملة وبثلاث مكررات. اوضحت النتائج بان رش خلطات المسطحات بتركيز 10 ملغم لتر⁻¹ من حامض السالسيك كان لها تأثير معنوي في الكثافة النباتية (2010.19 نبات 100 سم²)، عدد القصات (2.67)، الوزن التراكمي الجاف للنمو الخضري (25.20 غم) والنسبة المئوية للكاربوهيدرات (0.88%). الرش الورقي لخلطات المسطحات بالتركيز 200 ملغم لتر⁻¹ تفوق معنويا على معاملة المقارنة والتركيز 100 ملغم لتر⁻¹ النسبة المئوية للكاربوهيدرات (0.89%)، بينما نتائج التركيز 100 ملغم لتر⁻¹ من البنزيل ادنين سببت زيادة معنوية في الكثافة النباتية (208.39 نبات 100 سم²) مقارنة بالتركيزين الآخرين. اما بالنسبة لخلطات البذور لوحظت بان الخلطة 1 تفوق معنويا على الخلطتين الاخرتين في الكثافة النباتية (218.03 نبات 100 سم²)، المساحة الورقية (2.64 سم²)، الوزن التراكمي الجاف للنمو الخضري (24.92 غم) وعمق الجذور (21.03 سم)، بينما الخلطة 3 قد تفوقت معنويا على الخلطتين الاخرتين في النسبة المئوية للكاربوهيدرات في حاصل القص (0.91%).

الكلمات المفتاحية: حشائش الموسم البارد، خلطات البذور، حامض السالسيك، البنزيل ادنين.