Plant Archives Vol. 21, Supplement 1, 2021 pp. 854-857 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
doi link : https://doi.org/10.51470/PLANTARCHIVES.2021.v21.S1.130

EFFECTS OF FOLIAR SPRAYING OF SALICYLIC ACID WITH TRYPTOPHAN ON YIELD AND QUALITY PARAMETERS IN WHEAT

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ABSTRACT

The study was conducted during the winter season 2019/2020 at Al-Qurna (Al-Sharesh) which is about 65 kilometers north of the Basra governorate center to study the effect four concentrations of salicylic acid (0, 60, 120, 180 mg L^{-1}), and four concentrations of tryptophan acid (0, 60, 120, 180 mg L^{-1}), the yield and quality of bread wheat (Buhooth-22 variety). Experiment conducted as a factorial (4 × 4) according to Randomized Complete Block Design (RCBD) with three replicates. The results showed that concentration of120 mg L^{-1} salicylic achieved the highest number of spikes (603 spikes m^{-2}), number of grains spike (44.82 grain $spike^{-1}$), weight of 1000 grain (37.10 g), grain yield (6.12 µg ha^{-1}), chlorophyll content in the Flag leaf (475.00 mg m^{-2}), grain protein (14.31%), dry gluten (33.03%) and wet gluten (12.99%). Also concentration of 120 mg L^{-1} tryptophan achieved the highest number of spikes (622 spikes m^{-2}), number of grains spike (43.70 grain $spike^{-1}$), grain yield (5.93 µg ha^{-1}), chlorophyll content in the Flag leaf (485.30 mg m^{-2}) protein in grains (14.78%), dry gluten (34.05%) and wet gluten (13.37%). The interaction was significant; plants that sprayed with S_2T_2 were superior in all study characteristics. We conclude that it is possible to spray salicylic acid and tryptophan at a concentration of 120 mg L^{-1} to the wheat crop to improve the yield and quality of wheat grains at the lowest costs and reduce the environmental pollution resulting from the use of a large amount of chemical fertilizers.

***Keywords*:** Wheat, Tryptophan, Salicylic, Amino acid, foliar.

Introduction

Bread wheat (*Triticum aestivum* L.) is one of the most important cereal crops in the world, ranks first in world cereal production. The importance of wheat is due to the gluten of wheat, which produces the best types of bread that percentage ranges from 30-35%, Since Wheat grains known as the main source of Carbohydrates, and many other fats, Minerals and fibers (Jones *et al*., 2015). Although wheat is grown in almost all its regions, however, its productivity especially in the southern regions, is the lowest, due to the deterioration of production factors such as irrigation water, salinity, high temperatures and others. The modern scientific methods in agriculture have directed to the use of safe materials that increase the yield and quality of the crop and do not affect negatively on the environment. Among them are growth regulators, which have an important role in increasing the activity of physiological and biological processes in plants (Müller and Bosch, 2011). Salicylic acid spray on the shoot has an important role in increasing the growth of the plant. It participates in the regulation of many physiological processes in plants such as photosynthesis, ion absorption, bio-inhibition of ethylene, and bearing different stresses to which plants are exposed (Ebrahimian and Bybordi, 2012). Dahl and Kadhim (2017) showed that salicylic spraying at a concentration of 100 ppm achieved the highest grain yield, reaching 8.777 µg ha^{-1}, while the comparison treatment recorded 8.161 µg ha^{-1}. Studies have proven that the use of amino acids has a great role in the biosynthesis of a large variety of non-protein nitrogenous substances, such as vitamins, dyes, coenzymes, pyrimidine and purine bases. Mohamed *et al*., (2018) indicated that when sprinkling wheat with three concentrations of tryptophan (0, 50 and 100 mg L^{-1}), the concentration of 100 mg L^{-1} recorded the highest yield for grains with 1.58 µg ha^{-1}, while the non-addition treatment recorded 1.26 µg ha^{-1}. This study aimed to find out the response of the wheat crop to spraying with different concentrations of salicylic acids and tryptophan and to determine the optimal level of these two acids and the interaction between them in obtaining the highest yield and the best quality of wheat grains.

Materials and Methods

A field experiment conducted during the winter season 2019/2020 at Al-Qurna (Al-Sharesh) about 65 kilometers north of the Basra governorate center. The experiment included four levels of salicylic acid 0, 60, 120, 180 mg L^{-1} symbol for it S_0, S_1, S_2, S3 respectively - and four levels of tryptophan 0, 60, 120, 180 mg L^{-1} symbol for it with T_0, T_1, T_2, T_3. Field soil random samples taken to estimate soil physical and chemical properties (Table 1). Experiment conducted as a factorial according to Randomized Complete Block Design (RCBD) with three replicates. Area unit was 2 x 2 m included 10 lines with a length of 2 m and 20 cm distance between rows. Calcium superphosphate fertilizer (P_2O_5 45%) was added at the rate of 100 kg P_2O_5 ha^{-1} before planting. Urea fertilizer (46% N) added at a rate of 120 kg ha^{-1} (Al-Abdullah, 2015) in three equal portions, the first when planting, the second in the tillering stage, and the third at the

flowering stage. Buhooth-22 variety was planting at 15th November with a seed rate of 120 kg ha^{-1}. The concentrations of salicylic acid and tryptophan were prepared with the required concentration and placed in a volumetric flask of 1 liter and the volume completed to the liter by adding distilled water in addition to control treatment (distilled water spraying). The spraying carried out during three stages, tillering, booting and flowering, Plants harvested at full maturity on 15th of April. One square meter of each plot has chosen from the middle rows, it was considered to measure the traits of, number of spikes, number of grain/ spike/, 1000 grains Weight, grain yield, chlorophyll content, Protein in grains%, wet and dry gluten%. The data statistically analyzed, using Genstae, version 7, and the means compared using the least significant differences (LSD) under the probability level of 5% (AL-Sahuki and Wahib, 1990).

Table 1 : Some physical and chemical characteristics of field soil before planting.

Soil characteristic	Unit	value
pH	-	7.46
EC	dSm^{-1}	7.55
O.M	g kg^{-1}	1.65
N	$mgkg^{-1}$	52
P		22
K		112
Clay	g kg^{-1}	241.65
Silt		318.66
Sands		439.69
Texure	-	clay loam

Results and Discussion

Number of spike (m^{-2})

Table 2 shows that the number of spikes was superior at the concentration of S_2 (603 spikes m^{-2}), and it did not differ significantly from the two concentrations S_1, S_3 (583, 587 spikes m^{-2} respectively), While the S_0 concentration gave the lowest (528 m^{-2} spikes). This increase due to the role of salicylic acid, which has an opposite effect to the growth inhibitor Abscisic acid, as well as to its role in increasing the levels of auxins and cytokines, which stimulate the plant to form a greater number of anthers bearing anthers (El-Tayab, 2005). This finding is in agreement with Karim and Khursheed (2011). Also the results show that spraying with tryptophan with a concentration of T_2 gave the highest number of spikes, which reached 622 m^{-2} spikes, while the minimum was found in the control (549 m^{-2} spikes). The reason is attributed to the role of tryptophan in increasing the available of nutrients, including nitrogen, phosphorous and potassium (Abood *et al*., 2018), as well as its contribution to formation of IAA, which in turn stimulated cell division and elongation, thus increasing growth. This finding is in agreement with Baqir and Al-Naqeeb (2019).Table 3 shows that the combination S_2T_2 recorded the highest number of spikes, reaching 724 m^{-2} spikes, while the combination S_0T_0 recorded the lowest number of spikes (448 m^{-2} spikes).

Number of grains spike (grain $spike^{-1}$)

Table 2 indicated the significant effect of S_2 concentration of salicylic acid, by the highest number of grains spike, reaching 44.82 grain $spike^{-1}$.Which did not differ significantly from the S_1 concentration, (42.84 grain $spike^{-1}$), while lower number of grains were obtained from S_0 concentration (38.76 grain $spike^{-1}$). This can be caused by the role of salicylic acid in the regulation of many physiological processes, including photosynthesis and the uptake of nutrients. That result in optimal photosynthesis products, which reduces the competition between growing grains and reducing the abortion of grain, which in turn leads to an increase in the number of grains, formed in the spike (Assuero and Tognetti, 2010). Results are in agreement with Dahl and Kadhim (2017). The results of Table 2 show that the concentration of T_2 was superior, as the highest number of grains per spike recorded at 43.70 grain $spike^{-1}$. With no significantly differences from the concentrations T_1, T3, which scored 43.16, 43.36 grain $spike^{-1}$ respectively, While the T_0 concentration recorded the lowest value (37.94 grain $spike^{-1}$). The reason attributed to the role of the amino acid tryptophan in building DNA, RNA and proteins needed to form enzymes (Saikumar *et al*., 1990). Then the increase in plant vital activities and cell division that would lead to an increase in the origins of flowering formed, these matters will be reflected positively in the increase of grains the number. These results are in agreement with the findings of Baqir and Al-Naqeeb (2019). As for the interaction, (Table 3) the S_2T_2 treatment achieved the highest number of grains with 47.14 grain $spike^{-1}$, while S_0T_0 gave the lowest (26.57 grain $spike^{-1}$).

1000 grain weight (g)

Table 2 shows that the concentration of S_2 recorded the highest weight of 1000 grain, which reached 37.10 g, and did not differ significantly with S_3 (36.08 g), while the control recorded the lowest value (32.54 g). This due to the role of salicylic acid in encouraging the transfer of processed and stored metabolites from the source (stem and leaves) to the grains, as it regulates many physiological processes in the plant such as, photosynthesis and nutrients absorption (Ebrahimian and Bybordi, 2012). All these factors may have contributed to the increase in the grain weight. Our results agreed with Abdel-Lattif *et al*. (2019). There is no significant effect of tryptophan in this trait. Interaction of S_2T_2 gave the highest of 1000 grains weight (39.08 g), while S_0T_0 recorded 28.85 g.

Grain yield (µg ha^{-1})

The results of Table 2 show that spraying with concentration of S_2 recorded the highest grain yield, reaching 6.12 µg ha^{-1}, and it did not differ significantly from the concentration of S_3,Whereas, the S_0 concentration recorded the lowest grain yield (5.32 µg ha^{-1}). The reason for the increase is due to the effect of salicylic acid by increasing the yield components. Which are number of spikes, number of grains/ spike, and 1000 grain weight resulting in an increase in grain yield. Abdel-Lattif *et al*. (2019), have reported similar result. Table 2 indicates the significant effect of spraying with tryptophan at concentration T_2 recorded the highest grain yield (5.93 µg ha^{-1}). Moreover, It was observed there is no significant differences with T_1, T_3 (5.70, 5.91 µg ha^{-1} respectively), while the lowest rate was found in the control (5.49 µg ha^{-1}). This is due to the effect of the spraying of tryptophan, which increased number of spikes, number of grains/ spike resulting in an increase in grain yield. This result was in agreement with Baqir and Al-Naqeeb (2019). The interaction of S_2T_2 achieved the highest grain yield (6.70 µg ha^{-1}), while the lowest grain yield at S_0T_0 was 4.44 µg ha^{-1} (Table 3).

Total chlorophyll content in Flag leaf (mg m^{-2}):

Data on total chlorophyll content (Table 2) shows the superiority of the salicylic acid S_2 concentration, as the highest value recorded 475.00 mg m^{-2}, which was not significantly different from the S_1 concentration (453.84 mg m^{-2}) while control recorded the lowest value (382.25 mg m^{-2}). The reason for this increase due to the role of salicylic acid in stimulating the cytokinin hormone necessary for the formation of chloroplasts (Kaydan *et al*., 2006). This result is consistent with that found by Karim and Khursheed (2011). It also noted from Table 2 that the concentration of T_2 was superior, by giving the highest chlorophyll content (485.30 mg m^{-2}), while control recorded the lowest values (419.17 mg m^{-2}). This increase can be caused by the role of tryptophan acid in increasing the endogenous auxin level, thus it will prevent sensence and fall of leaves that delay the destruction of chlorophyll (Abdel Hafez, 2006). This result is similar to Al-Qaisi *et al*. (2017). Table 3 shows that the interaction of S_2T_2 achieved the highest chlorophyll content (602.4 mg m^{-2}) compared to S_0T_0, which recorded the lowest value (322.36 mg m^{-2}).

Protein (%)

Data presented in Table 2 showed the highest percentage of protein in grains when spraying with concentration of salicylic acid S_2 by giving 14.31%, compared with control, which produced the lowest average of 12.52%. The reason attributed to the role of salicylic acid in increasing the absorption of the basic nutrients for building proteins such as sulfur, phosphorous and nitrogen, in addition to increase the activity of some necessary enzymes for its formation (Rakova *et al*., 1969). It noted from Table 2 that the concentration of T_2 recording the highest protein, which reached 14.78%, with an increase of 26.32% over the control (11.70%). This increase may be attributed to the fact that the amino acid (tryptophan) is used in building proteins and thus will lead to an increase in the synthesis and formation of proteins (Attia *et al*., 1999). These results are in agreement with Al-Qaisi *et al*. (2017).As for the interaction (Table 3), the treatment S_2T_2 recorded the highest protein content, reaching 15.12%, compared to the S_0T_0 which recorded the lowest value (9.90%).

Wet gluten in grains (%)

Table (3) shows that the foliar spraying treatments with salicylic acid were significantly affected on wet gluten percentage where the spraying treatment with salicylic acid at a concentration of S_2, has excelled by giving the highest value of 33.03%, while the lowest Wet gluten percentage was at the control treatment which amounted to 29.89%. The reason attributed to increasing of protein, which reflected in the increase in hydrated gluten. As for the foliar spraying treatments with tryptophan, it is affected significantly on the wet gluten percentage, where the spraying treatment with a concentration of T_2 led to the highest value which amounted 34.05%, compared to the control treatmentT_0 (28.60%). The relationship between protein and gluten content is positive because gluten constitutes 80% of the protein found in wheat, and since tryptophan increases the protein content of grains, this positively reflected in the increase in the proportion of gluten in the grains. The result of the interaction between the foliar spraying with salicylic acid and tryptophan showed a significant effect on wet gluten percentage, where the interaction treatment S_2T_2 excelled by 35.58%, compared to the S_0T_0 interaction, which recorded the lowest value (27.57%) (Table 3). This is due to the common role of two acids in stimulating enzymes and increasing the formation of amino acids, which are the main part of protein building, which positively reflected in the increase in the proportion of gluten.

Dry gluten in grains (%)

The results of Table 2 indicate that the concentration of S_2 was superior, as it recorded the highest value for Dry gluten percentage (12.99%), while the minimum was found in the control (11.02%). It also noted that the concentration of T_2 was superior, recording the highest value, reached 13.37%, which was significantly superior to the control treatment (10.36%). Data of the interaction between the factors referred that the highest value of the Dry gluten reached (13.90%), at S_2T_2 treatment while the lowest value was (9.52%) when spraying at S_0T_0 treatment.

Table 2 : Effect of Salicylic(S) and Tryptophan (T) concentrations on yield components, yield, Chlorophyll content, Protein, Wet and dry gluten of wheat.

Treatments	Spikes number	Grains spike^{-1}	1000 grain weight	Grain yield mg ha^{-1}	Chlorophyll content (mg l^{-1})	Protein %	Wet gluten %	Dry gluten %
S_0	528	38.76	32.54	5.32	382.25	12.52	29.89	11.02
S_1	583	42.84	34.60	5.64	453.84	13.94	31.87	12.70
S_2	603	44.82	37.10	6.12	475.00	14.31	33.03	12.99
S_3	587	41.74	36.08	5.96	440.11	13.86	31.64	12.64
LSD ($P \leq 0.05$)	39.7	2.474	1.315	0.347	25.489	0.352	0.951	0.282
T0	550	37.94	35.04	5.49	419.17	11.70	28.60	10.36
T1	549	43.16	34.97	5.70	420.83	14.14	32.25	12.87
T2	622	43.70	35.03	5.93	485.30	14.78	34.05	13.37
T3	580	43.36	35.27	5.91	425.90	14.00	31.53	12.75
LSD ($P \leq 0.05$)	39.7	2.474	N.S	0.347	25.489	0.352	0.951	0.282

Table 3 : Effect of the interaction of Salicylic and Tryptophan acid concentrations onyield components, , Chlorophyll content, Protein ,Wet and dry gluten of wheat.

Treatments	Spikes number	Grains spike^{-1}	1000 grain weight	Grain yield mg ha^{-1}	Chlorophyll content (mg l^{-1})	Protein %	Wet gluten %	Dry gluten %
S_0T_0	448	26.57	28.85	4.44	322.36	9.90	27.57	9.52
S_0T_1	545	43.93	32.83	5.50	373.46	12.9	29.56	11.12
S_0T_2	520	42.53	34.57	5.39	401.68	14.37	33.46	12.30
S_0T_3	599	42.00	33.92	5.95	431.49	12.91	28.96	11.13
S_1T_0	565	42.13	34.88	5.55	536.88	12.36	29.69	10.69
S_1T_1	520	42.23	36.52	5.52	360.63	14.53	33.38	13.43
S_1T_2	697	42.57	33.16	6.04	556.71	15.00	32.67	13.80
S_1T_3	549	44.43	33.83	5.43	361.12	13.85	31.74	12.88
S_2T_0	651	42.77	38.33	6.56	368.19	12.22	29.29	10.57
S_2T_1	517	44.00	33.08	5.39	466.09	14.89	34.67	13.71
S_2T_2	724	47.14	39.08	6.70	602.40	15.12	35.58	13.90
S_2T_3	519	`45.37	37.89	5.81	463.32	14.99	32.58	13.79
S_3T_0	535	40.27	38.11	5.41	449.24	12.31	27.84	10.65
S_3T_1	615	42.47	37.43	6.39	483.14	14.25	31.38	13.20
S_3T_2	545	42.57	33.32	5.58	380.39	14.61	34.50	13.49
S_3T_3	652	41.63	35.45	6.46	447.65	14.25	32.82	13.20
LSD ($P \leq 0.05$)	**79.4**	**4.948**	**2.630**	**0.694**	**50.977**	**0.705**	**1.903**	**0.564**

References

Abdel Hafez, Ahmad Abu Yazid (2006). United for Agricultural Development. Faculty of Agriculture, Ain El Shams University, Arab Republic of Egypt: 1-15.

Abdel-lattif, H.M.; Abbas, M.S. and Taha, M.H. (2019). Effect of salicylic acid on productivity and chemical constituents of some wheat (*Triticum aestivum L.*) Varieties grown under saline conditions. Japs, journal of animal and plant sciences, 29(4): 1054-1064.

Abood, N.M.; Ajaj, H.A. and Hamidi, I.H. (2018). Response of wheat cultivars (*Triticum aestivum L.*) To foliar application with amino acids. Anbar journal of agricultural sciences, 16(2): 1017-1032.

Al-Abdullah, S.A.M. (2015). The effect of nitrogen addition on N, P and K uptake and distribution in plant parts, growth and yield of three varieties of wheat (*Triticum aestivum L.*), Ph.D. thesis, College of Agriculture, University of Basra.

Al-Qaisi, E.S. Amjad, M. Rahaf Wael Mahmoud, M. Iman Hussein Hadi El Hayani and Zina Taha Abdel Hafez. (2017). the response of the wheat plant (*Triticum aestivum L)*. to foliar spraying with tryptophan in some indicators of growth and yield. Journal of the College of Basic Education - Al-Mustansiriya University, 23(97): 95-104.

AL-Sahuki. M. and Wahib, K.M. (1990), Applications in design and analysis of experiments, University of Baghdad, House of Wisdom (488) pages. Iraq.

Assuero, S.G and Tognetti, J.A. (2010). Tillering regulation by endogenous and environmental factors and its agricultural management. The American J. Plant Sci. and Biotech. 4 (1): 935-954.

Attia, H.J. and Jadoua, K.K.A. (1999). Plant growth regulators theory and practice. House of Books for Printing. University of Baghdad: 11-18.

Baqir, H.A. and Al-Naqeeb, M.A.S. (2019). Effect of some amino acids on tillering and yield of three bread wheat cultivars. The Iraqi Journal of Agricultural Science, 50: 20-30.

Dahl, A.N. and Zaid, M.K. (2017). Effect of salicylic acid on growth and yield of bread wheat under drought conditions. Karbala Journal of Agricultural Sciences, 4(2): 91-111.

Ebrahimian, E. and Bybordi, A. (2012). Effect of salinity, salicylic, and ascorbic acid on lipid peroxidation, antioxidant enzyme activity and fatty acid content of sunflower. African Journal of Agricultural Research, 7(25): 3685-3694.

El-Tayab, M.A. (2005). Response of barly grains to the interactive effect of salinity and salicylic acid. Plant Growth Regulation., 45: 215-224.

Mckee, G.W. (1964). A coefficient for computing leaf area in hybrid corn . Argon. J., 56(2): 240- 241.

Jones, J.M.; Peña, R.J.; Korczak, R. and Braun, H.J. (2015). Carbohydrates, Grains, and Wheat in Nutrition and Health: An Overview Part I. Role of Carbohydrates in Health1,2 . Cereal Foods World. 60(5): 224-233.

Karim, F.M. and Khursheed, M.Q. (2011). Effect of foliar application of Salicylic acid on growth, yield components and chemical constituents of Wheat (*Triticum aestivum L.* Var. Cham 6). 5th Scientific Conference of College of Agriculture – Tikrit University.

Kaydan, D.; Yagmur, M. and Okut, N. (2006). Effect Salicylic acid on the growth and some physiological characters in salt stressed wheat (*Triticum aestivum L.*). Ankara University, Ziraat. 13(2): 114–119.

Mohamed, M.F.; Thalooth, A.T.; Essa, R.E.Y. and Gobarah, M.E. (2018). The stimulatory effects of tryptophan and yeast on yield and nutrient status of wheat plants (*Triticum aestivum L.*) grown in newly reclaimed soil. Middle East J. Agri. Res, 7(1): 27-33.

Müller, M. and Munné-Bosch, S. (2011). Rapid and sensitive hormonal profiling of complex plant samples by liquid chromatography coupled to electrospray ionization tandem mass spectrometry. Plant methods, 7(1): 37.

Rakova, N.M.; Klyshev, L.K. and Strongonov, B.P. (1969). The Effect of Na_2SO_4 and NaCl on the protein composition of pea roots. Sov. J. Plant Physiol., 16: 17-23.

Saikumar, P.; Murali, R. and Reddy, E.P. (1990). Role of tryptophan repeats and flanking amino acids in MYB-DNA interactions. Proc. Natl. Acad. Sci., 87: 8452–9456.