Effect of adding biofertilizer and Metribuzin on the quality traits of potatoes exposed to abiotic stress conditions.

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Abstract

A field experiment was conducted in Al-Mashroo / Al-Hamzawi area of Al-Musayyib district (35 km north of Babylon province) within longitude (44) and latitude (32). The cultivation took place in two seasons: the spring season on 18/1/2022 and the autumn season on 9/15/2022. For the purpose of finding out the effect of adding biofertilizer and Metribuzin on the quality traits under the influence of different irrigation periods on the growth and yield of potato Niemae using a split-split plot design within Randomized Complete Block Design(RCBD) with three replicates, with 108 experimental units. The following traits were measured: the percentage of dry matter in the tubers (%), the percentage of starch in the tubers (%), the percentage of nitrogen in the tubers (%), and the percentage of phosphorus in the tubers (%). The results of the statistical analysis showed that the pre-emergence and post-emergence treatments were significantly excelled in the percentage of dry matter, the percentage of starch and the percentage of nitrogen. 47.18%, 36.08%, 38.02%, 1.524, 1.934%, 0.431, and 0.448%) for both season, respectively. Irrigation treatment every 7 days was significantly exelled in dry matter, starch and phosphorous percentage (45.59, 47.62%, 36.09 and 38.41%, 0.443 and 0.462%) for both season, respectively. The bi- interaction between irrigation and herbicide periods was significant in qualitative traits indicators, exceeding the interaction of 7 days × each of pre and post, and the percentage of phosphorus was (0.484, 0.481%, 0.504, and 0.503%) for the both seasons, respectively. The interaction between irrigation and biofertilization periods had a significant effect, and the interaction of 7 days × Myco was excelled in the percentage of phosphorus (0.499 and 0.519%) for both season, respectively. The interaction between the herbicide and biofertilizer had a significant effect, and the interaction of post × Myco was excelled in dry matter and percentage of nitrogen amounted to (49.40 and 52.18%, 1.699 and 2.368%) for both seasons, respectively. The effect of the triple interaction between the three factors was significant, and the interaction of 7 days × post × Myco was excelled in the percentage of phosphorus (0.563 and 0.590%) for both season, respectively.

Keywords: Metribuzin, biological vaccine, water stress

introduction:

The potato, *Solanum tuberosum* L., belonging to the Solanaceae family, is one of the important vegetable crops in the world and ranks fourth globally after wheat, corn and rice in terms of nutritional importance (1) as it constitutes the daily food for more than 90-75% of the countries of the world, because it is a vegetable rich in nutrients It provides a large amount of energy, in addition to its content of some vitamins, such as thiamine, riboflavin, niacin, and vitamin C. It contains high amounts of carbohydrates and minerals, and it is used in many food industries (2 and 3)

The weed competition for this crop is one of the most important problems that negatively affect production, where it causes large losses in the total crop ranging between 30-50%. Sometimes the loss of half of the crop may reach more than 70%. The weeds competition for the potato crop is not limited to light and water. Not only nutrients but also affect the quality of the tubers causing huge losses to the

ISSN 2072-3857

farmer. Therefore, herbicides are among the fastest and most effective means in the weeds compared to other means (4)The growing problems in potato productivity are its high requirements of chemical fertilizers, which are important in increasing production, as they work to provide fast food for plants, causing them to grow quickly and efficiently, but the negative side effects are many, especially when excessive and unbalanced use of those fertilizers through the effect It affects soil microorganisms or disturbs the environment, as well as shows harmful effects on human health and the quality of ground water (5). Those concerned at the present time tended towards the use of biological fertilizers for their role in increasing the growth and development of plants and inhibiting the growth of pathogenic microorganisms, and their contribution at the same time to resisting various stress conditions (13 and 14). Biofertilizers are considered one of the modern technologies that have recently received great attention because of their low cost and their role in reducing soil pollution and improving the readiness of the basic elements needed for plant growth, such as nitrogen fixed by soil bacteria, lowering the soil pH value and then reducing Glomus mosseae. Nitrogen fixation, which is one of the oldest and most widely used biofertilizers, as Rhizobium bacteria have been used clearly in various parts of the world to increase the production and yield of plants. (15.)

MATERIALS AND METHODS

A field experiment was conducted in Al-Mashroo / Al-Hamzawi area of Al-Musayyib district (35 km north of Babylon provainc). For the purpose of knowing the effect of adding bio-fertilizer and Metribuzin on the quality traits under the influence of different irrigation periods on the growth and yield of Niemae potatoes, the land was prepared by plowing it with a flip-up plow to a depth of 30 cm. Vertically twice perpendicularly, then the soil was smoothed with disc harrows and the leveling process was carried out, and after preparing the field soil it was divided into three sectors for each experiment leaving a distance of 2m2 separating between the experimental units to prevent the transfer of fertilizer between treatments.Samples were taken from the field soil before cultivation to determine its physical and chemical properties (Table 1). Cultivation was coundected on a tuber, the length of the tuber was 4 m, the distance between one tuber and another was 75 cm, and between one tuber and another was 25 cm, at the rate of 6 tubers per experimental unit, whose area was 12 square meters (3×4 m), the number of tubers per experimental unit Each one has 42 tubers. At a rate of 108 experimental units, Diammonium phosphate was added before cultivation. The cultivation took place in two seasons: the spring season on 18/1/2022 and the autumn season on 9/15/2022. Potato seeds (Niemae of Dutch origin) were planted three days after irrigation in the upper third of the meadow, at a depth of 10 cm on one side. Biofertilizers were added first, then the seeds.

ISSN 2072-3857

Table (1) Some chemical and physical properties of field soil before cultivation.

values	units	traits	
2.5	ds m^{-1}	Electrical conductivity (EC)	
7.2	------	PH	
27	$mg.kg^{-1}$	Available nitrogen (N)	
14	$mg.kg^{-1}$	ready phosphorus (P)	
1.39	$Mg.g^{-1}$	bulk density	
479	$mg.kg^{-1}$	sand	Soil separator
325	$mg.kg^{-1}$	silt	
196	$mg.kg^{-1}$	clay	
Loam	-------	texture	

Experimental design

The experiment was carried out according to a split-split plot design within the RCBD (Randomized Complete Block Design) with three replicates.The experiment includes three factors, the first factor is the irrigation periods (5, 7, and 9) days, and it represents the main plots. The second factor is biofertilizer with three levels (control treatment without addition, inoculation treatment with rhizobia R, inoculation treatment with mycorrhizal M) and the sub-plots are represented. The third factor is metribuzin with four levels (no addition of CO, Pree-mergence, Post-emergence, Late post-emergence) and the sub-sub plots are represented. The arithmetic means were compared using the least significant difference (L.S.D) at the 5% probability level (6).

Results and discussion:

Tables (2 and 7) show that the herbicide treatment had a significant effect on the highest average trait of the percentage of dry matter in tubers, which amounted to (45.87 and 48.05%) compared to the control treatment, which gave the lowest average (36.20 and 38.05%) for both season, respectively. The two types of biofertilizers were significantly excelled on compared to the control treatment. This is due to the increase in dry matter in the tubers, due to the role of mycorrhiza in increasing the readiness of mineral elements and their ease of absorption by the root. In turn, these elements contribute to the activation of physiological processes and enzymes that enter into the process of photosynthesis, and then it is reflected on The increase in the stock of manufactured carbohydrate compounds in the tubers, which was reflected in the increase in the percentage of dry matter in the tubers, and this is consistent with (7, 8, 9) and the fertilizer (Myco) was significantly excelled on the highest average trait of the percentage of dry matter in the tubers, which reached (44.86 and 47.18%) compared to the fertilizer (Rhizo). The irrigation period every 7 days was significantly excelled, giving it the highest reading for the percentage of dry matter in tubers, which amounted to (45.59 and 47.62%), while the irrigation period every 9 days gave the lowest mean, which amounted to (38.76 and 40.75%) for both season, respectively. It also appears from the table that the bi- interactions between the factors of the experiment had a significant effect on this trait, where the interaction between the

ISSN 2072-3857

irrigation periods and the herbicide gave a significant effect, and the interaction of 7 days x each of the Pre and Late times had the highest average trait of the percentage of dry matter in the tubers (47.85 and 50.26%). respectively for the first season and (50.06 and 52.30%) respectively for the second season, while all irrigation periods × comparison gave the lowest mean for both season. The interaction between irrigation periods and bio-fertilizer gave a significant effect and was excelled on the interaction of 7 days x Rhizo. The highest mean of the percentage of dry matter in tubers was (48.81 and 50.50%) for both season, respectively, while all irrigation treatments with comparison (without biofertilizer) gave the lowest mean in both seasons.The interaction between the herbicide and biofertilizer gave a significant effect and the interaction of Post × Myco had the highest mean of the percentage of dry matter in tubers (49.40 and 52.18%) for both season, respectively, while the control interaction (without herbicide × without fertilizer) gave the lowest mean for both season.The interaction between the three factors had a significant effect, and the interaction between 7 days × Late × Myco was excelled by giving it the highest average trait of the percentage of dry matter in tubers (55.96 and 57.62) for both season, respectively, while the interactions of all irrigation treatments × without herbicide × without fertilizer gave the lowest average for both season.

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Table (2) Effect of herbicides, biofertilizers, and irrigation periods on the percentage of dry matter (%)for the potato crop

irrigation periods × herbicide	spring season			herbicide	irrigation periods
	Biofertilizer				
	Rhizo.	Myco.	without adding		
38.05	37.10	40.00	37.05	Co	5day
43.95	45.32	44.97	41.55	Pre	
49.10	53.67	48.78	44.85	Post	
43.74	45.30	47.35	38.56	Late	
37.31	37.34	37.80	36.79	Co	7day
47.85	53.04	44.65	45.88	Pre	
46.94	49.43	52.83	38.55	Post	
50.26	55.45	55.96	39.36	Late	
33.24	32.45	35.17	32.10	Co	9day
39.86	40.83	40.55	38.21	Pre	
41.56	42.27	46.60	35.82	Post	
40.37	42.59	43.65	34.88	Late	
2.140	**3.931**			L.S.D. 0.05	
Irrigation average	irrigation periods × Biofertilizer				
43.71	45.35	45.27	40.50	5 day	
45.59	48.81	47.81	40.14	7 day	
38.76	29.53	41.49	35.25	9day	
1.221	**2.184**			L.S.D. 0.05	
average herbicide	herbicide × Biofertilizer				
36.20	35.63	37.66	35.31	Co	
43.89	46.40	43.39	41.88	Pre	
45.87	48.46	49.40	39.74	Post	
44.79	47.78	48.99	37.60	Late	
1.297	**2.345**			L.S.D. 0.05	
	44.57	44.86	38.63	Biofertilizer average	
	L.S.D. 0.05		**1.432**		

ISSN 2072-3857

Table (3) Effect of herbicides, biofertilizers and irrigation periods on the percentage of dry matter (%) of the potato crop

irrigation periods ×herbicide	autumn season			herbicide	irrigation periods
	Biofertilizer				
	Rhizo.	*Myco.*	without adding		
40.04	38.40	42.05	39.66	Co	5day
46.58	47.81	47.88	44.05	Pre	
51.55	56.21	52.12	46.32	Post	
46.11	50.46	50.46	40.81	Late	
38.88	38.98	38.74	38.94	Co	7day
50.06	55.62	47.06	47.51	Pre	
49.22	51.09	56.18	40.40	Post	
52.30	57.53	57.62	41.74	Late	
35.24	34.97	36.94	33.81	Co	9day
41.67	42.36	42.45	40.21	Pre	
43.39	44.21	48.24	37.73	Post	
42.70	43.22	46.43	38.46	Late	
2.087	**3.812**			L.S.D. 0.05	
Irrigation average	irrigation periods × Biofertilizer				
46.07	47.37	48.13	42.71	5 day	
47.62	50.80	49.90	42.15	7 day	
40.75	41.19	43.51	37.55	9day	
1.090	**2.087**			L.S.D. 0.05	
average herbicide	herbicide × Biofertilizer				
38.05	37.45	39.24	37.47	Co	
46.11	48.60	45.80	43.92	Pre	
48.05	50.50	52.18	41.48	Post	
47.04	49.27	51.50	40.34	Late	
1.288	**2.266**			L.S.D. 0.05	
	46.46	47.18	40.80	Biofertilizer average	
	L.S.D. 0.05		**1.301**		

Tables (4 and 5) show that the herbicide treatment had a significant effect on increasing the percentage of nitrogen in the tubers to (1.666 and 1.913%) compared to control treatment that gave (1.310) and 1.605%) for both seasons, respectively. The two types of biofertilizer were significantly excelled compared to control treatment, and this is due to the role of the biofertilizer for mycorrhiza fungi, represented by stabilizing and activating the availability of nutrients in the plant through its settlement in the rhizosphere and the external and internal surfaces of the plant roots. Mycorrhizae contributed to increasing the readiness and uptake of nitrogen in tubers, due to its role in the processing of nitrogen in the form of ammonia NH4, and then providing the plant with high requirements for the nitrogen element (10), and the fertilizer (Myco) was significantly excelled, as it gave the highest average of (1.524 and 1.934%). Compared to compost (Rhizo).The irrigation

ISSN 2072-3857

period every 5 days was significantly excelled by giving it the highest reading of the percentage of nitrogen in the tubers, which amounted to (1.524 and 1.897%), while the irrigation period every 9 days gave the lowest mean, which amounted to (1.524 and 1.557%) for both seasons, respectively.It also appears from the table that the bilateral interactions between the factors of the experiment had a significant effect on this traits, where the interaction between the irrigation periods and the herbicide gave a significant effect, and the interaction of 5 days × each of Pre and Post gave it the highest reading for trait of the percentage of nitrogen in tubers, which amounted to (1.583 and 1.683%) respectively for the first season and (1.920 and 2.186%) respectively for the second season, while all irrigation periods × comparison gave the lowest mean for both seasons. The interaction between irrigation periods and bio-fertilizer gave a significant effect and excelled the interaction of 5 days × Myco by giving it the highest reading of trait of the percentage of nitrogen in tubers (1.797 and 2.177 %) for both seasons, respectively, while all irrigation treatments with comparison (without bio-fertilizer) gave the lowest mean in both seasons. The interaction between the herbicide and biofertilizer gave a significant effect and the post × Myco interaction was excelled by giving it the highest reading of the percentage of nitrogen in tubers (1.699 and 2.368%) for both seasons, respectively, while the control interaction (without herbicide × without fertilizer) gave the lowest average for both seasons.The interaction between the three factors had a significant effect and was excelled to the interaction of 5 days × Post × Myco by giving it the highest reading of trait of the percentage of nitrogen in tubers (2.253 and 2.870%) for both seasons, respectively, while the interactions of all irrigation treatments × without herbicide × without fertilizer gave the lowest average for both seasons.

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Table (4) Effect of herbicides, biofertilizers and irrigation periods on the percentage of nitrogen in the tubers of the potato crop

irrigation periods ×herbicide	spring season			herbicide	irrigation periods
	Biofertilizer				
	Rhizo.	*Myco.*	without adding		
1.321	1.283	1.363	1.317	Co	5day
1.583	1.420	2.017	1.313	Pre	
1.683	1.460	2.253	1.337	Post	
1.509	1.573	1.557	1.397	Late	
1.339	1.350	1.340	1.327	Co	7day
1.452	1.537	1.463	1.357	Pre	
1.380	1.323	1.473	1.343	Post	
1.399	1.323	1.490	1.383	Late	
1.270	1.287	1.257	1.267	Co	9day
1.296	1.257	1.407	1223	Pre	
1.336	1.363	1.370	1.273	Post	
1.306	1.287	1.297	1.333	Late	
0.129	**0.220**			L.S.D. 0.05	
Irrigation average	irrigation periods × Biofertilizer				
1.524	1.434	1.797	1.341	5 day	
1.392	1.383	1.442	1.352	7 day	
1.302	1.298	1.332	1.274	9day	
0.077	**0.099**			L.S.D. 0.05	
average herbicide	herbicide × Biofertilizer				
1.310	1.307	1.320	1.303	Co	
1.444	1.404	1.629	1.298	Pre	
1.666	1.382	1.699	1.318	Post	
1.404	1.394	1.448	1.371	Late	
0.077	**0.127**			L.S.D. 0.05	
	1.372	1.524	1.322	Biofertilizer average	
	L.S.D. 0.05		**0.058**		

ISSN 2072-3857

Table (5) Effect of herbicides, biofertilizers and irrigation periods on the percentage of nitrogen in the tubers of the potato crop

irrigation periods ×herbicide	autumn season			herbicide	irrigation periods
	Biofertilizer				
	Rhizo.	*Myco.*	without adding		
1.661	1.737	1.633	1.613	Co	5day
1.920	1.880	2.273	1.607	Pre	
2.186	2.103	2.870	1.583	Post	
1.822	1.863	1.930	1.673	Late	
1.628	1.573	1.647	1.663	Co	7day
1.702	1.720	1.907	1.480	Pre	
1.927	1.837	2.460	1.483	Post	
1.814	1.923	1.893	1.627	Late	
1.527	1.483	1.567	1.530	Co	9day
1.533	1.583	1.673	1.343	Pre	
1.627	1.670	1.773	1.437	Post	
1.542	1.483	1.583	1.560	Late	
0.145	**0.236**			L.S.D. 0.05	
Irrigation average	irrigation periods × Biofertilizer				
1.897	1.896	2.177	1.619	5 day	
1.768	1.763	1.977	1.563	7 day	
1.557	1.555	1.649	1.468	9day	
0.105	**0.120**			L.S.D. 0.05	
average herbicide	herbicide × Biofertilizer				
1.605	1.598	1.616	1.602	Co	
1.719	1.728	1.951	1.477	Pre	
1.913	1.870	2.368	1.501	Post	
1.726	1.757	1.802	1.620	Late	
0.081	**0.133**			L.S.D. 0.05	
	1.738	1.934	1.550	Biofertilizer average	
	L.S.D. 0.05		**0.062**		

Tables (6 and 7) show that the herbicide treatment had a significant effect on increasing the phosphorus concentration to (0.437 and 0.452%) compared to control treatment that gave (0.367 and 0.385%) for both season, respectively.The biofertilizer of both types was significantly excelled compared to control treatment, and this is due to the role of the biofertilizer. Perhaps one of the most important mechanisms for the action of mycorrhizae is to increase the readiness of the phosphorus element, as it contributed to increasing the phosphorus in the tubers, by dissolving the phosphorus and converting it into forms ready for absorption by the plant on the one hand, as well as excretion On the other hand (11) the organic acids that hold iron, calcium and aluminum elements, which ensures the presence of dissolved phosphorous in the soil solution (11) and (Myco) fertilizer was significantly excelled to the highest average phosphorus concentration of (0.431 and 0.448%) compared to (Rhizo) fertilizer. The irrigation period every 7 days was

ISSN 2072-3857

significantly excelled in increasing the phosphorus concentration to (0.443 and 0.462%), while the irrigation period every 9 days gave the lowest average (0.367 and 0.392%) for both season, respectively. Which suffer from a lack of phosphorus, but its role is not limited to that only, as it contributes to the plant's tolerance of drought, as it can encourage the formation of root hairs and the extension of long distances in search of water and nutrients (12).It also appears from the table that the bilateral interactions between the factors of the experiment had a significant effect on this trait, as the interaction between the irrigation periods and the herbicide gave a significant effect, and the interaction of 7 days × each of Pre and Post was excelled, with the highest average phosphorus concentration reaching (0.484 and 0.481%), respectively, for the first season and (0.504 and 0.503 (% respectively) for the second season, while all irrigation periods × comparison gave the lowest mean for both season.The interaction between irrigation periods and biofertilizers gave a significant effect, and the interaction of 7 days × Myco was excelled to the highest average phosphorous concentration (0.499 and 0.519%) for both season, respectively, while all irrigation treatments with comparison (without biofertilizer) gave the lowest average in both seasons.The interaction between the herbicide and biofertilizer gave a significant effect, and the interaction of Pre×Rhizo was excelled to the highest average of phosphorus concentration (0.491 and 0.506%) for both season, respectively, while the comparison interaction (without herbicide × without fertilizer) gave the lowest average for both season.The interaction between the three factors had a significant effect, and the interaction of 7 days × Post × Myco had the highest average phosphorus concentration of (0.563 and 0.590%) for both season, respectively, while the interactions of all irrigation treatments × without herbicide × without fertilizer gave the lowest average for both season.

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Table (6) Effect of herbicides, biofertilizers and irrigation periods on the percentage of phosphorus in the tubers of the potato crop

irrigation periods ×herbicide	spring season			herbicide	irrigation periods
	Biofertilizer				
	Rhizo.	*Myco.*	without adding		
0.374	0.393	0.360	0.370	Co	5day
0.429	0.490	0.427	0.370	Pre	
0.416	0.443	0.440	0.363	Post	
0.391	0.420	0.407	0.347	Late	
0.381	0.360	0.410	0.373	Co	7day
0.484	0.547	0.527	0.380	Pre	
0.481	0.500	0.563	0.380	Post	
0.427	0.423	0.497	0.360	Late	
0.346	0.340	0.350	0.437	Co	9day
0.399	0.437	0.400	0.360	Pre	
0.391	0.423	0.407	0.343	Post	
0.364	0.380	0.380	0.333	Late	
0.019	**0.033**			L.S.D. 0.05	
Irrigation average	irrigation periods × Biofertilizer				
0.403	0.437	0.408	0.363	5 day	
0.443	0.458	0.499	0.373	7 day	
0.375	0.395	0.384	0.346	9day	
0.016	**0.023**			L.S.D. 0.05	
average herbicide	herbicide × Biofertilizer				
0.367	0.364	0.373	0.363	Co	
0.437	0.491	0.451	0.370	Pre	
0.429	0.456	0.470	0.362	Post	
0.394	0.408	0.428	0.347	Late	
0.009	**0.019**			L.S.D. 0.05	
	0.429	0.431	0.361	Biofertilizer average	
	L.S.D. 0.05		**0.014**		

ISSN 2072-3857

Table (7) Effect of herbicides, biofertilizers and irrigation periods on the percentage of phosphorus in the tubers of the potato crop

irrigation periods ×herbicide	autumn season			herbicide	irrigation periods
	Biofertilizer				
	Rhizo.	*Myco.*	without adding		
0.388	0.407	0.377	0.380	Co	5day
0.442	0.510	0.437	0.380	Pre	
0.434	0.470	0.460	0.373	Post	
0.406	0.440	0.420	0.357	Late	
0.397	0.373	0.423	0.393	Co	7day
0.504	0.570	0.547	0.397	Pre	
0.503	0.527	0.590	0.393	Post	
0.443	0.443	0.517	0.370	Late	
0.371	0.340	0.367	0.407	Co	9day
0.409	0.437	0.410	0.380	Pre	
0.406	0.423	0.423	0.370	Post	
0.381	0.380	0.403	0.360	Late	
0.026	**0.0413**			L.S.D. 0.05	
Irrigation average	irrigation periods × Biofertilizer				
0.418	0.457	0.423	0.373	5 day	
0.462	0.478	0.519	0.388	7 day	
0.392	0.395	0.401	0.379	9day	
0.022	**0.028**			L.S.D. 0.05	
average herbicide	herbicide × Biofertilizer				
0.385	0.373	0.389	0.393	Co	
0.452	0.506	0.464	0.386	Pre	
0.448	0.473	0.491	0.379	Post	
410	0.421	0.447	0.362	Late	
0.012	**0.024**			L.S.D. 0.05	
	0.443	0.448	0.380	Biofertilizer average	
	L.S.D. 0.05		**0.016**		

Percentage of starch in tubers (%) :

Tables (8 and 9) show that the pesticide treatment had a significant effect on increasing the percentage of starch in the tubers to (36.83 and 38.80%) compared to control treatment that gave (28.24 and 29.92%) for both season, respectively.The two types of biofertilizers were significantly excelled compared to control treatment, and this is due to the role of biofertilizers in increasing the readiness of macro and micronutrients. These nutrients play an important role in activating the enzymes involved in the carbon metabolism process and increasing the manufactured carbohydrates that are stored in tubers, which leads to an increase in the percentage of starch that It is directly proportional to the increase in dry matter in the tubers, and these results are consistent with what was found by Sarhan (2008), and the fertilizer (Myco) was significantly excelled to the highest average characteristic of the percentage of starch in the tubers, which reached (36.08 and 38.02%)

ISSN 2072-3857

compared to the fertilizer (Rhizo).The irrigation period every 7 days was significantly excelled, with the highest average of the percentage of starch in tubers reaching (36.09 and 38.41%) for both season, respectively, while the irrigation period every 9 days gave the lowest average amounting to (30.65 and 32.27%) for both season, respectively. Its increase may be attributed to the availability of sufficient moisture. And the role of water in increasing enzymatic activity and increasing the permeability of membranes, and then increasing the transfer and accumulation of manufactured materials from vegetative in the form of simple sugars, then this sugar turns into starch as soon as it reaches the tubers (Khalil, 1998 and Al-Hamdani et al., 2013). The improvement of the qualitative traits by exploiting the symbiotic relationship between mycorrhiza and the roots of the plant host lies in increasing the readiness and absorption of nutrients by the plant. It also appears from the table that the bi- interactions between the factors of the experiment had a significant effect on this trait, as the interaction between the irrigation periods and the pesticide gave a significant effect, and the interaction of 7 days x each of the pre and late times had the highest average of the percentage of starch in the tubers, which reached (38.62 and 41.20%) for the season. the first, respectively, and (40.59 and 42.57%), respectively, for the second season, while all irrigation periods × comparison gave the lowest mean for both season. The interaction between the irrigation periods and biofertilizer gave a significant effect, and the interaction of 7 days × Rhizo was excelled to the highest mean of the percentage of starch in the tubers (39.46 and 41.24%) for both season, respectively, while all irrigation treatments with comparison (without biofertilizer) gave the lowest mean in both seasons.The interaction between the pesticide and the biofertilizer gave a significant effect, and the interaction of Late×Myco had the highest average of the percentage of starch in the tubers (41.13%) for the first season, and the interaction of Post×Myco gave the highest average of the percentage of starch in the tubers (42.47%) for the second season, while it gave The interaction of comparison (without pesticide × without fertilizer) is less average for both season.The interaction between the three factors had a significant effect, and the interaction between 7 days × Late × Myco had the highest mean of the percentage of starch in tubers (45.84 and 47.31%) for both season, respectively, while the interactions of all irrigation treatments × without pesticide × without fertilizer gave the lowest average for both season.

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Table (8) Effect of pesticides, biofertilizers and irrigation periods on the percentage of starch in tubers (%) for the potato crop

irrigation periods ×herbicide	spring season			herbicide	irrigation periods
	Biofertilizer				
	Rhizo.	*Myco.*	control		
29.89	29.05	31.63	29.00	Co	5 day
35.14	36.36	36.05	33.01	Pre	
39.73	43.80	39.44	35.94	Post	
34.96	36.35	38.17	30.35	Late	
29.23	29.23	29.68	28.77	Co	7 day
38.62	43.23	35.76	36.87	Pre	
37.75	40.03	43.05	30.18	Post	
41.20	45.36	45.84	32.40	Late	
25.60	24.91	27.33	24.57	Co	9 day
31.51	32.37	32.12	30.04	Pre	
33.02	33.65	37.51	27.91	Post	
32.45	33.90	36.37	27.07	Late	
1.949	**3.439**			L.S.D. 0.05	
irrigation average	irrigation periods × Biofertilizer				
34.93	36.39	36.32	32.08	5 day	
36.70	39.46	38.58	32.05	7 day	
30.65	31.21	33.33	27.40	9 day	
1.180	**2.015**			L.S.D. 0.05	
average herbicide	herbicide × Biofertilizer				
28.24	27.73	29.54	27.45	Co	
35.09	37.32	34.64	33.31	Pre	
36.83	39.16	40.00	31.34	Post	
36.20	38.54	40.13	29.94	Late	
1.163	**2.015**			L.S.D. 0.05	
	35.69	36.08	30.51	average Biofertilizer	
	L.S.D. 0.05		**1.111**		

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Table (30) Effect of herbicide, biofertilizer and irrigation periods on the percentage of starch in tubers (%)for the potato crop

irrigation periods ×herbicide	Autumn season			herbicide	irrigation periods
	Biofertilizer				
	Rhizo.	*Myco.*	control		
31.73	30.21	33.46	31.53	Co	5 day
37.39	37.99	38.65	35.54	Pre	
41.91	46.05	42.41	37.26	Post	
37.07	37.91	40.94	32.35	Late	
30.63	30.72	30.48	30.68	Co	7 day
40.59	45.53	37.91	38.31	Pre	
39.84	41.49	46.03	31.99	Post	
42.57	47.23	47.31	33.18	Late	
27.39	27.16	28.91	26.12	Co	9 day
33.12	33.73	33.81	31.81	Pre	
34.65	35.38	38.96	29.61	Post	
33.93	34.20	37.32	30.26	Late	
1.852	**3.379**			L.S.D. 0.05	
irrigation average	irrigation periods × Biofertilizer				
37.02	38.04	38.86	34.17	5 day	
38.41	41.24	40.43	33.54	7 day	
32.27	32.61	34.75	29.45	9 day	
0.990	**1.772**			L.S.D. 0.05	
average herbicide	herbicide × Biofertilizer				
29.92	29.36	30.95	29.44	Co	
37.03	39.08	36.79	35.22	Pre	
38.80	40.97	42.47	32.95	Post	
37.86	39.78	41.86	31.93	Late	
1.138	**2.008**			L.S.D. 0.05	
	37.30	38.02	32.39	average Biofertilizer	
	L.S.D. 0.051.162				

References

1- Taha, Farouk Abdel Aziz (2007). The effect of potassium fertilizer and soil mulching on three cultivars of potato (Solanum tuberosum L.) grown in Basra Governorate, PhD thesis, College of Agriculture, University of Basra, Ministry of Higher Education and Scientific Research, Republic of Iraq.

6- Alrawi, Mahmoud and Abdel-Aziz Muhammad Khalafallah. (1980). Design and analysis of agricultural experiments. faculty of Agriculture. University of Al Mosul. Iraq.

7- Dhiab, Naim Saeed. (2012). The use of rock phosphate and superphosphate and the addition of fungal and bacterial fertilizers on the growth and yield of potatoes. PhD thesis. College of Agriculture, University of Baghdad.

8- Aboud, Muhammad Rasool Hussein (2019). Effect of chemical fertilization, mycorrhiza, seaweed extract and yeast on some soil properties, growth and yield of potatoes. Master Thesis. faculty of Agriculture. Al-Qasim Green University. Iraq.

ISSN 2072-3857

9- Al-Asafi, Salam Muhammad Abd (2018). The interaction between azotobacter and mycorrhizae and the level of fertilizer recommendation in the concentrations of some avaibile elements in the soil and the growth and yield of potatoes. PhD thesis. faculty of Agriculture. Anbar University. The Republic of Iraq.

11- Matroud, Abd al-Nabi Abd al-Amir (2017). Soil fungi and their role in plant protection. faculty of Agriculture. Albasrah university. Ministry of Higher Education and Scientific Research. The Republic of Iraq.

2-McGregor, I. (2007). The fresh potato market. In: Vreugdenhil, D. (Ed.), Potato Biology and Biotechnology. lsevier, Amsterdam. pp.3-36.

3-Van Gijessel, J. (2005). The potential of potatoes for attractive convenience food: focus on productquality and nutritional value. In: Haverkort A.J.; Struik P.C. (Eds.), Potato in Progress ScienceMeets Practices. Wageningen Academic Publishers, Wageningen, The Netherlands. 27-32.

4-Al-Ziyadi, Saddam Hatem Abdel-Rahim, Raysan Karim Shatti. (2010). The effect of seed rates and herbicides on the growth of the bush accompanying the rice crop, Iraqi Journal of Agricultural Sciences-41(4):31-46.

5-Savci , S.(2012). An agricultural pollutant: chemical fertilizer. International Journal of Environmental Science and Development, 3(1) ,73.

10-Hodge, A. and K. Storer.(2015)..*Arbuscular mycorrhiza* and nitrogen: implications for individual plants through to ecosystems. Plant and Soil,386(1-2):1-19.

12-Utobo, E. B.; E. N. Ogbodo and Nwogbaga, A. C.(2011).Techniques for extraction and quantification of *Arbuscular mycorrhizal* Fungi. Libyan Agric. Res. Center J. Internet,2(2):68-78.

13-Mahanty, T., S. Bhattacharjee, M. Goswani, P. Bhattacharyya, B. Das, A. Ghosh and Tribedi, P. (2016). Bio fertilizers: a potential approach for sustainable agriculture development. Review Article. Environ Sci. Pollut Res., 1–22.

14-Tomer, S., D. C. Suyal and Goel, R. (2018). Biofertilizers: A timely approach for sustainable agriculture., Plant Microbe Interaction., 17 : 375 – 195.

Sturz, A.V.,B. chritie and J. Nowak .(2000). Bacterial role in developing sustainable systems of crops production. Crit. Rev. plant Sci., 19; 1-30.

ISSN 2072-3857