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THE EFFECT OF ORGANIC RESIDUES AND SPRAYING OF POTASSIUM AND ZINC ON QUALITATIVE CHARACTERISTICS AND EFFECTIVENESS OF PEROXIDASE ENZYME IN POTATO

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Abstract

In 2018 spring season, an experiment was conducted in one field in Babylon province to test the effect of adding organic residues (poultry dung, rice residues and palm fronds residues), spraying of zinc sulphate and potassium sulphate on qualitative characteristics and effectiveness of peroxidase enzyme of potato (SYLVANA cultivar). Results showed significant effect of rice residuesin the first spring season comparison with control treatment in qualitative weight of tubers (1.083), dry weight ratio (19.843%) and starch ratio (13.680%). Zinc sulphate treatment at concentration of 0.4 (gm.L^{-1}) was higher than control in dry weight ratio (18.952%) and starch ratio (12.885%). While in the second season, poultry dung treatment had the highest values in dry weight ratio (19.761%), starch ratio (13.610%) and peroxidase enzyme after harvesting directly (21.91 absorption unit.minte.gm^{-1} soft weight). Spraying zinc sulphate at 4 (gm.L^{-1}) concentrations had significant effect in dry weight ratio (19.042%), starch ratio (12.389%) and qualitative weight of tubers (1.117). Whereas 0.2 concentration had better value of vitamin C in tubers (12.389 mg.100 gm^{-1} soft weight) and peroxidase enzyme (16.90 absorption unit.minte.gm^{-1}) after harvesting directly.

***Keywords* :** *Solanum tuberosum*, leaf feeding, potassium sulphate, peroxidase enzyme.

Introduction

Potato (*Solanum tuberosum* L.) is vegetable crop that belonging to Solanaceae family. *Solanum* genus comprises more than 2000 species and all these species are annual plants, eudicots and most cultivated worldwide and consumed as a tuber crop (Hassan, 1999). Potato is become the fourth main food after wheat,riceand maize in terms of yield and consumption. The area that growing by potato reached 19089.328 h globally and total of 381,682,144 ton productivity, while the area that growing by potato in Iraq has reached 25.745 h with average productivity of 15.6 ton/h and total yield 402302 ton (FAO, 2017). Studies are clearly indicated the reduction of potato yield in Iraq in comparison with other countries. The organic fertilization is considered as an important method to provide plants with essential nutrient requirements without any negative effect on the environment. In addition, it improves the structure of soil and makes nutrients ready for plants (Cook, 1972). Thus, current study is conducted due to the major roll of potassium and zinc elements in physiological processes inside plant by spraying those nutrients on leafs of potato plants. This research aims to study qualitative characteristics and effectiveness of peroxidase enzyme in potato.

Materials and Methods

The experiment was conducted in two farms, the first one located in Keffel, Babylon province in 2017 first spring season and the second farm in Debla South of Babylon province in 2018second spring season. Potato seeds of SYLVANA cultivar for first spring season were planted in 1/2/2017 and for second spring season in 8/1/2018 on rows and the distance between these rows was 75 cm and between tubers was 25 cm. The total tubers in each row were 32 and the experimental unit area was 7.5m^2(1 meter was left between each experimental unit to prevent the transportation between treatments). The experiment was designed using RCBD and the organic residues were put in the main plot. 36 treatments were applied in this experiment with three replicates for each treatment. The least significant difference (L.S.D.) was used to compare means at 5% level of significance (P>0.05) (Al-Rawi and Khalafala, 2000).

Soil samples were taken from 0-30 cm depth of soil surface and analyzed in soil laboratory/ Faculty of Agriculture/University of Kufa(Table 1). While the chemical and physical characteristics of adding fertilizers were analysed in laboratories of Green University of Al Qasim (Table 2).

Table 1: Chemical and physical characteristics of field soil.

Soil characteristics	Standard Unit	Spring season 2017	Spring season 2018
PH	-		7.7
EC	$dS.m^{-1}$		2.2
N	%		1.4
P	%		0.33
K	%		0.13
Organic material	%		1.07
Sand	%		22
Silt	%		54
Clay	%		24
Soil texture	-		

Table 2 : Chemical and physical characteristics of added fertilizers in this study.

Soil characteristics	Palm fronds fertilizer	Rice residues fertilizer	Poultry dung fertilizer
PH	7.4	6.18	7
EC($Ds.m^{-1}$)	5.148	4.11	9.5
N%	1.46	0.96	0.71
P%	0.454	0.083	1.311
K+%	2.89	2.147	2.5
Organic material	68.7	12.14	65

All added fertilizers in this study were obtained from National Centre of Organic Agriculture/Najaf/Ministry of Agriculture and added to soil 10 days before planting potato tubers by sawing and mixing these fertilizers very well with soil as a first factor. The average use of palm fronds and rice residues fertilizers was 20 $ton.h^{-1}$ and 2 $ton.h^{-1}$ for poultry dung fertilizer. The second factor was spraying potato leafs with potassium sulphate (SO_4K_2) using three levels of concentrations (0, 2.5 and 5 $gm.L^{-1}$). The third factor was spraying potato leafs with zinc sulphate using three levels of concentrations (0, 0.2 and 0.4 $gm.L^{-1}$). After 45 days of planting, plants were sprayed by both potassium and zinc sulphate in tuber initiation stage then spraying was don twice every 15 days and the following plant characteristics were recorded:

1- **Dry weight ratio in tubers:** 5 tubers were chosen randomly from each experimental unitthen washed with water after those tubers were cut into slices. 100gm of potato slices were taken and put electric oven at 70±2 for 72h then dry weight ratio calculated (Al-Sahaf, 1989).
2- **Carbohydrates ratio in tubers:** The total amount of soluble carbohydrates was estimated according to(Herbert *et al*., 1971).
3- **Starch ratio in tubers:** A.O.A.C. (1970) procedure was used to estimate starch ratio in tubers as follows: Starch ratio%= 17.55+0.89x (Dray weight ratio in tubers – 24.18).
4- **Qualitative weight of tubers:** 5 marketable tubers were chosen randomly from each experimental unit then scaled in electric scale and put in 1000ml flask that contains water then qualitative weight of tubers was calculated according to (Hassan, 1999).

5- **Tubers content of ascorbic acid (mg.100gm soft $weight^{-1}$):** Vitamin C was estimated according to (Abass and Abass, 1992).
6- **The effectiveness of peroxidase enzyme (absorption $unit.minte.gm^{-1}$ soft weight):** 1gm of potato tuber was smashed by clean knife in 10ml solution puffer (pH=7)then filtered by filter paper and centrifuged at 1000c/m then POD effectiveness was estimated according to (Nezih, 1985).

Results and Discussion

Dry weight ratio in tubers

Results of Table 3 for the first season showed that adding organic residues had significant effect on dry weight rate of tubers. Poultry dung treatment gave greater dry weight 19.843% in comparison with control treatment that showed the lowest rate17.192%. Spraying of zinc sulphate had also significant effect on the dry weight at 0.4 $gm.L^{-1}$96.08cm concentration where reached 18.952% while control treatment gave 17.964%.Potassium sulphate treatment was not significant in first season results. In the second season, poultry dung treatment increased dry weight rate to 19.761% compare to 17.199% in control. Zinc sulphate treatment at 0.4 $gm.L^{-1}$ concentration gave the highest dry weight 19.042% in comparison with 18.339% in control treatment, whereas 5 $gm.L^{-1}$ concentration of potassium sulphate gave 18.810% dry weight compare to 18.623% in control. Results of this study were in agreement with previous studies (Al Byati, 2013; Sultany, 2015) that reported increasing of dry weight ratio when adding organic fertilizers rather than chemical fertilizers. The reason for these results may be due to availability of mineral elements in soil solution as a result of decomposition of organic matter and increasing nutrient absorption by plant roots (Al-Sahaf, and Aty, 2007) as these nutrients with spraying of potassium and zinc on potato leafs play significant role to enhance enzymes that contribute in carbon synthesis and increasing of carbohydrates in tubers (AlNaamy, 2011).

Table 3 : The effect of zinc and potassium and their interaction on dry weight ratio in tubers.

Second spring season				**First spring season**				**Treatments**	
Interaction of residues ×zinc sulphate	**Potassium sulphate g.L^{-1}**			**Interaction of residues zinc × sulphate**	**Potassium sulphate g.L^{-1}**			**Zinc sulphate g.L^{-1}**	**Organic residues**
	5	**2.5**	**control**		**5**	**2.5**	**Control**		
17.133	17.000	17.483	16.917	17.033	16.897	16.887	17.317	**control**	**Control**
17.322	17.520	17.187	17.260	17.123	17.240	17.267	16.863	**0.2**	
17.142	17.110	17.050	17.267	17.419	17.217	17.500	17.540	**0.4**	
18.794	19.533	18.790	18.060	18.567	18.500	18.767	18.433	**control**	**Poultry dung 2 ton.ha^{-1}**
20.117	20.157	20.207	19.987	20.348	19.833	20.650	20.560	**0.2**	
20.372	20.353	20.397	20.367	20.616	20.667	20.467	20.713	**0.4**	
18.429	18.370	18.583	18.333	17.736	18.067	17.740	17.400	**control**	**Rice residues 20ton.ha^{-1}**
18.517	18.510	18.623	18.417	18.727	18.733	18.433	19.013	**0.2**	
18.640	18.430	18.707	18.783	18.201	18.357	17.927	18.320	**0.4**	
18.998	19.260	18.927	18.807	18.519	18.733	18.250	18.573	**control**	**Palm fronds residues 20ton.ha^{-1}**
19.361	19.443	19.373	19.267	18.806	18.940	19.203	18.273	**0.2**	
20.016	20.033	20.003	20.010	19.572	19.817	19.417	19.483	**0.4**	
0.248	0.424			1.061	n.s			LSD	
Effect of organic residues	18.810	18.777	18.623	**Effect of organic residues**	18.583	18.542	18.541	**Effect of potassium sulphate**	
	0.125				n.s			LSD	
17.199	17.210	17.240	17.148	17.192	17.118	17.218	17.240	**control**	**Interaction of residues ×potassium sulphate**
19.761	20.014	19.798	19.471	19.843	19.667	19.961	19.902	**Poultry dung 2 ton.ha^{-1}**	
18.529	18.437	18.638	18.511	18.221	18.386	18.033	18.244	**Rice residues 20ton.ha^{-1}**	
19.458	19.579	19.434	19.361	18.966	19.163	18.957	18.777	**Palm fronds residues 20ton.ha^{-1}**	
0.193	0.262			0.960	n.s			LSD	
Effect of zinc sulphate				**Effect of zinc sulphate**					
18.339	18.541	18.446	18.029	17.964	18.049	17.911	17.931	**control**	**Interaction of zinc sulphate potassium × sulphate**
18.829	18.907	18.847	18.732	18.751	18.687	18.888	18.678	**0.2**	
19.042	18.982	19.039	19.107	18.952	19.014	18.828	19.014	**0.4**	
0.115	0.206			0.385	n.s			LSD	

Carbohydrates ratio in tubers

Results of first season showed significant effect in carbohydrates ratio in potato tubers where reached 12.500%in the poultry dung treatment compare to 11.476 in control treatment (Table 4). Zinc sulphate treatment at 0.4 gm.L^{-1} concentration also gave better rate of carbohydrates in tubers11.904% in comparison with the control which gave 11.690%. Potassium sulphate treatment was not significant in carbohydrates ratio. The second season results showed greatest and significant effect in poultry dung residues treatments that reached 11.974% compare to 11.384% in control while, there were no significant effect in potassium and zinc sulphate treatments and their interaction. The increasing of carbohydrates ratio in tubers in the first season mayoccurred due to the spraying of zinc and potassium sulphate. The potassium element may enhances tubers growth by increasing leafs efficiency in carbon synthesis and transmission of manufactured materials to tubers. Moreover, potassium play major role in the movement of carbohydrates from their formation to their storage locations (Havlin *et al.*, 2005).Potassium also has an important role in starch formation and increase the efficiency of starch syntheatase, transport enzymes and carbon synthesis which lead to increase carbohydrates ratio inside potato tubers.

Table 4 : The effect of adding organic residues and spraying potassium and zinc sulphate and their interaction on carbohydrates ratio in tubers.

Second spring season				**First spring season**				**Treatments**	
Interaction of residues zinc × sulphate	**Potassium sulphate g.L^{-1}**			**Interaction of residues zinc × sulphate**	**Potassium sulphate g.L^{-1}**			**Zinc sulphate g.L^{-1}**	**Organic residues**
	5	**2.5**	**control**		**5**	**2.5**	**Control**		
11.191	11.410	11.203	10.96	11.252	11.350	11.333	11.073	**control**	**Control**
11.488	11.452	11.355	11.65	11.417	11.430	11.327	11.493	**0.2**	
11.473	11.950	11.220	11.250	11.759	12.020	11.820	11.437	**0.4**	
12.109	11.663	12.302	12.363	12.424	12.407	12.430	12.437	**control**	**Poultry dung 2 ton.ha^{-1}**
12.115	12.223	11.990	12.13	12.373	12.430	12.443	12.247	**0.2**	
11.698	11.902	11.482	11.71	12.703	12.730	12.613	12.767	**0.4**	
11.391	11.210	11.395	11.56	11.464	11.473	11.367	11.553	**control**	**Rice residues 20ton.ha^{-1}**
11.479	11.617	11.463	11.35	11.497	11.430	11.330	11.730	**0.2**	
11.316	11.228	11.280	11.44	11.613	11.707	11.737	11.397	**0.4**	
11.447	11.465	11.385	11.490	11.620	11.743	11.520	11.597	**control**	**Palm fronds residues 20ton.ha^{-1}**
11.726	11.730	11.830	11.61	11.629	11.613	11.510	11.763	**0.2**	
11.535	11.635	11.663	11.307	11.541	11.613	11.510	11.500	**0.4**	
n.s	n.s			0.175	n.s			LSD	
Effect of organic residues	11.624	11.547	11.571	**Effect of organic residues**	11.829	11.745	11.749	**Effect of potassium sulphate**	
	n.s				n.s			LSD	
11.384	11.604	11.259	11.289	11.476	11.600	11.493	11.334	**control**	**Interaction of residues potassium × sulphate**
11.974	11.929	11.924	12.068	12.500	12.522	12.496	12.483	**Poultry dung 2 ton.ha^{-1}**	
11.395	11.352	11.379	11.454	11.525	11.537	11.478	11.560	**Rice residues 20ton.ha^{-1}**	
11.569	11.610	11.626	11.472	11.597	11.657	11.513	11.620	**Palm fronds residues 20ton.ha^{-1}**	
0.182	n.s			0.072	n.s			LSD	
Effect of zinc sulphate				**Effect of zinc sulphate**					
11.534	11.437	11.571	11.595	11.690	11.743	11.662	11.665	**control**	**Interaction of zinc sulphate potassium × sulphate**
11.702	11.755	11.660	11.691	11.729	11.726	11.652	11.808	**0.2**	
11.506	11.679	11.411	11.427	11.904	12.017	11.920	11.775	**0.4**	
n.s	n.s			0.102	0.154			LSD	

Starch ratio in tubers:

Results of the first season showed that poultry residues had significant effect in starch ratio of potato tubers which reached 13.680% compare to control treatment that recorded the lowest rate 11.310% (Table 5). Zinc sulphate treatment had great rate of starch at 0.4gm.L^{-1} concentration 12.885% in comparison with control 12.009%. While potassium sulphate treatment was not significant in starch rate of tubers. In the second season, poultry dung treatment showed significant effect and recorded 13.610% of starch rate in comparison with control which recorded the lowest rate 11.328%. Zinc sulphate treatment at 0.4 gm.L^{-1}concentrations showed higher ratio of starch 12.763% compare with 12.343% in control. While the potassium sulphate treatment at 5.00 gm.L^{-1} concentration recorded 12.763% and increased starch ratio significantly compare to control treatment which recorded the lowest rate 12.596%. The reason for these results may be due to availability of meniral elements in soil solution as a result of decomposition of organic matter and increasing nutrient absorption by plant roots (Al-Sahaf, and Aty, 2007) as these nutrients with spraying of potassium and zinc on potato leafs play significant role to enhance enzymes that contribute in carbon synthesis and increasing of carbohydrates in tubers which lead to increase starch ratio (Hassan, 2003).

Table 5 : The effect of adding organic residues and spraying potassium and zinc sulphate and their interaction on starch ratio in tubers.

Second spring season				**First spring season**				**Treatments**	
Interaction of residues zinc × sulphate	**Potassium sulphate g.L^{-1}**			**Interaction of residues zinc × sulphate**	**Potassium sulphate g.L^{-1}**			**Zinc sulphate g.L^{-1}**	**Organic residues**
	5	**2.5**	**control**		**5**	**2.5**	**control**		
11.269	11.151	11.581	11.076	11.174	11.053	11.043	11.427	**control**	**Control**
11.364	11.614	11.317	11.382	11.236	11.360	11.323	11.023	**0.2**	
11.277	11.248	11.195	11.388	11.519	11.340	11.590	11.627	**0.4**	
12.749	13.407	12.745	12.095	12.543	12.487	12.720	12.423	**control**	**Poultry dung 2 ton.ha^{-1}**
13.927	13.963	14.008	13.811	14.128	13.670	14.397	14.317	**0.2**	
14.155	14.138	14.177	14.150	14.368	14.413	14.233	14.457	**0.4**	
12.424	12.371	12.561	12.339	11.801	12.093	11.807	11.503	**control**	**Rice residues 20ton.ha^{-1}**
12.481	12.495	12.536	12.413	12.684	12.690	12.423	12.940	**0.2**	
12.611	12.424	12.671	12.739	12.216	12.353	11.973	12.320	**0.4**	
12.930	13.164	12.867	12.760	12.519	12.747	12.263	12.547	**control**	**Palm fronds residues 20ton.ha^{-1}**
13.254	13.327	13.265	13.170	12.753	12.873	13.107	12.280	**0.2**	
13.838	13.856	13.826	13.833	13.437	13.657	13.297	13.357	**0.4**	
0.222	0.382			0.945	n.s			LSD	
Effect of organic residues	12.763	12.729	12.596	**Effect of organic residues**	12.561	12.515	12.518	**Effect of potassium sulphate**	
	0.113				n.s			LSD	
11.328	11.338	11.364	11.282	11.310	11.251	11.319	11.359	**control**	**Interaction of residues potassium × sulphate**
13.610	13.836	13.643	13.352	13.680	13.523	13.783	13.732	**Poultry dung 2 ton.ha^{-1}**	
12.505	12.430	12.589	12.497	12.234	12.379	12.068	12.254	**Rice residues 20ton.ha^{-1}**	
13.341	13.449	13.319	13.254	12.903	13.092	12.889	12.728	**Palm fronds residues 20ton.ha^{-1}**	
0.175	0.238			0.852	n.s			LSD	
Effect of zinc sulphate				**Effect of zinc sulphate**					
12.343	12.523	12.439	12.067	12.009	12.095	11.958	11.975	**control**	**Interaction of zinc sulphate potassium × sulphate**
12.729	12.850	12.781	12.694	12.700	12.648	12.812	12.640	**0.2**	
12.763	12.917	12.967	13.027	12.885	12.941	12.773	12.940	**0.4**	
0.101	0.186			0.346	n.s			LSD	

Qualitative weight of tubers

Results of Table 6 showed that there were no significant effects in quantitative weight of tubers when organic residues were added. Zinc and potassium sulphate treatment treatments and their interaction were also not significant. In the second season results, poultry dung treatment gave the highest quantitative weight 1.157compare to 1.053in control. Zinc spraying treatment was also gave significant level of tubers quantitative weight at 0.4 concentration where reached 1.117 in comparison with 1.082 in control treatment. Potassium sulphate treatment in the second season was not significant. Organic residues was increased the vegetative growth which lead to increase the amount of light and improve photosynthesis. When photosynthesis increased, sugars, proteins and other nutrients elements were transported to potato tubers and increased quantitative weight. Spraying of potassium and zinc sulphate was enhanced starch formation and increase quantitative weight of potato tubers too (Kandeel *et al.*, 1991; Abdul-Razik, 1996).

Table 6 : The effect of adding organic residues and spraying potassium and zinc sulphate and their interaction on tubers content of ascorbic acid.

Second spring season				First spring season				Treatments	
Interaction of residues zinc × sulphate	**Potassium sulphate g.L^{-1}**			**Interaction of residues zinc × sulphate**	**Potassium sulphate g.L^{-1}**			**Zinc sulphate g.L^{-1}**	**Organic residues**
	5	**2.5**	**control**		**5**	**2.5**	**control**		
1.027	1.070	1.046	0.966	1.036	1.040	1.060	1.010	**control**	**Control**
1.053	1.080	1.006	1.073	1.087	1.070	1.086	1.106	**0.2**	
1.078	1.080	1.073	1.083	1.091	1.043	1.080	1.150	**0.4**	
1.121	1.120	1.150	1.093	1.078	1.060	1.090	1.086	**control**	**Poultry dung 2 ton.ha^{-1}**
1.158	1.213	1.133	1.130	1.036	1.030	0.956	1.123	**0.2**	
1.192	1.143	1.203	1.230	1.083	1.080	1.063	1.106	**0.4**	
1.084	1.083	1.083	1.086	1.100	1.133	1.096	1.070	**control**	**Rice residues 20ton.ha^{-1}**
1.088	1.090	1.100	1.076	1.061	1.083	1.070	1.030	**0.2**	
1.083	1.086	1.080	1.083	1.088	1.103	1.100	1.063	**0.4**	
1.096	1.103	1.096	1.090	1.090	1.073	1.080	1.116	**control**	**Palm fronds residues 20ton.ha^{-1}**
1.128	1.120	1.116	1.150	1.084	1.066	1.116	1.070	**0.2**	
1.114	1.120	1.120	1.103	1.034	1.006	1.046	1.050	**0.4**	
0.024	0.039			n.s	n.s			LSD	
Effect of organic residues	1.109	1.100	1.097	**Effect of organic residues**	1.065	1.070	1.081	**Effect of potassium sulphate**	
	0.011				n.s			LSD	
1.053	1.076	1.042	1.041	1.071	1.051	1.075	1.088	**control**	**Interaction of residues potassium × sulphate**
1.157	1.158	1.162	1.151	1.066	1.056	1.036	1.105	**Poultry dung 2 ton.ha^{-1}**	
1.085	1.086	1.087	1.082	1.083	1.106	1.088	1.054	**Rice residues 20ton.ha^{-1}**	
1.113	1.114	1.111	1.114	1.069	1.048	1.081	1.078	**Palm fronds residues 20ton.ha^{-1}**	
0.015	0.022			n.s	n.s			LSD	
Effect of zinc sulphate				**Effect of zinc sulphate**					
1.082	1.094	1.094	1.059	1.076	1.076	1.081	1.070	**control**	**Interaction of zinc sulphate potassium × sulphate**
1.107	1.125	1.089	1.107	1.067	1.062	1.057	1.082	**0.2**	
1.117	1.107	1.119	1.125	1.074	1.058	1.072	1.092	**0.4**	
0.013	0.020			n.s	n.s			LSD	

Tubers content of ascorbic acid (mg.100gm soft weight^{-1})

Table 7 results showed that there were significant differences in tubers content of ascorbic acid. Rice residues treatment had the highest content of ascorbic acid in tubers 12.542mg.100gm soft weight^{-1} in comparison with 12.264mg.100gm soft weight^{-1} in control treatment. Zinc sulphate treatment gave the highest amount of ascorbic acid 12.308mg.100gm soft weight^{-1} at 0.2 gm.L^{-1} compare to 12.308 in control. While potassium sulphate treatment gave 12.389mg.100gm soft weight^{-1}at 5.00 gm.L^{-1} concentration compare to lowest amount 12.325 in control. The increasing amount of ascorbic acid may occurred due to increasing size of tubers which lead to increase the total dissolved solids such as sugars, organic acids, vitamin C, mineral salts and other nutrients elements. Abou-Hussein *et al*. (2003) reported that the amount of ascorbic acid was increased when organic fertilizers were added compare to menial fertilizers.

Table 7 : The effect of adding organic residues and spraying potassium and zinc sulphate and their interaction on tubers content of vitamin C.

Second spring season				**Treatments**	
Interaction of residues zinc sulphate×	**Potassium sulphate g.L^{-1}**			**Zinc sulphate g.L^{-1}**	**Organic residues**
	5	**2.5**	**Control**		
12.274	12.296	12.277	12.248	control	**Control**
12.260	12.254	12.267	12.261	0.2	
12.259	12.263	12.262	12.253	0.4	
12.264	12.268	12.259	12.264	control	**Poultry dung 2 ton.ha^{-1}**
12.296	12.259	12.366	12.264	0.2	
12.274	12.280	12.284	12.257	0.4	
12.425	12.500	12.267	12.508	control	**Rice residues 20 ton.ha^{-1}**
12.625	12.873	12.308	12.694	0.2	
12.577	12.753	12.731	12.248	0.4	
12.268	12.290	12.252	12.263	control	**Palm fronds residues 20 ton.ha^{-1}**
12.375	12.373	12.483	12.269	0.2	
12.323	12.260	12.337	12.373	0.4	
0.100	0.160			LSD	
Effect of organic residues	12.389	12.341	12.325	**Effect of potassium sulphate**	
	0.046			LSD	
12.264	12.271	12.269	12.254	control	**Interaction of residues ×potassium sulphate**
12.278	12.269	12.303	12.262	Poultry dung **2 ton.ha^{-1}**	
12.542	12.709	12.435	12.483	Rice residues **20 ton.ha^{-1}**	
12.322	12.308	12.357	12.302	Palm fronds residues **20 ton.ha^{-1}**	
0.082	0.103			LSD	
ct of zinc sulphateEffe					
12.308	12.338	12.264	12.321	control	**Interaction of zinc sulphate ×potassium sulphate**
12.389	12.440	12.356	12.372	0.2	
12.358	12.389	12.403	12.283	0.4	
0.043	0.076			LSD	

The effectiveness of peroxidase enzyme (absorption unit.minte.gm^{-1} soft weight)

Figure 1 showed that the effectiveness of peroxidase enzyme increase gradually over time after harvesting to reach its maximum at the end of storage period (after 90 days).Poultry dung treatment was significant and gave the highest value of enzyme effectiveness (21.91, 17.47, 24.06 absorption unit.minte.gm^{-1} soft weight) followed by palm fronds residues treatment and rice residues treatment was the lowest however, all organic residues treatment were higher than control treatment that recorded (8.39, 7.28, 9.41 absorption unit.minte.gm^{-1} soft weight). Zinc sulphate treatment increased the effectiveness of peroxidase enzyme at different concentrations compare to 5.625 in control treatment (13.47, 10.39, 15.71 absorption unit.minte.gm^{-1} soft weight) and reached its maximum at the end of cold storage. While potassium sulphate treatment gave a maximum effectiveness of enzyme (16.09, 12.69, 18.63 absorption unit.minte.gm^{-1} soft weight) at 2.5 gm.L^{-1} concentration compare to (15.52, 12.11, 17.59 absorption unit.minte.gm^{-1} soft weight) and the concentration 5 gm.L^{-1} for tow storage periods 0 and 90 days gave (14.98 and 18.18 absorption unit.minte.gm^{-1} soft weight). Many studies were confirmed that the effectiveness of hydrolytic enzymes including peroxidase increase gradually with storage period of potato tubers and the effectiveness affected by packaging type where it reached its maximum in cotton package and minimum in polyethylene package (Abbas *et al.*, 2016). The reason for this increasing may due to accumulation of hydrogen peroxidase in cells cytoplasm in static tubers because the decreasing of catalase enzyme and DAB-peroxidase, Di amino benzidixi-peroxidase which lead to the accumulation of H_2O_2 in cells cytoplasm in static tubers (Rojas-Beltran *et al.*, 2000).

Conclusion

Potato plants (*Solanum tuberosum* L.) are important vegetable crop and consider the fourth main food worldwide. Organic residues (poultry dung, rice residues and palm fronds residues), spraying of zinc sulphate and potassium sulphate wereexaminedsome qualitative characteristics and effectiveness of peroxidase enzyme of potato (SYLVANA cultivar). Results showed variation in quantitative weight and the effectiveness of peroxidase enzyme in potato tubers.

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