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SORPTION OF FUSILADE ON SOME SOILS AND ITS EFFECT ON THE RELEASE OF NUTRITIVE ELEMENTS

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ABSTRACT

A greenhouse pot experiment was conducted to investigate the effect of fusilade herbicide sorbed by some soil mineral components on the release of some nutritive elements. Combination (2% Tween 20 as spreading agent and 2 % molasses (M) as sticking agent) to herbicides spray solutions applied to two calcareous soils with different textures from Abis and El-Hammam sites, in Northwestern Coast of Egypt. The results reveal that applying fusilade in combination with additives at recommended rate (2.5 l/ ha) were the most effective treatments on release of macro- and micronutrients in both soils as well as increasing vegetative growth and chemical composition of faba beans. Combined fusilade with additives at the rate (2.5 l/ha) showed a significant increase in available N, (23.62 and 14.36%), P (40.77 and 20.03%), K (41.25 and 26.41%), in Abis and El-Hammam soils, respectively. Significant ($p < 0.05$) increase in available Fe (47.14 and 37.31%), Zn (78.13 and 32.03%) and Mn (8.63 and 6.02%) was observed. There was significant gradual reduction in Cu (16.79 and 21.05%) in Abis and El-Hammam soils, respectively.

Key Words: fusilade, macro- and micronutrients, mineral, sorption.

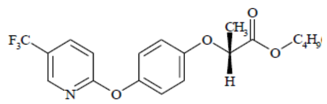
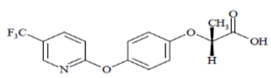
INTRODUCTION

The Nowadays, modern agriculture counts heavily on herbicides for weeds control in pastures and crops to maximize yields and for economical supports of increasing world population. Fusilade is a well-known worldwide selective grass herbicide for post-emergence application in many broad-leaved crops **(Keul *et al.*, 1990)**. Fusilade (Fluazifop-P-butyl) is used to control both annual and perennial grasses. Fusilade is related to aryloxyphenoxypropionate (AOPP), a graminicides class that act specifically on inhibiting the Acetyl CoA carboxylase enzyme in susceptible grass species **(Burton *et al.*, 1989)**. It fights weeds by inhibiting lipid synthesis (lipids are needful components of cell membranes), specially at the active growth sites.

Pesticides adsorption by clay minerals is one of the most important factors controlling their behavior and fate in soil (**Mortland, 1975),** and it may also have strong effect on the amplitude of other processes. The pesticide adsorption reversibility of clays has a fundamental importance as much as irreversible adsorption may cause a persistent contamination to soil as well as prohibit part of the soil cation-exchange capacity (CEC) **(White, 1976).**

Gessa *et al.*, (1987), found that, from the results, of IR which demonstrated that fusilade is adsorbed by at least two different mechanisms onto all homoionic clays both rely on the acidic properties of water molecules which coordinated with exchangeable cations. The mechanism for all clays unless Na-clay is the protonation of the pyridinic nitrogen atom of the organic molecule of the herbicide followed by adsorption on the clay surface . The evidence for this is the persists of NH stretching after heating at 110 C. The other mechanism regarding to Na-clay is the hydrogen bonds formation between the ester carbonyl group of herbicide and hydrogen water of metal ions as evidenced by the shift of C=O stretch toward lower frequencies dehydration at 110 C.

Table 1: Some physical and chemical characteristics of fusilade and Fluazifop-P

Properties	Fluazifop-P-butyl	Fluazifop-P	References
Molecular structure			U.S. EPA/OPP 2004,
Chemical formula	R-2-[4-[[5-(trifluoromethyl)-2-pyridinyl]oxy]phenoxy]propanate	(R)-2-[4-[[5-(trifluoromethyl)-2-pyridinyl] oxy]phenoxy]propanoic acid	Tomlin 2004
Herbicide Family	Aryloxyphenoxy-propionate	Aryloxyphenoxy propionate	Mallory-Smith and Retzinger 2003
Molecular formula	C19H20F3NO4	C15H12F3NO4	Tomlin 2004; U.S. EPA/OPP 2004
Molecular Weight	383.37 g/mole	327.26 g/mole	EPI-Suite 2011
pKa		2.8	U.S. EPA/OPP 2003a
Active substance	Fluazifop-P butyl	Fluazifop	

MATERIALS AND METHODS

1- Soil analysis:

1.1physic-chemical characteristics of soils

Abis and El-Hammam soils were selected due to their difference in the texture and clay minerals. Therefore, representative samples of these two types of soil were taken from the surface layer (0-30 cm). The main characteristics of the studied soils were determined as follows: Soil reaction (pH) was determined in the soil extract (suspension 1:2.5 Soil and water) using a pH meter, 3320 Jenway, total soil salinity (ECe) was measured in the soil saturation extract using a conductance meter YSI model (35) . Cation exchange capacity (CEC) was determined using the method described by **Dawid and Dorota (2014).** Organic matter content was determined as recommend by **De Vos *et al.*, (2007).** $CaCO_3$ content was determined using Collins calcimeter and particle size distribution by the pipette method **(Syvitski and Jams 2007)**.

1.2-Mineralogical analyses

Separation of the clay fraction (less than 2 μ) was carried out after the essential pretreatment recommended by **Jackson (1973).** The separated clays were X-rayed by Philips PW 3710 installation supplied with a horizontal goniometry and a vertical object plane, using Ni-The filtered Cu radiation (40 Kv operating voltage and current of 35 m Å). Identification of the different clay and non- clay minerals was carried out following the criteria established by **Brown & Brindelly (1980) ; Moore &Reynolds, (1989)** and **Burhan (2011)**.

2-Herbicide and chemicals.

Analytical-grade Fusilade (Fluazifop-P-butyl (FPB); (R)-2-[4-(5-trifluoromethyl-2-pyridyloxy) phenoxy] propionate; > 96 % purity), were purchased from Sigma Aldrich Co. Tween-20 (spreading agent) (polyoxyethylene sorbitan monolaurate),is an ethoxylated sorbitan ester based on a natural fatty acid (lauric acid) as spreading agent this ethoxylated is highly effective at forming oil in water emulsions, Molasses (M) is used as sticking agent.

3-Pot experiment setup

To evaluate the effect of fusilade herbicide at low concentration (< half recommended rate), half recommended rate or recommended rate alone or in combination with additives Tween20 2% (spreading agent) as spreading agent and molasses 2% (M) as sticking agent) to herbicides spray solutions in comparison to control on releasing some nutrients (N,P, K, Fe, Mn, Zn and Cu,) adsorbed on some mineral soil components on the growth of the faba bean plant. A pot experiment was carried out in plastic pots in the green house of the Desert Research Center. Four rates of fusilade herbicide were used (1.0, 1.5, 2.0 and 2.5 l/ha) (2.5 l/ha is equivalent to recommended dose) were added with and without Tween 20 as spreading agent and molasses (M) as sticker at 2% to herbicide spray solutions after 7days of planting.

4- **Available nutrients**

Available nitrogen **(N**) was extracted by 2 N KCl and measured as described by **Keeney and Nelson, (1982)**. Available phosphorus (P) was determined by Olsen's method (0.5*M* $NaHCO_3$, pH 8.5) **(Olsen *et al.*, 1954)** . Phosphorus in solution was measured calorimetrically according to **Jackson (1973**). Available potassium (K) was extracted by ammonium acetate (1N, pH 7) and K was determined by the flame photometer according to **Knudsen *et al.*, (1982).** Micro elements available micro elements studied were determined in both types of soils, as well as the growing faba bean. DTPA extractable Fe, Mn, Zn and Cu were determined according to **Barbarick and Workman, (1987),** using an AB-DTPA extractant (ammonium bicarbonate-DTPA) which is a mixture of 1.0 *M* ammonium bicarbonate and 0.005 *M* DTPA at pH of 7.6. The elements by using inductively coupled plasma-atomic emission spectroscopy (ICP–AES).

5-Statistical analysis

Data in the present work were statistically analyzed and significant differences were measured at p = 0.05 using the least significant differences (LSD) test and one-way analysis of variance (ANOVA) was conducted using SPSS 20.0.

RESULTS AND DISCUSSION

Soil properties and nutrients content

Data in Table 2 show that the soil texture of the Ibis soils was clays, while the texture of the El-Hammam soils was sandy clay loam. The soil reaction (pH) was slightly alkaline (7.72) in the Abis soils, while it was alkaline (8.34) in the El-Hammam soils. Total dissolved salts, (EC dS/m) of Abis soils was non-salty (1.57 dS/m), but of the El-Hammam soils was lightly saline (2.77 dS/m).

Table 2: Some physical and chemical properties of the studied soils

Soils	Soil separates %				Textural Class	Chemical properties					Available macronutrients			Available micronutrients			
	Coarse sand	Fine sand	Silt	Clay		pH	EC dS/m	Organic matter %	$CaCO_3$ %	CEC $Cmol_c$ kg^{-1}	N	P	K	Fe	Mn	Zn	Cu
											$mgkg^{-1}$			$mgkg^{-1}$			
Abis	6.60	31.52	10.72	51.16	Clay	7.72	1.57	0.79	12.58	25.87	75.26	11.98	193.65	10.98	7.18	0.95	2.73
El-Hammam	6.24	53.35	19.88	20.53	Sandy Clay Loam	8.34	2.77	0.12	38.10	19.48	35.45	6.78	136.65	4.12	1.32	0.76	0.38

The organic matter content of, Abis and El-Hammam soils, was, 0.79 and 0.12 %, respectively. The total content of calcium carbonate ($CaCO_3$) was 12.58 % in the Abis and 38.10 % in the El-Hammam. Both types of soils are classified as calcareous.

The cation exchange capacity (CEC) of Abis and El-Hammam soils ranged from 25.87 to 19.48 $Cmol_c$ Kg^{-1} due to the difference in clay minerals in both soils. The content of macronutrients in Abis soil nitrogen (N), phosphorus (P), and potassium (K) were, 75.26, 11.98 and 193.65 $mgKg^{-1}$, respectively, while in El-Hammam soil, the values were 35.45, 6.78 and 136.65, respectively. The content of microelements(iron (Fe), manganese (Mn), zinc (Zn), and copper (Cu), in Abis soil was, 10.98, 7.18, 0.95 and 2.73 $mgKg^{-1}$,respectively. But in El-Hammam soil the values were 4.12, 1.32, 0.76 and 0.38 $mgKg^{-1}$,respectively.

-Surface area, cation exchange capacity and mineralogical composition

Results in Table 3 show that the surface area of clay from Abis soil was 354.0 m^2g^{-1} clay. While the surface area of clay from El-Hammam soil was 197.0 m^2g^{-1} clay. The cation exchange capacity (CEC) of the clay of the Abis soil was 57.0 $Cmol_c$ Kg^{-1} clay. But it was 36.7 $Cmol_c$ Kg^{-1} clay for El-Hammam soil. The results tabulated in Table 3 and Fig. 1(a & b) show the mineral composition of the clay in Abis soil. The dominant clay minerals were as follows: Montmorillonite > Kaolinite > Illite > Palygorskite with accessory minerals of quartz and feldspars. The dominant clay minerals in the El-Hammam soil were kaolinite > Illite > Palygorskite > montmorillonite. While the accessory minerals were quartz and then feldspar **(Bahnasawy 2018)**.

Table 3. Surface area, cation exchange capacity and mineralogical composition of the clay fraction.

Soil clay	Surface area (m^2g^{-1}) clay	CEC Cmolckg^{-1} clay	Clay minerals %				Accessory minerals %	
			Mont.	Illite	Kaol.	Palyg.	Quartz	Feld.
Abis	354.0	57.0	52.28	3.42	23.36	2.25	16.45	2.24
El-Hammam	197.0	36.0	8.26	15.01	33.56	14.68	21.92	6.57

Mont. = montmorillonite Kaol. =kaolinite Palyg. = Palygorskite Feld. =Feldspars

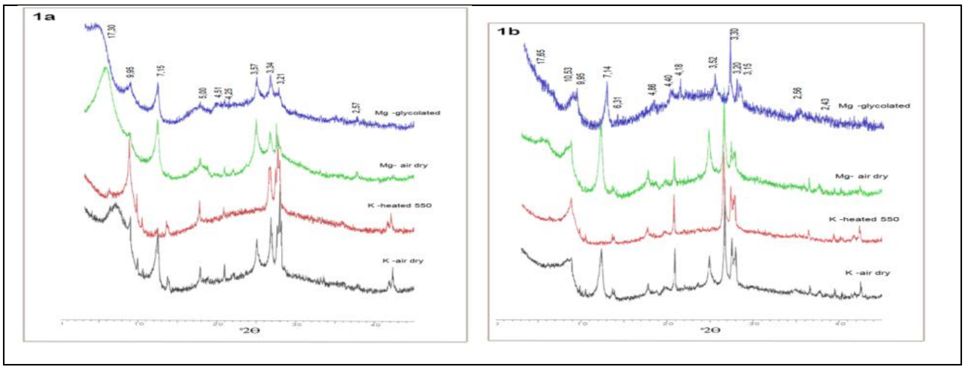


Fig.1: X-ray diffraction pattern of the clay fraction - (a) the Abis soil and (b) the El-Hammam soil.

Effect of fusilade herbicide on some soil chemical properties

Addition of fusilade herbicide to the studied soils has no significant effect on soil pH, electrical conductivity, and organic carbon content. Applying fusilade herbicide or / and additives has significant effect on soil cation exchange capacity (CEC). Fig.2, show that, the CEC values was decreased significantly ($p < 0.05$) with increasing fusilade herbicide rates or / and additives applied compared to the control. Results indicate that fusilade herbicide addition at levels of 1.0, 1.5, 2.0 and 2.5 l /ha, decreased the CEC of Abis soil by 1.35, 3.56, 4.33 and 5.42% respectively. While in El-Hammam soil, CEC decreased by 0.95, 2.26,2,83 and 3.22 %, respectively compared to the control. The decrements of the CEC under the combination of fusilade herbicide to additives had the same trend. The decrease in the CEC may be explained that organic molecule of herbicide forms a hydrophobic screen could and prevent hydrated cations penetration and therefore makes discrete amount of adsorbed ion exchangeable **(Gessa *et al.*, 1987)**.

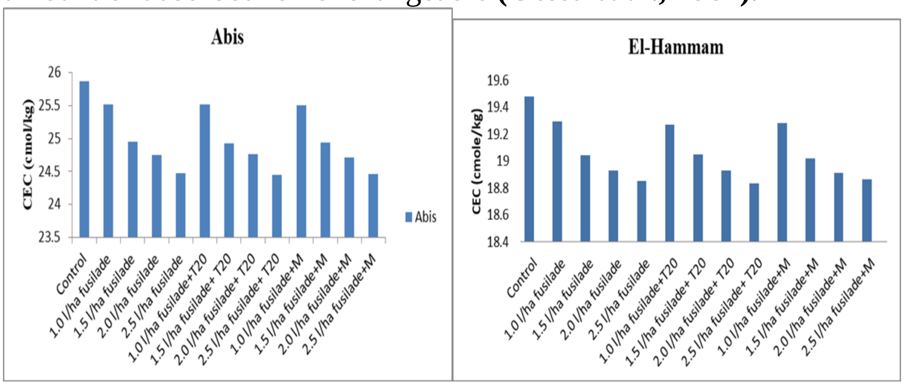


Fig. 2: Effect of fusilade herbicide addition on cation exchange capacity (CEC) in Abis and El-Hammam soils

Effect of fusilade herbicide on macronutrients availability

-Available Nitrogen (N)

Results in Table 4 indicate that the addition of fusilade herbicide has a significant increasing effect (at $P<0.05$) on available nitrogen (N), compared to control treatments. The obtained results indicated that fusilade herbicide addition at rate of 1.0, 1.5, 2.0 and 2.5/l ha increased the available nitrogen content of Abis soil by 9.94, 12.71, 17.75 and 20..06 %, respectively. While in El- Hammam soil the increase were3.58, 4.17, 9.12 and 13.49%, respectively. Increasing the levels of herbicide resulted in higher available nitrogen values. Meanwhile, the combination of herbicide and additives lead to higher release of nitrogen in both soils. The highest increments increased available nitrogen content upon the addition combination of fusilade (2.5 /l ha) with Tween20 in Abis soil (23.62%). In El-Hammam soil the highest increment increased nitrogen content (14.36%). Significant higher values of available nitrogen in Abis soil were observed than in the calcareous soil of El-Hammam. This may be due to ammonia losses. Calcareous soils with pH at about 8.34, favor NH_4^+volatilization loss. Losses of ammonia are highest in soil with low content clay and humus, as in El-Hammam soils. For these reasons, ammonia loss can be quite large in alkaline, sandy soils or calcareous soils, **(Taalab *et al.* 2019)**.

-Available Phosphorus (P)

Results in Table 4 show that the application of fusilade herbicide treatments led to a significant increase in releasing of P (at $p <0.05$) in fluviomarine soil of Abis and calcareous soil of El-Hammam. The addition fusilade herbicide rate at 1.0, 1.5, 2.0 and 2.5 L/ ha. increased the release of phosphorus in Abis soil by 13.01, 19.21, 27.68 and 39.85%, respectively. While in El-Hammam soil phosphorus content increased by 6.57, 9.79, 12.39 and 15.74%, respectively. Increasing the levels of herbicide resulted in higher release of phosphorus ions. While combination of herbicide and additives was superior in increasing the release of P in soil. The most effective treatment was at the rate of (2.5/l ha) of fusilade combined with molasses where the highest release of available P in both soils than other treatments. Releasing phosphorus (P) increased by 40.77 and 20.03%, in Abis and El-Hammam soils, respectively **(El-Said and Balah 2011).**

-Available potassium (K)

Results in Table 4 revealed that adding fusilade at levels of 1.0, 1.5, 2.0 and 2.5 l/ha, increased the release of potassium (K) in Abis soils by 11.78, 14.93, 24.10 and 34.55% respectively. While the of releasing potassium (K) upon the addition of 1.0, 1.5, 2.0 and 2.5 l/ha , in El-Hammam soils were 8.85, 14.98,17.63 and19.99 %, respectively. These results indicate that application rate of fusilade herbicide resulted in higher release of potassium (K). The combination of fusilade (2.5 l/ha) to 2% Tween 20 and molasses (M) lead to increasing where increased K. Releasing K was increased by 41.25 and 26.41%, in Abis and El-Hammam soils, respectively **(Sharshar *et al.*, 2015).**

Table 4: Effect of fusilade herbicide on the availability of macro- and micronutrients content in the studied soils

Fusilade treatment (l/ha)	Available macronutrients ($mgkg^{-1}$)			Available micronutrients($mgkg^{-1}$)			
	N	P	K	Fe	Mn	Zn	Cu
	Abis soils						
Control	73.25i	11.92h	192.75h	10.84i	7.18g	0.96h	2.74a
1.0	80.53h	12.75g	215.45f	11.88h	7.16h	1.09g	2.59d
1.5	82.56f	14.21e	221.53ef	12.23g	7.22ef	1.17f	2.51ef
2.0	86.25c	15.22c	239.21d	14.55d	7.35d	1.25e	2.43f
2.5	87.95b	16.67b	259.35b	15.83a	7.69b	1.65b	2.33g
1.0 + T_{20}	80.83h	13.75ef	218.35f	12.22g	7.21f	1.11fg	2.63c
1.5 + T_{20}	82.76ef	14.51d	234.53e	12.15gh	7.26e	1.35d	2.58d
2.0+ T_{20}	85.35d	15.52c	259.25b	14.75cd	7.49c	1.63bc	2.32g
2.5+ T_{20}	90.55a	16.87a	271.85a	14.99c	7.78a	1.71a	2.31g
1.0+M	81.22g	12.95f	198.45g	12.66f	7.20f	1.17f	2.71b
1.5+M	83.26e	14.41d	229.58e	13.52e	7.25e	1.35d	2.54e
2.0+M	86.95c	15.82bc	243.85c	15.55b	7.46c	1.59c	2.35g
2.5+M	89.65ab	16.78a	272.25a	15.95a	7.76a	1.65b	2.28h
L.S.D	1.05	0.03	2.03	1.25	0.21	0.34	0.03
mean	83.93	14.72	235,11	13.62	7.39	1.34	2,49
	El-Hammam soils						
control	34.32g	6.54f	135.55h	4.02g	1.33d	0.75i	0.38a
1.0	35.55ef	6.97e	147.76f	4.14g	1.34c	0.84g	0.35bc
1.5	35.75e	7.18d	155.85e	4.26f	1.34c	0.85f	0.34c
2.0	37.45c	7.35c	159.45d	4.42e	1.37b	0.95c	0.32d
2.5	38.95ab	7.57bc	162.65c	4.79de	1.39b	0.97b	0.31de
1.0+ T_{20}	35.15f	6.57f	136.66h	4.35e	1.35c	0.86f	0.37a
1.5+ T_{20}	35.85e	6.96e	156.75e	4.87de	1.37b	0.89e	0.33cd
2.0+ T_{20}	38.65b	7.28c	161.05c	4.95d	1.38b	0.95c	0.32d
2.5+ T_{20}	39.25a	7.68b	168.25b	5.04d	1.41a	0.99a	0.31de
1.0+M	35.05f	7.05de	139.96g	5.26c	1.35c	0.82h	0.36b
1.5+M	36.25cd	7.29c	156.55e	5.59b	1.37b	0.87	0.34c
2.0+M	38.05bc	7.55bc	167.45b	5.96ab	1.39ab	0.92d	0.32d
2.5+M	38.55b	7.85a	171.35a	6.32a	1.40a	0.95c	0.30e
L.S.D	0.31	0.02	1.56	0.22	0.01	0.03	0.02
mean	36.83	7.21	155.33	4.92	1.36	0.89	0.35

$T_{20=}$ Tween20 (spreading agent), M= Molasses (sticking agent).The means have the same letter in each column are not significant at p of 5%.

Effect of fusilade herbicide on some micronutrients availability

-Available Iron (Fe)

Results in Table 4 showed that the iron (Fe) concentration increased significantly (at $p<0.05$) as the application rate of herbicide increased compared to the control in both soils. The control samples showed the lowest concentration of available Fe (10.84 and 4.02 $mgkg^{-1}$). In Abis and El-Hammam soils respectively. The obtained results indicate that the highest iron (Fe) concentration of was at rate of fusilade (2.5/l ha). The release of Fe increased by 46.03 and 19.15%, in Abis and El-Hammam soils respectively compared to the control. The recommended rate of fusilade combined to with 2% molasses (M) had the highest release of iron (15.95 and 6.32 mgkg^{-1}). The release of Fe increased by 47.14 and 37.31% in Abis and El-Hammam soils respectively.

-Available manganese (Mn)

Results in Table 4 show that Mn concentration has slightly increased as the rate of herbicide increases. There was a slightly rise in the level of available Mn from 7.18 to 7,69 mgkg^{-1} and from 1.33 to 1.39 mgkg^{-1}as the rate of herbicide increases corresponding to 7.10 and 4.45% increase in Abis and El-Hammam soils, respectively. Combination of recommended rate of fusilade herbicide with additives led to significant ($p<0.05$) increase in releasing Mn ions compared to the control. The rate of 2.5 l/ha fusilade combined with 2% Tween 20 recorded the highest Mn concentration in both soils (7.78 and 1.41 mgkg^{-1}). The Mn was increased releasing by 8.36 and 6.02% in Abis and El-Hammam soils respectively.

-Available Zinc (Zn)

Results in Table 4 show that available Zn content increased significantly ($p<0.05$) with fusilade herbicide compared to the control. Zinc concentration increased when herbicide treated soils increased significantly ($p<0.05$) from 0.96 to 1.65 and from 0.75 to 0.97 mgkg^{-1} with a magnitude by71.88 and 29.33% in Abis and El-Hammam soils, respectively. The recommended rate of fusilade was effective in releasing zinc. Combination of fusilade to additives led to higher significant ($p<0.05$) increase of Zn compared to the control. Where 2.5 l/ha fusilade herbicide combine with 2% Tween 20 recorded the highest Zn content in both soils (Abis and El-Hammam (1.71 and 0.99 mgkg^{-1}) where releasing increased by 78.13 and 32.03% in Abis and El-Hammam soils, respectively.

-Available Copper (Cu)

Results in Table 4 reveal that the effect of all treatments on available Cu of the studied soils was significantly decreased at ($p<0.05$). Adding fusilade herbicide at levels of 1.0, 1.5, 2.0 and 2.5 l/ha, decreased available Cu in Abis soils, by 5.47, 8.57, 11.31 and 14.50%, respectively. The decrements of available Cu upon the addition of 1.0, 1.5, 2.0 and 2.5 l/ha, in El-Hammam soils were 7.89, 10.53, 15.79 and18.42%, respectively. Fusilade treatment at its recommended rate in combine with molasses (M) recorded the highest reduction in available Cu competed to fusilade treatment alone or in combination with Tween 20 where reduce by 16.79 and 21.05%, in Abis and El-Hammam soils respectively.

-Macro- and micronutrients concentrations in faba bean

Results in Table 5 show that faba bean dry weight values increased significantly under the application of fusilade herbicide and/or combined to additives. The highest values of dry weight were found when the recommended rate was used (33.16 and 26.49 % in Abis and El-Hammam respectively ,Moreover, combining fusilade of 2.5/l ha to 2% molasses were the best effective amongst other the treatments by up to 34.70 and 27.79%. In Abis and El-Hammam soils, respectively. Fusilade application promotes growth of plants and it has a positive effect on growth and productivity of faba bean crop.

Table 5: Concentrations of macro- and micronutrients in faba bean at the beginning of flowering with various fusilade treatments

Fusilade treatment (l/ha)	Dry weight of bean plant (g/pot)	macronutrients ($mg g^{-1} DW$)			Micronutrients ($\mu g g^{-1} DW$)			
		N	P	K	Fe	Mn	Zn	Cu
	Abis soils							
Control	5.85i	38.57g	2.82ef	22.72h	283.77g	62.30c	41.22g	12.05a
1.0	6.96hi	41.98f	2.95e	26.78g	285.48f	62.35c	44.27f	11.90b
1.5	7.33f	42.15ef	3.01bc	29.99e	256.75e	62.57c	46.32e	11.95b
2.0	7.56d	42.35de	3.19d	30.12d	297.75e	64.65a	49.45d	12.09a
2.5	7.79b	44.55c	3.25b	32.25c	339.05d	64.75a	52.51b	11.95b
1.0 + T_{20}	6.95g	41.95f	2.85ef	24.75g	285.05f	62.25c	44.26f	12.01a
1.5 + T_{20}	7.01f	42.25e	3.05d	28.85f	296.25e	62.37c	48.37e	11.85c
2.0+ T_{20}	7.66c	43.45b	3.14b	34.92e	348.45d	63.55b	50.45d	11.99b
2.5+ T_{20}	7.85ab	44.75a	3.19b	38.37b	389.75c	62.45c	54.77b	12.06a
1.0+M	6.75h	41.90f	3.05c	22.82f	284.50f	62.45c	45.52f	11.95b
1.5+M	6.89g	42.23e	3.17d	29.95e	389.00d	63.69b	49.75b	11.98b
2.0+M	7.34e	44.55b	3.22c	34.29c	431.85b	64.85a	54.89c	11.98b
2.5+M	7.88a	45.79a	3.32a	39.49a	492.70a	64.38a	56.91a	12.05a
LSD	0.04	1.03	0.01	0.07	1.03	0.30	0.07	0.11
Mean	7,22	43.05	3.51	30.25	339.26	61.63	42.42	11.99
	El-Hammam soils							
Control	3.85h	31.02i	3.24i	21.25h	167.20g	43.65f	31.75hi	9.05a
1.0	4.57e	32.35h	3.25g	22.35h	169.35e	43.74e	31.85h	9.01b
1.5	4.78d	32.45g	3.35f	24.56f	170.45e	43.75e	34.06g	8.95bc
2.0	4.82bc	33.77c	3.55de	26.75e	179.77d	43.81de	36.25f	9.75d
2.5	4.87b	34.95ab	3.69d	29.83c	189.55b	43.85d	41.33e	9.55f
1.0 + T_{20}	4.79d	32.55f	2.22h	22.34g	169.55f	43.79e	32.54i	8.97b
1.5 + T_{20}	4.80c	32.62e	3.36c	25.65ef	178.55d	43.86d	39.65d	8.85c
2.0+ T_{20}	4.81c	35.75c	3.48c	27.84d	184.75c	43.98c	43.74c	9.72d
2.5+ T_{20}	4.85b	35.85b	3.55b	30.95a	195.85c	44.05b	46.85b	9.55f
1.0+M	3.97g	32.65d	2.35f	22.43g	168.65f	43.85d	35.95h	8.91c
1.5+M	4.28f	32.75c	3.38e	25.63ef	184.95c	43.98c	41.23f	8.75d
2.0+M	4.89ab	34.89b	3.49c	30.85ab	195.55b	44.05b	44.75c	9.64e
2.5+M	4.92a	35.98a	3.58a	30.99a	206.45a	44.24a	46.98a	9.52f
LSD	0.35	0.22	0.65	1.05	0.22	0.65	1.05	0.07
Mean	4.26	33.98	3.47	25.54	183.51	43.89	38.22	9.24

$T_{20=}$ Tween20 (spreading agent), M= Molasses (sticking agent).The means have the same letter in each column are not significant at p= 0.05.

Also, results presented in Table 5 illustrate that there were significant differences of all analyses macro- and micronutrients in faba bean at early flowering. All the fusilade herbicide treatments significantly affected the content of N, P, K (mg/g dry weight), and concentration of Fe and Zn (µg/g dry weight), in faba bean. The herbicide did not show any significant effects on the concentrations of Mn and Cu elements. Results also show increasing in the content of N, P, K and concentrations of Fe and Zn as fusilade herbicide rate increase where the concentrations of N, P and K increased by 15.50, 15.25 and 41.95% in faba bean dry weight of Abis respectively at the recommended rate (2.5/l ha). The N, P, K of faba bean grown in El-Hammam raised by 12.67, 13.88 and 47.31%, respectively. The highest values constituents were obtained when fusilade herbicide was applied with additives (18.72, 17.73 and 43.0 % respectively, in Abis, while the unless were 15.57, 9.56 and45.89% respectively in El-Hammam. Results also illustrate that the content of Fe and Zn in faba bean dry weight was significantly increased, as the rate of the used herbicide increased. The highest concentration of Fe and Zn (µg/g), was obtained by treatment of combining of fusilade at recommended rate (2.5 l/ha) to additives. The increasing rates were 73.65 and 38.06% in Abis soils while in El-Hammam soils were 23.47and 47.96% respectively.

CONCLUSION

Adsorption of fusilade herbicide by clay minerals is one of the most important factors controlling its behavior and fate in soil. We can concluded that due to strong binding of fusilade herbicide to negatively charged clay minerals through protonation of pyridinic nitrogen atom of organic molecule causing ion exchange of ions and release some nutritive elements. These processes depend on the acidic properties of water molecule associated to cationic ions as well as many additives enhancing materials. The release of some nutritive elements due to their adsorption to soil particles via applying fusilade herbicide at its recommended rate with additives significantly increase the availability of some macro- and micronutrients in soils. Nitrogen, phosphorus, potassium, iron and zinc content were increased in faba bean plant grown in Abis and El-Hammam soils.

RECOMMENDATIONS

The researchers of the present work recommend using the fusilade pesticide on faba bean plants at a concentration of 2.5 liters per hectare, provided that it must be added with a (spreader + Sticky).The use of fusilade pesticide led to an increase in the concentrations of nitrogen, phosphorus, potassium, iron and zinc. Therefore, mineral fertilization of these elements for faba bean plants showed be reduced. The use of fusilade pesticide reduces production costs in light of the high prices of mineral fertilizers reveal. Using fusilade pesticide on dicotyledonous crops, such as ***Glycine max.L. , Arachis Hypogaea, Lens.Culinaris and Cicer arietinum*** is recommended.

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امتصاص الفيوزيليد فى بعض الأراضى وتاثيره علي انطلاق العناصر الغذائية

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أجريت تجربة أصص لمعرفة تأثير امتصاص الفيوزيليد (مبيد الحشائش) على بعض مكونات التربة المعدنية لإنطلاق بعض العناصر الغذائية في التربة بتركيزات منخفضة (أقل من نصف المعدل الموصى به) ونصف المعدل الموصى به أو المعدلات الموصى بها وهى:

1,0& 1,5& 2,0&2,5 لتر لكل هيكتار بمفردها أو بخلطها مع ماده ناشره وكذلك مادة لاصقه على نوعين من أراضى أبيس والحمام بالساحل الشمالي الغربى بمصر لإختلافهما فى القوام ونوع ونسبة معدن الطين السائد. وأظهرت النتائج أن:– إستخدام الفوزيليد مع الإضافات (الماده الناشره + الماده الاصقه) خاصة بالتركيز الموصى به 2,5 لترلكل هكتار كان أكثر التركيزات فاعليه في إنطلاق العناصر الغذائية الكبرى والصغرى في كلا النوعين من الأراضى بالإضافة إلى زيادة النمو الخضري والعناصر المغذيه للفول البلدي. كما أوضحت النتائج أن: إضافة الماده الناشرة واللاصقة الي الفيوزيليد بالتركيز الموصى به (2,5 لتر لكل هكتار) ادي إلي زيادة معنوية في النيتروجين الميسر14,36 & 23,62% ،الفسفورالميسر 20,03 & 40,77% والبوتاسيوم الميسر26,41 & 41,25% في أراضى أبيس والحمام على التوالي.

وأظهرت النتائج ايضا إلى زيادة معنوية في الحديد الميسر 36,31 & 47,14% والزنك الميسر32,03 & 78,13% والمنجنيزالميسر6,02 & 8,63% بينما كان هناك انخفاض تدريجي ملحوظ في النحاس الميسر21,05 & 16,79% في أراضى أبيس والحمام على التوالي

كما أوضحت النتائج زيادة معنوية من تركيز العناصر الغذائيه: النيتروجين – الفوسفور – البوتاسيوم– الحديد– الزنك في نبات الفول البلدى فى كلا النوعين من أراضى منطقتى الدراسه.