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INFLUENCE OF OXAMYL (PESTICIDE) ON THE AVAILABILITY OF NUTRIENTS (MAJOR AND MICRO) AND GROWTH OF TOMATO AND MUSTARD PLANTS

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ABSTRACT

Effect of oxamyl with time on the availability of macronutrients (N, P, K) and micronutrients (Zn, Cu, Cd, Mn and Ni) from alluvial soil and their impact on growth of tomato and mustard plants was studied. The availability of ammonium- nitrogen initially significantly decreased and then increased, while nitrate-nitrogen and nitrite- nitrogen increased up to 30 days and then decreased. The phosphorus availability, significantly increased with the increase in oxamyl concentration and time, reached a maximum value after 45 days of application. The availability of potassium decreased up to 30 days with the increase in pesticide concentration and then increased with time. The maximum concentration of DTPA extractable Zn, Cu, Cd, Mn and Ni was with 0.3 g of oxamyl kg^{-1} soil after an interval of 30 days. The decrease in concentration after 30 days of application might be due to decline in the chemical and biological activity of oxamyl in soil. Oxamyl up to 0.3 g kg^{-1} soil had a beneficial effect on the growth of root; shoot of pusa ruby tomato and up to 0.2 g kg^{-1} soil for pusa Dophasali mustard. Higher doses were toxic for both these crops.

Key words: Oxamyl, Nutrients, Tomato, Mustard.

INTRODUCTION

The soil solution is regarded as the medium for number of chemical and biological interactions that allows the growth of plants under a variety of physical, chemical and environmental conditions. Plants obtain their nutrients largely by uptake from soil solutions. However, knowledge of the composition of the soil solution and its seasonal variation is sparse even for micronutrients[1]. Sewage sludge, which is rich in N, P, organic matter and other micronutrients, is a good source of nutrients for plant growth and improve soil physical properties[2]. However, it also contains high levels of

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potential toxic elements such as Cd, Cr, Cu, Pb, Mn, Ni, Zn and their soluble salts[3], which may be accumulated in vegetative part of plants[4].

The ever-growing importance of the use of pesticides in crop production arouses interest regarding the impact of the pesticides on nutrient availability and soil properties. The information of pesticides impact on the trace element status in soil is meager[5].

The present study was made to study the effect of oxamyl on the availability of NPK and DTPA extractable micronutrients (Zn, Cu, Cd, Mn and Ni) in an alluvial soil of Aligarh and on the growth of tomato (*Lycopersicon esculentum*) and mustard (*Brassica juncea*).

EXPERIMENTAL

Material and methods

The soil used in this study (0-25 cm) was collected from central lowland type III, alluvial of Aligarh district. It was air dried, crushed and sieved. The physicochemical properties of the soil were : silt 48.6%; clay 13.8%, pH (1 : 2.5) 8.3; organic matter 9.2 g kg^{-1}, surface area 30.7 m^2g^{-1}, exchangeable, ammonium N 90 μg, nitrate N 64 μg, nitrate N 36 μg, available P 42 μg and available K 9.6 μg g^{-1} soil. DTPA extractable Cu, Cd, Ni, Zn, Mn were 0.5, traces, 0.02, 0.6 and 3.0 μg g^{-1} soil, respectively.

The greenhouse experiments were conducted in several glazed earthenware pots (60 x 45 cm) in six replications. In first set of experiment, the soil was amended with 0.45 g N; 0.45 g P and 0.45 g K kg^{-1} soil and 0.0, 0.1, 0.2, 0.3, 0.4 and 0.5 g oxamyl (obtained from EI DuPont deNemours & Co. Wilmington, Delaware, USA) kg^{-1} soil, separately. In second set of experiment, the soil samples were amended with 100 mg Zn; 125 mg Cu; 25 mg Ni, 10 mg Cd and 150 mg Mn kg^{-1} soil with 0.0, 0.1, 0.2, 0.3, 0.4 and 0.5 g oxamyl kg^{-1} soil, separately. Pregerminated seedlings of tomato (*Lycopersicon esculentum* var. Pusa ruby) and mustard (*Brassica juncea* var. Pusa Dophasali) were planted in all the pots. The plants were watered to maintain requisite soil-moisture. The treated samples were periodically drawn with a soil sampler at an interval of 15 days, air dried samples were analyzed for exchangeable ammonium, nitrate and nitrite-N[6]; available P by Olsen's method[7] available K by flame photometry; DTPA extractable Cu, Zn, Mn, Cd and Ni by Perkin-Elmer atomic absorption spectrophotometer. At maturity of plants, shoot height, weight of shoot, root weight

and root lengths were measured. Total produce of mustard was collected and weighed.

RESULTS AND DISCUSSION

Effect of different doses of oxamyl (Table 1) indicated that the availability of ammonium- nitrogen decreased up to 30 days of application; thereafter, it increased significantly, which may be due to fixation of NH_4^+ ion to clay complex[8] and partly due to nitrification by *nitrosomans* and *nitrobacter* bacteria[9] as.

$$NH_3 \rightarrow HNO_2 \rightarrow HNO_3$$

At the end of 90 days of application, the availability of ammonium N was in the order 0.1 ~ 0.5 > 0.2 > 0.3 > 0.4 > 0.0 g oxamyl kg^{-1} soil. The amount of nitrite N and nitrate N (Table 1) significantly increased up to 30 days and was significantly and positively correlated to the amount of ammonium- N decomposed. The increase in available N after 30 days might be due to reduction in the activity of nitrifying bacteria after a particular concentration and ammonification of ammonifying bacteria like *azotobacter*[10], which was supplemented by slow release of fixed NH_4^+ from the soil complexes[11].

Table 1 showed that the availability of P increased significantly with the increase in the doses of oxamyl upto 45 days of application. The increase in available P might be due to decomposition of soil organic matter and fertilizer with the stimulation of *actinomycetes*, *mycorrhizal* fungi, and *Bacillus magathelium* and arthrobactor activity in the soil[12]. The availability of P decreased after 45 days of application, which might be due to transformation of soluble phosphorus into insoluble forms as with the time, there was degradation of the oxamyl and reduction of available P to the unavailable phosphine[13] by bacteria as -

$$\underset{+5}{H_3PO_4} \xrightarrow{(H)} \underset{+3}{H_3PO_3} \xrightarrow{(H)} \underset{+1}{H_3PO_2} \longrightarrow \underset{-3}{PH_3}$$

The availability of K (Table 1) in the soil decreased with the rise in the concentration of oxamyl upto 30 days of application and then it increased. The decrease in K availability might be due to immobilization of K by pesticide and fertilizer[14] and in the microbial activity of *Bacillus siliceous* and *Aspergillus niger*. With the time, increase in the availability of K might be due to degradation of oxamyl and its leaching and the re-establishment of bacteria, which released fixed K.

Table 1: Effect of various doses of oxamyl on macronutrient availability at various intervals of time in soil amended with 0.45 g each of NPK

Doses in mL per kg soil	Average values of macronutrients in ppm for various days						
	1	**15**	**30**	**45**	**60**	**75**	**90**
	Ammonium nitrogen						
0.0	154	138	120	130	149	166	180
0.1	154	143	126	136	154	189	203
0.2	154	143	124	132	149	170	192
0.3	155	140	120	130	140	163	188
0.4	153	138	121	133	143	164	186
0.5	154	144	121	136	155	186	203
LSD Doses 3.6							
LSD Days 3.9							
	Nitrate nitrogen						
0.0	36	40	44	42	40	38	38
0.1	38	46	51	47	44	42	40
0.2	33	38	42	38	37	35	35
0.3	35	38	341	36	34	33	33
0.4	32	36	40	37	34	33	32
0.5	36	45	50	46	45	43	41
LSD Doses 1.6							
LSD Days 1.6							
	Nitrate nitrogen						
0.0	148	163	178	164	156	150	148
0.1	150	171	193	182	172	166	163
0.2	145	166	188	176	170	163	160
0.3	144	163	184	173	170	160	160
0.4	140	160	182	170	166	162	160
0.5	148	169	192	182	176	170	164
LSD Doses 3.9							
LSD Days 4.1							

Cont…

Doses in mL per kg soil	Average values of macronutrients in ppm for various days						
	1	**15**	**30**	**45**	**60**	**75**	**90**
	Available phosphorus						
0.0	220	236	249	272	261	212	242
0.1	224	240	262	292	279	270	260
0.2	225	246	270	300	270	260	252
0.3	228	250	280	316	292	278	274
0.4	230	252	286	342	312	300	283
0.5	234	260	300	364	322	310	300
LSD Doses 4.1							
LSD Days 4.0							
	Available potassium						
0.0	3.2	3.0	2.8	3.0	3.3	3.4	3.4
0.1	3.2	2.9	2.6	2.7	2.9	3.1	3.2
0.2	3.1	2.5	2.4	2.6	2.8	3.0	3.2
0.3	2.8	2.4	2.0	2.3	2.7	3.0	3.0
0.4	2.7	2.4	1.8	2.2	2.6	2.9	3.0
0.5	2.6	2.3	1.6	2.0	2.5	2.8	3.0
LSD Doses 0.06							
LSD Days 0.08							

The results of this study (Table 2) indicated that in the presence of oxamyl, DTPA extractable Cu, Zn, Mn, Cd and Ni increased significantly reaching a maximum of 0.3 g of oxamyl kg^{-1} soil after 30 days of application. The increase was from 80-96 for Cu; 41-62 for Zn; 140-194 for Mn; 4-5.8 for Cd and 9.3-12.0 kg kg^{-1} soil for Ni. The influence was in the order 0.3 > 0.2 > 0.4 > 0.1 > 0.5 > 0.0, which may be due to active role played by pesticides on soil microbial population[15]. Preliminary studies by the author[5] indicated that microbial population in presence of oxamyl increased with their dose up to 0.3 g kg^{-1} soil; thereafter, there was a decrease in the microbial population with the doses. The increase and then decrease in micronutrient concentration in presence of different doses of oxamyl may be due to solubilising effects[16] by *Aspergillus niger*, *Thiobacillus*, *Rhizobium* etc. with decrease in pH and increase in electrical conductivity at lower dose. Negative influence with higher doses may be due to reduction of biological activity and adsorption by soil minerals.

Table 2: Effect of various doses of oxamyl on DTPA extractable macronutrient at various intervals of time in soil amended with 20 mg Cd, 50 mg Ni, 250 mg Cu, 200 mg Zn and 300 mg Mn kg^{-1} soil

Doses in g kg^{-1} soil	Average values of macronutrients in ppm for various days						
	1	**15**	**30**	**45**	**60**	**75**	**90**
				Copper			
0.0	80	82	84	82	80	77	75
0.1	82	86	90	89	85	80	75
0.2	81	89	93	90	83	80	76
0.3	83	91	96	92	88	84	80
0.4	82	88	92	89	83	80	80
0.5	84	87	90	88	80	76	75
LSD Doses 1.4							
LSD Days 1.6							
				Zinc			
0.0	41	48	52	50	47	45	43
0.1	41	49	56	53	50	46	44
0.2	42	50	59	55	52	50	48
0.3	42	52	62	60	58	55	52
0.4	41	50	58	54	50	44	45
0.5	40	48	56	53	51	45	43
LSD Doses 1.2							
LSD Days 1.4							
				Manganese			
0.0	140	150	163	160	158	150	148
0.1	141	162	179	171	163	159	150
0.2	142	166	186	180	170	161	156
0.3	143	172	194	183	174	162	156
0.4	143	168	180	171	166	160	158
0.5	142	166	178	170	164	158	155
LSD Doses 3.0							
LSD Days 3.8							

Cont…

Doses in g kg^{-1} soil	Average values of macronutrients in ppm for various days						
	1	**15**	**30**	**45**	**60**	**75**	**90**
				Cadmium			
0.0	4.0	4.2	4.4	4.5	4.3	4.1	4.0
0.1	4.1	4.4	5.0	5.1	4.8	4.7	4.4
0.2	4.1	4.5	5.3	5.3	5.1	5.0	4.7
0.3	4.2	4.9	5.8	5.9	5.6	5.2	4.9
0.4	4.1	4.4	5.0	5.0	4.7	4.6	4.3
0.5	4.2	4.4	4.9	4.9	4.7	4.5	4.3
LSD Doses 0.08							
LSD Days 0.12							
				Nickel			
0.0	9.3	9.6	9.8	9.7	9.5	9.4	9.4
0.1	9.6	10.1	10.3	10.2	10.0	9.8	9.6
0.2	9.7	10.6	11.0	10.9	10.3	10.0	9.8
0.3	9.8	11.0	12.0	11.8	11.2	10.8	10.3
0.4	9.8	10.5	10.9	10.6	10.0	9.8	9.6
0.5	9.7	10.3	10.4	10.3	9.7	9.5	9.5
LSD Doses 0.16							
LSD Days 0.20							

Table 3 showed that shoot weight, shoot height, root weight and root length of 'Pusa Ruby' tomato increased by adding NPK or micronutrients in presence of oxamyl up to 0.3 g kg^{-1} soil, after which, there was decline in shoot weight, shoot height, root weight and root length, while the shoot periphery remain almost same. The shoot weight, shoot height, root weight, root length, grain yield and straw yield of Pusa Dophasali mustard (Table 3) increased up to 0.2 g of oxamyl kg^{-1} of soil, after which, it declined. The higher doses of oxamyl caused phytotoxicity, which might be due to decrease in availability of nutrients as there was formation of metal complexes with soil[17,18].

Table 3: Effect of various doses of oxamyl on the weight height and periphery of shoots and length and weights of roots of 'Pusa tomato' and 'Pusa Dophasali' mustard by addition of 0.45 g each of NPK kg^{-1} soil and 20 mg Cd, 50 mg Ni, 250 mg Cu, 200 mg Zn and 300 mg Mn kg^{-1} soil

Doses in g kg^{-1} soil	Shoot weight (g)		Shoot height (cm)		Shoot periphery (cm)		Root weight (g)		Root length (cm)		Grain yield per plant (g)		Straw yield per plant (g)	
	NPK	Heavy metal	NPK	Heavy metal	NPK	Heavy metal	NPK	Heavy metal	NPK	Heavy metal	NPK	Heavy metal	NPK	Heavy metal
				Pusa Tomato										
0.0	6.6	6.9	43.1	43.4	2.2	2.1	6.4	6.4	20.6	20.6	45	46	-	-
0.1	7.3	7.4	49.2	50.3	2.1	2.2	6.0	6.9	21.9	22.3	49	52	-	-
0.2	8.4	8.9	52.4	52.6	2.1	2.1	7.6	7.3	23.6	23.4	54	57	-	-
0.3	10.3	10.6	54.6	56.0	2.1	2.1	8.6	8.4	27.6	28.1	58	62	-	-
0.4	7.9	7.9	45.2	50.0	2.0	2.2	7.9	7.4	23.3	23.6	50	48	-	-
0.5	5.4	5.6	40.0	41.6	2.1	2.0	5.6	5.8	21.2	21.2	44	42	-	-
						Pusa Dophasali mustard								
0.0	6.1	6.3	63.6	64.6	1.9	1.9	1.0	1.1	20.6	21.2	0.76	0.84	2.45	2.55
0.1	6.2	6.5	74.1	75.9	1.9	2.0	1.2	1.3	21.6	21.6	1.40	1.64	3.56	3.14
0.2	5.4	5.7	80.3	83.6	2.0	2.1	1.4	1.4	22.4	23.2	1.74	1.89	3.69	4.01
0.3	5.0	5.2	69.1	72.4	2.2	2.2	1.5	1.4	20.0	21.0	0.80	1.06	2.84	3.06
0.4	5.0	5.3	70.1	71.6	2.1	2.1	1.3	1.3	21.0	21.6	0.66	0.84	2.14	2.74
0.5	4.9	5.0	71.4	71.6	2.0	2.1	1.1	1.2	20.0	20.2	0.66	0.90	2.56	2.46

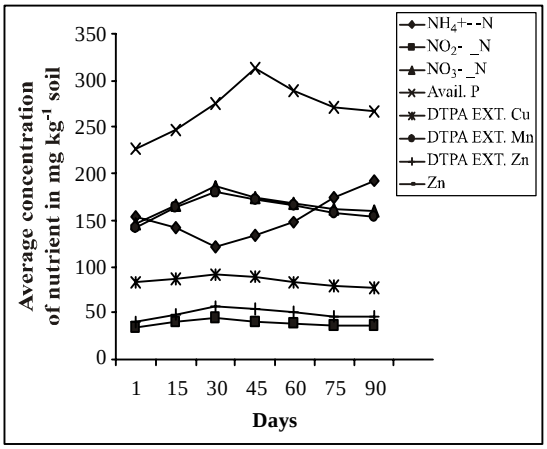

Fig. 1: Variation of nutrient concentration with days in presence of different concentrations of oxamyl

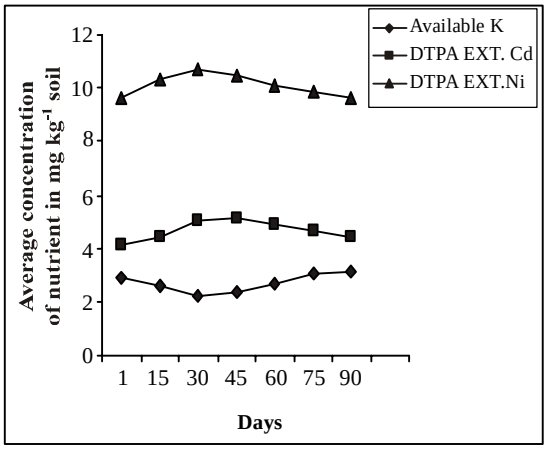

Fig. 2: Variation of nutrient concentration with days in presence of different concentrations of oxamyl

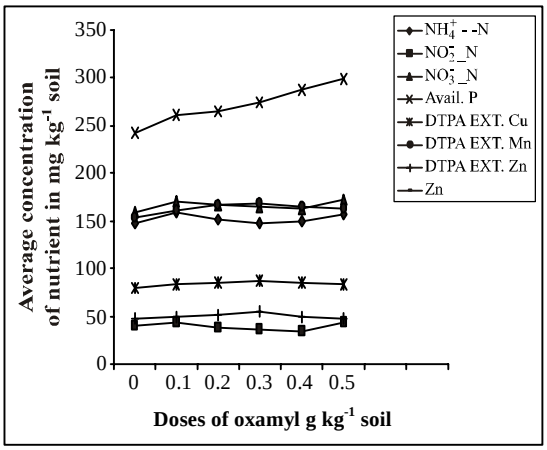

Fig. 3: Variation of nutrient concentration with different doses of oxamyl

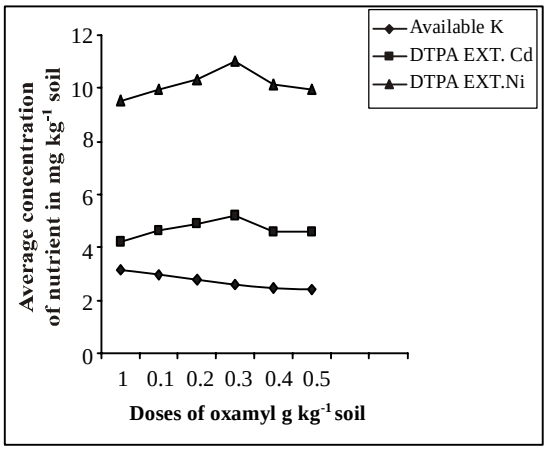

Fig. 4: Variation of nutrient concentration with different doses of oxamyl

From these results, it may be inferred that the interaction of the oxamyl with soil in presence of major nutrients (NPK) and micronutrients affects the growth and yield of mustard and tomato. Lower doses of oxamyl increases availability of macro and micronutrients, while higher doses of oxamyl causes phytotoxicity, which may be due to the conversion of available nutrients into the fixed form.

REFERENCES

1. K. D. Patil, M. B. Meisheri, D. J. Dakke and D. S. Bagade, J. Soils & Crops, **13,** 85 (2003).
2. M. Zhang, D. Heaney, B. Henriquez, E. solbey and E. Bittner, Compost Sci. Util., **14**, 68 (2006).
3. J. Y. Dai, M. Q. Xy, J. P. Chen, X. P. Yang and Z. S. Ko, Chemosphere, **66**, 353 (2007).
4. S. Odai, E. Mersah, D. Sipitey, S. Ryo and E. Awuah, Res. J. Environ. Toxico., **2,** 92 (2008).
5. O. P. Bansal, J. Indian Chem. Soc., **79,** 671 (2002).
6. A. B. Onken and H. D. Sunderman, Agron. J., **59,** 49 (1971).
7. S. R. Olsen, C. V. Cole, F. S. Watanabe and L. A. Dean, Circ. U. S. Dep. Agric., **939** (1954) p. 99.
8. Susan John and A. Abraham, J. Ind. Soc. Soil Sci., **43,** 47 (1995).
9. R. L. Donahue, R. W. Miller and J. C. Schickluna, Soil and Plant Nutrition. An Introduction to Soils and Plant Growth, Chapter 6, Ed. 4, Prentice Hall Inc. Englewood Clitts, N.J., (1977) pp. 123-141.
10. A. C. Das, A. Chakravarty, P. Sukul and D. Mukherjee, Microbiol. Res., **150,** 187 (1995).
11. R. L. Rajput, K. J. P. Kaushi and O. P. Verma, Indian J. Agron., **36,** 549 (1991).
12. V. P. Agnihotri, Can. J. Microbiol., **16,** 877(1970).
13. J. P. Singhal and C. P. Singh, Plant and Soil, **46,** 69 (1977).
14. D. S. Jenkinson and J. N. Ladd, Soil Biochem., **5,** 415 (1981).
15. D. C. Adriano, Water, Air and Soil Pollution, **57 & 58,** 331 (1991).
16. M. E. Sanchez, I. B. Estrada, O. Martinez, A. Aller and A. Moran, Amer. J. Env. Sci., **1**, 172 (2005).
17. A. A. Audu and A. O. Lahwal, J. Appl. Sci. Env. Mgt., **10**, 105 (2006)
18. Parkpain, P. Sirisukhodam and A. A. Carbonell Barrachina, Environ. Sci. Health, **A33**, 573 (1998).

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