The Effect of 2,4-D on the Microbial Action in Orchard Soils

By

Shuji Morita and Akira Aoki*

(森田修二・青木　朗)

It needs no saying that 2,4-D is used as a herbicide and its hormon effect is also observed.

Jones[1] experimented the effect of 24-D on nitrification. He used various amounts of 24-D ranging from 0 to 25 pounds per acre and observed no significant effect. Noda[2] reported that 24-D was ineffectual on nitrification and ammonification in the field condition. It is the purpose of this study to investigate the effect of 24-D on ammonification and nitirfication with various kinds of soils in laboratory, the amounts of 2,4-D being widely changed.

Materials and Methods

Three kinds of soils, whose chemical and physical properties were different from each other, were used in the present study. All the soils used in this study are surface soils. The sources of soils are as follows:

Soil Number	Location	Management
1	Kuroishi, Aomori Pref.	Orchard
2	Iwakura, Kyoto	Orchard
3	Shimogamo, Kyoto	Orchard

Their Properties in general are shown in Table 1.

Table 1. General properties of soil samples used

Soil Number	N	C	Humus	Available P_2O_5	Available K_2O	Texture Term
	%	%	%	%	%	
1	0.466	5.93	10.22	0.0105	0.0284	Loam
2	0.295	1.74	2.94	0.0031	0.0307	Clay
3	0.248	1.17	2.02	0.0121	0.0157	Fine clayey loam

For the experiment, 300 gm. of soils were put into small pots. On ammonification experiment, 150 mgm. of nitrogen, casein being used as nitrogen source, and 0.3 gm. of

* Contribution from the Laboratory of Soils and Fertilizers, Saikyo University, Kyoto, Japan. No. 1

$CaCO_3$ were mixed with 300 gm. of soils. 2,4-D* was used in three ways, viz. 0.03, 0.3, and 3 ppm, which were calculated from the amount of 2,4-D used as herbicide in field. Moisture was kept at 60 per cent of the maximum water capacity of each soil. The pots were kept at 28-30°C. Ammonium nitrogen was determined 3, 5, 7, 14, 21, and 28 days after the experiment started.

On nitrification experiment, 300 gm. of soils were mixed with 150 mgm. of ammonium nitrogen, ammonium sulphate being used as ammonium source, and 0.3 gm. of $CaCO_3$. Further treatment was the same as described in the experimental procedure of ammonification.

For both experiments the controls which were applied with no 2,4-D were prepared, and each experiment was conducted in triplicate ways.

Experimental Result

Result of Ammonificatication

The date obtained in the ammonification experiment are shown in Table 2.

Table 2. Effect of 2,4-D on the ammonification of soils

	2,4-D Application / Days	0 ppm	0.03 ppm		0.3 ppm		3 ppm	
		NH_3-N formed	NH_3-N formed	increased	NH_3-N formed	increased	NH_3-N formed	increased
		mgm	mgm	mgm	mgm	mgm	mgm	mgm
Soil No.1	3	18.41	27.83	9.42	20.35	1.94	19.58	1.17
	5	20.71	32.14	11.43	25.45	4.74	16.22	-4.49
	7	13.98	14.90	0.92	20.78	6.80	15.41	1.17
	14	15.71	13.38	-2.33	11.13	-4.58	10.45	-5.26
	21	4.01	9.40	5.39	8.20	4.19	5.75	1.74
	28	6.74	10.19	3.45	8.33	1.59	7.29	0.55
Soil No.2	3	25.66	16.44	-9.14	24.08	-1.58	19.87	-5.79
	5	22.74	24.49	1.75	23.89	1.15	22.51	-0.23
	7	23.40	22.65	-0.75	19.31	-4.09	26.53	3.13
	14	8.36	15.72	6.91	12.53	4.17	21.84	13.48
	21	1.82	4.43	2.61	4.21	1.39	14.75	11.93
	28	0.64	3.41	1.77	1.05	-0.58	9.86	8.22
Soil No.3	3	28.92	34.39	5.47	40.34	11.42	43.99	15.07
	5	35.40	24.01	-11.39	33.42	-1.98	28.63	-0.27
	7	41.13	43.52	2.40	49.61	8.48	51.56	10.44
	14	27.95	38.91	10.96	33.17	5.22	30.92	-0.20
	21	14.55	11.28	3.27	16.92	2.37	14.38	-0.17
	28	18.85	12.86	-5.99	10.33	-8.52	15.60	-3.25

* Sodium ester of 2,4-D. Kindly furnished by Kaken Yakuhin Kogyo Co.

Within one week each sample showed a wide variation in degree of ammonification, and thereafter almost a constant tendency. In the case of soil 1, both 0.03 and 0.3 ppm. applications showed in 3, 5 and 7 days higher amount of ammonified nitrogen as compared with the control. In 5 days, 3 ppm. addition showed rather less amount than the control. Three 2,4-D treatments showed in 14 days less amount of ammonified nitrogen, and in 21 and 28 days more amount than the control. In the latter case the degree of ammonification was in the following order: 0.03 ppm. > 0.3 pmm. > 3 ppm.

On soil 2, three 2,4-D treatments showed less ammonification than the control in 3 days. Afterwards ammonification increased gradually, showing higher value than the control, and attained to the maximum value after 14 days. The order was 3 ppm. > 0.03 ppm. > 0.3 ppm.

On soil 3, an increased ammonification was found after 3 days, it decreased after 5 days, and increased again after 7 days. 3 and 0.3 ppm. applications showed the maximum values after 7 days, and 0.03 ppm. application the maximum after 14 days, and after that the amount decreased remarkably.

Result of Nitrification

Result of nitrification is presented in Table 3.

Table 3. Effect of 2,4-D on the nitrification of soils

2,4-D Application / Days		0 ppm	0.03p pm		0.3 ppm		3 ppm	
		NO_3-N formed	NO_3-N formed	increased	NO_3-N formed	increased	NO_3-N formed	increased
		mgm	mgm	mgm	mgm	mgm	mgm	mgm
Soil No. 1	3	0.059	0.105	0.046	0.075	0.016	0.067	0.008
	5	0.143	0.126	-0.017	0.137	-0.006	0.125	-0.018
	7	0.290	0.180	-0.110	0.209	-0.081	0.222	-0.068
	14	0.417	0.293	-0.124	0.313	-0.104	0.405	-0.012
	21	0.543	0.352	-0.191	0.535	-0.008	0.601	0.058
	28	0.193	0.152	-0.046	0.261	0.063	0.320	0.122
Soil No. 2	3	0.606	0.380	-0.226	0.246	-0.360	0.297	-0.309
	5	0.718	0.775	0.057	0.516	-0.202	0.466	-0.252
	7	1.528	1.353	-0.175	1.155	-0.373	0.957	-0.571
	14	2.324	2.235	-0.089	1.763	-0.561	1.744	-0.580
	21	3.163	3.370	0.207	3.530	0.367	3.307	0.140
	28	3.596	3.495	-0.101	3.154	-0.442	3.097	-0.497
Soil No. 3	3	0.178	0.157	-0.021	0.180	0.002	0.173	-0.005
	5	0.272	0.135	-0.106	0.161	0.111	0.199	-0.073
	7	0.336	0.209	-0.127	0.270	-0.066	0.282	-0.053
	14	0.787	0.949	0.162	0.857	0.070	0.871	0.084
	21	1.748	1.208	-0.540	1.355	-0.393	0.853	-0.895
	28	1.333	1.339	0.006	1.551	0.218	1.280	-0.053

On soil 1,nitrification was affected slight positively after 3 days and afterwards it gradually decreased. Nitrified nitrogen of 0.03 ppm. application was less than the control throughout 28 days. After 21 days nitrification of 0.3 and 3 ppm. application increased gradually and showed higher values than the control, 3 ppm. much higher than 0.3 ppm.

On soil 2, 2,4-D treatment showed less values than the control, with exception of the 0.03 ppm. applic tion whose value after 5 days responded positively to 2,4-D treatment. After 21 days all the applications showed much higher values than the control, the order being $0.3 > 0.03 > 3$ ppm. After 28 days they decreased again.

On soil 3 no distinct responsibility to 2,4-D treatment was found after 3 days. Nitrification decreased thereafter, and showed lower values than the control after 5 and 7 days. Then nitrified nitrogen increased and showed higher value than the control after 14 days. After 21 d ys the control was higher than the 2,4-D treatment. After 28 days the 0.3 ppm. application showed a slight higher value than the control, but in other applications no significant effect was found.

Summary and Conclusion

From the above result it can be said that 2,4-D reacts sometimes supressively and sometimes promotively on ammonification. As for the time at which ammonification was promoted, there was much difference in response to the soils and no definite tendency was found. The maximum value was obtained within the experiment period of 28 days.

Nitrification was affected in different ways and it responded negatively to the 2,4 D treatment in general.

In short, 2,4-D presented positive or negative effect on ammonification and rather negative on nitrification.

References

(1) Jones, H. E.: Jour. Amer. Soc. Agron. **40**, 522 (1948).

(2) Noda, M.: Jour. Sci. Soil and Manure, Japan. **21**, 229 (1951).