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Moderately inhibitory effects of N-dodecyloxymethylene-N-methylpiperidinium and N-dodecyloxymethylene-N-methylmorpholinium chlorides on seed germination

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Abstract

N-Dodecyloxymethylene-N-methylpiperidinium chloride (DMMP) and N-dodecyloxymethylene-N-methylmorpholinium chloride (DMMM) retarded germination of seeds of 9 cultivated plant species when applied at a concentration of 10^{-3} M, and inhibited germination at a concentration of 10^{-2} M. The exceptions were represented by *Lepidium sativum* L. and *Linum usitatissimum* L. seeds which germinated well even in 10^{-2} M solutions of either DMMP or DMMM.

Key words: N-dodecyloxymethylene-N-methylpiperidinium chloride, N-dodecyloxymethylene-N-methylmorpholinium chloride, seed germination, monocotyledons, dicotyledons

INTRODUCTION

N-Alkoxymethylene-N-methylpiperidinium chlorides and their-morpholinium analogues have been described as algicidal, bacteriocidal and fungicidal agents (Ptaszkowska and Oświęcimska 1980, 1983). Because of the broad biocidal activity exerted by relatively low concentrations, these compounds have been recommended as potentially very promising in the control of biological slimes in industrial cooling water systems (Rucka et al. 1981, Witek et al. 1980).

Amongst the most active compounds of the above-mentioned group of alkoxymethylene derivatives (Komkov and Pankratov 1966) were N-dodecyloxymethylene-N-methylpiperidinium and -morpholinium chlorides (DMMP and DMMM, respectively), at least in respect to fungicidal acti-

vity including a number of phytopathogenic fungi (Ptaszkowska and Oświęcimska 1983). Recent experiments revealed that both compounds were also active as inhibitors of seed germination and seedling growth in lettuce and poppy, and as growth inhibitors in *Spirodela oligorrhiza* (Knypl and Oświęcimska 1985, 1986a, b) and *Cucumis sativus* (Knypl and Oświęcimska 1986c, d). Keeping in mind that the use of these compounds in industry may constitute a potential environmental hazard, we decided to investigate the effects of DMMP and DMMM on germination of seeds of 9 selected species of ornamental plants, vegetables and cereals.

MATERIAL AND METHODS

Seeds of nine species (*Hordeum vulgare* L. var. Triumph, *Secale cereale* L. var. Dańkowskie Złote, *Avena sativa* L. var. Boruta, *Lepidium sativum* L. var. Ogrodowa, *Linum usitatissimum* L. var. Niebieski, *Amaranthus caudatus* L. var. Pygmy Torch, *Brassica oleracea* L. ssp. *capitata* var. Langedijker Dauer, *Sinapis alba* L. var. Nakielska, *Agrostemma githago* L. var. Greifswald) in groups of 30, 50 or 100 (depending on seed size) were placed in 9-cm Petri dishes lined with a disc of Whatman No. 2 filter paper wetted with 3, 4 or 5 cm^3 of distilled water (the controls) or volumes of DMMP or DMMM solutions of the appropriate concentration. Germination was carried out at 25°C in darkness, and the number of germinated seeds counted each consecutive day for 6 days. Experiments were run in triplicate and repeated twice. The results are given either in direct graphical form presenting percentage of germination vs. concentration of the compound in question, or according to Timson (1965). DMMP and DMMM were synthesized as described (Knypl and Oświęcimska 1986a).

RESULTS AND DISCUSSION

The compounds in question in no case stimulated seed germination. Generally, both DMMP and DMMM when applied at a concentration of 10^{-2}M, inhibited seed germination with the exception of linen and cress seeds. At a concentration of 10^{-3}M, both compounds retarded germination, the effect disappearing in time. This relation is well illustrated by barley (Fig. 1) and rye (Table 1) of the monocotyledons. Oat was ca 10-fold more sensitive to DMMP and DMMM in comparison with barley and rye (Table 1).

Insofar as dicotyledons are concerned, DMMP and DMMM were non-

Table 1

Effects of DMMP and DMMM on germination of selected plant species. Results are presented according to Timson (1965); n.d. means not determined

Plant species	Germination percentage for 6 days, Σ6 concentration, M					
	0	10^{-6}	10^{-5}	10^{-4}	10^{-3}	10^{-2}
N-dodecyloxymethylene-N-methylpiperidinium chloride						
Secale cereale	450	445	420	380	360	112
Avena sativa	320	320	320	206	36	0
Lepidium sativum	585	583	583	581	550	476
Linum usitatissimum	224	223	223	223	222	n.d.
N-dodecyloxymethylene-N-methylmorpholinium chloride						
Secale cereale	450	450	430	437	410	150
Avena sativa	320	300	294	270	68	0
Lepidium sativum	585	580	579	550	550	484
Linum usitatissimum	224	225	227	181	107	n.d.

active as inhibitors of germination in cress and linen (Table 1). Both compounds at concentrations up to 10^{-3} M slightly retarded germination of *Amaranthus caudatus* L. (Fig. 2), *Brassica oleracea* L. (Fig. 3) and *Sinapis alba* L. (Fig. 4). Germination of *Agrostemma githago* L. was retarded during the initial days, the effect being transient in time (Fig. 5).

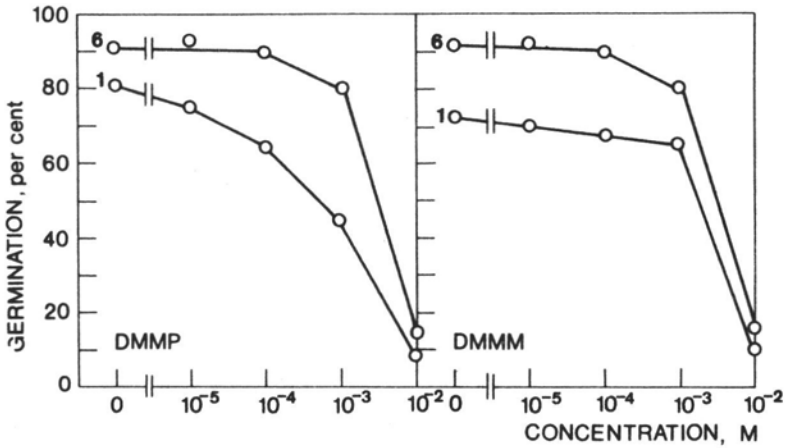

Fig. 1. Effects of different concentrations of DMMP and DMMM on germination of barley grains. Numbers on the left of each line in this and the following figures signify days of germination. A difference of 8 per cent between any two values is significant at $p = 0.01$

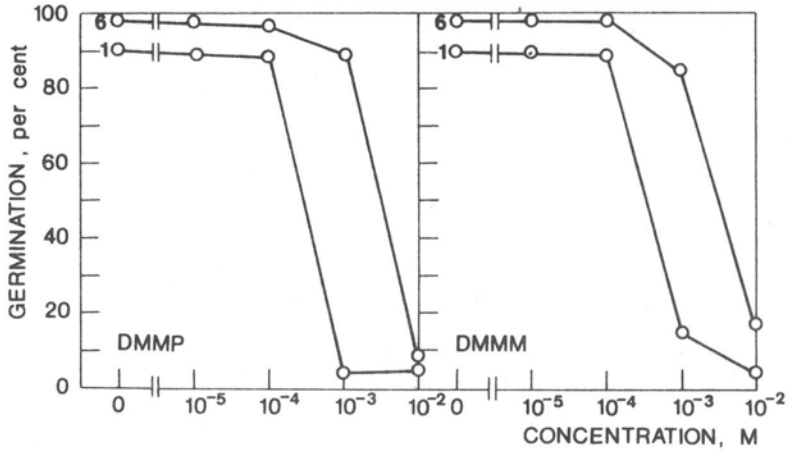

Fig. 2. Effects of DMMP and DMMM on germination of *Amaranthus caudatus* L. seeds. A difference of 8 per cent between any two values is significant at $p = 0.01$

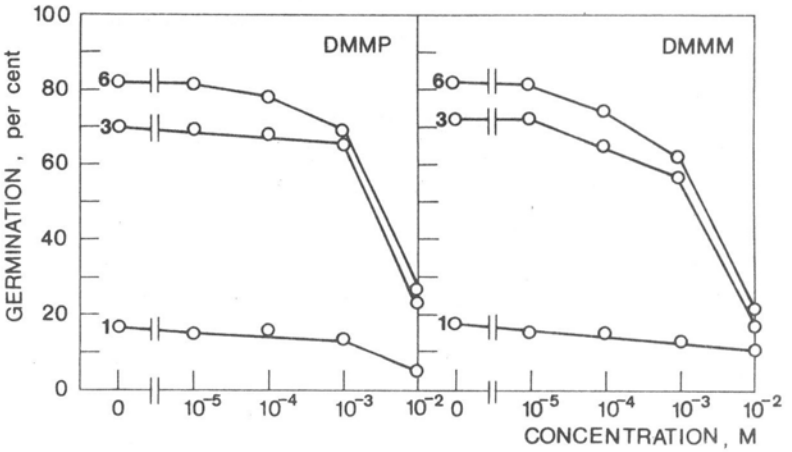

Fig. 3. Effects of DMMP and DMMM on germination of red cabbage seeds. LSD at $p = 0.01$: 6 and 10 per cent for 1 and 3-6 days, respectively

The data presented in this report show that neither DMMP nor DMMM represent an environmental hazard, at least as far as seed germination is concerned. These compounds can retard seed germination at a concentration of ca. 10^{-3} M, i.e. at a concentration 100-1000 times higher than that recommended for their use in industrial coling water systems for the control of biological slimes (Witek et al. 1980). In addition, it should be taken into consideration that both DMMP and DMMM are unstable in water solutions (Komkov and Pankratov 1966, Oświęcimska — unpublished data, cf. Knypl and Oświęcimska 1986c, d). It can be concluded, therefore,

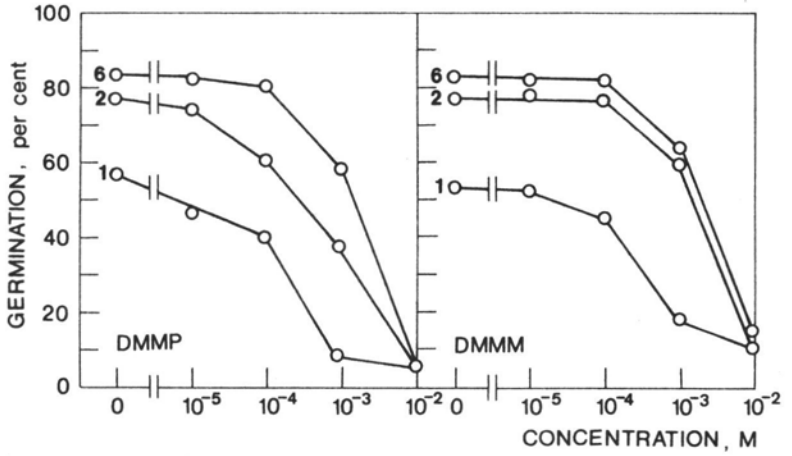

Fig. 4. Germination of *Sinapis alba* L. seeds under the influence of DMMP and DMMM. LSD at p = 0.01: 9, 7 and 5 per cent for 1, 2 and 6 days, respectively

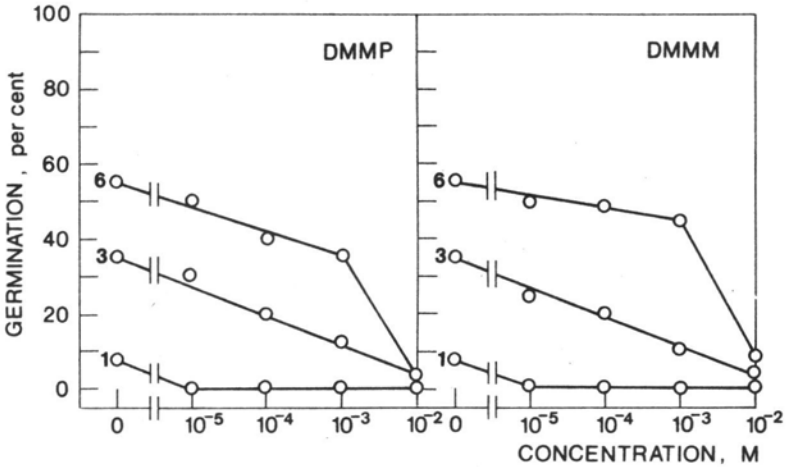

Fig. 5. Effects of DMMP and DMMM on germination of *Agrostemma githago* L. seeds. LSD at p = 0.01: 11, 9 and 6 per cent for 1, 3 and 6 days, respectively

that each of the compounds can be applied in practice without detrimental side-effects on the germination ability of seeds. Nevertheless, the compounds are much more active as inhibitors of growth, especially the growth of roots (Knypl and Oświęcimska 1985, 1986a-d). Hence, before DMMP and DMMM can be safely applied in industrial practice, their effects on the development of plants in natural conditions should be investigated. Neither DMMP nor DMMM, when applied as a soil drench even at a concentration of 10^{-3} M, affected growth and development of *Papaver somniferum* L. in field conditions (unpublished data).

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REFERENCES

Knypl J. S., Oświęcimska M., 1985. Physiological activity of N-dodecyloxymethylene-N-methylpiperidinium chloride (DMP) and N-dodecyloxymethylene-N-methylmorpholinium chloride (DMM) in higher plants. Int. Symp. "Regulation of Plant Integrity", Brno, Sept. 2-5, 1985. Abstracts, Univ. of Agriculture Brno, p. 35.

Knypl J. S., Oświęcimska M., 1986a. Growth regulating activity of N-dodecyloxymethylene-N-methylpiperidinium and N-dodecyloxymethylene-N-methylmorpholinium chlorides in *Lactuca sativa* and *Spirodela oligorrhiza*. J. Plant Physiol. (in press).

Knypl J. S., Oświęcimska M., 1986b. Effects of N-dodecyloxymethylene-N-piperidinium, N-dodecyloxymethylene-N-methylmorpholinium, and N,N-dimethylmorpholinium chlorides on seed germination and seedling growth in *Papaver somniferum* L. Plant Growth Regulation (in press).

Knypl J. S., Oświęcimska M., 1986c. Inhibition of seed germination and seedling growth by N-dodecyloxymethylene-N-methylpiperidinium chloride and N-dodecyloxymethylene-N-methylmorpholinium chloride in *Cucumis sativus* L. Acta Physiol. Plant. (in press).

Knypl J. S., Oświęcimska M., 1986d. Physiological activity of N-dodecyloxymethylene-N-methylpiperidinium chloride and N-dodecyloxymethylene-N-methylmorpholinium chloride in higher plants. Acta Univ. Agr. Brno (in press).

Komkov I. P., Pankratov V. A., 1966. Surface active salts of quaternary ammonium compounds with alkyloxymethylene radicals at the N. Zh. Prikl. Khim. 39: 1858-1860.

Ptaszkowska J., Oświęcimska M., 1980. Fungicidal activity of M-alkoxymethylene-N-methyl-morpholinium and -piperidinium chlorides. Organika Prace IPO (1980): 157-164.

Ptaszkowska J., Oświęcimska M., 1983. Evaluation of fungicidal activity of N-alkoxymethylene-N-methyl-morpholinium or -piperidinium chlorides. J. Environm. Sci. Health 18B: 505-514.

Rucka M., Oświęcimska M., Witek S., 1981. New biocides for cooling water treatment. II. Alkoxymethyleneammonium chlorides. Environm. Protect. Engineering 7: 45-54.

Timson J., 1965. New method of recording germination data. Nature (Lond.) 207: 216-217.

Witek S., Oświęcimska M., Ptaszkowska J., Bakuniak E., Górska-Poczopko J., Łaszcz E., 1980. A fungicidal agent. Patent of Poland No. 106 181 (1980-11-29).

Umiarkowanie inhibitorowy wpływ chlorku N-dodecylooksymetyleno-N-metylopiperydyniowego i chlorku N-dodecylooksymetyleno-N-metylomorfoliniowego na kiełkowanie nasion

Streszczenie

Chlorek N-dodecylooksymetyleno-N-metylopiperydyniowy (DMMP) i chlorek N-dodecylooksymetyleno-N-metylomorfoliniowy (DMMM) opóźniają kiełkowanie nasion, gdy stosuje się je w stężeniu 10^{-3} M, oraz hamują kiełkowanie w stężeniu 10^{-2} M. Wyjątek stanowią nasiona rzeżuchy i lnu, kiełkujące nawet wobec 10^{-2} M DMMP lub DMMM. Obiektem analiz były ziarniaki i nasiona dziewięciu gatunków roślin uprawnych, ozdobnych oraz chwastu *Agrostemma githago* L.