ACTA AGROBOTANICA
vol. 40, z. 1-2 — 1987
59-65

The interaction of 9-amine-9-fluorenephosphonic acid derivatives (new morphactins) with some herbicides in toxicity towards *Spirodela*

HENRYK SKRABKA and ELŻBIETA JASKULSKA

Institute of Plant Physiology, Agricultural Academy,
ul. Cybulskiego 32, 50-205 Wrocław, Poland

(Received: April 2, 1985)

Abstract

Examined was the possibility of interaction between morphactins and herbicides in phytotoxicity towards *Spirodela* as a test plant. Three newly synthesized 9-amine-9-fluorenephosphonic acid derivatives and the following herbicides were used: Aresin, Banvell D4-S, Gesagard, Pielik, Sys 67-Prop and U-46 KV Pulver. Synergism in phytotoxicity to *Spirodela* was found in the case of joint application of morphactin no. 1 and herbicides U-46 KV Pulver, Pielik and Sys 67-Prop.

INTRODUCTION

Fluorene derivatives, more precisely, 9-amine-9-fluorenephosphonic acid derivatives, are compounds with a similar structure and effectivity as morphactins (Schneider, 1970; Gancarz and Wieczorek, 1980; Czerwiński et al., 1982; Gancarz et al., 1983; Lejczak et al., 1984). They exert a strong influence on the physiological processes of plants (Mohr and Ziegler, 1969; Bopp, 1972; Katsumi, 1973; Skrabka et al., 1984; Skrabka and Jaskulska, 1987). Some morphactins interact with herbicides in such a way as to increase their phytotoxicity, which allows the herbicide dose to be lowered (Pieniążek and Saniewski, 1969; Schneider, 1970; Jindal and Singh, 1976).

In the first stage of these studies (Skrabka and Jaskulska, 1987), the overall physiological activity of newly synthesized 9-amine-9-fluorenephosphonic acid derivatives, also called morphactins, was determined in order to to select the most appropriate ones for further study. In the second stage, presented in this paper, a series of experiments was conducted in order to select morphactins and herbicides which interact with each other in toxicity towards the test plant.

MATERIAL AND METHODS

Duckweed great *(Spirodela oligorrhiza)* was used as the test plant. Preparation of the plant for testing has been described in other reports (Knypl et al., 1976; Czerwiński et al., 1982; Skrabka and Jaskulska, 1987). The prepared plants were placed in 100 cm^3 beakers containing 50 cm^3 of solutions of the studied compounds in distilled water. Six healthy plants, so-called tri-fronds, of uniform appearance, color and size, were placed in each beaker. The experiments were done in triplicate. This made it possible to calculate the average from over 50 fronds. After 24 h, changes in the appearance of the plants were recorded and the degree of damage, in a special 5 degree bonitation scale (Czerwiński et al., 1982) was determined. The measure of toxicity was the change in the appearance of the plants seen as epinasty, disintegration of fronds, changes in color, etc. The degree of damage was determined for each frond separately. Next, the results were transformed into percent of damage, and at the same time, vegetation inhibition, in respect to control plants. Statistical calculations showed that the experimental error did not exceed 10% for all of the experiments.

Morphactins

In the first series of these experiments, three morphactins were used: no. 1 — 9-amine-9-fluorenephosphonic acid diethyl ester hydrochloride; 2 — 9-N-sec-butylamine-9-fluorenephosphonic acid diethyl ester hydrochloride; 3 — 9-N-sec-butylamine-9-fluorenephosphonic acid hydrochloride. These compounds were selected on the basis of other experiments (Skrabka and Jaskulska, 1987) and unpublished results. The numeration of the compounds used in the cited paper (Skrabka and Jaskulska 1987) does not correspond to the numbers used here. In spite of the differences in structure and general toxicity, these morphactins interacted relatively well with herbicides. The studied morphactins were synthesized by staff members of the Wrocław Polytechnic. In the second series of experiments, only morphactin no. 1 (9-amine-9-fluorenephosphonic acid diethyl ester hydrochloride) was used.

Herbicides

The following herbicides were used: no. 1 — Aresin (monolinuron 50%); 2 — Banvell D4-S (dicamba 49%); 3 — Gesagard (prometrine 50%); 4 — Pielik (2,4-D 85%); 5 — Sys 67 — Prop (dichloroprop 50%); 6 — U-46 KV Pulver (mekoprop 75%).

These are market brands, obtained from the Department of Weed Biology and Combating Weeds of the IUNG (Institute of Cultivation,

Fertilization and Soil Science) in Wrocław. These compounds have different chemical structures and physiological effects.

In the first series, only U-46 KV Pulver was used, since in the initial experiments it exhibited high activity and a tendency to interact with morphactins.

In order to better ascertain the phytotoxicity of the studied compounds, various concentrations of herbicides and morphactins were used. To select the appropriate morphactins for use in the studies on the interaction with herbicides, experiments with 3 morphactins and 1 herbicide, U-46 KV Pulver, were done. In these experiments, the following morphactin concentrations were used: 0, 2, 4, 8×10^{-5} M; of herbicide: 0 and 1×10^{-4} M of active substance. The results of the first series of experiments are presented in Table 1.

Table 1

The interaction of herbicide U-46 KV Pulver with morphactins in phytotoxicity of *Spirodela* plants, expressed in percents of growth inhibition and development after 24 h, towards control plants

Numeration of morphactins	Concentration of herbicide X 10^{-4} M	Concentration of morphactins X 10^{-5} M			
		0	2	4	8
1	0	0	24	23	25
	1	0	18	41	84
2	0	0	20	40	81
	1	0	20	84	98
3	0	0	21	19	38
	1	0	16	40	84

RESULTS

Under the conditions of the experiment, the herbicide alone did not exhibit any signs of toxicity. The morphactins alone (without herbicide) were moderately toxic. The addition of a morphactin to the herbicide solution caused an increase in the activity of the mixture, as shown by the increase in the degree of damage to the plants. All three morphactins acted similarly. The greatest phytotoxicity was exhibited by morphactin no. 2, especially at higher concentrations.

Only morphactin no. 1 was used in the next series of experiments because it interacted in the most uniform way in respect to phytotoxicity. The 6 herbicides described in Methods were used.

The herbicides were used in the following concentrations: 0; 2×10^{-5} M; 4×10^{-5} M; 8×10^{-5} M of active substance; the morphactin was used at concentrations of 8×10^{-5} M and 16×10^{-5} M. The results are presented on Figs. 1-6.

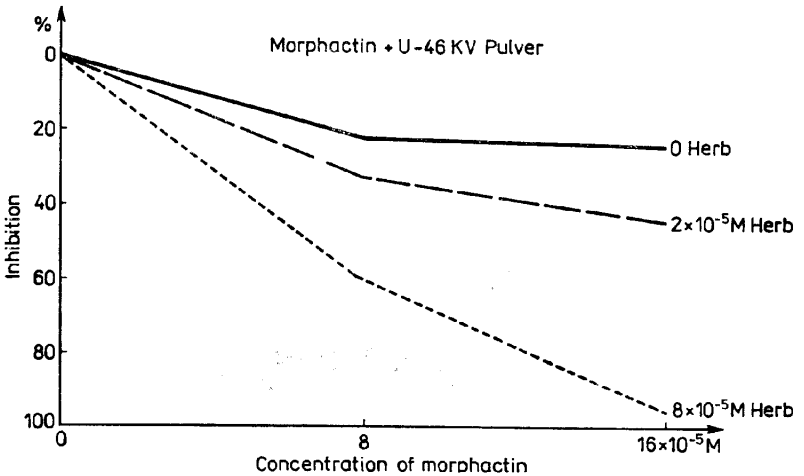

Fig. 1. The interaction of the herbicide, U-46 KV Pulver with morphactins in phytotoxicity to *Spirodela*, expressed in percent of inhibition of growth and development after 24 h, compared with control plants

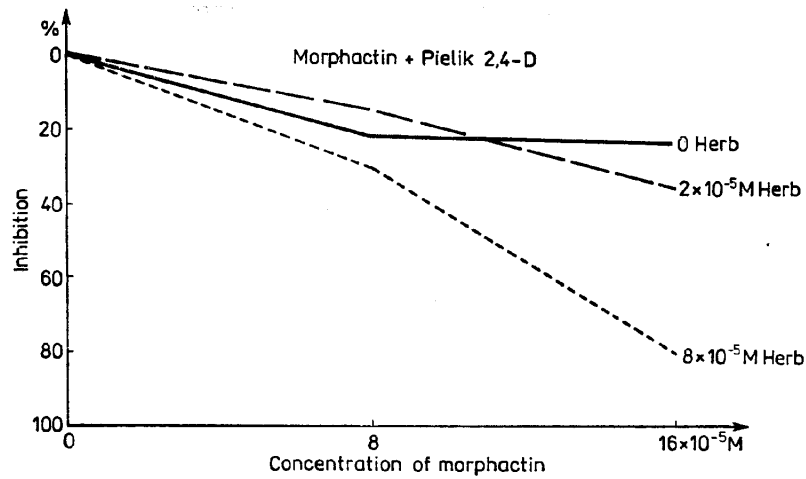

Fig. 2. The interaction of the herbicide, Pielik with morphactins in phytotoxicity to *Spirodela*, expressed in percent of inhibition of growth and development after 24 h, compared with control plants

In all of the applied concentrations, the tested herbicides did not cause changes in the appearance of the plants. The morphactin, in both concentrations, had only a slight effect on the plants, whereas after the morphactin was mixed with some of the herbicides, a distinct synergism in phytotoxicity was observed. Increased damage to *Spirodela* took place when the following were used with the morphactin: U-46 KV Pulver, Pielik and Sys 67-Prop. However, when the morphactin was added to

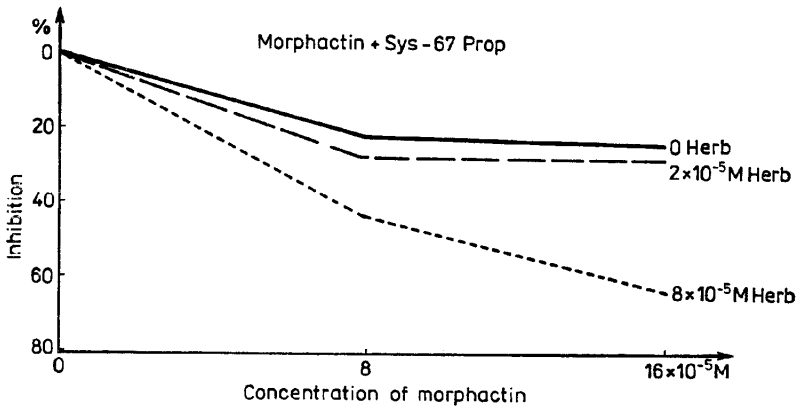

Fig. 3. The interaction of the herbicide, Sys 67-Prop with morphactins in phytotoxicity to *Spirodela*, expressed in percent of inhibition of growth and development after 24 h, compared with control plants

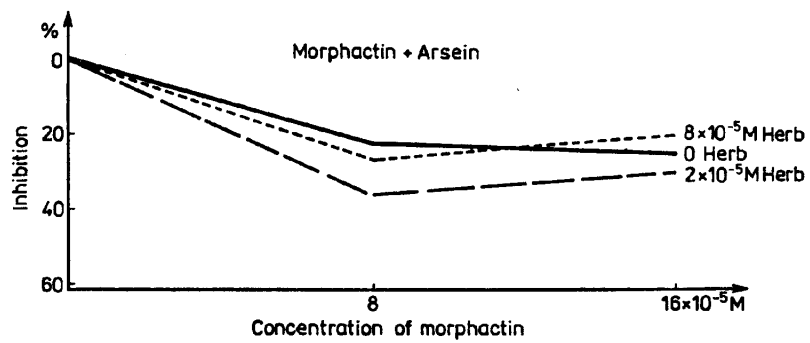

Fig. 4. The interaction of the herbicide, Aresin with morphactins in phytotoxicity to *Spirodela*, expressed in percent of inhibition of growth and development after 24 h, in comparison with control plants

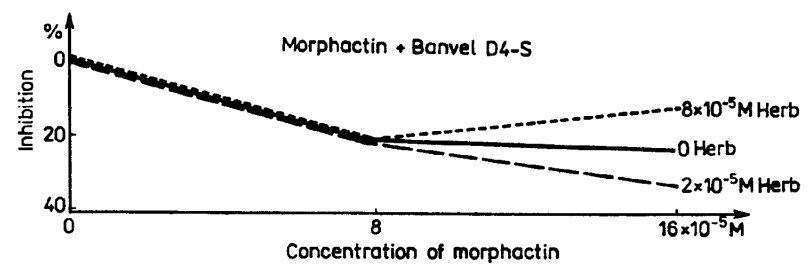

Fig. 5. The interaction of the herbicide, Banvell with morphactins in phytotoxicity to *Spirodela*, expressed in percent of inhibition of growth and development after 24 h, compared with control plants

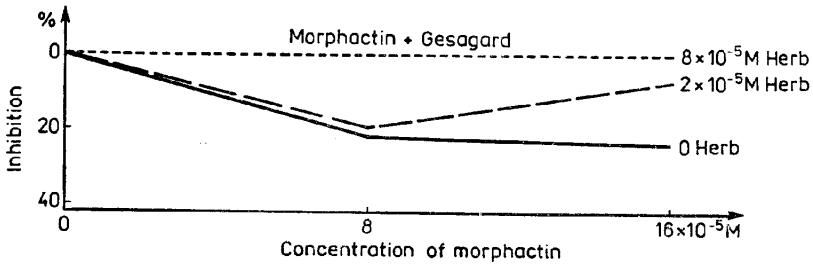

Fig. 6. The interaction of the herbicide, Gesagard with morphactins in phytotoxicity to *Spirodela*, expressed in percent of inhibition of growth and development after 24 h, compared with control plants

Banvell or Aresin, a decrease in their activity was seen. Because (in comparable concentrations) the morphactins exhibited a somewhat greater toxicity than the herbicides, this can also be seen as a decrease in the toxicity of the morphactin.

The use of morphactins as herbicides will depend on their selectiveness, rate of degradation in the soil and whether or not they are a hazard to the environment. At present there is a tendency to produce herbicides made up of various components and compounds which interact with herbicides and increase their effectiveness, thus reducing the danger to the environment.

REFERENCES

Bopp M., 1972. On the effect of morphactin. [In:] Hormonal regulation in plant growth and development. Kaldewey H., Vardar Y. Verlag Chemie, Weinheim pp. 333-348.

Czerwiński W., Gancarz R., Przybyłka E., Wieczorek J. S., 1982. Wstępna ocena fizjologicznej aktywności pochodnych kwasu 9-aminofluoreno-fosfonowego-9. Acta Agrobot. 34: 253-260.

Gancarz R., Wieczorek J. S., 1980. Synthesis of phosphonic analogues of morphactins. Journal of prakt. Chemie 322: 213-222.

Gancarz R., Kafarski P., Lejczak B., Mastalerz P., Wieczorek J. S., Przybyłka E., Czerwiński W., 1983. Phosphonic analogues of morphactins. Phosphorus sulfur 18: 373-376.

Jindal K. K., Singh R. N., 1976. Modification of flowering pattern and sex expression in *Carica papaya* by morphactin, ethephon and TIBA. Z. Pflanzenphysiol. 78: 403-410.

Katsumi M., 1973. The mode of action of a morphactin, fluoren-9-carboxylic acid. Bog. Mag. Tokyo 86: 267-273.

Knypl J. S., Witek S., Oświęcimska M., 1976. Growth retarding effect of N,N-dimethylmorpholinium chloride and CCC in *Spirodela oligorrhiza*. Z. Pflanzenphysiol. 79: 53-61.

Lejczak B., Kafarski P., Gancarz R., Jaskulska E., Mastalerz P., Wieczorek J. S., Król M., 1985. Phosphonic analogues of morphactins.

Part III: Peptides Containing P-Terminal [-aminofluoren-9-ylphosphonic acid]. Pestic. Sci. 16: 227-233.

Mohr G., Ziegler H., 1969. Symposium über Morphaktine. Dtsch. Bot. Ges. Neue Folge 3: 5-18.

Pieniążek J., Saniewski M., 1969. Nowe dane o morfaktynach i możliwościach praktycznego ich zastosowania w rolnictwie i ogrodnictwie. Post. Nauk Rol. 3/4: 27-38.

Schneider G., 1970. Morphactins: Physiology and performance. Ann. Rev. Plant Physiol. 21: 499-536.

Skrabka H., Grzyś E., Jaskulska E., 1984. Otsenka fiziologicheskojj aktivnosti novykh morfaktinov i ikh vzaimodejjstvie s nekotorymi gerbitsidami. Sbornik dokladov XIV Nauchno-Koordinastionnogo Soveshhanija spetsialistov SEV, Izuchenie mekhanizma dejjstivija gerbitsidov i sinteticheskikh regulatorov rosta rastenijj, Ufa.

Skrabka H., Jaskulska E., 1987. An evaluation of the physiological activity of 9-amine-9-fluorenephosphonic acid derivatives. Acta Agrobot. 40: 53—57.

WSPÓŁDZIAŁANIE POCHODNYCH KWASU 9-AMINOFLUORENO-FOSFONOWEGO-9 [NOWYCH MORFAKTYN] Z NIEKTÓRYMI HERBICYDAMI W TOKSYCZNOŚCI WZGLĘDEM SPIRODELI

Streszczenie

Badano możliwość współdziałania między morfaktynami a herbicydami w fitotoksyczności rośliny testowej spirodeli. Zastosowano trzy nowo zsyntetyzowane związki — pochodne kwasu 9-aminofluoreno-fosfonowego-9 oraz następujące herbicydy: Aresin, Banvell D4-S, Gesagard, Pielik, Sys 67-Prop, U-46 KV Pulver. Stwierdzono synergizm w fitotoksyczności spirodeli w przypadku łącznego zastosowania morfaktyny nr 1 (chlorowodorek estru dietylowego kwasu 9-aminofluoreno-fosfonowego-9) i herbicydów U-46 KV Pulver, Pielik i Sys 67-Prop.