BIOLOGIJA. 2004. Nr. 1. P. 45–47

Peculiarities of the effect of dimethylmorpholinium chloride derivative

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The present work deals with the principles of elaboration of new analogues of dimethylmorpholinium chloride (DMC) and elucidation of their specific effect on rape stem growth and productivity. The compound 17-DMC has been found to be an active stem growth retardant exerting a positive effect on rape productivity. 17-DMC is supposed to influence growth by changing the content of phytohormones, mainly IAA and GA_3.

Key words: spring rape, quaternary ammonium salts, phytohormones

INTRODUCTION

Synthetic growth regulators offer new prospects of the maximal involvement of the potential of a plant organism contained in its genome, and are promising in raising the productivity of cultured plants. Presently, growth regulators have to meet particular demands such as to be low-toxic and environment-friendly, *i.e.* to belong to the compounds of the 2nd or 3rd generation.

Presently, to efficient retardants CCC, camposan M, hydrel, terpal, finasol, retacel super and triazole are ascribed [1, 2]. However, they are not efficient enough to regulate stem growth in rape. We assumed that a purposeful search for new dimethylmorpholinium chloride derivatives could partially solve the problem of rape stem growth regulation and ensure regular high yields of rape seed. The search for original retardants was carried out according to the program of synthesis of active compounds, elaborated at the Laboratory of Plant Physiology of the Lithuanian Institute of Botany under the guidance of Prof. A. Merkys. The compounds were synthesized at the Department of Chemistry of Vilnius University in cooperation with Prof. V. Daukšas and Dr. Z. Ðaltytë on the grounds of the theoretical data on the mechanism of action of phytohormones and on the chemical groups that predetermine the retardant effect of the compounds [3, 4].

The present work was aimed to investigating the analogue of dimethylmorpholinium chloride for a purposeful regulation of the growth and productivity in rape.

MATERIALS AND METHODS

Field trials with spring rape (*Brassica napus* L. ssp. napus, variety 'Star') were carried out at the experimental base of the Lithuanian Institute of Agriculture on a turfy-gleyic podzol. Mineral fertilizers were applied in autumn ($P_{60}K_{60}$) and spring (N_{90}). The rape plot area was 22 m^2. The trials were carried out in four replications. The retardant properties of the compounds were determined from stem height and diameter. Stem resistance to lodging was evaluated on a 5-point scale [5]. The grain yield structure was evaluated at the stage of full ripeness. The results were statistically evaluated at the $p \leq 0.05$ significance [6].

Phytohormone content was assessed at the Laboratory of Growth Regulators and Development of Agricultural Plants of the Moscow Agricultural Academy (Russia). For phytohormones analysis, stems of spring rape grown in vegetative vessels and treated with the compound 17-DMC (10^{-3}M) at the phase of 5–6 true leaves were used. Sampling was done 10 days following the treatment. The level of ABA, zeatine and IAA was assessed by the method of high-efficiency liquid chromatography (HELC), and the content of GA (standard GA_3) was evaluated by means of biotesting in one sample [7, 8]. The samples were analysed in two replications, with fourfold chemical replicas. The HELC measurement accuracy was 5%. In Table the mean values are presented.

RESULTS AND DISCUSSION

In rape plants, physiologically active are compounds that contain in their molecular chain two methylene

groups bound by –CHOH group between two morpholine rings. To this group of compounds belongs 17-DMC which possesses an allyl alkylic group joined to the nitrogen atoms of morpholine in its molecule. This compound not only stimulates rape root formation and stem growth, but also enhances green and dry root mass increment.

Among the created DMC derivatives [3], the compound 17-DMC exhibited most pronounced regulating properties in rape. At the optimal dose (500 g/ha) applied at the stage of 4–5 true leaves it acted as a rape stem growth retardant and thus influenced formation of seed yield components. Under the effect of 17-DMC the growth of stems, because of a less intensive growth of their lower parts, was inhibited on average by 17% and the stem diameter increased by 19%. Because of the increased lodging resistance, stimulation of root system growth (Fig. 1), improved formation of rape productivity elements, the surplus yield of rape seed was 370 kg/ha, the average yield in control plants being 2585 kg/ha (Table).

Investigation of the peculiarities of the effect of the active compound 17-DMC on the level of native phytohormones in growing rape stems showed that this compound evoked changes in hormonal system components. A tendency was noted to a higher ABA content in rape stems as compared to control. Under the effect of 17-DMC the content of gibberellines in rape stems, judging by the biological activity of its known concentration (standard GA_3), was lower by 38%. 17-DMC influenced also the levels of other phytohormones: the content of IAA was found to be by 12% (Fig. 2) and of zeatine by 42% lower as compared to control. Changes in the content of separate phytohormones in rape stems under the effect of the compound 17-DMC were found to corespond to the inhibition of stem growth processes.

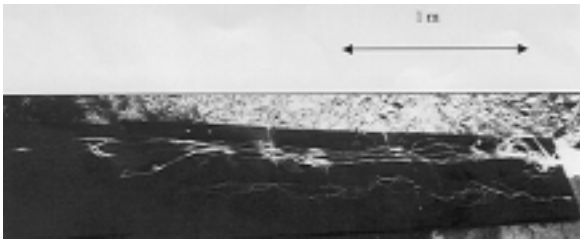

Fig. 1. Effect of 17-DMC on the formation of main roots at flowering phase: 1 – control; 2 – 17-DMC

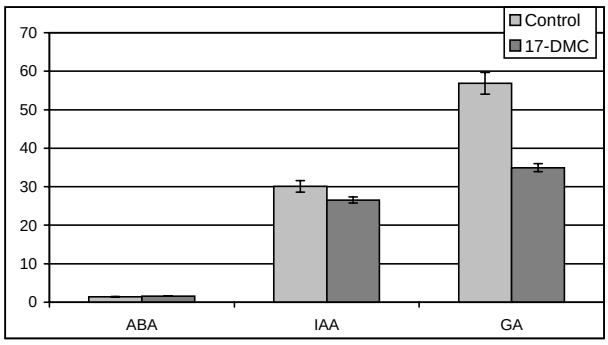

Fig. 2. Effect of compound 17-DMC ($1 \cdot 10^{-3}$M) on the amount (ng) of endogenic phytohormones (ABA, IAA, GA_3) in stem rape: 1 – control; 2 –17-DMC

The compound 17-DMC is low-toxic, environment-friendly and acceptable as a rape growth regulator increasing rape seed crops.

CONCLUSIONS

On summarizing the obtained data we have come to the conclusion that the compound 17-DMC in whose molecule the nitrogen atoms of morpholine ring are joined by a chain of two methylene groups separated by a –CHOH group exhibits a regulative effect on stem growth and seed yield productivity. 17-DMC is supposed to influence growth by chang-

Table. **Effect of compound 17-DMC on the formation of spring rape 'Star'**

Treatment variant	Number of siliquae per plant				Seed number per siliqua		1000 seed mass		Yield		Extra yield
	Main branches		Lateral branches								
	n	%	n	%	n	%	g	%	kg/ha	%	kg/ha
Control (H_2O)	31	100	34	100	25.0 ± 1.06	100	3.86 ± 0.91	100	2585	100	–
17-DMC (125 g/ha)	34	110	38*	118	27.9 ± 0.98	112	4.02 ± 0.19	104	2865*	111	280
17-DMC (250g/ha)	37*	119	41*	121	29.6 ± 2.03	119	3.98 ± 0.16	103	2915*	113	330
17-DMC (500g/ha)	36*	116	42*	124	29.7 ± 1.62	119	4.08 ± 0.14	106	2955*	114	370

* The data are statistically reliable at $p \leq 0.05.R_{95}\% = 180$.

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Received 4 January 2003
Accepted 5 November 2003

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DIMETILMORFOLINO CHLORIDO DARINIO AKTYVUMO YPATUMAI

S a n t r a u k a

Laboratoriniais ir lauko bandymais nustatyta, kad dimetilmorfolino chlorido darinys (17-DMC) modifikavo vasariniø rapsø *Star* stiebø ir ðaknø augimà teigiamai paveikdamas derliaus komponentus – padidindamas ankðtarø ir sëklø skaièiø bei jø masæ pagrindiniame ir ðalutiniuose þiedynuose. Galbût 17-DMC poveikis rapsø augimui yra susijæs su fitohormonø, ypaè IAR ir GR, kiekio pasikeitimu stiebo audiniuose. Manoma, kad junginio fiziologinis aktyvumas priklauso nuo dviejø metileno grupiø molekulëje, kurias skiria CHOH grupë, esanti tarp dviejø morfolino þiedø ir prie jø azoto atomø prijungtos alilo grupës.