Autumnal Growth Regulation and Nitrogen Fertilization on Winter Rapeseed (*Brassica napus L. convar. napus f. biennis*) with Different Density of Growth

Jiří Šimka[1)], David Bečka[1)], Pavel CIHLÁŘ[1)], Vlastimil MIKŠÍK[1)], Helena ZUKALOVÁ[1)], Jan VAŠÁK[1)]
[1)] Department of Crop Production, Czech University of Life Sciences, Kamýcká 129, 165 21 Prague 6 – Suchdol,
Czech Republic, Tel.: +420 2 2438 2672, fax: +420 2 2438 2535, e-mail: simka@af.czu.cz.

Abstract

The aim of the research is to specify the growth regulation and the nitrogen fertilization of the winter rapeseed with a different density of the growth in autumn season. In the vegetative year 2009/10 the specific field experiments with winter rapeseed of different variants of autumn agricultural practices and density of sowing rate were founded. The most influenced ones in view of production indicators and profitability are rare growths of the rapeseed. On the other hand the dense growths are influenced the least: At the low density of the growth (into 35 plants/m^2) the most economic variant of the growth regulator (*difenoconazole* + *paclobutrazole*) is the one that increases the yield about 13% and also the production indicators (average root collar, root length). At the optimal density of the growth (35 - 60plants/m^2) all applications positively influence yield indicators, but only the variant of growth stimulator (*difenoconazole* + *paclobutrazole*) is profitable. On the other hand at dense growth (over 60 plants//m^2) individual applications are of no effect on production indicators and they are all unprofitable.

Introduction

One of the essential cultivation practices of winter rapeseed in autumn is the application of the azole type of growth regulators and the application of *chlormequat-chloride (CCC)* based preparation. These chemical substances influence physiological processes in plant metabolism in a very desirable way and it also has a positive influence on the yield and quality parameters of winter rapeseed (Vašák a kol., 1997). The azole based preparations are most frequently used. The azoles have the fungicidal and also regulating effects. They are used as growth stimulators in lower doses, and most often combined with CCC substances. They have in full doses regulating effect. They also have the fungicidal effect. The azole prevents overgrowing and winter freezing injury of rapeseed, vitalizes the root growth, thickens the root collar, increases regeneration – so called „green effect“, inhibits maturing leaves and tissues and escalates the plant branching. The CCC based preparations reduce the overgrowing plant in autumn, increase the winter resistance, reduce overdevelopment of above-ground biomass and facilitate development of root system. The CCC preparations are applied in a dose about 2 liters/ha upon 2-4 leaves stage or later application in dose 4-5 liters/ha in 4-6 leaves stage. The list of permitted growth regulators for autumn application in the Czech Republic is shown in table 1.

The other very essential cultivation practice of winter rapeseed is the most effective nitrogen plant nutrient in autumn. The aim is to develop the optimal size, healthy and strong growth of rapeseed, which is the essential premise for fast plant regeneration at the beginning of spring.

The sowing rate should secure the sufficient number of plant in spring. Former results reached over 100 plants per m^2. Today the optimal number of plants is in range 40-60 per m^2 and for intensive cultivation technology 30 – 40 plants per m^2. Reducing sowing rate is caused by many factors. The breeding of new varieties (hybrid/line varieties) belongs to the most important factors. The optimal sowing rate secures the set up of the winter rapeseed growth for overwinter (the good habits of plant, strong root system etc.)

Table 1 Permitted chemical preparations for growth regulating of winter rapeseed in autumn term

Type	Name of the chemical preparations (*active substance*)	Term of application	Dose (l/ha)
Azole	Capitan 25 EW *(flusilazole)*	4.-6. leaves	0.6-0.8
	Caramba *(metconazole)*	4.-6. leaves	0.7-1.2
	Horizon 250 EW *(tebuconazole)*	4.-6. leaves	0.5-1.0
	Lynx *(tebuconazole)*	4.-6. leaves	0.5-1.0
	Lyric *(flusilazole)*	4.-6. leaves	0.5-0.8
	Ornament 250 EW *(tebuconazole)*	4.-6. leaves	0.5-1.0
	Orius 25 EW *(tebuconazole)*	4.-6. leaves	0.5-1.0
	Prosaro 250 EC *(prothioconazole, tebuconazole)*	4.-6. leaves	0.75-1.0
	Staccato (tebuconazole)	4.-6. leaves	0.5-1.0
	Toprex *(difenoconazole, paclobutrazol)*	1.-6. leaves	0.3
CCC	Celsar 750 SL *(chlormequat-chloride)*	2.-4. leaves	1.5-2.0
		2.-4. leaves	4.0-5.0
	Cycosel 750 SL *(chlormequat-chloride)*	4.-6. leaves	4.0-5.0
	Retacel Extra R 68 *(chlormequat-chloride)*	2.-4. leaves	2.0-3.0
		4.-6. leaves	5.0-6.5
	Stabilan 750 SL *(chlormequat-chloride)*	2.-4. leaves	1.5-2.0
		4.-6. leaves	4.0-5.0

Note: lower dose of azole - regulating effect, higher dose of azole - regulating and fungicidal effects

Material and methods

The aim of the research is to specify the growth regulation and the nitrogen fertilization of the winter rapeseed with different density of the growth in autumn season. The aim of every farmer of rapeseed in autumn should be the optimal growth set up for over winter (forcing the root system) and to create the yield premise for spring (to form more buds on branches) by the right application of growth stimulators or by the nitrogen fertilization. In recent years in the Czech Republic there was a problem with unbalanced and rare growths of the rapeseed caused by dry weather (years 2008, 2009) or humid weather (year 2007) in autumn season.

The specific field experiments with line variety of the winter rapeseed Californium were founded (plot size – 15 m^2,the total plot size for harvest 11.875 m^2) on the experimental farm that belongs to the Czech University of Life Sciences in Cerveny Ujezd (altitude above sea level 398 meters, average annual air temperature 7.7 °C, annual rainfall totals 549mm).

The experiment was realized in five different sowing rates (12; 25; 50; 100 a 150 seeds per m^2), in four variants and four repetitions:

1) Control variant - without any applications
2) Variant with application of growth regulators
3) Variant with nitrogen fertilization
4) Variant with nitrogen fertilization and with application of growth regulators

The dose of nitrogen is 45 kg N/ha in ASC (NH_4NO_3 + $CaCO_3$). As the growth stimulator there was chosen the azole preparation Toprex with active substance *difenoconazole* + *paclobutrazole* in dose 0.3 l/ha. The diagnostic of the growth in autumn is focused mainly in root system of the rapeseed (average of root collar, root length. The observation was done November 10, 2009, i.e. 38 days after the growth regulator application and the nitrogen fertilization.

Results and discussion

The rapeseed was sewn in optimal agricultural time in August 23, 2009. September was slightly warm and dry. The total rainfall was only 19.4 mm. In comparison to long-term average of rainfalls 42 mm (September normal of rainfall), the rainfalls per September were below on half of the long-term average of rainfall. In spite of desirable weather conditions, we succeeded with foundation of rapeseed growth technology. For this reason it is good to recommend in desirable weather conditions to do sowing tillage and pre-sowing soil preparation closely before rapeseed sowing.

Production indicators (average of root collar, root length, (%) dry root matter) and yield indicators at the single rapeseed growth are presented in table 2. At the single density of growth the most effective variants as to the profitability are written in bold. The application of the growth stimulator (*difenoconazole + paclobutrazole)* and nitrogen fertilizer ASC (NH_4NO_3 + $CaCO_3$) in autumn season influence the plant habits (table 2), growth and the plant development in all evaluated density of sowing rate. The principle of the better rapeseed over wintering is to intensify the root system (average of root collar, root length) which was occurred at the entire majority of the sowing rate in comparison to the control variant. Nevertheless the economic return is not secure in all application of fertilizer or azole.

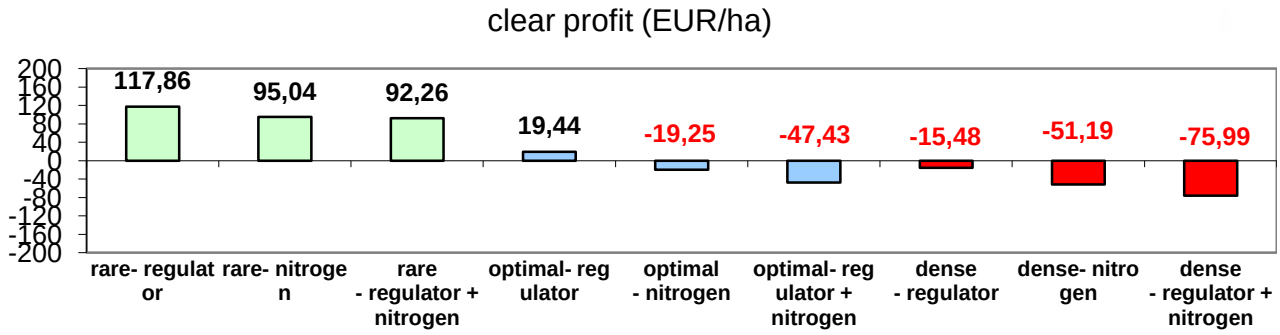
Table 2 Influence of application of azole and nitrogen on production parameters of winter rapeseed in vegetative year (2009/10)

Density	Variant	Average of root collar (mm)	Length of root (cm)	% dry matter in root	Yield - t/ha (%)
Loose (into 35 plants/m2)	Control	8.0	17.8	22.6	3.62 (100)
	application of Azole	**8.1**	**19.0**	**18.9**	**4.08 (113)**
	fertilization N	7.1	18.9	22.4	4.04 (112)
	appl. Azole + fer. N	8.1	19.7	20.2	4.12 (114)
Optimal (35 - 60 plants/m2)	Control	6.5	17.6	19.6	4.37 (100)
	application of Azole	**6.3**	**17.2**	**20.8**	**4.52 (103)**
	fertilization N	6.8	17.4	23.5	4.43 (101)
	appl. Azole + fer. N	7.2	18.3	21.3	4.43 (101)
High (over 60 plants/m2)	**Control**	**5.0**	**16.1**	**21.6**	**4.25 (100)**
	application of Azole	5.3	16.3	22.2	4.29 (101)
	fertilization N	5.2	16.7	20.3	4.22 (99)
	appl. Azole + fer. N	5.2	18.1	20.5	4.22 (99)

Note.: the variant in different density of growth written in bold are the most profitable; 100 % yield = control

In graph 1 the recount of clear profit at single variants with different density of growth per 1 hectare is given. The costs per 1 hectare: application of fertilizer and azole - 8 EUR; nitrogen fertilizer– 28 EUR; Azole – 20 EUR. The exercise price of rapeseed – 317 EUR/t (August 2010 – Czech Republic). It is evident that the highest profit was obtained at all variants with open growth. We can say, that the open growth is the most influenced by agricultural inputs in autumn season as regards the obtained profit in comparison to control variant (over 117.86 EUR/ha – variant with growth regulator). On the other hand a very non-profit-making is the agricultural inputs in dense growth. The application of azole (19.44 EUR/ha) is the only profitable input at the optimal density growth.

Graph 1 Obtained clear profit (EUR/ha) at the single variant with different density of growth



Auto regulation and reduction of rapeseed

The important obtained information of the reduction of the number of plants appears at the sowing rate 50 seeds/m^2 (48 plants in spring) which forms 4% reduction. At the sowing rate 100 seeds/m^2 plant reduction is 33% and at the sowing rate 150 seeds/m^2 plant reduction is nearly 53%, it means in fact 70 plants per m^2. Other obtained information is the number of weak plant in spring. These plants do not branch and the average of stalk is above 0.5 cm. These plants are undesirable in growth (sucking up the nutrition, water, competing other plants etc.). These plants appear in higher density of growth (100 seeds/m^2 2-3 weak plants/m^2, 150 seeds/m^2 6-8 weak plants/m^2). When combining these pieces of knowledge of obtained yields it is evident that the rapeseed can mostly balance both rare and dense growths. The open growths do not branch and at dense growth it happens to reduce ability of number of plant per m^2.

Conclusion

The autumn application of growth stimulators and nitrogen application have positive influence on growth and development of rapeseed. The joint application of growth stimulators and nitrogen fertilization strengthens mainly the root system of rapeseed (length of root, average of root collar). From obtained one-year results of the specific field experiment on the experimental farm Cerveny Ujezd we recommend for cultivation practice:

- **At the rare growth application of growth stimulator**
- **At the dense growth to drop the regulation and fertilization of rapeseed growth**
- **At the optimal sowing rate only application of growth stimulator**

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