Productional and developmental reaction of winter oil seed rape to an autumn application of selected agrochemicals under mild temperate climate

Andrzej Oleksy, Bogdan Kulig, Agnieszka Klimek-Kopyra, Marek Kołodziejczyk

Department of Agroecology and Crop Production, University of Agriculture, Mickiewicza 21, 31-120 Krakow

Introduction

Winterhardiness of winter oilseed rape varieties is affected by many factors. The percentage of survival of plants after winter depends among others on the date of sowing and nitrogen supply. Plants sown in early autumn, well-fertilized with nitrogen, have elongated hypocotyls which are causing their higher susceptibility to frost damage. Compact plants with small internodes in the 6-leaf stage usually present highest winter survival. Hence, this likely the reason for recent interest in obtaining oilseed rape with shorter stems. Other purposes of dwarf oilseed rape cultivation are to prevent or limit the lodging of plants and to facilitate harvesting. Dwarfing effect can be achieved by growing new cultivars but also by the use of appropriate regulators in the cultivation of traditional varieties. The most commonly used regulators in the cultivation include triazole compounds or quaternary ammonium salt derivatives. Triazole compounds, as active substances of formulations used in agriculture, next to fungicide properties, show a multidirectional impact on the metabolism of plants through changes in their hormone management. The characteristic effect caused by the triazoles is the inhibition of the production of growth hormones - mainly gibberellins, but also to a lesser extent brassinosteroids. Their action may results in the inhibition of plants growth. At the same time, these compounds can increase the levels of cytokines, which are responsible for the formation of auxiliary shoots. In addition, the production of typical stress hormones, like ethylene and abscisic acid, can be increased so that the plants can better endure the effects of stress factors during the growing season. The hormonal metabolism of plants, apart from triazoles, can be also affected by quarternary ammonium salt derivatives, and some of them (e.g., 17-dimethylmorpholinium chloride) can lower the content of growth hormones (gibberellin acid, indole-3-acetic acid and zeatin) in oilseed rape and increase the content of abscisic acid. However, the main reason for the application of triazole derivatives is their antifungal activity, because rape can be attacked throughout the growing season by various diseases, which often leads to significant yield losses. In general, a decrease in the yield of rape seeds caused mainly by fungal pathogenic infections, averages 15-20%. Pathogens are successful opportunists that are not only able to exploit the insufficient protection of plants, but also they can very easily adapt to the new conditions. Hence, preventive plant protection products are applied already in the autumn and winter to reduce the disease infections. The effects of this type of regulatory compounds may, however, be dependent on the genotype and can be modified by environmental conditions and weather pattern.

The aim of this study was to verify the action of selected agrochemicals applied in the autumn, on the health, growth, yield and chemical composition of seeds of varieties of winter oilseed rape (Jumper and Belleuve).

Material and methods

Field experiments were conducted between 2010 and 2012 at the Experimental Station, located in the village of Modzurów (50°09'N 18°07'E), situated at an altitude of 274 m above sea level, in Silesia. Oilseed rape cultivars 'Jumper' and 'Belleuve' were utilized. Seven active compounds were applied in 8 combinations in the first year of experiment and 11 combinations in the second. Treatments were arranged in a randomized complete block design with four replications. Agrochemicals were used in the autumn in the two stages of oilseed rape development. Calendar application dates in the growing seasons fell on the following days: September 27 (14 BBCH) and October 03 (18 BBCH) in 2010 and September 25 (14 BBCH) and October 6 (18 BBCH) in 2011. The assessment of the effectiveness of agrochemicals in oilseed rape crop was based on the measurements of height and weight of different parts of plants, leaf infection by fungal diseases in the autumn (Bellevue and Jumper) and spring (Bellevue). Seed yield (Bellevue and Jumper) and the quality of seed (Jumper) was also determined. At the end of autumn vegetation 25 plant samples were taken randomly from each plot for biometrical analysis [root, leaves and whole plant mass (g) and diameter of the root neck (mm)]. During the spring and summer growing season of winter oilseed rape, two measurements were made of plant height, i.e., before (BBCH 60-62) and after flowering (BBCH 69-70). Evaluation of leaf infection by fungal diseases of the *Alternaria* spp. (Alternaria blackspot - leaf and pod spots) and *Leptosphaeria* spp. (Phoma stem canker - blackleg), caused by *Leptosphaeria spp.* (anamorph of *Phoma lingam*) was made in the autumn (cv. Bellevue and Jumper) at stage BBCH 18-19. In the growing season 2010/2011, assessment of plant infection by fungal diseases of the *Leptosphaeria* spp. was performed additionally at stage BBCH 80-82 in the cultivar Bellevue. Seed yield was determined at 9% moisture. For the yield of seeds from 2012 (cv. Jumper), basic chemical composition was assessed (total fat, starch, proteins, fibre, ash), with the near-infrared reflectance spectroscopy.

Results

Active ingredient, dosage and time of application of agrochemicals tested.

Abbreviation	Active ingredient	Dosage (g ha^{-1})	Time of applications (BBCH scale)
con	control	-	-
pro+teb	(prothioconazole + tebuconazole)	(80+160)	14*
teb	(tebuconazole)	(250)	14
dif+pac	(difenoconazole + paclobutrazol)	(75+37.5)	14
(pro+teb)+teb I	(prothioconazole + tebuconazole) + (tebuconazole)	(60+120) + (75)	14
met+mep	(metconazole + mepiquat chloride)	(21+147)	14
chl	(chlormequat chloride)	(360)	14
(pro+teb)+(pro+teb)	(prothioconazole + tebuconazole) + (prothioconazole + tebuconazole)	(40+80) + (40+80)	14 + 18
(pro+teb)+teb II	(prothioconazole + tebuconazole) + (tebuconazole)	(40+80) + (125)	14
(pro+teb)+(dif+pac)	(prothioconazole + tebuconazole) + (difenoconazole + paclobutrazol)	(60+120) + (50+25)	14
chl+(pro+teb)	(chlormequat chloride) + (prothioconazole + tebuconazole)	(360) + (40+80)	14 + 18

*BBCH – 14 (4-leaf stage), BCH – 18 (8-leaf stage)

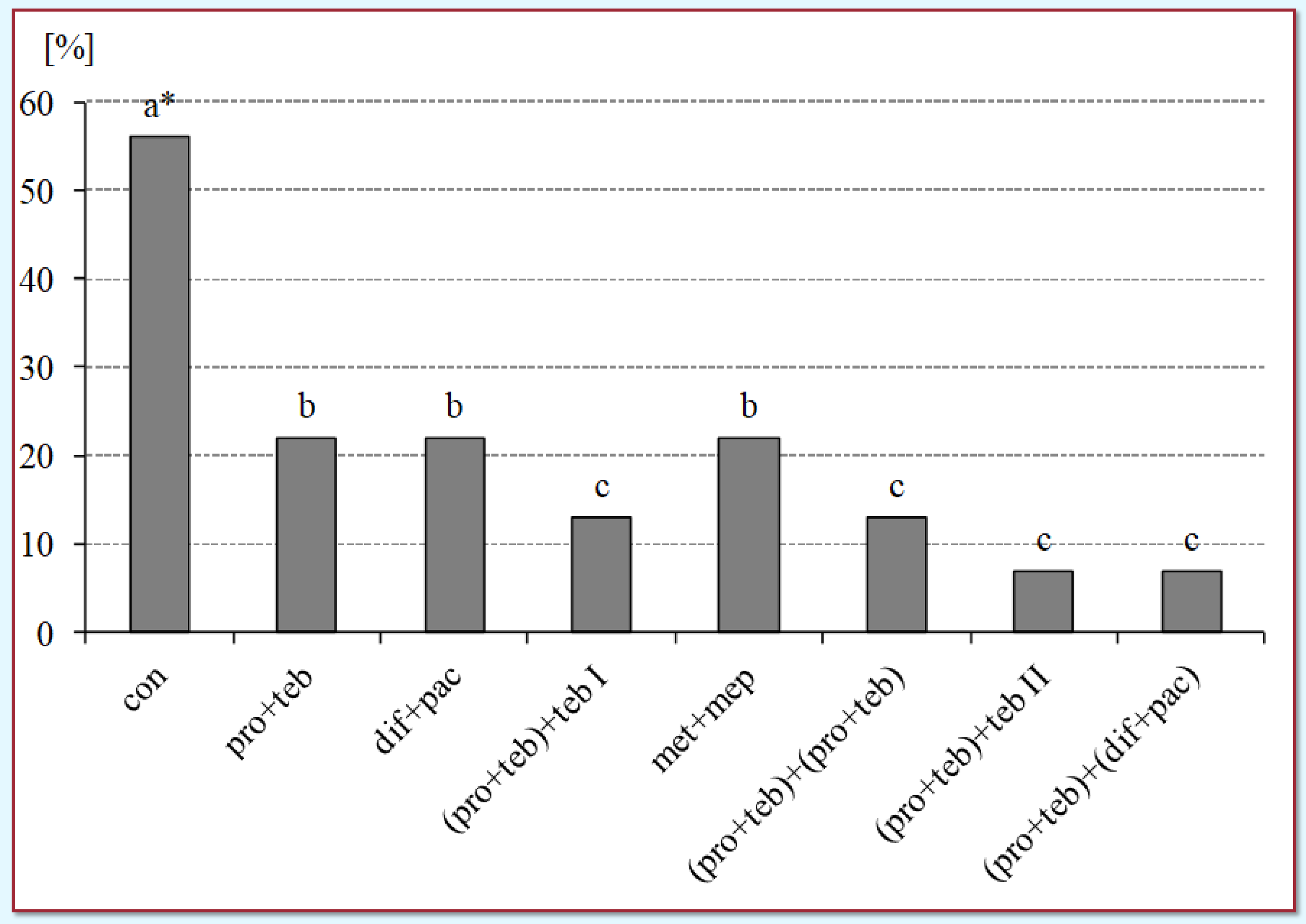
Effect of treatments on selected growth parameters of oilseed rape.

Treatment	Fresh mass (g)						Root-neck diameter (mm)		Share of root in whole plant mass (%)	
	root		leaves		whole plant					
	Bellevue	Jumper	Bellevue	Jumper	Bellevue	Jumper	Bellevue	Jumper	Bellevue	Jumper
con	2.09 b*	6.27 e	30.75 a	35.09 abcd	32.84 ab	41.36 bc	5.75 ab	8.09 a	6.37 b	15.22 de
pro+teb	2.24 b	6.64 de	29.90 a	30.48 d	32.14 b	37.12 c	5.56 b	7.84 a	6.97 ab	17.91 abcd
teb	ni**	7.91 ab	ni	31.87 cd	ni	39.78 bc	ni	8.41 a	ni	20.03 a
dif+pac	2.38 ab	6.51 de	29.59 a	33.60 bcd	31.97 b	40.11 bc	5.52 b	8.23 a	7.47 ab	16.34 bcde
(pro+teb)+teb I	2.21 b	7.49 bc	30.89 a	40.12 a	33.10 ab	47.61 a	5.82 ab	8.78 a	6.69 ab	15.84 cde
met+mep	2.76 a	8.38 a	32.17 a	36.57 abc	34.93 a	44.95 ab	6.31 a	8.69 a	7.91 a	18.73 ab
chl	ni	6.38 e	ni	36.33 abcd	ni	42.71 abc	ni	8.48 a	ni	15.00 e
(pro+teb)+(pro+teb)	2.04 b	6.92 cde	31.45 a	38.07 ab	33.49 ab	44.99 ab	5.92 ab	8.22 a	6.14 b	15.43 cde
(pro+teb)+teb II	2.38 ab	7.84 ab	31.44 a	35.79 abcd	33.82 ab	43.63 ab	6.01 ab	8.69 a	7.04 ab	18.16 abc
(pro+teb)+(dif+pac)	2.33 b	7.14 cd	30.81 a	33.30 bcd	33.14 ab	40.44 bc	5.83 ab	8.04 a	7.04 ab	17.66 abcde
chl+(pro+teb)	ni	6.92 cde	ni	33.12 bcd	ni	40.04 bc	ni	8.86 a	ni	17.32 abcde
p-value	0.025	<0.001	0.351	0.015	0.041	0.007	0.047	0.377	0.047	0.003

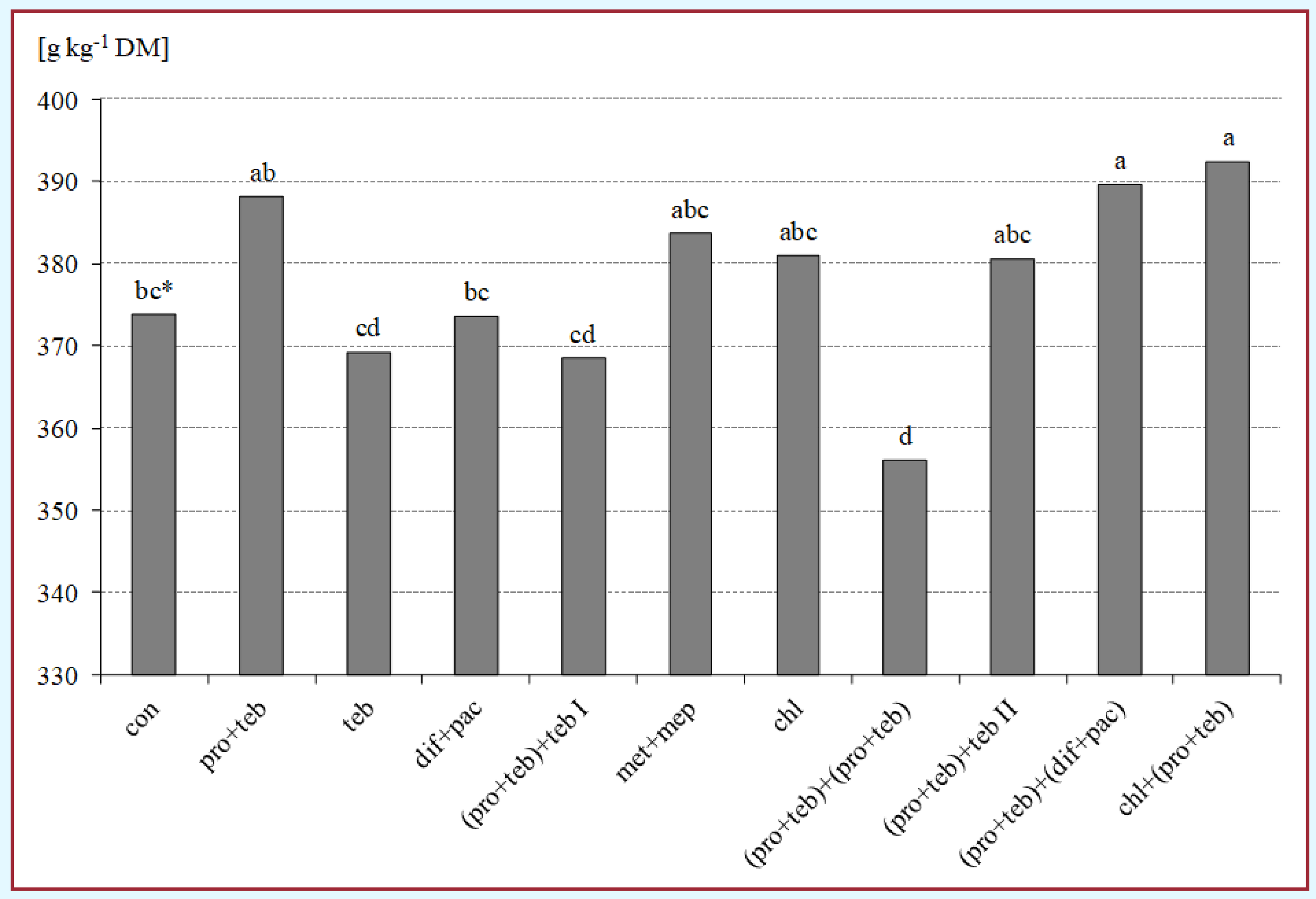
The effect of treatments on pathogen infection and height of oilseed rape plants.

Treatment	Incidence (% of damaged plants) BBCH 18-19				Plant height (cm)			
	Alternaria		Phoma		before flowering BBCH 60-62		after flowering BBCH 69-70	
	Bellevue	Jumper	Bellevue	Jumper	Bellevue	Jumper	Bellevue	Jumper
con	6.50 a*	1.28 b	4.68 a	1.83 a	126.5 a	142.8 a	159.8 abc	172.8 a
pro+teb	3.13 b	0.00 c	2.38 b	0.13 b	125.3 a	140.8 ab	156.8 abc	170.8 ab
teb	ni**	0.00 c	ni	0.00 b	ni	134.8 abc	ni	164.8 abc
dif+pac	1.00 c	0.10 c	1.00 cd	0.28 b	107.8 b	130.5 c	145.0 c	160.5 c
(pro+teb)+teb I	0.90 c	0.00 c	1.10 c	0.20 b	121.8 a	130.8 c	162.0 a	160.8 c
met+mep	1.00 c	0.00 c	1.05 c	0.05 b	111.8 b	132.8 bc	155.0 abc	162.8 bc
chl	ni	1.50 a	ni	1.75 a	ni	134.8 abc	ni	164.8 abc
(pro+teb)+(pro+teb)	1.15 c	0.00 c	1.10 c	0.25 b	120.3 a	136.5 abc	161.5 a	166.5 abc
(pro+teb)+teb II	0.58 c	0.00 c	0.90 cd	0.18 b	121.5 a	138.5 abc	161.8 a	168.5 abc
(pro+teb)+(dif+pac)	0.78 c	0.13 c	0.70 d	0.25 b	106.8 b	136.0 abc	152.8 bc	166.0 abc
chl+(pro+teb)	ni	0.00 c	ni	0.13 b	ni	138.5 abc	ni	168.5 abc
p-value	<0.001	<0.001	<0.001	<0.001	<0.001	0.039	<0.001	0.042

*Values followed by the same letters (within columns) do not differ at 5% level of significance;
**ni - not investigated



Oilseed rape infection by *Leptosphaeria* spp. depending on application fungicides and growth regulator (BBCH 80-82)
*values followed by the same letters do not differ at 5% level of significance



Influence fungicides and growth regulator on oil content in winter oilseed rape seeds
*values followed by the same letters do not differ at 5% level of significance

Conclusions

The vast majority of agrochemicals tested significantly reduced fungal infestation of both cultivars (cvs. Jumper and Belleuve). The exception was chlormequat chloride, which made the plants more susceptible to pathogens. Nevertheless, in the group of plants treated with agrochemicals, there has been no increase in the yield of oilseed rape in comparison to the control. The reasons for this should be sought in a good level of agricultural technology, a high level of fertilization and mild weather in the region.

Shorter stems (7-9%) were observed in both cultivars only after single-plant spraying in the 4-leaf stage with a combination of difenoconazole + paclobutrazol. At the stage of seed formation (BBCH 69-70) plants of cv. Bellevue, sprayed with these regulators were lower than the control by 9%, and the plants of cv. Jumper by 7%. The use of some agrochemicals increased also the mass of the roots.

Application of agrochemicals slightly modified the chemical composition of rape seeds and affected the content of ash, fibre, protein and starch. Seed oil content decreased after the application of (pro + teb) + (pro + teb) by about 5%, and increased by about 5% with the (pro + teb) + (dif + pac) and chl + (pro + teb) combinations.

Three of the combinations of agrochemicals tested can be recommended for use in similar weather conditions and agricultural practices, due to the fact that they presented more than one important function, i.e., dif + pac - fungicide effect and retard effect, (pro + teb) + (dif+ pac) - fungicide effect and increase in oil content, and chl +(pro + teb) - fungicide effect and increase in oil content.