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PLANT GROWTH REGULATORS EFFECT ON DOUBLE LOW WINTER RAPESEED VARIETIES

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INTRODUCTION

Under European intensive cropping system, plant growth regulators (PGR) like CCC, Ethephon and Mepiquat Chlorure, or a combination thereof, have been used for a long time in small grain production. Their major use is lodging and height control.

Several studies conducted on rapeseed never gave significant enough results to promote the use of these molecules to control lodging in winter rapeseed. In addition, short varieties like Bienvenu did not justify such a treatment.

In the mid 80's "Canola" quality varieties appeared on the market which were higher and more lodging susceptible.

Intensive cropping techniques like good control of disease and insects also justifies high nitrogen fertilization (up to 300 kgN/ha) increasing risk of lodging.

In the meantime, PGR from the Triazole family were released for testing and launched on the market in 1988 (a,b,c,d,e).

The purpose of this paper is to summarize results of the effect of PGR on winter "Canola" lines tested in 1987 through 1990 in France and answer questions on the effect on yield and its components.

MATERIAL AND METHOD

3 genotypes: Doublol (or DCH1, or CC349 in the USA) a "Jet Neuf" like line, MLCH005 and Idol (MLCH001) both "Bienvenu" like varieties.

Three locations in 87/88 and 89/90, 1 location in 88/89. Spring application was studied all 3 years. In addition, the fall application was tested in 89/90.

Rate and timing used were those recommended for each product by each manufacturer:

Spring:
- **PGR1**, Triapenthenol "Baronet"(Bayer) (500g/ha) at stem elongation or (750g/ha) at bolting stage.
- **PGR2**, Paclobutrazol+Chlormequat "ParlayC"(ICI) (1,25 l/ha + Agral) at regrowth.
- **PGR3**, Mepiquat chlorure "Terpal"(BASF) (3 l/ha) at regrowth.

Fall:
- **PGR1**, Triapenthenol 350 g/ha
- **PGR2**, Paclobutrazol 1,5 l/ha
- **PGR4**, CCC 3 l/ha

@ 5-6 leaves stage.

Parameters measured include lodging, height, grain yield, glucosinolates content (GLS), grain moisture at harvest, oil content, along with plant architecture characteristics like length of flower shaft, number of branches, and number of pods on main stem and per branch.

GLS measured with HPLC are in micromole/g dry seeds, oil content measured with NMR is in % dry seeds.
Plots were 21 square meters large, drilled and direct combined.

FALL APPLIED PGR

Lately, two major concerns of the farmer have been excessive growth and stem elongation in the fall along with increased winter hardiness which he wanted to control with fall applied PGR.
We addressed this issue by spraying, Doublol and MLCH005 at 2 plant populations (40 and 80 pl/square meter), with PGR1, PGR2, PGR4, in three locations.

Dry and warm weather conditions in late fall and winter 89/90, made us unable to answer the basic question.

PGR's had an effect on the crop, however. Visual effect on plants were a more prostate rosette for both varieties with a darker green color in treated plots. PGR2 had the strongest effect with a remaining effect on height in the spring (-10cm). PGR1 had a lighter effect both on rosette and height before flowering (-5cm) fading out rapidly. It was impossible to make a visual difference between PGR4 and the check.

Variety x PGR and population x PGR interactions are summarized on Table 1A and 1B. Only one location experienced some lodging and fall applied PGR was not able to control it. No effect on GLS and oil and moisture at harvest were reported at any of the three locations.

INDRE was the only location where PGR x variety interaction had a significant effect on yield. Under these dry conditions, Triazole type PGR appeared to have a positive effect on yield especially on MLCH005. This positif effect was especially visible on low population.

In the very good environment conditions of the MARNE location, PGR4 had a slightly positive effect on yield in high population in both varieties, whereas Triazole types had apparently no significant effect. Analysis of yield components was of no help to explain this result.

At this point it is not possible to promote fall applied PGR on canola. We have nevertheless shown some positive effect on the crop that requires further investigation.

SPRING APPLIED PGR

We are presenting each year separately because experimentation designs were different.

CROP YEAR 1987/88

For this first PGR testing year, questions were about lodging control and effect on yield on Doublol and Idol. PGR1 and PGR3 were tested on 3 locations, PGR2 only on 1.

Lodging occurred on 1 location only. Results are summarized on Table 2. PGR2 was not tested on this location.

No significant effect on moisture at harvest and GLS were measured, and no interaction with the environment was noted. Yield increase was not only the result of lodging control since we experienced yield increases in two locations with no lodging. With no lodging limitation effect and no yield improvement we decided not to go any further with "Terpal". Triazoles (PGR1 and PGR2) looked really promising.

Plant architecture characteristics have been measured for a better understanding of mecanisms. An increase in the number of branches and pods on the main stem was probably a part of the yield increase explanation. The number of pods per ramification and the number of seeds per pod did not show any differences partly because of the low test accuracy. (This would have required more than 50 plants to be measured in order to have acceptable CV).

CROP YEAR 1988/89

PGR1 and PGR2 were tested on 8 lines, applied at 2 different stage :
- Stem elongation and separated buds for PGR1.
- Regrowth and stem elongation for PGR2.

Lines were from Doublol (DCH) and Idol (MLCH) progenies.
Plant population was about 40 plants per square meter.

Plants height, lodging and yields are sumurized in tables 3A 3B .
PGR1 had a stronger control of both height and lodging than PGR2 but study of GenotypexPGR show specific responses. Application timing in relation with plant stage is also critical to get expected results.

In many case we experienced fading out of PGRs effectiveness with time.
Both PGRs increased yields significantly, PGR1 being even significantly superior to PGR2. Lodging control is only a part of the yield increase.
Specific interactions PGR x line are interesting to stress even though no solid explanation has been found.

CROP YEAR 1989/90

After two years of encouraging results with the use of PGR's, the question whether there were an interaction with high nitrogen fertilization level in order to assure or even improve productivity has been addressed.

Studies have been conducted in 3 environments: optimum conditions in MARNE, dry shallow soil in INDRE, and good conditions in Côte d'Or. Two varieties (Doublol, Idol), were tested with 3 levels of **N** fertilization (200, 300 kg**N**/ha applied at regrowth, plus 200 kg**N**/ha at regrowth and 100 kg**N**/ha at stem elongation) and an application of 500g/ha of PGR1 was compared with a check. All other field operations were conducted to insure a successful crop.

Lodging was well controlled, if any, as reported on Table 4A.

PGR had no effect on moisture or oil content at harvest.

The only measured effect on GLS occurred under dry conditions in INDRE and only on the variety Idol. Use of PGR significantly increased the GLS content by 5.7 micromoles.

Yields of the different treatments are summarized in Table 4B.

In optimum conditions, MARNE's top yields were reached with 200 kg**N**/ha and higher **N** rates were of no interest. PGR improved yield in every case, probably by a better lodging control.
In Côte d'or, 300 kg**N**/ha yielded 300 kg more no matter how applied and PGR provided an other 100 kg increase.
In INDRE, under dry conditions, one application of 300 kg**N**/ha was a waste of nitrogen, but 100 kg applied later improved the yield slightly. Variety x PGR did not show improvement under these conditions without lodging.

Plant architecture parameters were also measured in 89/90. The only accurate and reliable data that allow us to make a statement is from MARNE. PGR increased the length of the main shaft, the branch number and the number of pods on the branches. No effect on mainshaft pod numbers were observed. These results -not shown- are consistent with previous years data.

CONCLUSION

Despite the experimentation diversity, the three years have shown rather consistent results in the effect of PGR on winter rapeseed.

Small grain PGR's effectiveness is not obvious enough, if any, for this technique to be developed on a farm scale.

Triazole type PGR's are on the other hand very likely to provide winter rapeseed growers a technique to better manage their crop. Height and lodging reduction are the most visual effects. Risk of yield or quality (i.e., oil, GLS, etc.,) losses and delayed maturity are likely to be negligible.

Significant yield increases were measured several times even in the absence of lodging. This leads us to believe that there is a boost in plant metabolism. However, we feel that more data should be collected to better understand the conditions under which yield increases occur, and then promote the technique.

Triazole PGR on winter rapeseed is definitely a state of the art technique, to be used by technically advanced farmers under good environment conditions as the last step in an intensive cropping system. It can also be used to insure production jeopardized by excessive plant population and/or very high nitrogen levels, if those are the only factors at risk.

In several cases we experienced PGR x variety interaction that requires that every new cultivar or at least new genotype family should be tested with PGR for accurate advice for the farmer.

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Location		Indre			Marne			Cote d'Or		
Variety		Doublol	Idol	AVG.	Doublol	Idol	AVG.	Doublol	Idol	AVG.
Check	200	-	-	-	67	45	56	0	28	14
	300	-	-	-	85	56	71	47	23	35
	200+100	-	-	-	73	63	68	47	0	24
	AVG.	-	-	-	75	55	65	31	17	24
Baronnet	200	-	-	-	29	0	15	0	0	0
	300	-	-	-	31	0	15	2	0	1
	200+100	-	-	-	38	0	19	0	0	0
	AVG.	-	-	-	33	0	16	1	0	0

TAB. 4A = Spring Applied PGRs 1989/90 % Lodging.

Location		Indre			Marne			Cote d'Or		
Variety		Doublol	Idol	AVG.	Doublol	Idol	AVG.	Doublol	Idol	AVG.
Check	200	19.8	20.9	20.4	29.7	33.6	31.7	25.2	26.0	25.6
	300	16.5	19.6	18.1	26.9	34.2	30.5	29.3	29.5	29.4
	200+100	21.8	23.4	22.6	25.4	32.5	28.9	24.5	32.1	28.3
	AVG.	19.4	21.3	20.4	27.3	33.5	30.4	26.3	29.2	27.8
Baronnet	200	19.8	20.2	20	32.2	36.3	34.3	24.5	28.3	26.4
	300	16.7	21.5	19.1	31.7	37.3	34.5	27.9	31.8	29.8
	200+100	20.1	23.2	21.7	33.8	37.1	35.5	29.5	31.3	30.4
	AVG.	18.9	21.6	20.2	32.6	36.9	34.7	27.3	30.5	28.9

TAB. 4B = Spring Applied PGRs 1989/90 Yield (Qx/ha).

	Location	Indre		Marne		Cote d'Or	
	Variety	Doublol	MLCH005	Doublol	MLCH005	Doublol	MLCH005
Yield qx/ha	Check	19.5	18.9	28.5	37.4	25.1	27.3
	PGR 1	20.3	21.0	28.4	36.9	23.3	27.5
	PGR 2	18.6	22.9	30.7	36.3	26.8	28.6
	PGR 4	18.9	19.4	32.6	38.5	26.2	26.9
Lodging %	Check	0.0	0.0	65.3	33.8	0.0	0.0
	PGR 1	0.0	0.0	61.7	34.2	0.0	0.0
	PGR 2	0.0	0.0	61.7	32.5	0.0	0.0
	PGR 4	0.0	0.0	65.7	35.0	0.0	0.0

Tab. 1A = Fall Applied PGRs : Results @ Harvest.

	Location	Indre		Marne		Cote d'Or	
Plant Population / sq.m		40	80	40	80	40	80
Yield qx/ha	Check	16.2	22.3	36.3	29.6	25.5	26.9
	PGR 1	19.6	21.7	35.5	29.8	23.9	26.8
	PGR 2	19.6	21.9	34.7	32.3	24.6	30.8
	PGR 4	18.0	20.4	37.0	34.0	24.3	28.7
Significant Interaction @		0.05		0.09		N	0.0

Tab. 1B = Fall Applied PGRs * Plant Population.

	Variety	Doublol	Idol
% Lodging 1 location	Check	75	38
	PGR 1	6	0
	PGR 3	75	38
AVG. Yield 3 locations Qx/ha	Check	25.1	27.4
	PGR 1	34.5	39.3
	PGR 3	25.6	27.2
1 location	Check	16.1	25.0
	PGR 2	23.9	31.4
Plant Height (cm)	Check	165	160
	PGR 1	130	120
	PGR 2	140	130
	PGR 3	160	150
Branches #	Check	6.1	7.3
	PGR 1	8.4	7.4
	PGR 2	10.2	8.6
#Pods on Main Stem	Check	41.3	35.4
	PGR 1	46.9	45.3
	PGR 2	na	na

TAB 2 = Spring applied PGRs. 1987/88 Results.

MEASURE	% HEIGHT REDUCTION @ PODS EMBOSSED					LODGING @ MATURITY (Grade 1-9)				
PGR	CHECK	PGR 2	PGR 2	PGR 1	PGR 1	CHECK	PGR 2	PGR 2	PGR 1	PGR 1
APPLICATION STAGE	cm	regrowth	stem elong.	stem elong.	sep. buds		regrowth	tem elong.	tem elong.	sep. buds
DAYS after TREATMENT		78	63	64	55					
DCH 1	165	5	15	18	14	5.5	2.5	2.0	1.0	1.0
DCH 4	159	12	2	15	8	6.5	2.0	2.0	1.0	1.0
DCH 6	153	3	0	13	6	7.5	3.5	2.5	1.0	1.0
MLCH 001	153	11	11	13	13	6.5	2.0	2.0	1.0	1.0
MLCH 005	147	0	0	3	0	5.5	2.5	4.0	1.0	2.0
MLCH 006	151	2	1	6	6	7.0	3.0	5.0	1.0	3.0
MLCH 007	154	0	0	8	0	3.0	2.0	2.3	1.0	1.0
MLCH 008	143	1	0	5	3	4.0	2.0	2.5	1.0	1.0

Tab.3A : Spring Applied PGRs 1988/89.

Application Stage	AVERAGE		CHECK		PGR 1 Stem Elong.	PGR 1 Sep. Buds		PGR 2 Regrowth	PGR 2 Stem Elong.
All Varieties	26.5		22.1 a		28.7 c	29.0 c		26.3 b	26.1 b
DCH 4	28.3 ab		21.8 a		30.0 b	30.3 b		32.8 b	26.5 ab
DCH 6	24.8 b		17.8 a		28.2 b	30.7 b		20.6 a	26.8 b
MLCH 006	29.0 a		21.0 a		31.4 b	30.5 b		34.4 b	28.2 b
MLCH 007	27.8 ab		23.2 a		31.4 b	30.6 b		27.4 ab	26.1 ab
MLCH 008	25.2 ab		23.6 ab		26.5 b	28.8 b		19.5 a	27.9 b
DCH 1	28.2 b		}						
MLCH 001	24.4 ab		}		NO DIFFERENCES BETWEEN TREATMENTS.				
MLCH 005	23.1 a		}						

Tab. 3B : Spring Applied PGRs 1988/1989. YIELD Qx/ha (NK groups @ 5%)