Effect of different fungicides on seed yield and grain quality of rapeseed under two levels of nitrogen fertilization

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Introduction

Fungicides are currently used in rapeseed (Brassica napus L.) for both fungitoxic and growth regulatory properties. It is known that fungicides like triazoles affect isoprenoid pathway and alter the levels of certain plant hormones by inhibiting gibberellins synthesis, reducing ethylene production and increasing cytokinin levels (Zhou et al. 1993). After the launching of strobilurins, and with the evolution of this group of chemical products, the concept of disease control gained new perspectives especially when considering the advantages obtained by the action of positive physiological effects on plants. Triazole and strobilurin treatments are associated with various morphological and physiological changes in various plants, including inhibition of plant growth, decrease of internodal elongation, increased chlorophyll levels, enlarged chloroplast, thicker leaf tissue, increased root to shoot ratio and delayed senescence. In winter rapeseed triazole application reduced rate of photosynthesis by decreasing the stomatal conductance. The inhibition of stem and leaf growth by plant growth retardants can alter the canopy architecture of winter oilseed rape by shortening the stem of plants and improve production efficiency by stimulating the formation of lateral flights and auxiliary buds, and by uniform ripening of pods. Plant growth retardants also diminish the risk of early lodging, and induce a degree of frost tolerance in winter rapeseed (Berry et al. 2009). Little information exists based on field research about the use of strobilurin on rapeseed, especially whether an application causes non-fungicidal physiological changes and yield increases.

Rapeseed has a high requirement for nitrogen. Several studies have shown that nitrogen is a critical limiting nutrient in rapeseed production. Nitrogen increases grain yield by influencing a variety of growth parameters such as branches and buds per plant as well as by producing more vigorous growth as reflected by increase in stem length, number of flowering branches, total plant weight and seeds per pod (Brennan et al. 2000). Keeping the importance of these effects field experiments were conducted to study the effect of different fungicides on seed yield and grain quality of rapeseed under two levels of nitrogen fertilization.

Materials and Methods

The experiments were carried out in 2009 and 2010 at the research stations i.e. Giessen ($50^{o}47'$N and $8^{o}61'$E, 158 m above sea level, 25.3mg P, 14.7mgK/100g, pH 6.70) and Rauischholzhausen (50° 45´N and 8° 39´E, 220 m above sea level, 27.5mg P, 16.7mgK/100g, pH 6.25) of the university Giessen. The soil conditions are characterized by loess soil in Rauischholzhausen (RH) and silt clay soil in Giessen (GI). The experiments were designed as factorial RCBD with four replications. Cultivar “Fangio” was planted in 1.5 x 7.0 m^2 plots maintaining 50 plants per m^2. Eight different fungicides (triazole and strobilurin) and growth regulators (Moddus) were applied in different combinations at three different growth stages with two levels of nitrogen (Table 1). Sulphur was applied at the rate of 72 kg ha^{-1} at the growth stage of BBCH 18 in the form of Ammonium Sulphuric acid. All the agronomic practices with the exception of study factors were kept constant.

Factor A Nitrogen fertilization

N_1= 50 + 120 and 100 kg/ha (autumn, BBCH 18 and BBCH 53)

N_2= 30 + 90 and 80 kg/ha (autumn, BBCH 18 and BBCH 53)

Factor B Fungicides and Growth regulators

Table: 1 Fungicide and growth regulator treatments, dose and stage of application in 2009 and 2010

No.	1st Autumn application		2nd application BBCH 53		3rd Application BBCH 65	
	Treat.	Dose Lha^{-1}	Treat.	Dose Lha^{-1}	Treat.	Dose Lha^{-1}
1	Control (without fungicide)					
2	Caramba	0.7	-	-	-	-
3	Folicur	0.7	-	-	-	-
4	Moddus	0.5	-	-	-	-
5	-	-	Caramba	1.0	-	-
6	-	-	Folicur	1.0	-	-
7	-	-	Moddus	0.5	-	-
8	-		Caramba	1.0	Cantus Gold	0.5
9	-	-	Folicur	1.0	Cantus Gold	0.5
10	-	-	Moddus	0.5	Cantus Gold	0.5
11	-	-	Caramba + Moddus	0.8+0.5	Cantus Gold	0.5
12	-	-	Carax	1.0	Proline	0.7
13	-	-	Carax	1.0	Ortiva	1.0
14	-	-	Toprex	0.5	Proline	0.7
15	-	-	Toprex	0.5	Ortiva	1.0

Triazole: Toprex (Difenoconazole 250 g L^{-1} + Paclobutrazol 125 g L^{-1}), Carax (Metconazole 30 g L^{-1} + Mepiqua Chloride 210 g L^{-1}), Folicur (Tebuconazole 251.2 g L^{-1}), Proline (Prothioconazole 250 g L^{-1}) and Caramba (Metconazole 60 g L^{-1}). **Strobilurin:** Cantus Gold (Boscalid 200 g L^{-1} + Dimoxystibin 200 g L^{-1}) and Ortiva (azoxystrobin 250 g L^{-1}**)**. **Growth regulator**: Moddus (Trinexapac 222 g L^{-1} + Ethyl ester 250 g L^{-1}).

Data on growth and yield parameters were recorded using standard principles and procedures. Leaf area index (LAI) and planting stand were recorded weekly from BBCH 20 till maturity. Morphological data were collected which include seeds/pod, pods/plant, pod length and primary and secondary branches per plant, height of main stem from soil surface to 1st side branch and plant height readings were taken for all treatments. Disease incidence was assessed for each plot based on a scale of 1 to 9 with visual incidence at the plot level of Phoma lingam and Sclerotinia sclerotiorum at BBCH 75 of rapeseed. Lodging was estimated by grading from 1 (erect) and to 9 (flat) scale. Seed yield and thousand grain weight were adjusted to 9% moisture content. In quality parameters, oil content of rapeseed was determined by using Soxhlet. GC was used for quantification of fatty acids in the oil of rapeseed. Value of peroxide (PV) and concentration of free fatty acid (FFA) were measured with chemical method of titration. The protein content in the samples was assessed after the determination of nitrogen concentration (factor 6.25) by Dumas combustion method using CHNS analyzer EA1110 type thermo Finnegan. Statistical package PIAF Stat was used for statistical analysis of the collected data.

Results and Discussion

Important results of only one experiment from RH in 2010 are presenting here with brief description. In this experiment, effect of fungicides on growth parameters of rapeseed showed that LAI was affected significantly. Autumn applied fungicides and control (without fungicide) gave minimum value of LAI over other treatments at BBCH 72. Triazole and strobilurin delayed senescence which is the reason of higher value of LAI compared to control. Toprex + Ortiva application induced maximal LAI compared to other treatments. Same results were reported in other executed experiments.

Table 2 Effect of different fungicides on growth, yield and quality parameters of rapeseed under two levels of nitrogen in Rauischholzhausen, 2010

Trea.	Growth and Yield parameters				Quality parameters				
	LAI BBCH 72	Plant height cm	TGW g	Seed yield dt/ha	Oil %	Protein %	FFA %	PV mequ/kg	C 18:1 %
1	4.60 e	156.3 bcd	4.00 abc	33.6	45.4 cd	20.9	0.92 abc	4.05	59.2 ab
2	5.01 bcde	159.7 ab	3.94 bcd	36.2	45.0 d	20.4	0.82c	4.09	59.0 b
3	4.63 e	162.5 a	3.96 bcd	37.8	45.4 cd	21.4	0.84 c	3.88	59.2 ab
4	4.73 e	158.1 abc	3.92 bcd	36.0	45.5 bcd	20.8	0.89 bc	4.15	59.1 ab
5	5.41 ab	154.7 bcde	4.01 abc	36.9	45.3 cd	20.7	0.94 abc	4.48	59.2 ab
6	4.79 de	150.9 e	4.07 ab	36.5	45.4 cd	20.9	0.94 abc	3.74	59.1 ab
7	5.26 abcd	154.4 cde	3.94 bcd	36.4	45.3 cd	20.7	0.86 bc	4.01	58.8 c
8	4.88 cde	154.7 bcde	3.86 cd	36.8	45.6 bcd	21.3	0.91 abc	4.11	59.1 ab
9	5.28 abc	153.1 cde	4.13 a	37.8	45.1 d	21.0	1.04 a	4.24	59.2 ab
10	5.33 abc	155.9 bcde	4.05 ab	37.2	46.0 abc	20.5	0.93 abc	3.89	59.2 ab
11	5.58 a	154.1 cde	3.93 bcd	37.7	45.7 abcd	20.6	0.98 ab	4.28	59.2 ab
12	5.34 abc	151.3 de	4.05 ab	35.6	46.5 a	20.4	0.81 c	4.08	59.3 a
13	5.52 a	155.0 bcde	4.04 ab	37.4	46.5 a	20.8	0.81 c	4.25	59.3 a
14	5.49 a	158.1 abc	3.84 d	37.1	46.3 ab	20.3	0.86 bc	3.87	59.3 a
15	5.61 a	157.5 abc	3.92 bcd	38.0	46.3 ab	21.0	0.92 abc	4.24	59.1 ab
$LSD_{0.05}$	**0.47**	**4.05**	**0.15**	**ns**	**0.74**	**ns**	**0.13**	**ns**	**0.22**
N_1	5.36 a	156.8 a	3.95	37.6 a	45.3 b	21.0 a	0.96 a	3.75 b	59.3 a
N_2	4.96 b	154.7 b	4.00	35.9 b	46.1 a	20.5 b	0.83 b	4.43 a	59.0 b
$LSD_{0.05}$	**0.17**	**1.48**	**ns**	**0.92**	**0.27**	**0.24**	**0.05**	**0.17**	**0.08**

Plant height of rapeseed was reduced significantly with application of fungicides over control and autumn applied fungicides. Application of Tebuconazole (Folicur) at blossoming stage (BBCH 53) led to significant reduction of LAI and plant height in comparison with other treatments which is consistent with results reported by Child et al. (1993). Autumn applied Folicur had promising effect in increasing plant height and seed yield over control and other autumn applied treatments. Applications of triazole and strobilurin fungicides alter hormonal level of rapeseed plant, consequently affected LAI and plant height. Strobilurin fungicides are considered better for delaying senescence and increasing leaf area index by decreasing ethylene production compared to azole group of fungicides. In the executed experiments it was observed that alone application of azole reduced LAI while in combination with strobilurin LAI was increased. Lodging control has been shown to be strongly determined by the degree of height reduction achieved by Moddus and Folicur. Effect of fungicides on TGW was statistically significant, whereas non-significant effects were observed on seed yield of rapeseed. Maximum value of TGW was observed with application of Folicur + Catus Gold by other fungicidal treatments. In all experiments Toprex + Ortiva gave better response to enhance seed yield compared to other treatments. Toprex + Ortiva application also increased number of pods per plant, number of branches per plant and number of seeds per pod over other treatments. Higher dose of nitrogen (N_1) increased LAI, plant height and seed yield significantly compared to other treatment.

Oil content of rapeseed was affected significantly by application of fungicides. Application of Carax and Toprex in combination with Ortiva and Proline increased oil content significantly by other treatments. Folicur and Caramba alone and in combination with Cantus Gold had reducing effect on the oil content of rapeseed. Autumn applied Caramba gave minimum value of oil content by other fungicidal treatments. Application of fungicides did not show significant effects on the protein content of rapeseed but these effects were significant in 2009. Maximal value of protein content was observed with alone application of Folicur as well as in combination with Cantus Gold by other treatments. Protein and oil content were significantly affected by application of nitrogen. Increased nitrogen dose reduced oil and enhanced protein content of rapeseed which confirms the findings of Brennan et al. (2000).

Effect of fungicide application on quality parameters of rapeseed oil was not so prominent during both growing seasons. Value of FFA (unesterified fatty acid) was significantly affected by fungicidal treatments in RH, 2010. Average value of FFA in all experiments ranged from 0.2 to 1.5 which is not detrimental for human health. The PV is the quality component which arises from oxidation of polyunsaturated fatty acid of rapeseed. Peroxide value did not show significant variations with application of fungicides. Major fatty acids of rapeseed oil were affected significantly by application of fungicides and nitrogen. Interactions between fungicides and nitrogen were found for fatty acids of rapeseed. Concentration of oleic acid (C18:1) increased significantly with application of higher dose of nitrogen.

It can be concluded that Toprex in combination with Ortiva have the ability to improve morphological structure of rapeseed plant result in more upright canopy which is less susceptible to diseases, lodging and which allows better penetration of light. This may result in considerably increased photo productivity, with a consequent enhancement of seed yield. Better control of diseases and lodging was achieved with twice application of fungicides. Application of fungicides prevented a considerable loss in yield, as well as preserved the quality components of rapeseed.

References

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