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Agronomic characteristics of winter oil rape hybrids depending of nitrogen top dressing

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Summary

Oilseed rape is one of the most important sources of vegetable oil in the world. The nutrient demand of oilseed rape is considerably higher than that of cereals. Compared to cereals, winter oilseed rape requires more available nitrogen and this element is an important component with a strong effect on seed yield and quality, but it also affects the reduction of oil content. Winter oliseed rape hybrids with high yield potential might have high nitrogen requirements. On the other hand, the vigor of those plants might also be expressed as improved nitrogen uptake by a vigorous rooting system. In many cases, N fertilisation requirement does not take into account varietal types for *Brassica napus* L. Furthermore, it is based on fertiliser norm, with corrections according to environmental conditions. The objective of this study was to evaluate preliminary results of the influence of nitrogen top dressing on the yield and yield components of 8 winter oil rape hybrids and 2 winter oil rape cultivars. A field trial was carried out in village Gluvo (near Skopje) in 2010/2011. The experimental design was a split-plot with 3 replications and 3 nitrogen regimes as main factors. Fertiliser treatments were: N, N+120 kg N/ha, N + 120 + 70 kg N/ha. N treatment as a base fertiliser corresponded to 70 kg of N/ha. Two ammonium nitrate dressings were broadcast, first on 25 February and then on 15 March. It can be concluded from the results we obtained that twice applied top dressing had statistically significant differences (P = 0.05) on the yield of the hybrids/varieties, number of seed/pods and length of a pod (compared to one application and without top dressing), but did not significantly influence the height of a plant and number of primary branches/plant. On a hybrid/variety level, Hybrirock (KWS), Rohan (NPZ-Lembke) and Albatros (Limagrin) may be considered as the most promising for the Skopje region.

Key words: winter oilseed rape, nitrogen, top dressing, yield, yield components

Introduction

The use of oilseed rape is wide-ranging in human and animal nutrition as well as for technical purposes and in the chemical industry. For the last few decades, the acreage of winter oilseed rape has increased considerably in the world (*Sieling & Kage,* 2010). Given this development, the question arises whether such an increase might be enhanced by integrated N-management strategies (*Rathke et al.,* 2005). Mineral N-fertilisation is a crucial factor in oilseed rape production (*Dreccer et al.,* 2000), and together with sulphur is among the most important elements in canola production (*Mirzashahi et al.,* 2010). Compared with cereals, canola nitrogen requirements are higher and it is considered as a high nitrogen demanding crop (*Hocking et al.,* 1997; *Rathke et al.,* 2005), especially when it is grown in irrigated fields (*Ahmadi & Javidfar,* 1998 quotes from *Mirzashahi et al.,* 2010). For the production of 0.1 t of seeds, the whole crop accumulates approximately 6 kg of N. Therefore, the use of N source in a proper way is required so as to optimise the economic seed yield (*Mason & Brennan,* 1998), and also to minimise the potential risk of environmental pollution (*Aufhammer et al.,* 1994, quotes by *Karaaslan*, 2008). The nitrogen supply of oilseed rape depends on the type of subspecies and yield. Fertiliser N rate between 200 – 300 kg/ha is the best to obtain the highest seed and oil yield in winter canola production (*Smith et al.,* 1988; *Jackson,* 2000), although there are examples when application of smaller quantities of N, 135 and 150 kg/ha, increased canola yield significantly (*Porter,* 1993; *Seyyed et al.,* 2011). Choosing the correct rate and timing of nitrogen fertiliser application is one of the most important aspects of successful oilseed rape production. According to *Bilsborrow et al.* (1993), *Sieling et al.* (1998), *Sieling et al.* (1999) (quotes from *Narits,* 2010), optimal spring top-nitrogen rate ranged from 120 to 240 kg/ha. *Michael et al.* (1979) found that seed and oil yield in oilseed rape increased by applying top-dressing, with mean N-requirements of about 230 kg/ha for satisfactory crops. The plots with no response to N or no response beyond 90 kg/ha of N were mostly low yielding. Timing of N-application within the period of mid-February to late March had little influence on seed yield but applying all or half the N in April tended to give lower yield. *Vujakovic et al.* (2010), using three nitrogen doses as a top-dressing (N 50 kg/ha, N 100 kg/ha and N 150 kg/ha), report that the seed yield and germination of oilseed rape varieties depend on the year of examination and oil and protein contents depend on the year, genotypes as well as the amount of N/ha applied. Oilseed rape hybrids with high yield potential might have high nitrogen requirements in comparison with coventional varieties (*Didier*, 2002).

Bearing in mind the importance of N in affecting quantity and quality parameters of canola, the aim of the present study was to analyse the effects of nitrogen top-dressing on the yield and yield components of winter oilrape hybrids and cultivars.

Materials and methods

The study was conducted in the Gluvo district (a village near Skopje), in 2010/2011 growing season. Eight canola hybrids: Hybrirock, Triangle, Petrol, Speed, Artoga, Albatros, Rohan and Abakus and two canola varieties Banačanka and Majdan were tested. Experimental design was a split-plot with 3 replications and 3 nitrogen regimes as main factors. Fertiliser treatments were: N (N_0), N+120 kg N/ha (N_{0+1}), N+120+70 kg N/ha (N_{0+1+2}). N treatment as a base fertiliser corresponded to 70 kg of N/ha. Each sub plot consisted of 5 rows, 20 cm apart and 3 m long. The experiment was planted on 15 September. Sowing was done by hand. The previous crop was winter wheat. Other recommended cultural practices were applied during the period of the experiment. Ammonium nitrate (nitrogen content 34.4%) was used as top-fertiliser in two different application times: A) at the beginning of spring vegetation (oilseed rape growing code 30) and B) in phonological phases “green bud” (code 59). Timing of nitrogen application was based on the growth stages described by *Weber & Bleiholder* (1990) and *Lancashire et al.,* (1991).

Depending on the period of pods maturation of hybrids and varieties examined, the trial was harvested between 1–10 July. During the harvest, ten random guarded plants were chosen from each sub/sub plot and the data of plant height (cm), number of main branches/plant, pod length (cm) and number of seed/pod were recorded. Seed yield/ha (kg) was calculated from the yield of the inner 3 rows and then converted into kg seed/ha.

The Least Significant Difference (LSD) procedure was used when F-test was significant ($P>0.05$). The SPSS 6.1 programme was used to process the test results.

Results and discussion

Yield components

The effects of nitrogen rates on plant height are presented in Table 1. Means of the plant height under the nitrogen top-dressing rates showed an increase in plant height as nitrogen fertiliser rate increased, but no significant differences were detected. Plant height means ranged from 81.5 to 90.5 cm with N_0 and N_{0+1} treatment and 94.9 cm with N_{0+1+2} treatment, respectively. According to *Mobasser et al.,* (2008), nitrogen application had significant effect on plant height. *Yousaf and Ahmad* (2002) obtained almost similar results. The results obtained in our trial might be due to the positive effect of increased nitrogen and environment on the growth and development of the stem which was reflected in taller plants, but the differences were not statistically improved.

Comparing the hybrids/varieties, plant height (Table 2) revealed that hybrid Hybrirock was the tallest with mean value of 100.5 cm, with average plant height of 104.0 cm using two nitrogen applications and 103.9 cm with one nitrogen top-dressing, followed by Rohan whose mean value was 96.7 cm and 101.5 and 99.3 cm applying two or one nitrogen fertiliser. The Petrol and Abakus hybrids with average mean height of 83.4 and 86.5 cm as well as varieties Banačanka and Majdan with 82.4 and 76.1 cm formed the shortest plants. No statistical differences were calculated which means that certain cultivars may be sensitive to environmental factors while others may be tolerant. As *Sana et al.* (2003) report, variation in plant height of different oilseed rape hybrids and varieties may be attributed to their genetic potential.

For the number of branches/plant, the mean values in Table 1 revealed that the number of branches increased following the increase in N fertiliser application rate and the maximum number of 4.8 branches was observed with N_{0+1+2} treatment and minimum of 3.7 branches with N_0 treatment. Statistical differences at 0.05 levels were not significant. These results comply with those documented by *Öztürk* (2010), who stated that number of branches per plant increased with N doses but without statistical improvement. On a hybrid/variety level (Table 2), the highest branch number per plant was obtained on Rohan hybrid - 6.48 branches, followed by hybrids Albatros with 5.24, Artoga with 5.18, Speed with 4.93 and Petrol with 4.84. On each of them, the highest branch number was obtained with N_{0+1+2} application showing statistical differences.

Several other studies have also reported positive effect of the rate of N-fertilisation on the number of branches in canola, which is not far from expectations as N fertilisers stimulate better plant growth and development (*Kazemeini et al.* 2010 and authors in the paper). According to *Sana et al.* (2003), the number of branches per plant is the result of a combined effect of genetic make up of the crop and environmental conditions, which play a remarkable role in the final seed yield of the crop.

The interaction between the nitrogen rates, nitrogen split application and canola cultivars had significant effect on pod length (Table 1). Mean values for this characteristic showed that the N_{0+1+2} treatment resulted in higher pod length of 7.3 cm. This result is opposite to those of Faramarzi et al. (2009) who obtained higher pod length by applying low nitrogen rate. Some of the hybrids examined such as Petrol, Artoga, as well as Banačanka and Majdan varieties with 7.5 cm, 6.9 cm, 7.7 cm and 7.0 cm resulted in higher pod length after applying N fertiliser two times (Table 2). *Chay and Thurling* (1989 a, b) and *Leon and Becker* (1995) conclude that the length of the pod, besides the effect of environment and fertiliser application, largely depends on the genetic constitution of the canola cultivars being examined.

By increasing the N fertiliser application rate, a number of seeds per pod increased significantly between the treatments with N_{0+1} and N_{0+1+2} compared with N_0 with mean values of 25.6, 23.8 and 19.0, respectively, although the increase was not statistically significant. Similar results were obtained for each of the hybrids and varieties examined (Table 2). Mean comparison for this trait showed that Majdan and Banačanka varieties had the lowest seed number per pod – 16.7 and 18.2 using N_0 treatment, while Speed and Albatros hybrids with 27.7 and 27.0, respectively, where the N_{0+1+2} treatment was applied, had the highest number of seeds per pod. A positive correlation between the number of seeds per pod and the application rates of N-fertilisers has also been reported in results of *Allen and Morgan* (1972), *Chauhan et al.* (1995) and *Faramarzi et al.* (2009). Other studies: *Vullioud* (1974) and *Cheema et al.* (2001) suggested a negative correlation between the N application rate and number of seeds per pod.

The seed yield of canola is a function of population density, number of pods per plant, number of seeds per pod and seed weight. However, yield structure is very plastic and adjustable across a wide range of populations. Means of seed yield showed that N fertiliser had a significant effect on this characteristic. By increasing N rate from 70 (N_0) to 260 (N_{0+1+2}) kg/ha, the seed yield increased at 0.05 level. No significant increase in the seed yield was observed when the rate was increased from 190 (N_{0+1}) to 260 kg/ha. The maximum seed yield (2568 kg/ha) was obtained by plots that received N 260 kg/ha split in two top-dressings while the minimum seed yield (1535 kg/ha) was obtained by plot treated with N_0 as base fertiliser (Table 1). Analysing hybrids and varieties separately, positive yield response to higher N rates was observed only in Albatros, Rohan and Abakus hybrids where the highest seed yield from 3209 kg/ha, 3191 kg/ha and 2523 kg/ha, respectively, was obtained using two treatments of N. Other hybrids and varieties did not react significantly when nitrogen rate was increased. In the case of Hybrirock and Triangle hybrids, the increase in the amount of N (treatment N_{0+1+2}) led to a decrease in the seed yield compared with N_{0+1} treatment. Obviously, different genotypes, depending on certain environmental conditions, react positively or negatively to the increase in N-rates applied as top-dressing. Moreover, a lot of studies illustrate the positive effect of N on the seed yield of winter oilseed rape, some authors noting stagnation or reduction in seed yield at high rates of N-fertiliser (*Rathke et al.* 2006 and authors' quotes in the paper).

Tab. 1. The mean values of canola yield and yield characteristics depends of N top dressing
Srednje vrednosti prinosa repice i karakteristike prinosa u zavisnosti N-prihrane

Treatment Tretmani	Plant height Visina biljke (cm)	Number of branches/plant Broj grana/ biljka	Pod length Dužina mahuna (cm)	Number of seed/pod Broj semenki/ mahuna	Seed yield Prinos semena kg/ha
N_0	81.5	3.7	6.8	19.0	1534.7
N_{0+1}	90.5	4.4	7.1	23.8	1918.3
N_{0+1+2}	94.9	4.8	7.3*	25.6*	2568.2*
LSD (%5)	25.6	1.2	0.4	2.2	901.2

(N_0 = 70 kg/ha; N_{0+1} = 70+120 kg/ha; N_{0+1+2} = 70 + 120 + 70 kg/ha)

Conclusion

The study showed preliminary results of the effect of nitrogen top-dressing on the yield and part of the yield components of canola cultivars. According to the data which we obtained, the increased N fertiliser does not have any significant effect on the plant height and number of branches per plant. On an average level, increasing N fertiliser from 70 (N_0) to 260 kg/ha (N_{0+1+2}) length of the pod, number of seeds per pod and seed yield increased. However, no significant increase in the mentioned characteristics was observed when the rate was increased from 120 ($_{N0+1}$) to 260 kg/ha.

The results showed that some hybrids examined such as Albatros and Rohan had the significantly highest seed yield when nitrogen was applied two times. Together with Hybrirock hybrid, they are the most promising canola cultivars to be grown in the Skopje region.

Tab. 2. The mean values of yield and yield characteristics depends of N top-dressing on a hybrids/varieties level
Srednje vrednosti prinosa i karakteristike prinosa u zavisnosti ***N****-prihrane hibrida/ sorte*

Type Hibrid/ sorta		N-rates N-režim	Plant height Visina biljke (cm)	Number of branches/plant Broj grana/ biljka	Pod length Dužina mahune (cm)	Number of seed/pod Broj semenki/ mahuna	Seed yield Prinos semena kg/ha
Hibrirock	**H**	N_0	93.5	3.9	6.4	18.9	2184.2
		N_{0+1}	103.9	4.6	6.8	23.6*	2730.2
		N_{0+1+2}	104.0	4.4	6.8	24.6	2679.3
Triangle	**H**	N_0	78.5	3.3	6.8	17.7	1318.6
		N_{0+1}	87.2	3.8	7.2	22.1*	1648.3
		N_{0+1+2}	91.2	3.8	7.1	22.5	1393.6
Petrol	**H**	N_0	73.0	3.4	6.8	19.0	1435.8
		N_{0+1}	81.1	4.0	7.0	23.7*	1794.8
		N_{0+1+2}	96.2	4.8*	7.5*	26.4*	2315.0
Speed	**H**	N_0	83.5	3.2	7.0	20.4	1905.6
		N_{0+1}	92.8	3.8	7.4	25.5*	2382.1
		N_{0+1+2}	99.4	4.9*	7.4	27.7	2823.1
Artoga	**H**	N_0	84.2	4.0	6.4	20.1	1336.9
		N_{0+1}	93.5	4.7	6.8	25.1*	1671.1
		N_{0+1+2}	99.0	5.2	6.9*	26.5	2195.3
Albatros	**H**	N_0	86.7	3.8	6.8	20.8	1375.8
		N_{0+1}	96.3	4.5	7.1	26.0*	1719.6
		N_{0+1+2}	99.3	5.2*	7.2	27.0	3209.2*
Rohan	**H**	N_0	89.4	5.0	6.8	18.8	1863.6
		N_{0+1}	99.3	5.9	7.2	23.4*	2329.3
		N_{0+1+2}	101.5	6.5*	7.3	23.8	3191.1*
Abakus	**H**	N_0	78.7	4.0	7.3	19.7	1526.0
		N_{0+1}	87.4	4.7	7.7	24.6*	1908.7
		N_{0+1+2}	93.4	4.8	7.7	25.3	2522.7*
Banacanka	**V**	N_0	75.9	3.6	7.0	18.2	1494.1
		N_{0+1}	84.3	4.2	7.4	22.8*	1867.6
		N_{0+1+2}	87.1	4.4	7.7*	26.2*	2067.0
Majdan	**V**	N_0	71.3	3.0	6.3	16.7	905.2
		N_{0+1}	79.2	3.5	6.6	20.9*	1131.4
		N_{0+1+2}	77.9	3.4	7.0*	25.0*	1285.0
LSD (%5)			27.0	1.3	0.4	2.3	949.2

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Агрономске карактеристике хибрида озиме уљане репице од зависности азотне прихране

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Сажетак

Уљана репица је једна од значајних извора биљних уља у Свету. Потребе прихране код уљане репице су знатно веће од потребе прихране житарица. Упоређено са житарицама, зимска уљана репица захтева више расположљивог азота, који је важна компонента са јаким утицајем на принос и квалитет са једне стране, а са друге стране утиче на смањење садржаја уља. Хибриди зимских уљаних репица са високим потенцијалом родности, имају високе захтеве за азотом. Вигор биљака преко азотне прихране побољшава развој снажног кореновог система. У многим случајевима потреба азотне прихране не узима у обзир врсту *Brassica napus* L. већ се темељи на нормама ђубрења у складу са вањским условима. Циљ ове студије је да процени резултате утицаја азотне прихране према приносу и компоненте приноса код 8 зимских хибрида и 2 зимске сорте уљане репице. Истраживање је спроведено у селу Глуво (код Скопља), у периоду од две године (2010/2011). Статистичка обрада је направљена према сплит-плот експерименталном дизајну, где се као главни фактор узимају 3 понављања и 3 азотна режима. Постављени третмани азотног режима су: N, N+120 кг N/ха, N+120+70 кг N /ха. Прихрана азотом, као основним ђубривом кореспондира са 70кг N/ха. Апплициране су две амонијум нитрат прихране у два наврата, 25-ог фебруара и 15-ог марта. Од добијених резултата може се закључити да код двојне прихране постоје статистички значајне разлике (P = 0.05) на принос хибрида односно сорти, број семена / љушпи и дужине махуна, у поређењу са једном прихраном и без прихране, али нема никакве сигнификантне разлике код висине биљке и броја примарних грана по биљци. На нивоу хибрида/сорте, за скопски регион, сматра се да највише обећавају или су најперспективније Hybrirock (KWS), Rohan (NPZ-Lembke) и Albatros (Limagrin).

Кључне речи: озиме уљане репице, азот, прихрана, принос, компоненте приноса

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