The application of plant growth regulator in Italian ryegrass seed crop

Simić A.[1], Jovanović-Radovanov K.[1], Vučković S.[1], Bijelić Z.[2], Mandić V.[2], Sokolović D.[3] and Babić S.[1]

[1]Faculty of Agriculture, University of Belgrade, Nemanjina 6, Belgrade – Zemun, Serbia; [2]Institute for Animal Husbandry, Autoput 16, Belgrade-Zemun, Serbia; [3]Institute for Forage Crops, Globoder, Kruševac, Serbia

Abstract

In seed crops of many temperate grass species stem lodging occurs during reproductive development. Nitrogen (N) spring application maximizes grass seed production, but influence the incidence and severity of lodging. Therefore, we analyzed the effect of different N rates (0, 50 and 100 kg ha^{-1}) in spring and growth regulator trinexapac-ethyl (TE) doses (0, 0.5 l ha^{-1} and 1 l ha^{-1}; Moddus 250-EC) on morphological parameters of two commercial Italian ryegrass (*Lolium multiflorum* Lam) cultivars, K-13 diploid and K-29 tetraploid type. Before swathing, internodes length, stem length, spike length and the number of spikelet from 10 randomly picked tillers per plot were measured. The increase of N rate significantly increased the fifth and sixth internodes length of cv. K-29. Also, significant decrease of internodes length was achieved in cv. K-29 with 1 l ha^{-1} TE, while stem length in cv. K-13 was unchanged by TE and N spring application. Cv. 29 had higher spike length than cv. K-13 and TE decreases length in both cultivars, in K-13 with 1 l ha^{-1} TE, while in K-29 with both doses of TE. The use of higher N fertilizer rates together with TE in Italian ryegrass seed crop can be more valuable practice for tetraploid cultivars.

Keywords: growth regulator, Italian ryegrass, nitrogen application, seed production

Introduction

Italian ryegrass is one of the best forage grasses in Serbia, producing high-quality forage from early spring to late summer. The Serbian production of forage and grass seed is often in areas characterized by seasonally very variable conditions (Simić *et al.*, 2009, 2012). Italian ryegrass seed crops are often routinely fertilized with a predetermined amount of nitrogen (N) fertilizer in spring (Vleugels *et al.*, 2017) which influences N uptake and consequently chlorophyll concentration (Rowarth *et al.*, 1999). The recommended N doses for ryegrass varies considerably, but especially based on soil texture, length of growing season, ploidity of ryegrass, as well as weather conditions (Kusvuran, 2011). If the level or source and timing of N application are incorrectly managed, a reduction of grass seed yields might occur. High ryegrass plant density could place leaf laminae at different heights within the canopy, affecting their ability to compete for light and, consequently, leading to lower effectiveness of photosynthesis, affecting plants susceptibility to wind and possibly lodging (Griffith, 2000). Lodging is ubiquitous in Italian ryegrass grown for seed, especially under high N fertilization. However, lodging could be prevented by using plant growth regulators (PGR), such as trinexapac-ethyl at appropriate growth stage and in adequate dose (Trethewey *et al.*, 2016). The objectives of this study were to determine the impact of N early spring application on one hand, and impact of plant growth regulator trinexapac-ethyl (TE) application on the other hand on crop agronomic performance in the first-year Italian ryegrass seed production.

Materials and methods

Field experiment was conducted under no irrigation conditions during the 2018 harvest season, near Belgrade, Serbia (N: 44° 50' 18.9", E: 20° 17' 0.6", and altitude: 66 m a.s.l.), located in a semi-humid region, on degraded chernozem soil. Soil properties were: pH (KCl) 6.64; 30.36% sand, 35.28% silt,

34.36% clay, 2.70% organic matter, 0.42% of $CaCO_3$, 0.0014 μg N g^{-1} of N-NO_3, 0.0035 μg N g^{-1} of N-NH_4, 103.43 mg kg^{-1} available P and 178.48 mg kg^{-1} available K (Van Reewijk, 2002). Italian ryegrass was sown in third decade of October with seeding rate of 20 kg ha^{-1} and 20 cm inter-row spacing. The experimental design was a randomized complete block with four replications and individual plot size 10 m^2. One factor was N rate (0, 50, and 100 kg ha^{-1}), and the other factor was PGR (TE) rate (0, 0.5 and 1 l ha^{-1}). Nitrogen was applied in early spring. TE applications were made with a hand-held CO_2-presurized sprayer equipped with flat fan nozzles (XR Tee Jet 11002) which delivered a spray volume of 240 l ha^{-1}. Those treatments were applied when ryegrass crop was at 2nd internode detectable growth stage (BBCH 32). Prior to the seed harvest, biometrical traits such as number of generative tillers, internodes' length, stem length, spike length and the number of spikelets per spike were measured on 10 randomly sampled tillers from each plot. The data were analysed by ANOVA and LSD test indicated differences between treatments.

Results and discussion

Overall response expressed through morphological parameters varied among cultivars, doses of N and TE applied (Table 1). In general, diploid cv. K-13 showed less sensitivity to both different N and TE application treatments.

Table 1. The influence of nitrogen and trinexapac-ethyl application on ryegrass morphological parameters. Means followed by a common letter are not different at the 5% level (LSD test).[1]

Treatments	Diploid cv. K13									
	NT	1st IN	2nd IN	3rd IN	4th IN	5th IN	6th IN	SL	SPL	NS
N (kg ha^{-1})										
0	12.9	4.79	8.52	9.85	13.9	24.3	14.6	75.9	27.7	26.4
50	14.1	5.26	8.83	9.80	13.4	22.3	12.6	72.1	27.1	27.2
100	12.4	5.24	9.24	9.64	12.6	21.2	14.6	72.5	26.4	27.3
F test N	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
PGR (L ha^{-1})										
0	13.1	6.03a	9.91	9.76	12.2	24.1	12.4	74.4	27.3b	26.2b
0.5	12.5	5.17a	8.82	10.15	13.6	19.2	15.3	72.3	28.4a	28.2a
1	13.7	4.09b	7.86	9.38	14.1	24.4	14.0	73.9	25.6c	26.6ab
F test PGR	ns	**	ns	ns	ns	ns	ns	ns	**	*
Average	13.1	5.10	8.86	9.76	13.3	22.6	13.9	73.5	27.1	27.0
Treatments	**Tetraploid cv. K29**									
	NT	1st IN	2nd IN	3rd IN	4th IN	5th IN	6th IN	SL	SPL	NS
N (kg ha^{-1})										
0	15.1	4.75	9.10	11.1	11.3	8.20b	6.81b	52.5b	22.0b	24.6
50	14.5	5.98	10.4	11.0	13.3	18.4a	13.5a	74.4a	23.7a	24.3
100	14.6	5.76	10.6	11.7	12.6	17.0a	13.8a	73.6a	22.3b	24.1
F test N	ns	ns	ns	ns	ns	**	**	**	*	ns
PGR (L ha^{-1})										
0	14.6b	6.44a	12.2a	13.0a	11.5b	15.5	15.1a	76.7a	24.1a	24.7
0.5	17.7a	6.17a	10.2b	11.3b	13.8a	13.7	9.35b	64.8b	22.9b	23.9
1	11.9c	3.88b	7.77c	9.43c	11.9b	14.4	9.59b	59.0b	21.1c	24.4
F test PGR	**	**	**	**	*	ns	*	**	**	ns
Average	14.7	5.50	10.0	11.2	12.4	14.5	11.4	66.8	22.7	24.3

[1] NT = number of tillers; 1st IN =first internode length (cm); 2nd IN = second internode length (cm); 3rd IN = third internode length (cm); 4th IN = fourth internode length (cm); 5th IN = fifth internode length (cm); 6th IN = sixth internode length (cm); SL = stem length (cm); SPL = spike length (cm); NS = number of spikelet; PGR = plant growth regulator.

There were no statistically significant differences for all measured parameters in regard to different N rates concerning diploid cv. K-13. The recommended TE rate (0.5 l ha^{-1}) induced unexpected effects manifested through increased spike length and number of spikelet, while TE rate of 1 l ha^{-1} resulted in reduction of the first internodes' length (unexpected due to the time of TE application). Tetraploid cv. K-29 expressed clear influence of N application rates to all internodes length, with statistically significant differences for the 5th and 6th internodes, as well as for the stem and spikelet lengths. On the other hand, very obvious influence of TE application rates on all parameters measured was recorded with exception of the number of spikelets. Both recommended and twice the recommended doses induced length reduction of all internodes except the 4th (where reverse effect was recorded, probably due to stronger N rate influence). The length reduction was more pronounced for treatment with higher TE rate. The spike length reduction was also established for both PGR doses, but with no effect on spikelet number. The 2018 vegetation season was characterized by adequate precipitation evenly distributed throughout the period of ryegrass vegetative development resulting in positive influence on N uptake and consequent crop growth, also stated by Chastain (2000).

Conclusion

The results of this research showed that applications of N and PGR in Italian ryegrass seed crop could be an effective strategy for tetraploid but not for diploid type of ryegrass. The results of the present study indicated that in order to improve tetraploid Italian ryegrass features for seed production in the first production year, a medium N rate is preferable (50 kg ha^{-1}) with trinexapac-ethyl application at recommended dose (0.5 l ha^{-1}).

Acknowledgements

The research received funding from the Serbian Ministry of Education and Science (Project TR 31016).

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