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THE INFLUENCE OF DIFFERENT NITROGEN FORMS OF FERTILIZERS AND METEOROLOGICAL CONDITIONS ON NITROGEN TRANSFORMATION AND EVAPORATION

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Nitrogen is one of the most important nutrients used worldwide to increase and maintain crop production and is considered a key element in maintaining the sustainability and economic viability of farming systems across the world (Hawkesford, 2014; Wang et al., 2016). Soil nitrogen transportation and transformation are important processes for crop growth and environmental protection, and they are influenced by various environmental factors and human interventions (Zeng et al., 2016). Globally, about 50% of the N fertilizer applied to cropping systems is not absorbed by plants, but lost to the environment as ammonia (N-NH_3), nitrate (N-NO_3^-) and nitrous oxide (Readman et al., 2002, Tamme et al., 2009). The biggest problem with the use of urea for crop fertilization is the control of ammonia (N-NH_3) volatilization into the atmosphere by preventing urea hydrolysis (Bolado Rodríguez et al., 2005). Several studies have shown that the emission of nitrogen compounds depended on the form and norms of fertilizers (Liu, 2014).

The study was aimed to estimate the changes in ammonium (N-NH_4^+), nitrate (N-NO_3^-) and mineral (N-NH_4^+ + N-NO_3^-) nitrogen in the soil, nitrogen loss via volatilization and uptake as influenced by the nitrogen fertilizer form applied, soil moisture and temperature in the crop stand of the winter wheat at the tillering stage.

Field experiment were carried out at the Vytautas Magnus University Agriculture Academy's Experimental Station in Lithuania, during in 2015 – 2018. Winter wheat (cultivar 'Skagen', seed rate 5.0 million ha^{-1}) were grown. The experiment was carried out according to a two-factor design: factor A – fertilizer application time: beginning of spring growth of winter wheat (BBCH 23–25) – control, 4, 8, 12 and 16 days after resumption of spring growth; factor B – nitrogen fertilizer forms: ammonium nitrate (NH_4NO_3) and urea ($CO(NH_2)_2$). Nitrogen fertilizer rate applied at the tillering stage was N_{90}. Winter wheat was additionally dressed with ammonium nitrate at the stem elongation stage N_{45} and heading stage N_{30}. Volatilization of N-NH_3 was measured in the winter wheat crop applied with 90 kg ha^{-1} N as ammonium nitrate and urea at the winter wheat tillering stage using the vented chamber method (Yang et al., 2018).

After analysing the results (Table 1), it was found that the content of N-NH_4^+ in the soil was on average 25% higher in the urea-applied treatments as compared with ammonium nitrate-applied treatments. This is probably due to the chemical composition of fertilizers and the fact that urea and ammonium are converted to nitrate at different intensity.

In the ammonium nitrate-applied plots the content of N-NO_3^- in the soil (Table 2.) averaged 17.8–19.2 mg kg^{-1}, and in the urea-applied plots – 11.0–12.4 mg kg^{-1}. The significantly higher concentrations of N-NO_3^- was in the soil, where winter wheat fertilized with ammonium nitrate.

According to the data (Figure1.) from the three experimental years, the highest mineral nitrogen content was determined in the soil where winter wheat was fertilized with ammonium nitrate at the beginning of spring growth (in 2018) and 4 days later (in 2016 and in 2017).

Volatilization of N-NH_3 in the winter wheat plots (Figure 2.) fertilized with ammonium nitrate was negligible and totalled 0.24%, while in the plots applied with urea it averaged 7.3%. Volatilization of N-NH_3 from urea depended on the soil temperature and moisture.

Conclusion

In the plots of winter wheat fertilized with ammonium nitrate or urea, 4 days after beginning of spring growth, the contents of N-NH_4^+, N-NO_3^- and N-NH_4^+ + N-NO_3^- in the soil were significantly higher than those in the winter wheat plots fertilized 8–16 days after beginning of spring growth.

At the winter wheat tillering stage, the content of mineral nitrogen in the soil depended on the soil temperature and moisture.

The volatilisation loss of N-NH_3 fertilized with ammonium nitrate was insignificant, while in the urea-applied - it averaged 7.3%.

Table 1. The effect of of nitrogen fertilizer form and application time on the N-NH_4^+ ions content in the soil mg kg^{-1}

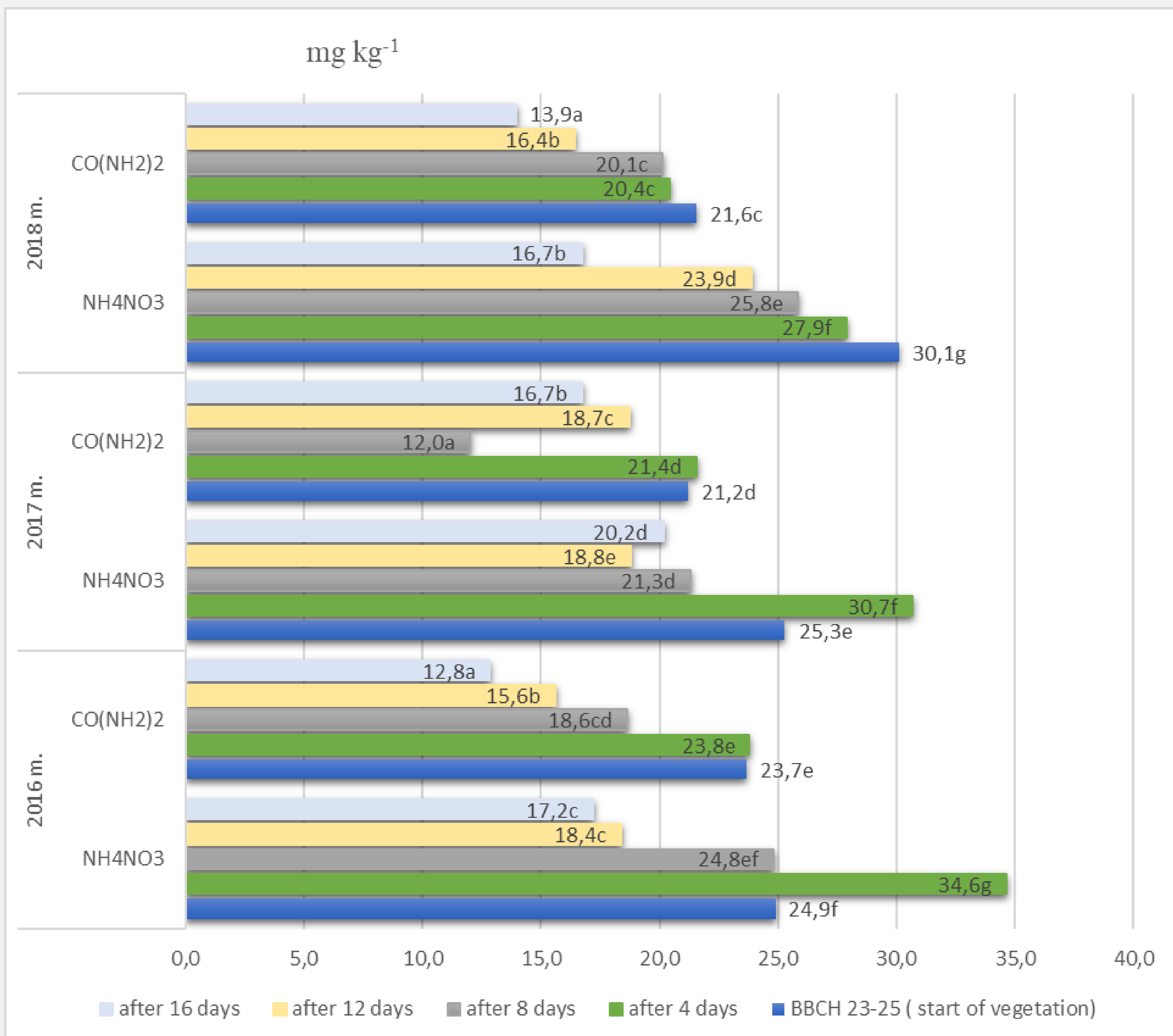
Application time	NH_4NO_3	$CO(NH_2)_2$	NH_4NO_3	$CO(NH_2)_2$	NH_4NO_3	$CO(NH_2)_2$
	2016 m.		2017 m.		2018 m.	
Start of vegetation (BBCH 23-25)	5.1b	10.9d	5.4d	6.5e	6.4c	8.1d
After 4 days	11.9d	11.2d	6.1e	10.2f	8.3d	9.3e
After 8 days	5.3b	8.2c	2.6a	2.6a	6.9c	9.1e
After 12 days	3.6a	4.5ab	2.6a	3.1ab	4.6a	4.8a
After 16 days	5.0b	4.6b	3.4b	4.2c	4.9ab	5.4a

Note: Values followed by the same letters are not significantly different (P < 0.05)

Table 2. The effect of of nitrogen fertilizer form and application time on the N-NO_3^+ ions content in the soil mg kg^{-1}

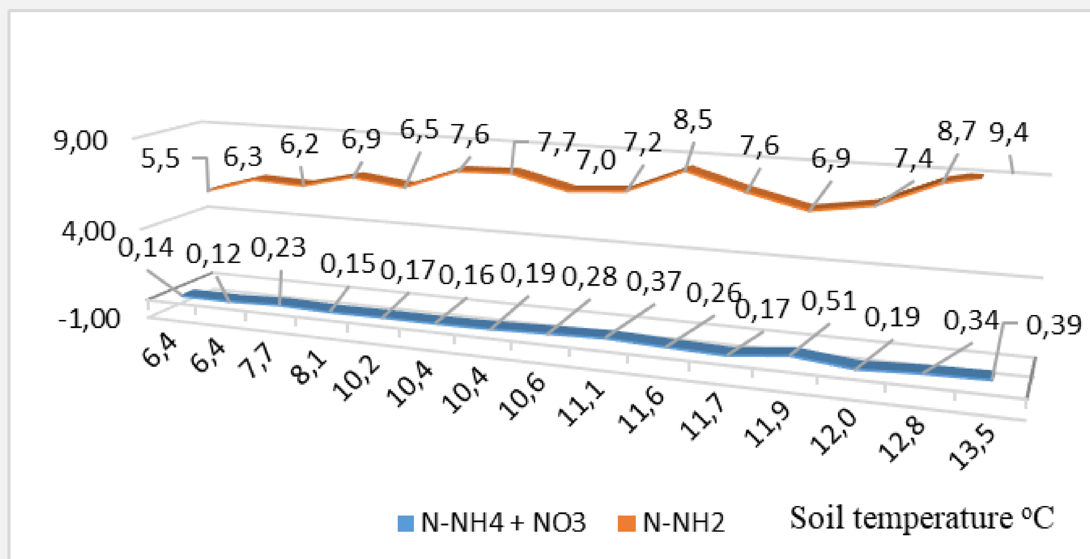
Application time	NH_4NO_3	$CO(NH_2)_2$	NH_4NO_3	$CO(NH_2)_2$	NH_4NO_3	$CO(NH_2)_2$
	2016 m.		2017 m.		2018 m.	
Start of vegetation (BBCH 23-25)	19.8f	12.8d	19.9g	14.7d	23.6e	13.5c
After 4 days	22.8g	12.6d	24.6h	11.4b	19.6d	11.2b
After 8 days	19.5f	10.5b	18.7f	9.4a	18.9d	11.0b
After 12 days	14.9e	11.1bc	16.2d	15.6d	19.3d	11.6b
After 16 days	12.2cd	8.2a	16.8d	12.6c	11.8b	8.5a

Note: Values followed by the same letters are not significantly different (P < 0.05)



Note: Values followed by the same letters are not significantly different (P < 0.05)

Figure 1. The effect of of nitrogen fertilizer form and application time on the mineral nitrogen (N-NH_4+N-NO_3) content in the soil mg kg^{-1}



Note: $LSD_{05\ N\text{-}NH4\ +\ N\text{-}NO3}$ = 0.100; $LSD_{05\ N\text{-}NH2}$ = 0.634

Figure 2. The influence of soil temperature (°C) and fertilizers forms on the ammonia nitrogen (N-NH_3) evaporation %

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