RESEARCH ARTICLE

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Effects of different doses of ammonium nitrate applications on nutrient content in some types of grass: nutritional support

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Abstract

This study was conducted under ecological conditions of Çanakkale (Turkiye) province to investigate the effects of different ammonium nitrate (33% N) dose (0, 50 and 100 g m^{-2}) on nitrogen, protein, macro-micro nutrient analyses of 3 different commonly cultivated grass varieties (*Lolium perenne* TOPGUN, *Festuca rubra* SERGEİ and *Poa pratensis* AVALANCHE). Plant nitrogen-protein analyses (nitrogen, protein) were determined besides plant macro-micro nutrient analyses (phosphorus, potassium, calcium, magnesium, ıron, manganese) of grass plants were determined. In the study, in addition to having information about the mineral content of grass species removed from the soil, the potential of the cuttings, which are formed when the grass plants are mowed, when used as green manure or compost has been determined.
Fertilizer treatments increased nitrogen, phosphorus, potassium and protein contents of grass clippings and decreased calcium, iron, magnesium and manganese contents. In general, it was determined that the application of ammonium nitrate (33% N) at a dose of 100 g m^{-2} increased the nitrogen, protein, phosphorus and potassium amounts of plants compared to the application of ammonium nitrate (33% N) at a dose of 50 g m^{-2}. Especially nitrogen phosphorus potassium fertilizers are among the fertilizers applied in intensive amounts in the agricultural sector. It is seen that nitrogen-containing ammonium nitrate fertilizer applied to grass plants increases the nitrogen content of grass plants. When the results of the study were examined, important information was obtained about how the fertilization density affects the nutrient content of the grass plants according to the species.

Keywords: Grass species, Grass clippings, Fertilization, Mineral composition, Aesthetic and functional effects

INTRODUCTION

World consumption of major mineral fertilizer elements such as nitrogen, phosphorus and potassium has increased steadily from 112 million metric tons in 1980 to 143 million metric tons in 1990 to meet the increasing food demands and has remained stable over the last ten years. Unused minerals can intrude into surface waters, hold on to soil particles or cause air pollution (Taiz and Zeiger, 2008). According to the data of 115 countries in terms of nitrogen, it is reported that 161 metric tons of nitrogen was consumed for products up taking 73-86 metric tons of nitrogen and nitrogen use efficiency was calculated as 46%

(Zhang et al., 2021). Since a significant part of nitrogenous fertilizers is used to provide continuous green cover in sportive and recreational areas, the nitrogen balance between the nitrogen applied to green areas and the nitrogen removed through mowing is an important issue. It is thought that the data obtained from this study, which was designed to determine the effects of different nitrogen fertilization applications on mineral composition of grass, will have great contributions to scientific literature (Atar, 2020). The grass clippings that emerge during mowing can be used in the form of green manure, mulch and compost (Anonymous, 2021a). Organic materials obtained from grass clippings can help in reaching the ideal form (management) when the soil is sandy, heavy clayey or poor in organic matter.

Composting is a process of inoculating grass clippings or the other plant materials with a small amount of soil, including microorganisms that decompose organic matter, until reaching odorless, dark-colored and slightly moist form through aeration and maturation stages. Grass clippings with high nitrogen contents may offer great contributions to compost piles. Grass clippings should not solely be a compost material, but should be mixed with dry materials such as leaves or straw (Anonymous, 2021b). When grass clippings are used as mulch, they help maintain soil moisture and prevent weeds on soil surface. Clippings can also be used as green manure (Anonymous, 2021c). Agustina and Sriharti (2020) reported that they obtained compost by mixing grass clippings with goat manure, rice bran and three different commercial microbial activators.

Fernando et al. (2015) conducted a study to determine whether an approach focused on producing perennial herbs as a source for bio-based (bioenergy) crops in marginal Mediterranean soils (without consuming soil nutrients, water resources or adversely affecting biological and landscape diversity) could diminish greenhouse gas (GHG) emissions. In their study, they mentioned that the demand for more new, various and sustainable agricultural production systems has increased due to reasons such as the decrease in supply and safety of petroleum based materials, climate change, and increase in environmental concerns. They concluded in their study that it is possible to grow perennial herbs in marginal Mediterranean soils and would have relatively few environmental side effects if properly managed.

Among the purposes of fertilization applications is to determine the degree of effect of high-dose fertilization on plants. Williams and Silcock (1997) conducted an ammonium nitrate fertilization study on *Sphagnum magellanicum* plant. It was reported that 1 g N m-2 year-1 ammonium nitrate treatments promoted plant growth and development; 3 g and 10 g N m-2 year-1 treatments did not have any favorable effects on plant growth and development. It was stated that increase in N without an increase in carbon quantity of the plant caused a decrease in C:N ratio in plant tissues.

Some plant species may remove more nutrients from soil than other species. Singh et al. (2015) conducted a study on mineral composition and nutrient removal of 6 perennial grass species *[(sugarcane (Saccharum spp.* hybrid), energy cane (*Saccharum spp*. hybrid), sweet cane *(S. arundinaceum (Retz.)* Jesw.), elephant grass *(P. purpureum (Schum.)),* giant miscanthus (Miscanthus × giganteus (Greef and Deuter ex Hodkinson and Renvoize), giant reed (*A. donax L.*)]. The greatest N, P and K removals were observed in sugarcane, sweet cane, energy cane and elephant grass varieties and the lowest in giant miscanthus variety. Significant variations were observed in nutritional composition of the varieties.

The amount of nutrients that plants remove from the soil can also vary according to the dose of fertilizer used (Balcı and Taban, 2018). Kleiber and Komosa, (2011) applied 0, 50, 100, 150, 200 mg N dm-3 ammonium nitrate doses to soils in which mixture of different grass species [(perennial ryegrass (*L. perenne L.*) var. Grasslands Nui (45%), tall fescue (*F. arundinacea Schreb*) Finelawn (25%), red fescue (*F. rubra*)] Hack.) Olivia (10%), red fescue (*F. rubra Hack*.) Boreal (15%) and Kentucky bluegrass (*P. pratensis L.*) Balin (5%)] were sown. It was reported that Fe content of above-ground parts of the plants decreased in 150 and 200 mg N dm-3 treatments and there was no significant difference in the other treatments. It was also reported that Mn contents increased in 50, 100, 150 mg N dm^{-3} treatments and there was no significant difference in the other treatments.

In the light of above-specified studies, objectives of the present study were set as:

- To determine the effects of ammonium nitrate fertilizer doses on mineral composition of the plants,
- To determine the changes in nutritional composition of grass species when the clippings were used in compost or mulch production,
- To determine optimum fertilization practice for classical grass applications.

Grass Plants In General

Grass plant; predominantly aesthetic and functional use and marked by different shades of green, can grow up to 10-15 cm from the surface, form superficial roots and can be walked on ground cover plants. Within the scope of design and planning principles and elements, it is essential for landscaping or open and green areas. Especially in urban areas, the richness of aesthetic and functional use is the determinant of the quality of life of the individual today. In other words, it is an indispensable landscape dimension that offers the opportunity for the individual to renew himself or to use recreationally in terms of physical and spiritual. Grass species, which play an important role in the landscape as a green surface cover, are members of the Graminae family. With the spread of outdoor sports such as football and golf, the role of grass areas in planning has also started to increase (Anonymous, 2008).

Definition and Importance Grass plants are horizontal elements of space. It gives vitality and beauty to the environment in which they are located. Grass plants; It has many functional effects in parks and gardens, playgrounds, promenades. Functional Effects • Absorbs the sun's rays in large areas. • Eliminates dust problem. • Prevents erosion in inclined places. • Provides a place of play and rest for people. Aesthetic Effects • Provides a beautiful appearance. • Beautifies the urban appearance. • Creates color harmony with other plants used in the park and garden. Lawn plants are the cornerstones of grass cover. Grass plants should tend to form a densely formal structure, especially spread out with leaf shoots. Grass plants have some characteristics that they are desirable to have. These are; Main Features • Resistant to form • Strength ability • Regeneration strength • Competitiveness • Rooting intensity Auxiliary features • Resistance to diseases • Pressability • Minimal tangling • Suitable color • We can list it as drought resistance. In order to grow grass plants in the best way, it is necessary to know the botanical features of plants in this group, such as leaves, roots, stems, rhizomes, stolon (Anonymous, 2008).

The general definitions of the 3 grass seeds evaluated within the scope of this study are mentioned below.

Lolium perenne (English grass); It is a type of perennial grass that is not very resistant to being pressed and in hot climate, developing quickly, preferring more flat areas. It stands out for its plump structure and fringe root, which loves fertilization (Anonymous, 2008).

Festuca L. (Yumak); It has a thin and hard texture and is resistant to printing. It is a type of grass that is close to blue or green in color, resistant to arid and unproductive soils, loves perennial, shaded environments.

Poa pratensis L. (Meadow panicle grass): This species, which is resistant to diseases, contraction and drought, is perennial and attracts attention with its fine texture and dark green color. It is preferred in repairing deteriorating places in grass areas with good development in shaded and calcareous environments (Anonymous, 2008).

MATERIALS AND METHODS

The study was carried out under the ecological conditions of Çanakkale province. This study, which provides a different approach to the lawn area facility within the scope of landscape design and planning, focuses on the inclusion of clippings obtained from mowing the lawn in the fertilizer support program. In this context, in the study, the reactions of 3 different grass species suitable for the ecology of the region to the application of Ammonium Nitrate in different doses and the determination of nutrients within the scope of the content were investigated. Therefore, a significant development in cultivation will be achieved by using the clippings obtained due to mowing in the fertilizer support program within the scope of the nutrients it contains. A map of the location of the workspace is given in Figure 1.

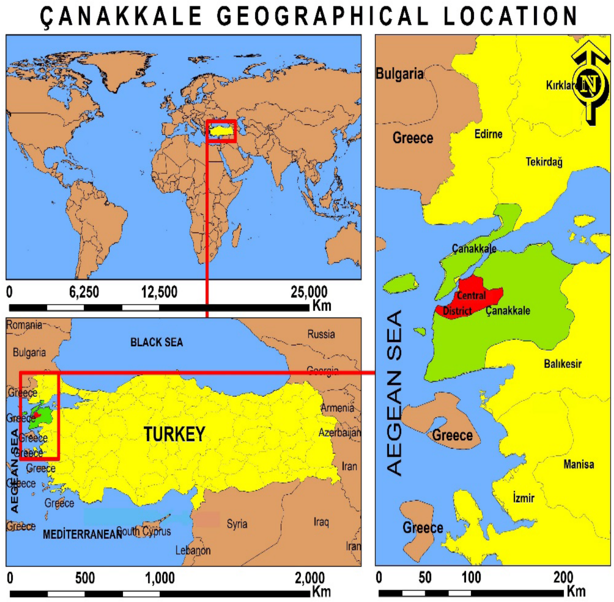

Figure 1. The location map of the study area

The *L. perenne* TOPGUN (British Grass), *F. rubra* SERGEI (Red Festuca) and *P. pratensis* AVALANCHE (Blue Grass) were used as the plant material of the present study. Ammonium nitrate (33% N) fertilizer was applied to grass species at 0, 50 100 g m-2 doses (Table 1). Seeds were manually sown into equal-size boxes (40x60x10 cm) filled with equal quantity of soil. Boxes of grass varieties irrigated daily with a watering can until the sand filled with water and boxes irrigated until excess water seeps out of the holes in the bottom of the boxes. A plastic sheet was kept ready next to the trial in case the newly planted grass seeds would come out of the container in case of rain. In order to protect the grass seeds from excessive heat and sunlight until germination, the seeds were covered with a net shading material with 40% light transmission until germination was completed.

It is known that all cultivars included in the study are drought resistant cultivars. It is known that the FR variety is a shade-tolerant variety. In addition, it is known that LP and FR varieties are easily germinated and tilled varieties. It is known that the PP variety spreads easily with the help of root stems.

Experiments were built in randomized plots design with 5 replications on 36 plots (3 grass species x 3 treatments including control x 4 replicates). Statistical analyses were conducted on measurement, observation and analysis data.

Analysis-based parameters of grass plants

Plant nitrogen-protein analyses; green parts of dried grass plants were ground in a plant mill with steel blades. Ground samples were wet-digested (Müftüoğlu et al., 2014) and nitrogen contents were determined with the use of Kjeldahl device (Bremner, 1965). Resultant nitrogen contents were multiplied by a coefficient of 6.25 to get protein contents of the samples (Kacar and İnal, 2008).

Plant macro-micro nutrient (K, P, Mg, Ca, Fe, Mn) analyses; previously dried and ground (Kacar and İnal, 2008; Müftüoğlu et al., 2014) samples were wet-digested (Jones et al., 1991) and resultant extracts were subjected to macro-micro nutrient analyses in an ICP-OES (Perkin Elmer Optima 8000) device. A verification reading was performed in the device with the control sample in every 20 readings.

Table 1. Grass varieties and fertilizer doses

Grass Varieties	Fertilizer Doses ($g.m^{-2}$)	Code	Replicate
Lolium perenne TOPGUN (British Grass)	0	LP0	4
	50	LP50	4
	100	LP100	4
Festuca rubra SERGEI (Red Festuca)	0	FR0	4
	50	FR50	4
	100	FR100	4
Poa pratensis AVALANCHE (Blue Grass)	0	PP0	4
	50	PP50	4
	100	PP100	4

Experimental soil properties; medium-textured field soil taken from Lapseki (Çanakkale/Turkey) location was used in present experiments. Soil samples were initially dried at shade, then fragmented with a wooden hammer and pass through 2 mm sieve. Samples were made ready for analyses as indicated by Müftüoğlu et al. (2014). Soil samples were analyzed for the relevant parameters in accordance with the relevant methods and results are provided in Table 2.

Statistical analysis: Experimental data were subjected to variance analysis in accordance with randomized plots design with the use of SAS.9 software. Significant means were compared with the use of LSD test (P<0.05) (Yurtsever, 1984). Bi-plot analysis was used for interpretation of data on morphological and chemical parameters.

RESULTS AND DISCUSSION

In all varieties, nitrogen, protein, potassium contents were increased with increasing dose of fertilization treatments (Table 3). Nakano et al. (2008), reported that increasing the dose of applied N at active tillering and anthesis periods generally increased grain protein content in bread wheat cultivar 'Minaminokaori'. Godebo et al. (2021), applied N (0, 23, 46, 69 kg Nha-1) and K_2O (0, 30, 60 kg Nha-1) on bread wheat and increased N doses resulted as increasion of K uptake in bread wheat (Triticum aestivum L.) at 0 doses of K_2O treatments.

Table 2. Experimental soil properties

Soil properties	Analysis value	Unit	Method
Soil reaction (pH) 1:2.5 aqueous mixture	6,44 (Slight acidic)	--	(Richards, 1954)
Soil salinity (EC) 1:2.5 aqueous mixture	0,23 (Unsaline)	dS m^{-1}	(Richards, 1954)
Soil organic matter (OM)	1,82 (Low)	%	(Jackson, 1958)
Lime ($CaCO_3$)	3,86 (Low)	%	(Allison ve Moodie, 1965)
Texture (Sand-Silt-Clay)	35-29-36 (Clay-Loam-CL)	%	Bouyoucos (1951)
Total nitrogen	0,12	%	Bremner (1965)
Available phosphorus	10	ppm	Olsen et al. (1954)

In LP variety, manganese content was not change with both fertilization treatments and there were not important statistical change (P<0,05) in ıron content with 100 g m-2 fertilization. Sharp increase was detected in phosphorus content with 100 g m-2 fertilization. Calcium and magnesium contents statistically (P<0,05) decreased with both fertilization treatments while ıron content decreased with 50 g m-2 fertilization.

Iron contents did not change with both fertilization treatments in FR variety. In PP variety, iron contents decreased with both fertilization treatments. Kleiber and Komosa (2011) reported decreasing iron contents of grass species with 150 and 200 mg N dm-3 ammonium nitrate treatments.

Manganese contents, which did not change in LP variety with fertilization treatments; decreased in FR variety with fertilization treatments. In PP variety it did not change with 50 g.m-2 fertilization treatment and increased with 100 g.m-2 fertilization treatment. Kleiber and Komosa (2011) reported increasing manganese contents of grass species with 50, 100 and 150 mg N dm-3 ammonium nitrate treatments.

In FR variety, phosphorus changes in plots without and with 100 g m-2 fertilization were placed into the same group statistically (P<0,05). Calcium and magnesium contents decreased statistically (P<0,05) with fertilization treatments and more decrease occurred with more fertilization doses.

In PP variety there was a visible increase in phosphorus content with both fertilization treatments. Decreasing calcium contents were seen in all varieties with fertilization treatment. PP variety didn't show same results with other varieties about decreasion of magnesium content with fertilization treatments.

In non-fertilized plots, significant differences were not observed in potassium, nitrogen and protein contents. As compared to the other varieties, LP variety had greater phosphorus contents and PP variety had greater iron contents. FR variety had lower magnesium content than the other varieties. In terms of phosphorus, iron and magnesium contents, afore-mentioned varieties were placed into the same statistical group (P<0,05). In terms of calcium content, grass species were ordered as LP > FR > PP and manganese contents as FR > LP > PP.

PC1 (1st Component) and PC2 (2nd Component) are the two main components used to achieve the biplot. In study, PC1 and PC2 scores describe the interaction of 3 grass varieties and 2 fertilization applications for 8 mineral components by 78,5%.

Biplot graph for mineral contents of grass plants (Figure 2) revealed that the plots without fertilization (L0, F0, P0) and iron, magnesium, calcium and manganese parameters were placed in the same direction (PC1<0). The fertilized plots (L50, L100, F50, F100, P50, P100) were placed in the same direction (PC1<0) with nitrogen, phosphorus, potassium, protein parameters.

Such a case revealed that a decrease was seen in iron, magnesium, calcium and manganese contents of grass varieties and an increase was seen in nitrogen, phosphorus protein and potassium contents of grass varieties with fertilization treatments.

When the issues other than fertilization applications were evaluated, it was seen that the FR variety had almost twice the manganese content of the other varieties. It has been observed that the manganese content of a compost to be produced using the clippings obtained from this variety will be much higher than the compost produced from other varieties. The same is true for the iron content of the PP variety. From here, it is seen that the elements in some soils rich in the mentioned elements can be transferred to the soils that need these elements with the help of grass plant compost by using specific grass varieties.

It was observed that fertilizer treatments at different doses resulted in different mineral contents in different grass varieties. In addition, it was determined that ammonium nitrate fertilization significantly increased the phosphorus and potassium contents of grass plants. This showed that only as a result of nitrogen-containing fertilization, grass plants also absorb the phosphorus and potassium contents of the soil. It is seen that the use of clippings fertilized with ammonium nitrate in a compost application to be made using grass clippings will contribute to indirectly benefiting from the ammonium nitrate fertilizer applied to grass plants. This contribution may also be in the direction of benefiting more from the phosphorus and potassium content in the soil where grass plants are grown. At the same time, it should not be forgotten that if the grass plant provides the desired parameters such as surface coating, texture, color, plant height as a result of fertilization applied at a low rate, fertilizing at high doses can be avoided both in terms of environmental health and economically. In addition, as seen in the study, a decrease was observed in the micro element content of grass with ammonium nitrate fertilization. This shows that the micro element content of the compost material, which produced using grass clippings with ammonium nitrate fertilizer applied, will be lower than the subject without fertilizer application. If the compost produced from grass clippings is planned to be applied to the farm, it is thought that it may be beneficial to consider this situation.

Further research is recommended to be conducted under micro-scale controlled conditions with different grass mixtures, different fertilizers and different soil types for longer durations.

Table 3. Change in some nutrients of the seedlings based on grass varieties and fertilization treatments

Varieties	Nitrogen dose (g m^{-2})	Nitrogen (%)	Protein (%)	Phosphorus	Potassium	Calcium	Magnesium	Iron	Manganese
				(ppm)					
Lolium perenne Topgun (LP)	0	1.69 F*	10.57 F	1942 CD	13789 D	11079 A	6553 AB	1011 BC	125.2 BC
	50	2.41 D	15.09 D	1991 BCD	22706 B	7291 CDE	5684 C	737.7 C	119.5 BC
	100	2.77 A	17.29 A	2607 ABC	27157 A	7617 CD	5223 C	906.3 BC	118.6 BC
Festuca rubra Sergeı (FR)	0	1.69 F	10.54 F	1577.71 D	13560.3 D	10057.6 B	6305.92 B	932.3 BC	218.3 A
	50	2.26 E	14.1 E	2791.62 A	21414.6 B	8072.54 C	5727.07 C	844 BC	149.6 B
	100	2.76 A	17.28 A	1583.39 D	27543.2 A	6503.42 E	4564.28 D	924.6 BC	133.4 BC
Poa pratensis Avalanche (PP)	0	1.68 F	10.49 F	1432 D	10900 D	8108 C	6530 AB	1625 A	105.3 C
	50	2.53 C	15.81 C	2655 ABC	17384 C	6747 DE	6961 A	1081 BC	102.5 C
	100	2.63 B	16.43 B	2720 AB	21043 B	6741 DE	6428 B	1313 AB	121.7 CB
LSD		0.0935	0.5846	735.86	3276.2	1021.2	504.24	478.45	38.844

*: Means indicated with different capital letters in the same column are significantly different.

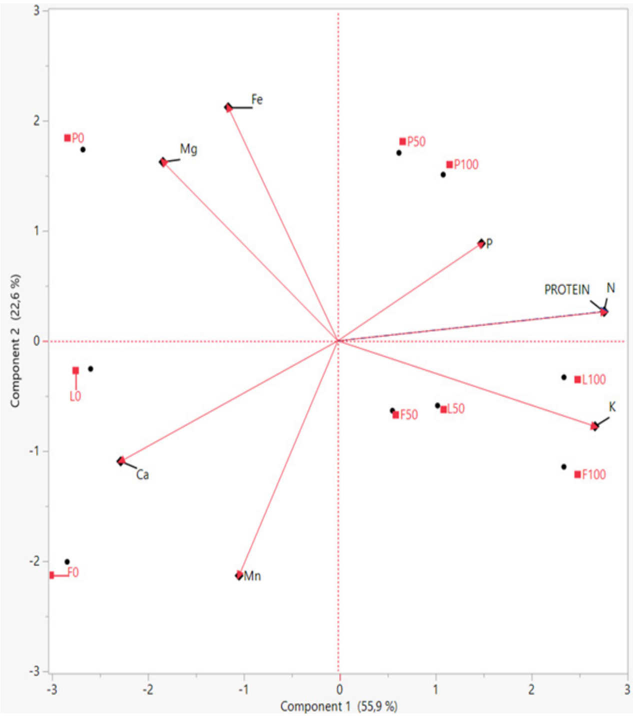

Figure 2. Biplot graph for changes in mineral contents of grass plants based on grass varieties and fertilization treatments

COMPLIANCE WITH ETHICAL STANDARDS

Conflict of interest

The authors declared that for this research article, they have no actual, potential or perceived conflict of interest.

Author contribution

Associate Professor Dr. Yavuz Alkan took part in determining the subject and scope of the experiment. It also provided the identification and supply of tools and equipment required for the Test. Contributed to the establishment of the experiment. Contributed to the writing of the article.

Prof. Dr. Cafer Türkmen: Made some analyzes and contributed to some analyzes. Contributed to the wri-ting of the article.

Dr. Tolga Sarıyer: Contributed to the establishment of the experiment. Involved in the inclusion of some analyzes in the study. Made some analyzes and contributed to all analyzes. Contributed to the writing of the article.

Prof. Dr. Abdullah Kelkit: Contributed to the writing of the article. Made the final check of the article.

All the authors read and approved the final manuscript. All the authors verify that the Text, Figures, and Tables are original and that they have not been published before.

Ethical approval

Ethics committee approval is not required.

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Data availability

Not applicable.

Consent for publication

Not applicable.

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