Granulometric Study of Calk Ammonium Nitrate Fertilizer

Tomáš Šima, Ladislav Nozdrovický, Josef Krupička, Koloman Krištof

Abstract: *Quality of work of the fertilizer spreaders is effected by physical properties of the fertilizer. One of the most important factors is the fertilizer particle-size distribution which depends upon the size of the fertilizer particles. Fertilizer Calk ammonium nitrate is one of the most used fertilizers in Slovakia. Differences between the size of the particles of fertilizer cause problems during the field application. The aim of the paper was to evaluate the particle-size distribution of the fertilizer separated at first in the vertical air flow by K-293 Laboratory screening machine and secondary by sieve screening of the samples by Haver EML digital plus Test Sieve Shaker. Sieves with square holes with dimensions 1 mm, 2 mm, 3.15 mm, 5 and 10 mm were used. By this way, samples of fertilizer were sorted into 6 classes of particles.*

Keywords: *fertilizer, granulometry, particle-size distribution, airflow, sieve screening, sorting*

INTRODUCTION

Fertilization is an important factor that affects crop yields [1, 2]. Correct application of fertilizers has both positive economical and environmental effect. Physical properties [3], especially particle-size distribution of fertilizer particles [4, 5, 6] strongly affect the quality of application. The differences and variability in physical properties of fertilizers cause problems during the field application by the most used spinning fertilizer spreaders [7, 8, 9]. The effectiveness of mineral fertilizers in plant cultivation depends upon the particle stability and speed of their transformation to solution state to be acceptable by plants. This process depends upon the particles dimension, so that the dimension of particles is one of the main parameters that influence the fertilizer effectiveness [10]. The need for using fewer amounts of fertilizers means that it must be applied in a right way, and fertiliser losses are reduced to an absolute minimum. An optimal application of fertilizers, minimisation of the spoilage of fertilizers, improvement of existing and development of possible new application techniques, all this requires a detailed knowledge of the processes and factors that affect the spreading of fertilisers [11].

The aim of the paper is the study of granulometric composition of the calk ammonium fertilizer when vertical airflow and sieve separation are used.

MATERIAL AND METHODS

Experimental measurements were conducted in the laboratory of Department of Agricultural Machines, Faculty of Engineering at Czech University of Life Sciences in Prague. Calk ammonium nitrate (CAN) fertilizer delivered on the market under the trademark LAD27 was used (manufacturer Duslo, Inc., Šaľa). This is one of the most used fertilizers on fields in Slovakia. CAN is a grey-white ammonium nitrate granulate with fine grounded dolomite decreasing the fertilizers natural acidity. Fertilizer is protected by anti-caking surface treatment. CAN fertilizer is suitable for all kinds of field crops and soils in different agro-environmental conditions for basic fertilization or additional fertilization in vegetation time (www.duslo.sk). Chemical composition and grain-size distribution are shown in tables 1 and 2, respectively. Total weight of sample was 25 kg. From the sample there was taken 6 individual specimens of 0.5 kg weight. There were created 6 replications of measurement (n=6).

Table 1 – Chemical composition of Calk ammonium nitrate fertilizer

Technical specification	Content, %
Total nitrogen content (N)	27.0
Ammonium nitrogen content	13.5
Nitrate nitrogen content	13.5
Content of total magnesium oxide (MgO)	4.1
Content of magnesium oxide (MgO) soluble in water	1.0

Table 2 – Particle-size distribution of Calk ammonium nitrate fertilizer (Source: DUSLO, Inc.)

Dimension, mm	**Content of particles, %**
<1	max. 1
2 - 5	min. 90
>10	0

Fertilizers were separated at first by K-293 apparatus (figure 1 - left) in the vertical air flow stream with steeply increasing flow speed. The airflow speed was regulated by airflow volume from 60 to 150 $m^3.h^{-1}$. The step of next airflow speeds was set up for 10 $m^3.h^{-1}$.

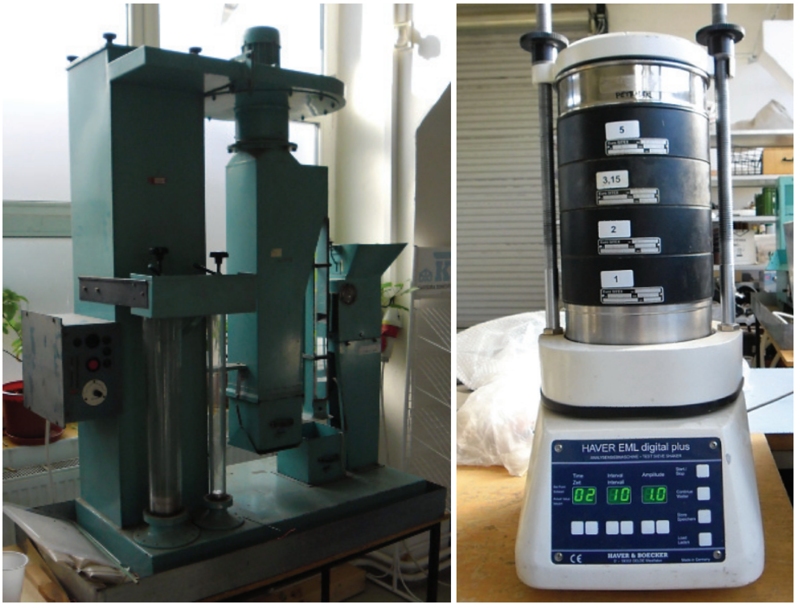

Figure 1 – K-293 Laboratory screening machine with vertical air flow (left) and Haver EML digital plus Test Sieve Shaker (right)

Secondary, there were conducted sieve analysis by Haver EML digital plus Test Sieve Shaker (figure 1- right) for every class of fertilizer sorting in the vertical airflow. Sieves with square holes with dimensions 1 mm, 2 mm, 3.15 mm, 5 and 10 mm were used. By this way samples of fertilizer were sorted into 6 classes of particles.

RESULTS AND DISCUSSION

Average values (six replication n=6) of obtained data are presented in table 3 where f_{im} (%) and f_{id} (%) means mass classes in percent of the specimen mass and percentage of the grain number in the total class particles.

Calk ammonium nitrate fertilizer content 98.05 % of particles with dimension from 3.15 mm to 5 mm and 99.44 % particles with dimension from 2 mm to 5 mm. Content of dust particles under 1 mm is lower than maximum allow value 1 %. Fertilizer contains no particles over 10 mm. Based on the results shown in table 3, Calk ammonium nitrate fertilizer is in conformity with the demanded range given by manufacturer and also meets the requirements of the national standards ČSN 01 5030. There is possible to replace sieve analysis by air flow analysis to separate class of particles with dimension from 3.15 mm to 5 mm by air flow speed 110 and 140 $m^3.h^{-1}$. Classical screen analysis can be replaced by aerodynamic particle testing and it can be used directly in evaluation of the aerodynamic spreading of the fertilizer in the field conditions.

Table 3 – Averaged relative weight frequencies of Calk ammonium nitrate fertilizer, (n=6)

$V, m^3.h^{-1}$		60	70	80	90	100	110	120	130	140	150
$v, m.s^{-1}$		7.32	8.54	9.76	10.98	12.2	13.42	14.64	15.86	17.08	18.30
f_{im}, %		0.21	0.27	0.32	0.35	1.20	8.58	34.59	35.96	16.59	1.69
f_{id}, %	< 1 mm	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1 - 2 mm	0.19	0.17	0.07	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	2 - 3.15 mm	0.01	0.08	0.24	0.26	0.35	0.40	0.05	0.01	0.00	0.00
	3.15 – 5 mm	0.00	0.00	0.00	0.07	0.84	8.74	34.39	35.85	16.49	1.67
	5 - 10 mm	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
	> 10 mm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

CONCLUSION

Calk ammonium nitrate fertilizer is in conformity with the demanded range given by manufacturer and also meets the requirements of the national standards ČSN 01 5030. There is possible to replace sieve analysis by air flow analysis to separate class of particles with different dimensions. Classical screening analysis can be replaced by aerodynamic particle testing and can be used directly in evaluation of the aerodynamic spreading of the fertilizer in the field conditions.

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