GRANULOMETRIC STUDY OF DASA® 26/13 FERTILISER

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ABSTRACT

Effectiveness of the spinning disc fertiliser spreaders is affected by the physical properties of the fertiliser. One of the most important factors is the fertiliser particle-size distribution which depends upon the size of the fertiliser particles. The aim of the paper was evaluation of the particle-size distribution of the fertiliser separated at first in the vertical air flow by K-293 Laboratory screening machine with steeply increasing flow speed. The airflow speed was regulated by airflow volume from 70 to 130 $m^3.h^{-1}$. Secondary separation was done 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. Fertiliser meets the requirements of the manufacturer for grain-size distribution.

Key words: fertilizer, particle, sorting, airflow

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INTRODUCTION

Fertilisation is an important factor that affects crop yields (Ložek et al., 1997; Kajanovičová et al., 2011). Effectiveness of the spinning disc fertiliser spreaders is affected by the physical properties of the fertiliser. Correct application of fertilisers has both positive economic and environmental effects (Nozdrovický et al., 2009; Šima et al., 2011; Šima et al., 2012a; Šima & Dubeňová, 2013; Šima et al., 2013a). Quality of work of the spinning disc fertiliser spreaders is affected by many factors (Macák & Nozdrovický, 2009; Šima et al., 2012b; Šima et al., 2012c). One of the most important factors is the fertiliser particle-size distribution which depends upon the size of the fertiliser particles (Macák et al., 2011; Macák & Nozdrovický, 2012). The differences and variability in physical properties of fertilisers causes problems during the field application by the commonest spinning disc fertiliser spreaders (Macák & Nozdrovický, 2010). The effectiveness of mineral fertilisers in plant cultivation depends upon the particle stability and speed of their transformation to a solution state acceptable for plants. This process depends upon the particle's dimension, so that the dimension of particles is one of the main parameters that influence fertiliser effectiveness (Krupička & Hanousek, 2006, Šima et al., 2012d, Šima et al., 2013b). The need for using fewer amounts of fertiliser means that it must be applied in the right way, and fertiliser losses are reduced to an absolute minimum. An optimal application of fertilisers, minimisation of the spoilage of fertilisers, improvement of existing and development of possible new application techniques, all requires a detailed knowledge of the processes and factors that affect the spreading of fertilisers (Hofstee, 1993).

The aim of the paper is the study of the granulometric composition of granulated nitrogen fertiliser with sulphur content DASA® 26/13 when vertical airflow and sieve separation are used.

MATERIAL AND METHODS

Experimental measurements were conducted in the laboratory of the Department of Agricultural Machines, Faculty of Engineering at Czech University of Life Sciences in Prague, Czech Republic. During experiments we have used granulated nitrogen fertiliser with sulphur content DASA® 26/13. Nitrogen is in an ammonium and nitrate form and sulphur is in a water-soluble sulphate form. The granulate has a pink to brown colour and surface treated by a coating agent. Manufacturer of fertiliser is DUSLO, Inc. The chemical composition of DASA® 26/13 fertiliser is presented in Table 1. Grain-size distribution of DASA® 26/13 fertiliser declared by manufacturer is shown in Table 2.

Tab. 1 Chemical composition of DASA® 26/13 fertiliser

Technical specification	Content, %
total nitrogen content (N)	26
ammonium nitrogen content	18.5
nitrate nitrogen content	7.5
sulphur (S) soluble in water	13

Tab. 2 Grain-size distribution of the DASA® 26/13 fertiliser declared by manufacturer

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

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).

Fertilisers were separated at first by K-293 apparatus in the vertical air flow stream with steeply increasing flow speed. The airflow speed was regulated by airflow volume from 70 to 130 $m^3.h^{-1}$. The next step of airflow speeds was set up for 10 $m^3.h^{-1}$.

Fig. 1 Laboratory screening machine K-293 with vertical air flow (left)and Haver EML digital plus Test SieveShaker (right)

Secondary, there were conducted sieve analyses by Haver EML digital plus Test Sieve Shaker for every class of fertiliser 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 method, the samples of fertiliser were sorted into 6 classes of particles.

RESULT AND DISCUSSION

Average values (six replication n = 6) of obtained data for DASA® 26/13 fertiliser are presented in table 3. There where f_{id} (%) and f_{im} (%) means mass classes in percent of the specimen mass and percentage of the grain number in the total class particles.

Tab. 3 Averaged relative weight frequencies of DASA® 26/13 fertiliser, (n=6)

V, m^3 h^{-1}		70	80	90	100	110	120	130
v, m s^{-1}		8.54	9.76	10.98	12.2	13.42	14.64	15.86
f_{im}, %		0.27	0.32	0.35	1.20	8.58	34.59	35.96
f_{id}, %	<1 mm	0	0	0	0	0	0	0
	1–2 mm	0.1	0.1	0	0	0	0	0
	2–3.15 mm	0.04	0.19	0.99	2.94	0.83	0	0
	3.15–5 mm	0	0	1.48	14.07	41.04	26.69	8.11
	5–10 mm	0	0	0	0	0.38	1.12	1.92
	>10 mm	0	0	0	0	0	0	0

f_{im} – grain number in the total class particles, f_{id} – mass classes in percent of the specimen mass, V – airflow quantity, v – airflow speed.

DASA® 26/13 fertiliser content 96.37% particles with dimension from 2 to 5 mm, respectively. Fertiliser contain no particles under 1 mm and no particles over 10 mm. Based on these results, particle-size distribution of DASA® 26/13 fertiliser is in conformity with the demanded range given by the manufacturer and also meets the requirements of national standards. The content of fertiliser particles less than 1 mm (dust particles) may be caused by minimal manipulation with the fertiliser bags. Fertiliser was packed into polyethylene bags containing 25 kg of the fertiliser.

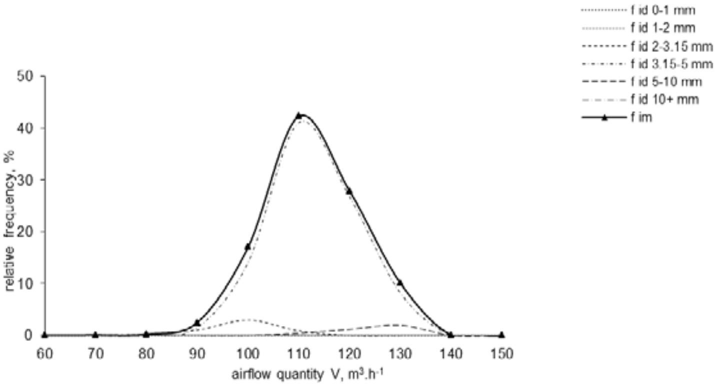

Fig. 3 The effect of airflow quantity on the relative weight frequencies of DASA® 26/13 fertiliser particles. Where: f_{im} – grain number in the total class particles, f_{id} – mass classes in percent of the specimen mass.

There is the possibility to replace sieve analysis by air flow analysis to separate the class of particles with dimension from 3.15 mm to 5 mm by air flow speed from 90 to 130 $m^3.h^{-1}$ for DASA® 26/13 fertiliser. The effect of the airflow quantity on relative weight frequencies of DASA® 26/13 fertiliser particles f_{im} and f_{id} is shown in the figure 3. Most used method for detection of the fertiliser size distribution is screen analysis. This method can be replaced by photo-optical image analysis (Macák & Nozdrovický, 2010b) and aerodynamic particle testing. Classical screen analysis can be replaced by aerodynamic particle testing and it can be used directly in evaluation of the aerodynamic spreading of the fertiliser in the field conditions. Photo-optical analysis may be used for monitoring of particle-size distribution of fertilisers, but only by screen analysis and aerodynamic particle testing is it possible to separate particles.

CONCLUSIONS

The main objective of experiment was the study of granulometric composition of granulated nitrogen fertiliser with sulphur content DASA® 26/13 from DUSLO, Inc. manufacturer. For the separation of particles, vertical airflow and sieve separation were used. Fertiliser meets the requirements of the national standards and is in conformity with the demanded range given by the manufacturer. Classical screen analysis can be replaced by photo-optical analysis for the monitoring of grain-size distribution of fertilisers. To separate the particles of fertiliser it is possible to use screen analysis or aerodynamic particle testing.

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