Granulometric study of Synferta N-22 and Synferta N-17

J. Krupička, B. Hanousek

Department of Agricultural Machines, Technical Faculty, Czech University of Agriculture in Prague, Prague, Czech Republic

Abstract: Physical properties of commercial fertilizers play important role from precision application point of view. Granulometric evaluation is usually performed by sieve separation according ČSN 01 5030 standard. The main subject of this work is the presentation of separation results when vertical airflow is used.

Keywords: granulometry; fertilizer; airflow; sorting; particle

The effectiveness of mineral fertilizers in plant cultivation depends on the particle stability and speed of their transformation to solution state to be acceptable by plants. This process depends on the particles dimensions, so that the dimension of particles is one of the main parameters that influence the fertilizer effectiveness.

Application of solid commercial fertilizers plays important role in precision farming technologies. The application quality is dependent on chemical composition and physical properties of fertilizer (Jager & Hegner 1987). Important from physical properties point of view is the grading of aggregate evaluation (Bartoš & Waradzin 1981) that is still performed by standard ČSN 01 5030. The dimension of particulars only is characterized by this way.

In this paper we continue in the previous research program, in which the granulometric study Synferta-P, Synferta N-17 and Synferta N-22 were studied. In contrary to the similar study of other authors screen and airflow sorting were combined.

This paper contains results obtained by this method is applied to two mineral fertilizers Synferta N-17 and Synferta N-22.

Particles are preferably a readily soluble material that, after distribution of the granules in the soil, releases the nitrogen source particles to permit the action of water and microorganisms on the particles (Allan *et al.* 1989). Experiments with particles can be designed differently. An elutriator was designed and constructed in which an airflow is supplied by a centrifugal fan (Csizmazia 2000). Methods for measuring the coefficient of friction, the coefficient of restitution, the aerodynamic resistance coefficient, and the breaking force (particle strength) of fertilizers (Hofstee 1992) were taken into account. The breaking force feature was skipped. The problem of particle destruction was overcome by fertilizer Synferta selection. Opposite solution was studied in Japan. The control of fertilizer discharge was studied for different designs of distributors and an experimental accurate fertilizer distributor with a rotary vessel type feeder was developed (Kudoh 1989) what shows that dissolution of fertilizer also makes some problems. Consequent logistical problems are equally difficult for both pumping liquids, and transportation of particles by the air.

The size of particles makes the fertilizer's shelf life and stability of particulars behaviour in the airflow more stable in storage and better acceptable by the plant. Synferta is the most suitable fertilizer for purposes of precision farming for its resistance against particle destruction in the airflow. Therefore, experiments studying motion of particles through the air were accompanied by grading of particles.

This paper contains results obtained for two mineral fertilizers Synferta N-17 and Synferta N-22 using the method developed previously.

MATERIAL AND METHODS

Experimental material was supplied by its producer Synthesia Pardubice. Total weight of the supplier sample was 25 kg. The sample was divided

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Table 1. Averaged relative weight frequencies of Synferta N-22 fertilizer (n = 8)

V (m^3/h)		65	75	85	95	105	115	125	135
v (m/s)		7.94	9.15	10.37	11.60	12.82	14.04	15.26	–
f_{im} (%)		0.172	1.504	6.485	22.732	34.255	25.193	8.881	0.5
f_{id} (%)	< 2 mm	0.05	0.12	0.05	0.004	–	–	–	–
	2–3 mm	0.12	1.27	5.32	12.68	11.54	2.11	0.16	–
	3–5 mm	–	0.11	1.12	9.97	22.44	22.72	8.41	0.43
	> 5 mm	–	–	–	0.08	0.28	0.36	0.31	0.07

Table 2. Averaged relative weight frequencies of Synferta N-17 fertilizer

V (m^3/h)		80	90	100	110	120	130	135	140
v (m/s)		9.76	10.98	12.20	13.42	14.64	15.87	16.48	17.09
f_{im} (%)		0.16	1.36	10.14	26.53	44.20	13.22	3.60	0.75
f_{id} (%)	< 2 mm	0.08	0.00	0.00	0.02	0.03	1.35	0.00	0.00
	2–3 mm	0.09	0.86	4.06	5.75	2.91	0.20	0.01	0.00
	3–5 mm	0.04	0.50	6.06	20.72	4.08	12.94	3.51	0.70
	> 5 mm	0.03	0.00	0.04	0.07	0.21	0.13	0.10	0.07

into 8 individual specimens of 0.5 kg weight that was measured repeatedly. The homogenization of the individual specimens was saved by previous mixing of the sample and then by stochastic composite sampling (ten parts per specimen). The specimens were separated at first in the vertical air flow stream with steeply increasing flow speed. The airflow speed was regulated by airflow volume between 65 to 135 m^3/h and between 80 to 140 m^3/h for Synferta N-22. The steps of airflow speeds are given in Tables 1 and 2. The results of this separation were expressed by the mass classes f_{im} in percent of the specimen mass. Every class of the specimen was than sieved on the sieves with holes 2 mm, 3.5 mm, and 5 mm resulting four new subclasses characterized by the sieve mesh dimension. They were marked as f_{id} expressed by percentage of the grain number in the total class particles.

RESULTS

Mean values of the obtained data: f_{im} (%) (based on 0.5 kg specimen) and f_{id} (%) are presented in Tables 1 and 2. The averages were calculated from

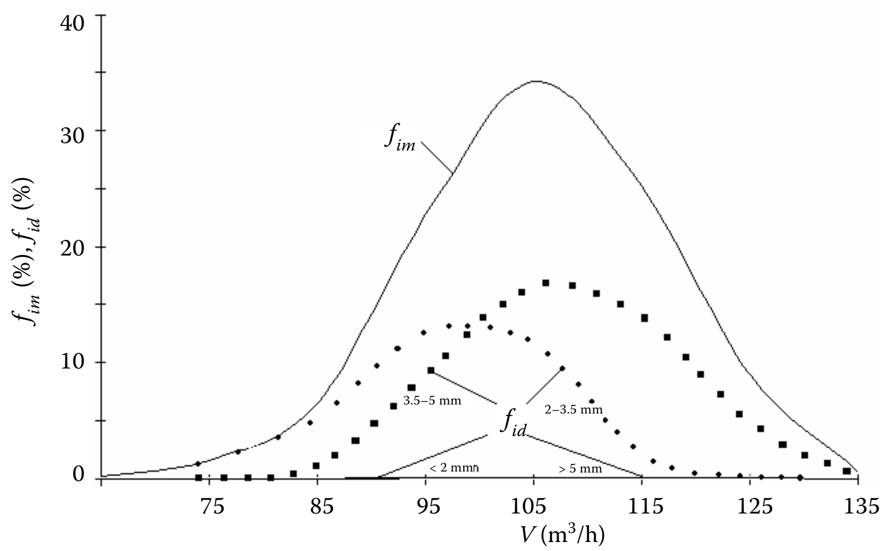

Figure1. The dependence of relative weight frequencies of particles f_{im} (%) and f_{id} (%) on the airflow quantity V (m^3/h)

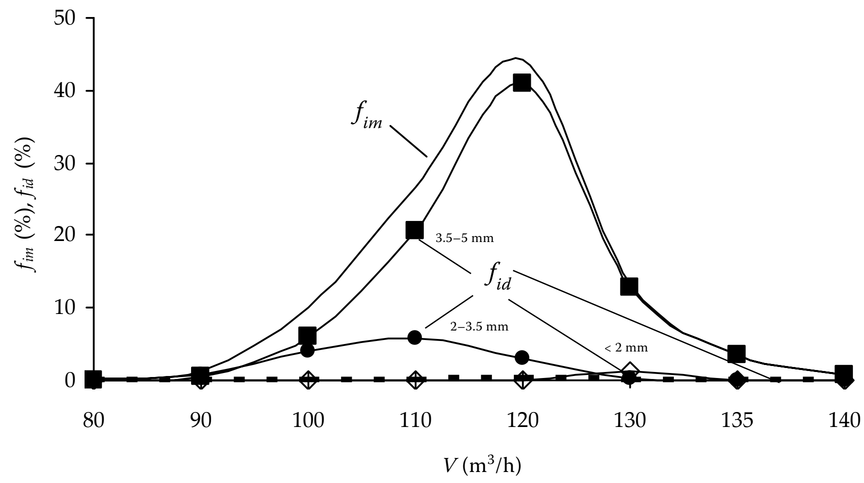

Figure 2. The dependence of relative weight frequencies f_{im} (%) and f_{id} (%) on the airflow quantity V (m^3/h)

measurements repeated eight times. The results are graphically presented in Figures 1 and 2.

It was achieved by statistical evaluation that relative frequencies are in agreement with N-distribution. It is clear from achieved values that in fertilizer samples there are in Synferta N-22 33.2% of particles with dimension from 2 to 3.5 mm and 65.2% with dimension from 3.5 to 5 mm. In fertilizer Synferta N-17 there are 13.88% of particles with dimension from 2 to 3.5 mm and 85.55% with dimension from 3.5 to 5 mm. It means that 98.4% particles of Synferta N-22 and 99.43% of particles of Synferta N-17 are between 2 and 5 mm and this is in agreement with the demanded range (ČSN 01 5030).

The method that was used for the critical airflow speeds is applicable for different dimensions and weights of particles groups. The method could be used in this form also for determination of the critical airflow speeds in case of other products in form of particles. In our case the mean critical speed v_k = 12.2 m/s (coefficient of variation CV = 25%) was determined for Synferta N-22. The same value Synferta N-17 is 13.80 m/s (CV = 20%). The mean critical speeds, standard deviations, and CVs were derived for significant groups of particles. The mean critical airflow speed v_k = 11.59 m/s (CV = 17%) was found for group of Synferta N-22 particles with size from 2 to 3.5 mm ignoring marginal relative occurrence smaller then 0.7%. Values v_k = 13.42 m/s (CV = 17%) were calculated for group 3.5 to 5 mm ranked of Synferta N-22 particles. Mean critical airflow speed v_k = 12.81 m/s (CV = 13%) is valid for Synferta N-17 particles with size 2 to 3.5 mm. The same value for particles 3.5 to 5 mm is v_k = 14.96 m/s (CV = 13%).

CONCLUSION

Classical screen analysis was enriched by aerodynamic particle testing that can be used directly in evaluation of the aerodynamic spreading of the fertilizer in the field conditions. The data for two tested fertilizers are in agreement with demanded range.

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Abstrakt

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Z hlediska precizní aplikace granulovaných minerálních hnojiv hrají významnou roli jejich fyzikální vlastnosti a granulometrické složení, které se určuje soustavou sít podle ČSN 01 5030. Článek obsahuje výsledky třídění granulí hnojiv Synferta N-17 a Synferta N–22 podle jejich hmotnosti ve vertikálním vzduchovém proudu.

Klíčová slova: granulometrie; hnojivo; vzduchový proud; třídění; částice

Corresponding author:

Ing. Josef Krupička, CSc., Česká zemědělská univerzita v Praze, Technická fakulta, Kamýcká 129,
165 21 Praha 6-Suchdol, Česká republika
tel.: + 420 224 383 127, fax: + 420 234 381 828, e-mail: krup@tf.czu.cz