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THE COST EFFICIENCY OF HIGHER DOSES OF COMPOST APPLICATION

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Abstract

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Application of higher doses of compost has several technical problems at the same time. Compost application at higher doses required relatively high consumption of working time deployed machinery. That is mainly affected loading capacity of the spreaders. Standard is a spreader with a loading capacity of 5–10 t, for higher capacity it is necessary to monitor the influence of the chassis to a higher soil compaction, especially in wheel tracks. This paper deals with determination of the cost of application for spreading compost at high doses 60–100 t.ha^{-1}. From the proven data of performance, acquisition costs of machinery and fuel consumption were determined hectare costs for the spreader of carrying capacity 5, 8, 10 a 15 t and transport distances corresponding to an area of 8–100 hectares of fertilized land. Costs were determined by using the program AGROTEKIS, by using the database machines, manufacturers data and other available data, direct measurements and related experiments. Application costs for the dose 60 t.ha^{-1} are 2 100–5 250 CZK.ha^{-1}, for the dose 80 t.ha^{-1} are 2 750–7 000 CZK.ha^{-1}and for the dose 100 t.ha^{-1} are 2 650–8 650 CZK.ha^{-1}. The results are useful for quick and easy calculation of costs for fertilizing with higher doses of compost and deciding on the selection of used spreader.

compost, spreader, costs of application, compost fertilizing

During farming on soil, nutrient depletion occurs gradually. These nutrients must be replenished periodically. Agricultural practice is often just application industrial fertilizers. That is subsequently reflected on the degradation of soil properties, especially a higher degree of the soil compaction and reduced retention capacity of the soil profile (BADALÍKOVÁ, HRUBÝ, 2008). The way to improve the physical and chemical properties of soil is extensive use of organic fertilizers, which have influence on the plant nutrition, but also contribute significantly to improving the quality of the soil sorption capacity. MEIER, PLOEGER, VOGTMANN (2003) state that the increase of humus content of 0.2% causes an average increase of available water capacity of 0.5% and a pore volume of 1%. HALL *et al.*, 1977, In: MERRINGTON *et al.*, 2006; reported a positive correlation between the retention capacity of the soil with content of organic matter and negative with bulk density of soil. The Efforts to systematic processing of all kinds of biodegradable waste from agriculture, processing industry and from the municipal sector are reflected in the development of composting technology. The produced compost is a stable material, with a high proportion of organic matter, that reliably contribute to the formation of soil humus (BADALÍKOVÁ, HRUBÝ, 2008). KASPEROVÁ, JANDOVÁ *et al.* (2006) state that are considered to be the most effective in this regard especially application of higher doses of compost, that are to say doses above 50 t.ha^{-1}. Retention capacity of the soil significantly increased at doses 90 t.ha^{-1}, monitored is also the impacts of doses 120–150 t.ha^{-1} (MAREŠOVÁ, 2009). But application of higher doses of compost also has several technical problems at the same time. Compost application at higher doses required relatively high consumption of working time deployed machinery. That is mainly affected loading capacity of the spreaders. Standard is a spreader with a loading capacity of 5–10 t, for higher capacity it is necessary to monitor the influence of the chassis

to a higher soil compaction, especially in wheel tracks (HŮLA, 1997). Influence on the performance of the load off the spreader especially land area. In many cases, is the requirement to ensure high performance application and defray in short agrotechnical time limits also limited by weather. Procedures for the application of higher doses of compost are costly, therefore farmers are looking for opportunities to carry out preliminary calculating of costs. These calculations allow them to decide on the choice of used machinery or the use of existing services.The available papers dealing with this issue are for example ABRHAM (1998), KOVAŘÍČEK (2005). Practice requirement is that the calculations have to be based on the fair value and easy to use.

Of the practically applicable methods for quick and affordable cost calculating certifies normative systems, available as data, elaborated by KAVKA (2006) or ABRHAM (2004). SYROVÝ (2008) elaborated normative for application and incorporation relative to 1 t of fertilizer for doses 20–50 $t.ha^{-1}$.

The aim of this paper is to process the cost evaluation of the machines application of compost in doses 60, 80 and 100 $t.ha^{-1}$ according to used of spreaders and land area.

MATERIALS AND METHODS

The choice of technical equipment

The choice of the compost spreaders for application is based on loading capacity (which is given by the type of chassis sizes and loading volume. The choice of machinery for the row cultures is given by width of the inter row and passability. From the width of the inter row, which is at most vineyards about 3.0 m, for orchards 5–6 m, is derived the choice of the spreader. The machine width essentially determines its capacity. The requirement for aggregation decides carrying capacity of the spreader and terrain of the fertilized land (plain x slope), according to which is selected the tractor with the required performance and driveability (4 × 2–4 × 4).

Entry conditions for the determination of costs

For the purposes of economic evaluation is an important indication of the cost spreader and tractor, driver's salary, the range of annual deployment of the tractor and spreader etc. From the technical parameters of the most important is achieved performance, which is influenced by the loading capacity and applied dose (the performance of compost application in a row cultures is also influenced by the relief of the terrain and length of rows). The spreaders performance is significantly affected by the acreage of fertilized area. For high doses application of compost is very important the transporting distance to land, which respects rightly acreage of fertilized area – for example, a square of size 30 ha has an approximate traveling distance to the center 400 m, in rectangular shapes can be the distance calculated easily. The results of the cost calculations are then given in dependence on this distance.

Determining the technical-economic parameters monitored machines

The application procedure consists of three basic working operations is compost loading, transport and spreading. Applied compost has a bulk density 0.55–0.60 $t.m^{-3}$. To determine the cost were used time monitoring of several different machines with different loading capacity conducted between 2009–2011. Monitored were mostly machine performance and fuel consumption, further price of the machines and mechanized works costs.

By time monitoring were measured these spreaders:

- SIP ORION – 60 H PRO – loading capacity 4.2 t
- PÖ 6001 – loading capacity 5.2 t
- RA100 AGS Pelhřimov – loading capacity 10 t
- MC 186 ZDT Nové Veselí – loading capacity 10.5 t
- STROM export TS 21000 – loading capacity 14.0 t
- STROM export TSW 521 OS – loading capacity 16.0 t.

Determination of the the cost of compost application

Costs were determined by using the program AGROTEKIS, by using the database machines, manufacturers data and other available data, direct measurements and related experiments. Purchase prices of the spreaders were entered as the average values in each category.

For a spreaders with carrying capacity 5, 8, 10 and 15 tones were performed calculations per hectare costs for doses 60, 80 and 100 $t.ha^{-1}$. Variable parameters were further transporting distance to the center of fertilized area, respecting the achieved performance by land acreage. For the purposes of determining the operational costs of the application of compost at different doses by different spreaders were data processed in the tables for the resulting cost values in $CZK.ha^{-1}$. Knowing the area of land and the required dosage of the user can determine the cost of application for the used spreader easily. For a more comprehensive option cost calculating were also determinated costs for incorporation to the soil ($CZK.ha^{-1}$) according to the type of machine.

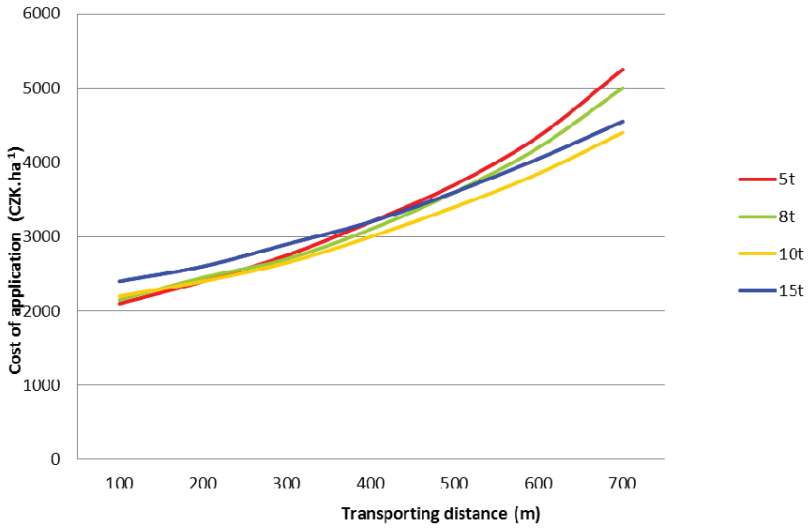
RESULTS AND DISCUSSION

The resulting cost values in $CZK.ha^{-1}$ for a spreader with loading capacity of 5 t, 8 t, 10 t and 15 t with transporting distances 100–700 m (acreage 2–100 ha) are shown Table I–III and Graph 1–3.

Determine the cost of compost application by using standard methods, therefore to calculate the hourly cost and by performance (by type spreader and dose) converted them to a cost per acre, is for

I: *The cost of compost distribution on land and spreading, depending on the size of the area and loading capacity of the spreader*

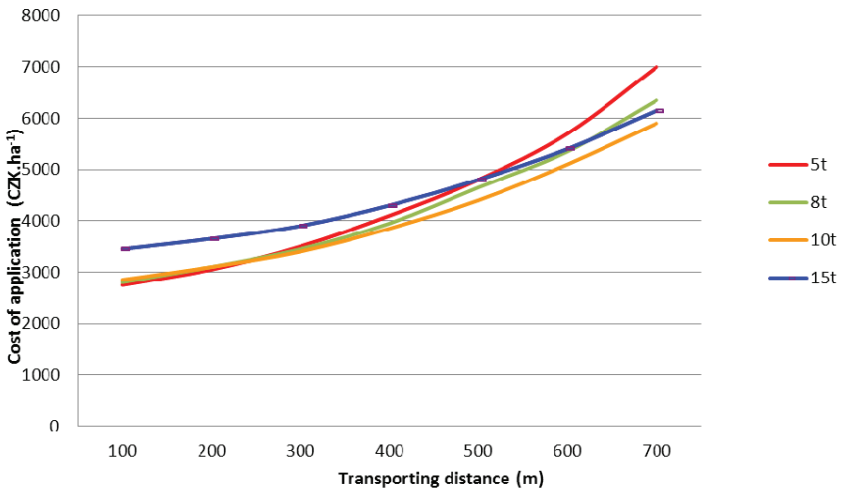
Dose 60 t.ha^{-1}	Transporting distance (m)						
Carrying capacity (t)	100	200	300	400	500	600	700
	Cost of application (CZK.ha^{-1})						
5	2 100	2 400	2 750	3 200	3 700	4 350	5 250
8	2 150	2 450	2 700	3 100	3 600	4 200	5 000
10	2 200	2 400	2 650	3 000	3 400	3 850	4 400
15	2 400	2 600	2 900	3 200	3 600	4 050	4 550



1: *The costs curves of distribution and spreading of compost–dose 60 t.ha^{-1}*

II: *The cost of compost distribution on land and spreading, depending on the size of the area and loading capacity of the spreader*

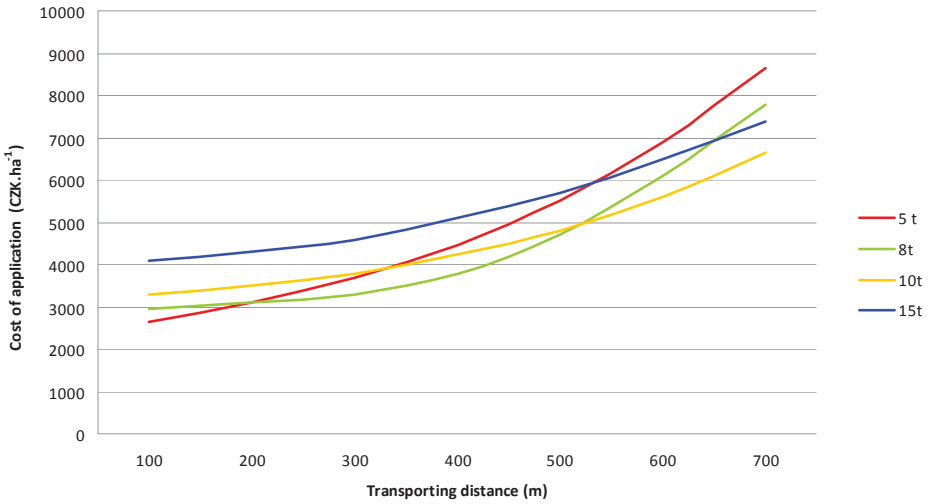
Dose 80 t.ha^{-1}	Transporting distance (m)						
Carrying capacity (t)	100	200	300	400	500	600	700
	Cost of application (CZK.ha^{-1})						
5	2 750	3 050	3 500	4 100	4 800	5 700	7 000
8	2 800	3 100	3 450	3 950	4 650	5 350	6 350
10	2 850	3 100	3 400	3 850	4 400	5 100	5 900
15	3 450	3 650	3 900	4 300	4 800	5 400	6 150



2: *The costs curves of distribution and spreading of compost–dose 80 t.ha^{-1}*

III: *The cost of compost distribution on land and spreading, depending on the size of the area and loading capacity of the spreader*

Dose 100 t.ha^{-1}	Transporting distance (m)						
Carrying capacity (t)	100	200	300	400	500	600	700
	Cost of application (CZK.ha^{-1})						
5	2 650	3 100	3 700	4 450	5 500	6 900	8 650
8	2 950	3 100	3 300	3 800	4 700	6 100	7 800
10	3 300	3 500	3 800	4 250	4 800	5 600	6 650
15	4 100	4 300	4 600	5 100	5 700	6 500	7 400



3: *The costs curves of distribution and spreading of compost–dose 100 t.ha^{-1}*

high doses of compost more complicated specifically because of the significant influence of size on the performance of fertilized areas. Cost modeling is necessary to carry out specifically for each evaluated case. During an effort to generalize the application conditions and determine costs in CZK.ha^{-1} for simple calculations, was effect expressed by the value of land acreage distance the center of the parcel that can be for areas of regular shapes easily determined, or for more complicated shaped parcel deducted from the map. Any small inaccuracy will affect the resulting cost only minimally. User knows the acreage of land required dose of compost, knows the loading capacity of the spreader and according to the shape of area can determinate the transporting distance the center of the parcel. From these data can be easily readable cost of the application (CZK.ha^{-1}). Similarly, is the determination of the cost of the incorporation. According to the total area can user determinate the total cost for application of compost and incorporation.

From the data stated by ABRHAM (1998) shows, that the determined costs, without specifying distance, reached for a dose 60 t.ha^{-1} for the spreader with carrying capacity 5 t amount 3 900 CZK.ha^{-1} and for the spreader with carrying capacity 5 t amount 3 750 CZK.ha^{-1}. BURG (2009) performed cost calculation with changing particular labor intensity of application for various doses and performance for incorporation of compost disk tiller. Application costs for transporting distance 2 km and area 20 ha reached for the dose 60 t.ha^{-1} 4 428 CZK.ha^{-1} and for dose 90 t.ha^{-1} 6 542 CZK.ha^{-1}.

Graph 1 indicates for the dose 60 t.ha^{-1} only small cost differences for the different carrying capacity of the spreaders for areas up to 30 ha. The reason is a balanced proportion of higher depreciation and higher performance of spreaders with carrying capacity 10 and 15 t. At areas with acreage more 30 ha is the higher efficiency of larger spreaders reducing costs.

For the dose 80 t.ha^{-1} differences in carrying capacity spreaders show up from the 50 ha. For the dose 100 t.ha^{-1} are these differences more significant. The Graph 3 also shows that the increase in carrying capacity of the spreader from 10 to 15 t is reflected by reducing costs at the area from 50 ha (performance improvement does not cover the higher cost of the more expensive spreaders depreciation). Knowledge of the cost course may be basis for the choice of spreaders for the acreage of land.

CONCLUSION

This paper deals with determination of the cost of application for spreading compost at doses 60, 80 and 100 t.ha^{-1}. Results by using techno-economic data of monitored machines allowed to prepare an overview of costs per hectare for

different carrying capacity spreaders (8–15 t) and for different acreage given by the transporting distances. The results are useful for quick and easy calculation of costs for fertilizing with higher doses of compost and deciding on the selection of used spreader. Application costs for the dose 60 $t.ha^{-1}$ are 2 100–5 250 $CZK.ha^{-1}$, for the dose 80 $t.ha^{-1}$ are 2 750–7 000 $CZK.ha^{-1}$and for the dose 100 $t.ha^{-1}$ are 2 650–8 650 $CZK.ha^{-1}$. Knowledge of the cost may be basis for the choice spreaders for the acreage of land.

SUMMARY

This paper deals with determination of the cost of application for spreading compost at high doses 60–100 $t.ha^{-1}$. From the proven data of performance, acquisition costs of machinery and fuel consumption were determined hectare costs for the spreader of carrying capacity 5, 8, 10 and 15 t and transport distances corresponding to an area of 8–100 hectares of fertilized land. Results show, that for the dose 60 $t.ha^{-1}$ only small cost differences for the different carrying capacity of the spreaders for areas up to 30 ha. The reason is a balanced proportion of higher depreciation and higher performance of spreaders with carrying capacity 10 and 15 t. At areas with acreage more 30 ha is the higher efficiency of larger spreaders reducing costs. For the dose 80 $t.ha^{-1}$ differences in carrying capacity spreaders show up from the 50 ha. For the dose 100 $t.ha^{-1}$ are these differences more significant.

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