CIRCWASTE
Deliverable C.8.2.3

Summary of the properties of the organic fertilizers included in demonstrations

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Contents

1. Introduction

Precision farming practices benefit if different nutrients from different fertilizers can be brought together and applied as individual fertilizer mixes to plants according to their site-specific and timely needs. Liquid form fertilizers are a good alternative as additional nutrient source in precision application, since the liquid tanks can be installed fairly freely to the machinery combinations and the fertilizers can be conducted to desired place in application system through hosing. Liquids are also easy to dose accurately. In some cases, liquid nitrogen fertilizers are also applied to the cereal growth as so called split application during the growing season to raise protein content of grain or to minimize nitrogen residues in the soil in such field sites which have yield risks. There have not been many liquid fertilizers in the market in Finland to fulfil the need of precision farming, so the possibility to use recycled liquid fertilizers is very interesting. However, these fertilizers are rather new in the market and they have not been tested and experimented in farm scale, especially in precision farming.

In the CIRCWASTE demonstration in 2017 and 2018 used fertilizers were taken under close analysis. The fertilizers were recycled ammonium sulphate (AMS), produced by Envor Group Oy, and Bio-Kali, produced by Finnamyl Oy. AMS was used as a source of nitrogen (N) and sulfur (S). Bio-Kali was used as a source of potassium (K). AMS and Bio-Kali were delivered in industrial IBC chemical plastic containers of 1 m^3 volume (Figure 1). There were two kind of Bio-Kali used in the demonstration; so called raw Bio-Kali and pooled Bio-Kali (Figure 2). The pooled Bio-Kali contained some small particles from surrounding trees or vegetation, i.e. tree seeds, which caused difficulties in field operation by blocking the sieves of liquid bumping system. Thus, most of the pooled Bio-Kali was applied and analyzed after sieving the blocking particles out.

Fig. 1. AMS container on the CIRCWASTE combined seed driller system.

Fig. 2. Bio-Kali containers in the storage. The dark containers contain so called raw Bio-Kali (left) and the lighter colored contained pooled Bio-Kali (right).

2. Samples for laboratory analysis

Samples for chemical analysis were collected in the field right before starting the seeding and fertilizing operation. Before taking the sample (and before the field operation), the liquid in the container was mixed with a stick. The samples were ladled to 0,5 l plastic bottles and stored in cool temperature (cooler in the field and fridge in lab) before sending to laboratory analysis (Figure 3 and 4). In 2017 four samples of Bio-Kali were taken during spring demonstrations, of which 3 as duplicates, with remarks A and B. The A samples were sent to the laboratory analysis soon after the demonstration. The B samples were stored over summer in temperatures varying from 5 to 25 C°, but covered from sunshine, imitating possible storing conditions in farms during the summer. At autumn demonstration the other two Bio-Kali samples were taken, also as duplicates A and B. Again, the A samples were sent to laboratory analysis right away, together with the B samples from the spring, and new B samples were stored now over the winter. The storing temperature during the winter varied between 10 and -10 C°, and the samples were covered from direct sunshine. During the demonstration of spring 2018, three single Bio-Kali samples were collected and sent to the analysis together with the B samples from the autumn.

At the same time as Bio-Kali samples, also AMS samples were collected, stored and taken to laboratory analysis similarly as Bio-Kali samples as follows: spring 2017: 3 samples of which 1 as a duplicate (A and B samples); autumn 2017: 2 samples were taken of which 1 sample as a duplicate; spring 2018: 4 samples were taken as singles.

The chemical analysis was carried out by SeiLab Oy in Seinäjoki.

Fig. 3. Collecting Bio-Kali samples before the field operation. The Bio-Kali was mixed well before starting the field operation.

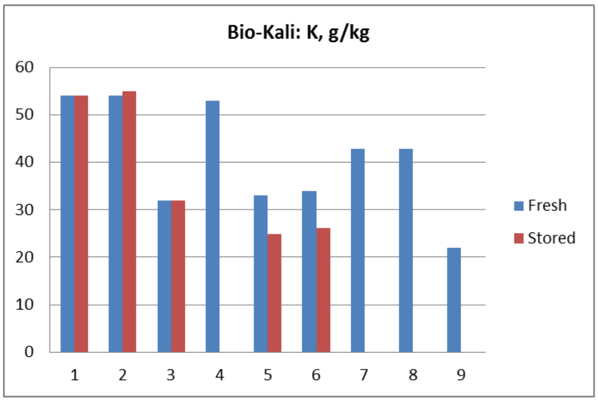
Fig. 4. Bio-Kali containers on the front of the picture and an AMS container on the seeding machine in the service area of the Toivon Tila demonstration site.

3. Results

According to the chemical analyses carried out in the demonstration of 2017, raw Bio-Kali's pH was around 5,4-5,6, potassium content 5,4-5,5 % and dry matter content 32 %. Pooled Bio-Kali's pH was 5,4-5,6, potassium content 3,2-3,4 % and dry matter content 17,4-18,5 %. The measured nitrogen and phosphorous contents in the raw Bio-Kali were 1,06-1,15 % total N (1,04-1,08 % soluble N) and 0,37-0,40 % total P (0,32-0,37 % soluble P). The pooled Bio-Kali contained 0,5 11[1] % total N, where low values from represented sieved Bio-Kali. The soluble N content was 0,32-0,45 %. Total P of pooled Bio-Kali was 0,22 % P (0,19-0,2 % soluble P). Raw Bio-Kali needed more mixing before the use than the pooled one due to stratification (see Figure 2).

According to the chemical analyses carried out from the fertilizer samples from 2018 demonstrations, Bio-Kali's (raw) pH was around 4,4-5,5, potassium content 2,2-4,3 % and dry matter content 34 %. Also, the measured nitrogen and phosphorous contents in the raw Bio-Kali were 1 % N (0,98 % soluble) and 0,18-0,34 % P (0,16-0,31 % soluble). Bio-Kali needed mixing before the use. In the demonstration used AMS contained 7,7 % of N, all in a soluble form.

Figures 5a and 5b illustrate total potassium (K) and dry matter contents of all analysed Bio-Kali samples. Figures 6a and 6b show results of total N and P in Bio-Kali samples. Samples 3, 5 and 6 are pooled Bio-Kali samples.



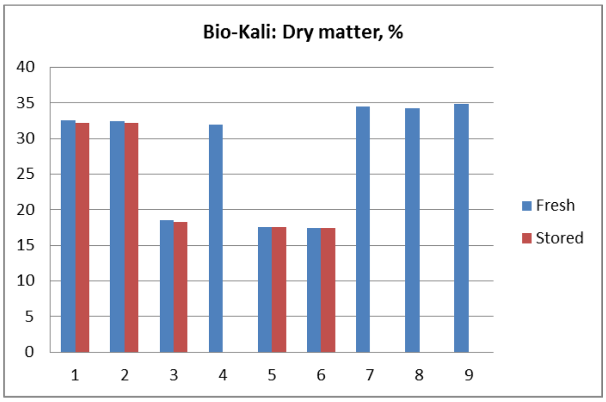


Fig. 5a and 5b. Total potassium (K) and dry matter contents of all analysed Bio-Kali samples. Samples 3, 5 and 6 are pooled Bio-Kali samples, 5 and 6 were also sieved before sample collection.

[1] It is obvious that one of the pooled, not sieved Bio-Kali samples had contained perhaps an extraordinary nitrogen rich clod.

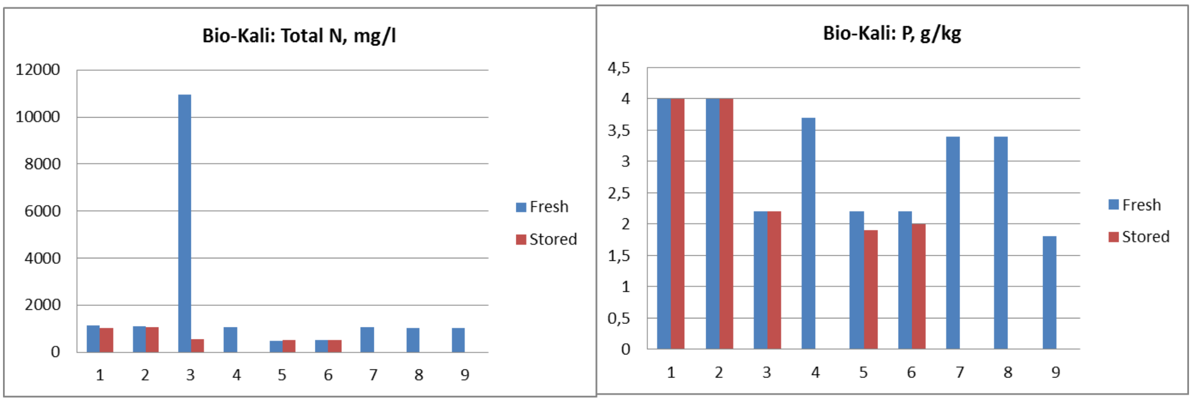


Fig. 6a and 6b. Results of total N and P in Bio-Kali samples. Samples 3, 5 and 6 are pooled Bio-Kali samples, 5 and 6 were also sieved before sample collection.

Figures 7a and 7b illustrate total and soluble nitrogen (N) contents of all analysed AMS samples. Figures 8a and 8b show results pH and electric conductivity of the samples.

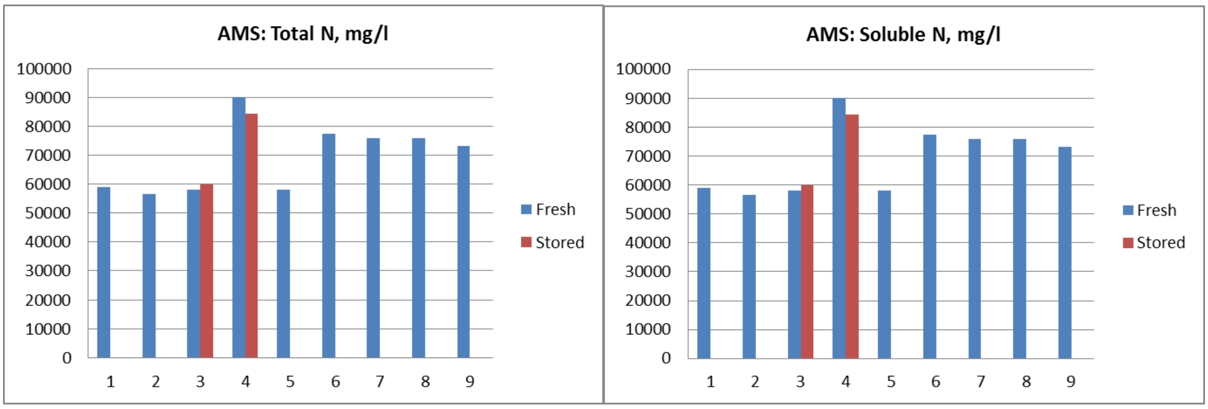


Fig. 7a and 7b. Total and soluble nitrogen (N) contents of all analysed AMS samples.

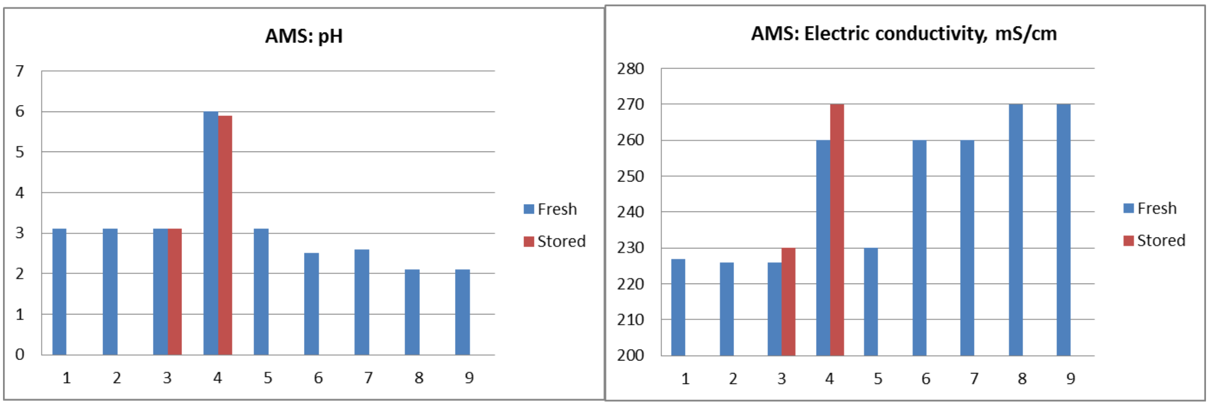


Fig. 8a and 8b. Results pH and electric conductivity of the AMS samples.

As summary, the nutrient contents between different AMS and Bio-Kali containers varied in some extent. Nitrogen in AMS varied from 5,6-9 % (Table 1) and potassium in Bio-Kali from 2-5,4 %, pooled Bio-Kali having the lowest potassium content (Table 2). The storing, either in summer time or over the winter, did not affect the nutrient content, at least when stored in small airtight bottles. However, the liquid fertilizers should be protected against freezing to avoid breaking the containers when frozen liquid expands. And, Bio-Kali should be stored in a cool place to minimize its microbial activity, which may occur in large containers, especially when the container is partly empty and contains lot of air.

Table 1. Overview of the analysis result of AMS samples indicating effect of storing to nutrient content and variation of nutrient content between fertilizer containers.

AMS	Average difference between fresh and stored samples per container, 5 containers	Minimum content between containers, 9 containers	Maximum content between containers, 9 containers
pH	0,05	2,1	6
Electronic conductivity	7	226	270
Total N, mg/l	1750	56500	90000
Soluble N, mg/l	1750	56500	90000

Table 2. Overview of the analysis result of Bio-Kali samples indicating effect of storing to nutrient content and variation of nutrient content between fertilizer containers.

Bio-Kali	Average difference between fresh and stored samples per container, 5 containers	Minimum content between containers, 9 containers	Maximum content between containers, 9 containers
Volume weight, g/ml	0,00	1,08	1,19
Dry matter, %	0,14	17,4	34,8
pH	0,1	4,5	5,6
Total N, mg/l *	2110	470	10950
Soluble N, mg/l	103	350	1080
Total P, g/kg	0,1	1,8	4
Soluble P, g/kg	0,06	1,6	3,7
Total K, g/kg	2,98	22	54
Soluble K, g/kg	3,5	20,9	54
** Very high Total N in pooled sample*			

The results are in line with the product information received from the manufacturers of the fertilizers (Table 3). Only the pH of the AMS used in this demonstration was remarkably lower. One of the AMS containers was neutralised to pH 6 in this trial.

Table3. Properties of Bio-Kali and recycled AMS according to the manufacturers. Figures were used in the planning of the field demonstration.

Bio-Kali

by Finnamyl Oy

- Concentrated potato cell sap, the side product of potato starch industry
- Nutrients:
  - Total N 1,3 %
  - Soluble N 0,85 %
  - P 0,25 %
  - K 4,5 %
  - Ca 0,04 %
  - Mg 0,28 %
- Dry matter 42 %
- pH 4,5-5,6
- Volume weight 1 kg/dm3

Ammoniumsulphate (AMS)

by Envor Group Oy

- Nitrogen that is stripped from waste waters
- Nutrients (35% AMS):
  - Total N 9%
  - Soluble N 8,9 % (Ammonium N)
  - S 10,2 %
- pH 7,1
- Volume weight 1,2 kg/dm3

4. Conclusions

The quality of the recycled fertilizers varied between the delivery and even container specific in the dimension that must to be recognized in precision fertilizing planning and execution. The variation as such is not a problem if so called smart farming machinery and smart solutions are in use in farms, since then fertilizing system is usually able to adapt to variation during the field operation, if the variation is known. So, the container specific list of nutrient contents would be needed. Also, farmers should be able, in this case, to order a certain amounts of nutrient instead of a certain amount of fertilizer product to have a right amount of product delivered. This is important when handling liquid fertilizers, which must be protected from freezing and/or can be prone to microbial or chemical changes during the storing (i.e. Bio-Kali).

Another approach is to improve and develop the production process of fertilizer manufacturing further to achieve more homogenized fertilizers products.

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