Nutrient Management and Nutrient Recovery Thematic Network

The results of some demonstration trials carried out in Italy using fertilizers selected by the NUTRIMAN project

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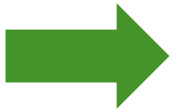
Demonstration trials

The fertilization trials were carried out first in greenhouse and subsequently in open field.

Fertilizers tested during the demo trials in greenhouse

Treatment	Product
1	Unfertilized control
2	Mineral control
3	Calcium Sodium Phosphate (ID:397)
4	Formulation 1 – Compost + BioPhosphate (ID:192)
5	Formulation 2 – Compost + BioPhosphate (ID:192)
6	Formulation 3 – Compost + BioPhosphate (ID:192)
7	Struvite 1 (ID:250)
8	Struvite 2 (ID:208)
9	Compost (ID:210)
10	Manure (commercial control)
11	Green compost (ID:280)
12	Dried digestate (ID:270)



NPK concentrations corrected with:

- urea,
- triple superphosphate,
- K sulfate.

Pot trial on tomato

Evaluation of the use at different dosages of different products from N and P recovery chains.

Comparison (from left to right): **Unfertilized control, Mineral control, Calcium Sodium Phosphate**, **Formulation 1 – Compost + BioPhosphate**

Fertilization protocol – pot trial on tomato

Treatments	Product
1	Unfertilized control
2	Mineral control
3	Calcium Sodium Phosphate (ID:397)
4	Formulation 1 – Compost + BioPhosphate (ID:192)
5	Formulation 2 – Compost + BioPhosphate (ID:192)
6	Formulation 3 – Compost + BioPhosphate (ID:192)
7	Struvite 1 (ID:250)
8	Struvite 2 (ID:208)
9	Compost (ID:210)
10	Manure (commercial control)

•NUTRIMAN product •Control

Dosages (kg/ha)	N	P2O5	K2O
Low	85	40	100
Medium	170	80	100
High	340	160	100

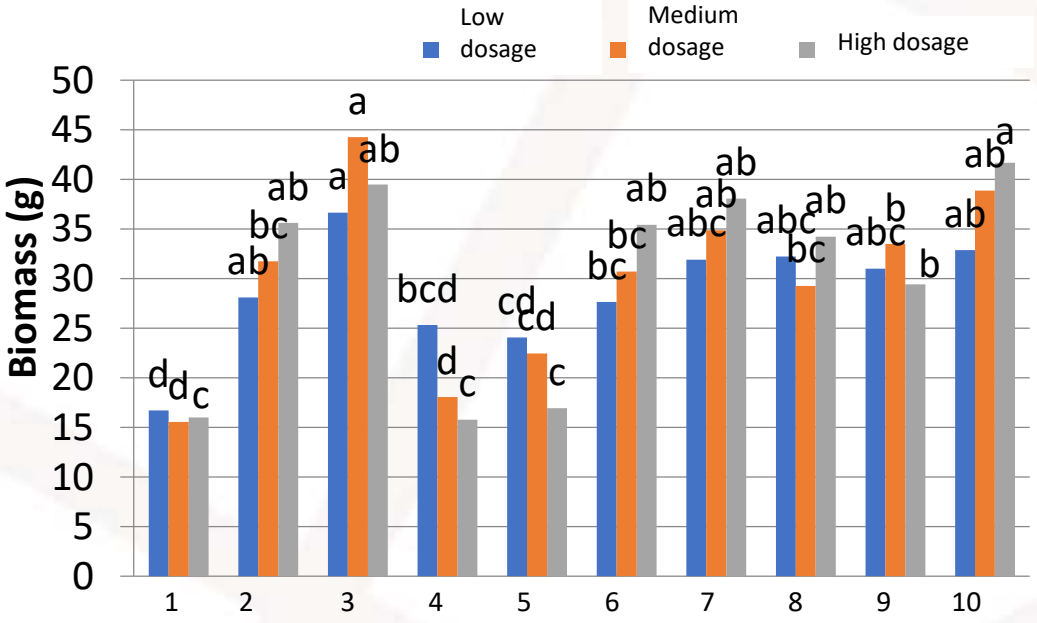
NPK concentrations corrected with:

- urea,
- Triple superphosphate,
- K sulfate.

Trial duration (6 weeks):

- **Seeding**: 24/04/2019 (I-II)
- **Transplanting** 25/05/2019 (I)-29/05/2019 (II)
- **Harvest**: 12/07/2019 (I)-16/07/2019 (II)

Effect of different treatments at different dosages on tomato above-ground biomass production (g)



Conclusions:

•**Calcium Sodium Phosphate** and **Struvite 1** generated a **significantly greater** above-ground biomass production than **unfertilized control** at any dosages. However they provided **the same** biomass of the **mineral control** and the **commercial control.**

•NUTRIMAN product •Control

Treatments	Product
1	Unfertilized control
2	Mineral control
3	Calcium Sodium Phosphate (ID:397)
4	Formulation 1 – Compost + BioPhosphate (ID:192)
5	Formulation 2 – Compost + BioPhosphate (ID:192)
6	Formulation 3 – Compost + BioPhosphate (ID:192)
7	Struvite 1 (ID:250)
8	Struvite 2 (ID:208)
9	Compost(ID:210)
10	Manure (commercial control)

Pot trial on lettuce

Evaluation of the use at different dosages of different products from N and P recovery chains.

External view of the pot trial on lettuce.

Fertilization protocol – demo trial on lettuce

Treatment	Product
1	Unfertilized control
2	Mineral control
3	Calcium Sodium Phosphate (ID:397)
4	Formulation 1 – Compost + BioPhosphate (ID:192)
5	Formulation 2 – Compost + BioPhosphate (ID:192)
6	Formulation 3 – Compost + BioPhosphate (ID:192)
7	Struvite 1 (ID:250)
8	Struvite 2 (ID:208)
9	Compost (ID:210)
10	Manure (commercial control)
11	Green compost (ID:280)
12	Dried digestate (ID:270)

Dosages (kg/ha)	N	P2O5	K2O
Low	85	40	100
Medium	170	80	100
High	340	160	100

NPK concentrations corrected with:

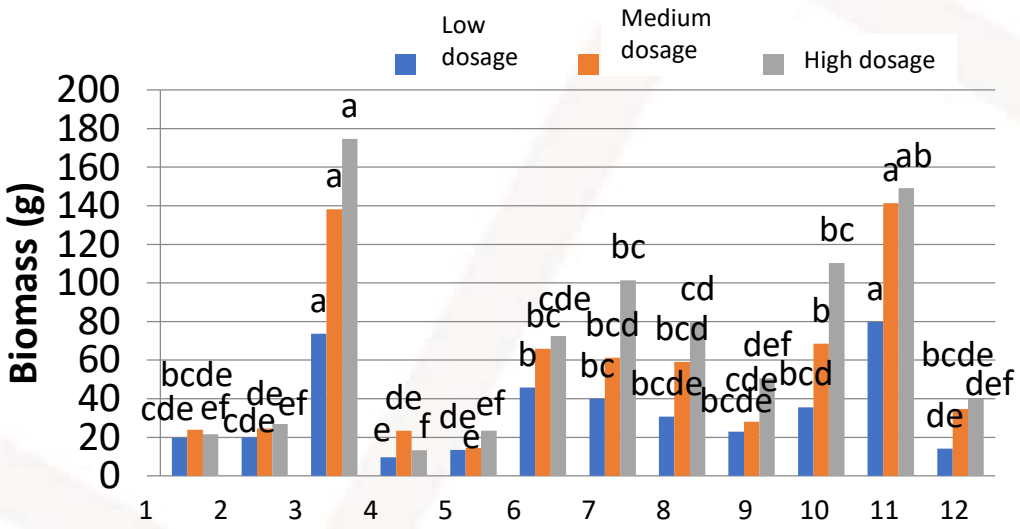
- urea,
- Triple superphosphate,
- K sulfate.

Trial duration (6 weeks):

- **Seeding**: 01/06/2019
- **Transplanting:** 21/06/2019
- **Harvest**: 08/08/2019

•NUTRIMAN product •Control

Effect of different treatments at different dosages on the production in above-ground biomass (g) of lettuce



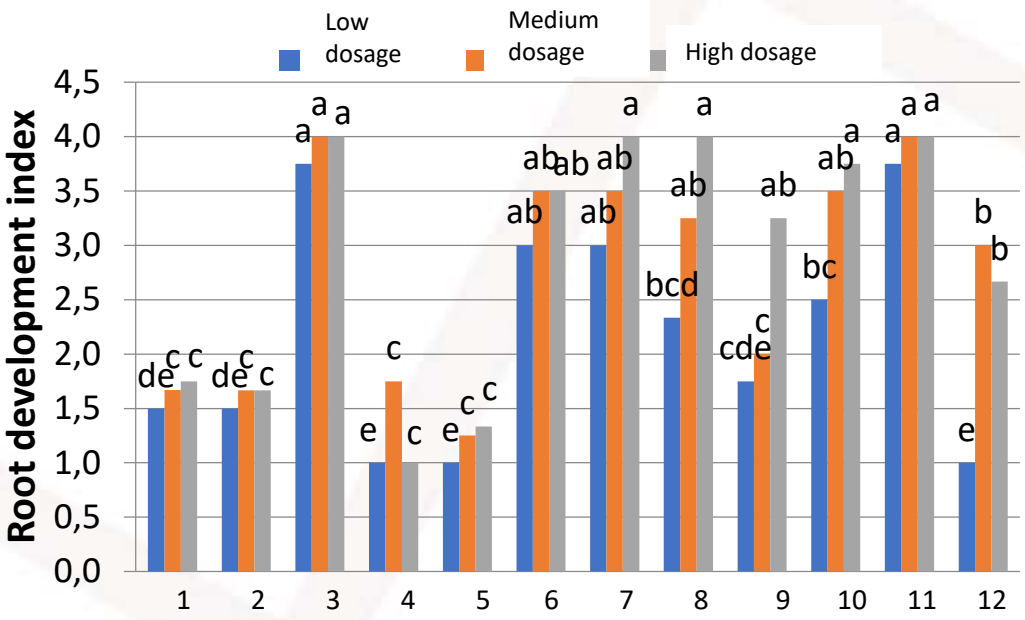
Conclusions:

- **Calcium Sodium Phosphate**, and **Gren Compost** provided a **significantly greater** above-ground biomass production than **Unfertilized control** and **Mineral control** at all dosages.
- **Mineral control** did not improved lettuce biomass: a delicate crop with a very short cycle and susceptible to “burning”.

Treatment	Product
1	Unfertilized control
2	Mineral control
3	Calcium Sodium Phosphate (ID:397)
4	Formulation 1 – Compost + BioPhosphate (ID:192)
5	Formulation 2 – Compost + BioPhosphate (ID:192)
6	Formulation 3 – Compost + BioPhosphate (ID:192)
7	Struvite 1 (ID:250)
8	Struvite 2 (ID:208)
9	Compost (ID:210)
10	Manure (commercial control)
11	Green compost (ID:280)
12	Dried digestate (ID:270)

- NUTRIMAN products
- Control

Effect of different treatments at different dosages on root development index (1-4) of lettuce



Treatment	Product
1	Unfertilized control
2	Mineral control
3	Calcium Sodium Phosphate (ID:397)
4	Formulation 1 – Compost + BioPhosphate (ID:192)
5	Formulation 2 – Compost + BioPhosphate (ID:192)
6	Formulation 3 – Compost + BioPhosphate (ID:192)
7	Struvite 1 (ID:250)
8	Struvite 2 (ID:208)
9	Compost (ID:210)
10	Manure (commercial control)
11	Green compost (ID:280)
12	Dried digestate (ID:270)

•NUTRIMAN products •Control

Conclusions:

•The root development basically **follows the trend** of the above-ground development.

•**Calcium Sodium Phosphate, Formulation 3 Compost + BioPhosphate, Struvite1-2,** and **Green Compost** provided a **significantly higher** root development index in comparison with **Untreated control** and **Mineral control** at all dosages.

Trial on lettuce in nursery

- Evaluation of the use of different products from N and P recovery chains

- Evaluation of the suppressiveness of the fertilizers distributed on tray at seeding vs *Fusarium oxysporum*

External view of the trays.

External view of the demo tray trial on lettuce.

Fertilization protocol for trial on lettuce in nursery

Treatment	Product
1	Unfertilized control
2	Mineral control
3	Calcium Sodium Phosphate (ID:397)
4	Formulation 1 – Compost + BioPhosphate (ID:192)
5	Formulation 2 – Compost + BioPhosphate (ID:192)
6	Formulation 3 – Compost + BioPhosphate (ID:192)
7	Struvite 1 (ID:250)
8	Struvite 2 (ID:208)
9	Compost (ID:210)
10	Manure (commercial control)
11	Green compost (ID:280)
12	Dried digestate (ID:270)
13	Unfertilized control treated with fungicide
14	Untreated healthy control

	%
Dosages (v/v)	1

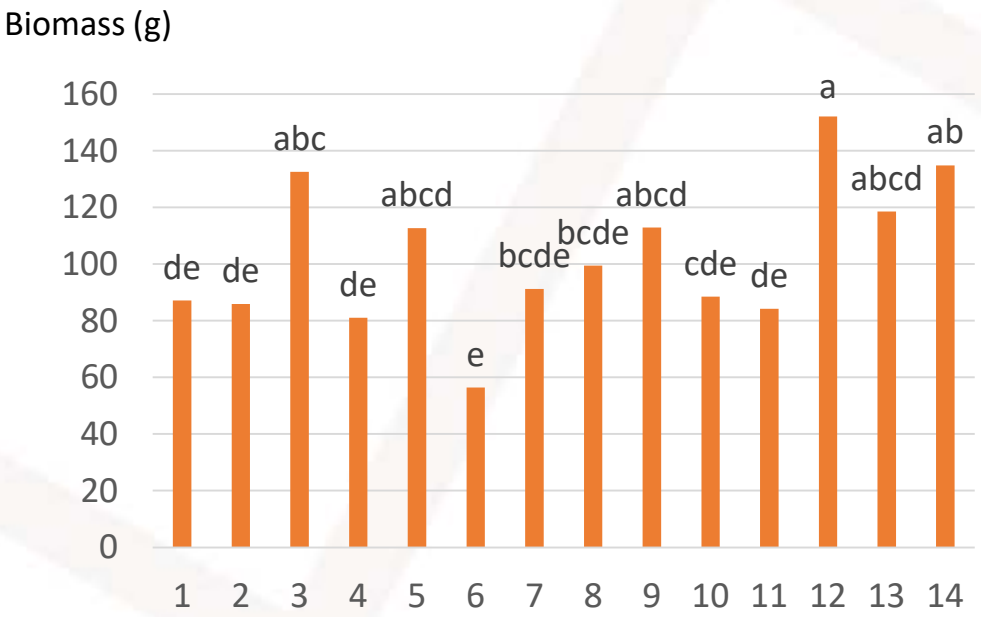
- NUTRIMAN product
- Control

N.B. The soil was inoculated with ***Fusarium oxysporum* f. sp. *lactucae***

Duration of the trial (2 months):

- **Seeding and fertilization**: 10/09/2020
- **Inoculation**: 01/10/2020
- **Transplanting**: 08/10/2020
- **Harvest**: 05/11/2020

Effect of different treatments at seeding on the production of lettuce's above-ground biomass (g)



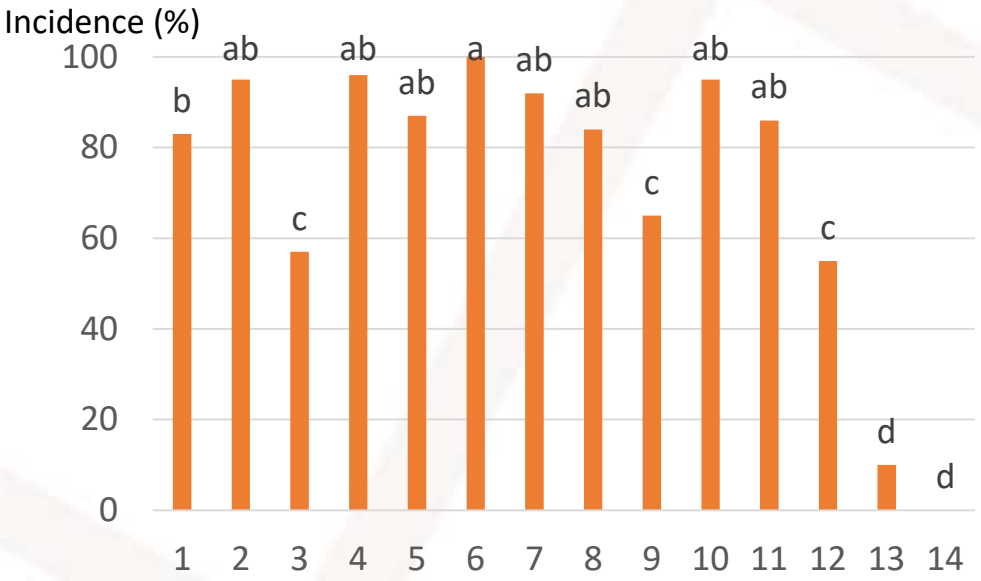
Treatment	Product
1	Unfertilized control
2	Mineral control
3	Calcium Sodium Phosphate (ID:397)
4	Formulation 1 – Compost + BioPhosphate (ID:192)
5	Formulation 2 – Compost + BioPhosphate (ID:192)
6	Formulation 3 – Compost + BioPhosphate (ID:192)
7	Struvite 1 (ID:250)
8	Struvite 2 (ID:208)
9	Compost (ID:210)
10	Manure (commercial control)
11	Green compost (ID:280)
12	Dried digestate (ID:270)
13	Unfertilized control treated with fungicide
14	Untreated healthy control

• NUTRIMAN product • Control

Conclusions:

• **Dried digestate** provided **the same** above-ground biomass production as the **Untreated healty control** and the **Untreated control treated with fungicide.**

Effect of different treatments at seeding on the incidence of fusarium wilt



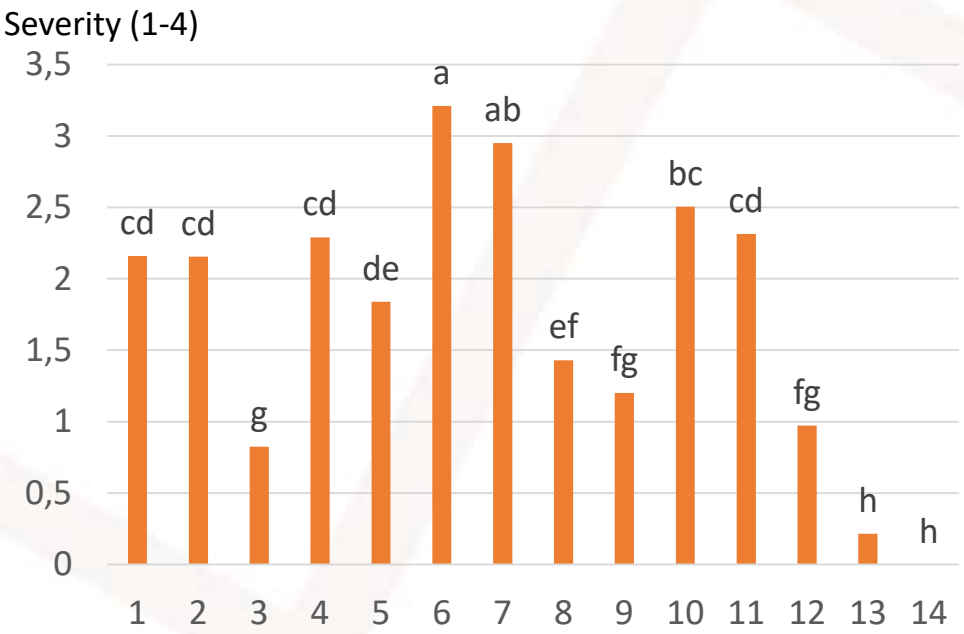
Treatment	Product
1	Unfertilized control
2	Mineral control
3	Calcium Sodium Phosphate (ID:397)
4	Formulation 1 – Compost + BioPhosphate (ID:192)
5	Formulation 2 – Compost + BioPhosphate (ID:192)
6	Formulation 3 – Compost + BioPhosphate (ID:192)
7	Struvite 1 (ID:250)
8	Struvite 2 (ID:208)
9	Compost (ID:210)
10	Manure (commercial control)
11	Green compost (ID:280)
12	Dried digestate (ID:270)
13	Unfertilized control treated with fungicide
14	Untreated healthy control

Conclusions:

- **Calcium Sodium Phosphate, Compost, Dried digestate** provided a **significantly lower** disease incidence compared to the **Untreated control** and the **Mineral control**, but **higher** than the **Untertilized control treated with fungicide** and the **Untreated healthy control.**

- NUTRIMAN product
- Control

Effect of different treatments at seeding on the severity (0=healthy; 4=death) of fusarium wilt



Treatment	Product
1	Unfertilized control
2	Mineral control
3	Calcium Sodium Phosphate (ID:397)
4	Formulation 1 – Compost + BioPhosphate (ID:192)
5	Formulation 2 – Compost + BioPhosphate (ID:192)
6	Formulation 3 – Compost + BioPhosphate (ID:192)
7	Struvite 1 (ID:250)
8	Struvite 2 (ID:208)
9	Compost (ID:210)
10	Manure (commercial control)
11	Green compost (ID:280)
12	Dried digestate (ID:270)
13	Unfertilized control treated with fungicide
14	Untreated healthy control

Conclusions:

- **Calcium Sodium Phosphate, Struvite 2, Compost, Dried digestate** provided a **significantly lower** disease severity compared to the **Unfertilized control** and the **Mineral control**, but **significantly higher** than the **Untreated healthy control** and the **Unfertilized control treated with fungicide.**

• NUTRIMAN product • Control

Demo field trial on lettuce

Evaluation of the use of different products from N and P recovery chains.

External view of the demo field trial on lettuce

Fertilization protocol – Demo field trial on lettuce

Treatment	Product
1-H	Unfertilized healthy control
1	Unfertilized control
2	Mineral control
3	Struvite 1 (ID:250)
4	Dried digestate (ID:270)

•NUTRIMAN products •Control

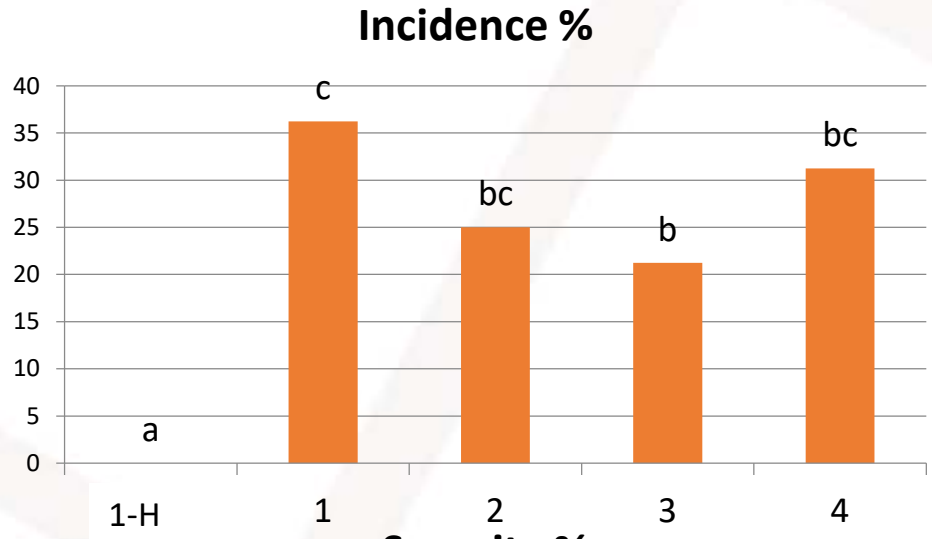
Note: the soil was inoculated *with* ***Fusarium oxysporum*** f.sp. *lactucae* race one.

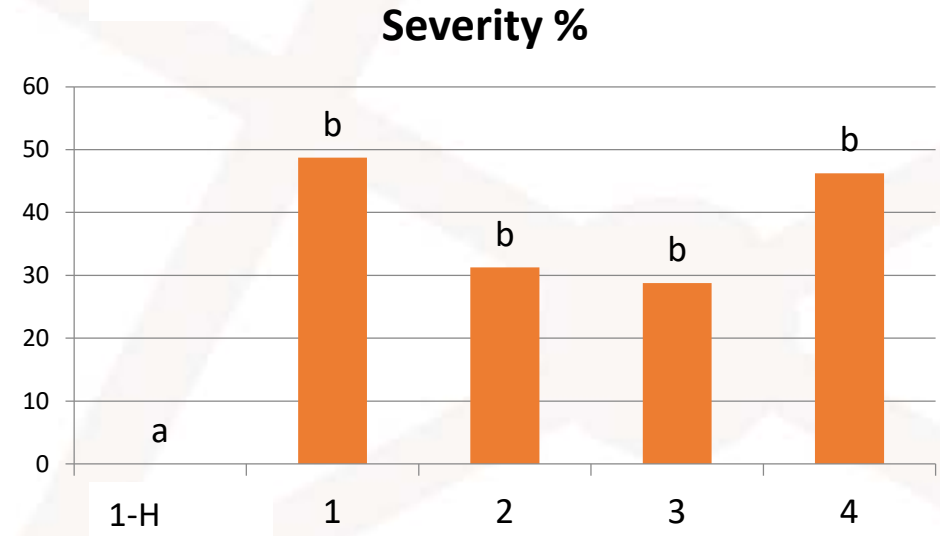
	N	P2O5	K2O
Dosages (kg/ha)	50	50	50

NPK concentrations corrected with:
- urea,
- Triple superphosphate,
- K sulfate.

Duration of the trial (6 months):
- **Seeding**: 12/05/2020
- **Transplanting**: 05/06/2020
- **Harvest**: 02/07/2020

Effects of different treatments in terms of incidence and severity of fusarium wilt





Treatment	Product
1-H	Unfertilized healthy control
1	Unfertilized control
2	Mineral control
3	Struvite 1 (ID:250)
4	Dried digestate (ID:270)

•NUTRIMAN products •Control

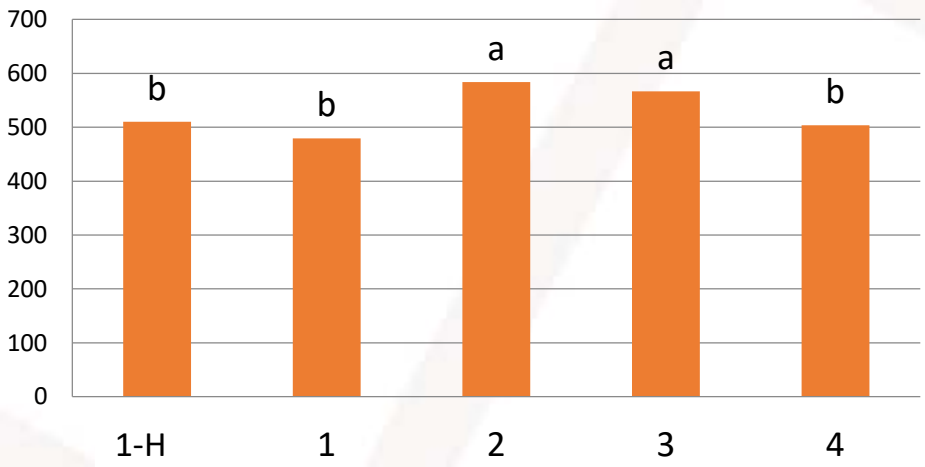
Conclusions:

•**Struvite 1** reduced the disease **incidence** compared to the **Untreated control**.

•**No differences** were observed in terms of disease severity among the treatments.

Effects of different treatments in terms of above-ground biomass production (g)

Total above-ground biomass (g)

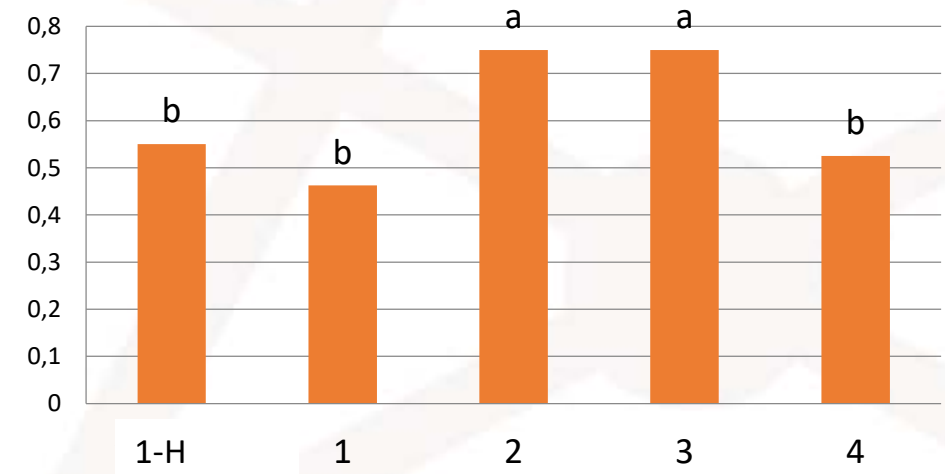


Treatment	Product
1-H	Unfertilized healthy control
1	Unfertilized control
2	Mineral control
3	Struvite 1 (ID:250)
4	Dried digestate (ID:270)

•NUTRIMAN products •Control

***Not marketable: <250g**

Marketable/not marketable*



Conclusions:

- A **significantly higher** above-ground biomass was achieved using **Struvite 1** in comparison with the **Untreated control** and the **Untreated healthy control.**
- Also the relationship between Marketable/not marketable above-ground biomass production using **Struvite 1** was similar to the **mineral control**.

Demo field trial on cabbage

Evaluation of the use of different products from N and P recovery chains.

External view of the demo field trial on cabbage.

Fertilization protocol – Demo field trial on cabbage

Treatment	Product
1	Unfertilized control
2	Mineral control
3	Calcium Sodium Phosphate (ID:397)
4	Formulation 1 – Compost + BioPhosphate (ID:192)
5	Formulation 2 – Compost + BioPhosphate (ID:192)
6	Struvite 2 (ID:208)
7	Compost (ID:210)
8	Manure (commercial control)
9	Green compost (ID:280)
10	Dried digestate (ID:270)

- NUTRIMAN product
- Control

	N	P2O5	K2O
Dosages (kg/ha)	170	80	190

NPK concentrations corrected with:

- urea,
- Triple superphosphate,
- K sulfate.

Duration of the trial (6 months):

- **Seeding**: 03/07/2019
- **Transplanting**: 23/08/2019
- **Harvest**: 18/01/2020

Comparison – Demo field trial on cabbage

1. **Unfertilized control**

2. **Mineral control**

3. **Ca&Na Phosphate**

4. **F. 1 Compost + BioPhosphate**

5. **F. 2 Compost + BioPhosphate**

6. **Struvite 2**

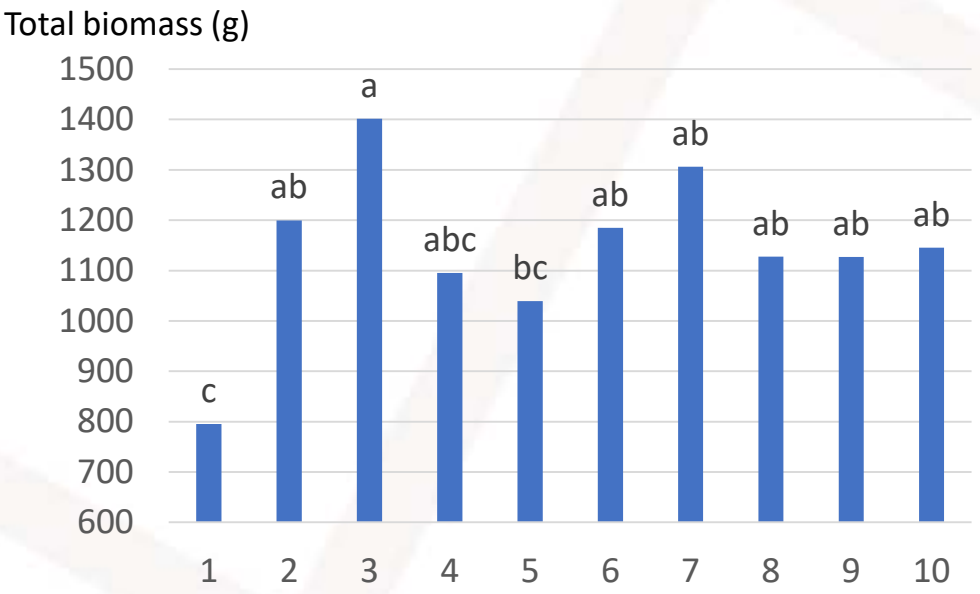
7. **Compost**

8. **Organic control**

9. **Green compost**

10. **Dried digestate**

Effects of different fertilizers on the above-ground total biomass (g) production of cabbage



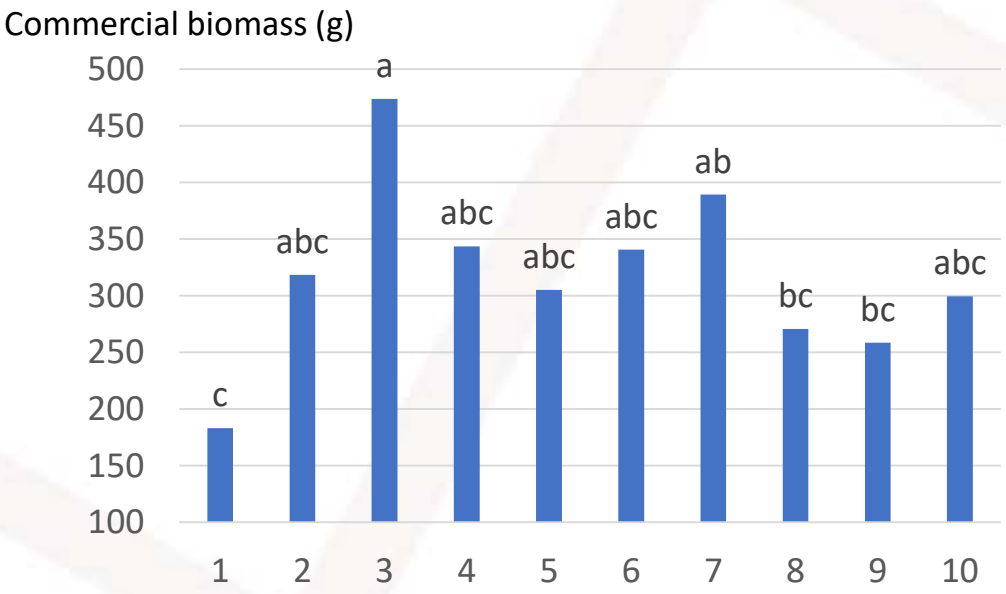
• NUTRIMAN product • Control

Treatment	Product
1	Unfertilized control
2	Mineral control
3	Calcium Sodium Phosphate (ID:397)
4	Formulation 1 – Compost + BioPhosphate (ID:192)
5	Formulation 2 – Compost + BioPhosphate (ID:192)
6	Struvite 2 (ID:208)
7	Compost (ID:210)
8	Manure (commercial control)
9	Green compost (ID:280)
10	Dried digestate (ID:270)

Conclusions:

• **All the treatments** except for **Formulation 2 Compost + BioPhosphate** provided an above-ground total biomass **significantly higher** than the **Untreated control** and similar to the **Mineral control**.

Effects of different fertilizers on the above-ground commercial biomass (g) production of cabbage



• NUTRIMAN product • Control

Treatment	Product
1	Unfertilized control
2	Mineral control
3	Calcium Sodium Phosphate (ID:397)
4	Formulation 1 – Compost + BioPhosphate (ID:192)
5	Formulation 2 – Compost + BioPhosphate (ID:192)
6	Struvite 2 (ID:208)
7	Compost (ID:210)
8	Manure (commercial control)
9	Green compost (ID:280)
10	Dried digestate (ID:270)

Conclusioni:

• **Calcium Sodium Phosphate** and **Compost** provided a commercial biomass significantly higher than the **Untreated control** and similar to the **Mineral control**.

Demo field trial on corn

1. Subdivision of pre-plowing plots to distribute fertilizers

2. Push fertilizer spreader

3. Fertilizers distributed in pre-plowing

4. Post-sowing replenishment

Fertilization protocol - Demo field trial on corn

Treatment	Product
1	Unfertilized control
2	Mineral control
3	Formulation 1 – Compost + BioPhosphate (ID:192)
4	Formulation 2 – Compost + BioPhosphate (ID:192)
5	Struvite 1 (ID:250)
6	Struvite 2 (ID:208)
7	Compost (ID:210)
8	Manure (commercial control)
9	Farmers' fertilization plan*

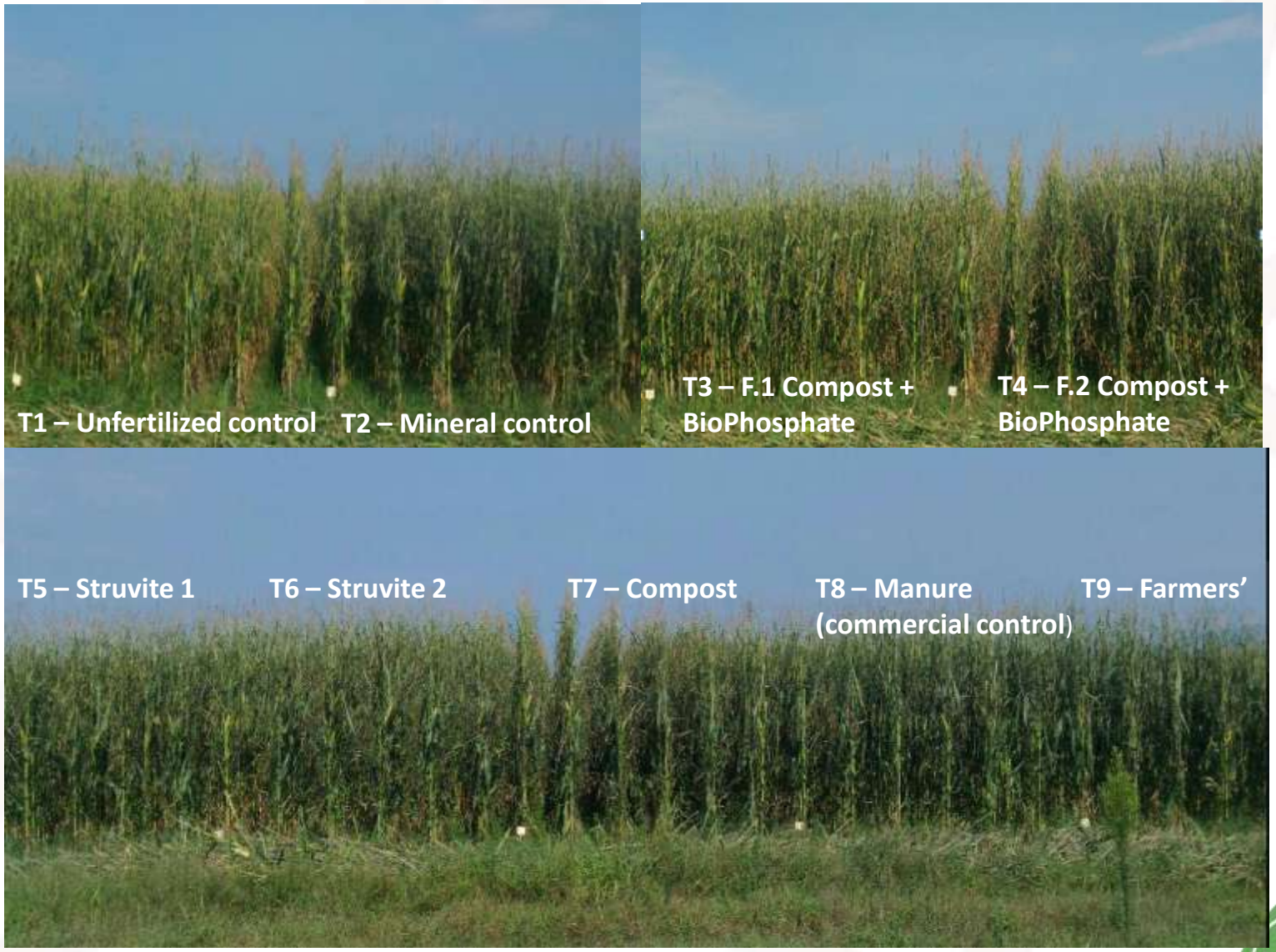
* Mineral fertilization plan by distribution of farm cattle manure (53t/ha), for a total contribution of: 290 kg/ha of N, 66 kg/ha of P2O5, 119 kg/ha of K2O.

NPK concentrations corrected with:
- urea,
- Triple superphosphate,
- K sulfate.

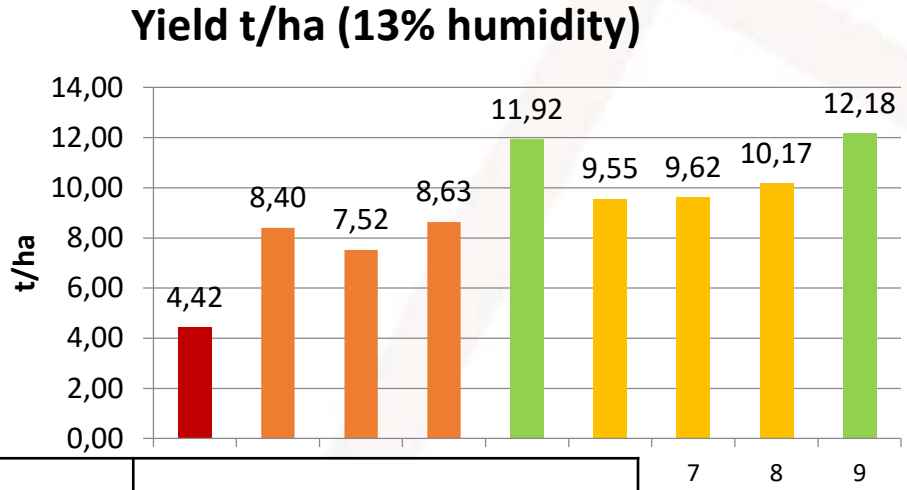
Duration of the trial (6 months):
- **Seeding**: 13/03/2019
- **Harvest**: 13/09/2019

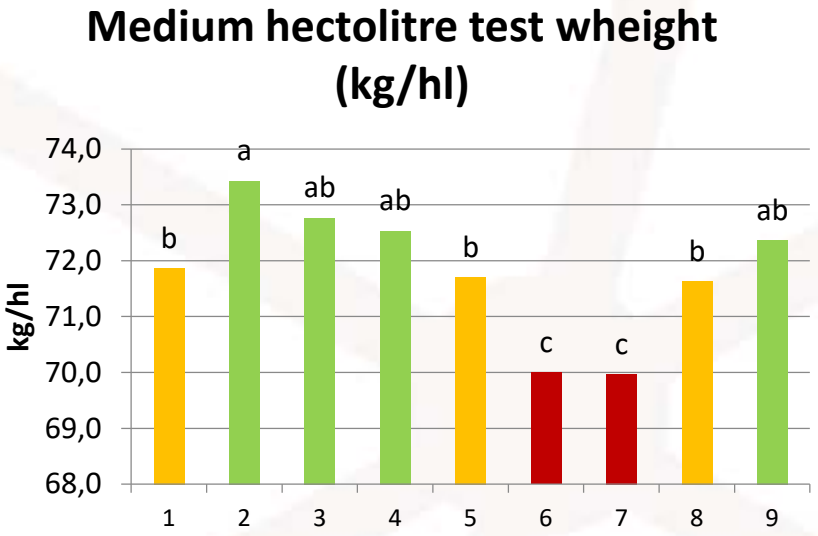
•NUTRIMAN product •Control

Visual comparison – Demo field trial on corn



Yield and grain quality





Treatment	Product
1	Unfertilized control
2	Mineral control
3	Formulation 1 – Compost + BioPhosphate (ID:192)
4	Formulation 2 – Compost + BioPhosphate (ID:192)
5	Struvite 1 (ID:250)
6	Struvite 2 (ID:208)
7	Compost(ID:210)
8	Manure (commercial control)
9	Farmers' fertilization plan

Conclusions:

•**Yield**: **Farmers' fertilization plant and Struvite 1** generated the **highest** yields; **all treatments** provided yields **higher** than the **Unfertilized control** and similar to the **mineral control**.

•**Quality**: **BioPhosphate** and **Farmers' fertilization plan** provided a **higher** medium hectolitre test wheight rather than the **Unfertilized control**.

Demo field trial in vineyard

Evaluation of the use of different products from N and P recovery chains.

External view of the demo field trial on vineyard.

Harvesting.

Fertilization protocol – Demo field trial on grape

Treatment	Product
1	Unfertilized control
2	Mineral control
3	Struvite 1 (ID:250)
4	Compost (ID:210)
5	Green compost (ID:280)
6	Dried digestate(ID:270)
7	Calcium Sodium Phosphate (ID:397)

	N	P2O5	K2O
Dosages (kg/ha)	50	50	50

NPK concentrations corrected with:

- urea,
- Triple superphosphate,
- K sulfate.

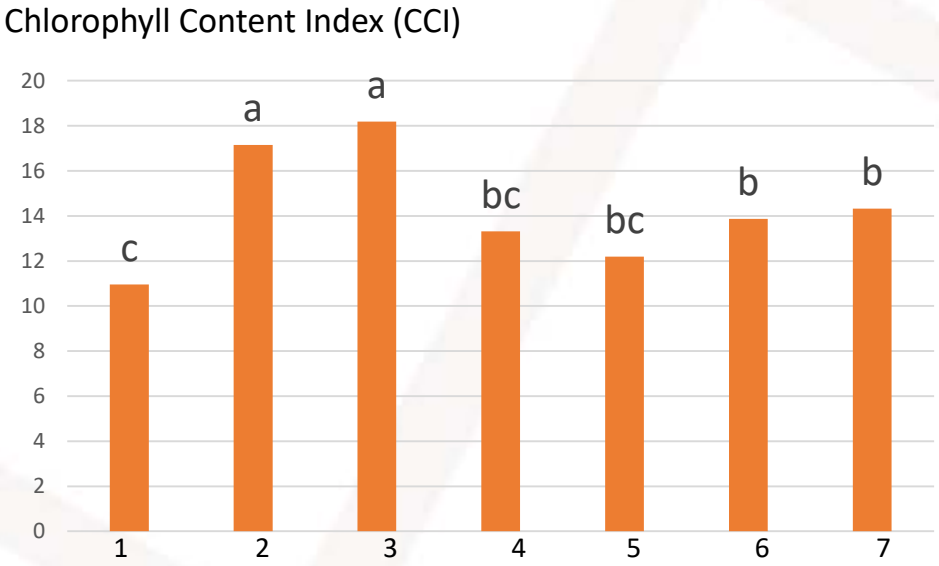
•NUTRIMAN product •Control

Duration of the trial (4 months):

- **Fertilization**: 18/05/2020 (BBCH: 53)
- **Harvest**: 20/08/2020 (BBCH: 85-89)

Experimental vineyard of UNITO (cv. Moscato) on 18° May 2020.

Effects of different fertilizers on the Chlorophyll Content Index 1 month after the distribution



Treatment	Product
1	Unfertilized control
2	Mineral control
3	Struvite 1 (ID:250)
4	Compost (ID:210)
5	Green compost (ID:280)
6	Dried digestate(ID:270)
7	Calcium Sodium Phosphate (ID:397)

•NUTRIMAN product •Control

Conclusions:

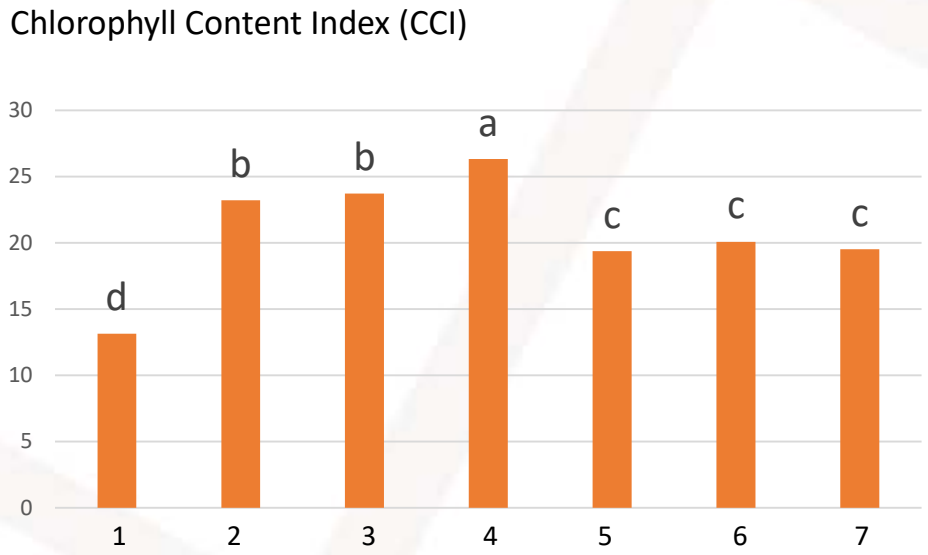
•Plants treated with **Compost** and **Green compost** had the **same** CCI than the **Untreated control** and a **significantly lower** CCI than **Mineral control.**

• Plants treated with **Dried digestate** and **Calcium Sodium Phosphate** had a CCI **significantly higher** than **Untreated control**, but **significantly lower** than **Mineral control.**

•**STRUVITE 1** provided the **same** CCI of the **Mineral control.**

Demo field trial on vineyard – 1 month after distribution of fertilizers

Effects of different fertilizers on the Chlorophyll Content Index 2 months after the distribution



Treatment	Product
1	Unfertilized control
2	Mineral control
3	Struvite 1 (ID:250)
4	Compost (ID:210)
5	Green compost (ID:280)
6	Dried digestate(ID:270)
7	Calcium Sodium Phosphate (ID:397)

•NUTRIMAN product •Control

Conclusions:

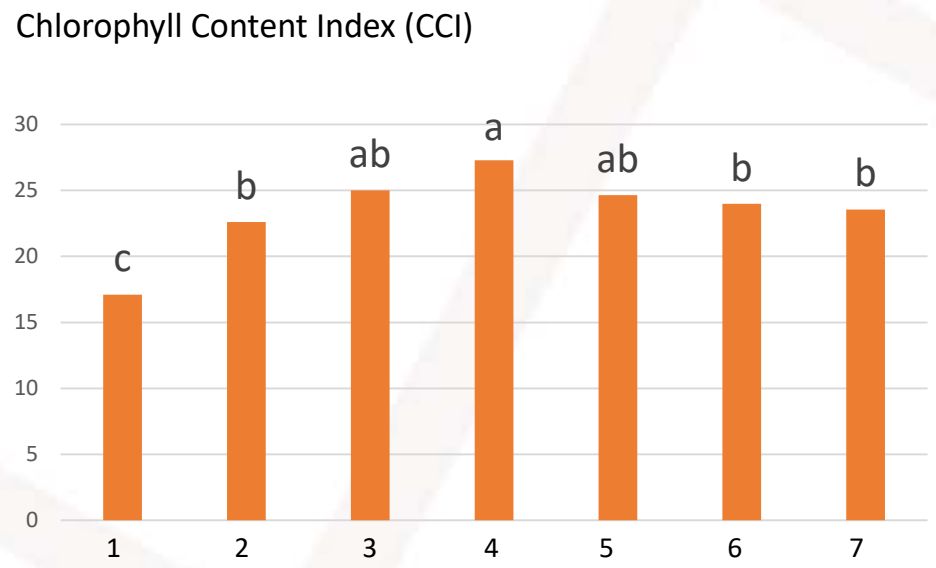
•**Compost** provided a CCI **significantly higher** than **all other treatments and controls**.

•Plants treated with **Dried digestate, Green compost, Calcium Sodium Phosphate** had a CCI **significantly higher** than the **Untreated control**, but **significantly lower** than **Mineral control.**

•**Struvite 1** provides **the same** CCI of the **Mineral control**.

Demo field trial on vineyard – 2 months after distribution of fertilizers

Effects of different fertilizers on the Chlorophyll Content Index 3 month after the distribution



Treatment	Product
1	Unfertilized control
2	Mineral control
3	Struvite 1 (ID:250)
4	Compost (ID:210)
5	Green compost (ID:280)
6	Dried digestate(ID:270)
7	Calcium Sodium Phosphate (ID:397)

•NUTRIMAN product •Control

Conclusions:

•**Compost** provided a **significantly higher** CCI than **all other treatments and controls**.

•Plants treated with **all the treatments** had a CCI **higher** than the **unfertilized control,** and **similar** to the **mineral control**.

Demo field trial on vineyard – 3 months after distribution of fertilizers

Effects of different fertilizers on grape downy mildew.

Plasmopara viticola on leaf.

Plasmopara viticola on cluster.

Treatment	Product
1	Unfertilized control
2	Mineral control
3	Struvite 1 (ID:250)
4	Compost (ID:210)
5	Green compost (ID:280)
6	Dried digestate(ID:270)
7	Calcium Sodium Phosphate (ID:397)

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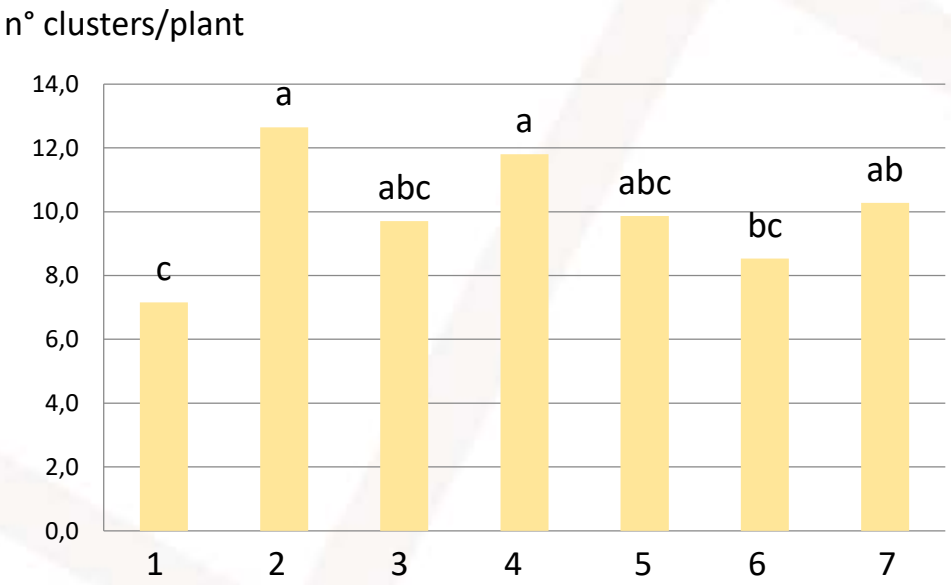
Monitoring **every 15 days** of the **incidence** and **severity** of *Plasmopara viticola* on the leaves and clusters.

There were **no significant differences** between the various treatments throughout the season. Therefore, recovery fertilizers, even if provided an increased development of leaves and plant growth, did not improved the disease.

Effects of different fertilizers on the number of clusters for each plant



Treatment	Product
1	Unfertilized control
2	Mineral control
3	Struvite 1 (ID:250)
4	Compost (ID:210)
5	Green compost (ID:280)
6	Dried digestate(ID:270)
7	Calcium Sodium Phosphate (ID:397)

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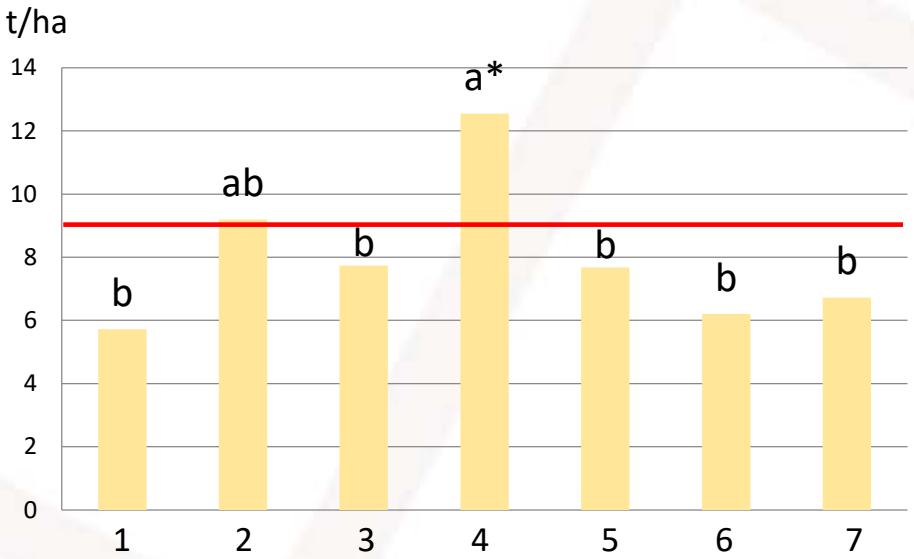
Conclusions:

•**Compost** generated a n° of clusters/plant **significantly higher** than the **Untreated control** and **the same** of the **Mineral control**.

• Plants treated with **Calcium Sodium Phosphate** showed a n° clusters/plant **significantly higher** than the **Untreated control** and **the same** of the **Mineral control**.

Each plant was harvested indipendently.

Effects of different fertilizers on grape yields



Treatment	Product
1	Unfertilized control
2	Mineral control
3	Struvite 1 (ID:250)
4	Compost (ID:210)
5	Green compost (ID:280)
6	Dried digestate(ID:270)
7	Calcium Sodium Phosphate (ID:397)

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Conclusions:

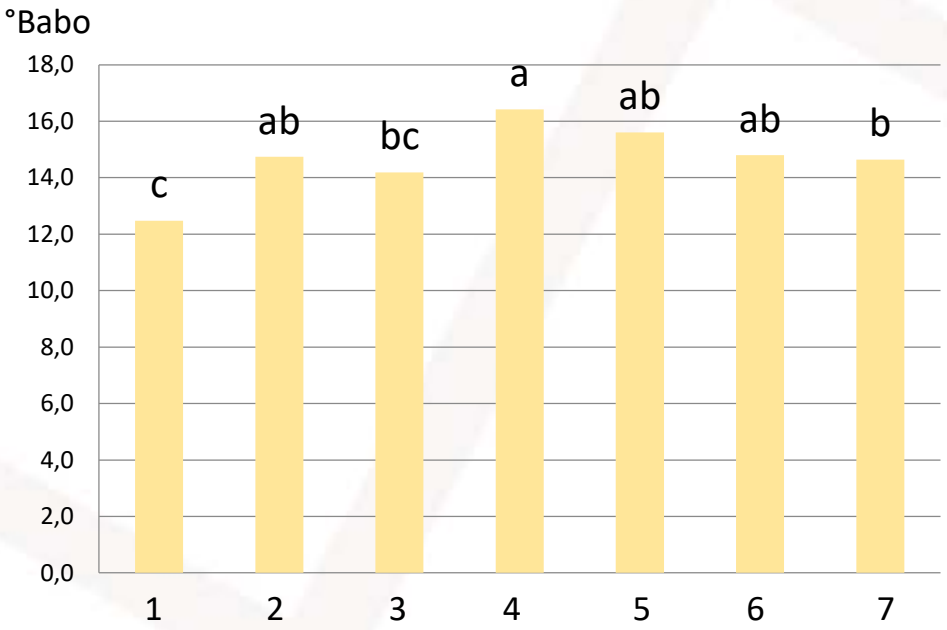
•**Compost** provided yields **significantly higher** than **Untreated control** and **similar** to the **mineral control***.

• **All other treatments** provided yields similar to the **controls**.

*Exceeding maximum harvest yields (9t/ha).

Each plant was harvested indipendently.

Effects of different fertilizers on the sugar content at harvest



Treatment	Product
1	Unfertilized control
2	Mineral control
3	Struvite 1 (ID:250)
4	Compost (ID:210)
5	Green compost (ID:280)
6	Dried digestate(ID:270)
7	Calcium Sodium Phosphate (ID:397)

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Conclusions:

•**Compost, Green compost, Dried digestate** and **Calcium Sodium Phosphate** provided a sugar content **significantly higher** than the **Untreated control** and **equal** to **Mineral control.**

Type of refractometer used to determine the sugar content (° Babo)

Conclusions

Fertilizers from nutrient recovery chains such as those used in the demonstration trials showed effects similar to mineral fertilizers.

Some biofertilizers such as **BioPhosphate, Calcium Sodium Phosphate, Struvite, Compost** and **Dried digestate**, resulted in similar or even better effects on plant development and yields than mineral fertilizers, on the crops involved in the demo trials (tomato, lettuce, cabbage, corn, grape).

Numerous technicians and farmers had the opportunity to see the demo trials carried out in Italy and to participate to the demonstration events.

Further demo trials and events are under organization during 2021: for more information www.nutriman.net

Thank you for the attention!

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