

The background features a complex, swirling pattern of bright blue and white light, resembling a plasma or nebula. The central part of the image is dominated by a large, circular, multi-layered swirl of light. The text is centered over this swirl.

WELCOME TO OUR
COLD PLASMA WORLD
Plasmas in Agriculture

What is plasma?

0°C



solid

10°C



liquid

100°C



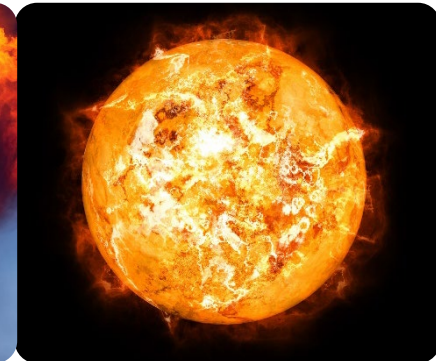
gaseous

1,000°C



atomic

10,000°C



plasma

100,000°C

What is cold atmospheric plasma?

0°C



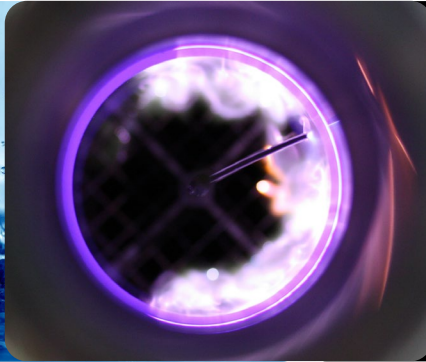
solid

10°C



liquid

100°C



gaseous

1,000°C

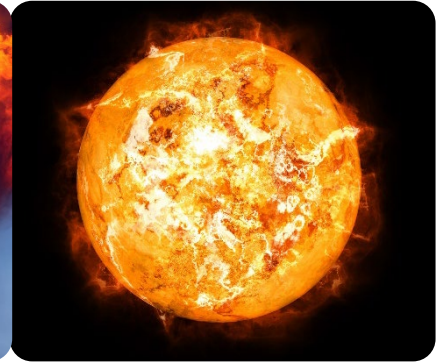


10,000°C



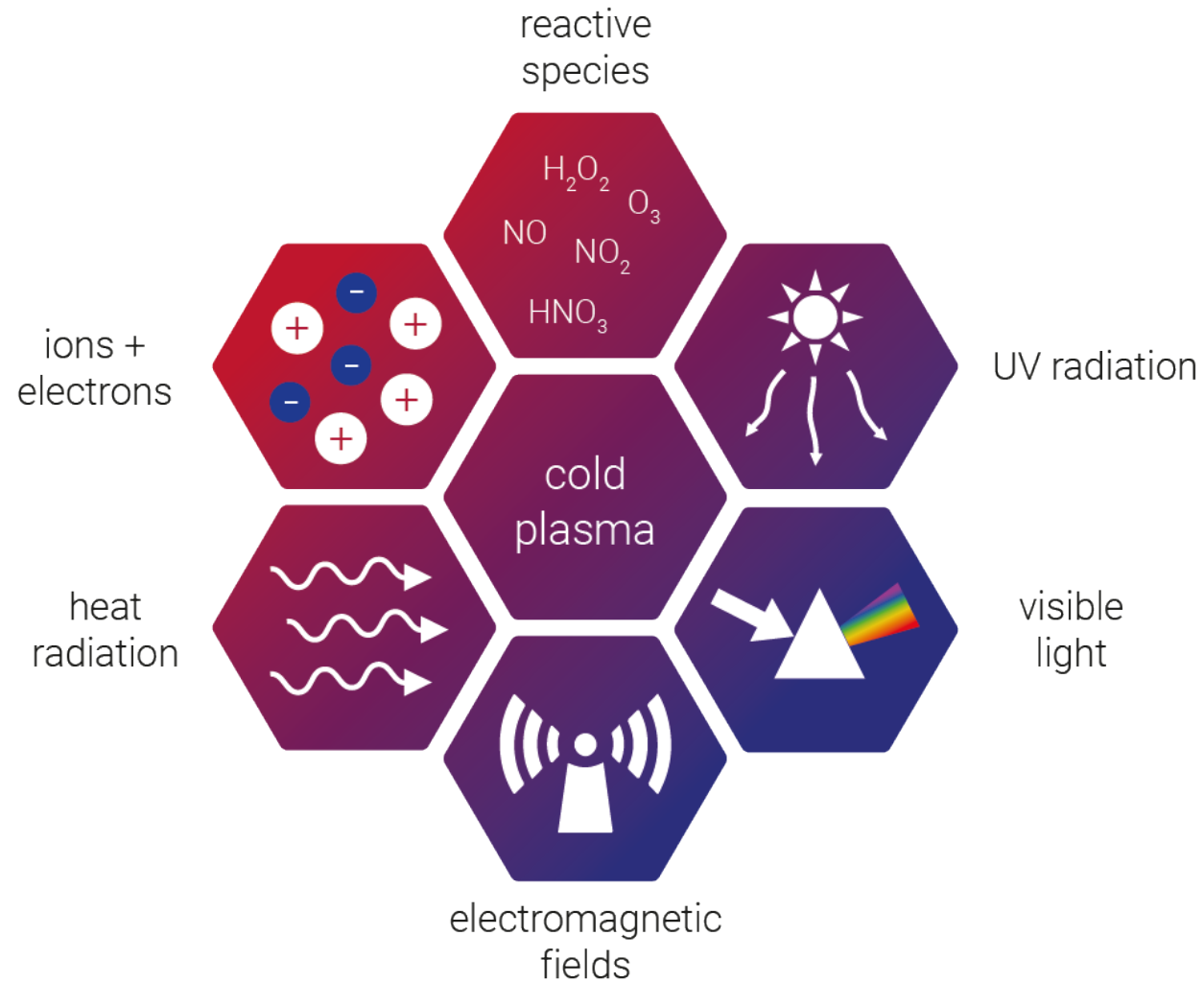
atomic

100,000°C

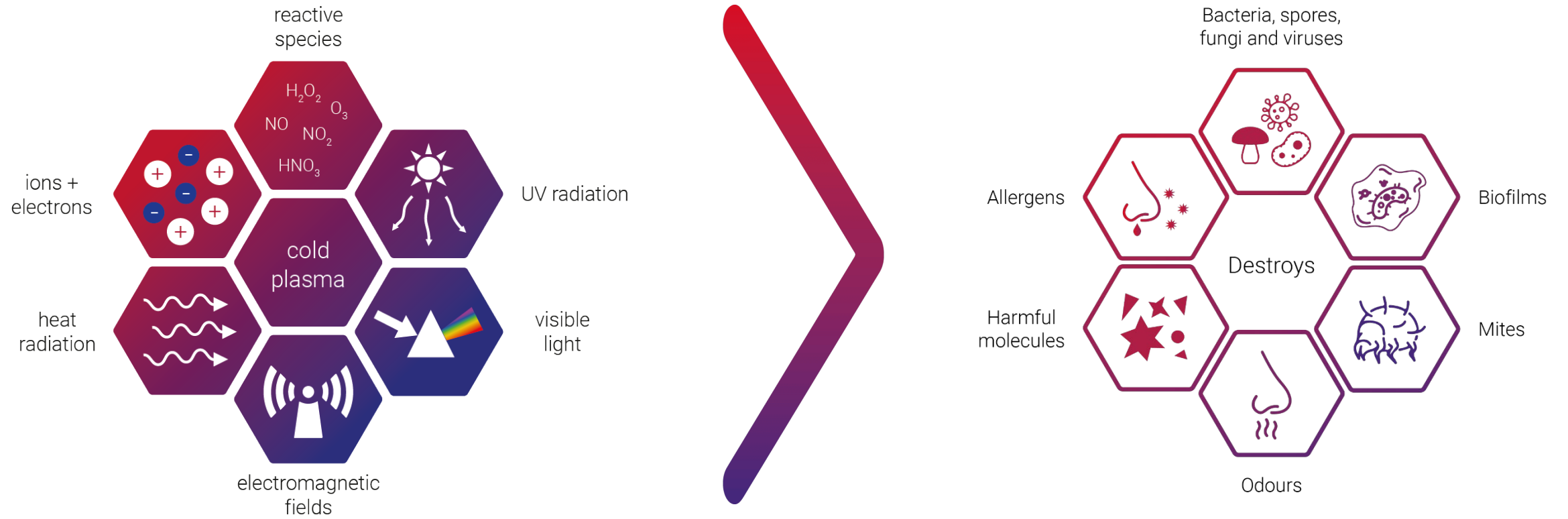


plasma

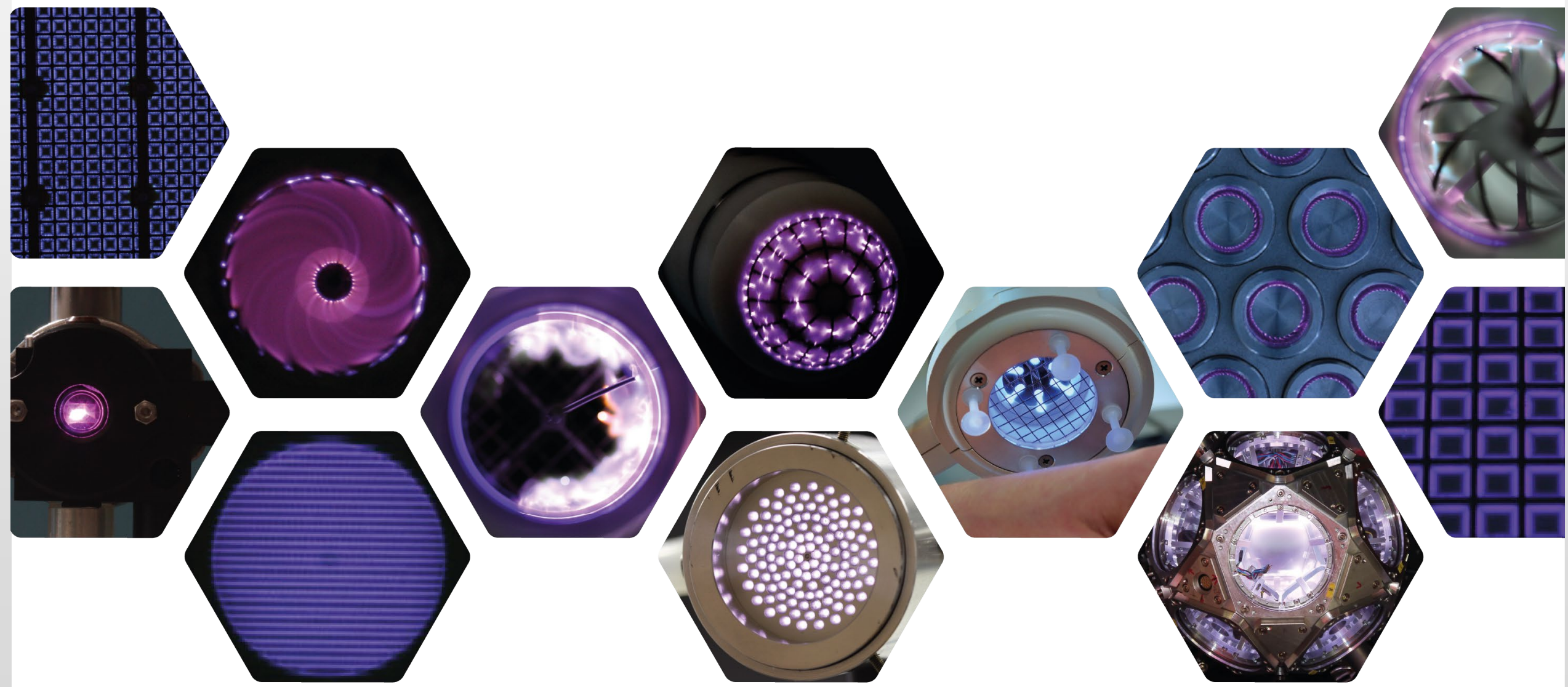
Components in a cold atmospheric plasma



Cold atmospheric plasma destroys...



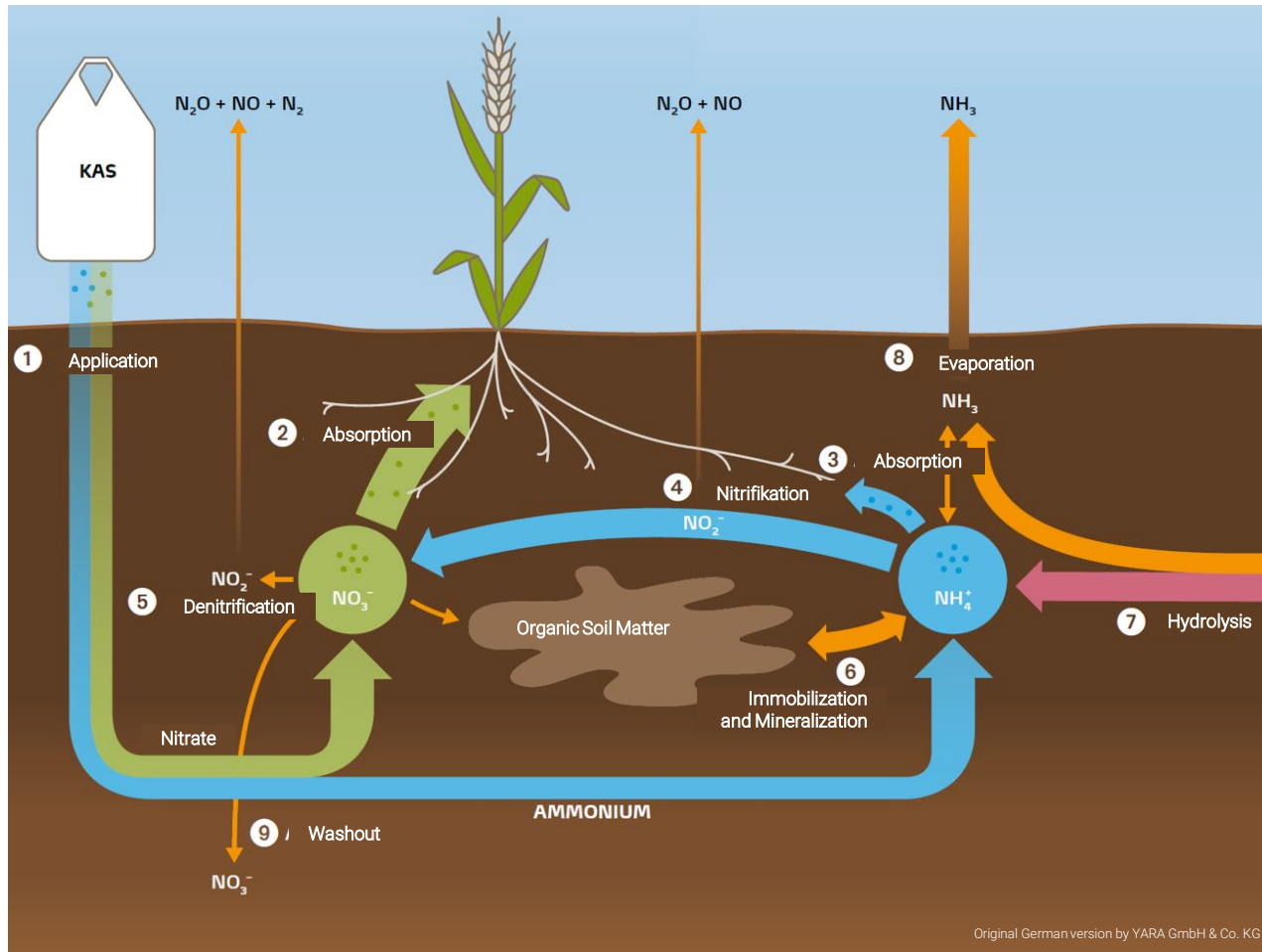
Our cold plasma technologies




Application fields of cold atmospheric plasma



Current fertilization technology with nitrate and ammonia



- Fertilizers are applied over the entire area
- PROBLEM:**
- Only a small fraction reaches the plant
- Most of the fertilizer ends up in the ground water

A close-up photograph of a cannabis plant, showing several large, serrated, green leaves with prominent veins. The leaves are densely packed and fill the frame. The lighting is bright, highlighting the texture and color of the foliage.

What if you could increase yield and growth of various plants in agriculture without environmental pollution?

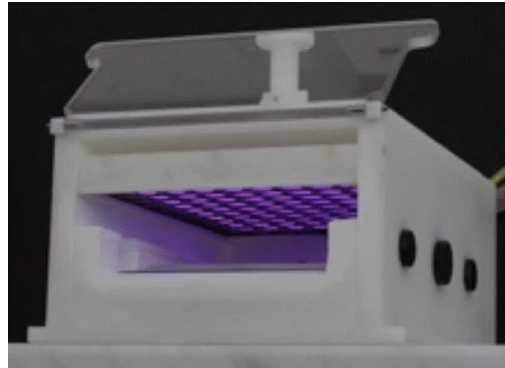


Our answer: First, cold atmospheric plasma seed treatment

Cold plasmas produce “personalized fertilizer” on the seeds

Plasma seed treatment

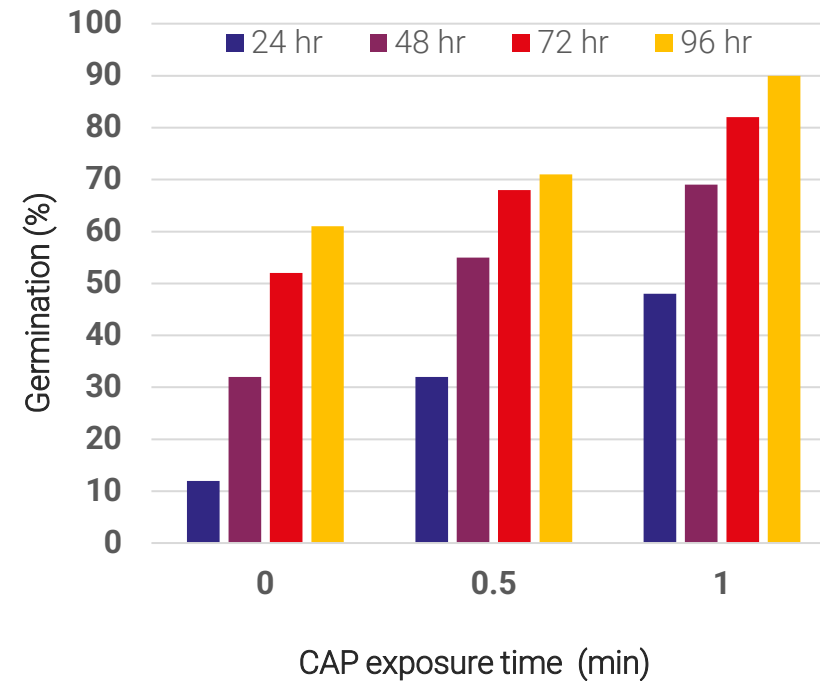
Treatment of *Cicer arietinum* seeds with cold atmospheric plasma



| Treatment time | Speed of germination (seed/day) | Seedling length (cm) | Seedling dry weight (mg) |
|----------------|---------------------------------|----------------------|--------------------------|
| Control | 3.9±0.1 | 8.8±0.3 | 25±1 |
| 30s | 5.5±0.1 | 9.5±0.5 | 26±3 |
| 1 min | 7.1±0.1 | 22.3±0.5 | 55±2 |

→ Increased germination
→ Increased growth

- *Cicer arietinum* seeds were treated in a plasma device
- Treatment times: 30s and 1 min



Plasma seed treatment

Cold atmospheric plasmas produce „personalized fertilizers“

- In over 600 plasma-air reactions, a number of reactive species are generated, including NO_3^- and NH_4^+ .
- These species attach to the seed and combine in part with H_2O , C, Ca to form more stable components, which then supply the important nitrogen to the seedling over time through further reactions.
- This gives each treated seed the following benefits:
 - reduction of bacteria and fungi on the surface for better germination and yield.
 - "Personalized nitrogen fertilizer" on each seed for stronger growth.

→ No pollution of the environment!

The background of the slide is a close-up photograph of water ripples. The ripples are concentric circles of varying sizes, creating a complex, textured pattern. The color is a light, clear blue, with highlights and shadows that give the water a sense of depth and movement. The text is overlaid on this background.

Our answer: Second, plant treatment with plasma activated water

Plasma activated water supplies the plant with further nitrogen products for better growth



Plant treatment with plasma activated water

Cold atmospheric plasma is produced in air and mixed into water

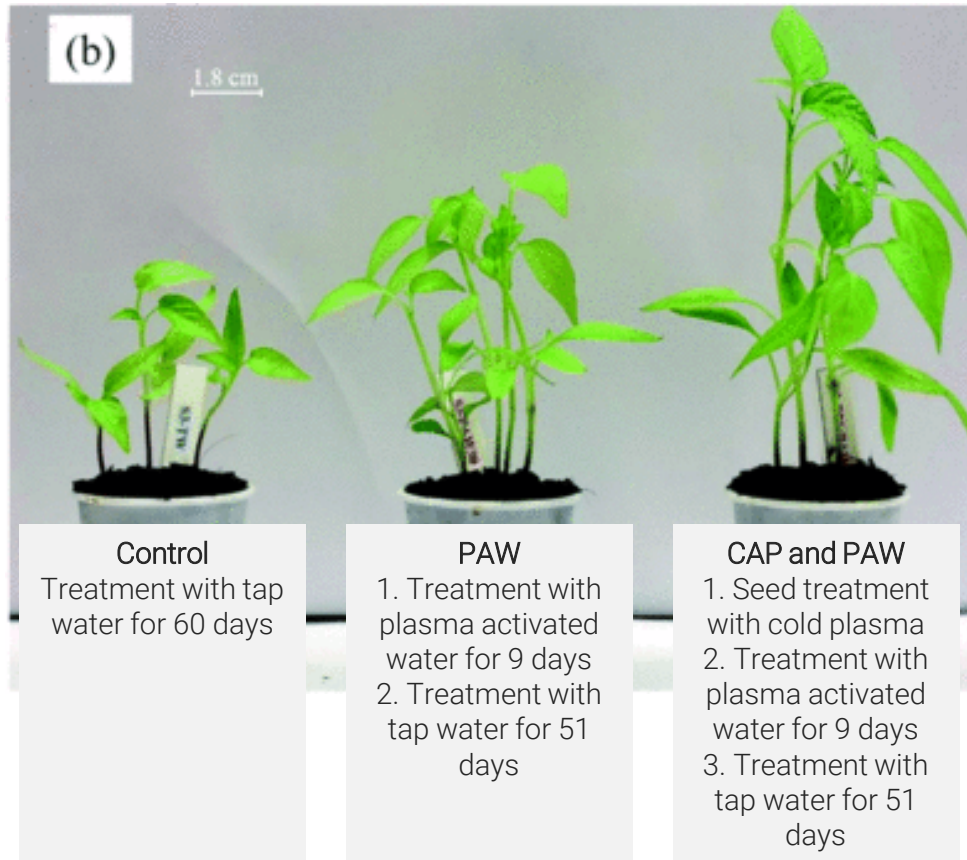
→ Plasma activated water

Advantages:

- Easy to produce (only electricity, air and water needed)
- Low power requirement
- Can be designed for optimum nitrogen chemistry
- Reverts back to drinking water after a certain time period
- Sustainable

Plant treatment with plasma activated water

Pepper Plant



→ Plant treatment with plasma activated water improves plant growth!

→ Cold plasma seed treatment in combination with the treatment with plasma activated water leads to synergistic effects and even larger plant growth!

Enhanced seed germination and plant growth by atmospheric pressure cold air plasma: combined effect of seed and water treatment

Sivachandiran L. and Khacef A.
RAC Advances Issue 4, 2017



Cold atmospheric plasmas and plasma activated water in agriculture

Cold atmospheric plasma seed treatment:

- Reduction of microbial load on the seed
- Improves germination
- Enhances growth

→ „Personalized fertilizer“ on the seeds

Use of plasma activated water:

- Reduction of microbial load in water (keeps pipe systems clean)
- Regulation of pH (optimum pH for plant growth 5.5. – 6.5)
- Adds oxygen to the water, which improves plant health
- Increases the solubility of carbonates
- Serves as a perfect nitrogen fertilizer in the form of nitrates
- Enhances plant growth

→ **No pollution of the enviroment!**



Cold atmospheric plasmas and plasma activated water in agriculture

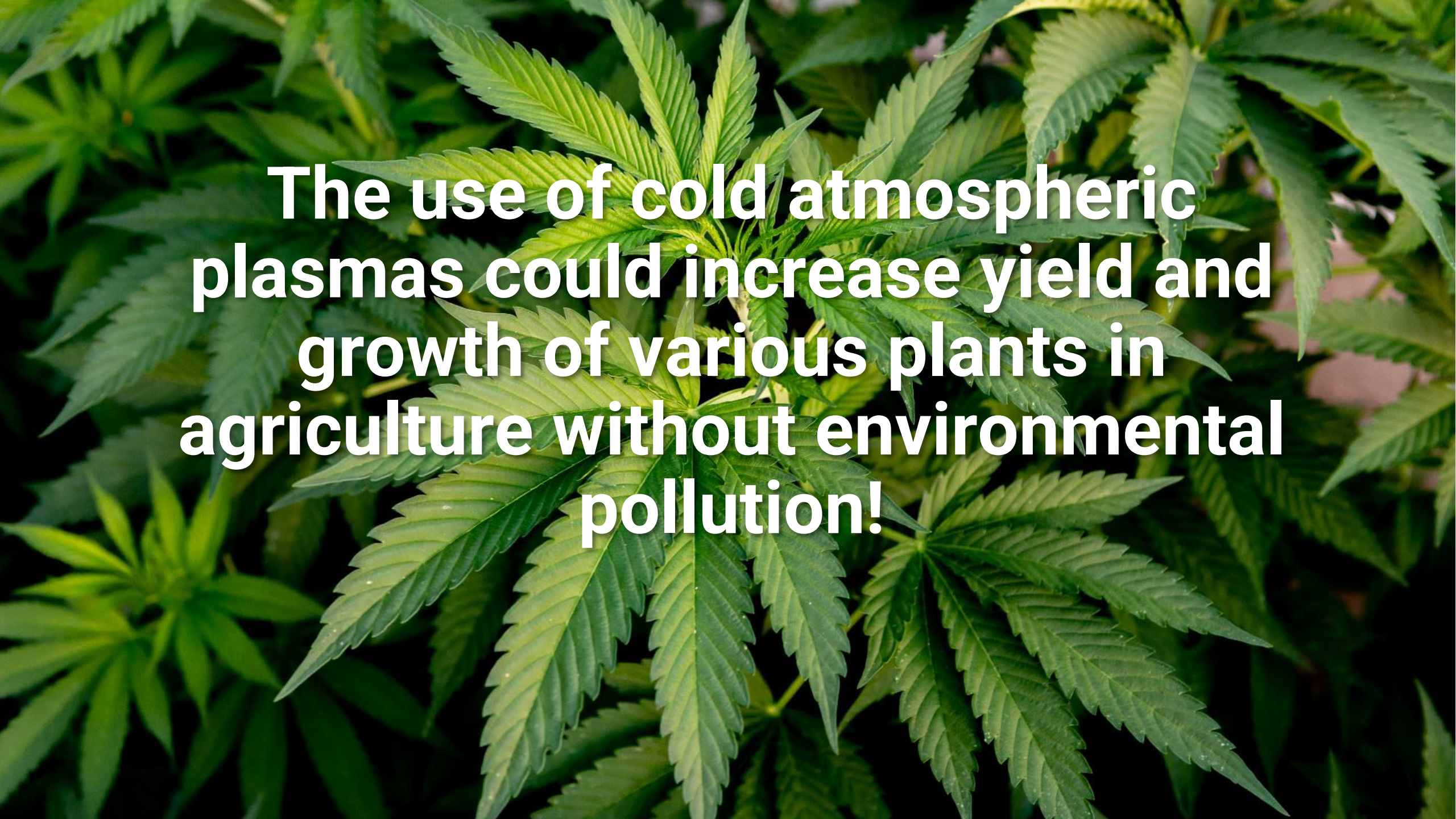
Plasma Agriculture Expert Review of over 70 studies

Plasma Agriculture from Laboratory to Farm: A Review

Attri P., Ishikawa K., Okumura T., Koga K. and Shiratani M.

Processes 2020, 8 (8), 1002

“All the above studies showed that plasma treatment and PTW (Plasma Treated Water) treatment had a positive effect on seeds; it improves the germination percentage, seedling growth, and yield.”



The use of cold atmospheric plasmas could increase yield and growth of various plants in agriculture without environmental pollution!

Our own patents and patent applications & patent license agreements

Plasma device

Owned by: terraplasma & BSH

Priority date: 18.05.2020

Patent application: 102020206222.6

Plasma device

Owned by: terraplasma

Priority date: 19.11.2019

Patent application: EP19210075.8

Electrode arrangement and plasma source for generating a non-thermal plasma, as well as method for operating a plasma source

Owned by: terraplasma

Priority date: 25.01.2019

Patent applications: PCT/EP2019/051851

Method for testing and / or monitoring an electrode arrangement for generating a non-thermal plasma

Owned by: terraplasma

Priority date: 15.06.2018

Patent applications: DE 10 2018 209 729.1, PCT/EP2019/065582

Plasma device for the treatment of body surfaces

Owned by: terraplasma & terraplasma medical

Priority date: 15.06.2018

Patent applications: DE 10 2018 209 735.6, PCT/EP2019/065570

Method for testing an electrode arrangement for generating a non-thermal plasma and plasma source with such an electrode arrangement

Owned by: terraplasma & terraplasma medical

Priority date: 15.06.2018

Patent applications: DE 10 2018 209 730.5, PCT/EP2019/065574

Device and method for treating objects, in particular dental prosthetics and/or teeth

Owned by: terraplasma

Priority date: 05.02.16

Patent: EP 3411085

Visit our patents in detail at:
<https://www.terrapplasma.com/en/about-us/patents/>

Magnetically Organised Plasma Sheet

Owned by: terraplasma

Priority date: 06.08.2015

Patent applications: DE 10 2015 215 051.8, EP: 16751211.0, US 15/750,372

Electrode assembly and plasma source for generating a non-thermal plasma and a method for operating a plasma source

Owned by: terraplasma

Priority date: 23.07.2015

Patent applications: DE 10 2015 213 975.1, JP 2018-522866, EP 16744694.7

Patent: US 10470285B2, CN 107852806A

Method for deactivating preferably odour-relevant molecules and device for carrying out said method

Owned by: Max-Planck Society – terraplasma has excl. worldwide license

Priority date: 05.05.2011

Patent applications: DE 102011100751A1, EP 2704655

Patent: US2014147333

Disinfection appliance, container, use of a container and disinfection method for disinfecting a container, in particular for a food container

Owned by: Max-Planck Society – terraplasma has excl. worldwide license

Priority date: 25.02.2011

Patent: EP 2678046

Electrode arrangement for generating a non-thermal plasma

Owned by: Max-Planck Society – terraplasma has excl. worldwide license

Priority date: 15.03.2009

Patents: JP 5746980, US 9889218, EP 2399432

Plasma source

Owned by: Max-Planck Society – terraplasma has excl. worldwide license

Priority date: 15.05.2007

Patents: EP 2147582, JP 5663819, US 8926920

Plasma source

Owned by: Max-Planck Society – terraplasma has excl. worldwide license

Priority date: 16.09.2005

Patents: EP 1925190, US 7683342