NIBIO
NORWEGIAN INSTITUTE OF BIOECONOMY RESEARCH

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1.Plant nutrients and stress resistance

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TheTurfgrass Research Group







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From the research project 2014 – 2017:

Optimal Application of Nitrogen and Suphur in Autumn for Better Winter Survival of Perennial Grasses – With Emphasis on Turf

The Research Council of Norway

Norwegian Greenkeepers Association

Norwegian Golf Course Owners

Tapiola GC, Finland

Kungliga Drottningholm GC, Sverige

Hauger GC, Norway

Keilir GC, Iceland

Roskilde GC, Denmark

Outline:

1. Plant energy and nitrogen levels
2. Nitrogen and disease resistance
    1. Anthracnose
    2. Red thread
    3. Dollar spot
    4. Take all patches
3. Rhizosphere and fertilization
4. Autumn fertilization and snow mould


FAKTABLAD - Integrert plantevern

Gjødsling som ledd i integrert plantevern

Balansekunst

Sammendrag

Jordbruks verket

Sterf

Comments to the «ideal» fertilizer

Macronutrients	A	B	Micronutrients	A	B
Nitrogen (N)	100	100	Iron (Fe)	0.7	0.2
Potassium (K)	65	30	Manganese (Mn)	0.4	0.06
Phosphorus (P)	14	8	Boron (B)	0.2	0.04
Sulphur (S)	9	5	Zinc (Zn)	0.06	0.05
Calcium (Ca)	7	4	Copper (Cu)	0.03	0.02
Magnesium (Mg)	6	4	Chlorine (Cl)	0.03	*
			Molybdenum Mo)	0.003	*
			Nickel (Ni)**	*	*

* Lack of reliable data ** Very low requirement, can be omitted from fertiliser

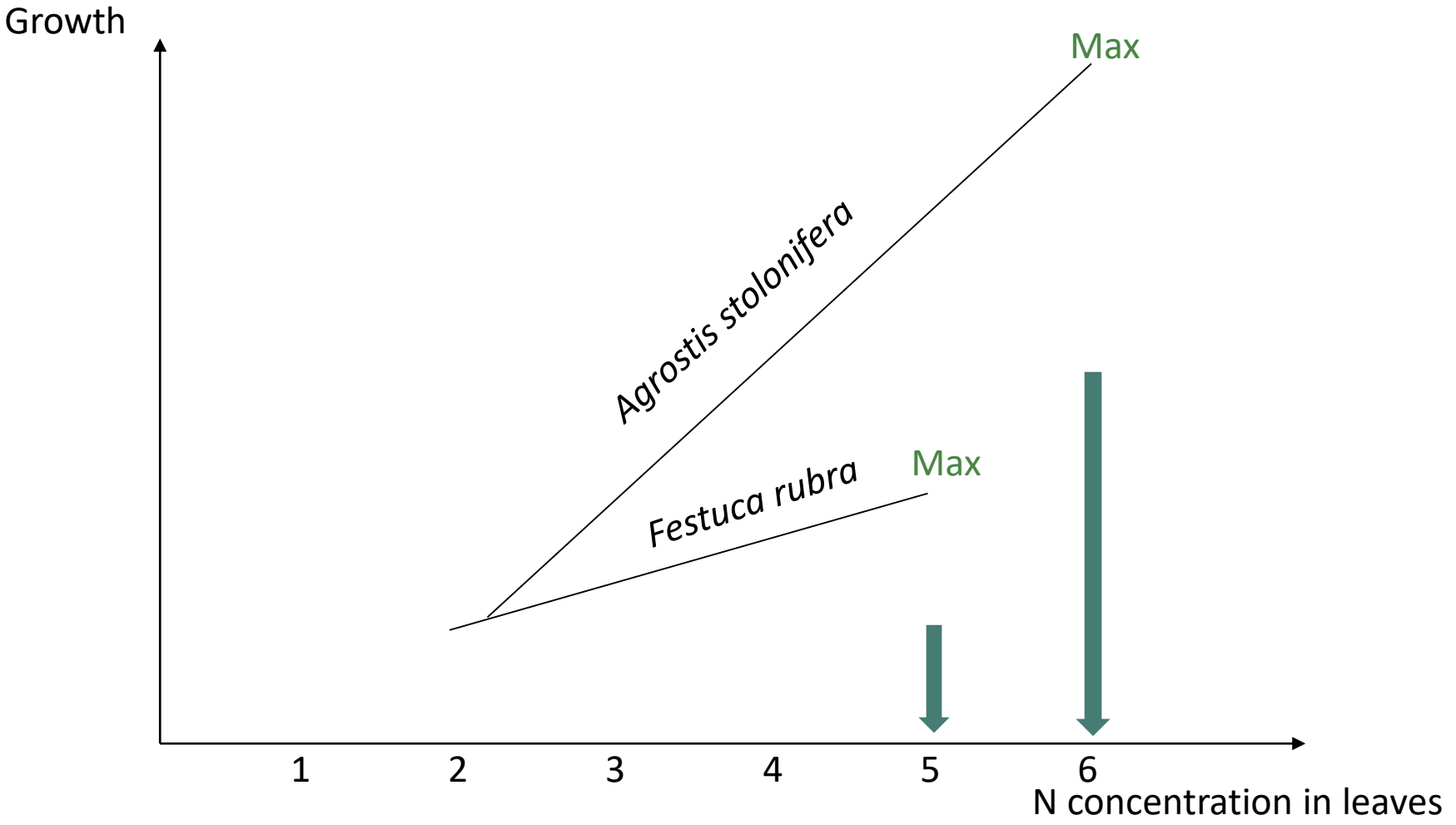
All numbers are related to the N level.
N is the minimum factor in this recipe and will control the growth rate

The need for Ca is low. Most plants contain much more than this.
("Luxury uptake" that cause problems for plants with perennial leaves, like Rhododendron)

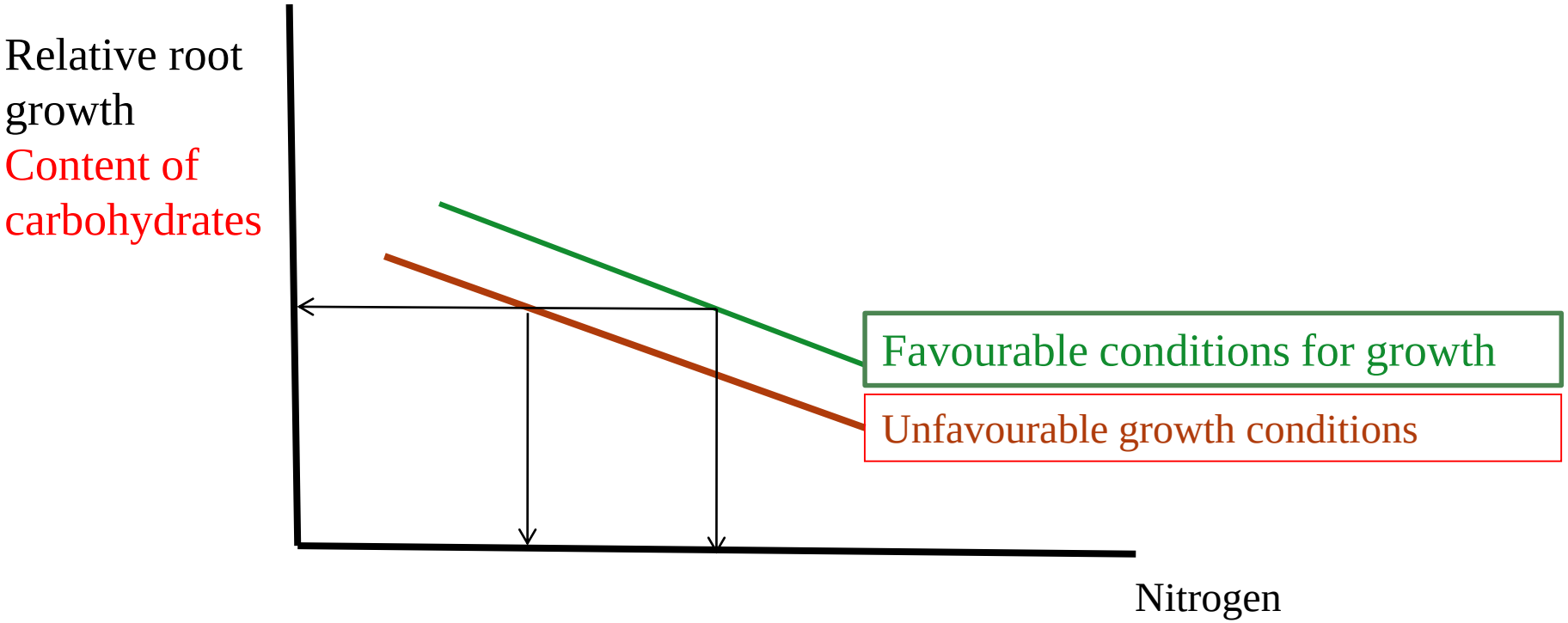
Uptake of Mn (and Zn) is negatively related to soil pH, and extra applications should be considered when pH is extreme.

Thompson, K et al. 1997: A comparative study of leaf nutrient concentrations in a regional herbaceous flora. New Phytol. 136, 679 – 689

Grass growth CAPACITY and nitrogen status



Carbon allocation and n-rates

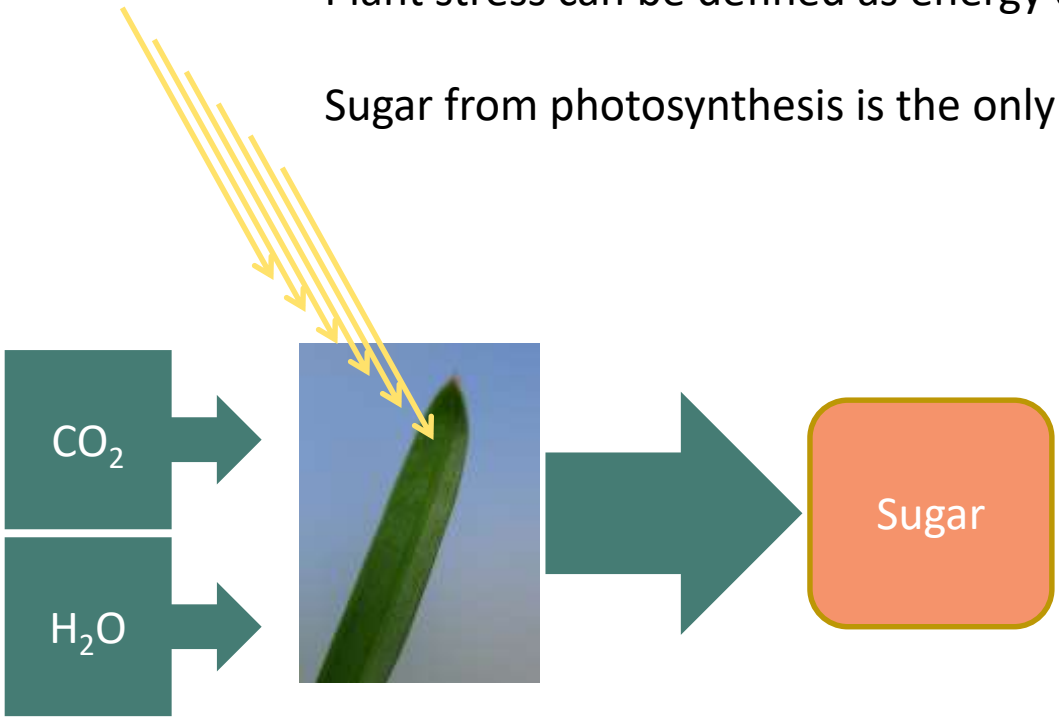


The N-flux has impact on the carbohydrate content in the plants, and the carbohydrates are the energy source that can be used to resist stress situations.

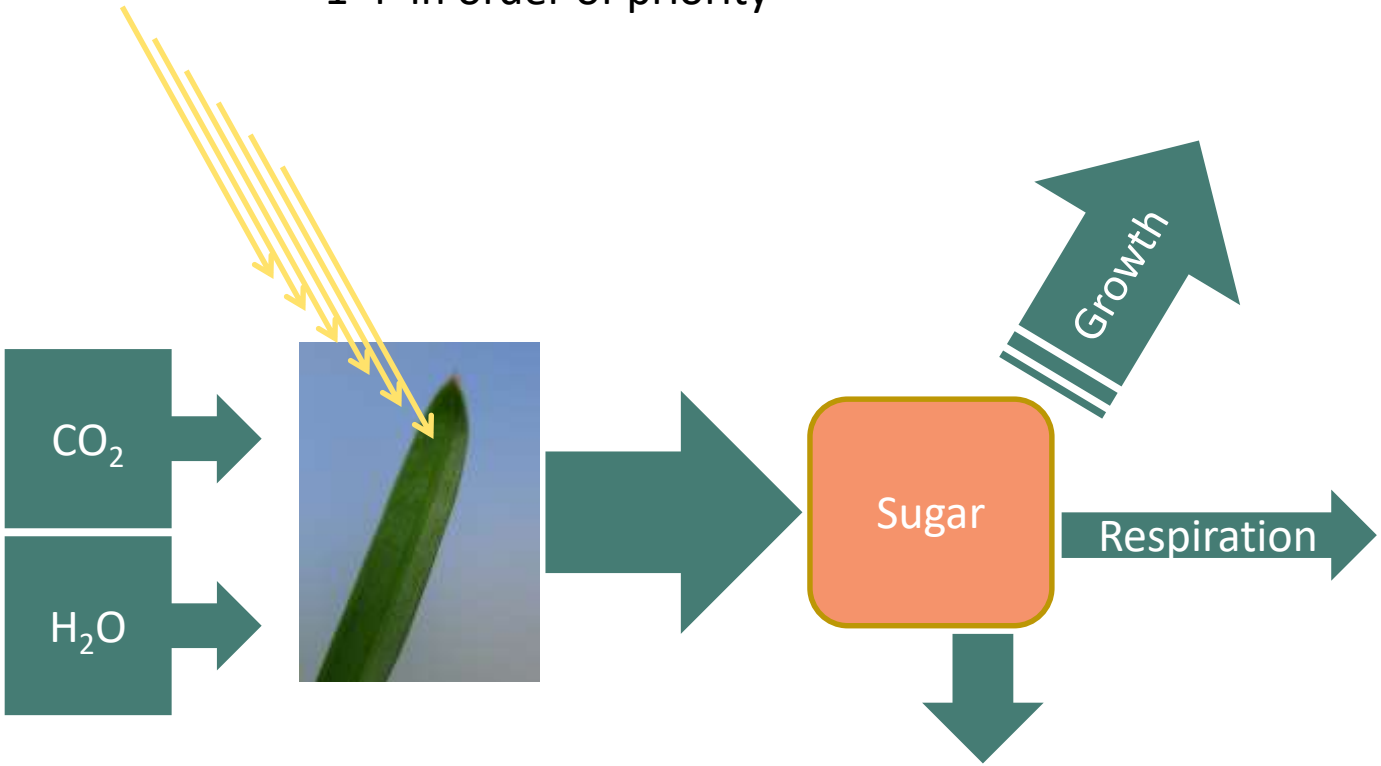
Greenkeepers are «carbohydrate managers».

Plant stress can be defined as energy depletion.

Sugar from photosynthesis is the only energy source for the plants



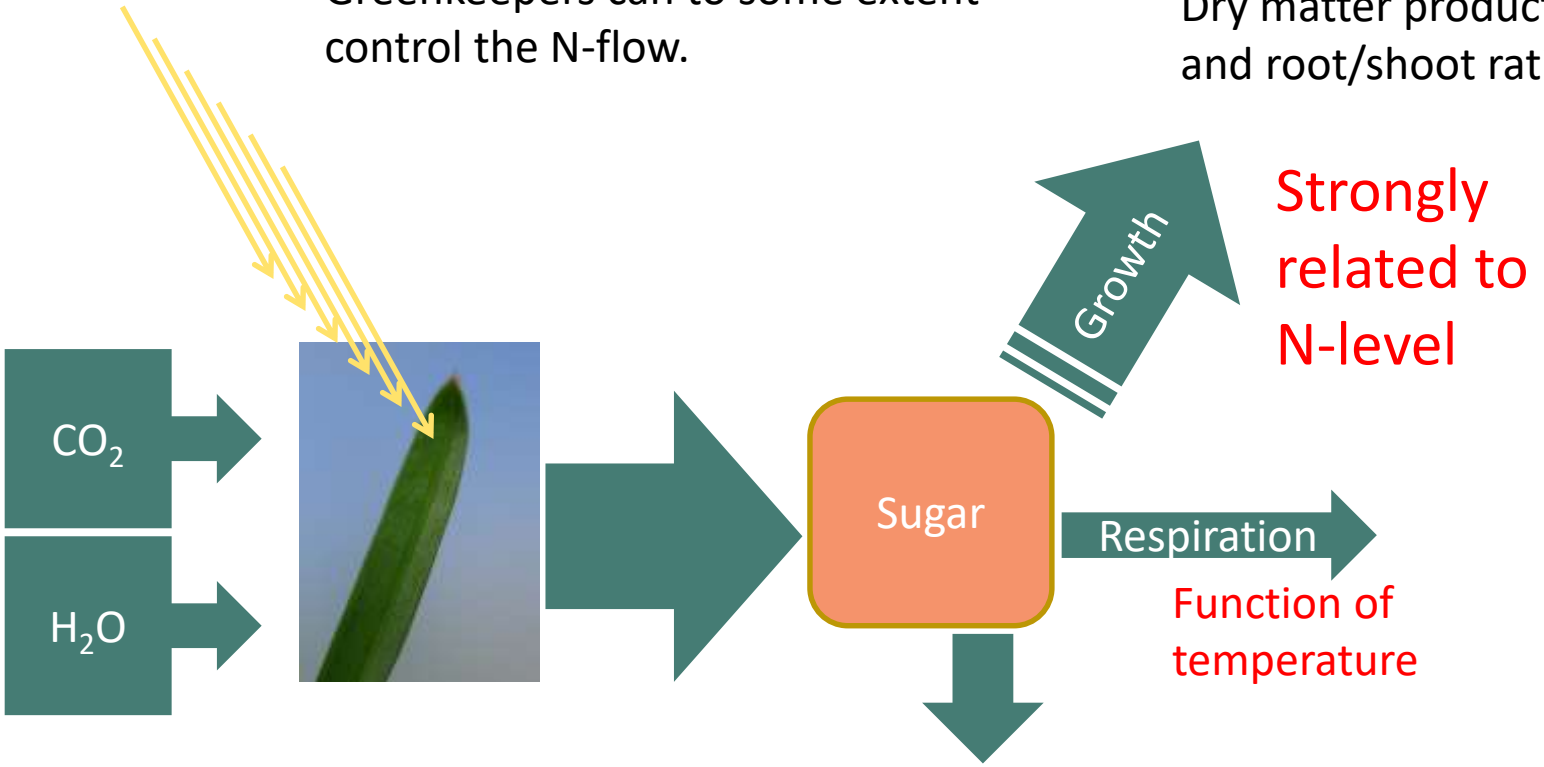
Sugar is used for all processes in the plants
(flowering and seed production are not mentioned here).
1-4 in order of priority



1. Uptake and transport of nutrients and metabolites
2. Defence
3. Symbiosis
4. Root exudates

Growth and respiration are related to environmental factors.
Greenkeepers can to some extent control the N-flow.

Dry matter production and root/shoot ratio



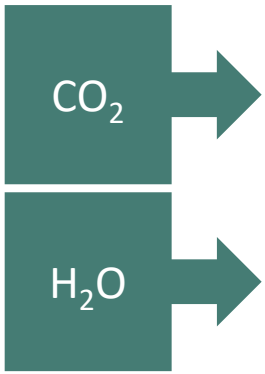
Strongly related to N-level

Function of temperature

1. Uptake and transport of nutrients and metabolites
2. Defence
3. Symbiosis
4. Root exudates

Factors that reduce/influence on the plant's growth capacity:

- Wind
- Diffusion from soil

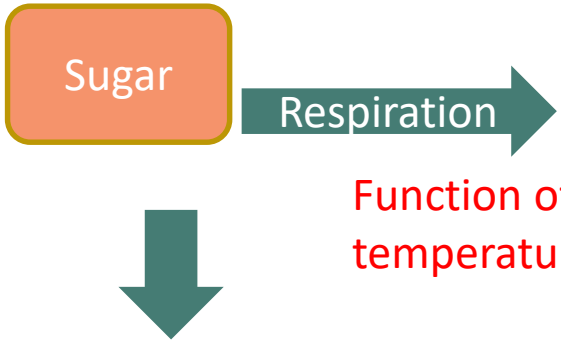


- Low cut
- Wear

- Drought
- Dry spots
- Shallow roots
  - Compaction
  - Diseases
  - Oxygen depletion

By controlling (reducing) the N-rate, the greenkeeper can avoid plant stress caused by unfavourable growth conditions and keep the plants alive

Reduce N-level



Function of temperature

1. Uptake and transport of nutrients and metabolites
2. Defence
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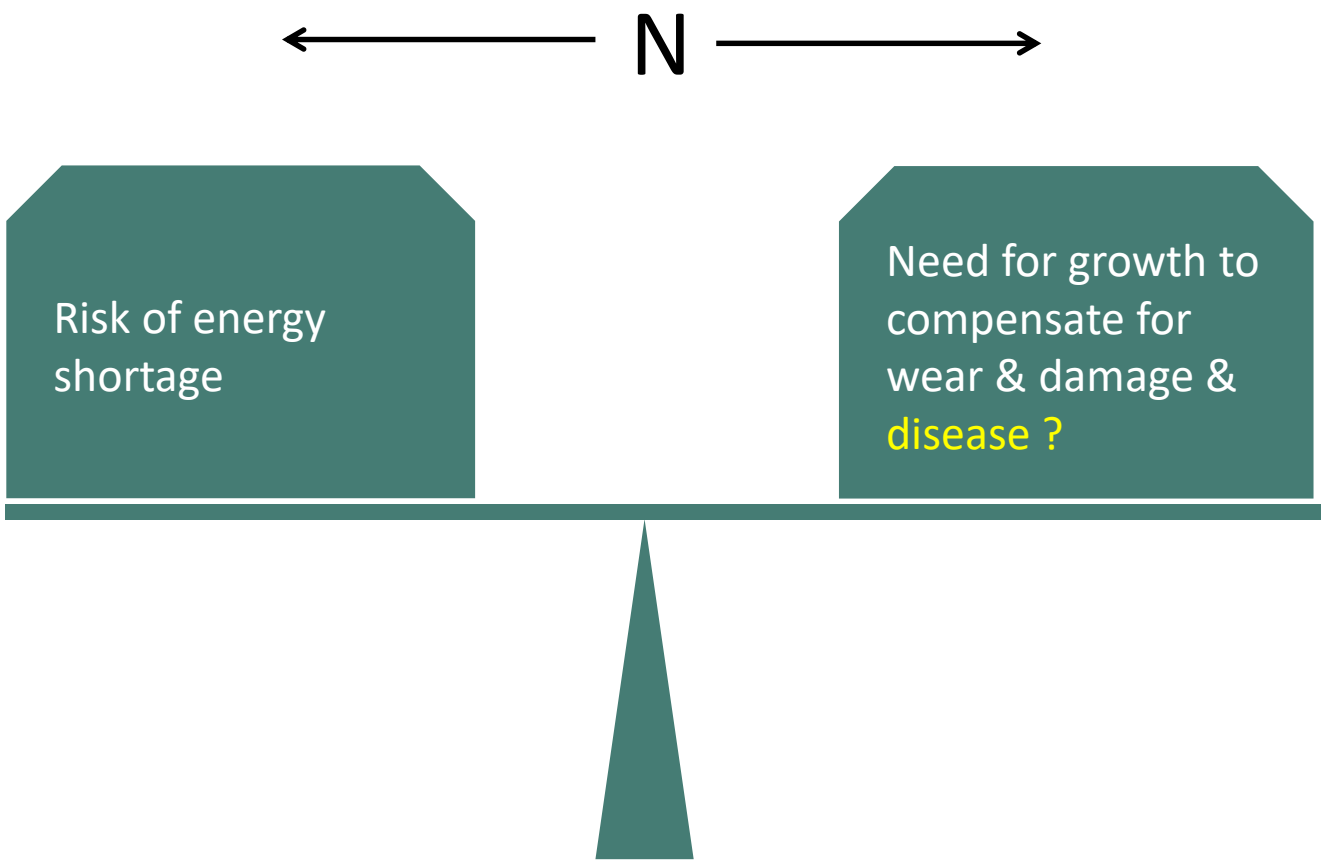
Finding the optimal ferilization rate is a delicate and difficult balance



Nitrogen and turf grass diseases

Reduced by increased N

- Antrachnose *(Colletotrichum graminocola)*
- Red thread / pink patch *(Laetisaria fuciformis & Limnomyces roseipellis)*
- Take all patch *(Gaeumannomyces graminis)*
- *Dollar spot (Sclerotinia homoeocarpa)*

Stimulated by high N rate?

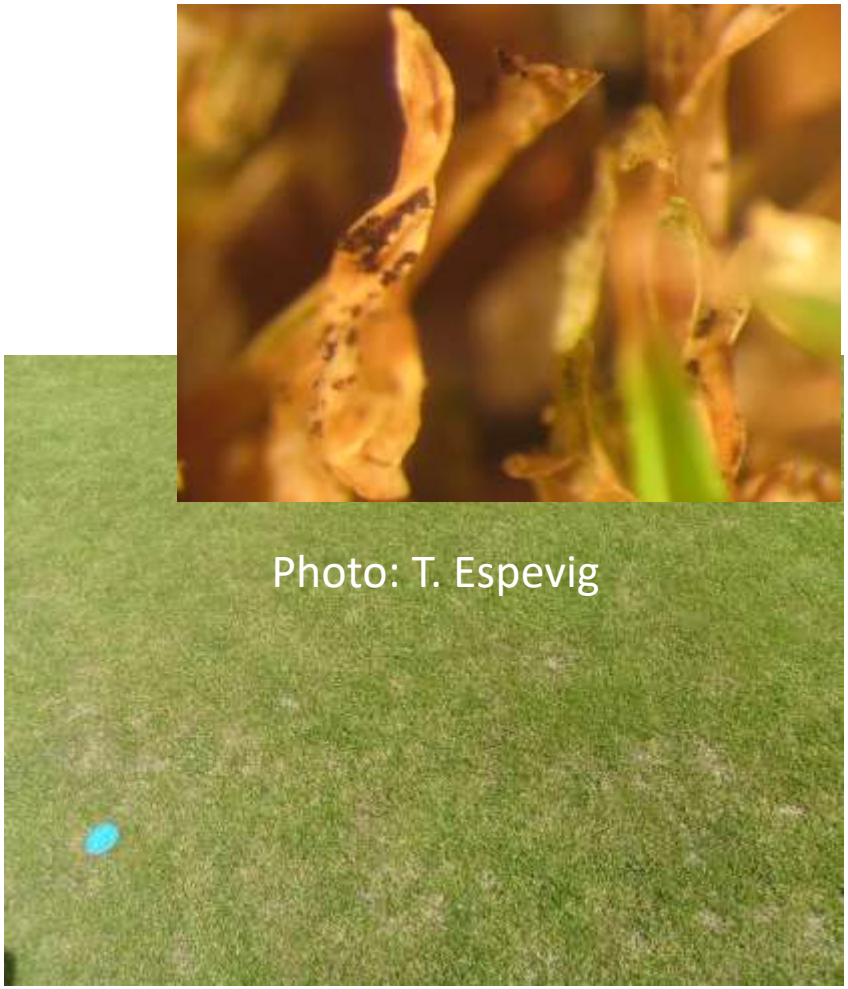
- Pink snow mould / microdochium patches (*Microdochium nivale*)

Antrachnose (*Colletotrichum graminicola*)

Disease fact

Can attack several plants but typically annual meadow-grass (*Poa annua*) in summer stress situations.

Recommendation: Increased mowing height (top-dressing) and nitrogen rates.



Red thread /pink patch

Laetisaria fuciformis & Limnomyces roseipellis

More common on fairways than greens. Attacks red fescue (*Festuca rubra*) and ryegrass (*Lolium perenne*)

Minor problem for playing quality.

Disappears usually when N-status is increased.

Dollar spot (*Sclerotinia homoeocarpa*)

Disease fact

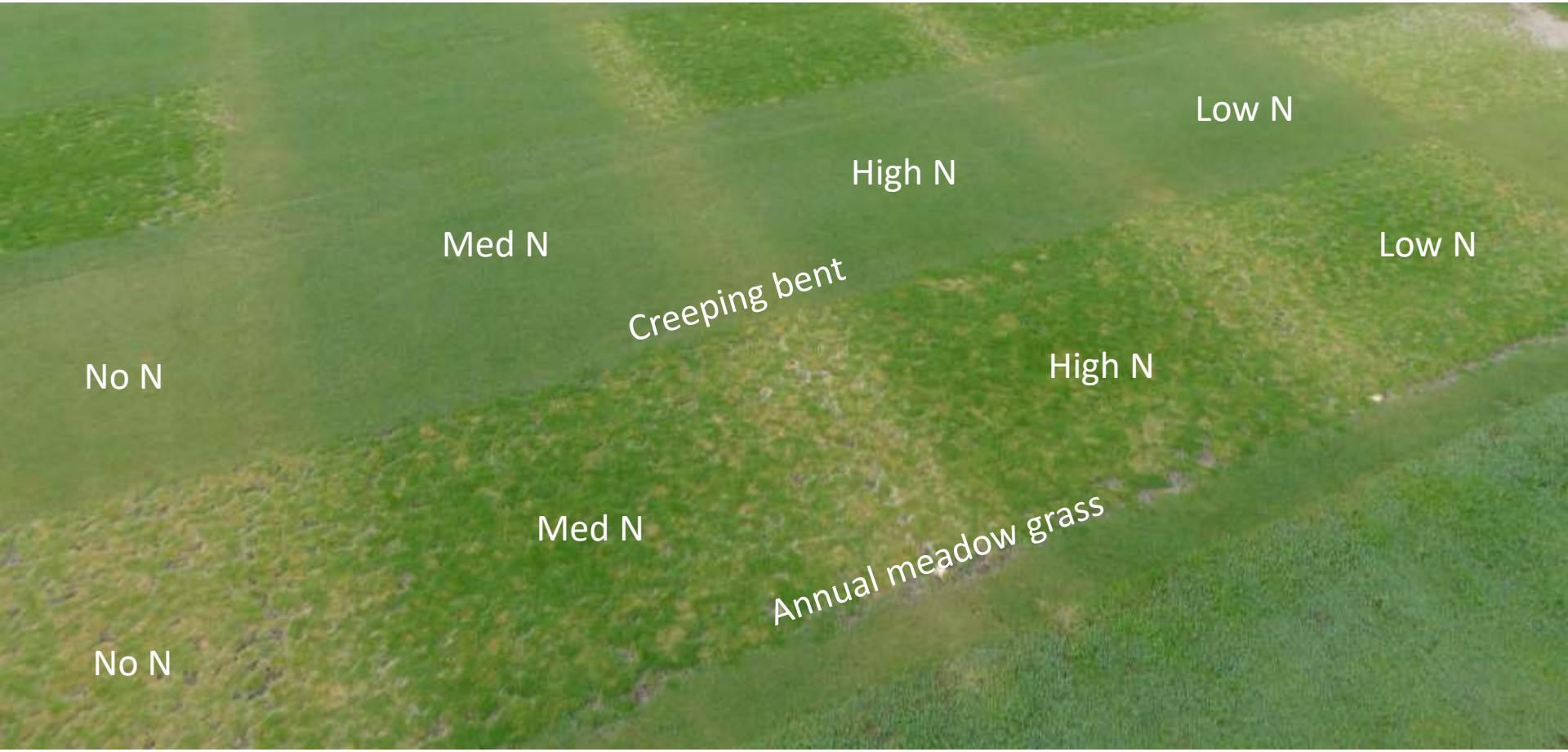
- New disease in Scandinavia
- Attacks several grass species when weather is warm.
- Most commonly starting in for-greens / fairways
- Spread with infected grass/thatch !
- Symptoms reduced with frequent irrigation and increased N rates. Rolling greens may help.

Photos: Karin Normann

Take all disease *Geaumannomyces graminis* is related to soil nutrients

- Fungi reduce root function.
- Severety reduced if
  - pH < 6.2
  - Application of manganese (Mn) (2.5 kg Mn /ha every year)
- Symptoms are reduced by frequent irrigation and increased fertilization level.

Microdochium patch /pink snow mould (Microdochium nivale) and N-levels?



Effect of different fertilization levels (N) Landvik 7 October 2014

Autumn application of fertilizers

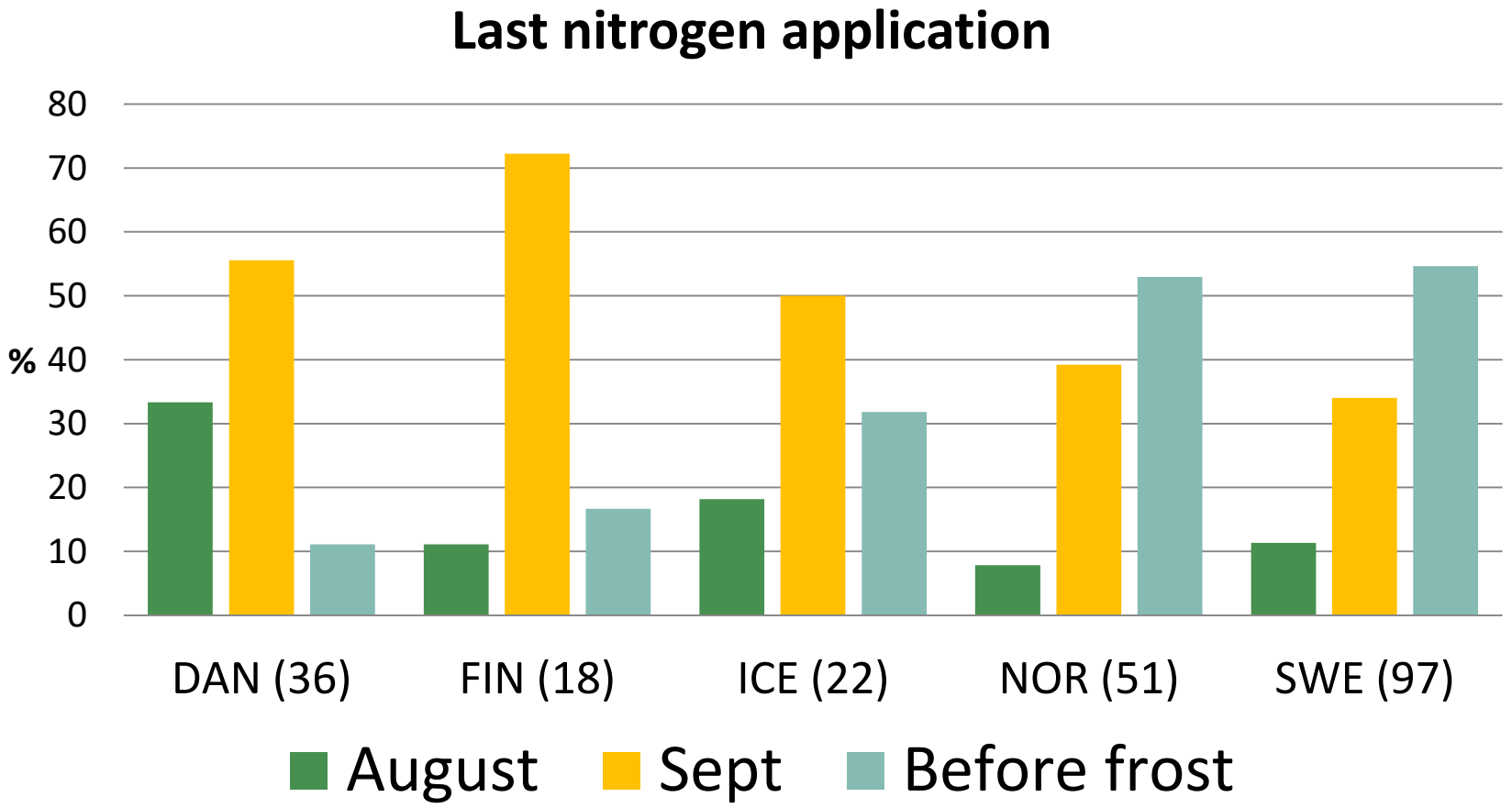
Background:

- Tradition of high potassium (K) and iron (Fe) applications
- American way: «Late fall fertilization» with nitrogen
- Research project 2008-2010 with late fall fertilization (20 kg N/ha) on 18 Nordic golf courses. Mainly positive results.
- Environmentally acceptable to use nitrogen in the late autumn?

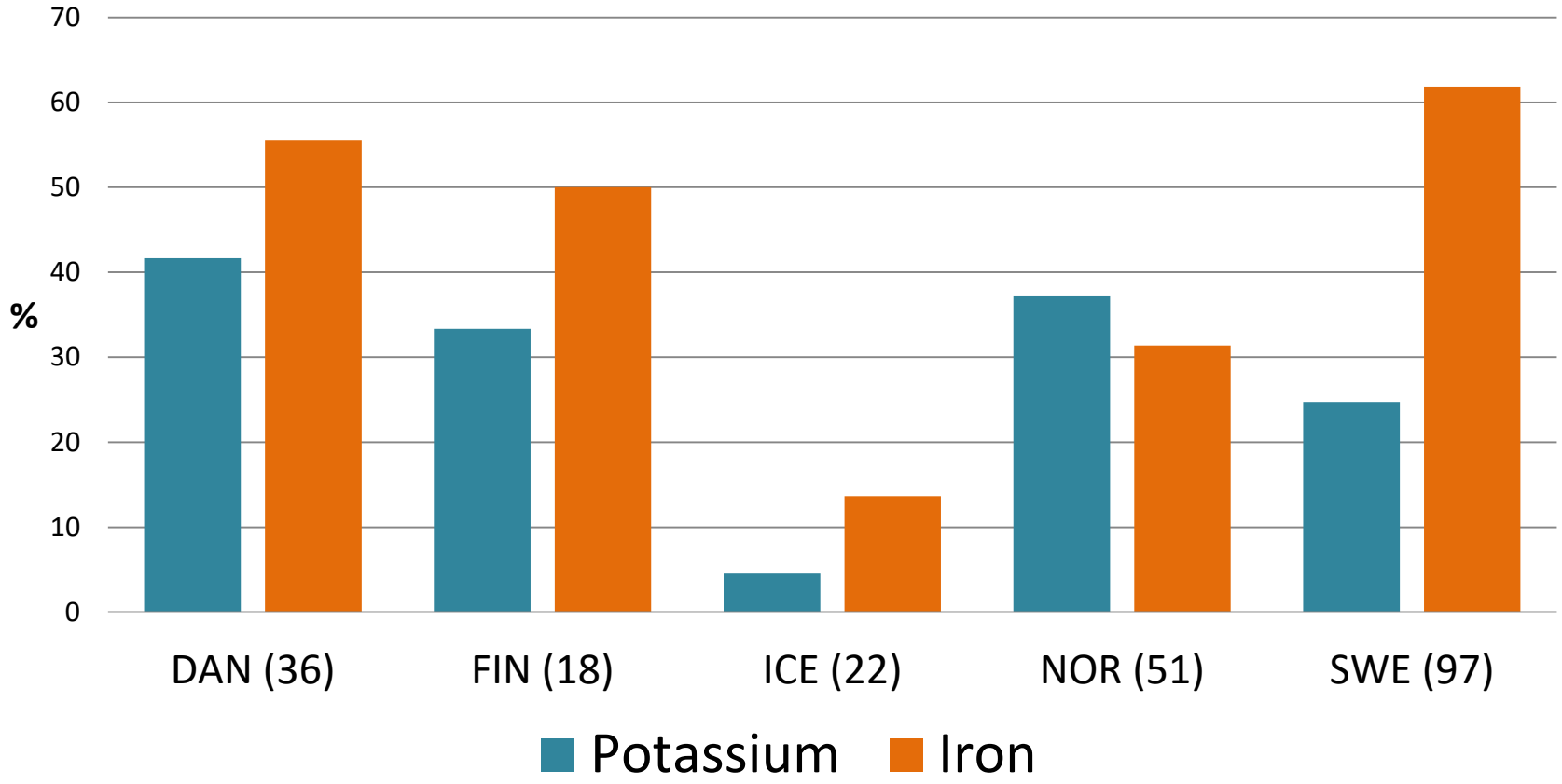
Lloyd et al 2011. Low-temperature Nitrogen Uptake and Use of Three Cool-season Turfgrasses under Controlled Environments.HortScience 46 (11):1542-1549

Autumn fertilization practice 2015.

Results from NGF/STERF/NIBIO survey Winter Injuries on Nordic golf courses.



Additional potassium or iron



NGF/STERF/NRC/NGA/FNG project:

Optimal application of nitrogen and sulfur in autumn for better winter survival of perennial grasses – with emphasis on turf

Short name: AUTUMN APPLICATIONS

- Parallel field experiments at NIBIO Landvik and NIBIO Apelsvoll.
- Landvik: on a lysimeter for nitrogen leakage analyses
- Apelsvoll: half the green in shade

Lysimeter green where drain water can be colleced from each experiment plot

Experiment over two winters 2014-2016

Two grass species:

- Creeping bent (CB) *(Agrostis stolonifera)*
- *A*nnual meadow-grass (AMG) *(Poa annua)*

Established every year by the end of June. CB 'Independence' seeded 7g/m2.

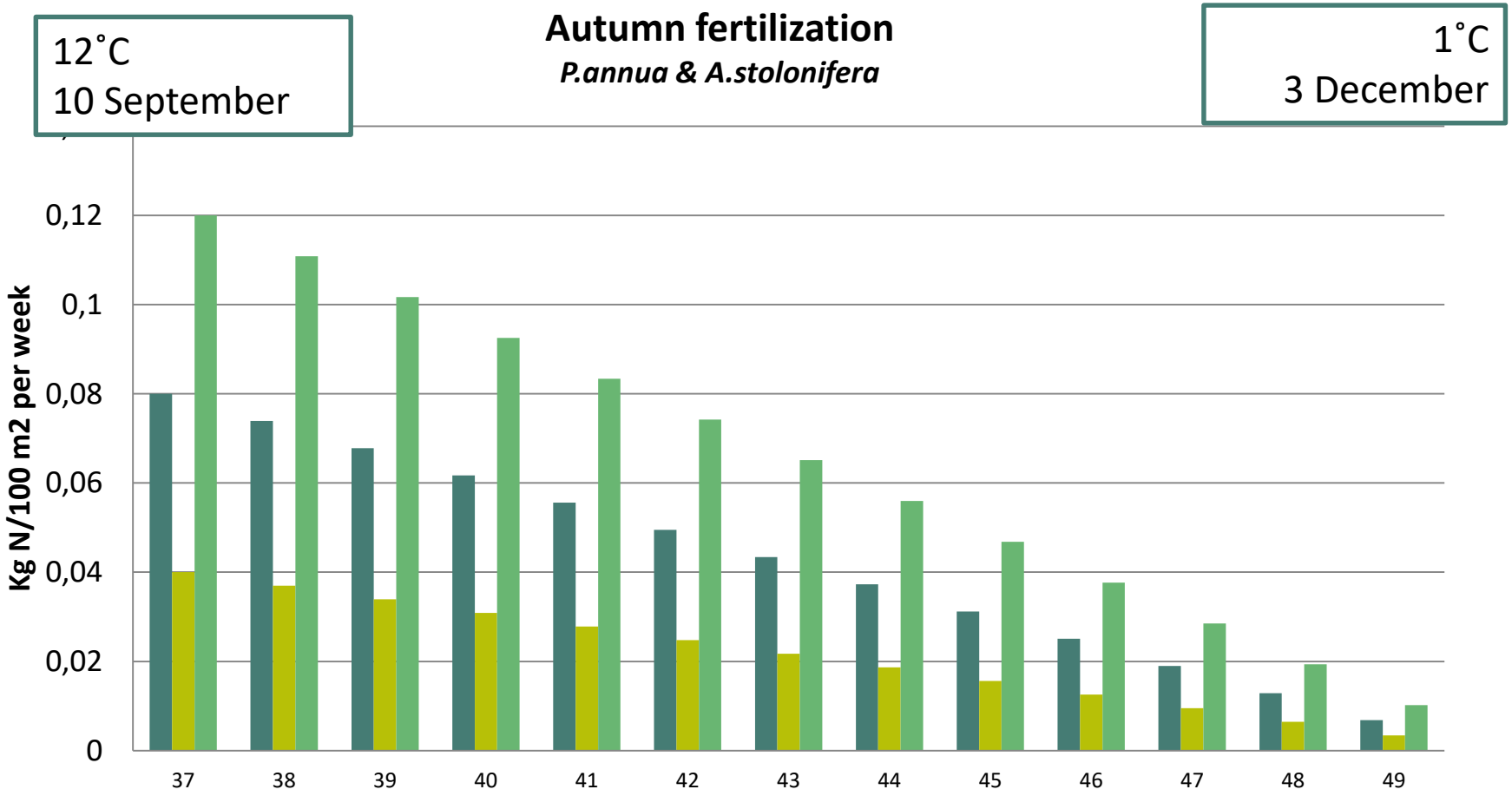
AMG established from 8 kg hollowcore plugs from Borregaard GC, Sarpsborg (50 year old Poa green)

Fertilzer treatments:

Content of nutrients in the six different fertilizers.											
Treatment	N	P	K	Mg	Ca	S	Fe	Mn	Zn	Cu	Mo
1. No N	0.00	0.16	0.76	0.08	0.09	0.11	0.011	0.0043	0.0023	0.0005	0.00036
2. Low N	0.40	0.16	0.77	0.08	0.09	0.14	0.011	0.0043	0.0023	0.0005	0.00036
3. Med N	0.80	0.16	0.77	0.08	0.09	0.14	0.011	0.0043	0.0023	0.0005	0.00036
4. High N	1.20	0.16	0.77	0.08	0.09	0.14	0.011	0.0043	0.0023	0.0005	0.00036
5. No S	0.80	0.16	0.77	0.08	0.09	0.0	0.011	0.0043	0.0023	0.0005	0.00036
6. High S	0.80	0.16	0.78	0.08	0.09	1.27	0.011	0.0043	0.0023	0.0005	0.00036

«Home made» nutrient mix. The rates of other nutrients were sufficient even at the high N content fertilizer.
Differences marked in red letter.

Experiment treatments in project Autumn application of fertilizer:
Weekly application of fluid fertilizer at declining rates in the period when air temperature was expected to dicrease 12-1 ˚C



Overview of the AUTUMN APPLICATION experiments

Factors tested at both locations:

- Species
- N-level
- S-level

WP 1-2 (2014-2016)

Field experiment Sun versus shade

samples

Field experiment on lysimeter. N-leakage

samples

WP 3-4 (2014- 2016)

Lab tests:
1.Resistance to *M.nivale*
2. Freezing resistance
3. Resistance to suffocation

WP6 (2016-2017)

Full scale demonstration trials at golf courses based on results from the scientific experiment

New data from this reseach project will be marked

without other references.

Sulphur / Sulphate in the autumn?

We have seen recommended useage of

- Ammonium suphate
- Iron sulfate
- Manganese sulfate
- Calcium sulfate

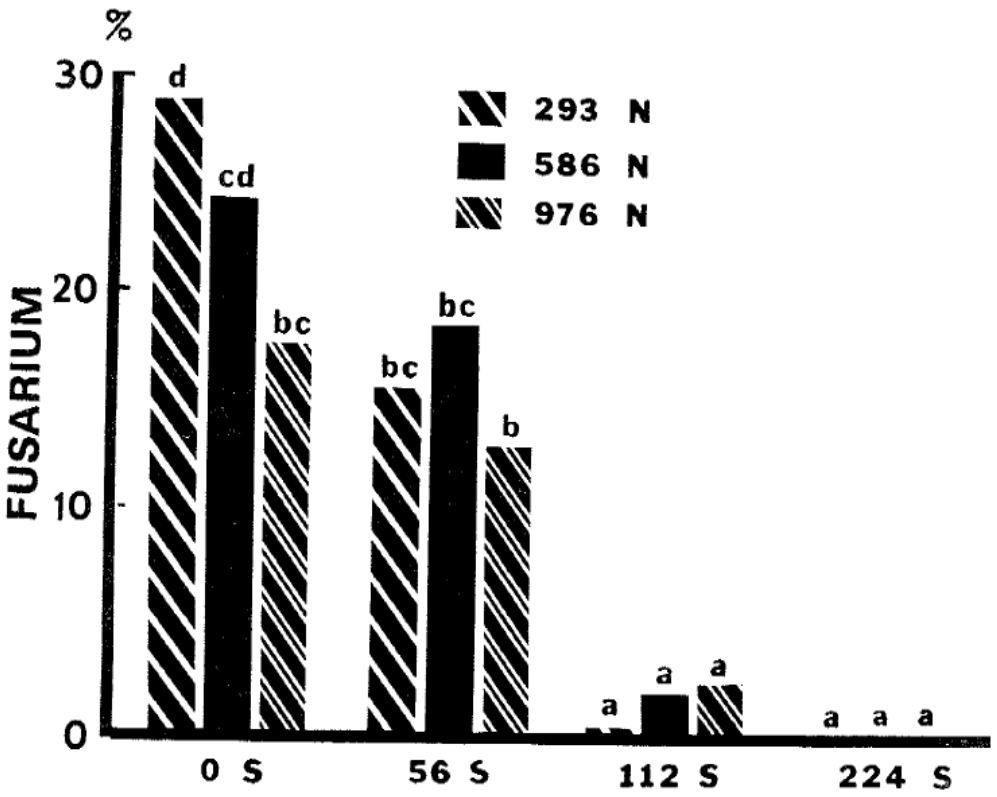
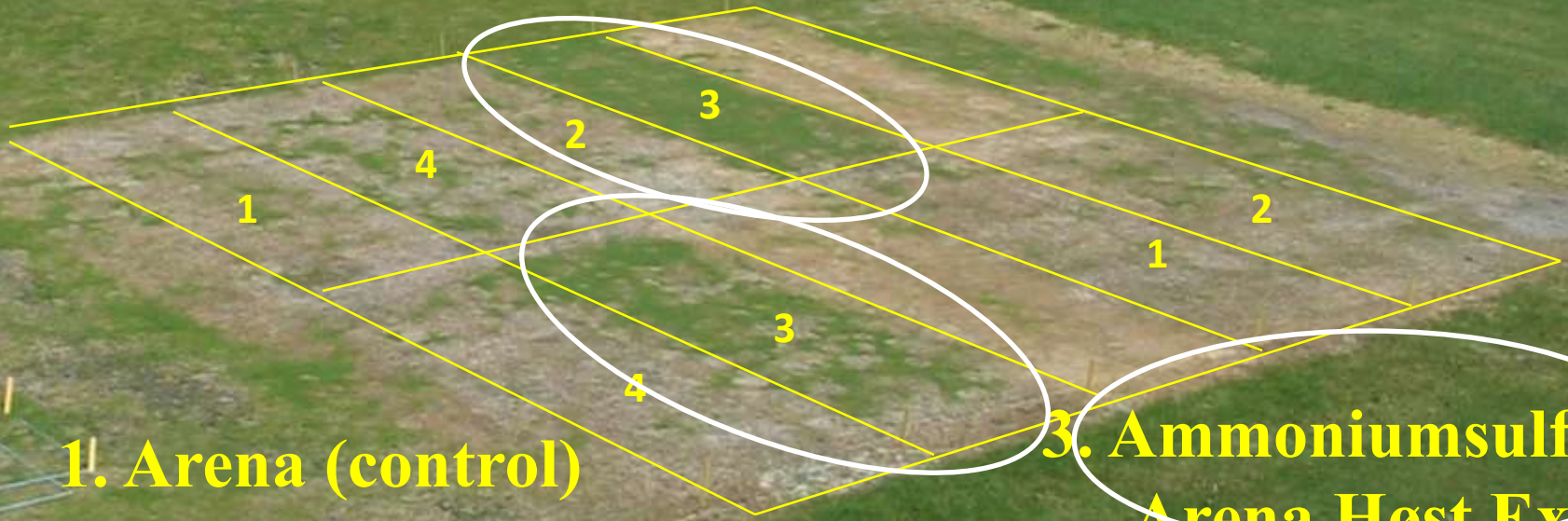


Fig. 2. Average percent fusarium patch disease in Astoria bentgrass putting turf when fertilized with combinations of 0, 56, 112 or 224 kg/ha S and 293, 586 or 976 kg/ha N at Puyallup, Washington. Bars designated by the same letter are not significantly different by Duncan's Multiple Range Test at the 0·05 level of confidence.

Brauen et al. The effects of Sulphur in combinations with Nitrogen, Phosphorus and Potassium on colour and Fusarium Path disease of Agrostis butting green turf. Washington St Univ. Proj. 1538

Photo Apelsvoll, 8 May 2006

Can sulphate reduce snow mold ?



1. Arena (control)

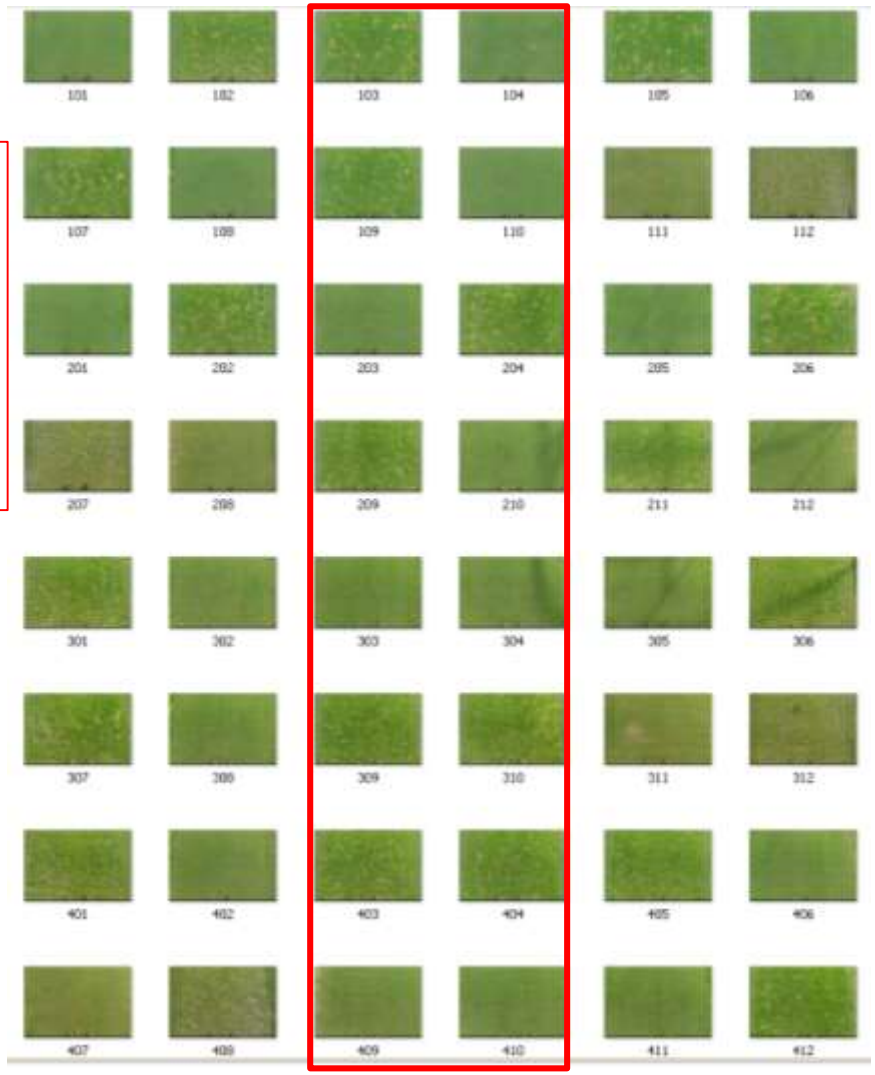
2. Arena + 1x GoGreen

3. Ammoniumsulfat + Arena Høst Extra

4. Arena + 2x GoGreen

Normal N
S as sulphate

S= 0
S:N = 1.6
(8.4 g/m2 in autumn)



Picture Landvik
October 2014

No effect of sulfate in field at Landvik

NEWS from Autumn application

Field observations of disease (% spots) at Landvik

Species	Treatment	2014 Autumn	2015 Spring	2015 Autumn	2016 Spring
A. stolonifera	No SO_4	1.1	2.5	0.1	0.0
A. stolonifera	Excessive SO_4	1.0	2.8	0.1	0.0
P. annua	No SO_4	14.2	57.9	0.1	1.8*
P. annua	Excessive SO_4	12.0	62.1	0.1	0.4
Number of observations		10	2	13	1

*one of three plots had 3% disease

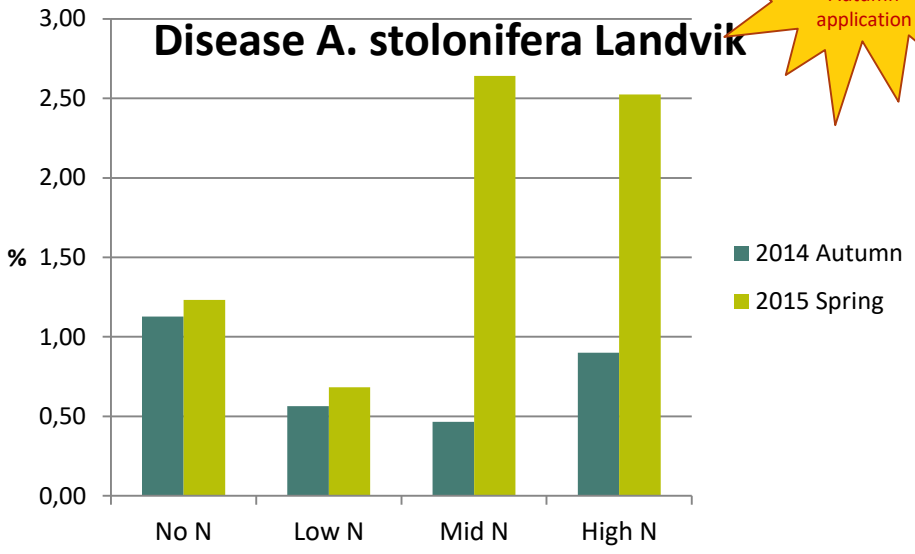
Effects of fertilization levels on Microdochium patches and pink snow mould (both caused by M.nivale)

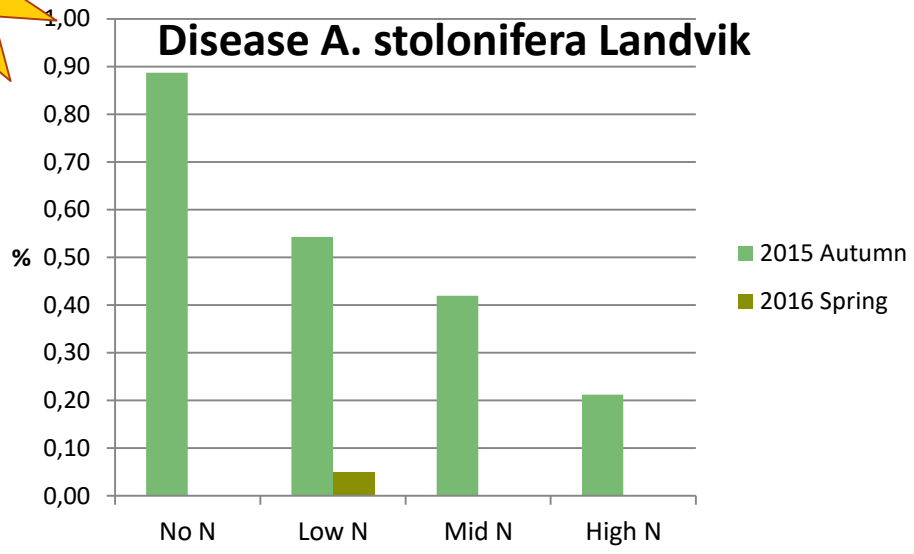
Results on next picture

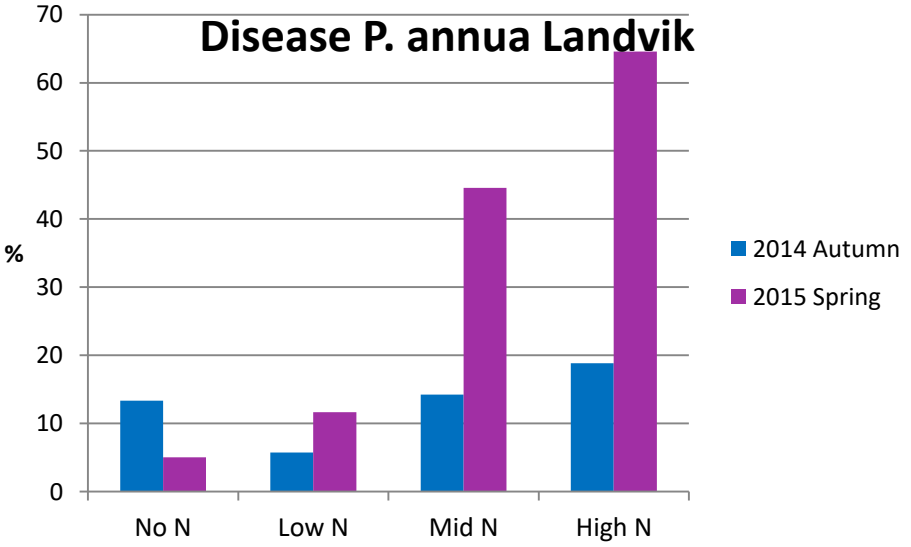
First year, no fungicide

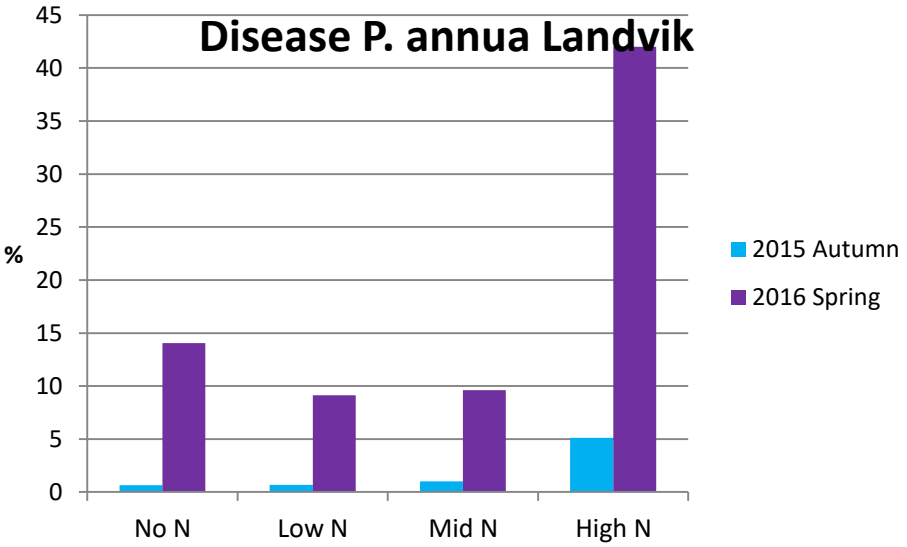
NEWS from Autumn application

Second year, 1 kg/ha Delaro 31st Sept









Conclusion

High rates of fertilizer (nitrogen) in the autumn inccrease the risk of Microdochium pathces in the autumn and pink snow mould in the spring.