

How effective are undersown crops and strip-tillage at mitigating soil erosion and pesticide transfer in maize crops ?

Results and insights from field trials

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Background

 Spring crops (maize, potato, beet) are susceptible to runoff and erosion



Source : C. Bielders

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 Sediment-laden runoff from agricultural land causes infrastructure and environmental **damage**



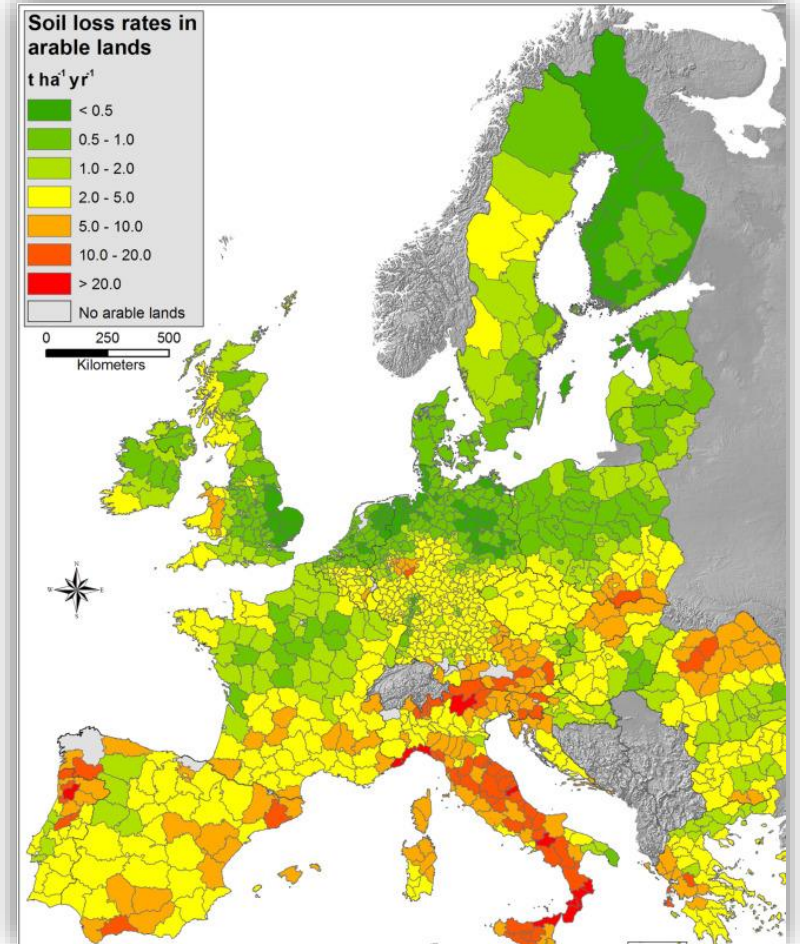
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 **Soil loss rates** under « conventional » agricultural practices are often not sustainable



*Mean soil loss rates for arable lands
in the EU (Panagos et al., 2015)*

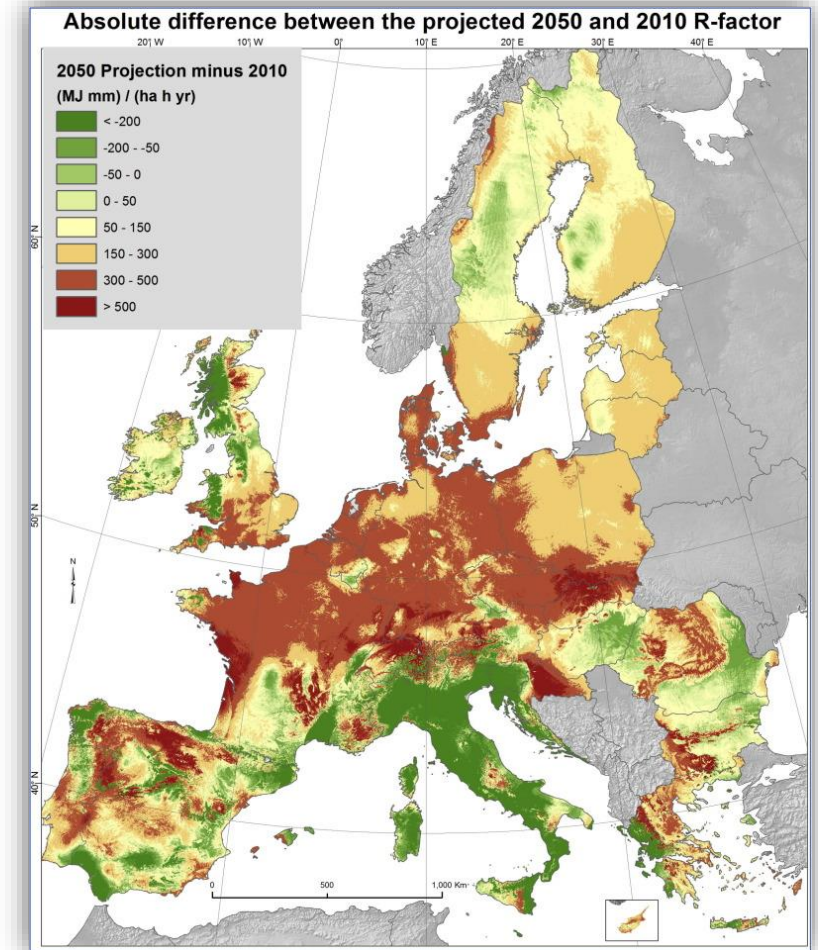
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 **Climate change** likely increases rainstorm frequency and intensity



Difference between projected 2050 and 2010 rainfall erosivity (Panagos et al., 2017)

Background

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 Sediment-laden runoff from agricultural land causes infrastructure and environmental damage

 Soil loss rates under « conventional » agricultural practices are often not sustainable

 Climate change likely increases rainstorm frequency and intensity

 Need to develop more sustainable farming practices, mitigating surface flow hazards

Emerging conservation cropping practices in maize

Undersowing : Intercropping maize with red fescue (*Festuca rubra*) or white clover (*Trifolium repens*), sown in-between rows, at the same time as maize



Maize + Fescue



Maize + Clover



Maize

Undersown crops are expected to :

- Protect soil from raindrop impact
- Increase soil infiltration capacity
- Provide a cover crop after maize harvest
- Improve soil structure in the long term



Reduction in runoff, erosion, and associated pesticide transfer

Emerging conservation cropping practices in maize

Strip-tillage : only maize rows are tilled (tine), leaving between-row area untilled



Strip-tiller. Source : CIPF



Strip-tilled soil

*Conventionally
tilled soil*

Expected benefits of reduced tillage : crop residues, macroporosity, less fine soil, etc



Reduction in runoff, erosion, and associated pesticide transfer

Experimental setup

🌱 Experimental unit : hydrologically isolated subplot of 60 m², on sloping agricultural land, with silt-loam or sandy-loam soils

🏠 Fully randomized block design with 3 replicated subplots/treatment

🧪 Runoff and sediment are collected in a tank downstream

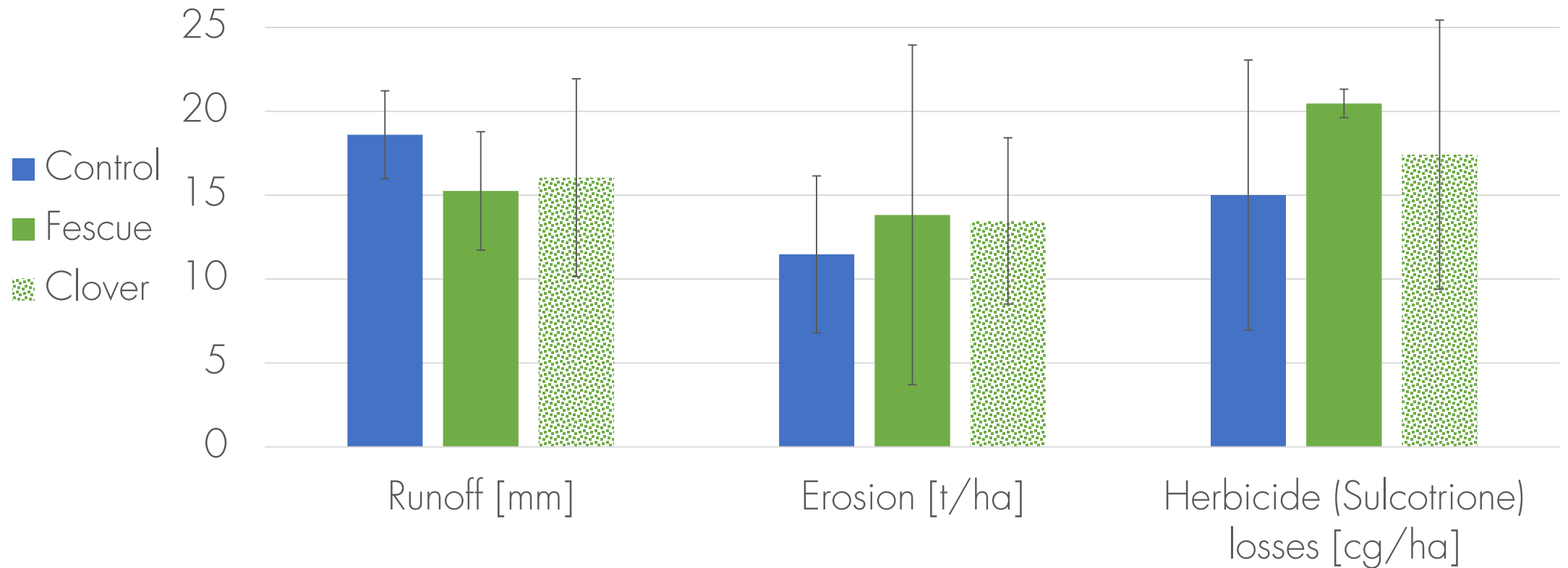
Cropping season	Trial sites (treatments)		
2021	Ottignies (undersowing, strip-tillage, control)	Rebecq (undersowing, control)	Bonlez (strip-tillage, control)
2022		Ittre (undersowing, strip-tillage, control)	



Experimental subplot

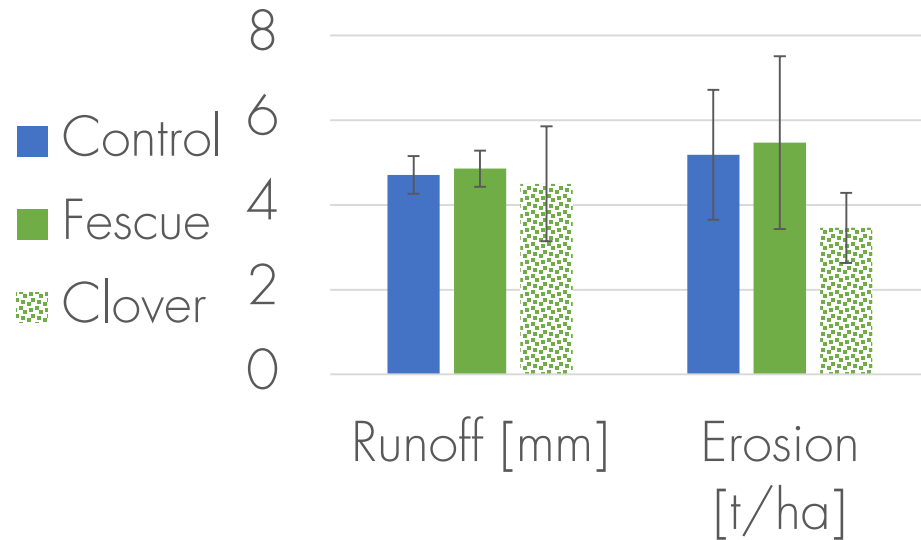
Results : undersown crops

Cumulative runoff, soil and herbicide losses at Ottignies in 2021 (10/5 - 17/9)

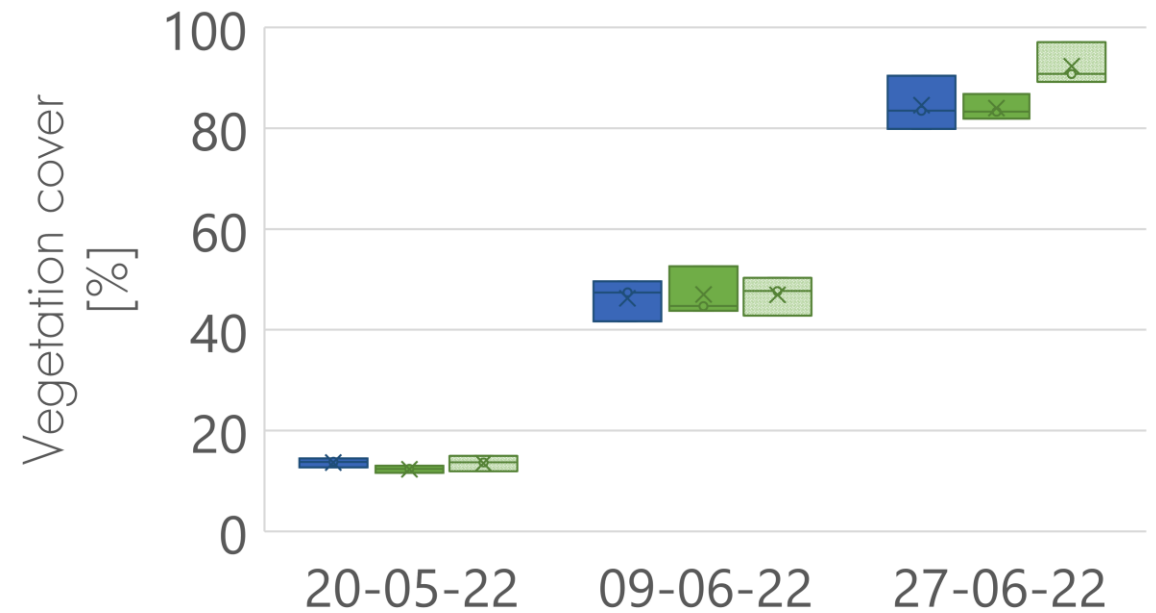


Results : undersown crops

Cumulative runoff, and soil losses at Ittre in 2022 (27/4 - 24/8)



Evolution of vegetation cover at Ittre in 2022



- Undersowing maize **did not mitigate** runoff and erosion during the maize cropping season.
- There is no substantial increase in vegetation cover nor infiltration capacity (not shown).

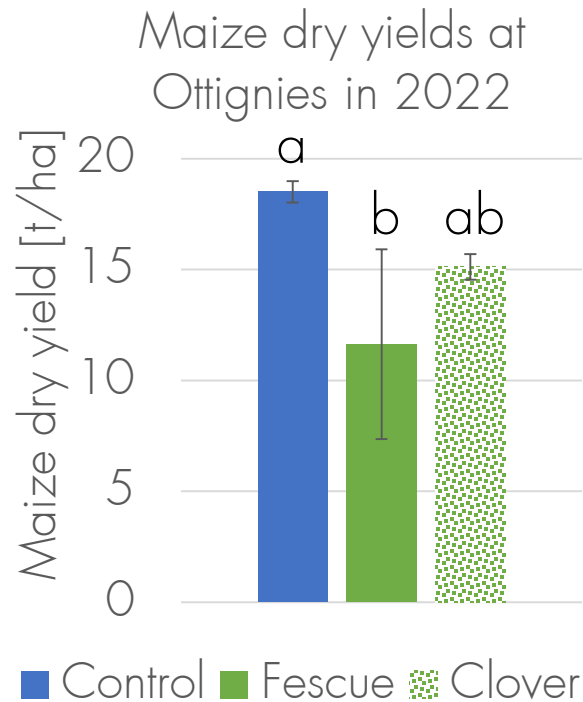
Results : undersown crops



Weed control is challenging because of *sulcotrione* high selectivity

Weeds can survive herbicide spraying :

The undersown crop can be killed by the herbicide :

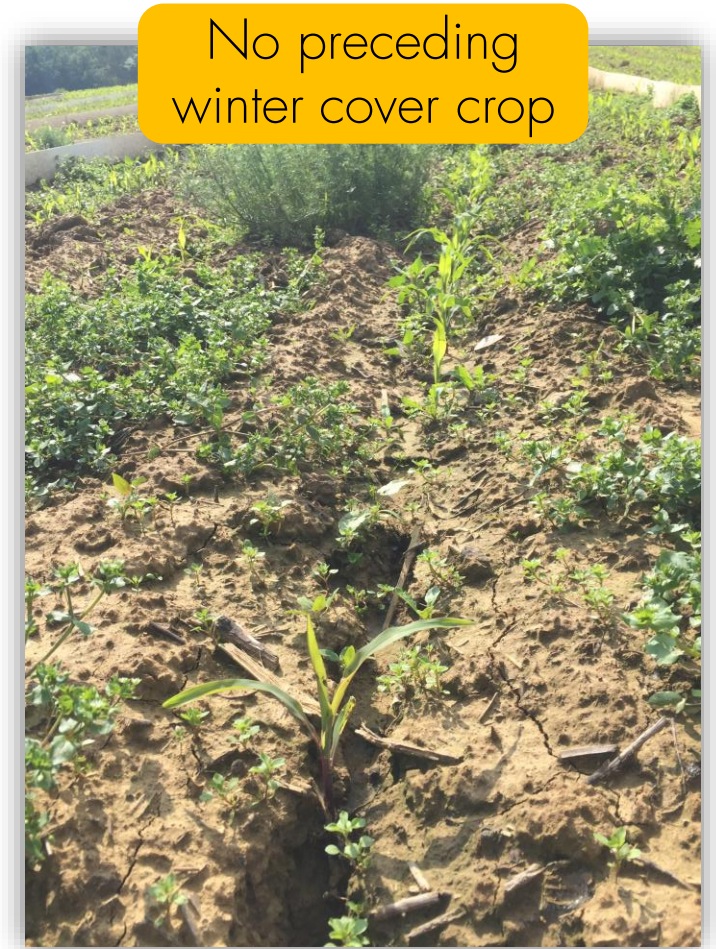
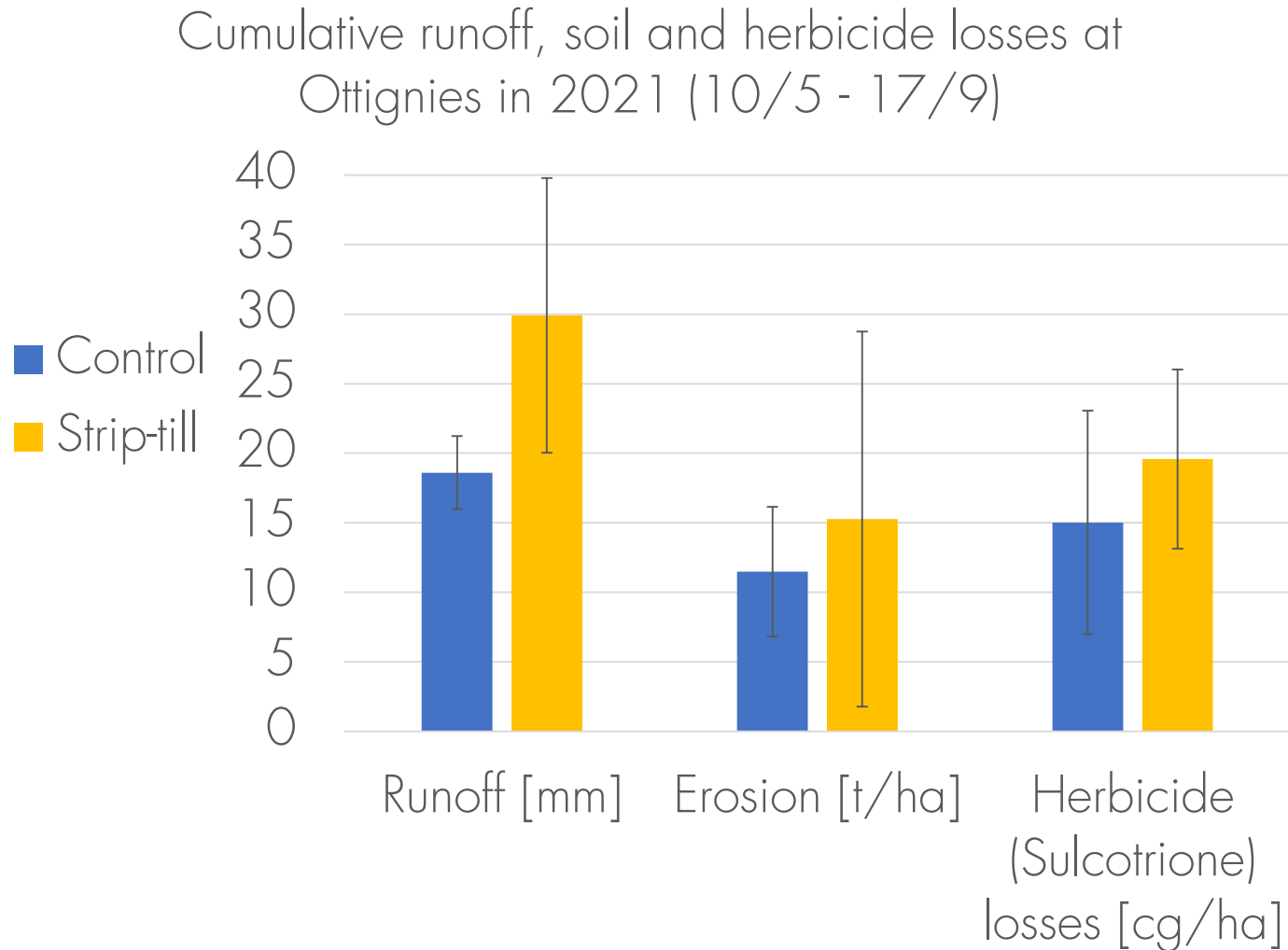


High weed grasses (*Echinochloa crus-galli*) pressure (Ottignies, 2022)



Killed undersown clover (Rebecq, 2021)

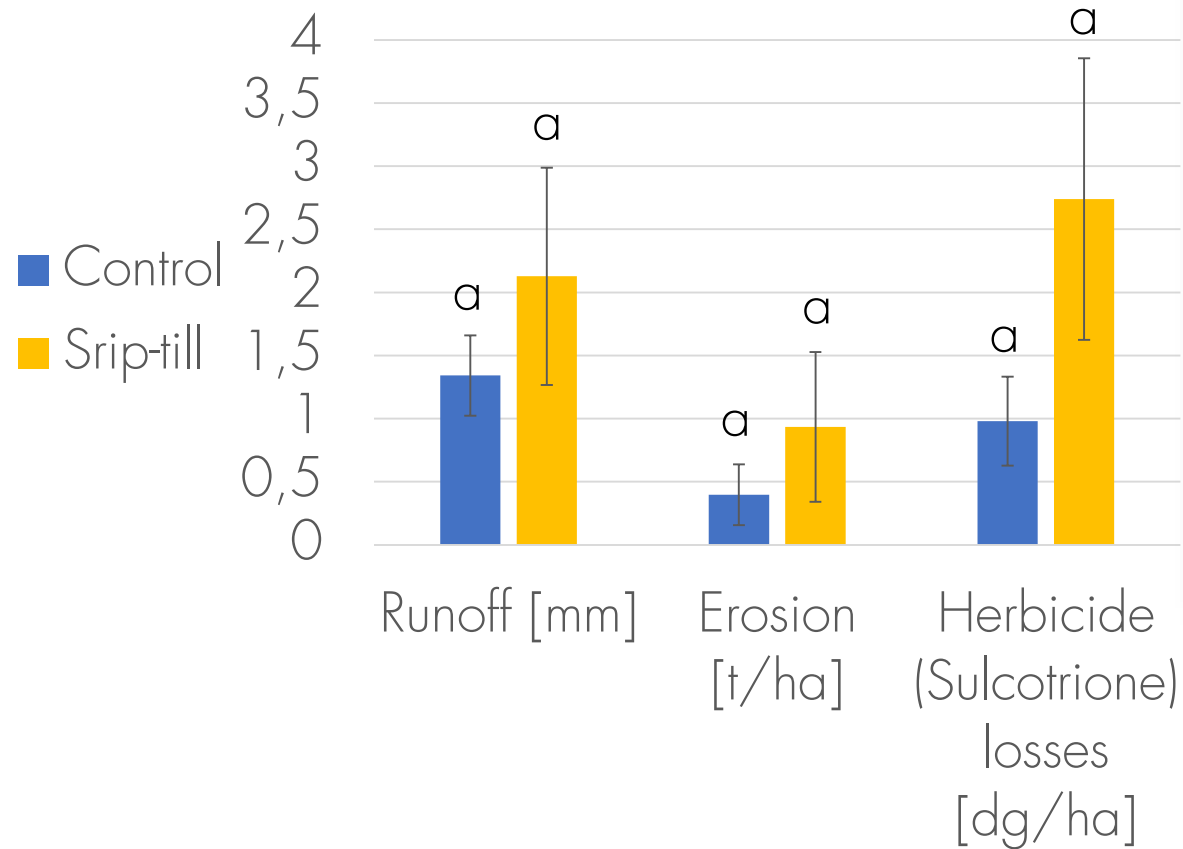
Results : strip-tillage



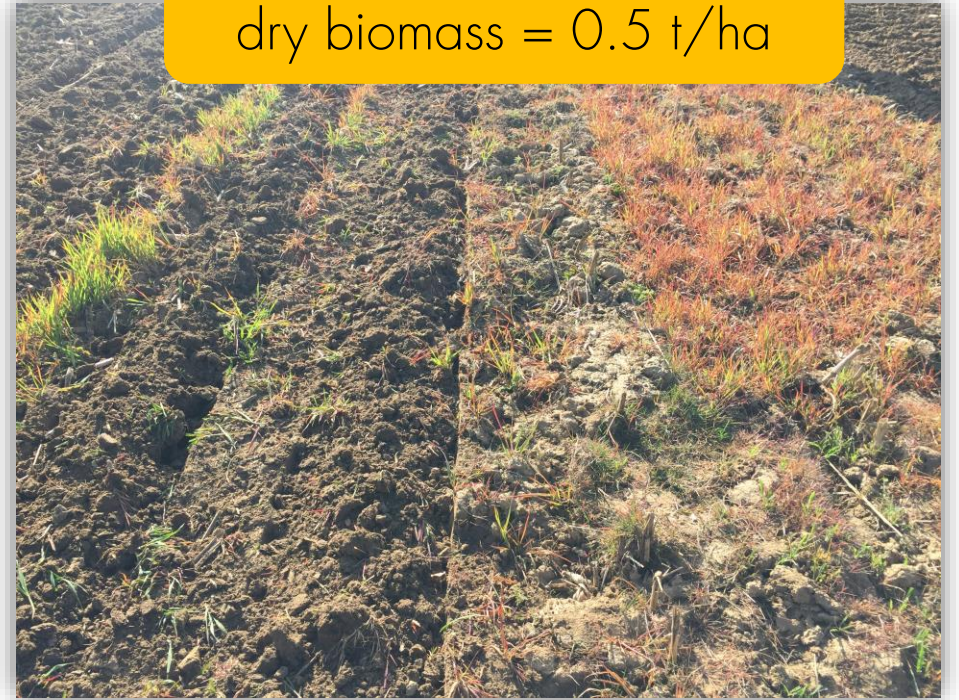
Rill erosion in maize rows at Ottignies in 2021

Results : strip-tillage

Cumulative runoff, soil and herbicide losses
at Ottignies in 2022 (22/4 - 25/8)

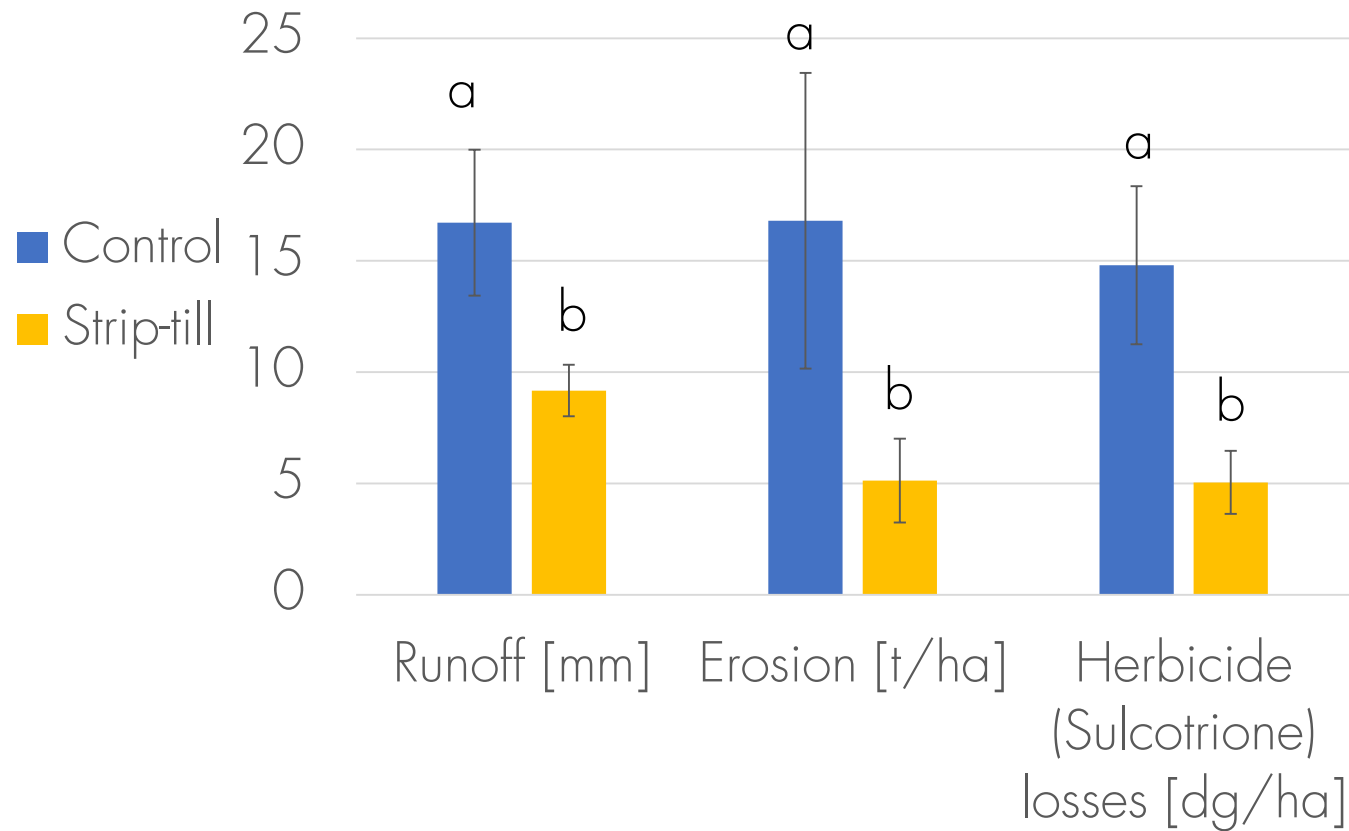


Preceding winter cover crop
dry biomass = 0.5 t/ha

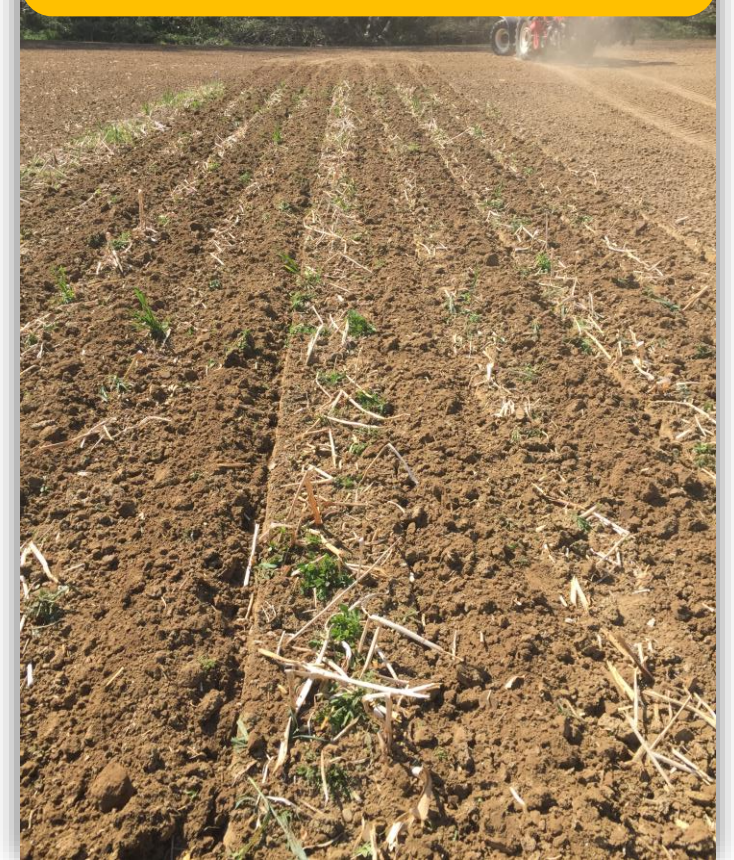


Results : strip-tillage

Cumulative runoff, soil and herbicide losses at Bonlez in 2021 (4/5 - 15/9)

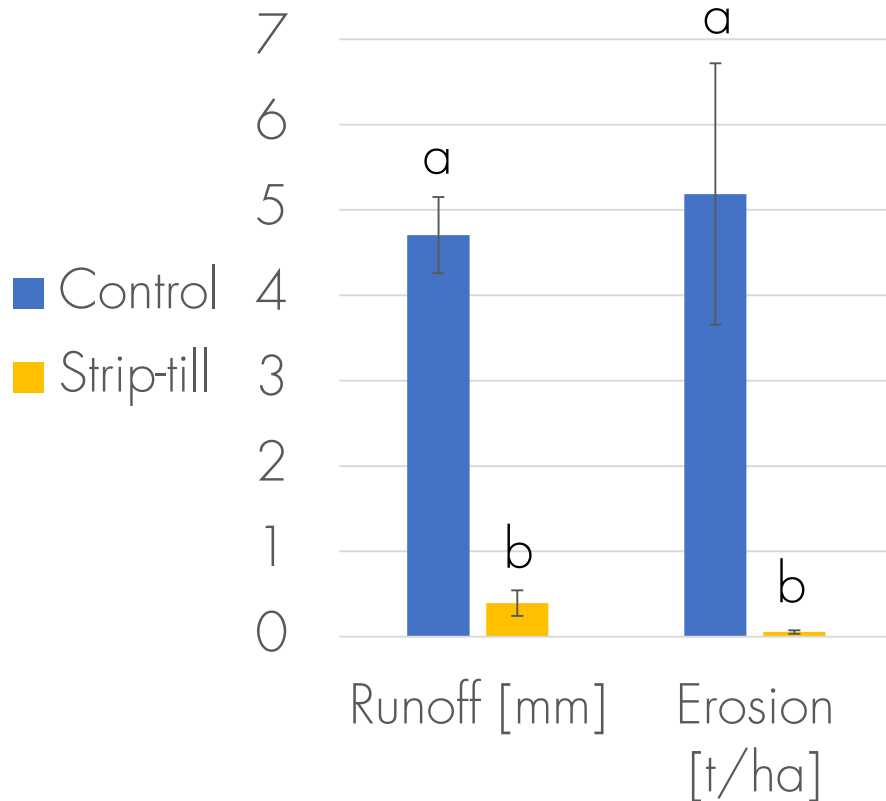


Preceding winter cover crop dry biomass > 2 t/ha ?



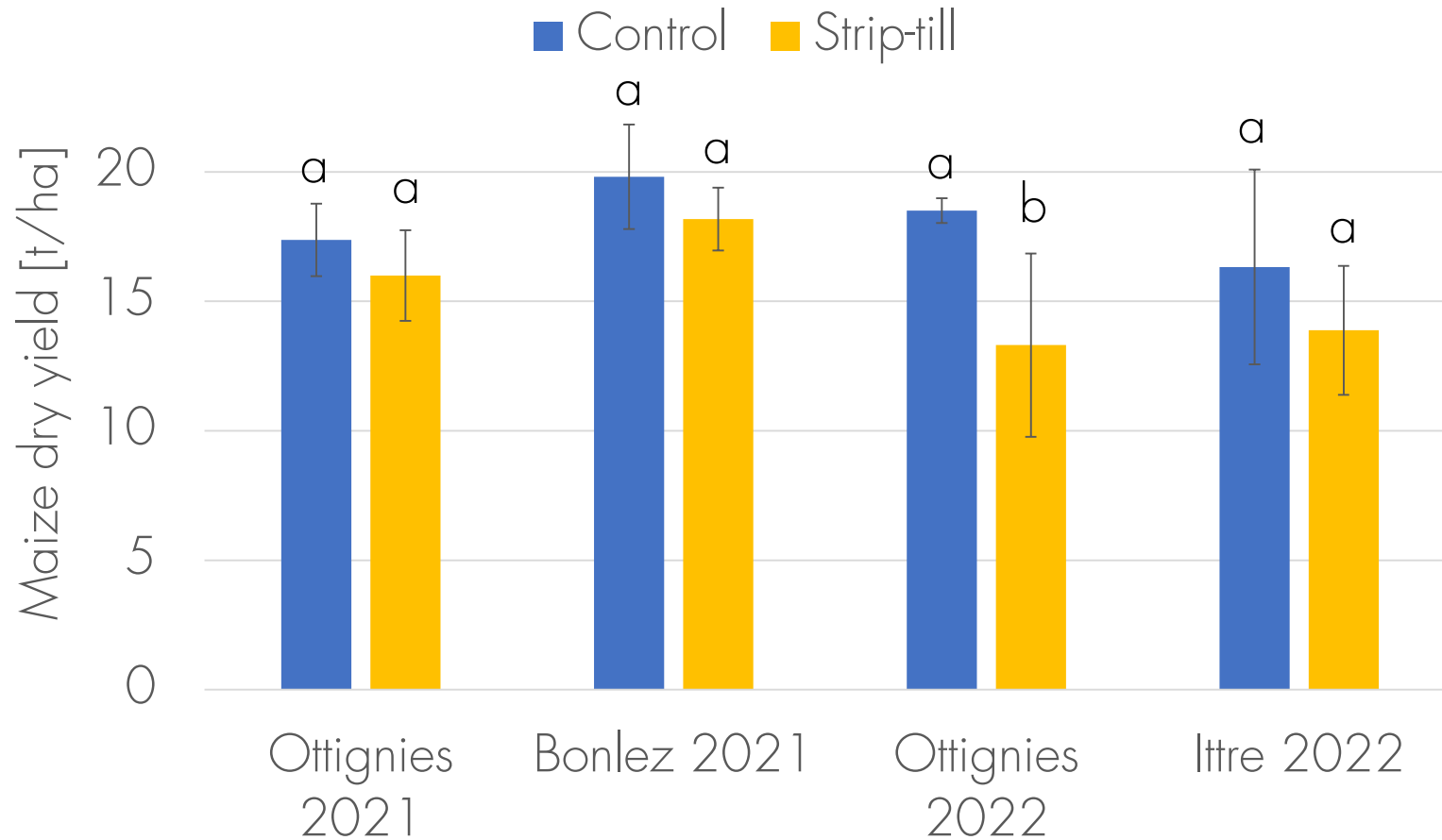
Results : strip-tillage

Cumulative runoff, and soil losses
at Ittre in 2022 (27/4 - 24/8)



Results : strip-tillage

Maize dry yields in strip-tillage trials in 2021 and 2022



→ Maize yield is reduced by 15% on average.

Take-home messages

Undersowing :

- is an agronomically challenging practice
- was not effective at reducing runoff, soil and herbicide losses, during the maize growing season
- value as winter cover crop and long-term impact on soil structure should be investigated

Strip-tillage :

- is very effective at mitigating surface flows, provided that it is performed after a well-developed winter cover crop
- On average (when preceded by a winter cover crop), -26% runoff, -12% soil erosion, but +5% herbicide losses compared to conventionally tilled plots

A blue tractor is pulling a red and blue Monosem seed drill across a brown, tilled field. The seed drill has four large, tan-colored seed hoppers and a central red hopper with the brand name 'MONOSEM' visible. Red and white diagonal hazard stripes are on the sides of the machine. A person is standing on the tractor. The sky is blue with some clouds.

Thank you for your interest !

Supplementary material

Adapted seeding unit for undersowing



Air distribution for
undersown seeds

Light harrow to cover
undersown seeds

Coulter drill for maize

Suitability of weed control schemes with undersown maize

N°	Traitement	Dosage	Taux freinage des sous-semis (%)					
			Fétuque rouge Rubra commutatae	Fétuque rouge + fétuque élevée	Fétuque rouge Musica	Lotier	Trèfle blanc nain	Trèfle blanc
1	Témoin non traité		0	0	0	0	0	0
Post précoce								
2	Osorno + Onyx	0,75 l + 0,5 l	3	0	2	73	20	37
3	Osorno + Onyx + Most Micro	0,75 l + 0,5 l + 2 l	7	7	3	78	28	40
4	Osorno + Onyx + Xınca	0,75 l + 0,5 l + 0,25 l	10	7	5	85	33	45
5	Auxo + Onyx	1 l + 0,5 l	7	8	7	92	43	53
6	Laudis + Onyx	1 l + 1 l	32	28	32	96	35	42
7	Laudis + Onyx + Most Micro	1 l + 0,5 l + 2 l	28	25	32	98	40	47
8	Zeus + Onyx + Most Micro	1 l + 0,5 l + 2 l	0	0	0	12	9	5
9	Zeus	1 l	0	0	0	6	6	3
10	Callisto	0,9 l	0	0	0	32	16	12
11	Callisto + Onyx	0,9 l + 0,5 l	0	0	0	75	20	20
12	Callisto + Xınca	0,9 l + 0,25 l	0	0	0	67	53	47
13	Callisto + xınca + Stomp Aqua	0,9 l + 0,25 l + 1,5 l	0	0	0	73	65	58
14	Nagano + Stomp Aqua	0,9 l + 1,5 l	0	0	0	43	57	55
15	Callisto + Banvel	0,9 l + 0,4 l	0	0	0	30	67	56
16	Callisto + Samson extra 600D	0,9 l + 0,4 l	96	93	96	42	67	66
17	Laudis WG + Actirob B	0,3 kg + 1 l	6	11	3	82	15	12

Source : CIPF