RESULTS OF UAV-BASED PHENOTYPING FOR SPRING WHEAT GENOTYPES ACCROSS CONTRASTING GROWING CONDITIONS

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The EUCARPIA Cereals Section Conference, Szeged, Hungary, May 15-20, 2023

The objective of study

to assess the UAV-derived multispectral vegetative indices for spring wheat genotypes most useful for estimating grain yield and nitrogen use traits under contrasting growing conditions

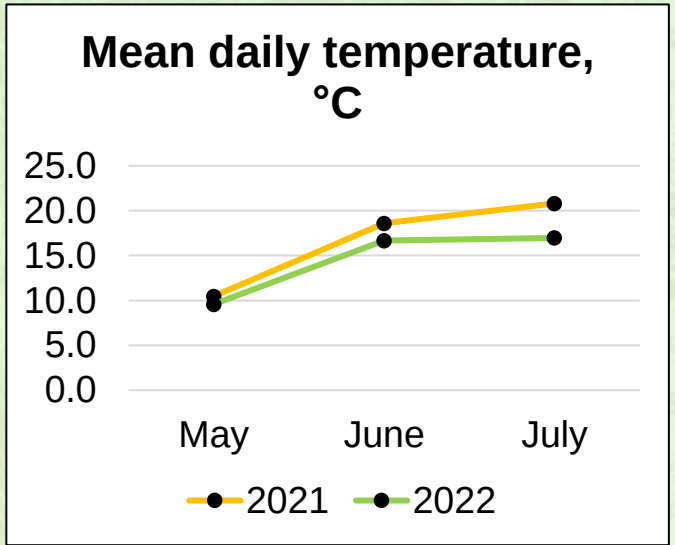
Materials and Methods

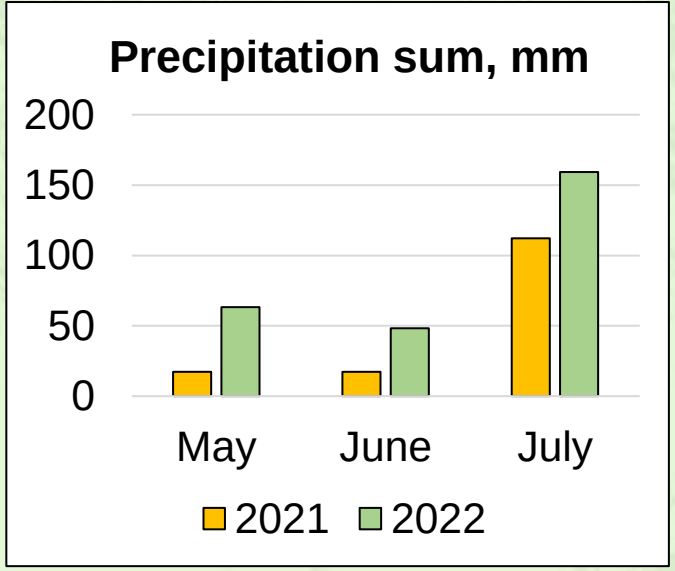
The field trial

- Located at the Stende Research Centre, Institute of Agricultural Resources and Economics, **Latvia** (57.18927N 22.56187E);
- Two consecutive seasons: **2021 and 2022;**
- Split plot factorial design with 2 randomized replicates with 2 N fertilization levels: **75 kg N ha^{-1} (N75); 150 kg N ha^{-1} (N150)** as main plots and **16 wheat genotypes** as subplots with size of 10 m^2.

Trait measurements

- Total nitrogen (N) in soil (0-20 cm depth) in early spring and mature plant samples were determined by Kjeldahl method.
- Grain yield (GY) and N use related traits NUpE, NUtE, NUE
- UAV-based multispectral data at three growth stages (GS21, GS65, GS73) by DJI Phantom 4 Multispectral (20 m altitude maintaining 85% frontal and 75-80% side overlaps among images).
- Multispectral vegetative indices: RNDVI, GNDVI, NDRE, RECI, NGRDI





Grain yield and N use related traits: variation and correlation

Source of variation	Grain yield	NUpE	NUtE	NUE
Genotype (G)	25*	ns	5*	5*
N rate (N)	4*	44*	15*	5*
Year (Y)	50*	4*	52*	41*
G x N	ns	ns	ns	33*
G x Y	8*	ns	ns	4*
N x Y	ns	ns	6*	5*
N x N x Y	ns	ns	ns	ns

Linear correlation (r) between NUE and its components; *p<0.05;**p<0.01

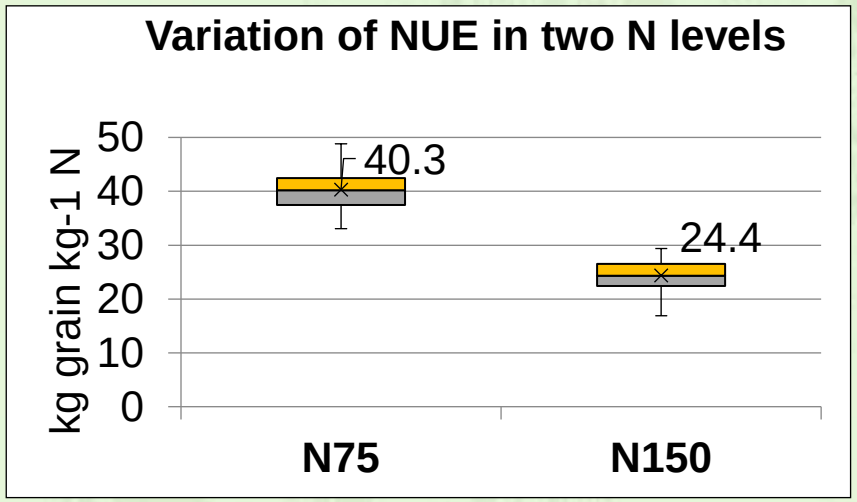
Variables	2021		2022	
	NUpE	NUtE	NUpE	NUtE
N75	0.878**	0.325	0.674**	0.389*
N150	0.876**	0.080	0.602**	0.490**

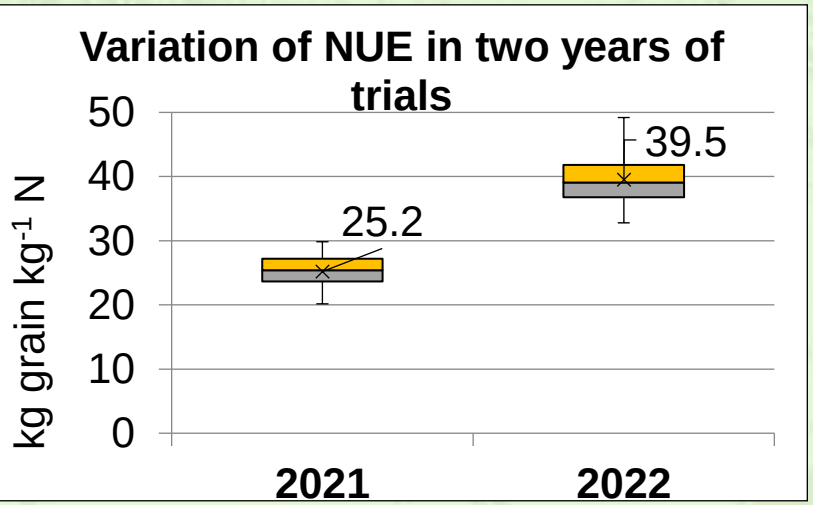
Descriptive statistics for grain yield, t ha^{-1}

Descri-ptives	2021		2022	
	N75	N150	N75	N150
Average	**4.67**	**5.13**	**6.10**	**6.35**
min	3.75	4.37	4.79	5.08
max	5.71	6.08	7.25	7.26
s	0.45	0.43	0.76	0.63

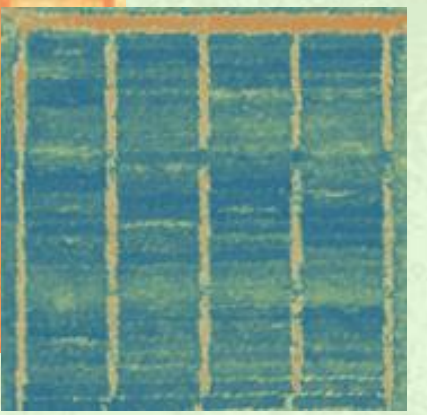
Linear correlation (r) between grain yield and N use related traits; *p<0.05;**p<0.01

N use related traits	2021		2022	
	N75	N150	N75	N150
NUpE	-0.076	0.397*	0.040	-0.137
NUtE	0.490**	0.004	0.404*	0.427*
NUE	0.180	0.446**	0.354*	0.275





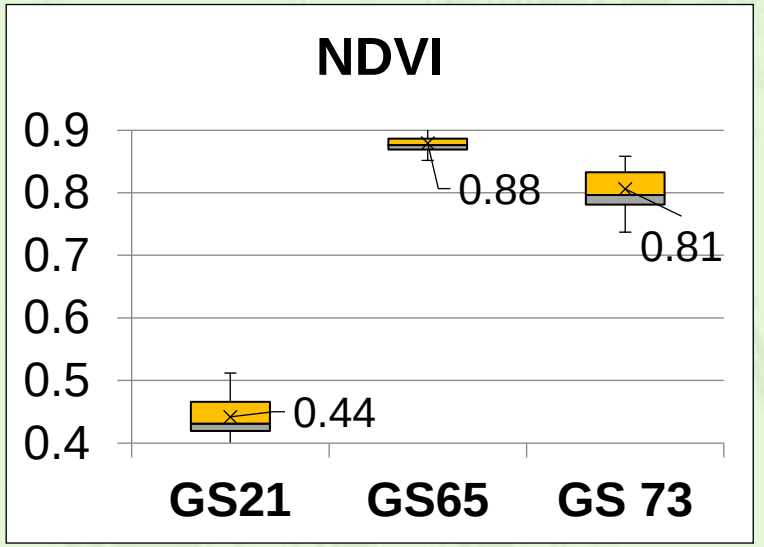
UAV imaging data: variation

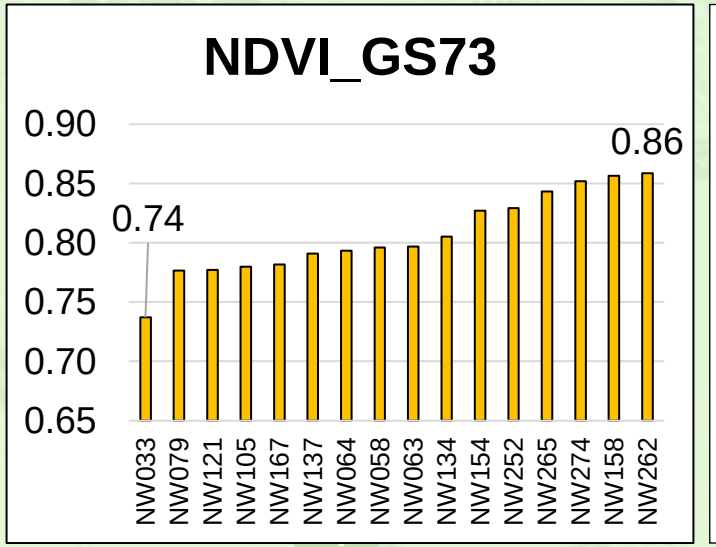


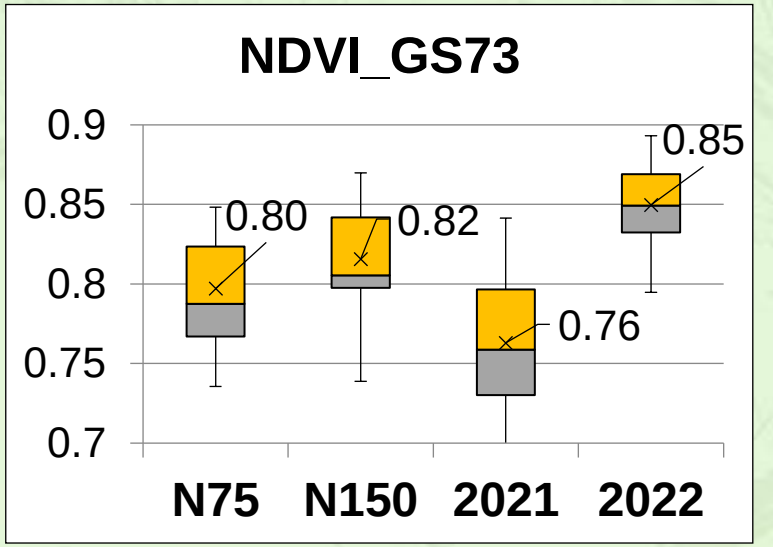
Vegetation indices		Function
NDVI	Normalized difference vegetation index	N content, biomass
GNDVI	Green normalized difference vegetation index	Green biomass, Chlorophyll
NDRE	Normalized difference red-edge index	Greenness
NGRDI	Normalized green red difference index	Yellowing

Contribution of different sources of variation (%)to total variation of VIs

Source of variation	Beginning of tillering (GS21)				Middle of flowering (GS65)				Early milk stage (GS73)			
	NDVI	GNDVI	NDRE	NGRDI	NDVI	GNDVI	NDRE	NGRDI	NDVI	GNDVI	NDRE	NGRDI
Genotype	37*	26*	20*	58*	19*	31*	22*	12*	30*	42*	42*	15*
N level	n.s	n.s	1*	n.s.	3*	7*	13*	1*	2*	6*	6*	1*
Year	43*	56*	55*	19*	65*	49*	49*	80*	50*	14*	14*	77*
G x N	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
G x Y	10*	9*	10*	10*	3*	n.s	n.s	n.s	5*	n.s	n.s	n.s
N x Y	n.s	n.s	n.s	1*	n.s	n.s	n.s	n.s	1*	n.s	n.s	3
G x N x Y	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s







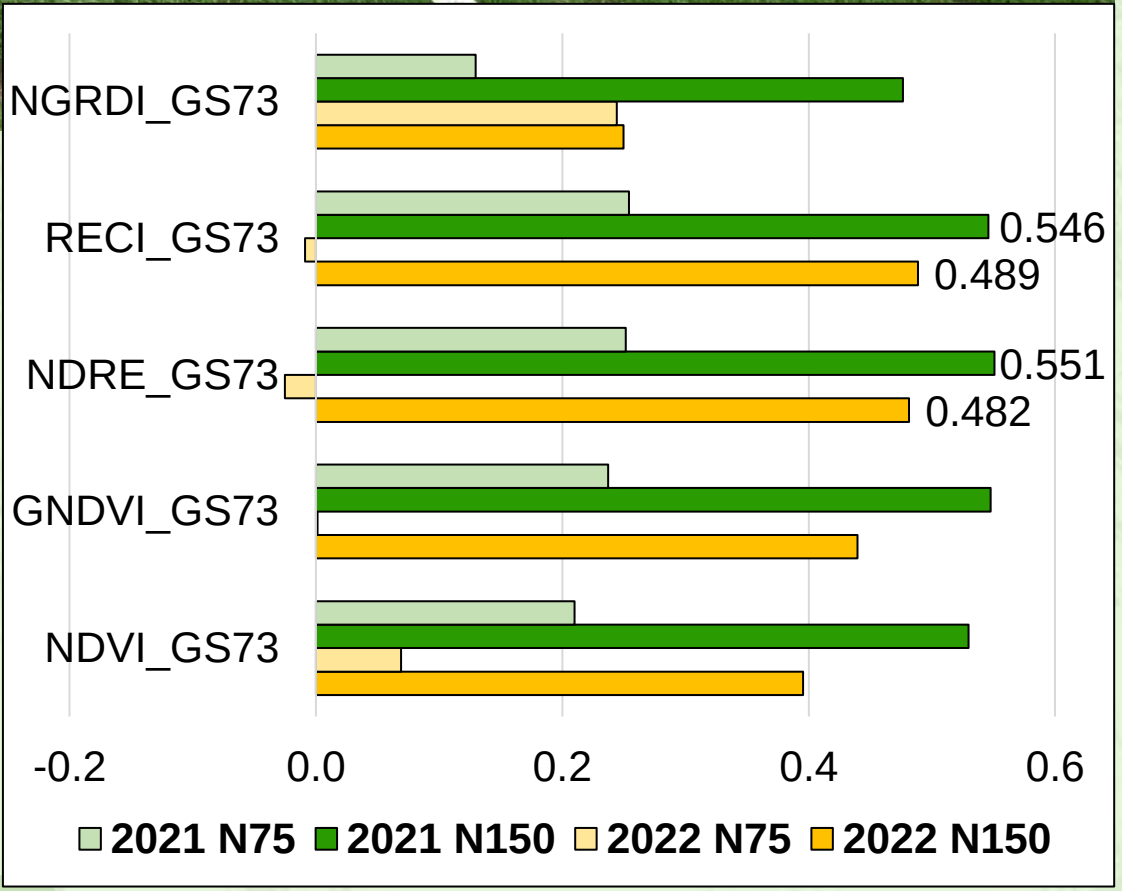
Correlation between traits

Linear correlation (r) between grain yield and multispectral vegetation indices

Growth stage	Multispectral indice	2021		2022	
		N75	N150	N75	N150
GS21	**NDVI**	0.20	0.07	-0.13	-0.41*
	GNDVI	0.21	0.14	-0.10	-0.40*
	NDRE	0.07	0.20	-0.03	-0.36*
	RECI	0.07	0.20	-0.04	-0.37*
	NGRDI	0.18	0.00	-0.20	-0.44*
GS65	**NDVI**	0.44*	0.56**	0.27	0.19
	GNDVI	0.51**	0.60**	0.30	0.18
	NDRE	0.58**	0.62**	0.30	0.17
	RECI	0.58**	0.62**	0.28	0.16
	NGRDI	0.27	0.43	0.10	0.11
GS73	**NDVI**	0.58**	0.70**	0.50**	0.40*
	GNDVI	0.59**	0.70**	0.51**	0.38*
	NDRE	0.64**	0.72**	0.52**	0.39*
	RECI	0.64**	0.72**	0.52**	0.39*
	NGRDI	0.53**	0.67**	0.39*	0.38*

*p<0.05;**p<0.01

Linear correlation (r) between NUE and multispectral vegetation indices



Acknowledgement

Funding of European Economic Area/Baltic Research Programme grant project: ***“NOBALwheat – breeding toolbox for sustainable food system of the NOrdic BALtic region”,***
No S-BMT-21-3 (LT08-2-LMT-K-01-032)

Iceland Liechtenstein Norway grants

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