Water Rennovation in Ukraine
Project no. 22320101

Water Rennovation in Ukraine

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The project is co-financed by the Governments of the Czechia, Hungary, Poland and Slovakia through Visegrad Grants from International Visegrad Fund. The mission of the fund is to advance ideas for sustainable regional cooperation in Central Europe.

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Assessment of crop health and growth under different water regimes

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The complex soil tillage experiment

rotation x tillage x fertilization x **irrigation** x plant density x genotype

Control, 80kg N ha-1 + 60kg P2O5 ha-1 + 90kg K2O ha-1, and 160kg N ha-1 + 60kg P2O5 ha-1 + 90kg K2O ha-1 fertilization treatments were randomized; I., II., III., IV: replications; three different tillage methods, inside the treatment blocks of the three maize varieties

Precision sowing

Different plant density:

- 60.000 – 80.000 plants/ha

Electric drive sowing machine! (1755NT)

Basic concepts of soil cultivation

The concept and tasks of soil cultivation

Concept:

The change in the physical condition of the upper, regularly cultivated layer of ***soil by means of cultivation equipment,*** in order to ensure optimum soil conditions for the crop.

Tasks: designing a suitable soil structure

1. Influencing soil heat, air and water balance
2. Weed control
3. Root and stem residues are incorporated into the soil.

Basic concepts of soil cultivation

The tillage system

I. **Stubble cleaning and management:** shallow tillage of summer-harvested crops, which may be carried out during or after crushing the residues in one pass. The aim is to incorporate the residues into the soil, **reduce water loss** and provide mechanical weeding.

II. **Primary tillage:** the deepest tillage in the cropping system in a given year. Its function is to provide the soil condition and depth required during the growing season of the crop. It can be done with ploughing, without ploughing (***water saving – eco-friendly***) and combined.

III. **Finishing primary tillage:** further shaping of the soil condition established by primary tillage to suit the purpose of cultivation. It can be done in one pass with the primary tillage.

IV. **Seedbed preparation:** shaping the topsoil to the needs of the crop and the sowing technology for rapid emergence and initial development. To avoid drying out of the seedbed, this should be done no more than one day before or at the same time as sowing.

Basic concepts of soil cultivation

Soil tillage systems

Includes pre-sowing works

1. Ploughing
   - With a plough
   - With discs
   - With active machines

2. Without ploughing
   - With a cultivator or a loosener
   - Strip-tiller

Tillage systems in the tillage experiment

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Winter ploughing

Strip-tillage

Deep ripping (loosening)

Failures of traditional systems

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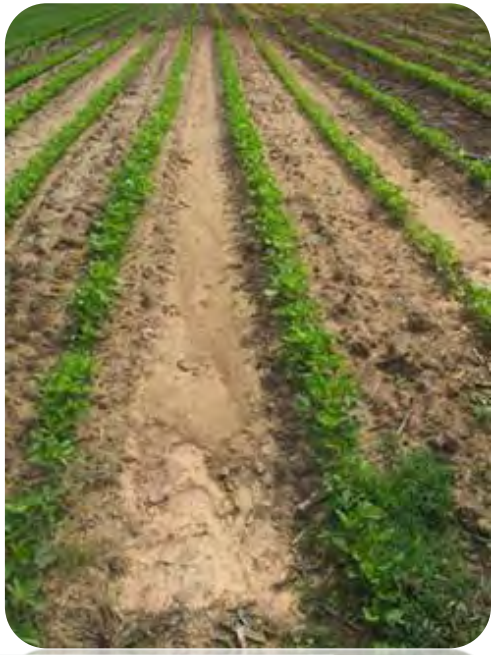
Subsoil denser layer: 18 – 22 cm
Disc harrows

Subsoil denser layer: 30-40 cm
Ploughing

Failures of traditional systems



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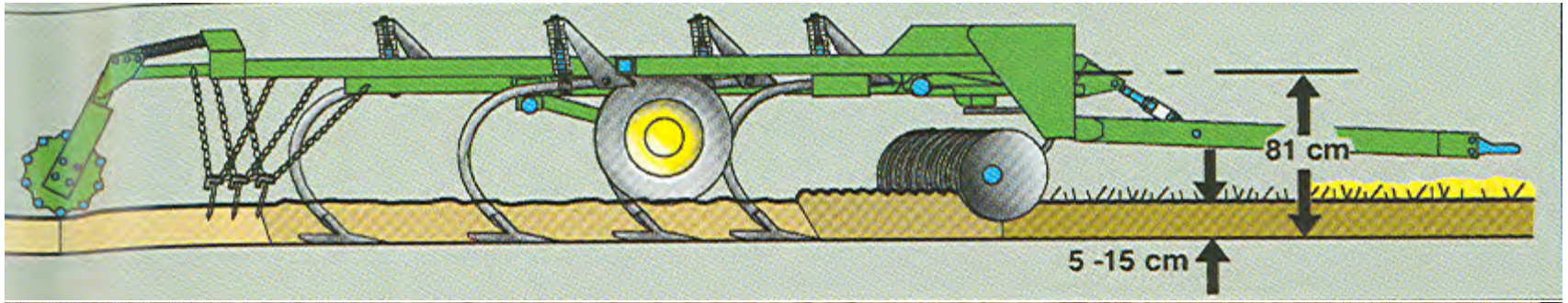
Combined tillage machinery

Mulch tillers

~ Heavy field cultivator with a set of discs in front „Disc Ripper"



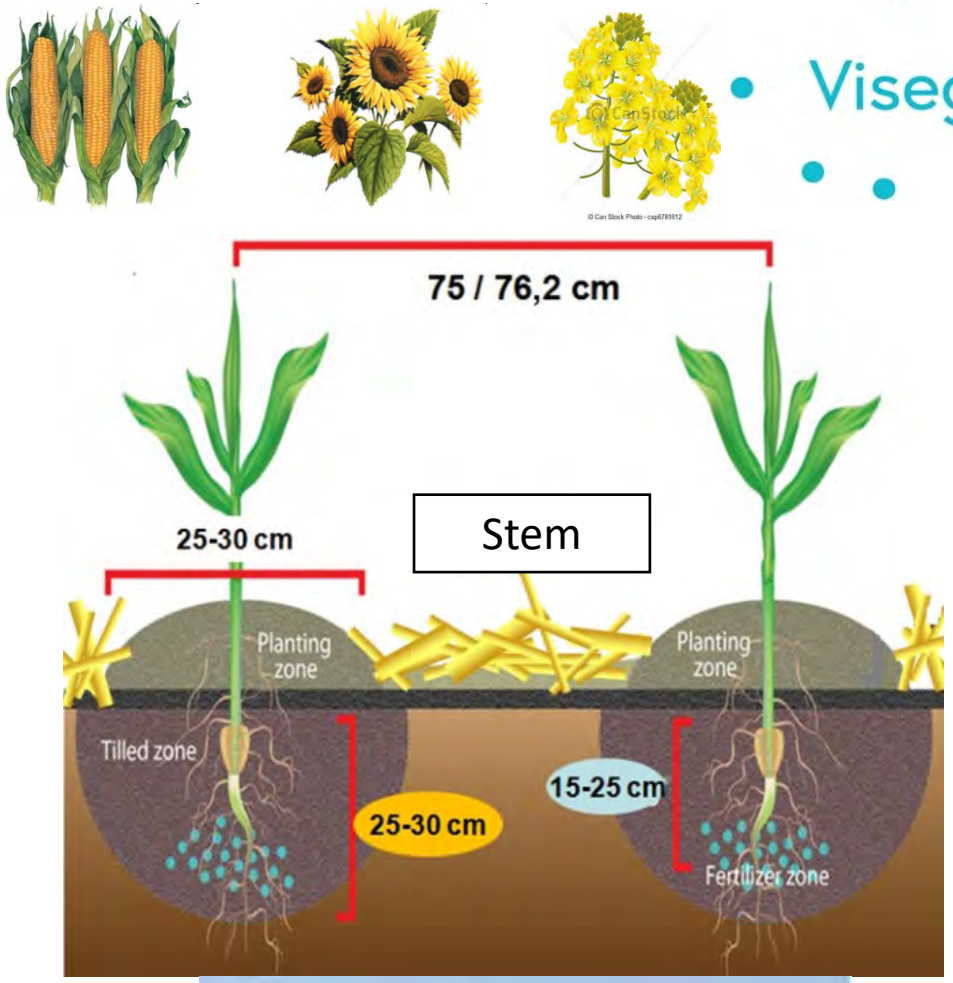
The spacing of the hoes is the same as the row spacing of the catch crops.

Strip-tillage system

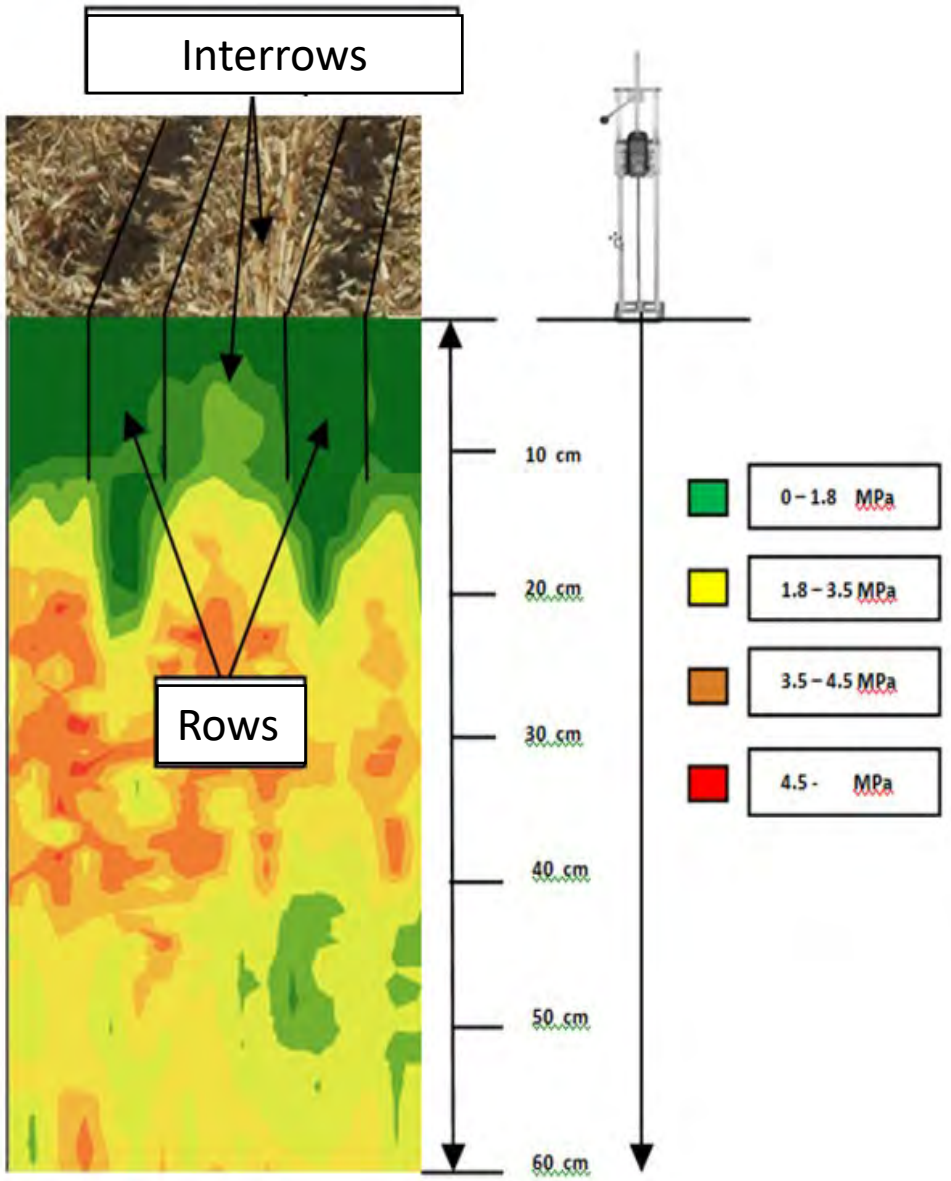
Applicable: currently used in the soil preparation of maize, sunflower and rape

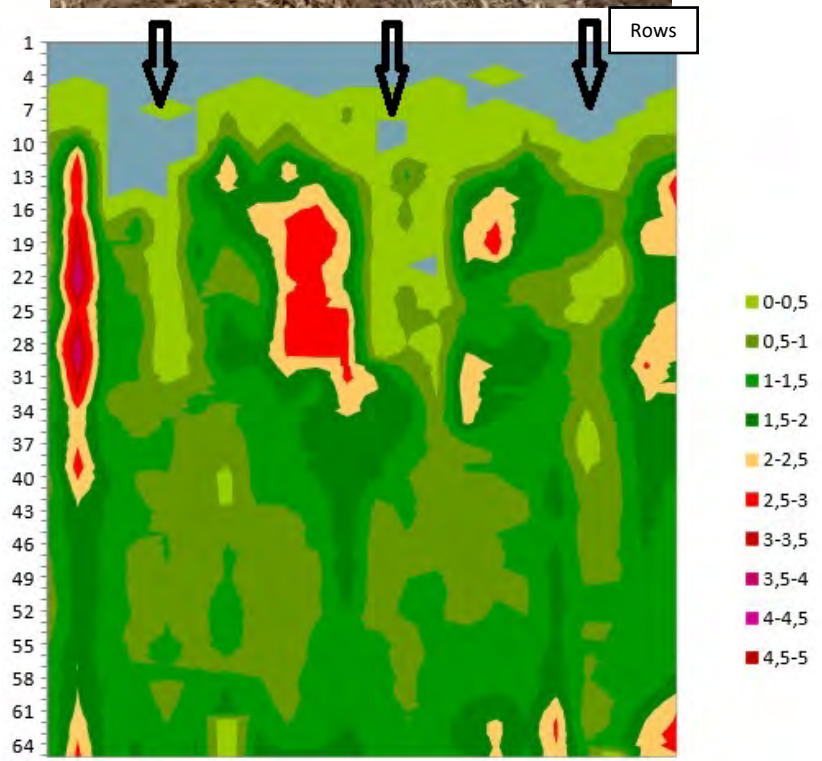
System steps:

1. Stem crushing, shallow, sealing the surface
2. Stubble management, slightly deeper than tillage, sealing the surface
3. Primary tillage + finishing + seedbed preparation in one pass with a strip-tiller in autumn
4. Sowing in spring in the loosened strips
5. Interrow cultivation after emergence



Strip-tillage system





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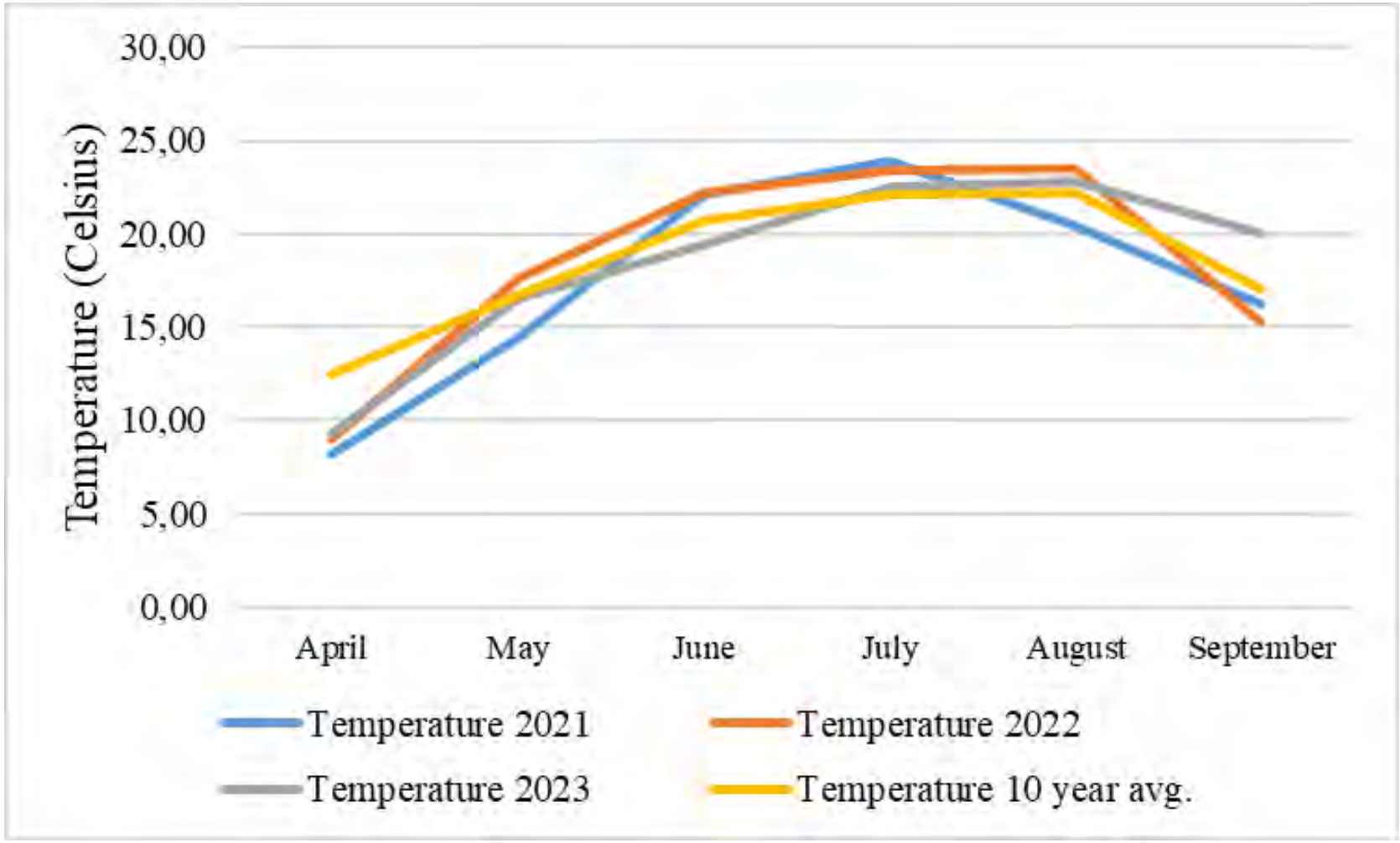
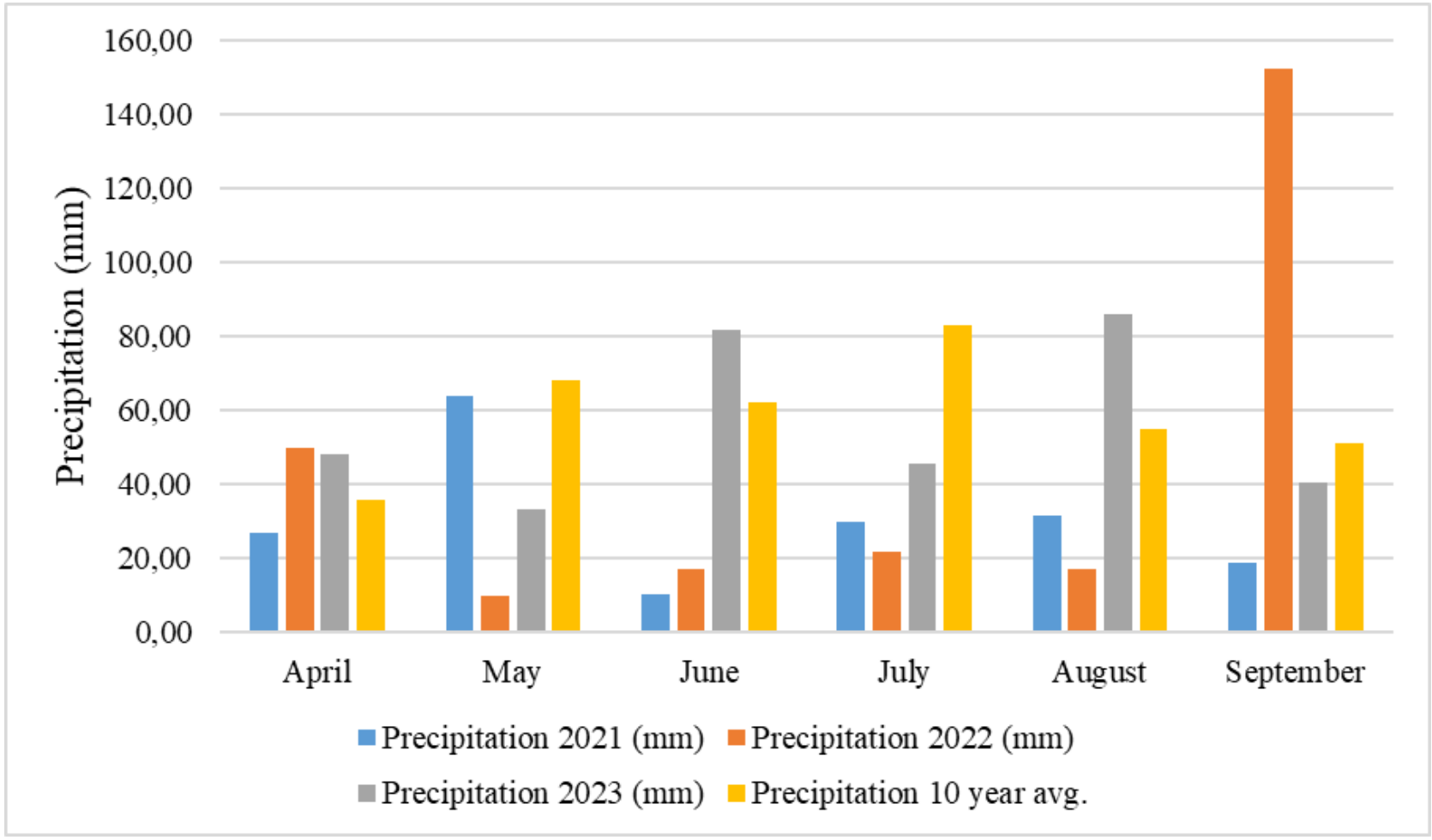
Interrow cultivation in one pass with top-dressing

The additional N active ingredient was applied in spring as liquid Nitrosol (27% N + 2% S) by top-dressing in June.

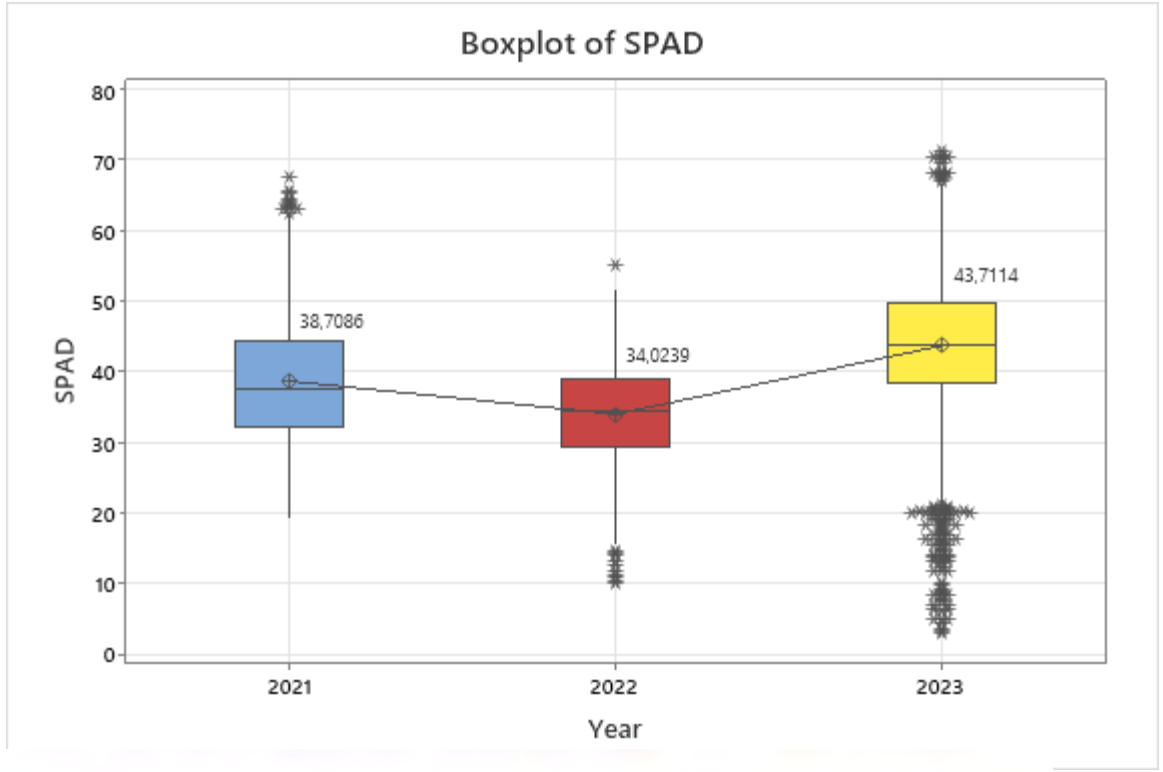
Temperature avg. (experimental site)

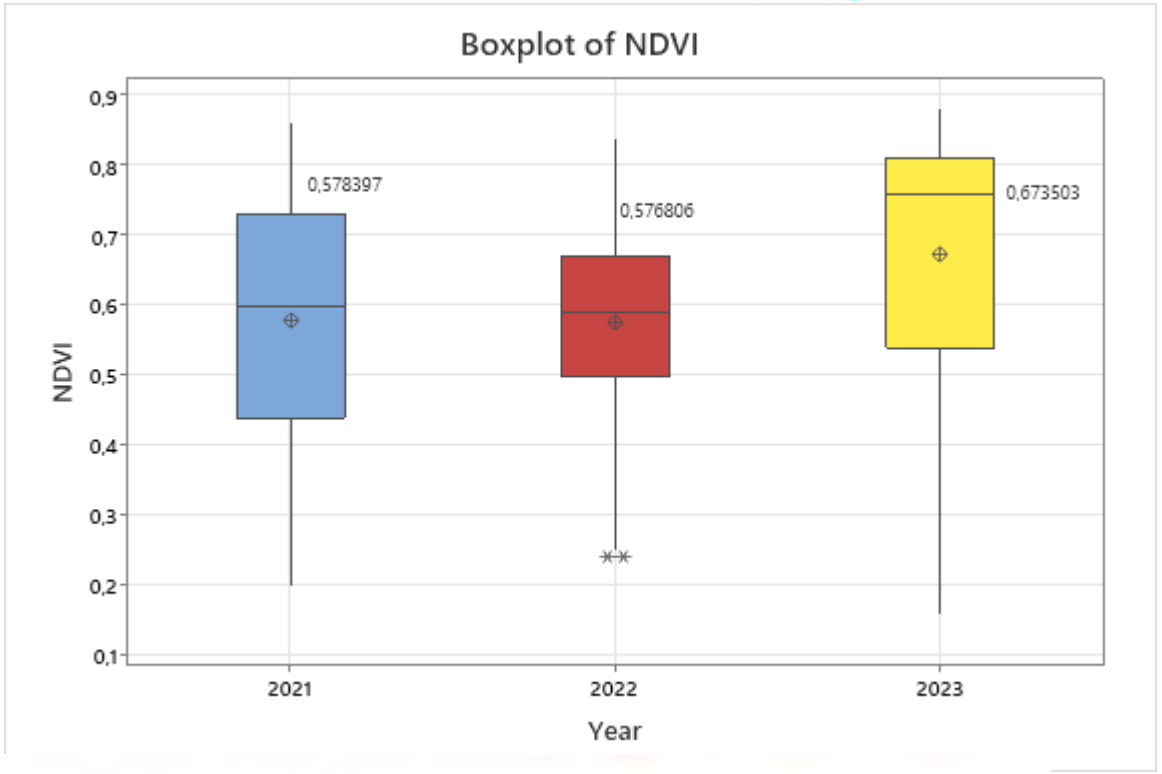


Precipitation avg. (experimental site)



Results of SPAD and NDVI by year (treatments average)





Grouping Information Using the Tukey Method and 95% Confidence

Year	N	Mean	Grouping
2023	2700	43,711	A
2021	4320	38,709	B
2022	2160	34,024	C

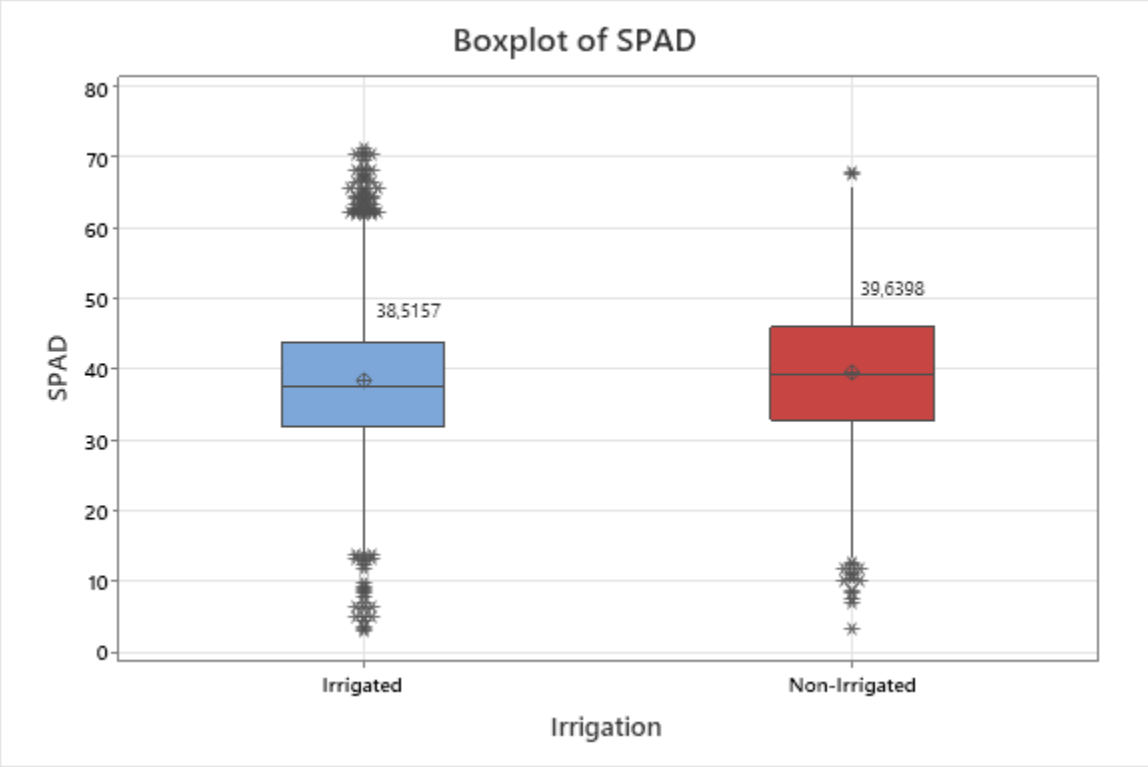
Means that do not share a letter are significantly different.

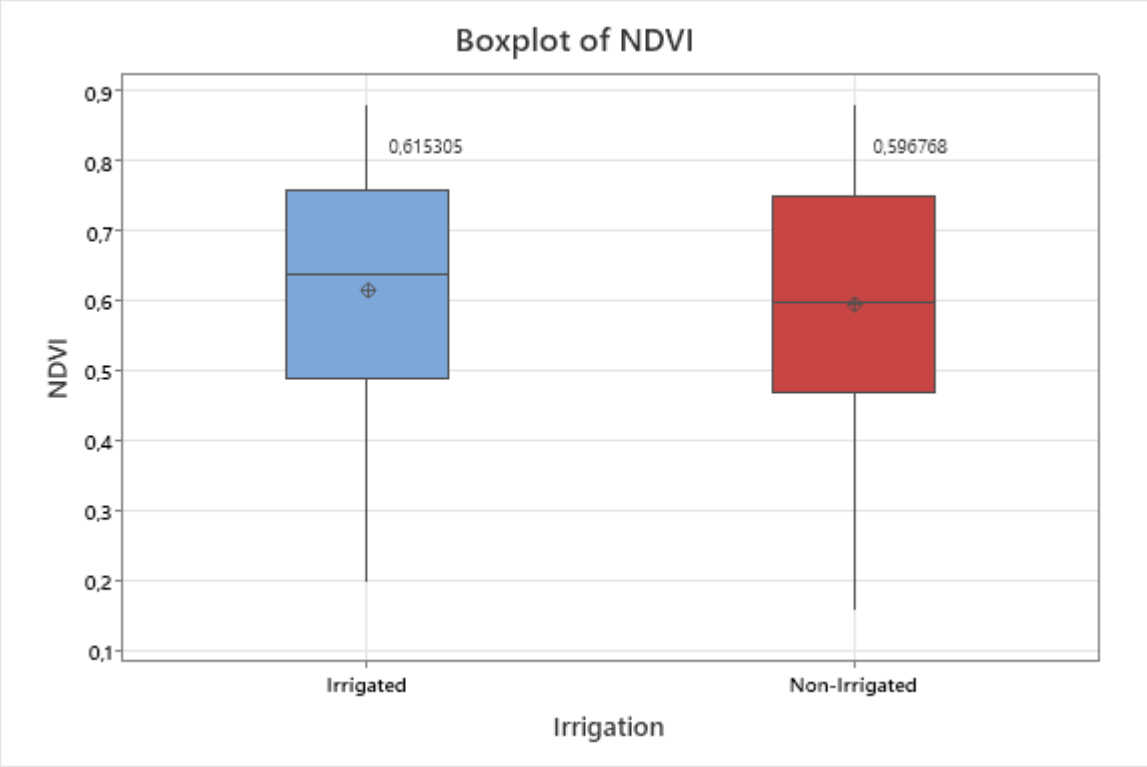
Grouping Information Using the Tukey Method and 95% Confidence

Year	N	Mean	Grouping
2023	1082	0,67350	A
2021	1728	0,57840	B
2022	864	0,57681	B

Means that do not share a letter are significantly different.

Results of SPAD and NDVI by irrigation (years and other treatments average)





Grouping Information Using the Tukey Method and 95% Confidence

Irrigation	N	Mean	Grouping
Non-Irrigated	4590	39,640	A
Irrigated	4590	38,516	B

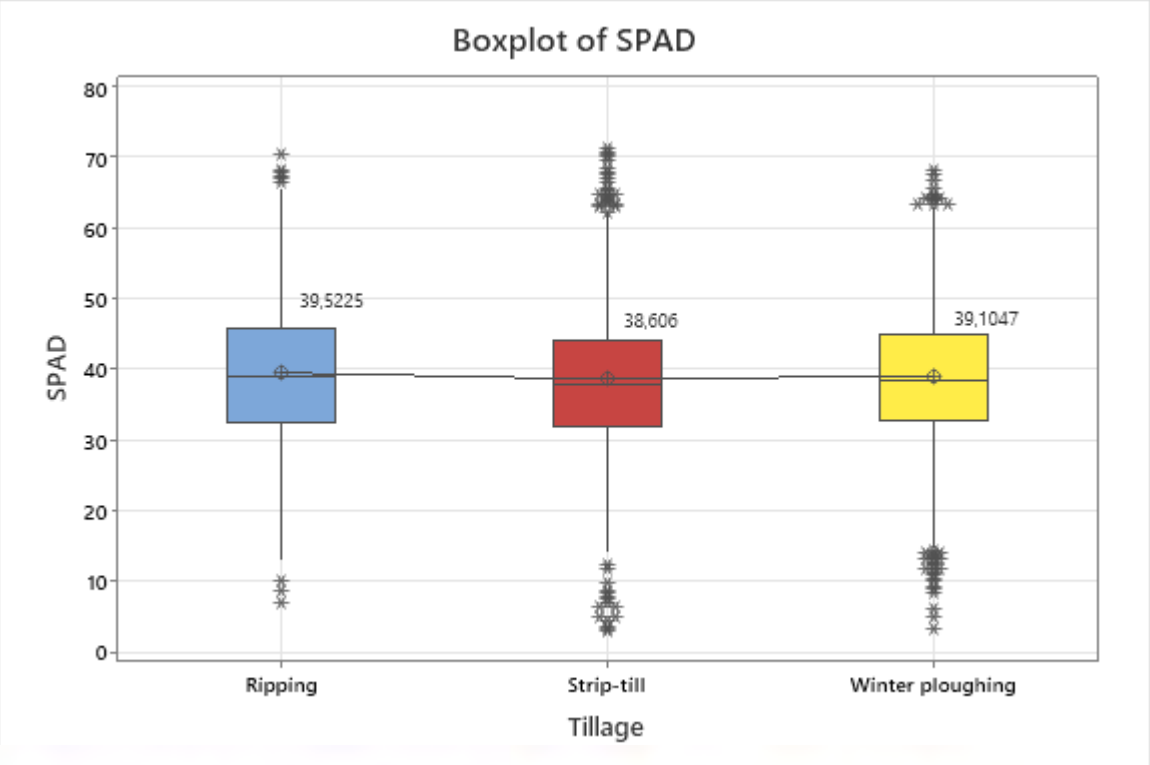
Means that do not share a letter are significantly different.

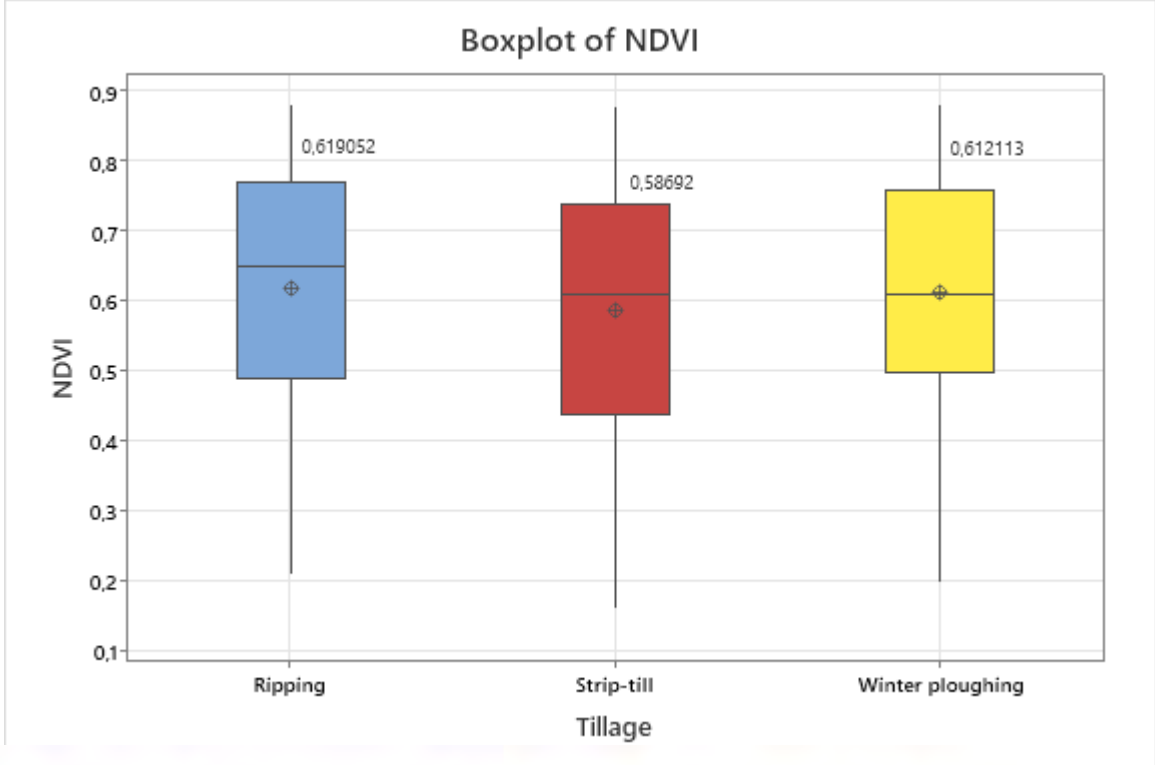
Grouping Information Using the Tukey Method and 95% Confidence

Irrigation	N	Mean	Grouping
Irrigated	1836	0,61531	A
Non-Irrigated	1838	0,59677	B

Means that do not share a letter are significantly different.

Results of SPAD and NDVI by tillage (years and other treatments average)





Grouping Information Using the Tukey Method and 95% Confidence

Tillage	N	Mean	Grouping	
Ripping	3060	39,522	A	
Winter ploughing	3060	39,105	A	B
Strip-till	3060	38,606		B

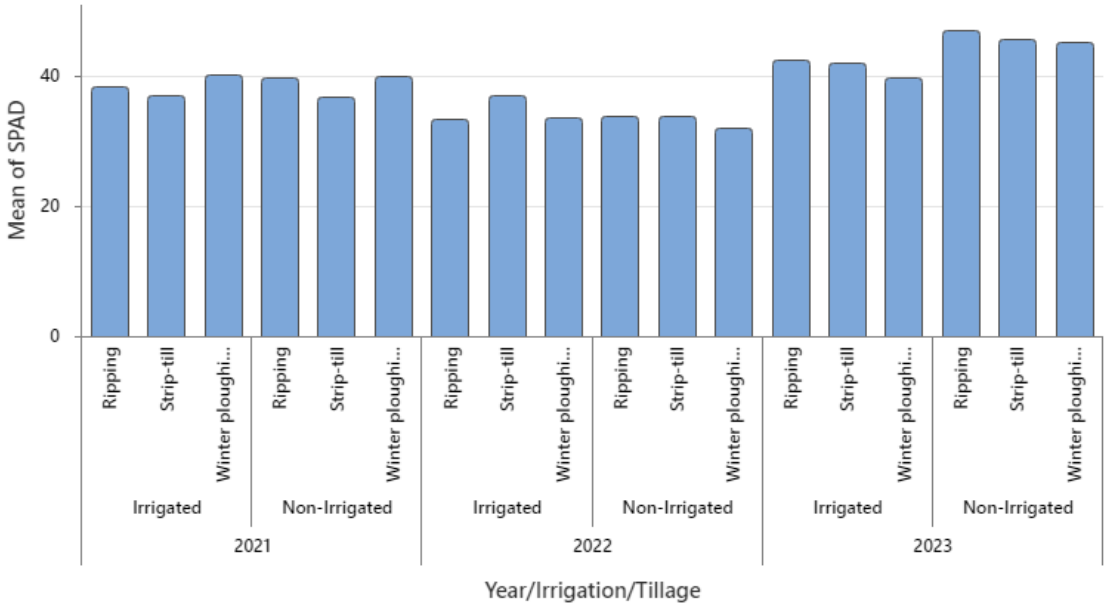
Means that do not share a letter are significantly different.

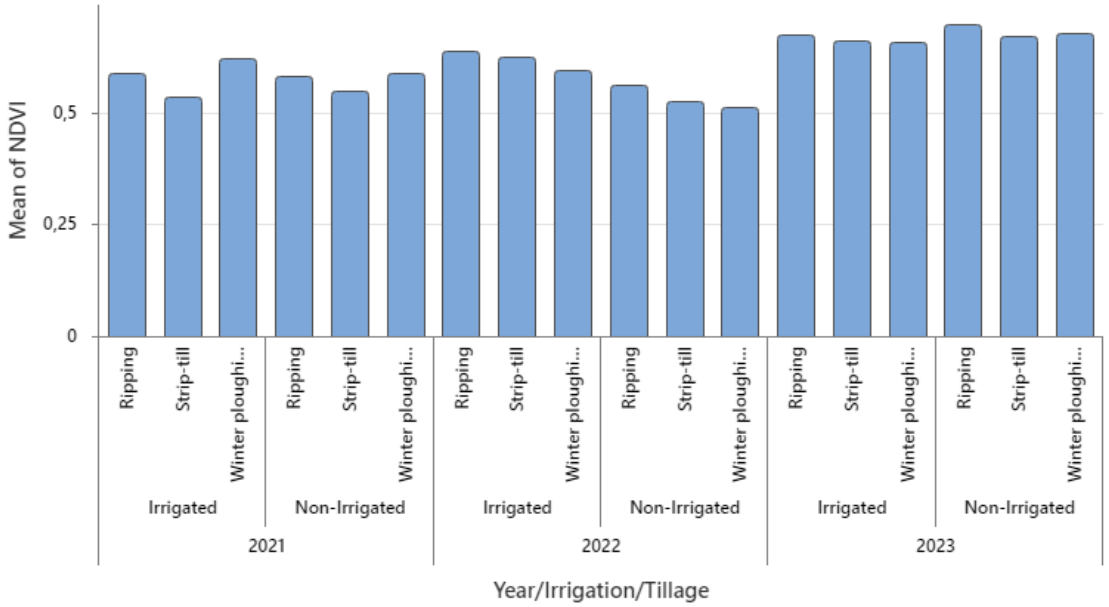
Grouping Information Using the Tukey Method and 95% Confidence

Tillage	N	Mean	Grouping	
Ripping	1224	0,61905	A	
Winter ploughing	1226	0,61211	A	
Strip-till	1224	0,58692		B

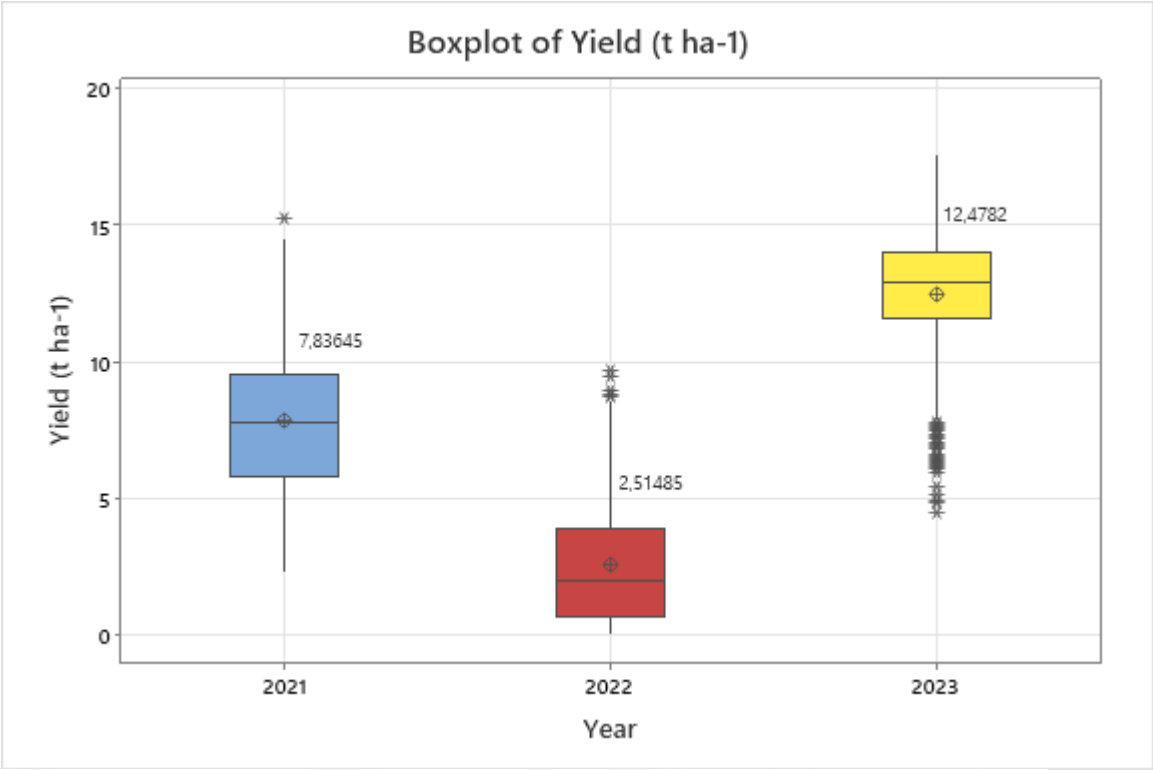
Means that do not share a letter are significantly different.

Results of SPAD and NDVI by interaction of year, tillage, irrigation





Results of yield (t ha-1) by year (treatments average)

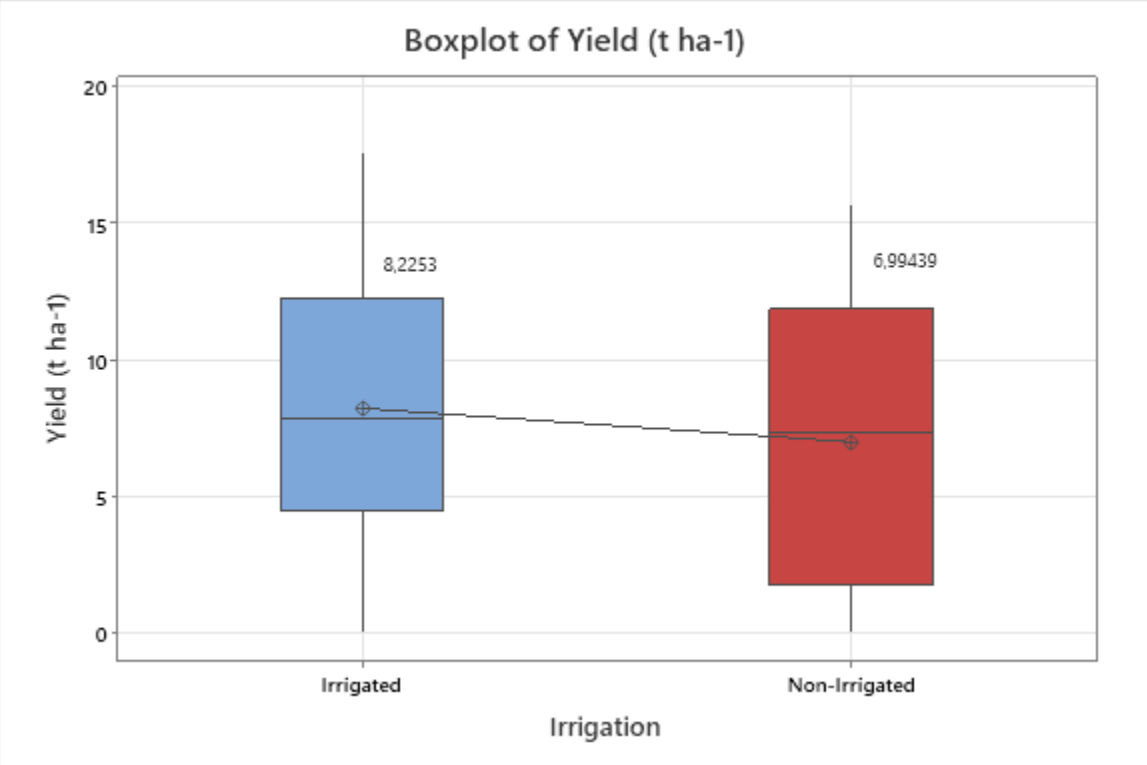


Grouping Information Using the Tukey Method and 95% Confidence

Year	N	Mean	Grouping
2023	648	12,4782	A
2021	648	7,836	B
2022	648	2,5149	C

Means that do not share a letter are significantly different.

Results of yield (t ha-1) by irrigation (years and other treatments average)

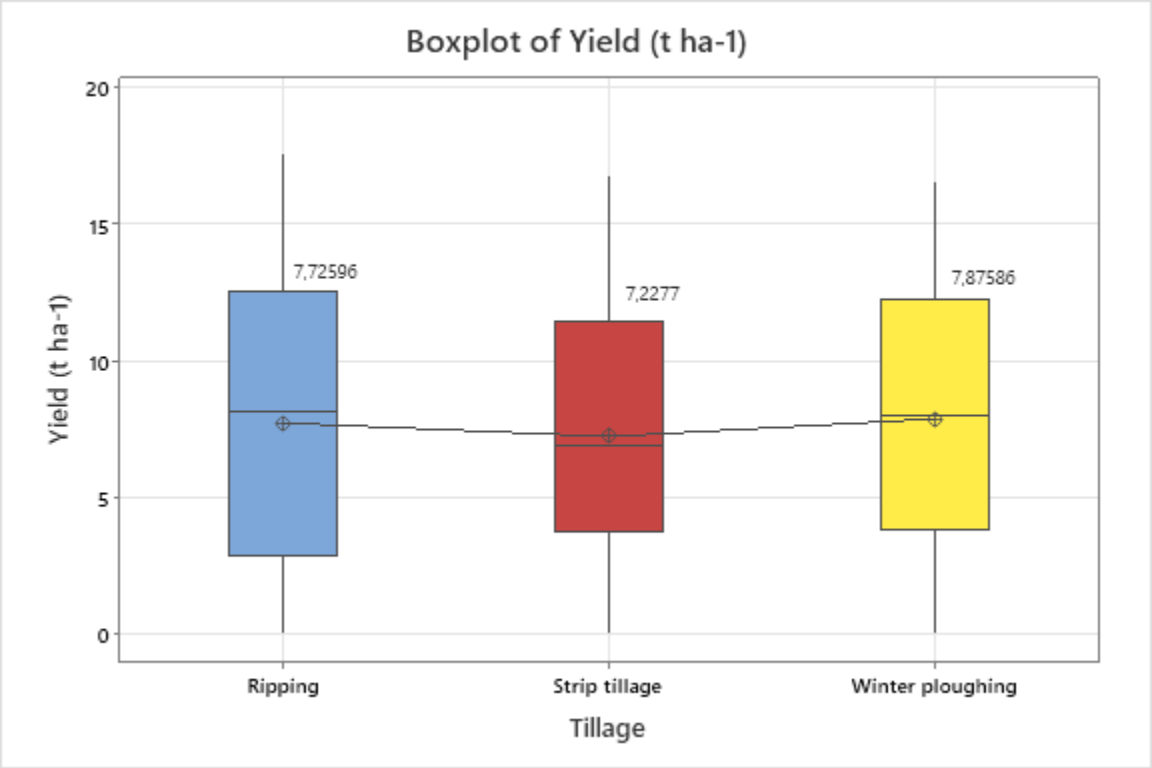


Grouping Information Using the Tukey Method and 95% Confidence

Irrigation	N	Mean	Grouping
Irrigated	972	8,225	A
Non-Irrigated	972	6,994	B

Means that do not share a letter are significantly different.

Results of yield (t ha-1) by tillage (years and other treatments average)

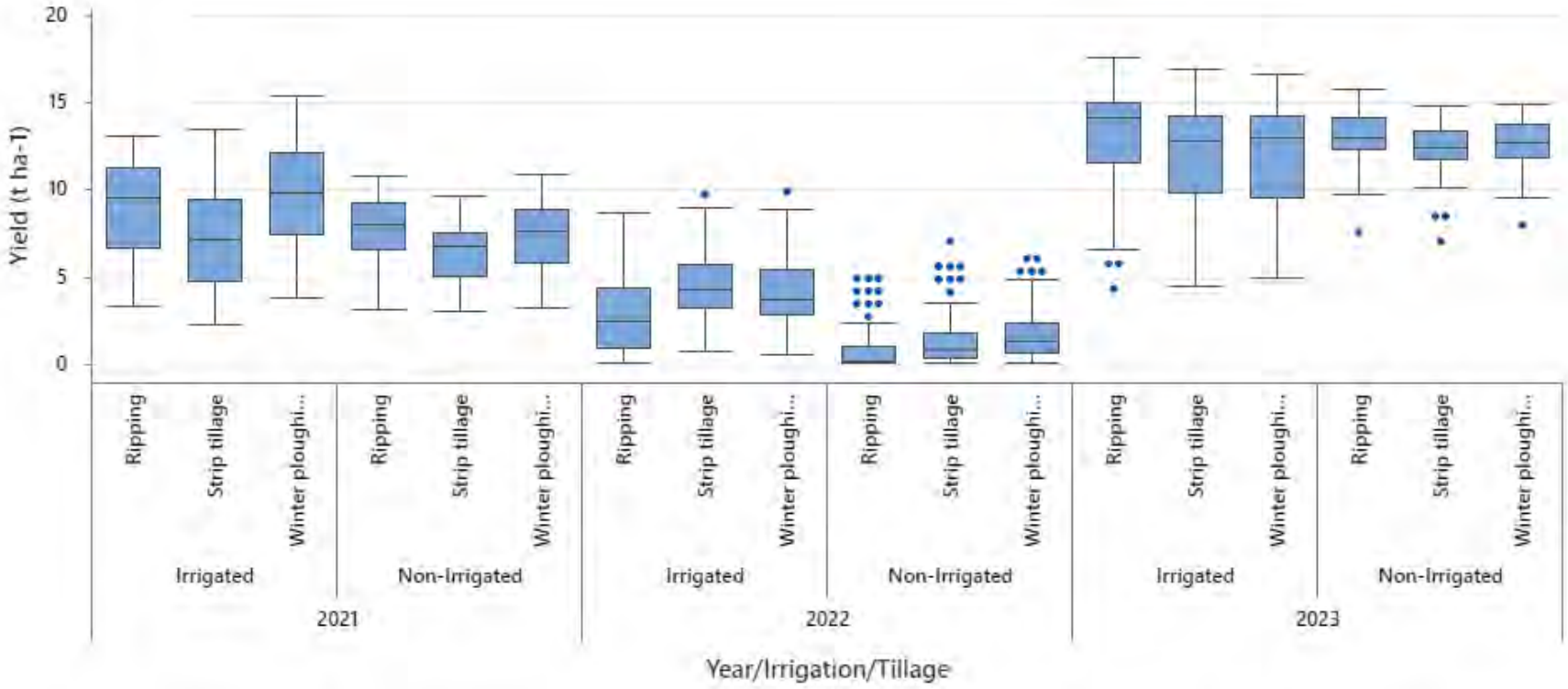


Grouping Information Using the Tukey Method and 95% Confidence

Tillage	N	Mean	Grouping	
Winter ploughing	648	7,876	A	
Ripping	648	7,726	A	B
Strip tillage	648	7,228		B

Means that do not share a letter are significantly different.

Results of yield (t ha-1) by interaction of year, tillage, irrigation



Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Year	2	32213,0	16106,5	3569,09	0,000
Irrigation	1	736,4	736,4	163,17	0,000
Tillage	2	149,2	74,6	16,53	0,000
Year*Irrigation	2	729,2	364,6	80,79	0,000
Year*Tillage	4	476,3	119,1	26,39	0,000
Irrigation*Tillage	2	6,9	3,5	0,77	0,465
Year*Irrigation*Tillage	4	91,0	22,8	5,04	0,000
Error	1926	8691,6	4,5		
Total	1943	43093,6			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
2,12433	79,83%	79,65%	79,45%

Yield avg. (t ha-1) by parcels 2015-2023.

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DJI Mavic 3 Multispectral

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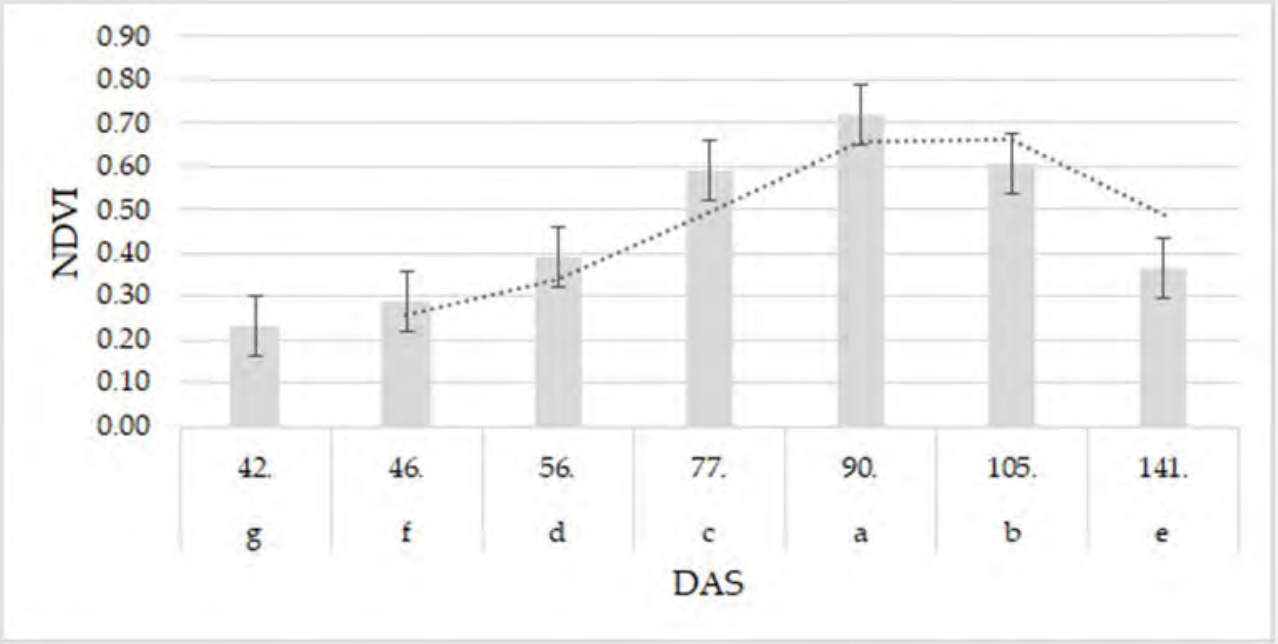
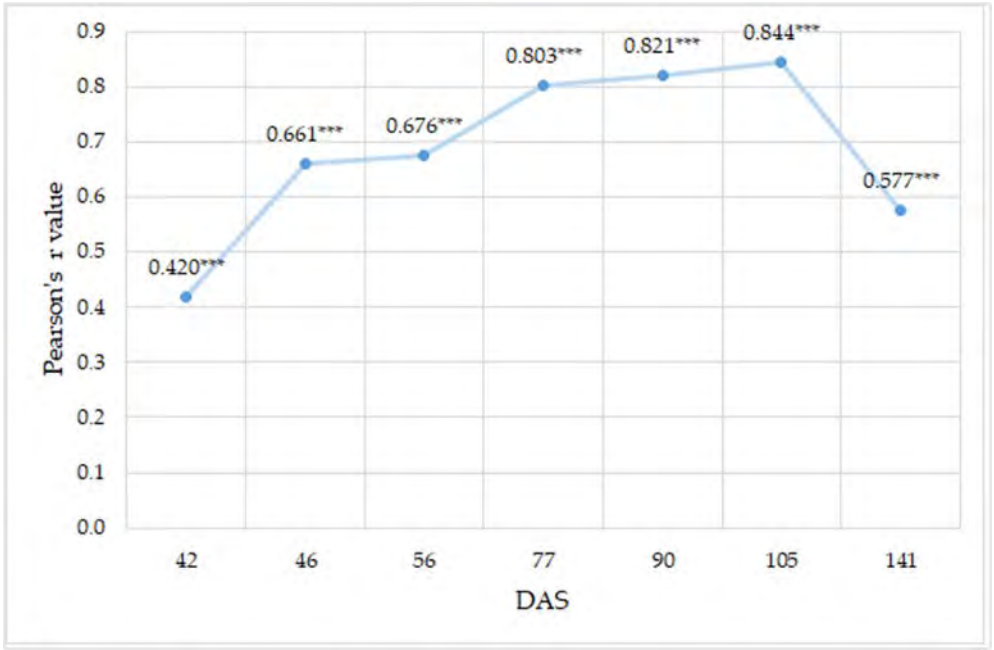
UAV NDVI dynamics results I.

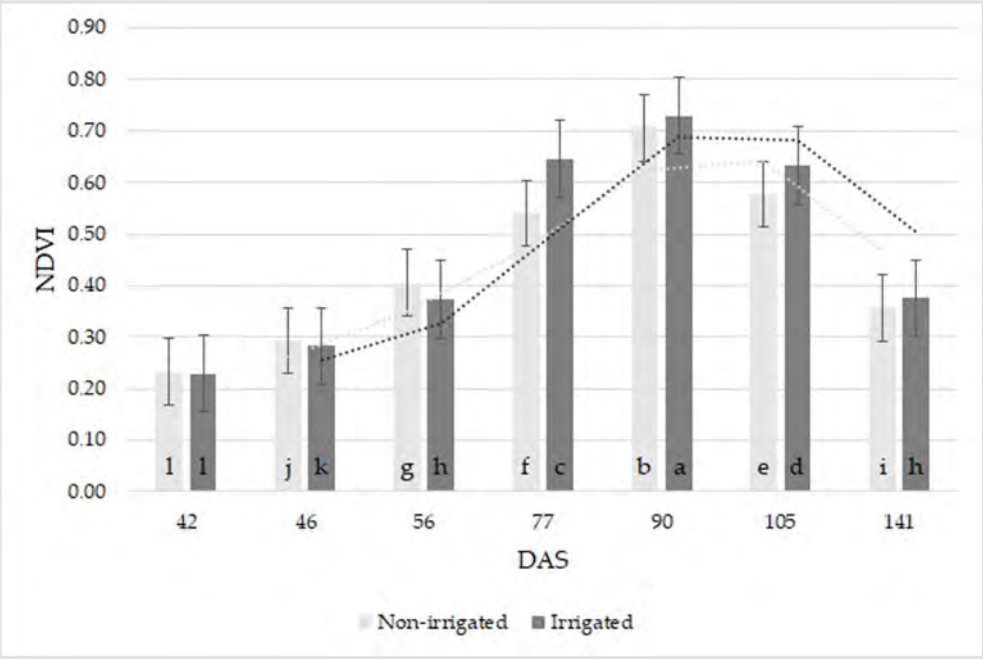


The NDVI-UAV values of maize as the effect of days after sowing (DAS) (Debrecen, 2021); means of the varieties ± standard error. The differences among the measurement days were significant at the p = 0.001 level. Different letters mean significant difference at the p < 0.05 level among the measurement days. LSD = 0.003.

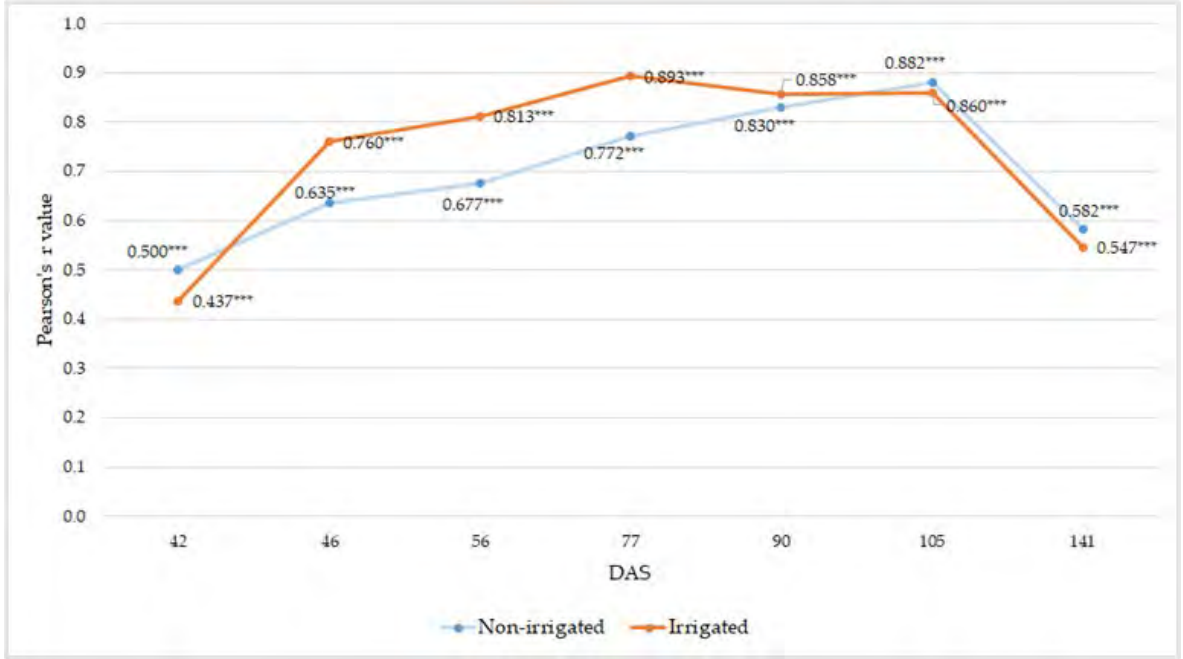


Pearson correlation coefficient (r) dynamic among NDVI-UAV and yield t ha-1 (2021, Debrecen)
Note: ***. Correlation is significant at the 0.001 level

UAV NDVI dynamics results II.

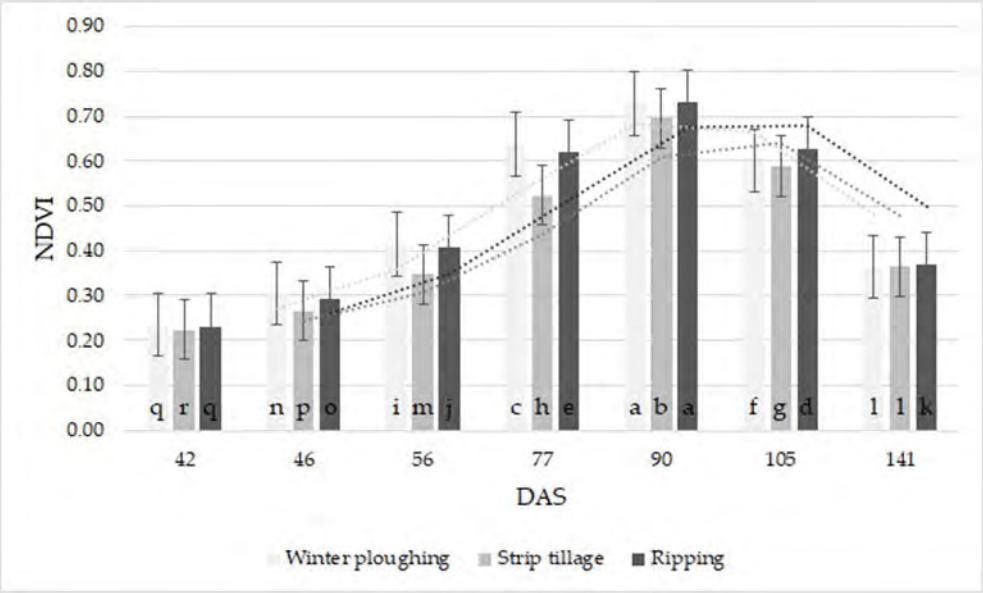


The NDVI-UAV values of maize as the effect of irrigation at different DAS (Debrecen, 2021); means of the varieties ± standard error. At the p = 0.001 level, the differences between the DAS treatments were considered significant. The different letters indicate treatments that differ significantly ($p < 0.05$). LSD = 0.004.

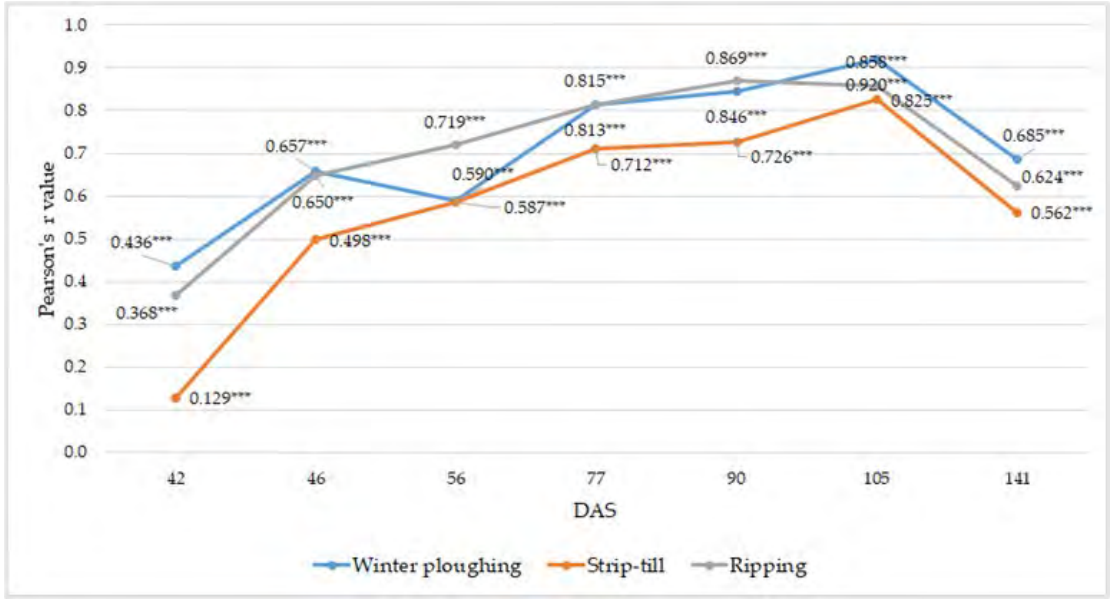


Pearson correlation coefficient (r) dynamics among NDVI-UAV and yield t ha-1 in non-irrigated and irrigated conditions (2021, Debrecen)
Note: ***. Correlation is significant at the 0.001 level

UAV NDVI dynamics results III.



The NDVI-UAV values of maize as the effect of tillage at different DAS (Debrecen, 2021); means of the varieties ± standard error. At the p = 0.001 level, the differences between the DAS treatments were considered significant. The different letters indicate treatments that differ significantly ($p < 0.05$). LSD = 0.005.



Pearson's correlation coefficient (r) dynamics among NDVI-UAV and yield t ha-1 as a result of tillage systems (2021, Debrecen)
Note: ***. Correlation is significant at the 0.001 level

Discussion of UAV-NDVI results

- The NDVI dynamics of maize, averaged across cultivars and hybrids, showed a significant correlation with yield on days 90 - 105 after sowing ($r = 0.821^{***} - 0.844^{***}$). The developmental stage of the plant at this time was VT and R1.
- In the analyzed year, precipitation in June and July was well below the 30-year average, and irrigation in June significantly increased NDVI values, which can be seen on day 77 after sowing.
- The NDVI values measured in the tillage treatments differed statistically ($p < 0.001$) during the maize growing season. The negative effects of droughty weather in summer were confirmed in the study of NDVI dynamics of maize under conventional tillage.
- With UAV-based remote sensing, more accurate information can be gathered about plant condition, because atmospheric disturbing factors can be excluded and phenological phases can be precisely determined.
- The promotion of environmentally friendly tillage techniques is an important aspect of sustainability, and we recommend the use of ripping and strip-tillage over winter ploughing.

Thank you for your attention!

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