# Four directions for enhancing plant nutrition management system under arid growing season

*Yevheniia Hladkikh*

SOILS: WHERE FOOD BEGINS

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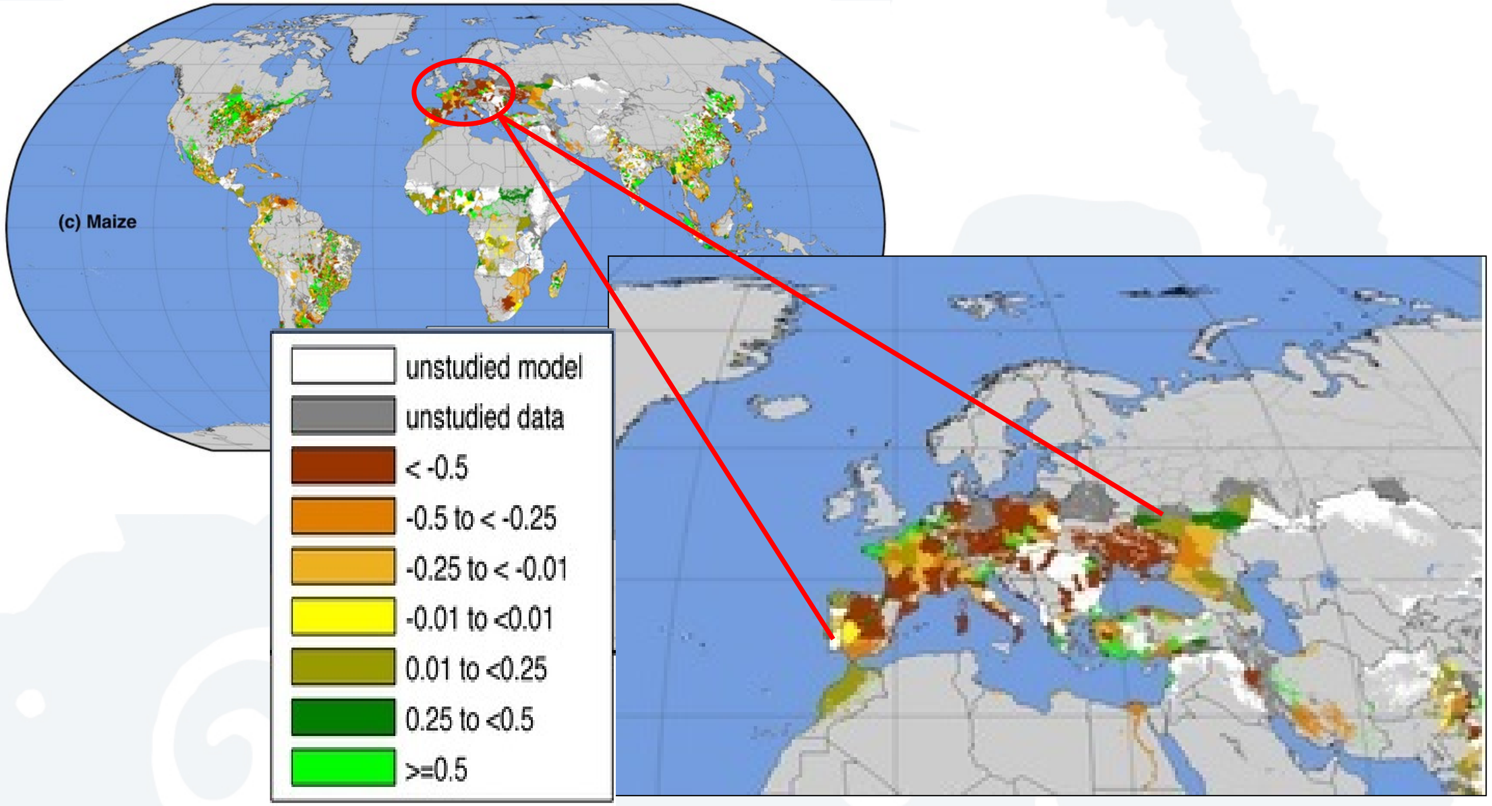
GLOBAL SOIL PARTNERSHIP

# Climate change is one of the important reasons for the decline in crop yields around the world




**Impact of mean climate change on crop (maize) yield (tons/ha/year)** (Ray et al., 2019, CC BY)

Recent climate change generally decreased yields across **Europe, Sub-Saharan Africa and Australia**.

Yields for all the dominant crops (wheat, barley, maize) in **western and southern Europe decreased 6.3–21.2%** because of climate change. Similarly, in **eastern and northern Europe** yield losses are widespread for **maize (-24.5%), barley (-9.1%), and wheat (-2.1%)** (Ray et al., 2019, CC BY).

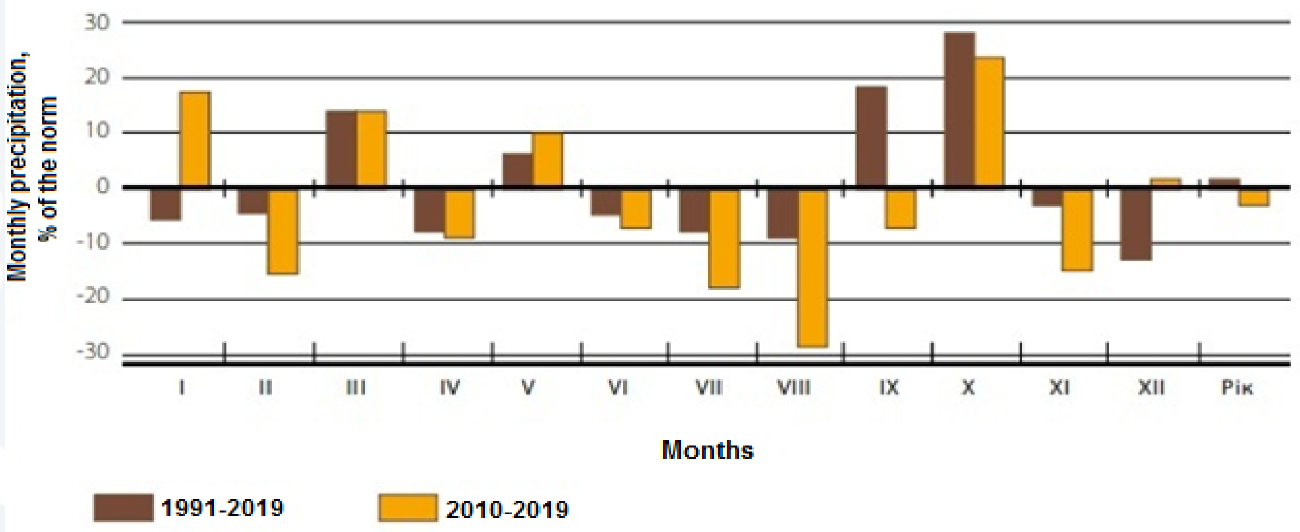

Map developers: Polupan M., Solovei V., Velychko V., Zalavskyi Yu.

## The chernozem soils zone of Ukraine

Chernozem Luvic,
Chernozem Haplic,
Chernozem Calcic,
Chernozem Calcic (dry zone)

Feature of current climate in chernozem zone of Ukraine is often repeating extreme hydrothermal conditions.

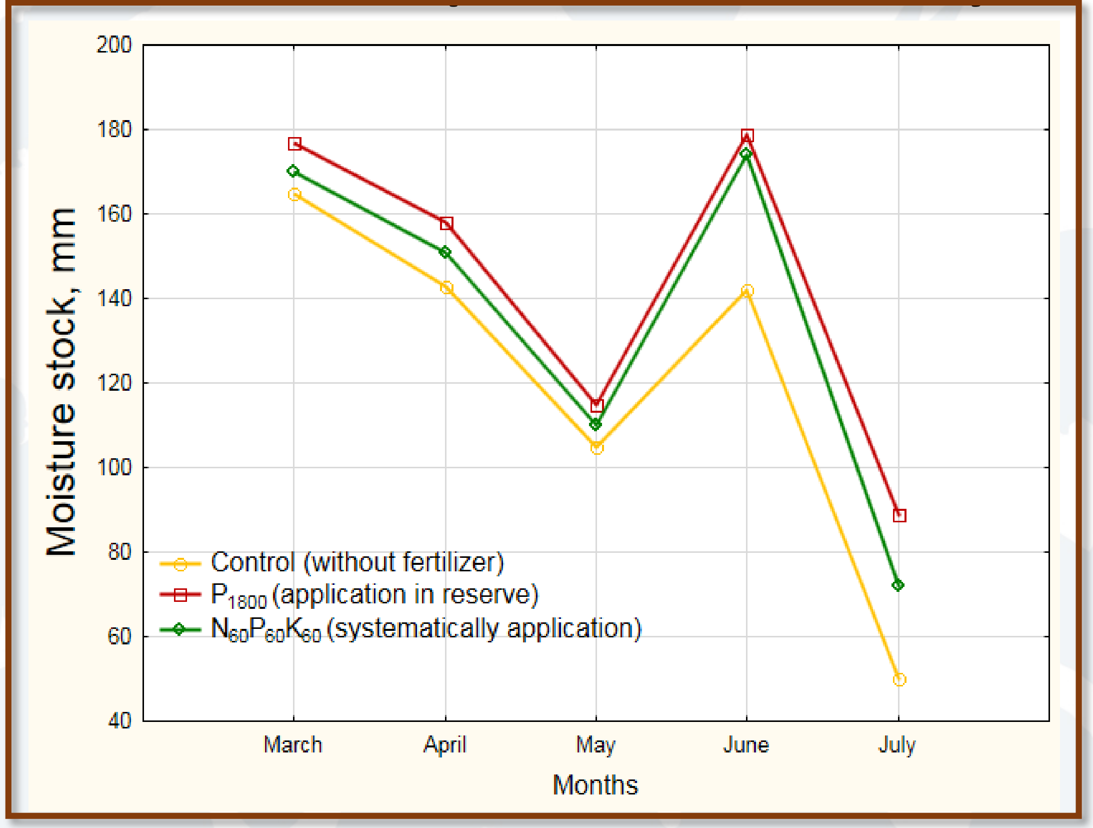
The average annual precipitation rate in the chernozem soils zone of Ukraine is about **450-580 mm**. Whereas sustainable farming needs at least **700 mm** of annual precipitation.

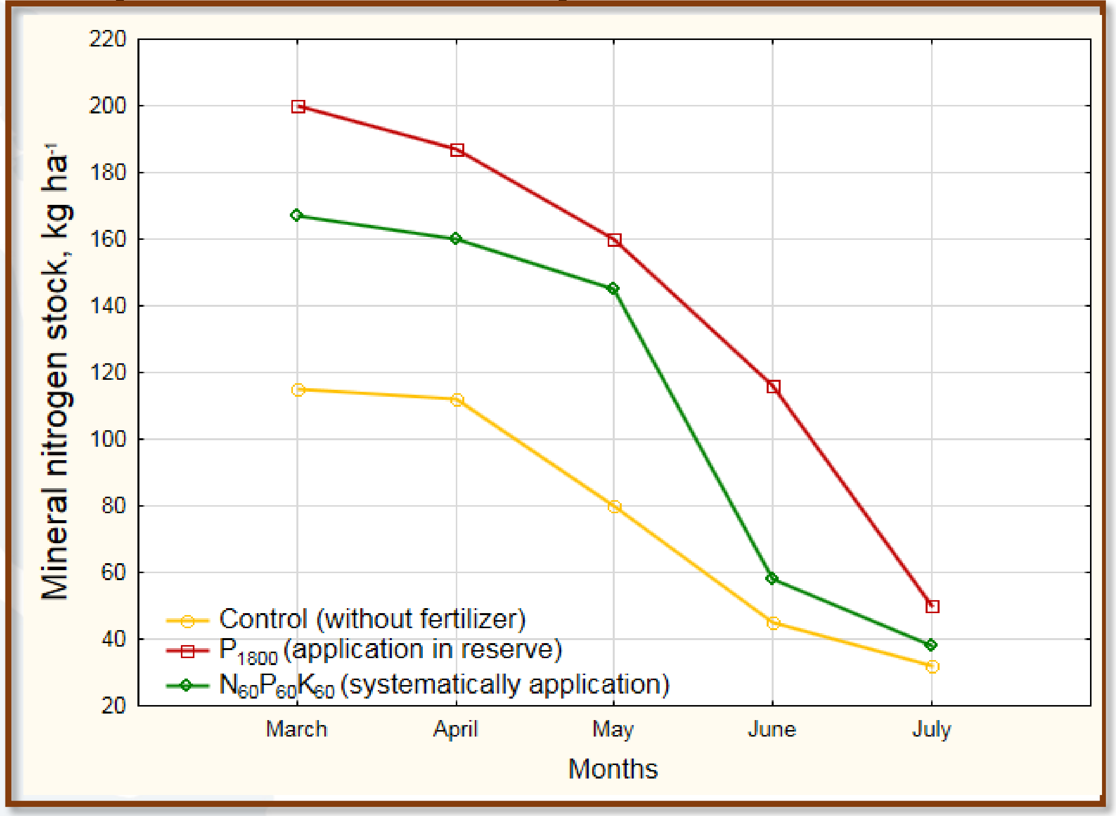



**Difference between the amount of monthly total precipitation and the norm in Ukraine during 1991-2019 and 2010-2019**

# 1st direction - Formation of high soil phosphorus levels

## Dynamics of moisture and mineral nitrogen stock in the soil layer 0-100 cm during the period of March-July in different options of field experiment




Formation of high soil phosphorus levels (mobile phosphorus content in chernozem was 115-120 mg kg$^{-1}$) significantly increase efficiency of plant using both moisture (by 4-20%) and nitrogen (by 15-60%) higher compared to other options. And contributed to the formation of the residual phosphates.

# 1st direction - Formation of high soil phosphorus levels

The use of water per 1 ton of dry matter of plant is less on soil with a high phosphorus content compared to soil with a low phosphorus content **by 20-25%.** With NPK application this difference decreases, but remains significant.

**Influence of different levels of phosphorus content in chernozem on the yield and the use of water by Corn silage**

| Available phosphorus content in soil, mg $kg^{-1}$ | Experiment options | Yield, t $ha^{-1}$ | Reserves of productive moisture in soil layer 0-160 cm, $m^3$ $ha^{-1}$ | | Water use, $m^3$ | |
|---|---|---|---|---|---|---|
| | | | the beginning of the growing season | the end of the vegetation | evapo-transpiration | per 1 ton of yield |
| 40-50 | Control | 34.0 | 1050 | 550 | 2280 | 0.67 |
| | NPK | 34.4 | 1000 | 460 | 2330 | 0.52 |
| 115-120 | $P_{1800}$ (application in reserve) | **36.9** | **1140** | **510** | **2410** | **0.65** |
| *LSD($P \leq 0.05$)* | | *1.5* | *36* | *42* | *98* | *0,06* |

# 2nd direction - Combined application of mineral fertilizers and stress-protective substances

## Scheme of the field experiment

1. $N_{30}P_{30}K_{30}$ - agrochemical background (AB);
2. AB + **SPs*** (at rate 1.0 L $t^{-1}$);
3. AB+ SPs (at rate 1.0 L $t^{-1}$)+ **SPf**** (at rate 0.5 L $ha^{-1}$ twice);
4. AB+ SPf (at rate 1.0 L $ha^{-1}$ once);
5. AB+ SPf (at rate 0.5 L $ha^{-1}$ twice)

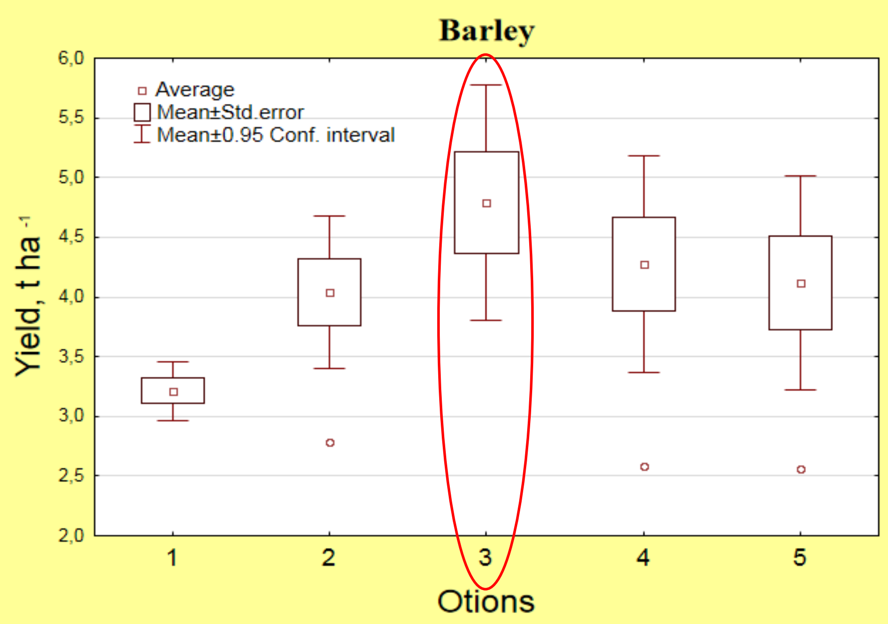
***SPs - stress protector for seeds**

****SPf - stress protector for foliar**

## Yield and plant production indicators of spring barley depending on the application of stress-protective substances in combination with mineral fertilizers

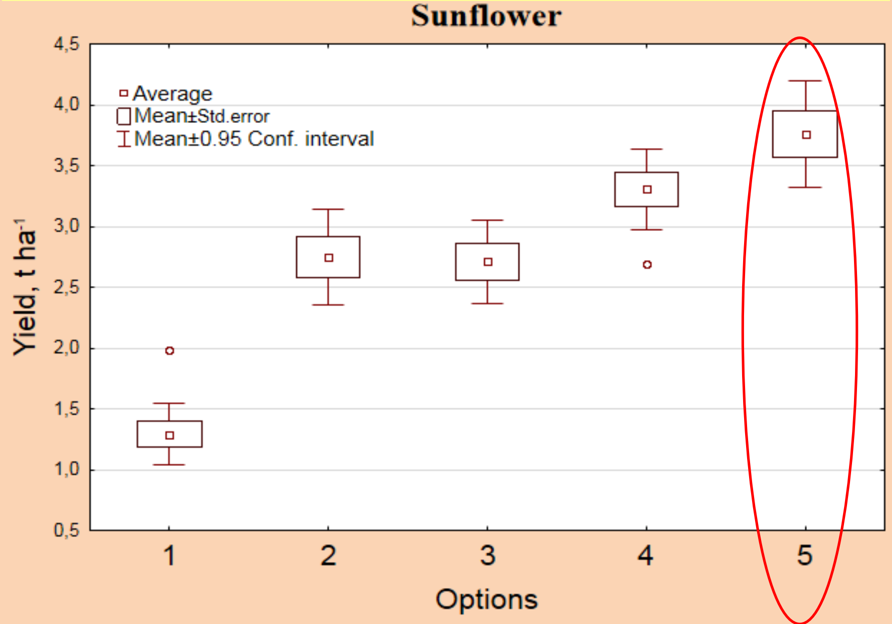
| Treatments | Grain yield, t $ha^{-1}$ | Content in barley grain, % | | | Chlorophyll content in plant tissues, units SPAD-502 Plus | Bound water content in plant tissues, % |
|---|---|---|---|---|---|---|
| | | N | P | K | | |
| 1 | 2.00 | 1.54 | 0.86 | 0.53 | 35.3 | 9.0 |
| 2 | 2.36 | 1.81 | 0.91 | 0.56 | 45.7 | 12.5 |
| 3 | 2.32 | 1.81 | 0.91 | 0.52 | 45.0 | 10.8 |
| **4** | **2.84** | **1.72** | **0.90** | **0.54** | **48.9** | **13.8** |
| 5 | 2.69 | - | - | - | 47.0 | 13.0 |
| *LSD($P \le 0.05$)* | *0.67* | *0.13* | *0.03* | *0.01* | *5.9* | *2.5* |

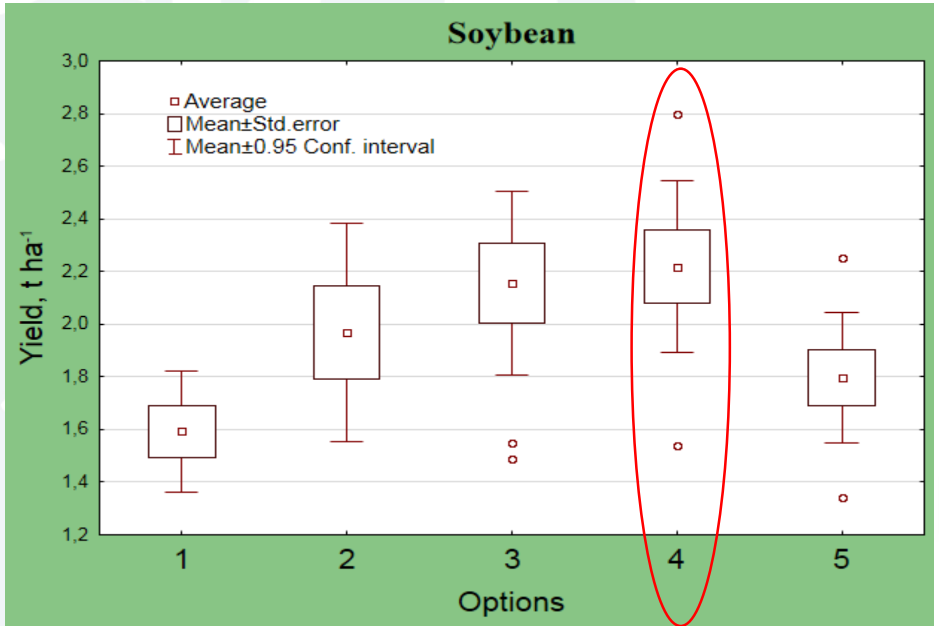
# 3rd direction - Regulation of the depth of fertilizers placement




## Scheme of the field experiment

| No | Kind of fertilizers | Rate of fertilizer application, kg $ha^{-1}$ | Depth of fertilizer localization, cm |
|---|---|---|---|
| 1 | Without fertilizers | 0 | - |
| 2 | Nitroamofoska | $N_{60}P_{60}K_{60}$ | 10-12 |
| 3 | Nitroamofoska | $N_{60}P_{60}K_{60}$ | 20-22 |
| 4 | Nitroamofoska | $N_{60}P_{60}K_{60}$ | 10-12 and 20-22 |
| 5 | Ammonium nitrate, potassium chloride and ammophos | $N_{60}P_{60}K_{60}$ | 20-22 |

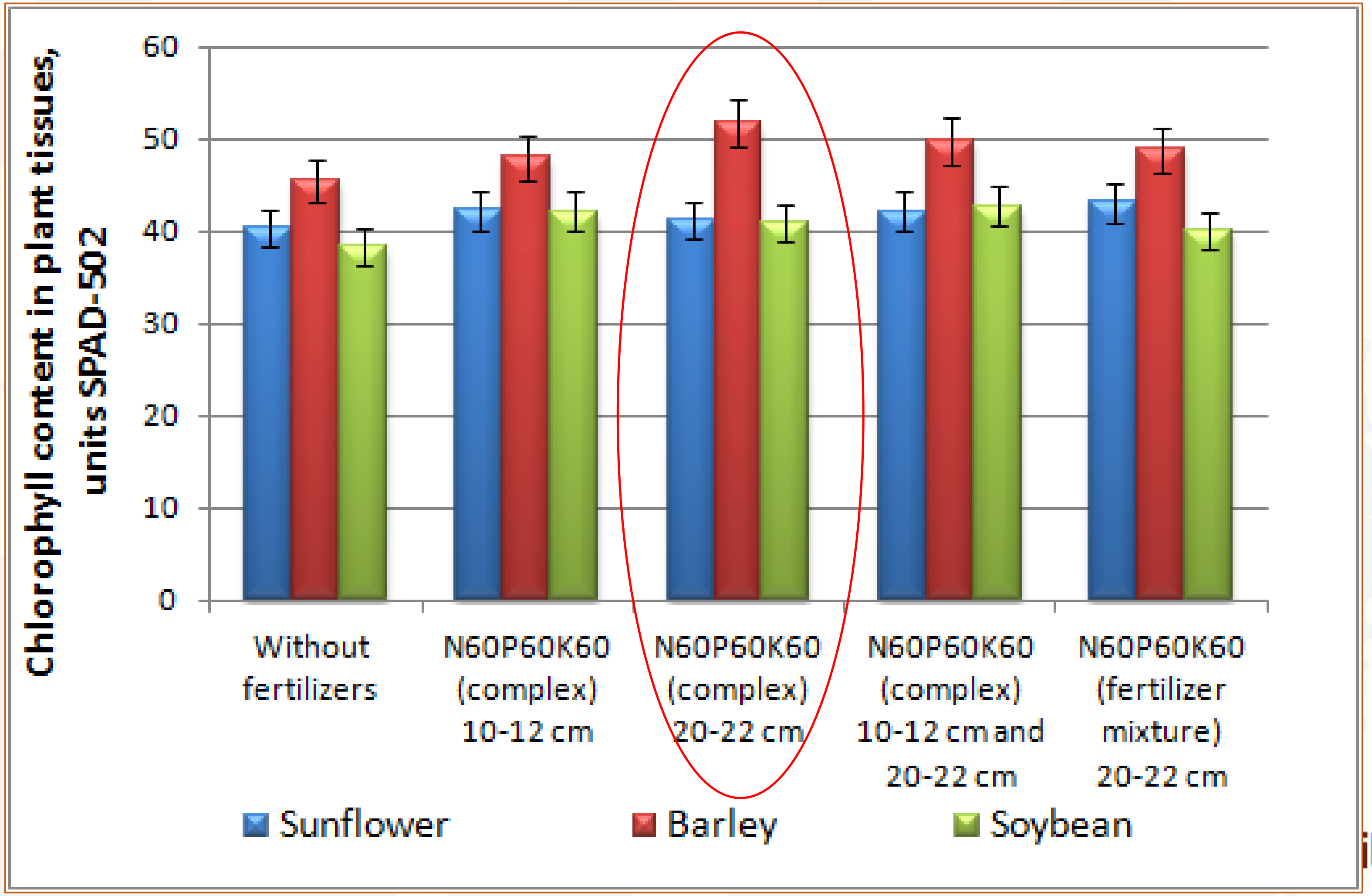



Crops yield by the depth of application and forms of fertilizers

# 3rd direction - Regulation of the depth of fertilizers placement

## Chlorophyll content in plant leaves depending on the depth of localization and type of fertilizers




# 4th direction - Proportion optimization of macro- and mezoelements for nutrition plants in soil and fertilizers

| No. options | Fertilizer doses, kg ha$^{-1}$ of active substance | | | |
|---|---|---|---|---|
| | N | P | K | S |
| 1 | 100 | 60 | 60 | **0** |
| 2 | 100 | 60 | 60 | **20** |
| 3 | 100 | 60 | 60 | **40** |
| 4 | 100 | 60 | 60 | **60** |

Scheme of the field experiment

Yield and plant production indicators of Sudan sorghum depending on the ratio of N:S

| Experiment options | The ratio of N:S in fertilizers | The ratio of N:S in the soil | Yield, t ha$^{-1}$ | Nutrient content, % | | | Bound water content in plant tissues, % |
|---|---|---|---|---|---|---|---|
| | | | | N | P | K | |
| 1 | 1:0 | 3,3:1 | 39,4 | 1,47 | 0,50 | 1,36 | 51,9 |
| **2** | **5:1** | **2,5:1** | **52,2** | **1,70** | **0,55** | **1,50** | **56,0** |
| 3 | 2,5:1 | 0,8:1 | 51,4 | 1,64 | 0,56 | 1,25 | 52,9 |
| 4 | 1,7:1 | 0,6:1 | 45,7 | 1,48 | 0,53 | 1,28 | 55,1 |
| LSD($P \leq 0.05$) | | | 6,7 | 0,27 | 0,04 | 0,2 | 4,31 |

# PLANT NUTRITION MANAGEMENT STRATEGY
## under condition of dry growing season on chernozems soil

**Combination of the application of macro- and mesoelements in optimal ratios against a formation of a high soil phosphorus levels**

This provides both plant nutrition during the growing season and an increase in soil fertility

**Increasing the depth of fertilizers localization**

This ensures stimulation of the root system of plants and its proliferation under conditions of unstable moisture

**Application of stress-protective preparations**

This agricultural practice against the background of mineral nutrition, described above, provides a significant improvement in the physiological characteristics of plants and, accordingly, increases resistance to extreme droughts

# Thank you !


**National Scientific Center**
**«Institute for Soil Science and Agrochemistry Research named after O.N. Sokolovsky», Ukraine**

http://issar.com.ua

nsc.issar@gmail.com

ecosoil@meta.ua – **Mykola Miroshnychenko**

ye.hladkikh@gukr.net – **Yevheniia Hladkikh**