Food and Agriculture Organization of the United Nations

موسسه تحقیقات خاک و آب

Salt-affected soils: threats and potentials

Assessing Soil Potassium and Phosphorus Dynamics in Potato and Maize under Drip Irrigation

Joint meeting of

INSAS and SUSTAIN

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International Network of Salt-Affected Soils

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SUSTAIN

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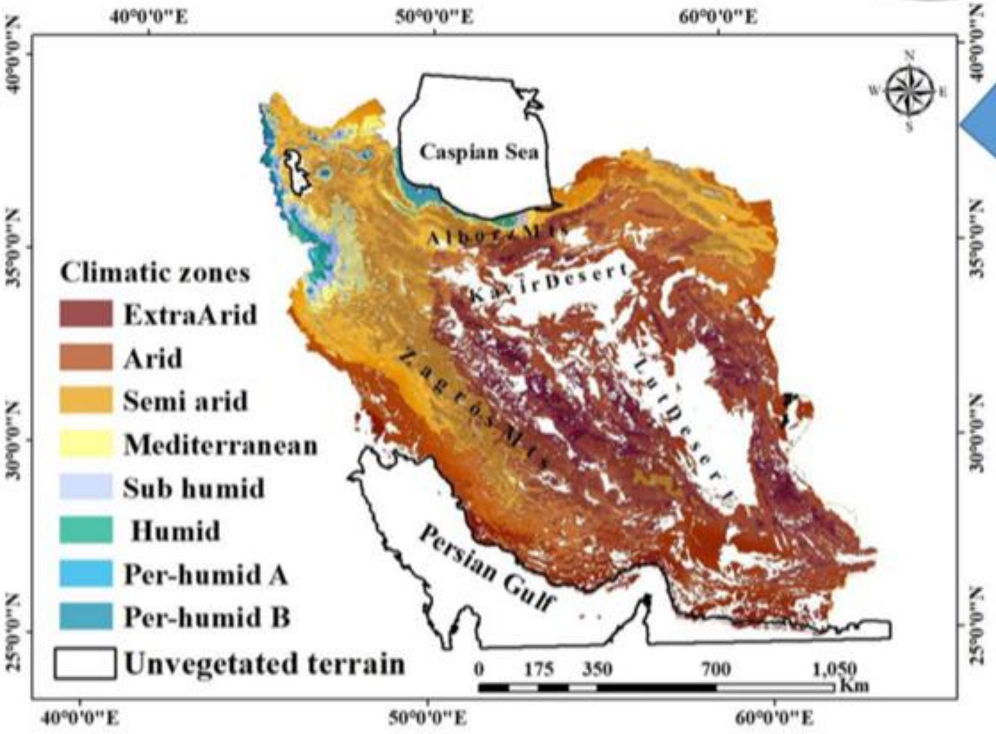
GLOBAL SOIL PARTNERSHIP


1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

~ 85% of **Iran** is arid, semi-arid or hyper arid environment with
~ 30 - 50% salinity problem (Khorsandi et al. (2009); Rezaei et al. (2021))

- **Climate change**
- **Population growth**
- **Agriculture development**
- **Low water use efficiency**
- **Food demand**
- **Soil and water quality**
- **Improper practices/management**



(Eskandari dameneh et al. (2021))

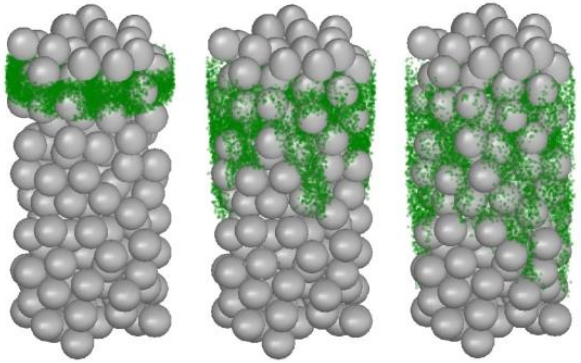
Water crisis; Food security

The combination of fertigation and drip irrigation system

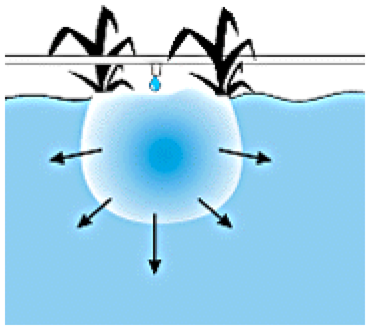
Main Advantages:

- ✓ **Reduces resource loss**
- ✓ **Improves water use efficiency**
- ✓ **Precise nutrient application; fertilizer use efficiency**
- ✓ **Synchronizing the Water and nutrients application with crop demand**

Spatial distribution of water, solute and nutrients

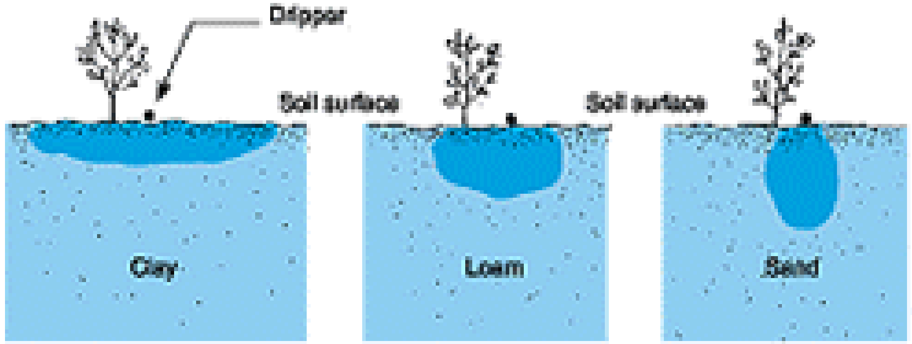


Mass flow & Diffusion: the main mechanisms in the transport/movement of K and P

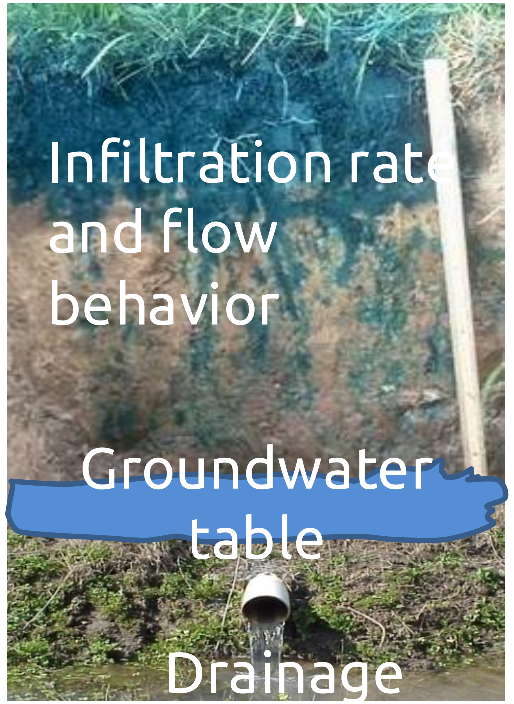


Factors affecting the spatial distribution and movement

- soil characteristics; texture, CEC, HP, pH
- quality of irrigation water; EC, TDS
- fertilizer composition
- irrigation pattern and strategy
- concentration of the fertilizer solution
- Boundary condition; ET, GW



(Ajdary et al., 2007; Gärdenäs et al., 2005; Phogat et al., 2014; Ramos et al., 2011&2012; Rezaei et al., 2021; Šimůnek and Hopmans, 2009; Wang et al., 2017)



The spatial/vertical distribution of water, K and P =====➔ **fertigation and resource use efficiency**

knowledge of water, K and P and movement and transformation

The problem statement...

Understanding the interrelated dynamics of nutrient (NPK) and salt transport, as well as plant uptake processes, in order to improve the efficiency and sustainability using drip irrigation systems

Objectives

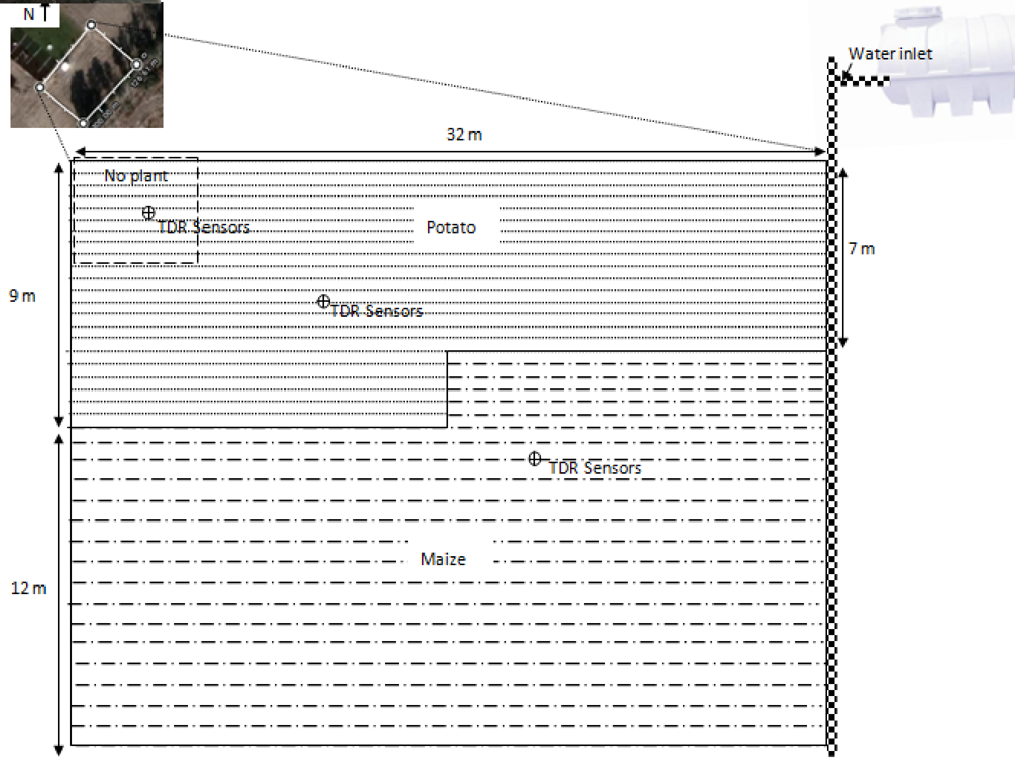
- Identify P&K distribution and movement pattern and transformation in different soils
- Developing modeling approach for optimizing water and P&K fertilizer use efficiency

Filed monitoring setup and measurement (drip irrigation):






- **Soil water content:** TDR, at 10, 20, 30, 40 cm depth ; daily
- **Sampling method**: micro/auger, at of 0-5, 5-10, 10-15, 15-20, 20-30, and 30-40 cm, P&K, EC
- **Sampling time:** 0, 4, 24, 98, 624, and 1632 h after fertigation: for 2 fertigati
- Irrigation: 21 times; 4 h
- **Fertilizer:** Urea, KH_2PO_4 and K_2SO_4 (450, 150 and 250 kg/ha NPK)
- **Plant root and leaf analysis**



Filed monitoring setup and measurement (drip irrigation):

- **Metrological data: nearby synoptic station at SWRI research station in Karaj,**
- **Plot scale characterization:**
- **Hydraulic properties Ks and SWRC:**
  a) Rosseta (PTF); b) Kopecky ring samples

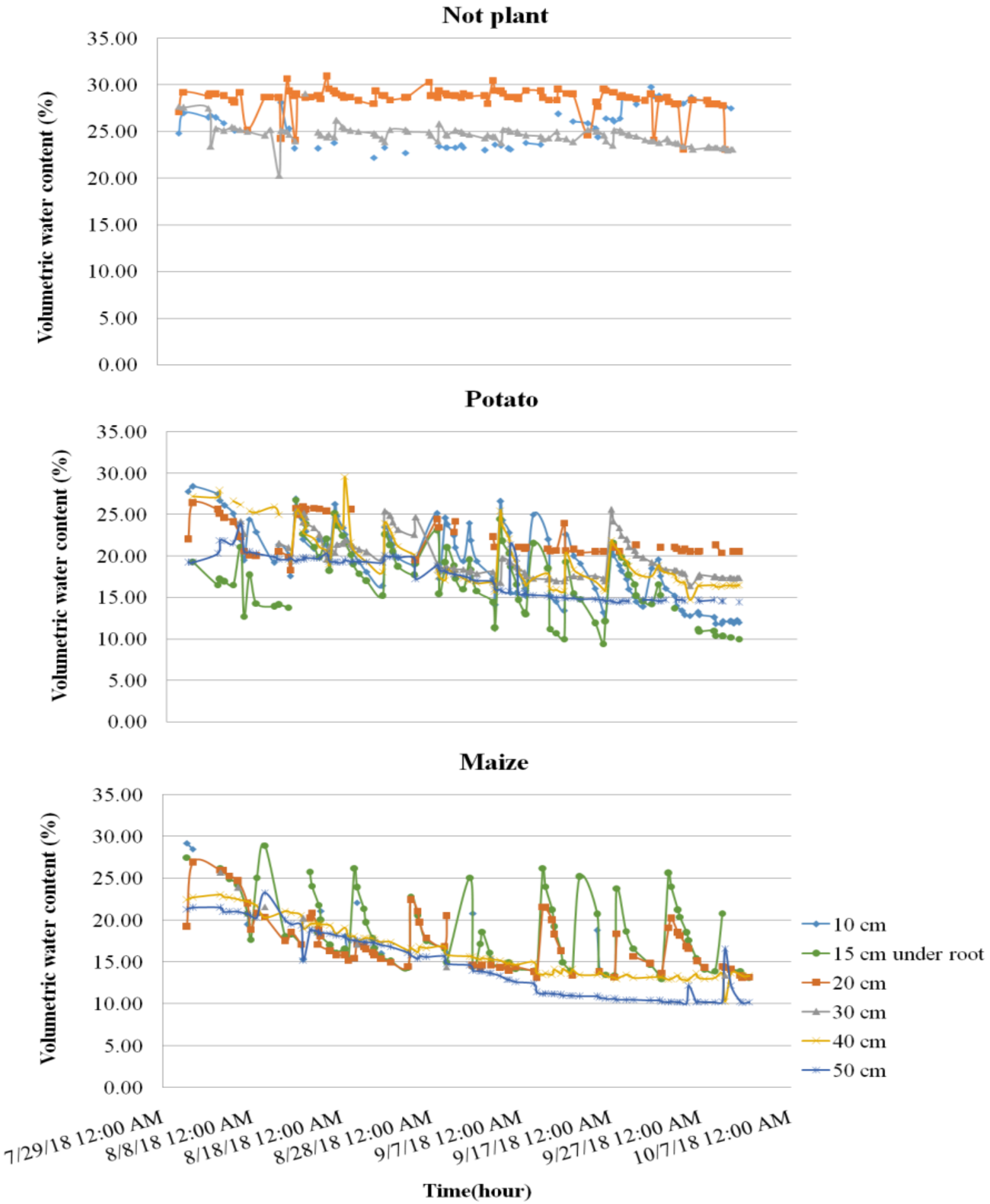
Composition of irrigation water and fertilizer solutions

	pH	ECe	P	NH_4^+	NO_3^-	Ca^{2+}	K^+	Na^+	Cl^-	Mg^{2+}	HCO_3^-	CO_3^{2-}
		ds m^{-1}	%	mg/l								
Irrigation water	8.5	0.34	0	3.92	6.44	46	0.8	13.75	35.5	7.2	103.7	0.2
Fertilizer solution first event	7.8	1.1	0.044	516	504.6	3	514	18	18	3	256	48
Fertilizer solution second event	7.8	1	0.035	500	479.3	5	423	19	25	9	628	0

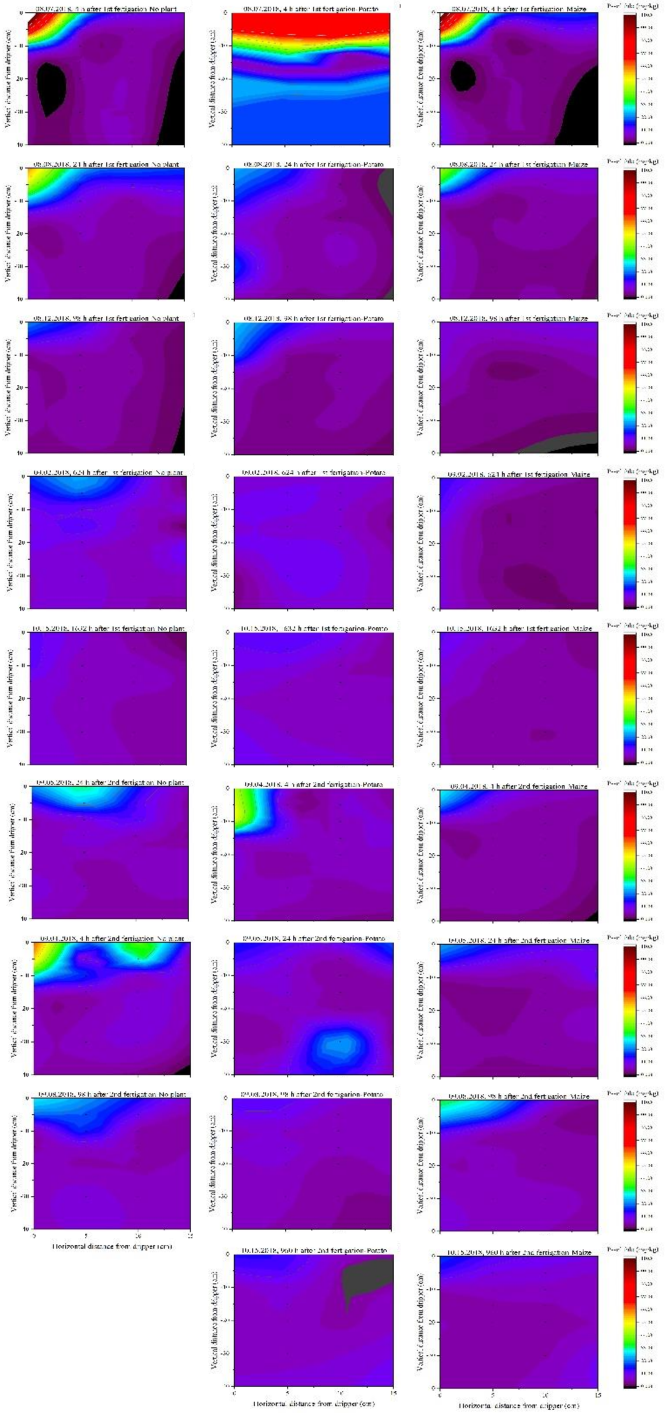
Soil physical and chemical properties of four layers.

Depth (cm)	0-15	15-35	35-65	65-100
Sand (%)	42	44	30	50
Silt (%)	30	32	40	38
Clay (%)	28	24	30	12
Texture	Clay loam	loam	Clay loam	Loam
EC (dS/m)	2.51	2.55	2.66	2.58
pH	7.9	7.9	7.9	7.8
Soluble ion (mg/l)				
K^+	51.6	25.2	46.7	58.4
Ca^{2+}	135	88	96	98
Mg^{2+}	16	19	22	15
Na^+	23.5	18	24	23
P	0.07	1.1	0.8	0.7
Cl^-	67.5	40	43	50
Exchangeable ion (meq/kg)				
K^+	0.064	0.064	0.049	0.063
Ca^{2+}	2.12	1.99	1.97	2.14
Mg^{2+}	0.22	0.18	0.21	0.24
Na^+	0.23	0.20	0.21	0.21
P ava (mg/kg)	7.9	7.1	5	4.9

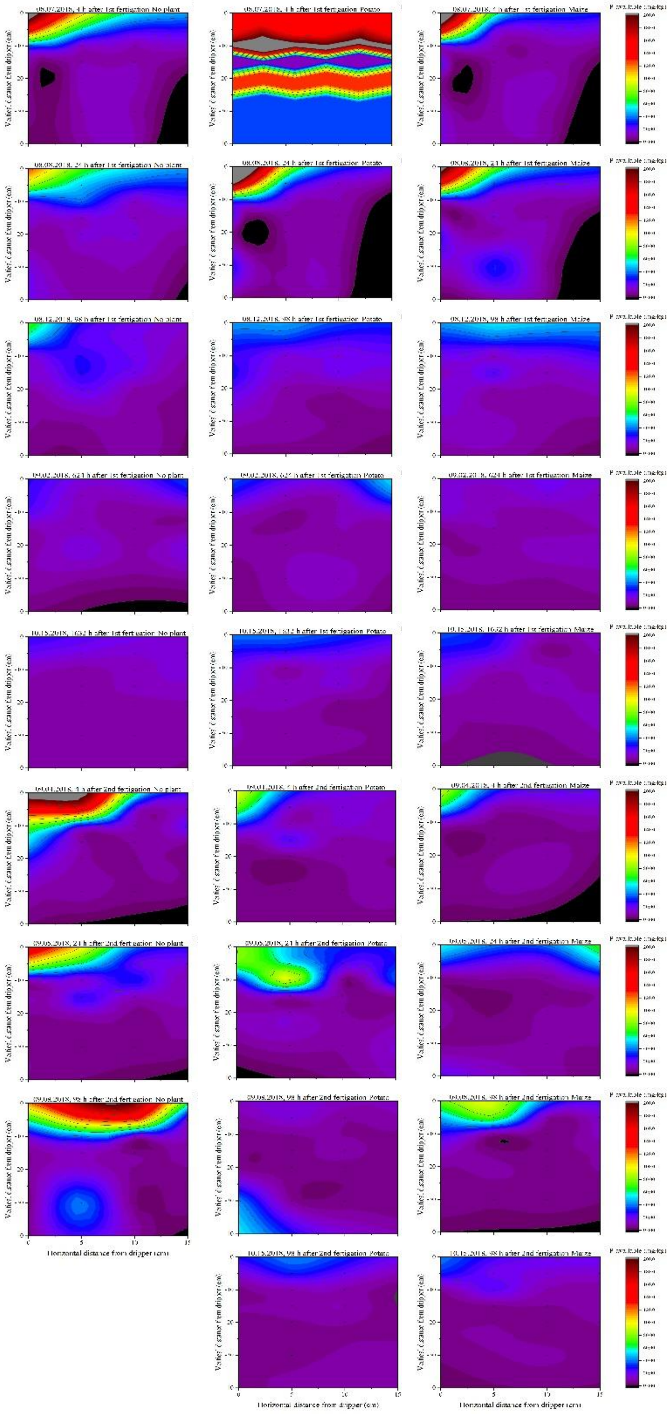
Soil water content



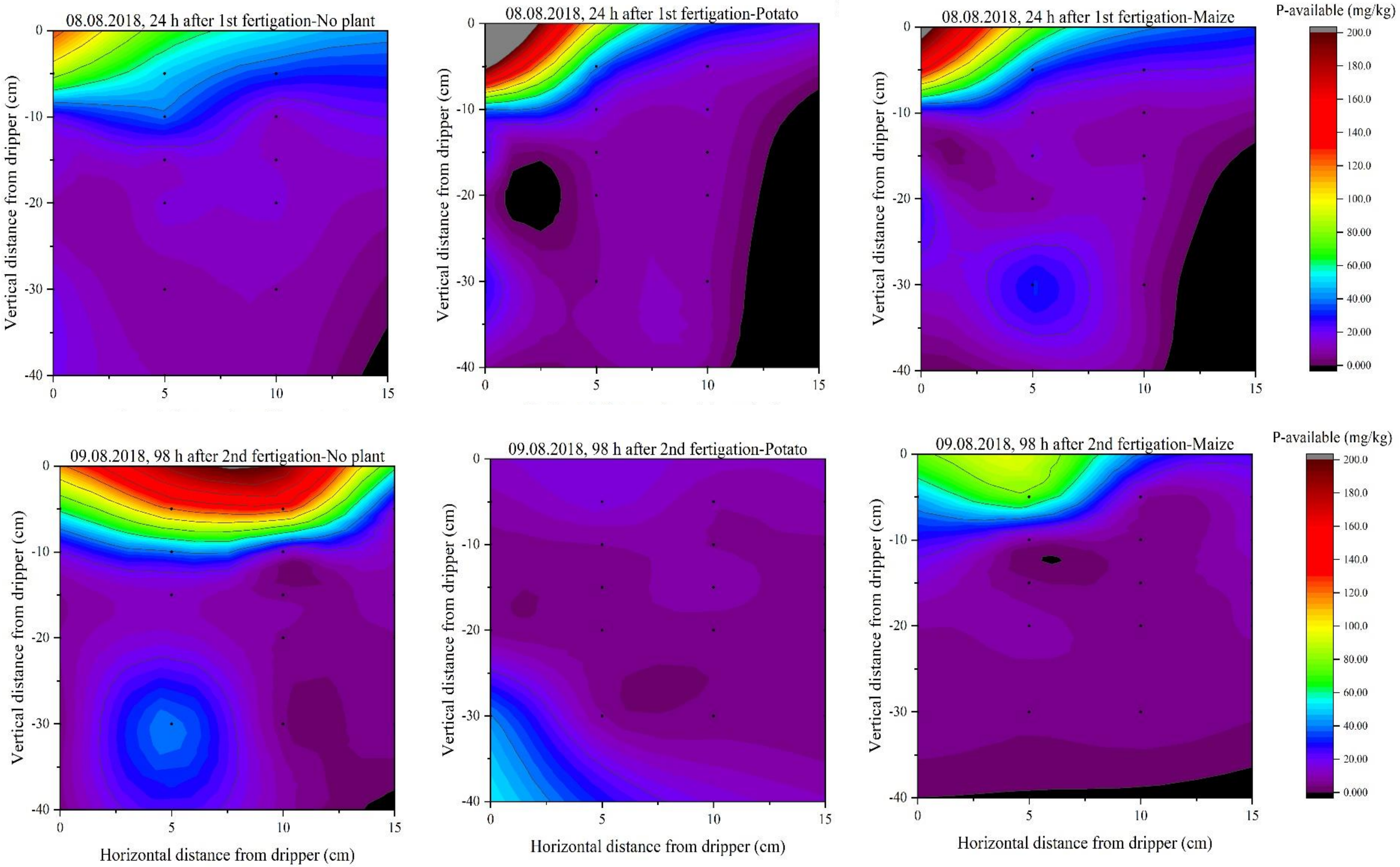
P soluble



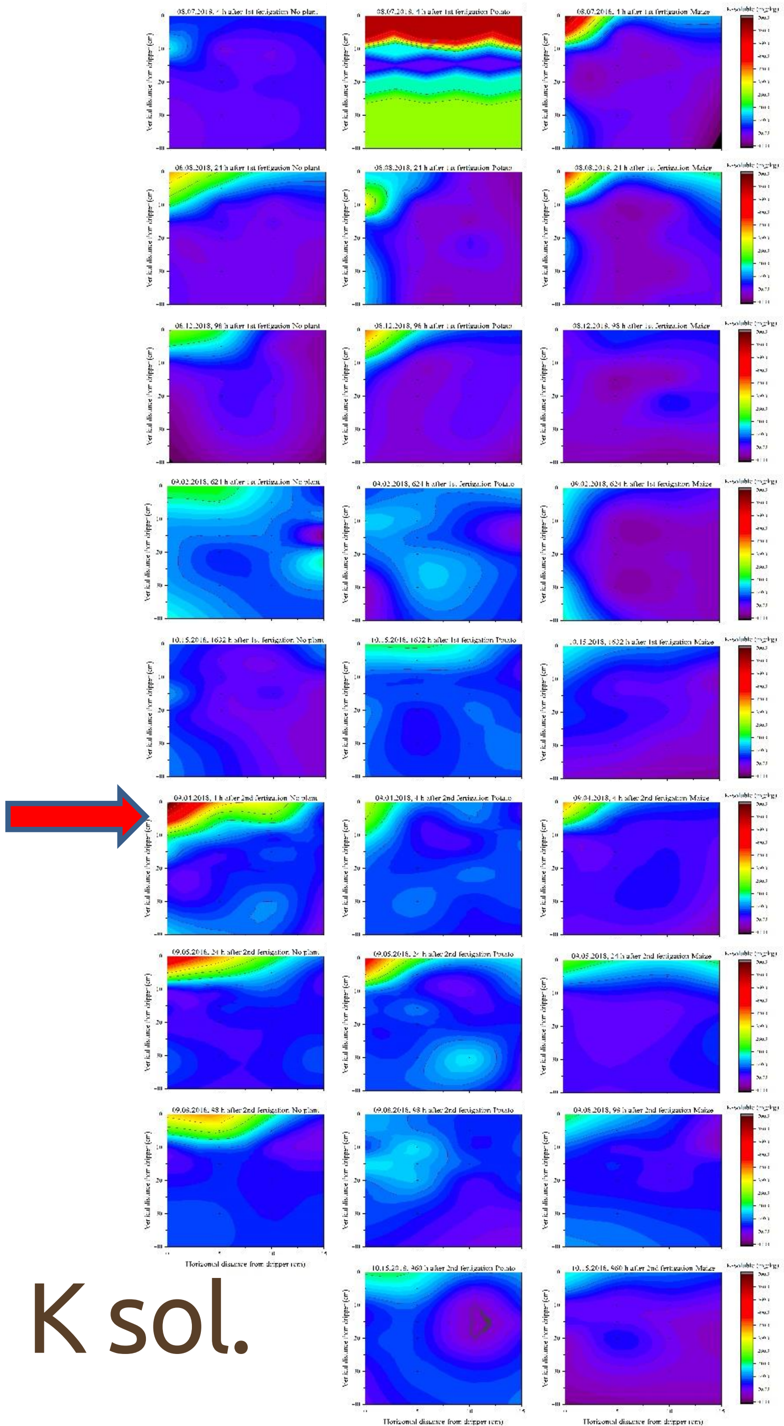
P available



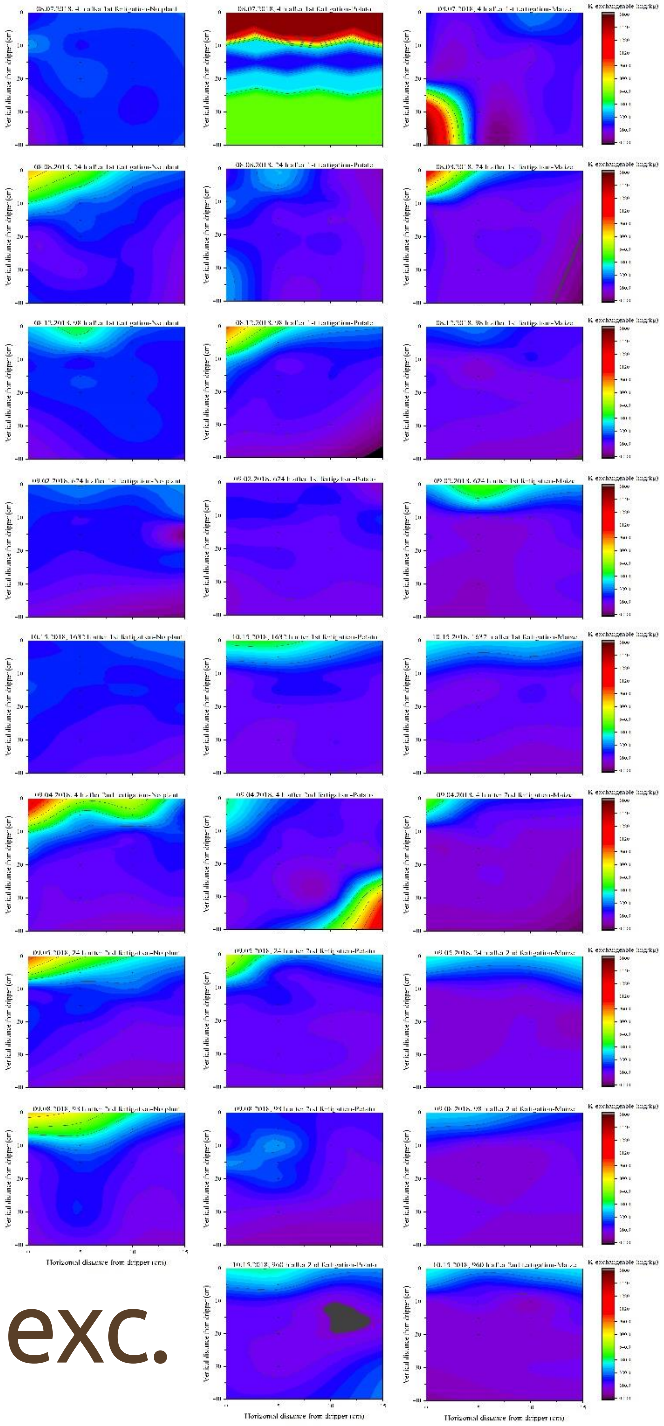
P available



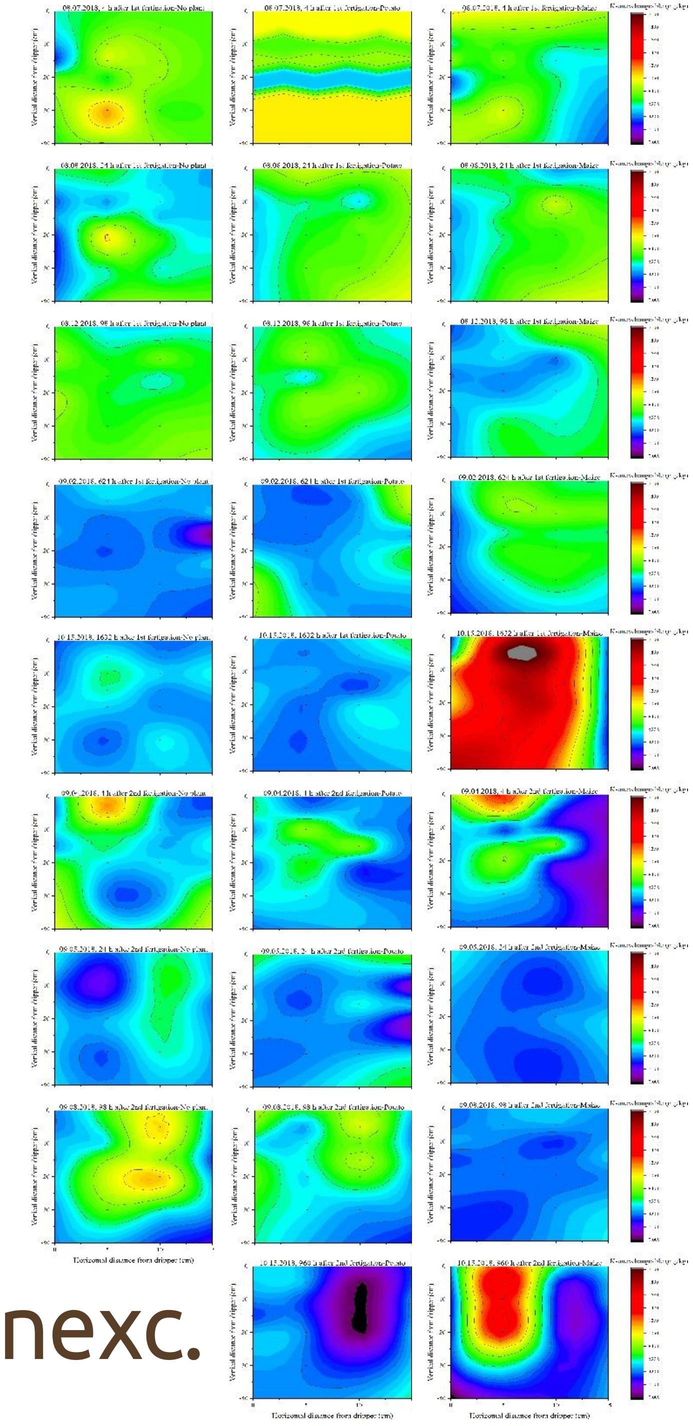
08.08.2018, 24 h after 1st fertigation-No plant
08.08.2018, 24 h after 1st fertigation-Potato
08.08.2018, 24 h after 1st fertigation-Maize
09.08.2018, 98 h after 2nd fertigation-No plant
09.08.2018, 98 h after 2nd fertigation-Potato
09.08.2018, 98 h after 2nd fertigation-Maize
Vertical distance from dripper (cm)
Horizontal distance from dripper (cm)
P-available (mg/kg)
0.000
20.00
40.00
60.00
80.00
100.0
120.0
140.0
160.0
180.0
200.0
0
-10
-20
-30
-40
0
5
10
15



K sol.

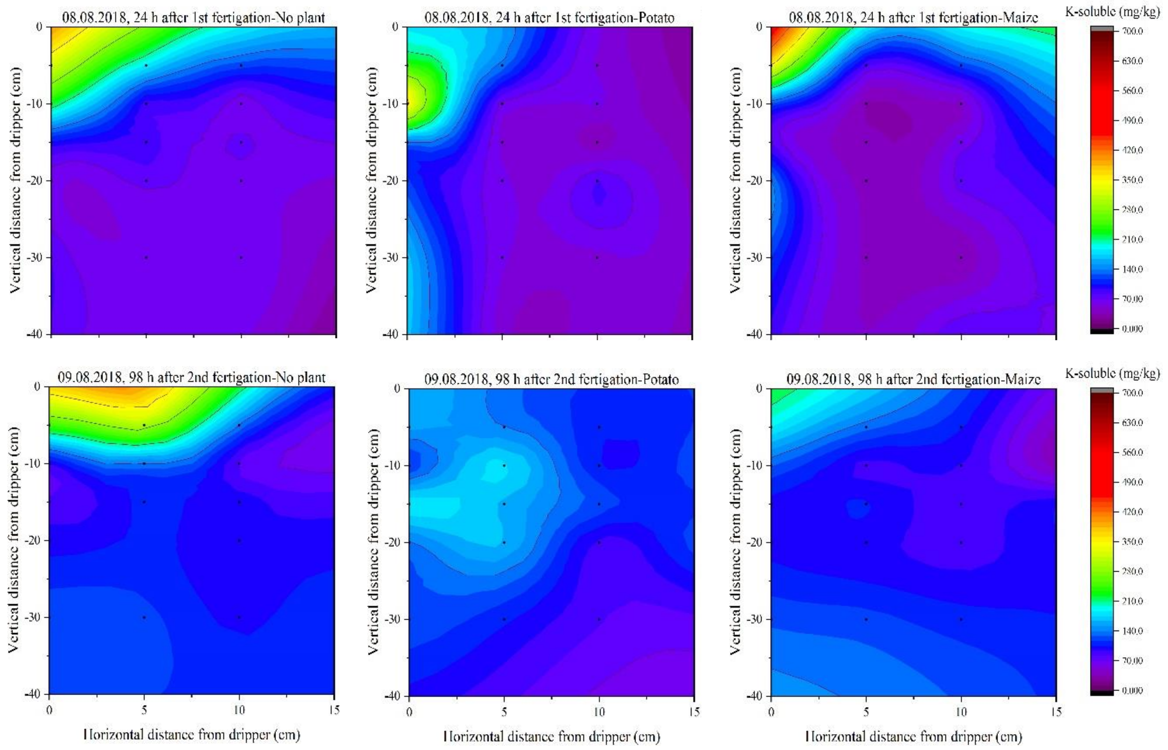


K exc.

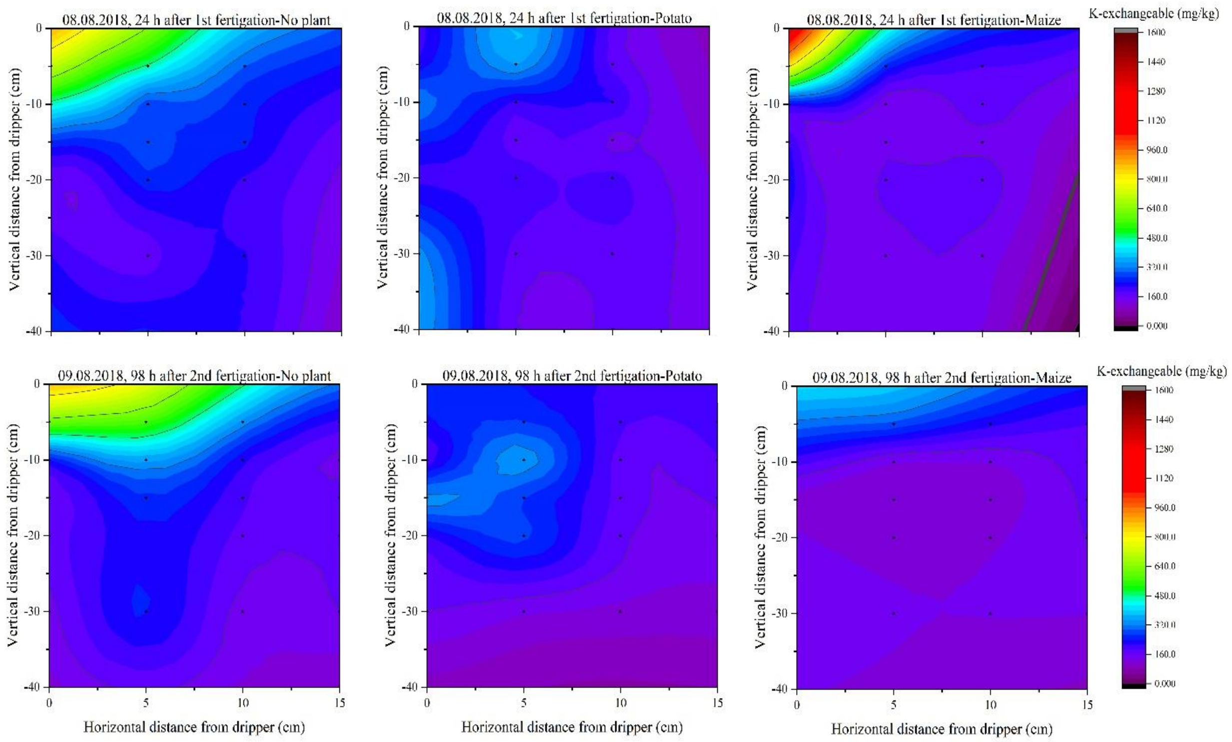


K unexc.

K soluble



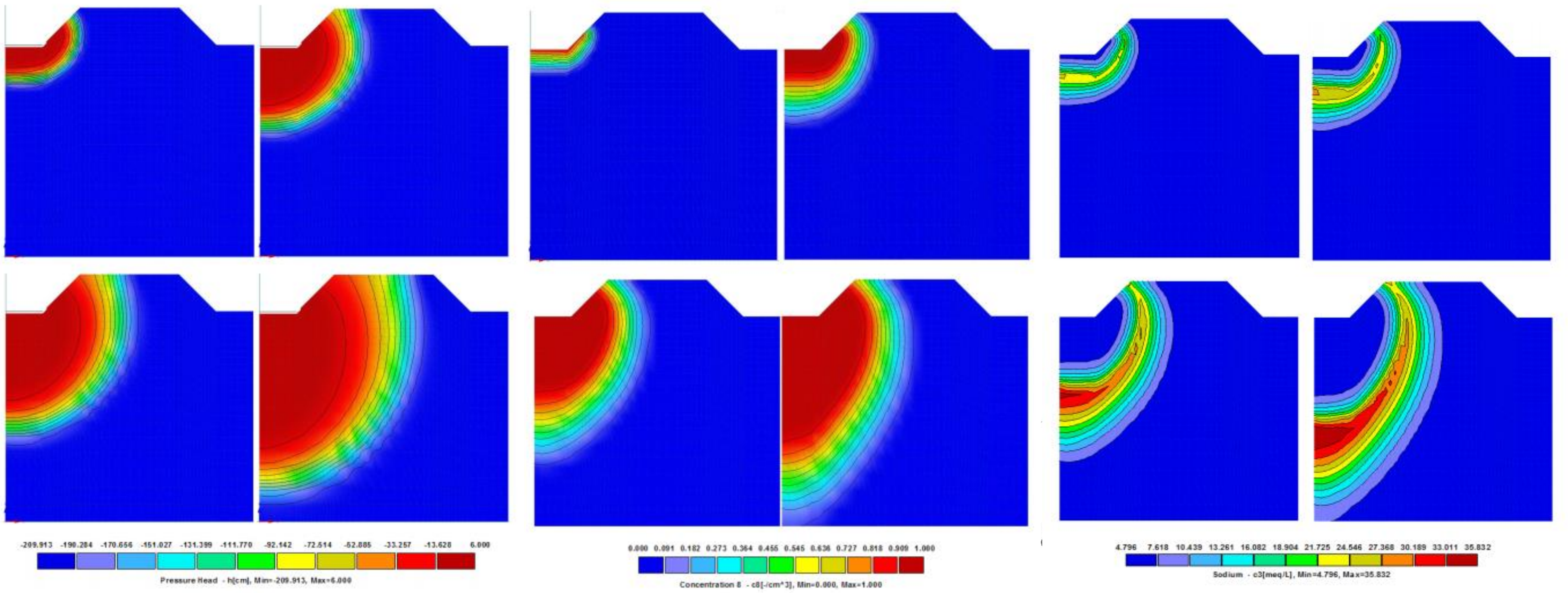
K exchangeable



Future perspective…

Developing modeling approach

- Crop growth model: DSSAT (Hoogenboom et al. 2019)
- Hydrological model: Hydrus 1/2/3D (Šimůnek et al. 2024)



Take Home message

- Plant influences soil P and K distribution / movement.
- Soil heterogeneity impacts solute dynamics in soil.
- Understanding nutrient dynamics is key for designing efficient fertigation systems and water management.
- Advanced monitoring and modeling (scenario analysis) are necessary for optimal assessment and management.

Integration of these approaches enhances resource efficiency, improves nutrient distribution, avoid soil salinization and ultimately increases productivity.

Thank you

- ✓ **Karim, SHABAZI**
- ✓ **Kambiz, BAZARGAN**
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- ✓ Mojgan, YEGANEH
- ✓ Kobra sadat, HASHEMINASAB ZAVAREH

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