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Soil water content and EC distributions under drip fertigation of onion

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Zusammenfassung

Tropfbewässerung und Fertigation sind effektive Methoden zur Steigerung der Wasser- und Nährstoffnutzugseffizienz im Gemüseanbau in Bulgarien. Ziel der Studie war es, die erhöhte Mobilität von Nährstoffen unter solchen Bedingungen anhand von Elektrischen Leitfähigkeit (EC) -Messungen zu überprüfen. Feldstudien mit Zwiebeln wurden an schwach sauren alluvialen Böden durchgeführt: unter Verwendung von Tropfbewässerung (Kontrolle) und in Kombination mit Fertigation mit zwei Dünger KSC und Duofertil pTOP 34 + KSC. Bodenproben zur Bestimmung von Wasseranteil und die EC-Verteilung im Bodenprofil wurden genommen. Die Ergebnisse zeigten, dass Änderungen des Wasseranteiles während der Wachstumsperiode durch Bewässerungs- und Niederschlagsereignisse sowie durch die Wurzelaufnahme stark beeinflusst wurden. Zu Beginn der Saison waren die EC-Werte weitgehend mit dem niedrigen Wassergehalt und ursprünglichen Nährstoffgehalt im Boden verbunden, später jedoch hauptsächlich mit der Fertigation (Ereignisse und Dünger). Die Verteilung der löslichen Salze konnte leicht durch die EC-Messungen beurteilt werden. Daher kann man diese als geeignete Methode zur Bewertung der Nährstoffverteilung im Feld verwenden.

Schlagwörter: Gemüseanbau, Bulgarien, Tropfbewässerung, Stickstoff- und Phosphordünger

Summary

Drip irrigation and fertigation are effective methods for enhancing water and nutrient use efficiency in vegetable farming in Bulgaria. The aim of the study was to verify the increased mobility of nutrients under fertigation conditions using EC measurements as an indicator. Field study with onion was conducted on slightly acidic alluvial soils with coarse texture: using only drip irrigation (Control) and in combination with fertigation using two fertilizers (KSC and Duofertil TOP 34 + KSC). Soil samples were taken to assess soil water content and EC distributions down the profile. The results showed that soil water content changes during growth season were clearly affected by irrigation applications, precipitations events as well as by the root uptake. In the beginning of the season, the EC results were largely linked to the low water contents and nutrients with soil origins, while later on they mostly related to the fertigation treatments. The soluble salts distributions were readily assessed by the EC measurements. Hence, they can be used as appropriate method for evaluation of nutrients distribution in the field.

Keywords: vegetable farming, Bulgaria, drip irrigation, nitrogen and phosphorous fertilizers

Introduction

Under continuously changeable climate conditions, the irrigation water demand continuously increase for high-value crops such as vegetables, especially in arid areas. Soil water is considered as a one of the limiting factors for the vegetable farming in Bulgaria (Atanasova et al. 2007, Philipova et al. 2012, Tzenova & Mitova 2010). Precise irrigation can help farmers to save water while increasing productivity. The efficiency differs according to the practices and crop demands, soil and climate conditions (e.g. Nolz & Cepuder 2014, Himmelbauer et al. 2015). Drip irrigation is the most precise kind of irrigation as it provides plants with water directly at their roots with less water losses. For more efficient use of nutrients, drip fertigation is often recommended for vegetables (Hatfield et al. 2001), and different fertilizers are applicable for it (Atanasova et al. 2007). It allows more precise timing, in appropriate quantities by controlling nutrient movement and losses below the rooting zone owing to the higher mobility of dissolved fertilizers (Segars 2003, Anitta Fanish & Muthukrishnan 2013). Vegetable crops generally make do with intensive fertilization, but onion does not tolerate high doses (Mitova & Dinev 2012). The main objective of this study was to verify the increased mobility of nutrients under fertigation conditions in onion using EC measurements as an indicator for their distribution in the soil profile.

Materials and methods

Field study with onion was carried out on Alluvial soils at a Research field Vrajdebna near Sofia. The fine sand of 23.3% is the dominant fraction in the soil texture; the gravel content is 37.2%. The soil is classified as non-carbonate and slightly acidic. The long-term average annual temperature is 10.6°C, the annual precipitation is 581.8 mm. The

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lowest precipitation rate is usually in the period in January - March, the highest ones in May - June (stringmeteo.com, 2010). The onion was planted in Nov 2017 in four rows on a plot with of 12m length and at 10cm between bulbs. Drip irrigation system was installed to the field. AQUATRAXX 6MIL 16MM / 10CM / 1.14L / H tape drip hose was used: doubled in the middle of the plot between the 2nd and the 3rd onion rows, while the 1st and 4th were 30 cm apart of the lines. The irrigation schedule was arranged according to the growth stage and crop needs, and the climate conditions. The following fertilizers were used for the fertigation treatments: Duofertil TOP 34 (N-P-K 5-19-10 + 19SO_3 + 0.1% B + 0.1 Zn) - containing polyphosphates and KSC for vegetables (15% N, 5% P_2O_5, 35% K_2O, 0.1% B, 0.1% Fe, and 0.1% Mo). Both fertilizers were applied five times during vegetation period. In addition, nitrogen was applied at a rate of 200 kg/ha and phosphorus at 150 kg/ha. Potassium was given before onion sowing as background fertilization. The fertilization rates were fitted to the usual practice in Bulgaria (Dinev et al. 2016a, 2016b). The treatment scheme was as follows: 1. Control – no fertilizers applied; 2. with application of KSC fertilizer for vegetables; 3. with application of Duofertil TOP 34 + KSC for vegetables. Soil sampling and measurements started after the first irrigation events. The samples were collected at 0-20cm, 20-40cm and 40-60cm depths in positions: between onions rows beneath the drip irrigation line, between 1st and 2nd onion rows, and between 3rd and 4th ones. Volumetric soil water content and soil electrical conductivity (EC) were measured.

Results and discussion

Soil sampling started just after the first irrigation occasion in April, 2018, no fertigation was applied until so far. The soil water content distribution down the profile is shown in *Figure 1*. Just below the drip irrigation line, the soil water content was relatively low; while the highest values were measured at 50cm depth and apart of the onion rows. Due to soil conditions being too dry (i.e. only 15 mm precipitations in April); the soil water content distributions were largely affected by the applied irrigation water and root uptake. Comparing to April, the soil water contents at the beginning of August (after the harvest) showed different distributions. Untypically for the season, the soil water contents were higher than in the beginning of the growing season, with the highest values in the top soil (*Figure 2*). There were many heavy rains of more than 150 mm in July. Thus, the soil water content distribution was also strongly affected by the precipitation water.

In April, the treatments 2 and 3 of the onion plot were fertigated with nitrogen, phosphorus and potassium fertilizers, while the treatment 1 (Control) was just irrigated. Hence, the result of the EC distribution through the soil profile in the control indicated the presence of nutrients lone with soil origins (*Figure 3*). In the treatments 2 and 3, salts of phosphorus fertilizers showed different mobility distributions: they were clearly present (i.e. higher EC contents measured) in the areas just under the drip irrigation line (*Figure 7*), but moved laterally where only potassium was applied (*Figure 5*). The reason for that most probable was linked to the higher mobility of potassium in light soils compared to polyphosphates. In July, large rainwater amount passed through the soil profile provoking leaching of soluble salts downwards. As a result, similar EC profile distributions have been shaped in all three fertilizer treatments (*Figures 4, 6, 8*). Dissolved salts moved down with the water front, so the highest EC was observed deeper in the soil profile and laterally in the fertilized treatments (*Figure 8*).

The presented results here were obtained within one growing season. Hence, for a proper evaluation of the drip irrigation and fertigation performance, further studies and analyses are needed.

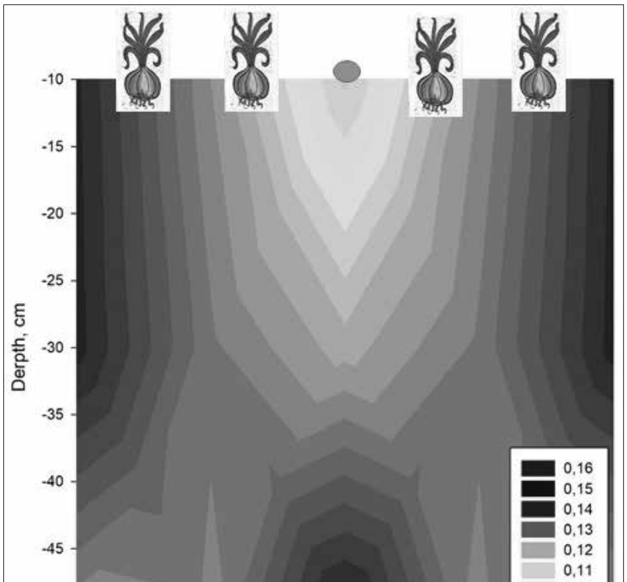

Figure 1. **Soil water content after irrigation in April in m³/m³.**

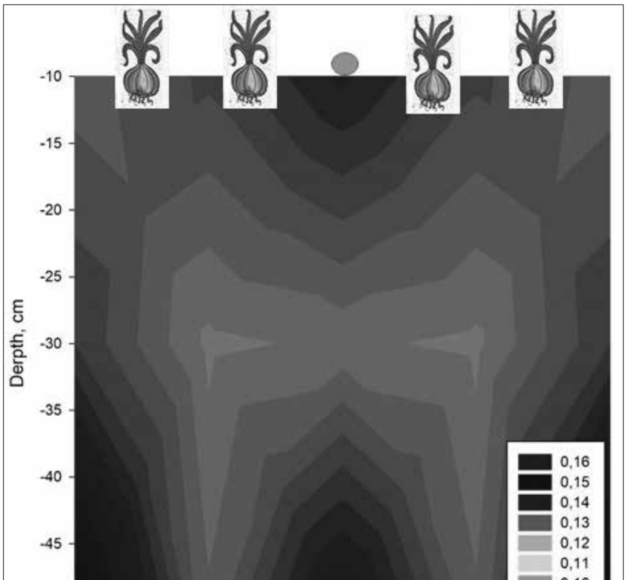

Figure 2. **Soil water content after fertigation in August in m³/m³.**

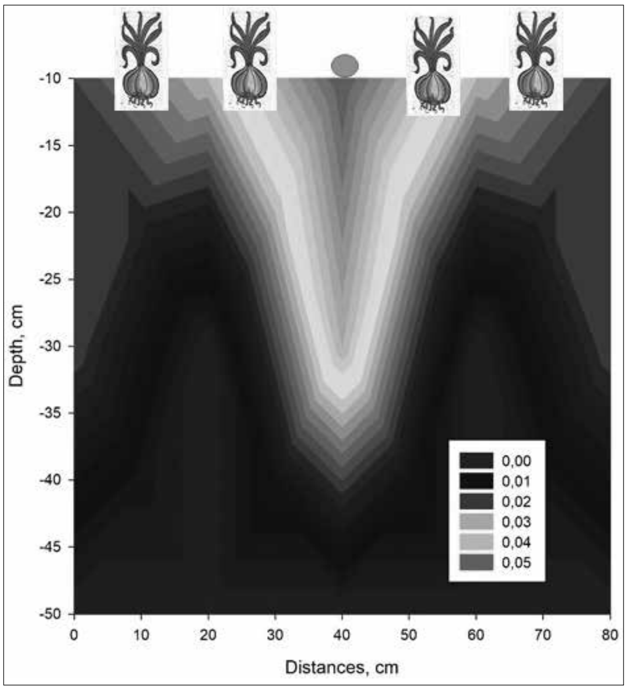

Figure 3. **Soil EC in Control (treatment 1) after irrigation in April in dS/m.**

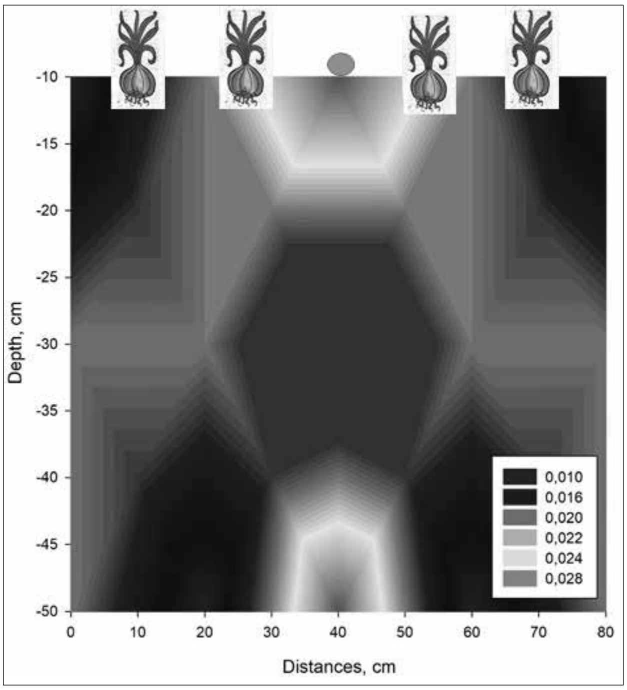

Figure 4. **Soil EC in Control (treatment 1) after irrigation in August in dS/m.**

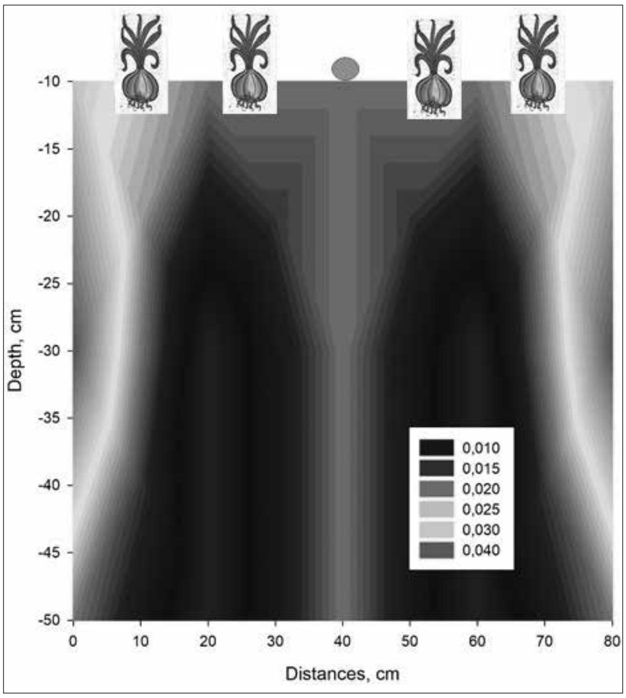

Figure 5. **Soil EC in KSC treatment 2 after irrigation in April in dS/m.**

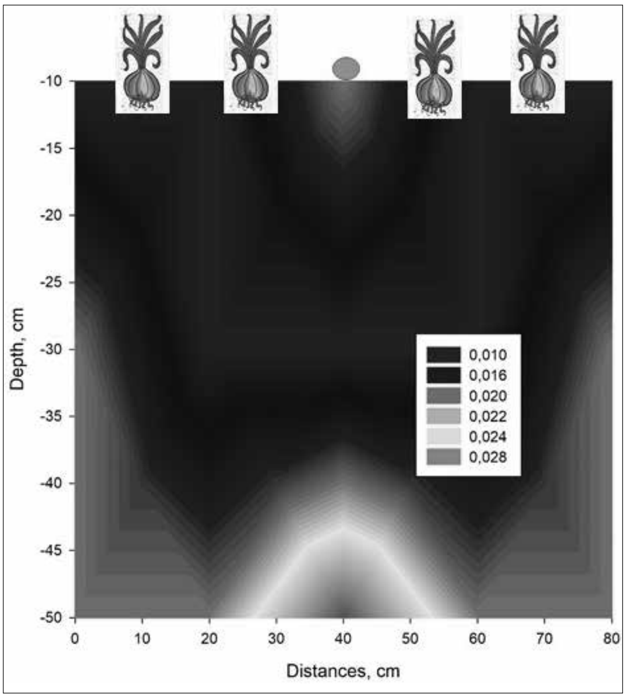

Figure 6. **Soil EC in KSC treatment 2 after irrigation in August in dS/m.**

Conclusions

Changes in the soil water content distribution in the soil during growth season were clearly affected by irrigation applications, precipitations events and rates as well as by the root uptake. Results for EC distribution in the soil profile in April (beginning of the growth season) largely linked to the low water contents and presence of nutrients in the soil in the Control, and to the rate of fertilizer applications in fertilized treatments. In August, the EC content distributions were additionally affected by the irrigation events, heavy precipitations, and the type of fertigation applied accompanied by the nutrient uptake of onion roots. Measurements of the EC in soil profile are appropriate indicators of nutrients re-distribution and uptake availability to the root system of studied crops in the field.

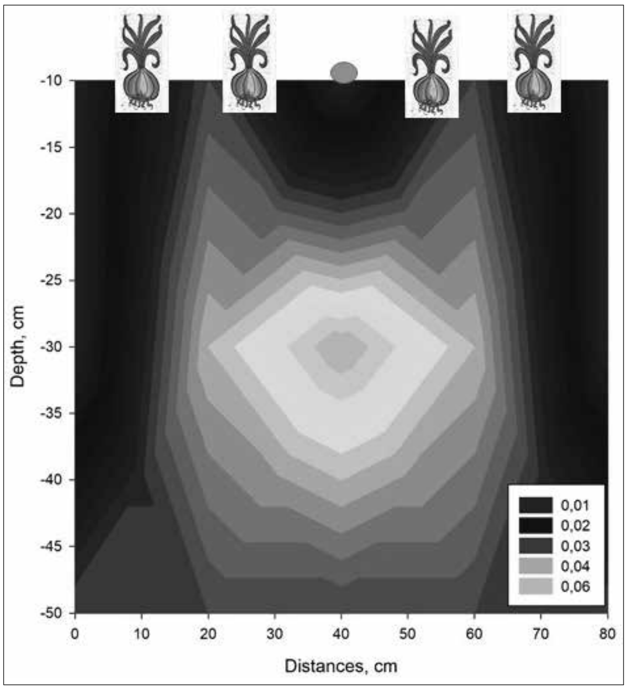

Figure 7. **Soil EC in Duofertil+KSC treatment 3 after irrigation in April in dS/m.**

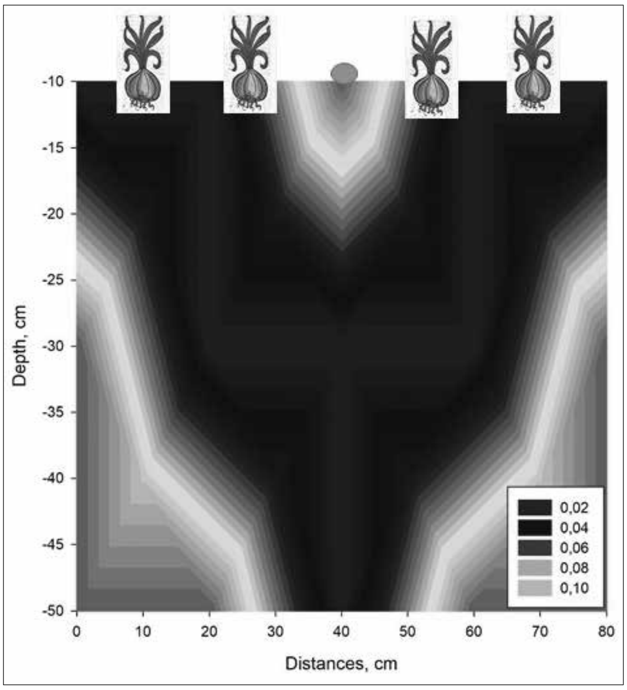

Figure 8. **Soil EC in Duofertil+KSC treatment 3 after irrigation in August in dS/m.**

Acknowledgment

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