Condensation irrigation greenhouse dataset

Farhad Mirzaei*, Hamideh Noory, Hossein Arabnejad

Department of Irrigation and Reclamation Engineering, College of Agricultural and Natural Resources, University of Tehran, Karaj, Iran

Abstract

Highly valuable data related to two types of planting media and two planting conditions, with and without plastic cover, were obtained from condensation irrigation experiments in the greenhouse. Data on the physical model include the humidifier dimensions and the cultivation bed, the pipe diameter and length, the water tank, and its adjustment devices. The measured data consisted of different water balance components in the studied condensation irrigation system, including saline water evaporated in the humidifier, water produced in the planting medium and pipes, water flowing out of the planting medium, transpiration by the plant, and the water storage changes in the planting medium. Other measured data included the height of plants, wet and dry weights of the plants, moisture content of the planting medium, the greenhouse temperature, water temperature, temperature of the humid air inflow to the buried pipes, and the planting medium temperature. These data can be used to proceed with the current research or similar research in the future.

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* Corresponding author
E-mail address: fmirzaei@ut.ac.ir (F. Mirzaei).

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### Specifications Table

| Subject | Agronomy and Crop Science |
|---------|---------------------------|
| Specific subject area | Condensation irrigation (CI): CI is indeed a combination of a simple solar evaporator and a subsurface irrigation system. Solar distillation is a thermal method for removing contaminants from gross or saline water using solar energy. |
| Type of data | Table |
| | Photo |
| | Figure |
| | Schematic view |
| Data acquisition method | A small greenhouse cultivation plan using CI was created at the greenhouse of the University of Tehran. The experiments were carried out in two stages, the second of which were designed according to the results of the first experiments. In the first experiment on 15 March 2019 and after five days, when the system was at equilibrium and some moisture was stored in the planting medium of the CI, basil transplant was cultivated in an area of 20 × 20 cm². The second experiment was conducted in the same way, except that the basil seed was sown instead of its transplant on 16 May 2019. The amount of water produced by the system was measured by determining the moisture content in the planting medium of the CI every day. To this end, nine samples were taken from different beginning, middle, and end parts of the planting medium of the CI in different points along the box at depths of 4, 12, and 20 cm at 18:00, followed by measuring the dry weight of the samples. In both experiments, the greenhouse, water, and the humid air temperatures, the inflow into buried pipes, and the planting medium temperature of the control pots, and the six points of planting medium of the CI were measured at a depth of 8 cm at 16:00 every day (Fig. 4). The temperatures of the abovementioned points of the CI were measured every 2 h from 8:00 to 16:00 on the last five days of both experiments. Based on the assumption that the plants with the same weight have the same transpiration rate (de Wit, 1958), the mean total transpiration rate in these three control pots was considered the mean total transpiration in the CI. Therefore, the regression equation for the wet weight of plants in the control pots and their total transpiration were obtained. The total transpiration rate of the plants was estimated in the planting medium of CI. Every two days, the height of all plants was measured in the planting medium of the CI and control pots. These measurements continued until the harvesting day. The wet and dry weights of the plants were also measured after harvesting. |
| Data format | Raw |
| Parameters for data collection | Analyzed |
| Description of data collection | Different water balance components were measured in the studied CI system, including saline water evaporated in the humidifier, water produced in the planting medium and pipes, water flowing out of the planting medium, transpiration by the plant, and the water storage changes in the planting medium. Other measured data included the height of plants, wet and dry weights of the plants, moisture content of the planting medium, temperatures of the greenhouse, water, and the humid air inflow into the buried pipes, and the planting medium temperature. To measure the moisture content of the planting medium, nine samples were taken from the beginning, middle, and end parts of the planting medium of the CI (points 2, 4, and 6 in Fig. 2) at depths of 4, 12, and 20 cm. The soil temperature in the CI was also measured every 2 h from 8:00 to 16:00. The pots were weighed and completely irrigated every day until their water content reached the field capacity. The irrigation rate was recorded afterward. The planting medium of control pots was also covered to prevent evaporation. The difference in the weight of each pot before and after irrigation was equal to transpiration. The mean total transpiration rate in the three control pots was assumed as the mean total transpiration in CI. Based on the assumption that the plants with the same weight have the same transpiration rate (de Wit, 1958), the regression equation for the wet weight of plants in the control pots and their total transpiration was obtained in the second experiment. The total transpiration rate of the plants was estimated in the planting medium of CI. |

(continued on next page)
Value of the Data

- This dataset provides the CI with the plant that had never been done before.
- The dataset is important for farmers, consultant engineering, and researchers to design CI.
- These data can be used for obtaining freshwater for irrigation from brackish and salt waters.
- These data can be used for improving the living standards of agricultural areas with a shortage of freshwater.
- Making a physical model, the amount of water produced, plant growth, etc., are a successful experience, which can be employed in similar research. It is suggested to perform a similar study using solar energy in the following two steps:
  A. For a plant resistant to water scarcity.
  B. For other plants using the results of Step A.

1. Data Description

Highly valuable data, including the average temperature (°C) of the greenhouse, water produced by the system, crop growth and production, and water content of the planting medium, were obtained from CI experiments in greenhouses. All these data were measured in the laboratory during the research. To measure the moisture content of the planting medium, nine samples were taken from the beginning, middle, and end parts of the planting medium of CI (points 2, 4, and 6 in Fig. 1) at depths of 4, 12, and 20 cm. The soil temperature in CI was also measured every 2 h from 8:00 to 16:00. To measure transpiration, the regression equation for the wet weight of plants in the control pots and their total transpiration were obtained. The total transpiration rate of the plants was estimated in the planting medium of CI. Water balance components including total transpiration of the plants in CI (L), the total amount of evaporated water in the humidifier (L), the total water storage in planting medium (L), the total water vapor leaving the planting medium (L), the total freshwater production (L), the average freshwater production (L/day), and irrigation amount (mm/day) were measured and calculated here.

The supplementary file includes:

A. The height and production of the basil plant in greenhouse cultivation using condensation irrigation.
B. The temperature of the first and second experiments (greenhouse, saline water, and planting medium temperatures in the control pots, the temperature of the inflow air to the perforated pipes, and the planting medium temperature in condensation).
C. The water production of the basil plant in greenhouse cultivation using CI, including the transpiration of the control pots (ml), the wet weight of the planting medium (g), and the dry weight of the planting medium (g).
D. The transpiration of the basil plants in greenhouse cultivation using CI (transpiration day after planting seeds).
Fig. 1. Schematic view of the studied CI system (numbers 1–6 show the points of temperature measurements). This figure was more explained in our previous studies [1] (https://doi.org/10.1016/j.agwat.2020.106526).
2. Experimental Design, Materials and Methods

A small greenhouse cultivation plan using CI was created at the greenhouse of the University of Tehran. The experiments were carried out in two stages, the second of which was designed according to the results of the first experiments. A schematic view of the studied CI system is shown in Fig. 1.

To compare the plant growth and potential transpiration, a number of pots were assigned as the control treatment or conventional treatment that were fully irrigated using the conventional method. The pots were placed in the same greenhouse for the CI test, weighed, and completely irrigated every day until their water content reached the field capacity, along with recording the irrigation rate. The planting medium of control pots was also covered to prevent evaporation. The difference in the weight of each pot before and after irrigation was equal to transpiration.

3. Crop Growth and Production

Every two days, the height of all plants was measured in the planting medium of CI and control pots, and these measurements continued until the harvesting day. The wet and dry weights of the plants were also measured after harvesting (Table 2).

4. Water Balance

During 22 days of the first experiment, 251 L of saline water was evaporated (EW) and entered the perforated pipes as vapor. Of all this evaporated saline water, 75.9 L of water was consumed by plants as transpiration (Tcrop), and 7.45 L of water was stored in the planting medium (ΔS). Thus, the total freshwater production (CW) is 83.35 L and 167.65 L of water flowing as water vapor out of the planting medium (ESW). Accordingly, the average daily freshwater production and irrigation rates are 4.17 L and 2.08 mm day\(^{-1}\), respectively. The second experiment lasted 24 days, and the total evaporated saline water (EW) was 301 L, from which 135.6 L was consumed by plants as transpiration (Tcrop), 17.21 L was stored in the planting medium (ΔS), and 148.19 L flowed out of planting medium (ESW). Therefore, the total water production (CW) and the daily irrigation rate were 152.81 L and 3.18 mm day\(^{-1}\), respectively.

Appropriate planting medium temperature had a positive effect on root growth, moisture adsorption, nutrient uptake, and plant growth [2]. In both experiments, the temperatures of the greenhouse, water, the humid air inflow into the buried pipes, and the planting medium of the control pots and the six points of planting medium of CI (Fig. 1) were measured at a depth of 8 cm at 16:00 every day (Table 1).

5. Measuring Transpiration

The planting medium composition of the control pots and CI were similar for each of the experiments. The moisture of field capacity (FC) was measured to determine the transpiration rate in the control pots. Then, the weight of the pots was recorded while their water content was in the FC. Afterward, the pots were weighed and completely irrigated every day until their water content reached the FC, along with recording the irrigation rate. The planting medium of the control pots was also covered to prevent evaporation. The difference in the weight of each pot before and after irrigation was equal to transpiration.

In the first experiment, the mean final wet weights of the plants in the planting medium of CI were not significantly different from those of the three control pots. Based on the assumption that the plants with the same weight have the same transpiration rate [3], the mean total transpiration rate in the three control pots was assumed as the mean total transpiration in CI. In the second experiment, the mean weight of the plants in the planting medium of CI was higher than that of control pots since the production rate was linearly related to the transpiration
Table 1
Data RAW about temperature in experiment No.2.

| Days after planting seeds | T air, G | T water | Twet,air | No.1 | No.2 | No.3 | No.4 | No.5 | No.6 |
|---------------------------|----------|---------|----------|------|------|------|------|------|------|
| 16                        | 28.2     | 44.2    | 37.4     | 35.4 | 35.4 | 35.2 | 35.8 | 35   | 35.2 |
| 17                        | 27.6     | 44.8    | 37.6     | 35   | 35.2 | 35.4 | 35.2 | 35.2 | 35.4 |
| 18                        | 27.2     | 44.2    | 37.2     | 35.2 | 35.4 | 35.2 | 35   | 35.4 | 35.6 |
| 19                        | 29       | 44.2    | 37.4     | 35   | 35   | 35.4 | 35.4 | 35   | 35.4 |
| 20                        | 28.2     | 44.4    | 37.6     | 35.2 | 35   | 35.2 | 35.4 | 35.6 | 35.6 |
| 21                        | 29.2     | 44.6    | 37       | 34.4 | 34.2 | 34   | 34.4 | 34.2 | 34.4 |
| 22                        | 28       | 44      | 36.6     | 34   | 33.8 | 34.2 | 33.6 | 34.4 | 34.2 |
| 23                        | 27.8     | 44      | 36.4     | 34   | 33.8 | 34.2 | 34   | 34.2 | 33.8 |
| 24                        | 28.6     | 43.6    | 36.6     | 34.2 | 34.4 | 34   | 34.4 | 34   | 34.2 |
| 25                        | 28.4     | 44.8    | 37.2     | 35.4 | 35.4 | 35.2 | 35.2 | 35.2 | 35.4 |
| 26                        | 27.8     | 43.8    | 37.2     | 35.8 | 35.6 | 35.2 | 35   | 35   | 35.6 |
| 27                        | 29.2     | 44.4    | 36.8     | 34.6 | 34.2 | 34.4 | 34.4 | 34   | 34.2 |
| 28                        | 29       | 44.8    | 37       | 35.4 | 35.2 | 35   | 35   | 35   | 35.4 |
| 29                        | 28.6     | 44.2    | 36.2     | 35   | 34.8 | 35.2 | 34.8 | 35   | 35   |
| 30                        | 27.6     | 44.8    | 37       | 35   | 35   | 35.4 | 35   | 35   | 35   |
| 31                        | 27.8     | 44.2    | 36.2     | 34.6 | 34.6 | 34.4 | 34.2 | 34.2 | 34   |
| 32                        | 29.2     | 44.8    | 37.2     | 35.2 | 35   | 35.4 | 35.2 | 35.2 | 35   |
| 33                        | 29       | 44.4    | 37.2     | 35.6 | 35.6 | 35.2 | 35.4 | 35.2 | 35.4 |
| 34                        | 27.6     | 44      | 36.4     | 34.2 | 34.4 | 34.2 | 34.4 | 34.2 | 34.4 |
| 35                        | 28.2     | 44.6    | 37       | 35   | 35   | 35.2 | 35.2 | 35.2 | 35.4 |
| 36                        | 27.8     | 44.6    | 36.6     | 34.8 | 34.2 | 34.6 | 34.4 | 34.2 | 34.4 |
| 37                        | 29.6     | 44.6    | 36.8     | 34.8 | 35   | 34.6 | 34.2 | 34.2 | 34.4 |
| 38                        | 29       | 44      | 36.6     | 35.2 | 35   | 35.2 | 35.2 | 34.8 | 34.8 |
### Table 2 (continued)

|   | Production | Wet Matter (gr) | Dry Matter (gr) |
|---|------------|----------------|----------------|
| 29 | Control 29 | 3.82 | 0.4 |
| 30 | Control 30 | 4.43 | 0.49 |
| 31 | Control 31 | 7.47 | 0.82 |
| 32 | Control 32 | 3.11 | 0.35 |
| 33 | Control 33 | 4.81 | 0.58 |
| 34 | Control 34 | 5.08 | 0.62 |
| 35 | Control 35 | 6.09 | 0.7 |
| 36 | Control 36 | 4.57 | 0.5 |
| 37 | Condensation Irrigation 1 | 10.12 | 1.18 |
| 38 | Condensation Irrigation 2 | 13.97 | 1.75 |
| 39 | Condensation Irrigation 3 | 21.9 | 3.3 |
| 40 | Condensation Irrigation 4 | 23.39 | 3.45 |
| 41 | Condensation Irrigation 5 | 13.63 | 1.63 |
| 42 | Condensation Irrigation 6 | 8.5 | 0.77 |
| 43 | Condensation Irrigation 7 | 13.05 | 1.72 |
| 44 | Condensation Irrigation 8 | 13.05 | 2.01 |
| 45 | Condensation Irrigation 9 | 18.05 | 2.81 |
| 46 | Condensation Irrigation 10 | 18.77 | 2.73 |
| 47 | Condensation Irrigation 11 | 13.84 | 1.87 |
| 48 | Condensation Irrigation 12 | 18.32 | 2.84 |
| 49 | Condensation Irrigation 13 | 10.29 | 1.21 |
| 50 | Condensation Irrigation 14 | 13.73 | 1.8 |
| 51 | Condensation Irrigation 15 | 21.68 | 2.98 |
| 52 | Condensation Irrigation 16 | 10.9 | 1.42 |
| 53 | Condensation Irrigation 17 | 20.18 | 2.68 |
| 54 | Condensation Irrigation 18 | 12.18 | 1.6 |
| 55 | Condensation Irrigation 19 | 17.84 | 2.5 |
| 56 | Condensation Irrigation 20 | 18.13 | 2.24 |
| 57 | Condensation Irrigation 21 | 13.78 | 1.82 |
| 58 | Condensation Irrigation 22 | 8.5 | 1.04 |
| 59 | Condensation Irrigation 23 | 14.3 | 1.92 |
| 60 | Condensation Irrigation 24 | 16.79 | 2.14 |
| 61 | Condensation Irrigation 25 | 15.71 | 2.11 |
| 62 | Condensation Irrigation 26 | 13.47 | 1.97 |
| 63 | Condensation Irrigation 27 | 13.96 | 1.86 |
| 64 | Condensation Irrigation 28 | 14.37 | 1.99 |
| 65 | Condensation Irrigation 29 | 13.19 | 1.85 |
| 66 | Condensation Irrigation 30 | 13.51 | 2.1 |
| 67 | Condensation Irrigation 31 | 13.21 | 1.73 |
| 68 | Condensation Irrigation 32 | 10.68 | 1.41 |
| 69 | Condensation Irrigation 33 | 13.34 | 2.04 |
| 70 | Condensation Irrigation 34 | 15.61 | 2.36 |
| 71 | Condensation Irrigation 35 | 14.06 | 2.08 |
| 72 | Condensation Irrigation 36 | 21.77 | 2.63 |
| 73 | Condensation Irrigation 37 | 17.79 | 2.33 |
| 74 | Condensation Irrigation 38 | 12.11 | 1.47 |
| 75 | Condensation Irrigation 39 | 12.87 | 1.74 |
| 76 | Condensation Irrigation 40 | 15.35 | 2.21 |
| 77 | Condensation Irrigation 41 | 6.6 | 0.8 |
| 78 | Condensation Irrigation 42 | 9.38 | 1.09 |
| 79 | Condensation Irrigation 43 | 10.47 | 1.33 |
| 80 | Condensation Irrigation 44 | 17.57 | 2.52 |
| 81 | Condensation Irrigation 45 | 11.64 | 1.63 |
| 82 | Condensation Irrigation 46 | 12.25 | 1.72 |
| 83 | Condensation Irrigation 47 | 20.39 | 2.88 |
| 84 | Condensation Irrigation 48 | 10.48 | 1.37 |
| 85 | Condensation Irrigation 49 | 15.37 | 2.03 |
| 86 | Condensation Irrigation 50 | 14.06 | 1.82 |
rate [3]. Therefore, the regression equation for the wet weights of plants in the control pots and their total transpiration were obtained. The total transpiration rate of the irrigated plants in the planting medium of CI was estimated using the regression equation of the total transpiration of the control plants relative to their wet matter (Table 3).

\[ T = 0.106Wt + 1.1771 \]

\[(R^2 = 0.93)\]

Where T is the transpiration rate (lit), and Wt is the wet matter (g) of the plants.

**CRediT Author Statement**

Farhad Mirzaei: Supervision, Conceptualization, Writing original draft, Writing review & editing; Hamideh Noory: Project administration, Investigation; Hossein Arabnejad: Data curation, Methodology, Validation.
Declaration of Competing Interest

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Supplementary Materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.dib.2021.107086.

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