



## Regulation of nutrient content in peach fruits under different soil moisture regimes

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### ABSTRACT

**Background:** Peaches (*Prunus persica*) are known help improve metabolic health, as they contain bioactive compounds such as vitamins, flavonoids, and minerals. However, their biochemical composition changes significantly depending on environmental conditions, particularly soil moisture. These conditions can influence fruit development, nutrient accumulation, and overall quality.

**Objective:** This study aimed to measure the impact of different pre-irrigation soil moisture levels (90%, 80%, 70%, and 60% of field capacity) on the growth of the "Narnji" peach variety. Fields such as yield, vegetative growth, and the biochemical composition of grown fruits were used to assess the optimal irrigation for maximizing nutritional value and functional food properties.

**Methods:** From 2017 to 2019, experiments were conducted in the pre-mountainous zone of the Ararat Valley, Armenia, using 5–7-year-old "Narnji" peach trees. Trees were irrigated under four pre-irrigation soil moisture levels along with a

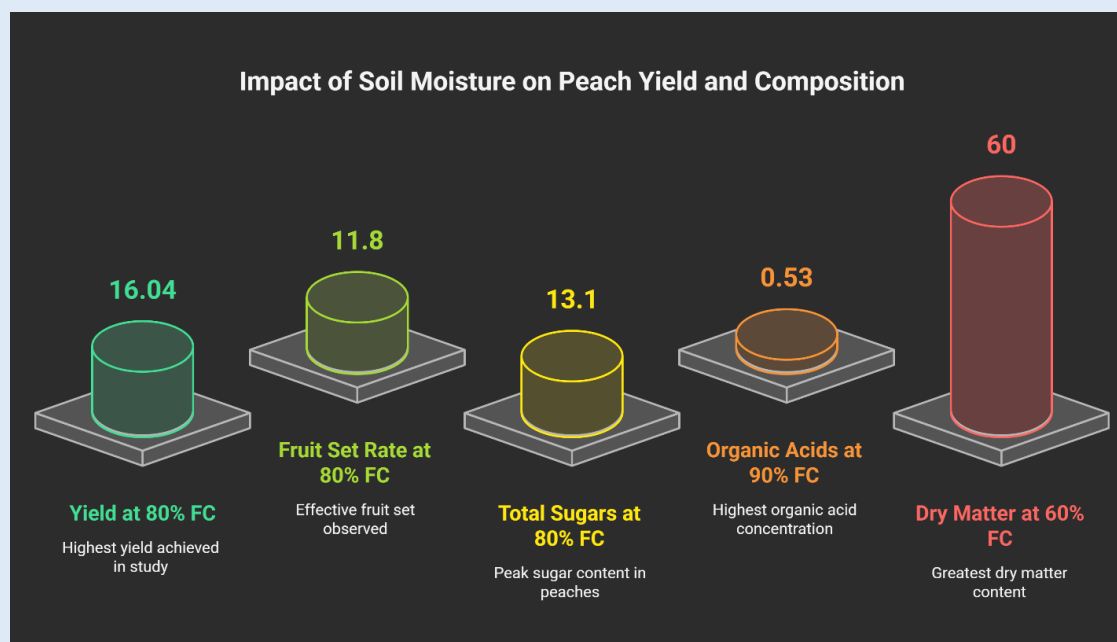
control group based on standard farm practices. The gravimetric method monitored soil moisture on four horizons (0–80 cm). Morphological and biochemical measurements were performed using standard methodologies.

**Results:** Soil moisture levels significantly influenced growth, fruit set, yield, and biochemical composition. The 80% field capacity (FC) regime produced the highest yield (16.04 tons/ha) and an effective fruit set rate of 11.8%, with a seasonal irrigation volume of 6630–7370 m<sup>3</sup>/ha. Total sugars (11.3–13.1%) peaked at 70% and 80% FC, organic acids (0.45–0.53%) were highest at 90% FC, and dry matter was greatest at 60% FC. The 80% FC regime best balanced productivity and bioactive compound accumulation.

**Novelty:** The innovation of this study lies in its integrated assessment of irrigation levels on fruit yield, water use efficiency, and the concentration of key functional food. Unlike previous works that examined irrigation from a yield or growth perspective alone, this study combines plant physiology, soil-water dynamics, and functional food science to reveal how ecological management can optimize the health-promoting potential of fruits. The identification of 80% field capacity as the optimal irrigation level offers a scientifically grounded standard for maximizing both agricultural output and nutritional quality.

**Conclusion:** Maintaining pre-irrigation soil moisture at 80% of field capacity is optimal for peach cultivation under Armenian conditions. It improves yield and nutritional quality, reinforcing the value of peaches as a functional food and supporting sustainable horticultural practices.

**Keywords:** peach, fruit, variety, mid-season, Narnji, soil, pre-irrigation moisture, biochemical and bioactive compounds.



**Graphical Abstract:** Regulation of Nutrient Content in Peach Fruits under Different Soil Moisture Regimes

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## INTRODUCTION:

Bioactive compounds (BCs) are essential components in functional foods (FFs) that offer health benefits in ways beyond providing basic nutrition. Polyphenols, carotenoids, flavonoids, fatty acids, fiber, and probiotics are examples of such compounds that contribute to metabolic regulation, immune support, and lowering the risk of chronic diseases like cardiovascular conditions, diabetes, and certain types of cancer. This review examines the classification, mechanisms of action, and safety considerations of BCs, drawing on recent research and the framework of the Functional Food Center (FFC). It also highlights the impact of environmental factors on BC composition and explores technologies, such as encapsulation, to improve bioavailability.

Functional food science (FFS) is an emerging field that links food technology, biomedical research, and nutrition policy. The review highlights the importance of standardized terminology, regulatory clarity, and scientifically validated interventions in advancing FF development and combating non-communicable diseases globally. [1]

Peaches (*Prunus persica*), particularly yellow-fleshed varieties, are widely valued for their nutritional density. According to the USDA Food Data Central, the nutrition facts of a 100-gram serving of raw yellow peaches provide approximately 42–46 kcal, 88.3 grams of water, 0.91 grams of protein, 10.1 grams of carbohydrates, 8.39 grams of total sugars, and 1.5 grams of dietary fiber. They are a notable source of vitamin C (4.1 mg), niacin (0.806 mg), and vitamin A (24 µg RAE), while also containing a various antioxidant compounds: beta-carotene (224 µg), lutein and zeaxanthin (132 µg), and cryptoxanthin (117 µg). Mineral content includes potassium (122 mg), phosphorus (22 mg), magnesium (8 mg), and trace amounts of iron, zinc, copper, and selenium [1].

Peaches contain bioactive compounds that support digestion, metabolism, and nutrient absorption, while offering antihypertensive, detoxifying, antitumor, and cholesterol-lowering effects. Under favorable conditions, a single peach tree can yield up to 300 kg or 20.5 tons per hectare, which is highly efficient. According to literature, the beneficial properties of peaches were mentioned as early as 2000 BC in Chinese scientific texts, and later the cultivation of peaches spread to Armenia, Persia, and Europe. Many Armenian and foreign authors have written about peach cultivation in Armenia, including Amirdovlat Amasiatsi (1990), Grossgeim A.A. (1946), Umikov N.Z. (1947), Vermishyan A.M. and others (1958), Konduralov P.G. (1899), Rollov A.Kh. (1899, 1908), Beketovski D.A. (2017), and more.

Numerous studies have investigated the bioactive potential of various fruits commonly used in functional foods. Fruits such as apricot [4–6], cherry [7], Indian walnut olive [9], almond pumpkin [10], pistachio [11], peanut [9,12], mulberry [3], grape [2, 13], and pomegranate[8,16] have been shown to contain rich profiles of antioxidants, phenolic compounds, and other health-promoting phytochemicals. These compounds support cardiovascular health, modulate blood sugar levels, and exhibit anti-inflammatory and antimicrobial properties.

Additional research has highlighted the nutritional and therapeutic value of other fruits, including blackberry, *Rosmarinus officinalis* [17], jujube [18,19], mango [20], papaya [21], moringa [22], jackfruit [23], ziziphora [24], and sour apple [17]. These fruits are often rich in vitamins (e.g., C and A), dietary fiber, and unique plant secondary metabolites that may contribute to immune function, gastrointestinal health, and metabolic regulation.

Spices such as cardamom [25], coffee [26], and ginger [27] are also well-studied for their potent bioactive compounds, particularly polyphenols and

essential oils, which demonstrate antioxidant, digestive, and neuroprotective effects. Moreover, lesser-known fruiting plants like aloysia [28] and hibiscus [29] have shown promising roles in herbal medicine, offering anti-hypertensive, hepatoprotective, and diuretic benefits.

Several publications by Martirosyan et al. [28,30] highlight the role of plant-based bioactive compounds in managing chronic diseases through diet, reinforcing the link between functional foods, nutritional biochemistry, and preventive medicine.

## MATERIALS AND METHODS:

The experiment was conducted in 2017 and 2019 under the soil and climatic conditions of the pre-mountainous zone of the Ararat Valley, in the Oshakan village of Aragatsotn Marz, Republic of Armenia, in a fruit-bearing peach orchard with trees aged 5 to 7 years. The orchard was established using the mid-ripening "Narnji" variety, grafted onto peach rootstock seedling, with a 5.0 x 2.5 m<sup>2</sup> planting layout. The trees were trained using an improved vase-shaped system.



**Figure 1:** Fruit of the mid-ripening Narnji variety

The trial included four pre-irrigation soil moisture levels—90%, 80%, 70%, and 60% of field capacity (FC)—along with a control variant where all agronomic practices [31], including irrigation, followed standard farm management protocols.

Soil moisture in the active root zone was measured across four horizons (0–20 cm, 20–40 cm, 40–60 cm, and 60–80 cm), where most of the tree's absorbing roots are located. Moisture was determined using the gravimetric method at intervals of no less than five days

Morphological measurements and biochemical analyses of plants followed the standard methodology

for fruit, berry, and nut species [30,31]. The study of the tree's underground organs followed the method of V.A. Kolesnikov [32]. Leaf surface area was measured using the I.G. Fulga method [33]. Biochemical analyses of the fruit were performed using A. Ermakov's method [34]. Fruit ripening was assessed organoleptically, based on preliminary evaluation of technical indicators. Statistical analysis of yield data was carried out following Sakahakyan's approach [35].

**Results and Discussion (Analysis of Experimental Results):** Plant growth and development are typically

influenced by numerous environmental factors, including varietal composition, agronomic practices, soil and climatic conditions, physiological characteristics, and notably, soil moisture and the intensity of water flow

through the plant's vascular tissues to different organs. The study revealed (Table 1) that different pre-irrigation soil moisture levels (90%, 80%, 70%, 60%) had varying effects on the growth and development of peach trees.

**Table 1:** Effective Fruit Set Rate of Peach Trees Depending on Pre-Irrigation Soil Moisture Levels.

| (Variants)<br>Soil pre-irrigation<br>moisture limit from FCM*, % | Number of flowers |      | Number of fruits after<br>June fruit drop |      | Number of harvested<br>fruits |      | Effective fruit-bearing of<br>trees, % |      |
|------------------------------------------------------------------|-------------------|------|-------------------------------------------|------|-------------------------------|------|----------------------------------------|------|
|                                                                  | pcs/tree          |      |                                           |      |                               |      |                                        |      |
|                                                                  | 2017              | 2019 | 2017                                      | 2019 | 2017                          | 2019 | 2017                                   | 2019 |
| 90                                                               | 588               | 1798 | 62                                        | 185  | 59                            | 176  | 10.0                                   | 9.8  |
| 80                                                               | 604               | 1808 | 80                                        | 208  | 76                            | 198  | 12.6                                   | 11.0 |
| 70                                                               | 638               | 1764 | 88                                        | 198  | 82                            | 187  | 12.8                                   | 10.6 |
| 60                                                               | 547               | 1678 | 57                                        | 156  | 53                            | 143  | 97                                     | 8.5  |
| control                                                          | 553               | 1713 | 59                                        | 171  | 55                            | 160  | 9.9                                    | 9.3  |

Table 1 illustrates how varying pre-irrigation soil moisture levels influence the effective fruit set rate of *Prunus persica* (Narnji variety) over two growing seasons. The data indicate that fruit sets are highest under moderate moisture conditions, particularly at 70% and 80% field capacity (FC). In 2017, the 80% FC treatment resulted in a 12.6% effective fruit set rate, while 70% FC achieved a slightly higher 12.8%. In 2019, these rates were 11.0% and 10.6% respectively, showing consistent improvement across two years. These treatments also yielded the highest number of harvested fruits per tree, with 76–82 fruits in 2017 and

187–198 in 2019.

In contrast, over-irrigation (90% FC) and under-irrigation (60% FC) resulted in lower fruit set rates. At 90% FC, the rates were 10.0% and 9.8%, while 60% FC produced the weakest results, with just 9.7% in 2017 and 8.5% in 2019. These outcomes suggest that excessive moisture may lead to waterlogged conditions that are unfavorable for fruit setting such as bud drop or root stress. Conversely, insufficient moisture likely restricts the tree's ability to support fruit development due to limited canopy growth and fewer reproductive structures.

**Table 2:** Peach Yield in Relation to Pre-Irrigation Soil Moisture Levels

| Experimental<br>variants | The number of<br>harvested fruits,<br>pieces/tree. |      | The average fruit<br>mass, in grams. |       | Yield   |      |      |       |              |                                |
|--------------------------|----------------------------------------------------|------|--------------------------------------|-------|---------|------|------|-------|--------------|--------------------------------|
|                          |                                                    |      |                                      |       |         |      |      |       | Average t/ha | Compared to the<br>control, %. |
|                          |                                                    |      |                                      |       | Kg/tree |      | t/ha |       |              |                                |
|                          | 2017                                               | 2019 | 2017                                 | 2019  | 2017    | 2019 | 2017 | 2019  |              |                                |
| 90                       | 59                                                 | 176  | 161.3                                | 148.3 | 9.6     | 26.2 | 7.69 | 20.98 | 14.33        | 131.3                          |
| 80                       | 76                                                 | 198  | 149.4                                | 145.6 | 11.3    | 28.8 | 9.03 | 23.06 | 16.04        | 147                            |
| 70                       | 82                                                 | 187  | 131.3                                | 130.7 | 10.8    | 24.4 | 8.66 | 19.55 | 14.1         | 129.4                          |
| 60                       | 53                                                 | 143  | 124.6                                | 122.6 | 6.6     | 17.5 | 5.31 | 14.03 | 9.67         | 88.6                           |
| Control                  | 55                                                 | 160  | 128                                  | 126.8 | 7       | 20.3 | 5.61 | 16.21 | 10.91        | 100                            |
| LSD-0.05                 |                                                    |      |                                      |       |         |      | 1.36 | 1.04  | 1.20         |                                |

Table 2 provides comprehensive data showing how different pre-irrigation soil moisture regimes influenced the yield of Narnji peach trees over two growing seasons. The results reveal a consistent pattern: moderate moisture levels, particularly 80% of field capacity (FC), produced the highest yields regarding harvested fruit count, average fruit mass, and total yield per hectare.

In the 80% FC treatment, harvested fruits per tree reached 76 in 2017 and 198 in 2019, with an average fruit mass of 149.4 g and 145.6 g, respectively. This resulted in the highest yields, with 11.3 kg/tree and 28.8 kg/tree, translating to 9.03 t/ha and 23.06 t/ha, and an average of 16.04 t/ha over both years. Compared to the control group, this represented a 47% increase in productivity.

The 70% FC group also performed well, producing 82 and 187 fruits per tree and achieving an average yield of 14.1 t/ha, 29.4% higher than the control. However, while it had slightly more fruit than the 80% group, the fruits were smaller (average mass ~131 g), resulting in slightly lower overall weight.

In contrast, the 90% FC treatment, though producing a high number of fruits in 2019 (176), showed reduced fruit size (especially in 2019) and slightly lower yield consistency across years. The average yield was 14.33 t/ha, which, while better than the control, did not outperform the 80% FC group and showed greater variability, likely due to negative effects from over-irrigation, such as waterlogging and decreased sugar accumulation.

The 60% FC treatment produced the lowest yield among the experimental groups. With smaller fruit size (124–122 g) and fewer fruits per tree (53 and 143), the average yield was only 9.67 t/ha, which was 11.4% below the control. This confirms that under-irrigation hampers

both fruit development and total output.

The control group, which maintained around 70% FC naturally through standard farm practices, yielded 10.91 t/ha, lower than the 70% and 80% FC treatments, but significantly higher than the 60% group. This indicates that carefully controlled irrigation around 80% FC offers clear advantages over passive moisture management.

The LSD-0.05 values also indicate statistical significance, confirming that the yield differences, particularly between the 60%, 70%, 80%, and control groups, are meaningful and not due to random variation.

Results from Tables 1 and 2 indicate that both fruit set and final yield were relatively higher at 80% field capacity (FC). It was also found that increasing or decreasing the pre-irrigation soil moisture threshold did not improve the quantity or quality of the yield.

The control group, which followed traditional farm irrigation practices and maintained soil moisture naturally fluctuating around 70% FC, showed intermediate results with 9.9% and 9.3% fruit set rates over the two years. These values closely mirrored those of the experimental 70% FC treatment, lending further credibility to the conclusion that moderate irrigation is optimal.

Overall, a direct and proportional relationship is observed between effective fruit set and final yield, confirming that maintaining pre-irrigation soil moisture between 70% and 80% FC is ideal for supporting peach orchards' reproductive efficiency and productivity. This irrigation range balances vegetative growth and fruit development, ultimately contributing to higher yields and improved fruit quality suitable for functional food applications.

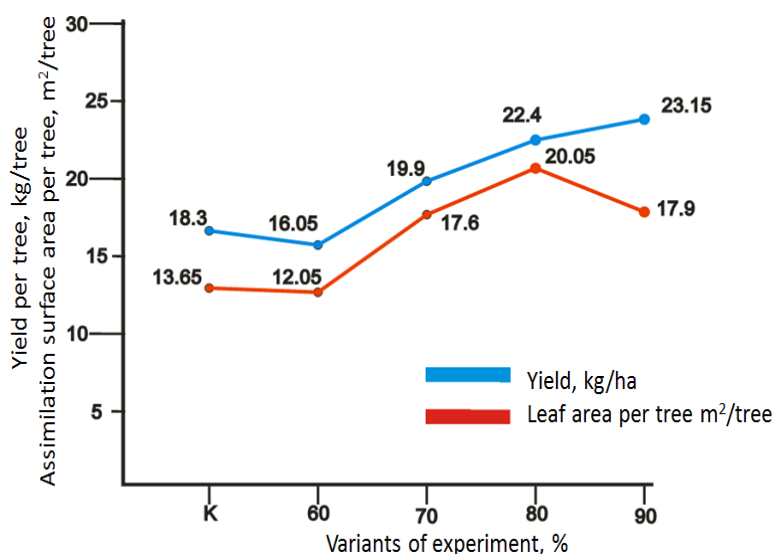
**Table 3:** Ratio of Tree Leaf Surface Area to Yield Depending on Pre-Irrigation Soil Moisture Levels.

| Soil pre-irrigation moisture limits from field capacity (FC), %. | Tree leaf area, m <sup>2</sup> /tree |      | The ratio of yield to leaf area, m <sup>2</sup> /kg |      |                          |
|------------------------------------------------------------------|--------------------------------------|------|-----------------------------------------------------|------|--------------------------|
|                                                                  | 2017                                 | 2019 | 2017                                                | 2019 | The average of two years |
| 90                                                               | 19.5                                 | 26.8 | 2.0                                                 | 1.0  | 1.50                     |
| 80                                                               | 18.6                                 | 26.2 | 1.6                                                 | 0.9  | 1.25                     |
| 70                                                               | 16.4                                 | 23.4 | 1.5                                                 | 0.9  | 1.20                     |
| 60                                                               | 14.5                                 | 17.6 | 2.2                                                 | 1.0  | 1.60                     |
| control                                                          | 15.5                                 | 21.1 | 2.2                                                 | 1.0  | 1.60                     |

The pre-irrigation soil moisture levels also had varying effects on the leaf surface area of the trees (Table 3). According to the results in Table 3, as soil moisture levels increased, the leaf surface area of the trees also increased across the different treatments. For example, under 90% FC, trees developed the most extensive canopy with an average leaf surface area of 23.15 m<sup>2</sup>/tree across two years. This was followed by 80% FC (22.4 m<sup>2</sup>/tree) and 70% FC (19.9 m<sup>2</sup>/tree). Conversely, the lowest canopy development occurred under 60% FC

(16.05 m<sup>2</sup>/tree), indicating that water availability significantly influences vegetative growth.

However, when considering the efficiency of fruit production relative to leaf area, a different pattern emerges. The leaf area-to-yield ratio is a critical indicator of how efficiently a tree converts its photosynthetic surface into fruit biomass. A lower ratio means less leaf area is needed to produce one kilogram of fruit, which is desirable regarding resource efficiency.



**Figure 2.** Correlation Between Leaf Surface Area and Yield in Peach Trees According to Pre-Irrigation Soil Moisture Levels. Pre-Irrigation Soil Moisture Level (%) According to Field Capacity (FC)

Under this metric, the most efficient performance occurred at 70% and 80% FC, with average ratios of 1.20 and 1.25 m<sup>2</sup>/kg, respectively. This means that at these moisture levels, trees produced more fruit per unit of leaf area, reflecting a more balanced allocation of energy

between vegetative and reproductive growth. In contrast, both over-irrigation (90% FC) and under-irrigation (60% FC) had higher ratios (1.50 and 1.60 m<sup>2</sup>/kg), indicating reduced efficiency. These trees had either excessive vegetative growth not matched by fruit

yield (in the case of 90% FC) or limited yield due to restricted overall growth (in the case of 60% FC). This indicates that soil moisture levels in both excessively high (90% FC) and low (60% FC) soil fail to ensure high yield and disrupt the correlation (see graph).

Among the key and decisive characteristics of fruit production are the quantitative and qualitative indicators of the yield, depending on the intended use of the produce. However, the quality indicators of the fruit do not always align with high yield levels. Biochemical analysis data revealed that across multiple growing seasons, the dry matter content in the fruits varied by treatment between 12.7% and 15.5%, and total sugars ranged between 11.12% and 13.70%. Under conditions of excessive soil moisture (90% FC), these values decreased, averaging 12.95% for dry matter and 11.31% for total sugars. In contrast, in the control treatment, these values were higher—15.05% and 12.59%, respectively.

The trend differed for acidity: the average acidity was higher at 90% FC, reaching 0.49%.

When analyzing soil moisture dynamics from

different depths (20, 40, 60, and 80 cm), it was found that under high-moisture conditions (90% FC), waterlogging occurred in the lower soil layer (60–80 cm). As a result, despite the normal vegetative growth of trees at 90% FC, there was a slowing in the development and maturation of generative organs, and in some cases, depending on weather conditions, mild chlorosis symptoms were observed in the trees.

This is critical from a functional food perspective: Over-irrigation promotes leafy growth but reduces the fruit’s nutrient density by diluting sugars and bioactive compounds. Additionally, waterlogging stresses the plant, leading to biochemical imbalances. As a result, fruits grown under high moisture conditions have lower concentrations of the functional compounds important for health benefits, such as antioxidant protection and metabolic regulation. This study reinforces that moderate soil moisture levels (70–80% FC) not only optimize yield but also enhance the accumulation of bioactive nutrients, making the fruits more valuable as functional foods.

**Table 4:** Biochemical Characteristics of Peach Fruits According to Pre-Irrigation Soil Moisture Levels (%).

| № | Pre-irrigation<br>soil moisture<br>limits, from<br>FCR | Dry matter (DM) |      | Sugars     |       |        |      |          |       | Acidity. |      |
|---|--------------------------------------------------------|-----------------|------|------------|-------|--------|------|----------|-------|----------|------|
|   |                                                        |                 |      | Total (TS) |       | Invert |      | sucrose, |       |          |      |
|   |                                                        | 2017            | 2019 | 2017       | 2019  | 2017   | 2019 | 2017     | 2019  | 2017     | 2019 |
| 1 | 90                                                     | 12.7            | 13.2 | 11.12      | 11.50 | 3.19   | 1.80 | 7.93     | 9.70  | 0.45     | 0.53 |
| 2 | 80                                                     | 13.8            | 15.0 | 11.38      | 13.10 | 3.32   | 2.30 | 8.06     | 10.80 | 0.37     | 0.40 |
| 3 | 70                                                     | 14.2            | 15.0 | 11.43      | 12.33 | 3.28   | 2.80 | 88. 15   | 9.53  | 0.29     | 0.40 |
| 4 | 60                                                     | 15.2            | 15.5 | 11.58      | 13.10 | 3.30   | 2.73 | 8.28     | 10.37 | 0.32     | 0.40 |
| 5 | Control                                                | 14.6            | 15.5 | 11.48      | 13.70 | 3.27   | 2.80 | 8.21     | 10.90 | 0.30     | 0.37 |

According to the data from Table 4, the results of biochemical indicators were higher under moderate soil moisture conditions in the 70–80% FC range where the dry matter (DM) content ranged between 13.8% and 15.5%, and total sugars (TS) between 11.38% and 13.7%. The amount of organic acids was highest in the 90% FC treatment (0.45–0.53%), while under relatively low soil moisture conditions, it was lower (0.29–0.40%). It was also found that in the control treatment, the pre-

irrigation soil moisture level fluctuated around 70% FC throughout the growing season; therefore, the recorded indicators in that treatment were close to those observed in the 70–80% variants.

**Health-Enhancing Compounds in Peaches: A Nutritional Overview:** Peaches (*Prunus persica* L.), a widely cultivated fruit native to China and belonging to the *Amygdalus* subgenus, are rich in various classes of

polyphenols. These include phenolic acids, flavonols, anthocyanins, flavan-3-ols, and proanthocyanidins (PACs). Hydroxycinnamic acids—particularly chlorogenic and neochlorogenic acids—are the dominant phenolic acids. Among flavonols, peaches contain glycosylated derivatives of kaempferol and quercetin, along with notable levels of rutin [37]. Catechin and epicatechin are the most prominent flavan-3-ols found in both the peel and pulp [1], while PACs such as proanthocyanidin B1 are also abundant and appear as oligomers or polymers of flavan-3-ol units [1][38].

These phenolic compounds are responsible for a range of biological effects, including antioxidant, anti-inflammatory, anti-allergic, and chemopreventive activities [39-42]. Carotenoids and vitamin C further contribute to the fruit's antioxidant potential [43]. The antioxidant properties of peach polyphenols have been confirmed through in vitro and ex vivo studies [44-45].

Phenolic content is higher in the peel than in the flesh [46], and significant variation occurs among cultivars and at different stages of ripening. Li et al. [47] demonstrated that total phenolic content (TPC) decreases as the fruit ripens, ranging from 75.5 to 46.4 mg GAE/100 g. In terms of cultivars, Spring Belle showed the highest phenolic levels (81.5 mg/g), followed by Cardinal, Dixired, and Red Top (34.3–37.9 mg/g), while Flavorcrest and Romea had the lowest (23.1 and 19.8 mg/g, respectively) [37].

**Scientific Innovation:** The innovation of this study lies in its integrated assessment of irrigation levels on fruit yield, water use efficiency, and the concentration of key functional food components such as sugars, organic acids, and dry matter. Unlike previous works that examined irrigation from a yield or growth perspective alone, this study bridges plant physiology, soil-water dynamics, and food science, revealing how ecological management can optimize the health-promoting potential of fruits. The identification of 80% field capacity

as the optimal irrigation level offers a scientifically grounded standard for maximizing both agricultural output and nutritional quality.

**Practical Implications:** Findings from this study provide actionable insights for farmers, agricultural engineers, and functional food developers. Implementing an irrigation regime that maintains 80% of field capacity not only improves fruit set and yield but also enhances the biochemical. This supports sustainable water use in orchard management and contributes to the production of fruits with superior health-promoting qualities. Additionally, this strategy can be adapted to other climatically similar regions, aligning local agricultural practices with global functional food standards.

## CONCLUSION

This study highlights the critical role of pre-irrigation soil moisture in shaping both the agronomic performance and nutritional quality of *Prunus persica* (Narnji variety) in the Ararat Valley of Armenia. The results confirm that maintaining soil moisture at 80% of field capacity (FC) throughout the growing season is optimal for achieving high yields (up to 16.04 tons/ha) and promoting healthy vegetative growth.

While increased moisture levels expanded leaf area, they did not necessarily correlate with better fruit outcomes. In fact, excessive irrigation at 90% FC, despite encouraging foliage, led to reduced sugar content and delayed fruit maturation, likely due to waterlogging and oxygen deficiency in deeper root zones. Conversely, insufficient moisture at 60% FC restricted growth and fruit development.

The most favorable biochemical profiles—including elevated dry matter and total sugars—were recorded under moderate moisture conditions (70–80% FC). These levels also aligned with the control treatment, further validating traditional irrigation practices when properly managed. Given the nutritional importance of peaches highlighted throughout this paper, the study concludes that environmental conditions—particularly pre-

irrigation soil moisture—can significantly influence both the yield and biochemical quality of peach fruits. Understanding the optimal soil moisture levels (70–80% of field capacity) for enhancing the nutrient density of peaches not only supports sustainable agricultural practices but also provides valuable insights for the development of health-promoting foods.

**List of abbreviations:** FCM – Field Capacity Moisture, PCS: unit, FCR: Field Capacity Rate; FC: field capacity; BC: before the Common Era; Ca: calcium; Fe: iron; Mg: magnesium; P: phosphorus; K: potassium; Zn: zinc; Mn: manganese; Cu: copper; F: fluoride; Se: selenium; DM: dry matter; TS: total sugar

**Competing Interests:** The authors declare that they have no competing interests.

**Authors' Contributions:** AM discussed the article's concept and developed the content. DB reviewed numerous literary sources. GS, AM, and DB conducted analyses. GS, AM, and DB carried out the data collection and compiled the tables. GS edited the article and contributed to its editing, formatting, and creation of the graphical abstract. All authors have read and approved the final version of the manuscript.

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