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Effect of Zeolux and Filters Backwash Water (FBWW) on plant growth and yield of sage (*Salvia officinalis*) plant

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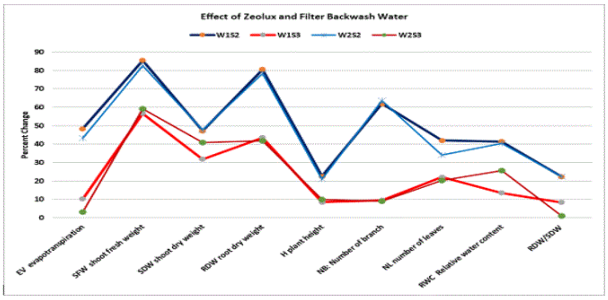
Graphical abstract



Abstract

Jordan is one of the few countries with constricted water resources, having one of the lowest per capita water levels in the world (Ministry of Agriculture 2015). Jordan's available water resources per person are predicted to fall from less than 160 m3/capita/year to roughly 90 m3/capita/year by 2025, placing the nation in the acute water shortage category. Massive volumes of filter backwash water (FBWW) are created and wasted in Jordan. The use of FBWW to Sage (*Salvia officinalis*) plant germination under controlled conditions with various dilution treatments would reduce water waste while also providing an alternate irrigation water supply. The effects of Zeolux as a soil amendment on the productivity and a variety of agronomic parameters of a Sage (*Salvia officinalis*) irrigated with fresh and FBWW were also studied. Various clay-zeolux mixtures were tested to achieve this goal. The combination soil mix of 25% zeolux and 75% clay watered with FBWW had the greatest results in terms of plant height, number of branches, fresh weight, dry weight, and root dry weight. The results reveal that the addition of zeolux to clay enhanced the yield and agrarian characteristics of plants cultivated in the soil. The results demonstrate that employing FBWW increased plant growth features greatly, and zeolux increases the favorable impact of FBWW irrigation on plant output. The study's main results will help to preserve valuable drinking water supplies while also increasing the yield of irrigated plants by using treated FBWW for irrigation.

Keywords: Filters Backwash Water (FBWW), reuse, irrigation; *Salvia officinalis*

1. Introduction

Jordan is one of the few countries in the world with scarce water resources, with one of the world's lowest per capita water levels (Ministry of Agriculture 2015). Jordan's available water resources per person are expected to decrease from less than 160 m3/capita/year today to around 90 m3/capita/year by 2025, putting the country in the category of absolute water deficit. Water shortage and growing demand exceed renewable sources by a wide margin. Several factors contribute to Jordan's low annual per capita water availability, the most visible of which is the increase in water consumption because of population growth, not to mention the immense development of diverse economic activities that require massive amounts of water. (Food and Agriculture Organization of the United Nations [FAO] 2018).

Because Jordan has the world's fourth poorest water resources, the ability to use treated water to irrigate certain types of crops is considered as vital for Jordanian agriculture (USAID 2012). The ever-increasing population strains current drinking water supplies, impacting per capita daily water supply. Given Jordan's scarcity of water and it's ranking as one of the world's poorest ten countries, the washing of filters is a source of consumption. Piped nonconventional water pollutes groundwater, causes soil salinization, and decreases crop output by lowering seed germination and growth agronomy indicators. (Rad & Rad 2013; Al-Tabbal & Ammary 2014; Al-Zou'by *et al.* 2017; Al-Mefleh *et al.* 2020)

Plant toxicity may result from the uncontrolled addition of contaminated nonconventional water due to the high concentration of components in soil and plants. Among the several types of nonconventional water, FBWW causes substantial abiotic stress, inhibiting the growth and development of many plants across the world (Yagmur & Kaydan 2008).

Yang *et al.* 2020 found that irrigation with brackish water is crucial for the efficient use of scarce water resources and ecological restoration and Brackish water irrigation could accumulate salt and the soil salt content in the 60–80 cm soil layer was the highest; With elevated irrigation salinity, the changes in $SO4^{2-}$, Cl^{-}, K^{+} and Na+ ion contents in the soil increased significantly (Yang *et al.* 2020).

Filtration is the process of removing water pollutants through filters. Backwashing cleans the filter by reversing the flow of water and forcing it upwards through the filter medium. The management, treatment, and safe disposal of FBWW pose serious environmental problems, especially when FBWW is designated as non-conventional contaminated water. Filters that are not treated with backwashing water are black, unique odors, acidic pH, and high organic content. Currently, Jordan has the only method of disposing of FBWW, which is to dispose of it without treatment in a landfill designed to deal with waste. Irrigation with recovered FBWW increases water supply and soil fertility. The accumulation of salts in the root zone can cause soil pollution caused by salt deposits in the root zone and is harmful to plants.

Given the scarcity of water in Jordon and mind of the poorest ten countries in the world, the processes of washing filters are a source of consumption. Because the process of washing filters required a huge amount of water so that the amount of water that may produce from the processing stage and given the importance of this technology so that Indispensable in order to ensure effectiveness and efficiency of water resulting from the process of filtering, especially that all treatment plants are using a technique the sand filter, they consume large amounts cannot be underestimated never which is a drain on resources that may be suitable for the use of these quantities in many areas and this point came the idea of washing water treatment filters (http://www.who.int/heli/risks/water/waterdirectory/en/index3.html).

The technique of eliminating suspended materials from water by passing it through a filter is known as filtration. Through a permeable fabric or porous material bed. Surface water and groundwater, on the other hand, the effect of surface water is likely to pollute from a variety of sources. Some contaminants are hazardous to human health, and filtration is one of the oldest and most straightforward means of eliminating them. Many water systems are required by federal and state requirements to filter their water (http://www.nesc.wvu.edu/pdf/dw/publications/ontap/2009_tb/filtration_DWFSOM51.pdf). Slow and quicksand filtration, organic material Earth filtration, direct filtration, packaged filtration, membrane filtration, and Cartridge filtration are all techniques of filtration (https://www.nesc.wvu.edu/wastewater/onsite-wastewater-systems/alternative-technologies/filtration).

Backwashing cleans the filter by reversing the flow of water and causing the water to course upward through the filter media. The backwash water action tends to slightly expand the Filter media, causing the sand particles to tremble and scrub against each other allowing the collected soil to break Free and wash out of the filter vessel to a point of Disposal so as Velocity of the backwash water, increased the requirement of wash water will be huge. (http://www.cob.org/services/utilities/water-treatment.aspx). Reuse of brackish water from water treatment units in agriculture will reduce the environmental impacts resulting from disposal in the soil and groundwater, thus reflecting positively in reducing costs (Bashabsheh *et al.* 2021).

The management, treatment, and safe disposal of FBWW create major environmental problems, particularly when FBWW is classified as nonconventional polluted water. Filters that were not treated Backwash Water have a variety of features, including a dark hue, a distinct odor, an acidic pH, and a high organic content. Currently, the only technique accessible in Jordan for disposing of FBWW is to dispose of the FBWW without treatment to a landfill designated to receive effluent.

Filter Exhaustion Backwash water entering soil can produce a variety of environmental problems, including leaf and fruit abscission (Erel 2008), seed germination suppression, microbial fermentation with methane generation, and phosphorus content proliferation. Irrigation management tactics that aim to maximize the use of low-quality water in agriculture by combining it with appropriate cultural approaches can greatly boost crop productivity in a variety of soil conditions. Soil or water additives can aid in the prevention or correction of soil permeability concerns. Zeolux was used as a soil amendment.

Irrigation with FBWW has a good influence on plant development in general because to enhanced water availability and soil richness. The buildup of salt in the root zone, on the other hand, has a deleterious effect on the plant (Biggs 2009) and may be a source of groundwater pollution owing to leaching below the root zone (Aragues 2004). On the other hand, the deficits of water effects the plant growth, Bettaieb *et al.* 2009 studied the effects of water scarcity on vegetative development, fatty acid and essential oil output, and aerial part composition of *Salvia officinalis*. The results revealed significant decreases in the various growth metrics. Drought drastically reduced foliar fatty acid content and the degree of the double bond index (Battaib *et al.* 2009).

Sonmez et al. studied the influence of varied water and nitrogen treatments on yield metrics and antioxidant activity in Sage (*Salvia officinalis L.* var. *Extrakta*) and discovered that antioxidant activity increased as soil moisture declined (Sonmez *et al.* 2017).

Natural zeolites (zeolux) are minerals that are often used as substrates for growth of plants, such as seedling germination, cutting roots, decorative plant potting, and so on. Natural zeolites are an appealing alternative to peat moss and other natural materials used in the industrial manufacturing of substrates due to their strong sorption capabilities, high cation exchange capacity (CEC), and rich macro and micronutrient content. Natural zeolites have also widely been developed to increase soil properties. Farmers use zeolites to manage soil pH and increase ammonium absorption (Dwyer & Dyer 1984).

Another research found that zeolite might be beneficial in reducing the detrimental consequences of excessive salinity (Noori *et al.* 2006). Soil salinity is a significant abiotic element that limits crop productivity. The application of zeolites as a soil supplement may help plants cope with salt stress.

A variety of metrics were used to assess plantation performance. Shoot or root height (Kaya *et al.* 2006), shoot length to root length ratio (Tadros *et al.* 2012), diameter, dry mass, or the ratio of shoot dry mass to root dry mass are examples of these (Bernier *et al.* 1995; Tadros *et al.* 2012). An imbalance in the shoot-to-root ratio can cause transplant shocks. The shoot-to-root ratio has also been used to evaluate drought resistance capability, with those with low shoot-to-root ratio values having a higher drought resistance capability (Bernier *et al.* 1995). The root mass is connected to a plant's ability to absorb water, whereas the shoot mass is related to the quantity of water a plant loses via transpiration, For the same plant, however, an equilibrium between the amount of shoot to the amount of root (shoot: root ratio) must be present (Wilson 1988).

The primary goals of this research are to tackle the challenges associated with using fitters backwash waters by reducing water wasted, to search for new sources of water, to accomplish additional irrigation water sources, to investigate the effects of FBWW on sage (*Salvia officinalis*) Plant Germination under controlled settings with various dilution treatments and the impacts of using Zeolux as a soil supplement on the production and several agronomic parameters of a sage (*Salvia officinalis*), watered with fresh and FBWW.

The Sage (*Salvia officinalis*) Plant was chosen since it is produced in large amounts in Jordan, and it is a well-known fodder supply as well as a nitrogen-fixer. The major findings of this study will contribute to the preservation of valuable drinking water resources by using treated FBWW for irrigation of non-edible plants. The Mediterranean plant sage (*Salvia officinalis* var. *purpurascens*) is an evergreen sub shrub has been used medicinally as an antihidrotic, spasmolytic, antibacterial, and anti-inflammatory, as well as in the treatment of mental and nerve diseases and has also typically been used in culinary preparation. (Baricevic & Bartol 2000). Plant production utilizing salty water may have a few negative consequences on plant development, morphology, and survival (Hasegawa *et al.* 2000).

2. Methodology

The experiments were carried out to study the effect of FBWW treatment on the yield and some of the agronomic traits of *Salvia officinalis* var. *purpurascens* grown under three types of soil. Seedlings of Sage (*Salvia officinalis* var. *purpurascens*) were kindly obtained from Zahran nursery, Al-Balqa, Jordan. Pots 30cm in diameter and 45cm depth were completely blocked to prevent water loss. They were divided into three groups: The first group contains a clay soil (S1 treatment) (as control), the second group contains a mixture of clay soil (75%) with zeolux (25%) (S2 treatment), and the third group contains a mixture of clay soil (50%) with zeolux (50%) (S3 treatment).

Each group of experimental plants was divided into two subgroups at randomized experiment and irrigated with two types of water; tap water (W1 treatment) and backwash water (W2 treatment), each of which is three times repeated. Two seedlings of *Salvia officinalis* var. *purpurascens* were planted in each pot. Soil water potential was maintained by frequently weighing the pots; the amount of water equal to the weight loss was added. Plants were irrigated to the pot capacity for one week before starting the experiment to improve root development.

Plants were harvested at the beginning of December. On the soil surface, shoots were extracted from roots. Yield and yield constituents were calculated for each pot's two plants. The cumulative quantity of water consumed was determined by subtracting the final and beginning pot weights from the amount of water provided to each pot. As a result, the total amount of water utilized comprised both transpired and evaporated water. The plants were harvested during the growing season by cutting the plants and the different vegetative growth parameters were recorded. These experiments were designed with three replications for each set. Several measurements on the geomorphologic analysis were taken during this study such as Mean plant height (PH), number of forest plant (NFB), number of papers (NP), weight of roots (WR), weight of plant (WP) and the ratio between weight roots and weight of plant (WR/WP) of Plant (*Salvia officinalis*) irrigated with two types of water and planted in different soil mixtures.

3. Materials and methods

3.1 Plant materials

The Sage (*Salvia officinalis* var. *purpurascens*) Plant was obtained from farmer fields from Zahran nursery, Al-Balqa, Jordan (about 35 km north of Amman, Jordan). The (*Salvia officinalis*) Plant was grown in several areas for forage production. Pots 30cm in diameter and 45cm depth were completely blocked to prevent water loss. They were divided into three groups: The first group contains a clay soil (S1 treatment) (as control), the second group contains a mixture of clay soil (75%) with zeolux (25%) (S2 treatment), and the third group contains a mixture of clay soil (50%) with zeolux (50%) (S3 treatment). Each group was divided into two subgroups at randomized experiment and irrigated with two types of water tap water - W1 treatment and backwash water - W2 treatment, each of which is three times repeated. Two seedlings of *Salvia officinalis* var. *purpurascens* were planted in each pot.

3.2 Filters Backwash Water (FBWW)

Backwashing filters are necessary when there is significant head loss and a demand for colorless water owing to high turbidity. Backwashing water filters are big tank-style filters with a capacity of 975 m^3 that clean and replace themselves continually at a maximum flow rate of 48 m^3/min. Backwashing involves reversing the flow of water so that it enters the filter media from the bottom, rises to rinse the filter media, and then exits the filter tank from the top. Granular carbon, sand, garnet, anthracite, zeolite, granular manganese dioxide, and greensand are examples of granular filter media.

Backwashing is a time-consuming technique that involves thoroughly rinsing and discarding the material. A basic filter backwash takes around 10 minutes. Backwash flow rates of 48 m^3/min are usually sufficient for most filters. The filtered backwashed water is stored in seven lagoons, each 14 meters wide, 110 meters long, and 0.9 meters deep. Each filter in the water treatment plant comprises of 450 mm anthracite layer with high carbon (coal) content, 450 mm Glauconitic manganese green sand, and 300 mm Gravel layer with perforated filter bottom. The anthracite layer will filter out the suspended particles, while the green sand layer will continue the filtration process and oxidize any leftover dissolved iron in the water. The green sand layer will be renewed by adding potassium permanganate ($KMnO_4$) to the water. Cleaning the filtered media is accomplished using eight high-pressure water jets, which help in breaking apart solidified masses of the filtered media and foreign elements obtained during filter agitation and the flow of back wash water. The sample are taken from lagoons of wash water in wadi al-Arab water treatment plants and there 7 lagoons with same area.

3.3 Data collection

The soil water potential was maintained by weighing the pots often and adding the amount of water proportional to the weight loss. To enhance root growth, plants were watered to the pot capacity for one week before the experiment. The plants were gathered in early December. Shoots were taken from roots at the soil's surface. Yield and yield components were estimated for the two plants in each container. The total amount of water consumed was calculated by subtracting the final and starting pot weights from the amount of water supplied to each pot. Consequently, both transpired and evaporated water were included in the total amount of water used. During the growing season, the plants were collected by cutting them, and the following vegetative growth data were recorded: Mean plant height (PH); (cm), number of branches per plant (NB), shoot fresh weight (SFW); (g/plant), shoot dry weight (SDW); (g/plant), root dry weight (RDW); (g/plant), number of leaves per plant (NL), shoot dry weight/root dry weight ratio (SDW/RDW), and relative water content (RWC) of sage plant (*Salvia officinalis*) under two types of water. The water samples were collected from wash water lagoons in the Wadi al-Arab water treatment facility, where there are seven lagoons in the same region.

3.4 Experimental site and experimental design

This study was conducted at the Al-Balqa' Applied University, Al-Huson University College, Al-Huson, Irbid, Jordan in the laboratory of the Department of Plant Production. The Sage (*Salvia officinalis*) Plant was grown in several areas for forage production. Pots 30cm in diameter and 45cm depth were completely blocked to prevent water loss. They were divided into three groups: The first group contains a clay soil (S1 treatment) (as control), the second group contains a mixture of clay soil (75%) with zeolux (25%) (S2 treatment), and the third group contains a mixture of clay soil (50%) with zeolux (50%) (S3 treatment). Each group was divided into two subgroups at randomized experiment and irrigated with two types of water (tap water (W1 treatment) and backwash water (W2 treatment)), each of which is three times repeated. Two seedlings of *Salvia officinalis* var. *purpurascens* were planted in each pot.

The impact of different water qualities and soil mixers with Zeolux on the growth of Sage (*Salvia officinalis*) Plant was investigated under control conditions. The water types used in this work were tap water (W1 treatment) and backwash water (W2 treatment). The experimental design used in this research was a complete random design with three replications.

3.5 Results and discussion

To evaluate the differences between plant height (PH) that occurred because of using different percentages of zeolux in soil, the value of **Fisher's Least Square Difference (LSD)** at 0.05 probability level was computed and found as shown in Table 5 for the plant height (PH). Fisher's least significant difference (LSD) procedure is a two-step testing procedure for pairwise comparisons of several treatment groups. In the first step of the procedure, a global test is performed for the null hypothesis that the expected means of all treatment groups under study are equal.

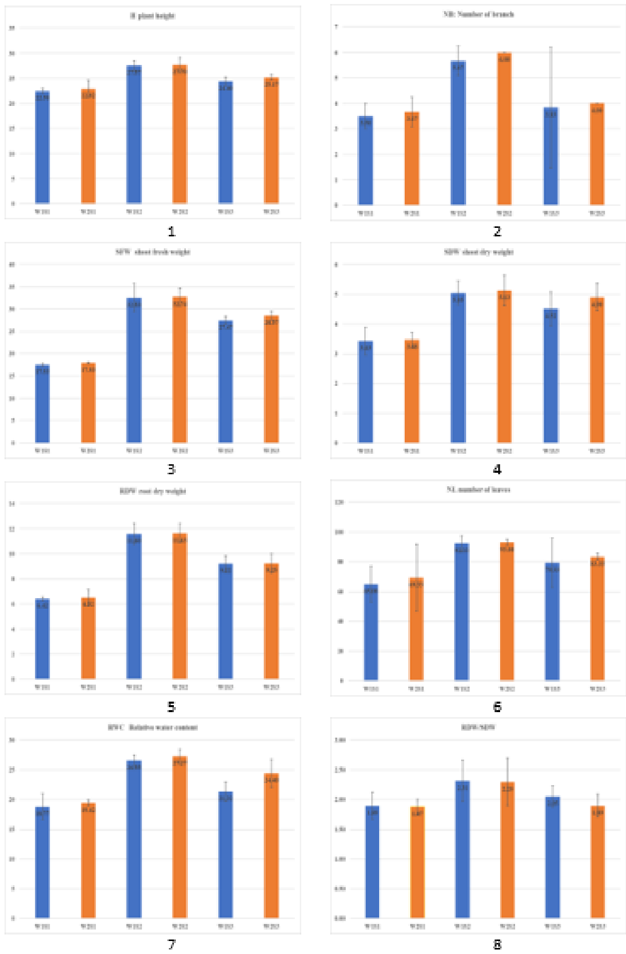


Figure 1. Effect of zeolux mixing with clay on 1. Sage Plant Height (PH), 2. Number of Branches (NB), 3. Shoot Fresh Weight (SFW), 4. Shoot Dry Weight (SDW), 5. Root Dry Weight (RDW), 6. Number of Leaves (NL), 7. Relative Water Content (RWC), 8. Root Dry Weight to Shoot Dry Weight (RDW/SDW) for both Fresh and Filtered Backwashed Water

As LSD shows, the 25% zeolux and 75% clay combination produced a PH that is lower than LSD value. In other words, a PH of less than the first group as the combination that produced the second score was 50% zeolux: 50% clay combination, as shown in Table 5 when both compared, there is a significant difference between these two zeolux-clay combinations according to Fisher's LSD at 0.05 probability. A combination that produces a PH that is lower than the value of LSD for the PH while all the other combinations scored a PH that is closer to the LSD value. The four combinations shown in Figure 1 are therefore not significantly different according to LSD at 0.05 probability level as shown in Table 5.

Table 1. Raw Data for the experimental work. Irrigation water: Fresh water (W1); Backwash water (W2); Mean plant height (PH), number of forest plant (NFB), number of papers (NP), weight of roots (WR), weight of plant (WP) and the ratio between weight roots and weight of plant (WR/WP) of Plant (*Salvia officinalis*) irrigated with two types of water and planted in different soil mixtures.

Input Cards	WS	R	EV	T	SFW	SDW	RDW	H	NB	NL	RWC
1	1	1	18.00	3.70	17.30	3.86	6.50	22.00	3.50	53.00	21.05
1	1	2	17.30	3.00	17.40	2.93	6.25	22.50	3.00	77.00	16.70
1	1	3	17.60	3.30	17.90	3.50	6.52	23.00	4.00	65.00	18.56
2	1	1	16.80	2.50	17.90	3.64	6.37	21.00	3.00	66.00	19.98
2	1	2	19.30	3.60	18.10	3.19	5.98	23.50	4.00	48.50	19.21
2	1	3	20.30	4.60	17.80	3.60	7.20	24.25	4.00	93.50	19.06
1	2	1	19.50	2.50	26.50	4.12	8.50	23.50	3.00	84.00	22.05
1	2	2	18.90	4.80	27.50	5.17	9.65	24.50	6.50	93.00	19.52
1	2	3	19.90	2.40	28.40	4.27	9.50	25.20	2.00	61.00	22.38
2	2	1	19.10	3.20	28.60	4.75	8.40	25.60	4.00	84.00	21.89
2	2	2	18.90	3.70	27.60	5.41	9.74	25.30	4.00	85.00	26.50
2	2	3	20.20	3.40	29.50	4.54	9.60	24.60	4.00	81.00	24.81
1	3	1	27.00	10.70	34.20	5.34	11.50	28.60	6.00	98.00	26.51
1	3	2	26.00	9.95	34.50	5.21	10.80	26.50	6.00	91.00	25.60
1	3	3	25.50	9.20	28.90	4.60	12.50	27.60	5.00	88.00	27.54
2	3	1	26.95	9.65	34.13	5.41	11.20	28.60	6.00	93.00	26.80
2	3	2	24.70	7.40	33.60	5.45	11.20	26.00	6.00	95.00	26.40
2	3	3	29.20	8.52	30.50	4.54	12.50	28.50	6.00	91.00	28.60

Table 2 shows the effects that the addition of zeolux on clay has on several parameters related to the growth of plant. Table 2 shows that the addition of zeolux has a significant effect on most of the parameters studied when fresh water and FBWW was used as irrigation water. Table 1 shows the Raw Data for the experimental work.

Table 2. Irrigation water: Fresh water (W1); Backwash water (W2); Mean plant height (PH), number of forest plant (NFB), number of papers (NP), weight of roots (WR), weight of plant (WP) and the ratio between weight roots and weight of plant (WR/WP) of Plant (*Salvia officinalis*) irrigated with two types of water and planted in different soil mixtures.

AVERAGE VALUES												
Irrigation Water (W)	**Soil mixture (%clay: %zeolux) (S)**	**R**	**EV evapo Transpiration**	**T**	**SFW shoot fresh weight**	**SDW shoot dry weight**	**RDW root dry weight**	**PH plant height**	**NB: Number of branches**	**NL number of leaves**	**RWC Relative water content**	**RDW/SDW**
Fresh Water (1)	100% clay: 0% zeolux (S1)	W1S1	17.63	3.33	17.53	3.43	6.42	22.50	3.50	65.00	18.77	1.89
Backwash Water (2)	100% clay: 0% zeolux (S1)	W2S1	18.80	3.57	17.93	3.48	6.52	22.92	3.67	69.33	19.42	1.87
Fresh Water (1)	75% clay: 25% zeolux (S2)	W1S2	26.17	9.95	32.53	5.05	11.60	27.57	5.67	92.33	26.55	2.31
Backwash Water (2)	75% clay: 25% zeolux (S2)	W2S2	26.95	8.52	32.74	5.13	11.63	27.70	6.00	93.00	27.27	2.29
Fresh Water (1)	50% clay: 50% zeolux (S3)	W1S3	19.43	3.23	27.47	4.52	9.22	24.40	3.83	79.33	21.32	2.05
Backwash Water (2)	50% clay: 50% zeolux (S3)	W2S3	19.40	3.43	28.57	4.90	9.25	25.17	4.00	83.33	24.40	1.89
STANDARD DEVIATION VALUES												
Irrigation Water (W)	**Soil mixture (%clay: %zeolux) (S)**	**R**	**EV evapo Transpiration**	**T**	**SFW shoot fresh weight**	**SDW shoot dry weight**	**RDW root dry weight**	**PH plant height**	**NB: Number of branches**	**NL number of leaves**	**RWC Relative water content**	**RDW/SDW**
Fresh Water (1)	100% clay: 0% zeolux (S1)	W1S1	0.35	0.35	0.32	0.47	0.15	0.50	0.50	12.00	2.18	0.23
Backwash Water (2)	100% clay: 0% zeolux (S1)	W2S1	1.80	1.05	0.15	0.25	0.62	1.70	0.58	22.68	0.49	0.13
Fresh Water (1)	75% clay: 25% zeolux (S2)	W1S2	0.50	1.36	0.95	0.57	0.63	0.85	2.36	16.50	1.56	0.18
Backwash Water (2)	75% clay: 25% zeolux (S2)	W2S2	0.70	0.25	0.95	0.45	0.74	0.51	0.00	2.08	2.33	0.19
Fresh Water (1)	50% clay: 50% zeolux (S3)	W1S3	0.76	0.75	3.15	0.40	0.85	1.05	0.58	5.13	0.97	0.35
Backwash Water (2)	50% clay: 50% zeolux (S3)	W2S3	2.25	1.13	1.96	0.51	0.75	1.47	0.00	2.00	1.17	0.40

Table 3: Percent Increase from Clayey Soil for Mean plant height (PH), number of forest plant (NFB), number of papers (NP), weight of roots (WR), weight of plant (WP) and the ratio between weight roots and weight of plant (WR/WP) of Plant (*Salvia officinalis*) irrigated with two types of water and planted in different soil mixtures when Irrigated with Fresh water (W1) and Filtered Backwash water (W2).

			Percent Increase from Clayey Soil									
Irrigation Water (W)	**Soil mixture (%clay: %zeolux) (S)**	**R**	**EV evapo Transpiration**	**T**	**SFW shoot fresh weight**	**SDW shoot dry weight**	**RDW root dry weight**	**PH plant height**	**NB: Number of branches**	**NL number of leaves**	**RWC Relative water content**	**RDW/SDW**
Fresh Water (1)	100% clay: 0% zeolux (S1)	W1S1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Backwash Water (2)	100% clay: 0% zeolux (S1)	W2S1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fresh Water (1)	75% clay: 25% zeolux (S2)	W1S2	48.39	198.50	85.55	47.23	80.59	22.52	61.90	42.05	41.45	22.25
Backwash Water (2)	75% clay: 25% zeolux (S2)	W2S2	43.35	138.97	82.58	47.65	78.52	20.87	63.64	34.13	40.43	22.29
Fresh Water (1)	50% clay: 50% zeolux (S3)	W1S3	10.21	-3.00	56.65	31.78	43.49	8.44	9.52	22.05	13.57	8.36
Backwash Water (2)	50% clay: 50% zeolux (S3)	W2S3	3.19	-3.74	59.29	40.94	41.89	9.82	9.09	20.19	25.67	1.04

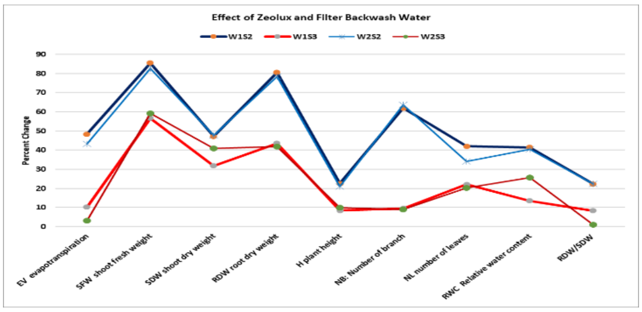


Figure 2. Effect of Zeolux and Filter Backwash Water (FBWW) on Plant (*Salvia officinalis*) irrigated with two types of water and planted in different soil mixtures when Irrigated with Fresh water (W1) and Filtered Backwash water (W2).

As shown in Table 3, when Zeolux added to clayey soil at 25% and 50% concentrations, all vegetation metric parameters increased for plants irrigated with Fresh water and increased for plants irrigated with FBWW when compared to clayey soil alone irrigated by Fresh water and FBWW, with the greatest results for 25% zeolux: 75% clay soil mix for all vegetative metrics in research.

As Zeolux was applied to clay soil at 25% and 50% concentrations, the PH plant height improved by 22.52 and 8.44 % for Fresh water and 20.87 and 9.82 %for FBWW, respectively, when compared to clayey soil alone watered by fresh water and FBWW. And, as demonstrated in Table 3 and as seen in Figure 1-2, for all vegetative metric parameters which indicates the effect of percentage Zeolux with clayey soil and the effect of irrigation with FBWW on the Sage plant.

The zeolux-clay combination that produced the largest plant vegetative metrics in Figure 1 and all subsequent figures indicate that it had the highest PH, greatest number of branches, greatest shoot fresh weight and shoot dry weight, considerably increased root dry weight, considerably improved the number of Leaves (NL), significantly improved the Relative Water Content (RWC), and Clayey soil with no zeolux added had the greatest RDW/SDW value. The extra zeolux-clay combinations signify that the difference was significant according to LSD at a 0.05 probability level. When no zeolux was employed, the combination produced the fewest branches (0% zeolux: 100% clay). Because the difference from the (50 % zeolux: 50% clay) combination was large, this combination generated greater branches than clay alone (0 % zeolux: 100 % clay).

Figures 1-3 and 1-4 illustrate that the soil with the greatest shoot fresh weight and shoot dry weight (25% zeolux:75 % clay). Conversely, (0 % zeolux:100% clay) soil produced the lowest results in both metrics. According to LSD, the difference was significant at a 0.05 probability level. Figures 1-3 and 1-4 further reveal that all zeolux-containing soil combinations (25 % and 500 % zeolux) generated greater shoot fresh weight and shoot dry weight than clay alone (0 % zeolux: 100 % clay). According to LSD, the difference was considerable.

As indicated in Figure 1-5, the application of Zeolux (at 25% and 50%) considerably increased root dry weight. The soil with 25% zeolux and 75% clay generated considerably more root dry weight than the soil with 50% zeolux and 50% clay. As represented in Figure 1-6, Zeolux application (at 25% and 50%) considerably improved the number of Leaves (NL). The 25 % zeolux: 75 % clay soil mix generated much more Leaves (NL) than the 0% zeolux:100 % clay soil mix. As Zeolux was added to clay soil at 25% and 50% concentrations, the number of Leaves (NL) increased by 48.8 and 66 %, respectively, when compared to clay soil alone.

As seen in Figure 1-7, the application of Zeolux at 25% and 50% soil mix significantly improved the Relative Water Content (RWC). The soil mix with 25% zeolux and 75% clay yielded a much greater value of RWC than the soil mix with 50% zeolux and 50% clay. As Zeolux was added to clay soil at 25% and 50% concentrations, the RWC increased by 48.8 and 66 %, respectively, when compared to clay soil alone.

Figure 1-8 characterizes the shoot dry weight to root dry weight (RDW/SDW) ratio for various zeolux percentages in soil. Clay soil with no zeolux added had the greatest RDW/SDW value, whereas soil with 0% zeolux had the lowest value. The RDW/SDW ratio drops as the proportion of zeolux in the soil increases. As previously stated, a low shoot to root ratio indicates a stronger drought resistance capability (Bernier *et al.* 1995).

Natural zeolites (zeolux) are minerals that are frequently utilized as plant growth substrates for seedling germination, cutting roots, ornamental plant potting, and so on. Because of their high cation exchange capacity (CEC) and rich macro and micronutrient content, natural zeolites are an intriguing alternative to peat moss and other natural materials utilized in the industrial manufacture of substrates. Natural zeolites have also been frequently used to improve soil qualities. Zeolites are used by farmers to control soil pH and improve ammonium uptake (Dwyer & Dyer 1984; Bernier *et al.* 1995).

In summary, the addition of zeolux to clay enhanced the agronomic features of plants cultivated in the soil and a mixture of (25 % zeolux: 75 % clay) has the best benefits. Irrigation with FBWW has a good influence and positive impact on plant development in general because of the increased water availability and soil richness. In conclusion, when Filtered Backwashed water is used for irrigation, the agronomic characteristics of plants growing in soil improve, as seen in Figures 1-8. Plants responded positively and benefited the most when a mix of (25 % zeolux: 75 % clay) to soil irrigation for both waters was used Fresh and Filtered Backwash.

These findings are consistent with those reported for Brassica napus and Picea orientalism plants, which demonstrated an increase in yield and yield components because of zeolite addition to soil (Sing & Bhargava 1994; Ayan *et al.* 2005). The increase in yield and yield component may also be due to increased nitrogen availability and nitrogen leaching avoidance. The presence of zeolux had a greater influence on root dry weight than on shoot dry weight, resulting in a drop in shoot to root ratio as the proportion of zeolux in soil increased.

Figure 1-8 represents the shoot dry weight to root dry weight (RDW/SDW) ratio for various zeolux percentages in soil. Clayey soil with 25% zeolux and 75% clay generated the greatest RDW/SDW. As previously stated, a low shoot to root ratio indicates a stronger drought resistance capability (Bernier *et al.* 1995). In other words, the presence of 25% zeolux boosted the plant's drought resilience. In zeolux mixed soils, the effect of zeolux usage may be related to water and nutrient dynamics.

Table 4. Characteristics of the Filters Backwash water (FBWW). (Ministry of Water & Irrigation Water Authority)

Parameter	Average	Parameter	Average
pH	7.4	Total alkalinity (mg/l $CaCO_3$)	310
EC (µs /cm)	762	Phenol Alkalinity	0
TDS (mg/l)	472	Bicarbonate HCO_3 (mg/l $CaCO_3$)	378.2
TH (mg/l CaCO3)	375	Carbonate	0
Ca (mg/l)	96	Odor (TON)	0
Mg (mg/l)	32.4	Turbidity (NTU)	0.75
Cl (mg/l)	44.6	Iron (mg/l)	0.5
Ammonia NH_3 (ppm)	< 0.05	Sulfate SO_4 (mg/l)	81.6

Table 4 shows the characteristics of the filter backwash water (Ministry of Water & Irrigation Water Authority). The rise in observed vegetative parameters attained in this work may be attributed to the fact that irrigation with Filtered Backwashed water adds nutrients to the soil and boosts water uptake and crop nutritional components from the soil via roots.

Statistical investigation revealed that the kind of water has a substantial impact on plant development and yield (Table 5). Plant irrigation using FBWW has been shown to improve all yield components. Plant height, number of branches per plant, shoot fresh weight, shoot dry weight, and root dry weight increased by 66 %, 79 %, 94 %, 95 %, and 85 %, respectively, when watered with Filters Backwash fluids (Table 5).

Table 5. Mean plant height (PH), number of branches per plant (NB), shoot fresh weight (SFW), shoot dry weight (SDW), root dry weight (RDW) and the ratio between shoot dry weight and root dry weight (SDW/RDW) of plant (Sage) under two types of water.

Type of water	Mean square					
	PH	NB	SFW	SDW	RDW	SDW/RDW
Fresh	43.05	19.2	67.3	20.36	6.16	3.40
Filters Backwash	14.4	4.05	3.43	0.98	0.25	4.03
LSD ($p \leq 0.05$)	2.08	1.22	2.59	0.76	0.24	0.39

Within columns, means followed by different letters suggest that the difference is significant at the 0.05 probability using LSD test. When Filtered Backwashed water is utilized for irrigation water reacted favorably to soil irrigation and almost all the agronomic features of plants growing in the soil increase at all mixtures of zeolux with clayey soil as indicated in Table 6.

Table 6. Effect of filter backwash water

Effect of water												
Irrigation Water (W)	Soil mixture (%clay: %zeolux) (S)	R	EV evapo Trans piration	T	SFW shoot fresh weight	SDW shoot dry weight	RDW root dry weight	H plant height	NB: Number of branches	NL number of leaves	RWC Relative water content	RDW/SDW
Fresh Water (1)	100% clay: 0% zeolux (S1)	W1S1										
Backwash Water (2)	100% clay: 0% zeolux (S1)	W2S1	6.62	7.00	2.28	1.36	1.45	1.85	4.76	6.67	3.45	-0.97
Fresh Water (1)	75% clay: 25% zeolux (S2)	W1S2										
Backwash Water (2)	75% clay: 25% zeolux (S2)	W2S2	2.99	14.34	0.65	1.65	0.29	0.48	5.88	0.72	2.70	-0.94
Fresh Water (1)	50% clay: 50% zeolux (S3)	W1S3										
Backwash Water (2)	50% clay: 50% zeolux (S3)	W2S3	-0.17	6.19	4.00	8.41	0.33	3.14	4.35	5.04	14.46	-7.66

4. Results

When Filtered Backwashed water is applied for irrigation, the results reveal that there is an improvement in the agronomic features of plants produced in the soil. Plants watered with Filtered Backwashed water reacted favorably to soil irrigation and have the most beneficial benefits when a mix of (25 % zeolux: 75 % clay).

The addition of zeolux to clay enhanced the yield and agronomic characteristics of soil-grown plants. Plants watered with fresh water responded strongly to zeolux addition to soil, and a mix of the two has the best benefits (25 %zeolux: 75 %clay).

Conclusions

When Filtered Backwashed water is utilized for irrigation water reacted favorably to soil irrigation and almost all the agronomic features of plants growing in the soil increase at all mixtures of zeolux with clayey soil.

The addition of zeolux to clay improves the yield and agronomic features of plants cultivated in the soil when fresh water was utilized for irrigation. Plants watered with fresh water made a significant contribution to zeolux addition to soil, and a mixture has the best benefits of (25 %zeolux: 75 %clay).

As the amount of zeolux in the soil increases up to 25%, the shoot dry weight to root dry weight ratio improves, suggesting that the plant is more drought resistant.

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