Significant savings in irrigation water by adding fuel from livestock wastes to the agricultural land

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Innovative description

For many years, the fuel is used in rural areas, which comes from animal waste residues (cattle and sheep). This fuel is used in furnaces, baking ovens, heaters, etc. to provide heat energy. The ashes which produced from burning of this material is mainly consist of silica compound, which is called "Koul" (in local language), and has structural differences with charcoal ash. This fuel is still used in many cities and villages of the country (Zanjan, Isfahan, Hamedan, Tabriz, Arak, etc.) as well as other countries such as Turkey. We discover that on this type of ash no studies have done so far, so we decided to do research on this type of ash and find scientific reasons for using it. This project was investigated in Ghani Beigloo Village, Zanjanrood Department of Zanjan, in 3 blocks and 12 plots. The area of each plot is 2.25 square meters. The amount of treatments was selected based on the most effective amount proposed in the sources.

figure 1. Blocks and Plots

In three types of Clay-Loam, Sandy-Loam and Clay soil texture, we add three treatments weighing 10,20,30 tons of ash per hectare to the soil area of Clay Loam texture and tested the percentage of moisture content, the average rate of water penetration in soil and water basic penetration rate, and took a sample as a witness. At first, a soil sample was taken from a depth of 0-30 cm and Soil texture was determined according to the standard hydrometric method - ASTM D422-63. Then, the percentage moisture content of each plot was calculated based on the standard moisture content determination test, AASHTO-T73-293, ASTM D2216-71and finally the resulting data have been analyzed.

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Determining the percentage of moisture content:

The purpose of measuring the percentage of soil moisture content is to determine the exact time to irrigate plants according to the plant's water requirement.

Table 1. Percentage of moisture content according to the tests

Ash			Witness	Treatment type
ton 30	ton 20	ton 10		Soil type
7.49	8.77	8.07	6.11	Clay Loam
7.25	5.71	4.68	4.3	Sandy Loam
9.88	8.37	8.23	7.5	Clay

According to the results of the above table, the treatment of 20 tons per hectare of ash in Clay Loam soil had the highest effect compared to the control sample and treatment of 30 tons of ash per hectare compared to the other two treatments reduced the percentage of moisture content weighted. We discovered Sandy Loam soil with 30 tons' ash per hectare had the highest increase in moisture content compared to the control sample and had no significant effect on the treatment of 10 tons. In all three treatments in clay soil (10 tons, 20 tons and 30 tons of ash) we noticed an increase in moisture content in weight percent compared to the control sample. Among the treatments, the treatment of 20 tons of ash in Clay Loam tissue was 8.77 percent, Sandy Loam texture of 30 tons of ash treatment was equal to 7.25% and in the clay texture of 30 tons of ash, 9.88% have the highest percentage of moisture content.

The overall result of this test shows the positive effect of ash on water retention.

To measure the infiltration, we used the instructions of measuring water penetration rate in in double ring field method from Iran's water industry standard (1981- A-84). Based on this Instructions, two cylinders with a diameter of 30 and 60 cm and a height of 30 cm in form of concentric were hammered Inside the plot and the permeability was measured with accuracy.

Figure 2. Measuring infiltration by double ring method.

In order to estimate the amount of water penetration into the soil and determine how to change it over time, in different soils and in different climatic and environmental conditions, it is necessary to use some special mathematical models or equations. For this purpose, the Lewis-Kostiakov equation which had experimental basis was applied. This equation obtains satisfactory results for short periods of time. For a short time, means about a few hours. Therefore, Therefore, this equation is widely used in designing irrigation systems and determining irrigation intervals.

Determination of the average penetration rate of water in soil

In the experiments conducted on different treatments, the average penetration rate of water to soil was studied, the data obtained are as follows:

Table 2. Average penetration rate (cm / h)

Ash			witness	Treatment type
ton 30	ton 20	ton 10		Soil type
1.02	1.68	1.22	1.19	Clay Loam
1.91	1.60	1.73	1.83	Sandy Loam
1.26	2.36	1.032	0.904	Clay

The results showed that 10 tons per hectare of ash had no effect on Loam Clay soil, but 20 tons per hectare increased the permeability, which shows the positive effect of this kind of Ash. In the treatment of 30 tons, the average penetration rate of water to soil have been reduced, the reason for this can be attributed to the loss of effective porosity of soil. Also, the effect of Koul on Loam Sandy soil was a decrease in permeability at 10 and 20 tons per hectare, while 30 tons per hectare had a positive effect on this parameter and increased the average permeation velocity. In Clay soil, as the ash increases, the average permeability rate increases, but the process is stopped at 30 tons per hectare.

Water penetration rate in the soil

Table 3. The rate of penetration of the water in the soil

Ash			witness	Treatment type
ton 30	ton 20	ton 10		Soil type
0.002	0.017	0.004	0.003	Clay Loam
0.010	0.007	0.014	0.013	Sandy Loam
0.003	0.03	0.004	0.002	Clay

As can be seen from the table compared to the control treatment, in Clay Loam soil, Water penetration rate of soil was increased in treatments of 10 and 20 tons of ash per hectare but in the treatment of 30 tons per hectare, the penetration has decreased due to the reduction of effective porosity of soil. In Loam Sandy soil, Koul had a little effect in the treatment of 10 tons per hectare and shows decrease of penetration rate in 20 and 30 tons of ash per hectare.

How to save water through this innovation

Since the dominant soil texture in region is Loamy-clay and the treatment of 20 tons per hectare has the greatest effect on increasing the moisture content and has a positive effect on increasing the penetration rate of water in the soil, we mixed this material with soil in a one-hectare apple garden

The length of the apple growth period and its pure water requirement in the studied area was extracted from NETWAT program, which is equal to 175 days and 10460 cubic meters. Also, 30 to 50 mm (for initial irrigation) is added to the pure irrigation requirement due to soil conditions and farming type.

Average irrigation interval in the region is every 6 days and during the growth period, in the region farmers use 12500 cubic meters' water to irrigate one hectare of apple gardens in gravity method. IN other words, each irrigation cycle consumes 431 cubic meters of water.

We changed the irrigation interval from 6 to 8 days by adding 20 tons of Koul (ash) to soil, and eventually we eliminated 8 times of irrigation from irrigation plan. In fact, according to the conditions of the area and the irrigation method, we released the same amount of 431 cubic meters from the pool at each irrigation interval and by eliminating eight periods of irrigation during a period of growth, we were able to consume about 3448 cubic meters of water per hectare in apple garden. At the end of the period, we also saw an increase in yield, due to increase in irrigation efficiency.

Description of how innovation began and developed

Due the trips of Mr. AmirAli Fattahi to his father's village in Zanjan, he knew that the villagers used livestock's to warm their houses and for cooking. He knew many years ago some villagers, were using this ash in their agricultural land and mixed it with agricultural soil without knowing the scientific reason of their work. So he decided find its scientific reason by doing some experiments. And if effective results obtained, use its results to solve drought-related problem and decrease immigration due to drought and water scarcity.

Explain the scope for further development of innovation

Considering the critical situation of drought and migration in Iran and taking into account the positive results and the beneficial effect of Koul on increasing the moisture content and water penetration rate, this material can be used on a large scale in the agricultural sector.
In next phase we are going to add Koul in alfalfa, wheat, barley and other products to find out the effective treatment. We will also test the blending of ash with manure mix.

In the greenhouse cultivation phase, Koul can be used and tested for different treatments and crops. It is also possible to use it in rain-feed cultivation, because by increasing soil water maintenance increases water productivity and increases product performance. The use of this method is very cost-effective and will be very beneficial for farmers and drought-affected areas.
According to the results of the last national census in 2016, the rural population is about 20 million and the total number of villages in Iran is about 62 thousand, the total number of rural households in 2016 is about 6 million and 70 thousand people. According to statistics, two thirds of the villages are located in areas with temperatures below 5 ° C with an average of 5 months a year. If every day from every 10 rural households, only in one household at least 2 kg of Cole is produced, during 150 days, 1214109.399 tons of ash is produced in Iran.

The total area under cultivation of horticultural and crops products in Zanjan province is about 186,000 hectares, which consumes 1.5 billion cubic meters of water each year. If according to the conditions of access to the Koul, soil texture and the condition of the area we succeed to reduce about 10%, of this volume, we can save 150 million cubic meters of water annually in the agricultural sector of the province.

Advantages

By using this method in an apple garden with an area of one hectare, we managed to save 27% of water consumption in a growing period.
- The use of this type of ash in agricultural fields is very cheap.
- Due to the water, soil and drought crisis in many parts of the world, this method can be easily used.
- the possibility of developing agriculture without need to increase harvesting of water resources
- Significant increase in irrigation efficiency and crop yield
- Increase in water storage capacity, especially in sandy soils
- Reduced adhesion, increased ventilation and permeability in clay soils
- Reducing bulk density and increasing porosity of the soil
- Improve the soil structure and increase water permeability in the soil

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