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The Economic Evaluation of Irrigation System, Plant Density and Potassium Silicate Spraying in Net Profits from Tomato Production

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ABSTRACT

Factorial experiment was carried out to study the effect of irrigation systems, planting density and potassium silicate spraying in growth and quality of tomato yield. The experiment included three factors, the first was represented type of drip irrigation systems (S) as follows: single line irrigation (S_1) and Double line irrigation (S_2). Second factor represented of planting densities that resulted from three spaces (D_1 (40 cm) (density: 12 plants); D_2 (50 cm) (density: 10 plants) and D_3 (60 cm) (density: 8 plants). Third factor was potassium silicate spraying by using three concentrations as follows: K_0 (control); K_1(treated of plant with 1 m l^{-1}) and K_2 (treated with 2 m l^{-1}). The experiment carried out by using factorial experiment within split-plot design, main plots were allocated to irrigation systems (S_1 and S_2), within main plots, used RCBD design and included 9 treatments (3D*3K). The results of the field experiment (Table 1) revealed that the treatment $S_1D_3K_2$ (used single irrigation system with planting of tomato at a distance of 60 cm and treated of tomato by potassium silicate at a concentration of $2ml^{-1}$) had a superiority in production of plant (3.3300 kg) and experimental unit (26.613 kg).The results of financial analysis (Table 5) showed that the same treatment ($S_1D_3K_2$) produced superiority in plant revenue (2497.50ID)and plant profit (1397.61ID) and profits of the experimental unit(11180.88 ID).

KEYWORDS: Horticulture Crops, Distances of Tomato, Foliar application

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INTRODUCTION

Before implementing any agricultural production project, there must be a comprehensive studying that ensures the achievement of a set of goals in the fields of economy and society, the most important of which is a study to evaluate the economic feasibility[1].In recently years some problems in the agricultural soilsuch as salinity and limitation of water resources in some of the countries; therefore the researchers and the producers began to the search for Modern farming methods are meteredand highly productive[2,3]. Because of environmental stress factors on the plants such as poor nutrition, loss of irrigation water and restriction of the soil diseases modern farming techniques have been used to production of the crops[4,5,6]. Tomato (*Solanumlycopersicum*L.) belongs to Solanaceae family[7,8] from 100 gender and 2500 species[9]. There was a decrease in arable areas due to drought, which caused a decline in water sources in Iraq [10,11,12]. The efforts of the producers focused on maintaining the tomato culture profitable, which can accomplished just by using modern technologies, which ensure earlier and superior yields that can be easily sold on the market at good prices[13.]There are methods and materials that can be used to improve production, such as the use of drip irrigation systems [14,15].Protective materials can helps the crop from the environmental stresses and improve growth and production, such as shading materials such as sun proof[16,17].Studies have shown that controlling plant density had a direct effects on the yield[18,19,20]. The financial analysis of agricultural projects is one of the basic items for studying and evaluating the initial feasibility of the agricultural investment project, which includes preparing tables of cash flows in and out of the project and then net profits and obtaining a scientific, statistical conclusion that supports the result of the economic evaluation [21].The economic feasibility report for any agricultural project includes the financial analysis of the fixed and variable investment costs, and then the financial analysis of the cash flows coming out of the project, which includes the total cash revenues, as well as the estimate of net profits, which is calculated by subtracting the total fixed and variable costs from the value of the total cash revenues from sales.From the above, the study aimed to conduct a financial analysis of the field experiment items and evaluation the economic feasibility of the methods of using the drip irrigation systems and planting density when used in tomato cultivation, as well as foliar spraying with potassium silicate in tomato production.

MATERIALS AND METHODS

The experiment carried out in College of Agricultural Engineering Sciences/ University of Baghdad during the spring season of 2023 to study the effects of irrigation systems (single row and double row systems), planting spaces (plant density), and spraying with potassium silicate on the productivity of tomato (S_{25}). This experiment included three factors: the type of drip irrigation systems (S_1: single row drip irrigation and S_2: double row drip irrigation), tomato planting densities (D_1: 40 cm spacing with 12 plants per experimental unit, D_2: 50 cm spacing with 10 plants per experimental unit, and D_3: 60 cm spacing with 8 plants per experimental unit), and spraying of tomato plants with potassium silicate (K_0: control, K_1: spraying with 1 ml l^{-1} concentration, and K_2: spraying with 2 ml l^{-1} concentration). The experiment was carried out by using factorial experiment within a split-plot design. Main plots consisted agricultural irrigation systems: single drip irrigation lines (S_1) and double drip irrigation lines (S_2). Within each main plot, a factorial experiment carried out using a randomized complete block design (RCBD) that included nine treatments. These treatments involved the interaction between three planting densities (D_1, D_2, and D_3) and three potassium silicate spraying levels (K_0, K_1, and K_2), Then resulted 18 treatments and 48 experimental units. Analyzed the experimental data and determine significant differences using the LSD test at a 0.05 probability level[22].

Measurements of TheExperimentand FieldOperations

1. Dimensionsof the experimental unit: 1 m x 2.5 m for both the single irrigation system (S_1) and double irrigation system (S_2).
2. Both systems included two cultivation lines within the experimental units as below:
3. Single irrigation line system (S_1) loaded with two tomato planting lines (one line to one side), while the distance between the planting lines was 20 cm.
4. Double irrigation line system (S_2) loaded with two tomato planting lines (one planting line to oneline irrigation), while the distance between the planting lines it was 40 cm.
5. Drip irrigation system consisted drip spaces of 20 cm and drainage rate of 2.6 l h^{-1}.
6. Calculated the water consumption for each plant based on the type of drip irrigation system with planting densities, these calculations are important to estimating the costs of water consumption when evaluating the feasibility of the project, as well as estimating the water using efficiency.
7. Tomato seedlings were planted alternately on both sides of the irrigation line, with planting distances according to the planting density under study (D).
8. Fertilization: Nutrition of tomato plants given with drip irrigation water (Fertigation, 1g $plant^{-1}$), by using a commercial fertilizer Altrasol (20-20-20).

Stage of FinancialAnalysis of TheProject

The results of the plant yield and the yield of the experimental unit were used to prepare the economic evaluation study for the project, which is shown in Table 1. The amount of 750 Iraqi dinars adopted as the average price of a kilogram of tomatoes in local markets to calculate the plant's financial revenue.

1- Preparing a fixed costs schedule: It includes the following

a) Investment capital costs
b) Annual extinction premium costs for investment items
c) The cost of renting the land
d) The interest rate on investment capital

2- Prepare a table of variable costs, including:

a) Prepare a cost schedule for the total production requirements associated with implementing the experiment
b) Preparing a wage schedule for the agricultural operations.

3- Prepare a financial analysis table to calculate total costs, revenues, and net profits according to the experiment's requirements.

Table: 1effect of the treatment onthe tomatoproduction. (LSD: 0.2685).

Treatments combination	**Kg Plant^{-1}**	**Kg experimental unit^{-1}**	**Treatments combination**	**Kg Plant^{-1}**	**Kg experimental unit^{-1}**
$S_1D_1K_0$	2.4233	29.080	$S_2D_1K_0$	2.0433	24.520
$S_1D_1K_1$	2.5367	30.440	$S_2D_1K_1$	2.2600	27.107
$S_1D_1K_2$	2.2567	27.093	$S_2D_1K_2$	2.2067	26.480
$S_1D_2K_0$	2.6633	26.633	$S_2D_2K_0$	2.5633	25.633
$S_1D_2K_1$	2.4633	24.633	$S_2D_2K_1$	2.8067	28.050
$S_1D_2K_2$	2.3767	23.767	$S_2D_2K_2$	2.3333	23.333
$S_1D_3K_0$	3.0200	24.160	$S_2D_3K_0$	2.7000	21.560
$S_1D_3K_1$	2.9867	23.893	$S_2D_3K_1$	2.9633	23.707
$S_1D_3K_2$	3.3300	26.613	$S_2D_3K_2$	2.6400	21.093

S_1=single drip irrigation system, S_2=double drip irrigation system; D_1 = planting distance 40 cm (density: 12 plants), D_2 = planting distance 50 cm (density: 10 plants), D_3 = planting distance 60 cm (density: 8 plants); K_0 = Control, K_1 = spraying at a concentration of 1 ml l^{-1}, K_2 = spraying at a concentration of 2 ml l^{-1}.

RESULTS AND DISCUSSION

Financial Analysis of Agricultural Projects: Is one of the basic items for assessing their initial feasibility, which includes tables of cash inflows and outflows from the project and tables of financial analysis to extract net profits and determine the appropriate evaluative decision.The financial analysis of the system according to requirements of the experiment as follows:

Fixed Costs: It includes the items of the investment capital costs for one greenhouse (6,342000 I D) and the annual depreciation premium for the items of the experiment implementation (909125ID), as well as other costs such as the rent of the land and the interest rate on the capital.In shorting, after conducting the financial analysis, it was found that the share of the main plant in the experiment (tomato) from the fixed costs was 900 Iraqi dinars as shown in Table 3.

Table: 2 fixed cost (plant) for the experiment (Iraqi dinar).

Fixed costs:	Land rent	interest on Capital	Annual extinction	Sum of the fixed costs
Cost of plant	6.945.83173.61	186.39		

***Annual depreciation premium for project items = cost of the investment item / expected useful life in year.**

Variable costs: Include both agricultural operations and production requirements costs which used in the experiment (Tables 3 and 4).

Table: 3 costs of agricultural operations that carried out in the experiment.

Treatments combinations	Transplant	Spraying Potassium Silicate	Spraying insecticides	Picking fruits	employment Irrigation system	Clearing bushes	Total amount (plant)
$S_1D_1K_0$	69.44	-	34.72	138.89	173.61	104.17	520.83
$S_1D_1K_1$	69.44	104.16	34.72	138.89	173.61	104.17	624.99
$S_1D_1K_2$	69.44	104.16	34.72	138.89	173.61	104.17	624.99
$S_1D_2K_0$	69.44	-	34.72	138.89	173.61	104.17	520.83
$S_1D_2K_1$	69.44	104.16	34.72	138.89	173.61	104.17	624.99
$S_1D_2K_2$	69.44	104.16	34.72	138.89	173.61	104.17	624.99
$S_1D_3K_0$	69.44	-	34.72	138.89	173.61	104.17	520.83
$S_1D_3K_1$	69.44	104.16	34.72	138.89	173.61	104.17	624.99
$S_1D_3K_2$	69.44	104.16	34.72	138.89	173.61	104.17	624.99
$S_2D_1K_0$	69.44	-	34.72	138.89	173.61	104.17	520.83
$S_2D_1K_1$	69.44	104.16	34.72	138.89	173.61	104.17	624.99
$S_2D_1K_2$	69.44	104.16	34.72	138.89	173.61	104.17	624.99
$S_2D_2K_0$	69.44	-	34.72	138.89	173.61	104.17	520.83

$S_2D_2K_1$	69.44	104.16	34.72	138.89	173.61	104.17	624.99
$S_2D_2K_2$	69.44	104.16	34.72	138.89	173.61	104.17	624.99
$S_2D_3K_0$	69.44	-	34.72	138.89	173.61	104.17	520.83
$S_2D_3K_1$	69.44	104.16	34.72	138.89	173.61	104.17	624.99
$S_2D_3K_2$	69.44	104.16	34.72	138.89	173.61	104.17	624.99

Table: 4. costs of the production requirements

Treatments combinations	**Seedling of tomato S_{25}**	**Compound fertilizer NPK 20-20-20**	**Soluble fertilizer NPK 20-20-20**	**Potassium silicate**	**Drip irrigation system**	**Insecticide**	**Total labor wages (plant)**	**Other costs**	**Total variable costs**
$S_1D_1K_0$	55.56	27.78	34.72	-	31.56	41.67	520.83	13.89	727.01
$S_1D_1K_1$	55.56	27.78	34.72	41.67	31.56	41.67	624.99	13.89	871.84
$S_1D_1K_2$	55.56	27.78	34.72	83.34	31.56	41.67	624.99	13.89	913.51
$S_1D_2K_0$	55.56	27.78	34.72	-	31.56	41.67	520.83	13.89	727.01
$S_1D_2K_1$	55.56	27.78	34.72	41.67	31.56	41.67	624.99	13.89	871.84
$S_1D_2K_2$	55.56	27.78	34.72	83,34	31.56	41.67	624.99	13.89	913.51
$S_1D_3K_0$	55.56	27.78	34.72	-	31.56	41.67	520.83	13.89	727.01
$S_1D_3K_1$	55.56	27.78	34.72	41.67	31.56	41.67	624.99	13.89	871.84
$S_1D_3K_2$	55.56	27.78	34.72	83,34	31.56	41.67	624.99	13.89	913.51
$S_2D_1K_0$	55.56	27.78	34.72	-	62.50	41.67	520.83	13.89	727.01
$S_2D_1K_1$	55.56	27.78	34.72	41.67	62.50	41.67	624.99	13.89	871.84
$S_2D_1K_2$	55.56	27.78	34.72	83,34	62.50	41.67	624.99	13.89	913.51
$S_2D_2K_0$	55.56	27.78	34.72	-	62.50	41.67	520.83	13.89	727.01
$S_2D_2K_1$	55.56	27.78	34.72	41.67	62.50	41.67	624.99	13.89	871.84
$S_2D_2K_2$	55.56	27.78	34.72	83,34	62.50	41.67	624.99	13.89	913.51
$S_2D_3K_0$	55.56	27.78	34.72	-	62.50	41.67	520.83	13.89	727.01
$S_2D_3K_1$	55.56	27.78	34.72	41.67	62.50	41.67	624.99	13.89	871.84
$S_2D_3K_2$	55.56	27.78	34.72	83,34	62.50	41.67	624.99	13.89	913.51

Cash inflows, Outflows and Net Profit for The Experiment Treatments

The final stage of the financial analysis of the agricultural investment project or the experiments is to determine the economic feasibility value of the investment the project, This process was achieved by calculating the total costs of the project and extracting the cash flows for sales, and then the net profits of the project are calculated, which represents the value of the economic feasibility of the project according to the investment items (treatments combinations), which helps in determining the most profitable options within the items of the investment project.The results of the financial analysis of the experiment (Table 5), showed that planting tomatoes at planting distances of 60 cm, alternating around the axis of the irrigation line (density: 8 plants per experimental unit), produced the highest yield per plant, the highest revenue, and the highest net profits for the plant and the experimental unit.

Table: 5 Costs, revenues, and profits of tomato plant at an average price of 750 ID kg-1.

Treatments combinations	Fixed costs	variable costs	Total costs	Plant revenues	plant profits	Experimental unit profits *
S1D1K0	186.38	727.01	913.39	1817.25	903.86	10846.32
S1D1K1	186.38	871.84	1058.22	1902.75	844,53	10134.36
S1D1K2	186.38	913.51	1099.89	1692.525	592.635	7111.62
S1D2K0	186.38	727.01	913.39	1997.475	1084.085	10840.85
S1D2K1	186.38	871.84	1058.22	1847.475	789.255	7892.55
S1D2K2	186.38	913.51	1099.89	1782.525	682.635	6826.35
S1D3K0	186.38	727.01	913.39	2265.00	1351.61	10812.88
S1D3K1	186.38	871.84	1058.22	2240.025	1181.805	9454.44
S1D3K2	186.38	913.51	1099.89	2497.50	1397.61	11180.88
S2D1K0	186.38	727.01	913.39	1532.475	619.85	7438.2
S2D1K1	186.38	871.84	1058.22	1695.00	636.78	7641.36
S2D1K2	186.38	913.51	1099.89	1655.025	555.135	6661.62
S2D2K0	186.38	727.01	913.39	1922.475	1009.085	1090.85
S2D2K1	186.38	871.84	1058.22	2105.025	1046.805	10468.05
S2D2K2	186.38	913.51	1099.89	1749.975	650.085	6500.85
S2D3K0	186.38	727.01	913.39	2025.00	1111,61	8892.88
S2D3K1	186.38	871.84	1058.22	2222.475	1164.255	9314.04
S2D3K2	186.38	913.51	1099.89	1980.00	880.11	7040.88

* Net profits of the experimental unit = net profits of the plant profits number of plants within experimental unit (D) (D1= 12 plants, D2= 10 plants, D3= 8 plants).

CONCLUSION

We can conclude that using the intensive cultivation method (12 plants per experimental unit) was not economically feasible in achieving profits, in addition to using double-line irrigation was not economically feasible under the experimental conditions.

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