The Economic Evaluation of Crops Intercropping by Using Soilless Culture System

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Abstract.
Soilless culture systems are considered one of the modren technologies in horticultural crop production and this systems follows an intensive farming method with the aim of increasing production per unit area .The study aimed to evaluation the economic feasibility of the soilless culture system, and used intercropping method between tomato plants (main plant) with strawberry plants (sub plant) at the multiple planting densities. Main plots represented loading of tomato plants with strawberry plants and included tow caces: L_0(tomato only) and L_1(intercropped with strawberry plants (1:1) by using four replicates, within replicates, factorial experiment carried out according to RCBD design and consist of two factors as follows: planting distances (D_{30}cm and D_{40}cm) and foliar application by Biozyme (untreated B_0, treated with biozyme B_1). The results revealed that the treatment $D_{40}L_0B_1$ had superiority in plant yield (4.74kg.plant^{-1}), while the treatment combination $D_{30}L_0B_1$ had superiority in the productivity (23.75kg m^2). Financial analysis for the experiment showed in Table 5 Recorded the highest net profit reached 5327.2 dinar for the treatment combinations $D_{40}L_0B_1$, while the highest summation of total profit was 7061.4 recorded for the treatment combinations $D_{40}L_1B_0$. It was striking in the results of Table 5, and the treatment $D_{30}L_1B_1$ had lowest profit net when reached 1733.52 dinars, the reason is the lack of tomato yield within a distance of 30 cm, as well strawberry plant, which could not reach the threshold of cultivation costs in the financial return.

Keywords: hydroponics; growth media; protected farming; intercropping; tomato; strawberry .

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Introduction

There are major problems that have begun to appear in recent decades, and they have become obstacles to agricultural development, Among these obstacles is the decrease in the areas of soil suitable for agriculture due to the high level of salinity and the limited water resources in some countries that resulted from climatic changes (10; 12) this conditions will be negatively effects on the quantity and quality of horticulture crops production especially that water sources in Iraq have faced many threats (5; 4). therefore, modern farming techniques have been used to production of the crops (7; 16) as well Modern techniques of the drip irrigation will be reduce water loss (3). Soilless culture systems represented one of the Modern techniques that may constitute a solution to confront water scarcity and the deterioration of agricultural soils, as well as high productivity (15; 13; 6). The production of horticultural crops within greenhouses depended on the used of intensive farming methods with rationing of production requirements through the adoption of modern production techniques. (18). Determining the planting distances and the number of the plants per meter depends on the plant growth and management of plants growth. Current producers' priorities include using modern technologies in conjunction with integrated production management to ensure the maintenance of good net profits. (11;19). The significant difference in the size of the foliage between tomatoes and strawberries is an important factor in using both plants in soilless production techniques, known as intercropping.(14). Previous studies have emphasized the importance of providing a set of tools when implementing agricultural projects, including preparing an economic evaluation study to ensure the achievement of the project's economic objectives. (15). 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 the conclusion about the economic evaluation (17 and 15) Therefore, The aim of this study to improve the productivity and conducting a financial analysis of investment items and production requirements associated with experiment factors in order to assess the economic feasibility of the project.

Materials and Methods

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The experiment carried out in the plastic house belonging to college of Agriculture / University of Diyala and cooperation with the College of Agricultural Engineering Sciences / University of Baghdad. The study aimed to improving production and conducting a financial analysis and economic evaluation of the project. The field experiment included intercropping of tomato planting by used two distances ($D_{30\ CM}$ and $D_{40\ CM}$), with strawberry plants (L_0: without straw berry and L_1: straw berry when planting below of tomato); Second factor included foliar application by Biozyme with tow treats: B_0 (control) and B_1(0.5mg l^{-1}) .The experiment carried out according to factorial experiment within split plot design, then the treatment combination shown as follows: $D_{30}L_0B_1$, $D_{30}L_0B_0$, $D_{40}L_0B_1$, $D_{40}L_0B_0$, $D_{30}L_1B_1$, $D_{30}L_1B_0$, $D_{40}L_1B_1$, $D_{40}L_1B_0$. (14).

Field operations and production requirements:

Using of plastic house to implementation the experiment and the production requirements shown as follows:

1- planter tables were used for the ring culture system. the greenhouse consist of 5 planters, all ones of planter table included 50 m^2.

2- within one meter, planting tables includes six rings culture dedicated to tomato growth

When using a distance of 30 cm (D_{30}) and six strawberry plants were planted between the ring in the case of intercropping (L_1) , while a distance of 40 cm (D^{40}) included four rings culture dedicated to tomato growth, as well as four strawberry plants.

3- growth medium in ring culture was mixed medium (pearlite + peat moss (1:1).

4-Used drip irrigation system type Spaghetti in the culture system.

5- Used commercial nutrient solution to nutrition of plants.

6- using Biozyme (B_1) to foliar application.

7-The tomato seedlings were transplanted to greenhouse in the ring culture.

8- Strawberry planting between the rings. (1:1).

The outcome results of the experiment carried out by (14) were adopted in conducting the financial analysis process for the economic evaluation of the project, that are shown in Table 1.

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Table 1. production of tomato plant (kg) and strawberry (g) (Obaid et al,.2022).

Treatments combinations	Type of plant	Yield of plant	Production of M^2	Treatments combinations	Type of plant	Yield of plant	Production of M^2
$D_{30}L_0B_0$	Tomato	3.79	23.10	$D_{40}L_0B_0$	Tomato	4.72	18.88
	Strawberry	0.00	0.00		Strawberry	0.00	0.00
$D_{30}L_0B_1$	Tomato	3.80	23.75	$D_{40}L_0B_1$	Tomato	4.74	18.96
	Strawberry	0.00	0.00		Strawberry	0.00	0.00
$D_{30}L_1B_0$	Tomato	3.70	22.17	$D_{40}L_1B_0$	Tomato	4.67	18.96
	Strawberry	212.09	1273		Strawberry	400.86	1603
$D_{30}L_1B_1$	Tomato	3.73	22.40	$D_{40}L_1B_1$	Tomato	4.71	18.85
	Strawberry	269.70	1618		Strawberry	416.24	1665

Fixed costs: 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

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experiment (tomato) from the fixed costs was 900 Iraqi dinars as shown in Table 2.

Table 2. Fixed cost items for the experiment (Iraqi dinar).

Fixed costs items:	**Land rent**	**Capital interest**	**Annual extinction**	**Summation of the fixed costs**
Cost for the plant:	8.67	367	525.51	900

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

Variable costs:

These are variable annual costs that included costs of agricultural operations wages (Table 3) and the costs of production requirements associated with field experiment factors (Table 4).

Table 3. Costs of agricultural operations according to treatments combinations (Iraqi dinar).

Treatments combinations	**Type of plant**	**Transplant cost**	**Spraying biozyme cost**	**Pruning cost**	**Spraying Pesticide cost**	**Picking fruits cost**	**operation of the system**	**Total costs of plant**
$D_{30}L_0B_0$	**Tomato**	**17.34**	**0.00**	**43.35**	**5.78**	**72.25**	**86.71**	**225.43**
	Strawberry	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
$D_{30}L_0B_1$	**Tomato**	**17.34**	**5.78**	**43.35**	**5.78**	**72.25**	**86.71**	**231.21**
	Strawberry	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
$D_{30}L_1B_0$	**Tomato**	**17.34**	**0.00**	**43.35**	**5.78**	**72.25**	**86.71**	**225.43**
	Strawberry	**17.34**	**0.00**	**0.00**	**5.78**	**72.25**	**86.71**	**182.08**
$D_{30}L_1B_1$	**Tomato**	**17.34**	**5.78**	**43.35**	**5.78**	**72.25**	**86.71**	**231.21**
	Strawberry	**17.34**	**5.78**	**0.00**	**5.78**	**72.25**	**86.71**	**187.86**
$D_{40}L_0B_0$	**Tomato**	**17.34**	**0.00**	**43.35**	**5.78**	**72.25**	**86.71**	**225.43**

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	Strawberry	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
$D_{40}L_0B_1$	**Tomato**	**17.34**	**5.78**	**43.35**	**5.78**	**72.25**	**86.71**	**231.21**
	Strawberry	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
$D_{40}L_1B_0$	**Tomato**	**17.34**	**0.00**	**43.35**	**5.78**	**72.25**	**86.71**	**225.43**
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	Strawberry	**17.34**	**5.78**	**0.00**	**5.78**	**72.25**	**86.71**	**187.86**

In order to assess the economic feasibility of this experiment, a financial analysis of the cash flows associated with the investment items of the experiment (fixed and variable costs, plant revenues, net profit for the plant and net profit in the square meter according to the culture system that used in the experiment (soilless culture).

Results and Discussion:

Economic evaluation of the experiment.

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 in table 4.

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Table4. Costs of production requirements for the experiment and total variable costs (Iraqi dinar).

Treatments combinations	Type of plant	seedling cost	Growth medium cost	Commercial solution cost	biozyme cost	Acramite Exterminator cost	Total costs of the plant	Summation of variable costs
$D_{30}L_0B_0$	Tomato	250	1500	475	0.00	37.57	2262.5	2488.0
	Strawberry	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$D_{30}L_0B_1$	Tomato	250	1500	475	14.45	37.57	2277.0	2508.21
	Strawberry	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$D_{30}L_1B_0$	Tomato	250	1500	475	0.00	37.57	2262.57	2488.0
	Strawberry	500	0.00	0.00	0.00	37.57	537.57	719.65
$D_{30}L_1B_1$	Tomato	250	1500	475	14.45	37.57	2277.0	2508.23
	Strawberry	500	0.00	0.00	14.45	37.57	552.02	739.88
$D_{40}L_0B_0$	Tomato	250	1500	475	0.00	37.57	2262.57	2488.0
	Strawberry	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$D_{40}L_0B_1$	Tomato	250	1500	475	14.45	37.57	2277.0	2508.23
	Strawberry	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$D_{40}L_1B_0$	Tomato	250	1500	475	0.00	37.57	2262.57	2488.0
	Strawberry	500	0.00	0.00	0.00	37.57	537.57	719.65

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$D_{40}L_1B_1$	Tomato	250	1500	475	14.45	37.57	2277.0	2508.23
	Strawberry	500	0.00	0.00	14.45	37.57	552.02	739.88

***the medium and solution it was carried out according to requirements of tomato growth only.**

Cash inflows, outflows and net profit for the experiment treatments:

The results of the financial analysis for the experiment that shown in Table 5 Recording the highest net profit reached 5327.2 dinar for the treatment combinations $D_{40}L_0B_1$ when tomato planting at distances of 40 cm without overlapping the culture system and foliar application by biozyme,

Table 5. Costs, revenues and net profits of plants and M^2 using soilless culture (Iraqi dinar).

Treatments combinations	Type of plant	Fixed costs **	Variable costs	Total costs	Revenue of plant *	Profit net of plant	Profit net of M^2	Sum total Profit
$D_{30}L_0B_0$	Tomato	900	2488.0	3388.0	3790	402	2412	2412
	Strawberry	0.00	0.00	0.00	0.00	0.00	0.00	
$D_{30}L_0B_1$	Tomato	900	2508.21	3408.21	3800	391.8	2350.8	2350.8
	Strawberry	0.00	0.00	0.00	0.00	0.00	0.00	
$D_{30}L_1B_0$	Tomato	900	2488.0	3388.0	3700	312	1872	1788.35
	Strawberry	0.00	719.65	719.65	636	-83.65	-501.9	
$D_{30}L_1B_1$	Tomato	900	2508.21	3408.21	3730	221.8	1330.8	1733.52
	Strawberry	0.00	739.88	739.88	807	67.12	402.72	
$D_{40}L_0B_0$	Tomato	900	2488.0	3388.0	4720	1332	5328	5328.0
	Strawberry	0.00	0.00	0.00	0.00	0.00	0.00	
$D_{40}L_0B_1$	Tomato	900	2508.23	3408.23	4740	1331.8	5327.2	5327.2
	Strawberry	0.00	0.00	0.00	0.00	0.00	0.00	
$D_{40}L_1B_0$	Tomato	900	2488.0	33.88.0	4670	1282	5128	7061.4
	Strawberry	0.00	719.65	719.65	1203	483.35	1933.4	
$D_{40}L_1B_1$	Tomato	900	2508.23	925.23	4710	1301.8	5207.2	5439.68
	Strawberry	0.00	739.88	739.88	1248	508.12	2032.48	

** **The fixed costs for this system Intended for the main plant only (tomato).**

*** Revenue Of plant: yield of plant (kg) * 1000 ID for 1kg.**

while the highest summation of total profit was 7061.4 recorded for the treatment combination D40L1B0. It was striking in the results of Table 5,

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that the treatment D30L1B1 had the lowest profit net when reached 1733.52 dinars, the reason is the lack of tomato yield within a distance of 30 cm, as well as the strawberry plant, which could not reach the threshold of cultivation costs in the financial return.

Conclusion:

Planting of tomato at a distance 40 cm by using ring culture (soilless) had a significantly superiority in the yield and the profit for each of tomato plants (main plant) and the strawberry plant (sub plant), and we concluded that the planting distance of 40 cm was the best for producing tomatoes and strawberries using intercropping culture system.

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References

-1

Alaa El-Den; G. M.Abd El-Wahab and S. A. Masoud.(2022). Using Salcylic Acid, Folic Acid and/or Mancozeb in Controlling Tomto Early Blight Biotic Stress and Thier Effect on Growth, Yield, Fruit Quality and Stress-related enzymes. Iraqi Journal of Agricultural Sciences, 53(6),1548- 1559. https://doi.org/10.36103/ijas.v53i6.1670

-2 Alwan. K. A.; A. W. Aljuboori.(2016). Perfomance Evalution of Field and Genitic for Some Sixth Radio Generation Mutants in Tomato.The jornal of Agriculture science,47(2), 506-510. https://doi.org/10.36103/ijas.v47i2.595

-3 Al-Dulaimy, S. E. and S. M. Al-Mhmdy.(2018). Performance Evaluation of Drip Irrigation System According to the Suggested Standards. Iraqi Journal of Agricultural Science, 49(6),1099-1109. https://doi.org/10.36103/ijas.v49i6.148

-4 Al-Lami A. A.A; A. S. Ati and S. S. Al-Rawi. (2023b). Determination of Water Consumpition of Potato under Irrigation System and Irrigation Intervals by Using Polymers and Bio-Fertilizers in Desert Soils. Iraqi Journal of Agricultural Sciences, 54(5),1351-1363. https://orcid.org/0009-0002-2565-2809

-5 Al-Lami; A. A.; S. S. Al-Rawi and A. S. Ati. (2023a). Evaluation of the Aquacrop Model Performance and the Impact of Future Climate Changes on Potato Production Under Different Soil Management Systems, Iraqi Journal of Agricultural Sciences, 54(1),253-267. https://doi.org/10.36103/ijas.v54i1.1698

-6 Bozo, T. T; Mpambani, B; Mbenga, A and Mhlontlo, S.2019. Comparative studies on yield and quality responce of soil and soilless grown tomates: the case study of masiphathisane community pruject and bathurst experimental farm.S. Afr. J. Agric. Ext.Vol. 47 No. 4: 75 – 85.

-7 Borji, H; Ghahsareh, A.M and Jafarpour, m. 2010. Effects of the Substrate on Tomato in Soilless Culture. Research Journal of Agriculture and Biological Sciences, 6(6): 923-927 .

-8 DU Plooy, CP; Maboko, MM and Van Den Heever. 2012. Research and technology transfer by Agricultural Research Council to sustain South African hydroponic industry. Acta Horticulturae 947: 147-151 .

-9 Dunn, B.2017.Pruning Hydro-ponic Crops, Division of Agricultural Sciences and Natural Resources, Technical report, Oklahoma State University, available at :https://www.researc- hgate.net .

-10 Gudmundsson L, Seneviratne SI, Zhang X .(2017). Anthropogenic Climate Change Detected in European Renewable Freshwater Resources.

Nature Climate Change, 7(11),813-816. https://www.nature.com/articles/nclimate3416

-11 Dysko, J; Szczech, M; Kaniszewski, S and Kowalczyk, W. 2020. Parameters of Drainage Waters Collected during Soilless Tomato Cultivation in Mineral and Organic Substrates. (PDF.(

-12 Jawad, T. K.; O. T. Al-Taai and Y. K. Al-Timimi. (2018). Evaluation of Drought in Iraq Using Dsi. by Remote Sensing. Iraqi Journal of Agricultural Sciences, 49(6), 0018-0041. https://doi.org/10.36103/ijas.v49i6.152

-13 Maboko,MM; DU Plooy, CP and Chiloane, S. 2017. Yield of determinate tomato cultivars grown in a closed hydroponic sys¬tem as affected by plant spacing. Horticultura Brasileira 35:258-264.

-14 Obaid,A.A; Khalil, N.H; Al-Alawy, H.H and Fahmi, A. H. (2022). Effect of Planting Density, Foliar Spraying and Overlapping System on the Growth and Productivity Using Soilless Culture System. Journal of the Saudi Society of Agricultural Sciences, 21, 506–510. https://doi.org/10.1016/j.jssas.2022.02.004

-15 Obaid, A. A. 2018.Effect of Nutrient Solution ,Substrates and Flowering management on growth and yield of Female Cucumber in Soilless Culture. Doctoral thesis, Department of Horticulture and Landscape Engineering, College of Agricultural Engineering Sciences, University of Baghdad, Baghdad, Iraq.

-16 Obaid, A.A. and K. Daley.2019. Effect of Nutrient Solution, Substrates and Lowering Management on Growth and Yield of Female Cucumber in Soilless Culture. Iraqi Journal of Agricultural Sciences ,1029, 50(1):175-184.

-17 Ponniah, A.2004. Agricultural Project Planning and Analysis: A Sourcebook Second edition Edited by P Anandajayasekeram CJ Van Rooyen F Liebenberg Emblems in the following order: UP University. https://www.researchgate.net/publication/267156522 .

-18 Raviv, M. and Heinrich Lieth J. 2008. Soilless Culture: Theory and Practice . Elsevier 84 Theobald's Road, London WC1X 8RR, UK.

-19 Salman, A. K and Ayad W.A.(2019). Determination of Gene Expression of Some Tomato Genotype Under Water Stress. Plant Archives, 19(2), 1199-1201