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Response of Tomatoes and Sunflower Intercropping to Organic and Mineral Fertilization

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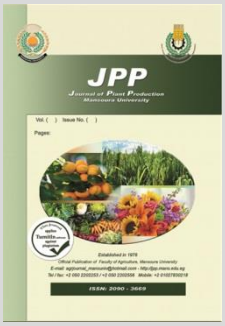

ABSTRACT

A field experiment was conducted at Etay El-Baroud Research Station, El Beheira Governorate, Agriculture Research Center (ARC), Giza, Egypt during 2023 and 2024 seasons to study the effect of intercropping 100% tomatoes + 43% sunflower and fertilization by 50% mineral, NPK + 50% farm-yard manure, FYM; 50% mineral, NPK + 50% poultry manure, PM; 75% mineral, NPK + 25% farm-yard manure, FYM; 75% mineral NPK + 25% poultry manure, PM; 25% mineral, NPK + 75% farm-yard manure, FYM; 25% mineral, NPK+ 75% poultry manure, PM; 100% mineral, NPK; 100% mineral NPK for sole tomatoes and 100% mineral, NPK for sole sunflower on yield, and its components of both crops. Randomized complete block Design (RCBD) with three replications was used. 100% tomatoes + 43% sunflower with 50% NPK + 50% FYM produced maximum fruit characters, fruit yield/ fed and marketable fruit yield/ fed of tomatoes in both seasons. Intercropping sunflower with tomatoes reduced of damaged tomato fruits was markedly affected by sun scorch to 4.12 and 4.45%, resulting in a 15.46 and 15.31% increase in marketable yield/ fed under average of seven fertilizer treatments compared with sole tomatoes in both seasons, respectively. Grown sunflower pure stand with 100% NPK resulted in the highest seed yield/ fed in both seasons. Intercropping 100%tomatoes + 43% sunflower which fertilized by 50% NPK + 50% FYM produced maximum LER, gross returns and net returns (1.66 and 1.66 LER, 86804.23 and 109299.48 L.E. as well as 59960.91 and 77111.98 L.E./ fed) in both seasons, respectively.

Keywords: Intercropping, Tomatoes, Sunflower, Fertilizers, LER.

INTRODUCTION

Tomatoes (*Solanum lycopersium, Mill)* are considered one of the most important vegetable crops grown in Egypt, with an annual consumption rate of about 9.8 million tons. The average production per fed in Egypt is 17 tons. The area of tomatoes in Egypt in 2023 reached 365,000 fed distributed over agricultural periods during the year, to 125,000 fed in the winter season, 210,000 fed in the summer season, and 30,000 fed in the fall season (Bulletin of the Agricultural Statistics 2023). In Egypt, the tomatoes market runs from open filed planting in May until August. During this period, temperatures might rise above 35°C in the field. The summer sun is scorching and dehydrating, leading to either irregular growth or decline in tomatoes fruit yield, or even completes failure of tomatoes cropping in a large portion of the planted region (Pressman *et al.*, 2002). Saeed *et al.* (2007) found that high temperatures led to an increase in flower drop and a reduction in fruit set, which led to a severe decrease in fruit yield. Therefore, providing natural protection for tomatoes fruits by planting them with sunflower *(Helianthus annus L.)*.

Sunflower *(Helianthus annus L.)* has features such as high-quality oil, harsh climate adaptation, growing in variation soil, short growth during, and is considered the highest crop oil production (Tavakoli, 2013). Kestha and El-Baz (2004) reported that seed and seed oil yields of sunflower were not significantly affected by intercropping with tomatoes at fruiting stage.

Intercropping tomatoes with field crops reduces production costs and increases the rate of land equivalent ratio and returns to the farmer. Other advantages and more stable returns can be obtained from intercropping compared to single crops. Therefore, much research was conducted on protecting tomatoes by planting them with some field crops. Abd El-Aal and Zohry (2003) found that planting maize with summer tomatoes led to greater benefits. They found that the marketable yield of tomatoes increased with shade of maize, along with the availability of water and increased land equivalent ratio. The shading resulting from intercropping reduces heat stress and is the most effective way to improve fruit set and increase their quality, especially the cultivation of tomatoes and sunflower, which led to an increase in productivity by 56.1% compared to alone (Abdel, 2006). Intercropping tomatoes with other crops caused maximum values of productivity, total land equivalent use, area time equivalent use, and income than tomatoes solid crop (El-Mehy and Mohamed, 2018 and Lamlom and Ahmed, 2021). The sunflower plant is over story above the tomatoes stands, resulting to protect from direct solar radiation by shady cool air columns (Ju *et al.*, 2021).).

The partial replacement of mineral fertilizer by organic fertilizer reduces pollution and maintains human health. It is preferable to use farm-yard manure on the farm to produce tomatoes because of its low price and it is environmentally friendly compared to mineral fertilizers (Alhrout *et al.*, 2018). Moreover, the frequent use of mineral fertilizers leads to poor soil fertility and natural properties and may lead to the accumulation of heavy metals in plant tissues, affecting the nutritional value of fruits and causing human contamination (Shimbo *et al.*, 2001). The demand for healthy, nutritious products and the market for gourmet products has increased the value of organic foods (Willer, H., and J. Lenoud, 2016). The practice of organic fertilizer is important for different crops, whether they use

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intercropping or sole planting systems. Sutoyo *et al.* (2020) found that using the organic of clay soil led to increased soil organic matter and decreased soil bulk density, filed capacity, soil particle, hydraulic conductivity available water and water content at wilting point compared with the control. Furthermore, increased productivity and improvements in the biological aspects of soil, and quality (Matos *et al.*, 2021). Therefore, this research aimed to determine the maximum profitability and land usage of intercropped sunflower with tomatoes under different organic and mineral fertilizer treatments.

MATERIALS AND METHODS

The experiment was conducted at Etay El-Baroud Research Station, El Beheira Governorate, Agriculture Research Center (ARC), Giza, Egypt in the 2023 and 2024 seasons to examination the effect of organics and minerals on the productivitity of sunflower cv. (Giza 102) and tomatoes cv. (Super Estrin B) association as follows:

1- (100 tomatoes + 43% sunflower) were fertilized by 50% mineral NPK+ 50% farm-yard manure (10 m^3 FYM)/ fed.
2- (100 tomatoes + 43% sunflower) were fertilized by 50% mineral + 50% poultry manure (5 m^3 PM)/ fed.
3-(100 tomatoes + 43% sunflower) were fertilized by 75% mineral NPK+ 25% farm-yard manure (5 m^3 FYM)/ fed.
4-(100 tomatoes + 43% sunflower) were fertilized by 75% mineral NPK+ 25% poultry manure (2.50 m^3, PM)/ fed.
5-(100 tomatoes + 43% sunflower) were fertilized by 25% mineral NPK+ 75% farm-yard manure (15 m^3 FYM)/ fed.
6-(100 tomatoes + 43% sunflower) were fertilized by 25% mineral NPK + 75% poultry manure (7.50 m^3 PM)/ fed.
7-(100 tomatoes + 43% sunflower) were fertilized by 100% mineral NPK/ fed.
8- 100% tomatoes (15555 plant/ fed) were fertilized by100% mineral NPK (153:60:125 kg NPK)/ fed for sole tomato as recommended.
9- 100% sunflower (36000 plant/ fed) was fertilized by100% mineral NPK (30:15:50 kg NPK)/ fed for sole sunflower as recommended.

The experiment was implemented in a randomized complete block design (RCBD) with three replications. Each plot comprised 6 ridges, 3 m long and 0.90 wide. The plot area was 16.20 m^2.

Soil chemical analysis was taken from depth 30 cm of the experimental site before planting to determine physical and chemical properties by the standard methods as described by Chapman and Pratt (1961). The obtained values are presented in Table 1.

Table 1. Physical and chemical analysis of experimental sit in 2023 and 2024 seasons.

Soil properties	Soil texture	Sand %	Silt %	Clay %	P^H	Organic matter%	Available N (ppm)	Available P (ppm)	Available K (ppm)	EC (m mhos) /cm (1;5)
2022/23	Clay	7.01	32.01	60.98	7.73	2.01	1.50	0.41	279.88	1.93
2023/24	Clay	8.50	31.79	59.71	7.77	2.05	1.54	0.40	287.79	1.61

Chemical analysis of farm-yard manure (FYM) and poultry manure (PM) of organic fertilizers were used in the research are presented in Table 2. Organic manures were applied during the soil preparation at different ratios, two weeks prior to transplanting according to Brown *et al.* (1995) in two growing seasons.

Table 2. Chemical analysis of organic fertilizer (farm-yard manure and poultry manure).

Type	N %	P %	K %	PH	Organic matter%	C/N ratio	Mg (ppm)	Ca (ppm)	S (ppm)
FYM	1.25	0.50	1.46	8.89	40.60	13/1	14	32	11
PM	2.13	1.48	1.69	7.20	45.90	10/1	27	55	5

Tomatoes were transplanted (30 days old) on 28th and 29th of February in the two growing seasons, respectively. Transplants were grown in hells spaced 30cm apart with one plant/ hill left (15555 plant fed^{-1}) over the two seasons. Sowing dates of sunflower were 15th and 17th April in the two growing seasons, respectively. Sunflower plants were grown in hills on the other side of tomatoes ridge 30 cm in hills apart with one plant/ hill (15555 plant/ fed was presented of 43% sunflower of the recommended) over the two seasons. Tomatoes were harvested, when the fruits were ripe, at the end of May and lasted until the 5th of July. Sunflower was harvested on 2nd July and 4th July in both seasons, respectively. Single agriculture was conducted according to technical recommendations of each crop.

Add calcium super phosphate (15.50% P_2O_5) while preparing the land. While ammonium nitrate (33.5% N) was added in four equal doses before transplanting and the first, second and third irrigations of tomatoes. While potassium sulfate (48% K_2O) was applied in four doses, the first before transplanting, the second and third at a month's interval, and the fourth at two weeks after the third. Other agricultural practices are based on the recommendations of the Ministry of Agriculture and Land Reclamation.

Data recorded in the study:

Tomatoes: 10 plants of the inner 4 ridges of each plot were taken to denote the representative samples of each plot. Characters recorded for tomatoes were plant height (cm) and number of branches/ plant. Number of fruits/ plant, average fruit weight (g), weight of fruits (kg/ plant), total yield (kg/ fed), damaged tomato (%) affected by sun scorch and Marketable fruit yield (kg/ fed) were estimated of all pickings.

Sunflower: 10 plants of each plot were taken to measure plant height (cm), head diameter (cm), seed weight (g/ head) and weight of 100- seed (g). While seed yield (kg/ fed) was taken in whole plot and consequently yield/ fed.

Yield and yield advantages:

A- Competitive characters:

1. Land Equivalent Ratio (LER):

LER explains that it is the crop production intercrop attributed to its single production (Mead and Willey, 1980), as follows:

$$\mathbf{LER = (Y_{ab} / Y_{aa}) + (Y_{ba} / Y_{bb})}$$

Where:

Y_{aa} = single yield of crop a (tomatoes).
Y_{bb} = single yield of crop b (sunflower).
Y_{ab} = Intercrop yield of crop a (tomatoes).
Y_{ba} = Intercrop yield of crop b (sunflower).

3. Aggressivity (A).

Aggressivity values were estimated by the equation proposed as follows:

$$\mathbf{A = (Y_{ab} / Y_{aa} \times Z_{ab}) - (Y_{ba} / Y_{bb} \times Z_{ba})}$$ according to Mc-Gilchrist (1965).

Where: A_{ab} = Intercrop yield of crop "a".
Y_{aa} is single yield of crop a, Y_{bb} is single yield of crop b, Y_{ab} is mixture yield of a (when combined with b) and Y_{ba} yield of b (when combined with a).
Z_{ab} is sown proportion of species a (in a mixture with b) and Z_{ba} is sown proportion of species b (in b mixture with a).

B- Economic evaluation.

1. Gross return:

The economic return of the intercropping system compared to single tomatoes was determined as follows: Total return from intercropped cultivation = crop price of tomatoes + crop price of sunflowers (Egyptian bounds). The total return was calculated from the price of tomatoes and sunflowers according to the local market, whereas 4 and 5 L.E. as well as 15 and 18 L.E. of the kilo (1000g) for tomatoes (marketable yield) and sunflower seeds in the two growing seasons, respectively.

2. Production costs: Costs of production = fixed costs of tomatoes +Land rent during the two tomatoes growing seasons.

3. Net return: Net return = gross return – costs of production.

Statistical analysis:

Analysis of variance for the obtained results in each growing season was conducted. The measured was analyzed by ANOVA by using the least significant differences (L. S. D.) at 5% level of probability, where it was computed using CoStat V 6.4 (2005) program.

RESULTS AND DISCUSSION

Tomatoes.

Results in Table 3 revealed that tomatoes characters were significantly affected by fertilizer treatments under intercropping of sunflower plants in both seasons, except number of fruits/ plant was not significantly affected in the first season. The highest values were obtained when applying tomatoes by 50% mineral NPK + 50% FYM in plant height, number of branches/ plant, number of fruits/ plant, and fruits weight/ plant under intercropping condition in both seasons. Followed by treatment (100% NPK for sole tomatoes) in fruits weight/ plant. This may be because organic fertilizers contain all the nutrients and are slowly released into the plants throughout the growing season (Ilodibia and Chukwuma, 2015). Farm-yard manure improved physical and chemical properties of soil to resulting increasing the availability of major and minor nutrients. That led to enhancement fruit quality (Alhrout *et al.,* 2018). Treatments 100%T +43%S were fertilized by 50%mineral NPK+50% PM, 100%T+ 43%S were fertilized by 75%mineral NPK+25% FYM and 100%T +43%S were fertilized by 100% mineral NPK didn't reach the 5% level of significance in the first and second seasons. On the other hand, the lowest values of tomatoes characters were obtained with 25% NPK +75% PM, followed by 25%mineral NPK+75% FYM in both seasons. Burhan and Hajo (2000) explained that poultry manure is acidic, so it is suitable for alkaline soil, it is considered easy to dissolve and decompose quickly, so care must be taken when using it because placing large quantities of it near plants may lead to damage to them as a result of the high heat resulting from its decomposition of the fertilizer as well as the high acidity around the roots.

Data presented in Table 6 obtained that the highest yields fed^{-1} were behaved the same trend of fruit characters, under intercropping condition in the two growing seasons. 100% tomatoes + 43% sunflower by fertilized 50%NPK + 50% FYM recorded the highest total fruit yield and marketable yield per fed in the first and second seasons. These results due to the shade of sunflower. Similar findings were obtained by Hussain *et al.,* (2008); Mohamed *et al.* (2013) and Degri *et al.* (2014). Intercropping sunflower with tomatoes reduced damaged tomatoes fruits as affected by sun scorch to 4.12 and 4.45 %, resulting in a 15.46 and 15.31% increase in marketable yield/ fed under average of seven fertilizer treatments compared with sole tomatoes in both seasons, respectively. Sunflower protects tomatoes from the increase in temperature, the flowers do not die, the nodes rise, and thus the production of fruits is high. These observations are consistent with Lamlom and Ahmed (2021). Sunflowers act as a buffer against high heat waves and make the climatic condition suitable around tomatoes plants. Reducing high temperatures by intercropping sunflowers led to evaporative cooling and shading, which improved fruit set and thus resulted in a high-quality tomatoes crop (Abdel, 2006). Intercropping sunflower with tomatoes leads to provides ample shade during tomatoes fruiting, and therefore reduces fruit damage resulting from direct sunburn (Kestha, and El-Baz, 2004).

Table 3. Effect of fertilizer treatments on yield components of tomato under intercropping system during 2023 and 2024 seasons.

Treatments	Plant height (cm)		Number of branches/ plant		Number fruits/ plant		Average fruit weight (g)		Fruits weight (kg/ plant)	
	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024
100%T+ 43%S fertilized by 50%mineral NPK+50% FYM	51.45	52.11	6.07	6.10	13.59	13.79	97.55	98.301	1.288	1.294
100%T+ 43%S fertilized by 50%mineral NPK+50% PM	50.73	51.69	5.88	5.90	13.15	13.19	96.14	96.39	1.241	1.248
100%T+ 43%S fertilized by 75%mineral NPK+25% FYM	48.66	48.75	5.78	5.85	13.01	13.09	95.16	95.63	1.228	1.234
100%T+ 43%S fertilized by 75%mineral NPK+25% PM	47.95	48.03	5.47	5.56	12.85	12.95	95.01	95.51	1.221	1.227
100%T+ 43%S fertilized by 25%mineral NPK+75% FYM	49.57	50.23	5.43	5.51	12.61	12.67	94.64	95.05	1.199	1.190
100%T+ 43%S fertilized by 25%mineral NPK+75% PM	48.81	49.07	5.18	5.26	12.23	12.24	93.44	94.38	1.148	1.152
100%T+ 43%S fertilized by 100% mineral NPK	50.91	51.18	5.82	5.91	13.19	13.30	94.34	94.66	1.248	1.252
100%sole tomatoes fertilized by 100% mineral NPK	49.39	50.01	5.77	5.88	12.37	12.41	101.17	101.71	1.265	1.270
LSD 0.05	1.71	1.57	0.27	0.24	ns	0.63	3.84	3.73	0.06	0.06

Table 4. Effect of fertilizer treatments on yield and quality of tomato under intercropping system during 2023 and 2024 seasons.

Treatments	Total fruit yield (kg/ fed)		Damaged tomato (%) as affected by sun scorch		Marketable fruit yield kg/fed	
	2023	2024	2023	2024	2023	2024
100%T+ 43%S fertilized by 50%mineral NPK+50% FYM	19959.00	20260.67	4.19	4.44	19122.82	19361.10
100%T+ 43%S fertilized by 50%mineral NPK+50% PM	19321.00	19422.00	4.11	4.05	18526.91	18635.41
100%T+ 43%S fertilized by 75%mineral NPK+25% FYM	19163.00	19264.00	4.21	4.21	18356.24	18452.99
100%T+ 43%S fertilized by 75%mineral NPK+25% PM	19025.00	19046.00	4.12	4.18	18241.17	18249.88
100%T+ 43%S fertilized by 25%mineral NPK+75% FYM	18681.00	18682.00	4.21	4.23	17894.53	17891.75
100%T+ 43%S fertilized by 25%mineral NPK+75% PM	17917.00	18054.67	5.02	5.02	17017.57	17148.33
100%T+ 43%S fertilized by 100% mineral NPK	19391.00	19493.00	5.01	5.02	18419.51	18514.45
100%sole tomatoes fertilized by 100% mineral NPK	19630.00	19731.00	21.51	20.75	15407.59	15636.82
LSD 0.05	141.51	279.04	0.18	0.15	253.59	213.27

Sunflower.

Results were presented in Table 5 revealed that sunflower plant height was significantly affected by different fertilizer treatments in both seasons. Sole sunflower (100% NPK) recorded the highest value compared with all intercropping treatments in the first and second seasons. These results may be due to inter-specific competition between sunflower plants which included 100% plant density compared other treatments which were 43% of its alone. Similar proofs were reported with Kestha and El-Baz (2004). Opposite, all intercropping treatments i.e. head diameter, seed yield/ plant and 100-seed weight were surpassed than sunflower pure stand. These results may be due to these traits as a yield component of sunflower increased fertilizer high levels for sunflower intercropped with tomatoes beside of fertilizer organic manure than sunflower in pure stand. Similar proofs were obtained by Shaik Mohammad *et al.* (1993) and Kestha and El-Baz (2004). Results were presented in Table 5 indicated that seed yield of sole sunflower (100% NPK) recorded the highest values from the work-intercropping in these study in the two growing seasons. These results may be due to plant density of sunflower being 100% of its pure stand compared with those in all intercropping treatments which were 43% of sunflower separately. These results coincided with those obtained by Shaik Mohammed *et al.* (1993), Kestha and El-Baz (2004), Jones and Sieving (2006) and Mehta *et al.* (2017). Data in Table 5 indicated that applying sunflower of 50% NPK + 50% FYM superior of seed yield /fed than other fertilizer treatments under intercropping condition in the two growing seasons. Farm-yard manure effects sunflower plants, it is an established fact in many previous studies that contains all micro and macro elements as well as released slowly into the plants. The organic fertilizer of sunflower showed a significant effect on seed weight/ head, and they attributed the increase in these traits to the increase in the shelling percentage and 100-seed weight (Al-Aref *et al.*, 2011 and Alzammel *et al.*, 2022). Mixing organic fertilizer and mineral nitrogen at a ratio of 25 + 25 kg/ ha resulting the highest yield of sunflower (Sharma *et al.*, 2008).

Table 5. Effect of fertilizer treatments on yield characters of sunflower during 2022/2023 and 2023/2024 seasons.

Treatments	Plant height (cm)		Head Diameter (cm)		Seed yield (g/ plant)		100-seed weight (g)		Seed yield (kg/ fed)	
	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024
100%T+ 43%S fertilized by 50%mineral NPK+50% FYM	170.14	171.44	17.45	17.66	45.13	45.49	7.55	8.15	687.53	691.11
100%T+ 43%S fertilized by 50%mineral NPK+50% PM	171.11	172.23	17.32	17.53	45.01	45.27	7.50	8.10	680.13	682.59
100%T+ 43%S fertilized by 75%mineral NPK+25% FYM	165.99	165.85	17.22	17.29	42.11	42.63	7.77	8.29	667.19	669.81
100%T+ 43%S fertilized by 75%mineral NPK+25% PM	167.06	166.81	17.17	17.21	41.90	42.30	7.68	8.21	665.13	666.44
100%T+ 43%S fertilized by 25%mineral NPK+75% FYM	174.48	175.11	17.40	17.61	41.71	41.85	7.36	7.93	635.91	637.33
100%T+ 43%S fertilized by 25%mineral NPK+75% PM	176.11	176.90	17.35	17.52	41.03	41.15	7.31	7.89	628.11	629.15
100%T+ 43%S fertilized by 100% mineral NPK	177.88	178.18	17.49	17.67	44.53	44.66	7.25	7.96	678.09	681.41
100%sole sunflower fertilized by 100% mineral NPK	180.30	182.19	15.11	15.18	36.67	37.19	7.33	7.86	1081.94	1093.88
LSD 0.05	7.58	6.95	0.53	0.67	2.37	2.37	ns	0.29	37.66	42.92

Yield and yield advantages.

A- ***Competitive characters.***

1. Land equivalent ratio (LER).

Results in Table 6 obtained that LER values, in 2023 and 2024 seasons exceeded than one in all intercropping treatments. It ranged from 1.49 to 1.66 due to the intercropping 43% of sunflower with tomatoes. The highest LER by application of 100% tomatoes + 43% sunflower were fertilized by 50% NPK + 50% FYM in both seasons. The number of 43% sunflower with tomatoes plants played a major role in enhancing productivity per unit area under different fertilization treatments, as it reached more than 60% compared to single cultivation in the two successive seasons. These results coincided with those obtained by Khan, *et al*. (2017); El-Mehy and Mohamed (2018) and Sheha *et al.* (2022).

2. Aggressivity (A).

Results in Table 6 reviled that the dominant crop has a (+) sign and the dominated crop has a (−) sign. Results obtained those tomatoes had a negative sign while the sunflower had a positive sign in all intercropping treatments in the two growing seasons. This indicated that tomatoes was a dominated crop while sunflower was dominant. Interpretation of this finding may be attributed to sunflower, which had a good protection to tomatoes plants against heat stress condition, leading to increasing the yield of tomatoes as well as its competitiveness ability. The successfulness of intercropping tomatoes with sunflower crop in ameliorating natural heat stress in this investigation might be attributed to many factors the most important of these are the evaporative cooling and shading which are usually confined to such circumstances. Similar results were obtained by Kurg (1997) and Abdel (2006).

Table 6. **Land equivalent ratio (LER) and aggressivity (A) as affected by fertilizer treatments under intercropping sunflower with tomatoes during 2023 and 202024 seasons.**

Treatments	Land equivalent ratio (LER)						Aggressivity (A)			
	2023			2024			2023		2024	
	Ry_t	Ry_s	LER	Ry_t	Ry_s	LER	A_t	A_s	A_t	A_s
100%T+ 43%S fertilized by 50%mineral NPK+50% FYM	1.02	0.64	1.66	1.03	0.63	1.66	-0.67	+0.67	-0.64	+0.64
100%T+ 43%S fertilized by 50%mineral NPK+50% PM	0.98	0.63	1.61	0.98	0.62	1.60	-0.70	+0.70	-0.69	+0.69
100%T+ 43%S fertilized by 75%mineral NPK+25% FYM	0.98	0.62	1.60	0.98	0.61	1.59	-0.65	+0.65	-0.63	+0.63
100%T+ 43%S fertilized by 75%mineral NPK+25% PM	0.97	0.61	1.58	0.97	0.61	1.58	-0.66	+0.66	-0.65	+0.65
100%T+ 43%S fertilized by 25%mineral NPK+75% FYM	0.95	0.59	1.54	0.95	0.58	1.53	-0.60	+0.60	-0.59	+0.59
100%T+ 43%S fertilized by 25%mineral NPK+75% PM	0.91	0.58	1.49	0.92	0.57	1.49	-0.63	+0.63	-0.61	+0.61
100%T+ 43%S fertilized by 100% mineral NPK	0.99	0.63	1.62	0.99	0.62	1.61	-0.68	+0.68	-0.67	+0.67
100%sole tomatoes fertilized by 100% mineral NPK	1.00	---	1.00	1.00	---	1.00	1.00	1.00	1.00	1.00
100%sole sunflower fertilized by 100% mineral NPK	---	1.00	1.00	---	1.00	1.00	1.00	1.00	1.00	1.00

B- Evaluation economic.

1. Gross return (L.E.).

The total economic return for tomatoes and sunflower crops intercropping, compared to single cultivation of both crops is shown in Table 7. All intercropping cultivation transactions increased the total economic return in the two cultivation seasons. The highest total return of intercropping sunflower with tomatoes 86804.23 and 109299.48 L.E. / fed were obtained when application of 50% NPK + 50% FYM in the first and second seasons, respectively. Intercropping sunflower with tomatoes increased gross return by 25.61% and 24.43% under average all intercropping treatments compared to tomatoes transplanting alone in both seasons. According to the stated objective, tomatoes grown with sunflowers are compared to single tomatoes under farm conditions. Similar proofs with Abdel (2006); Lamlom and Ahmed (2021) and Vlahova (2022).

2- Costs production (L.E.): Data in Table 7 revealed that costs production was highest when tomatoes were fertilized with 100% mineral fertilizer, either alone or under intercropping. However, increasing organic fertilizer in the treatments reduced costs of production. Intercropping sunflower with tomatoes leads to reduced costs compared with monoculture crop of tomatoes under farm conditions. Similar findings were reported by Upadhyay *et al*., (2010).

3- Net return (L.E.): All intercropping treatments increased net return in the two growing seasons as resulted in Table 7. The highest net return was obtained when application of 100% tomatoes + 43% sunflower were fertilized by 50% NPK + 50% FYM in the first and second seasons. Intercropping sunflower with tomatoes increased net return by 42.40 and 39.75% under average all intercropping fertilizer treatments as compared to tomatoes alone in the two growing seasons, respectively. Similar proofs were reported with (Lamlom and Ahmed, 2021 and Vlahova, 2022).

Table 7. Gross return, costs production and net return as affected by fertilizer treatments under intercropping sunflower with tomatoes during 2023 and 202024 seasons.

Treatments	Gross return (L.E.) /fed		Costs production (L.E.)/ fed		Net return (L.E.)/ fed	
	2023	2024	2023	2024	2023	2024
100%T+ 43%S fertilized by 50%mineral NPK+50% FYM	86804.23	109299.48	26843.32	32187.50	59960.91	77111.98
100%T+ 43%S fertilized by 50%mineral NPK+50% PM	84309.59	105463.67	26593.32	31937.50	57716.27	73526.17
100%T+ 43%S fertilized by 75%mineral NPK+25% FYM	83432.81	104321.53	26093.28	32756.50	57339.53	71565.03
100%T+ 43%S fertilized by 75%mineral NPK+25% PM	82941.63	103245.32	27968.28	32631.50	54973.35	70613.82
100%T+ 43%S fertilized by 25%mineral NPK+75% FYM	81116.77	100930.69	25589.96	30536.70	55526.81	70393.99
100%T+ 43%S fertilized by 25%mineral NPK+75% PM	77491.93	97066.35	25214.96	30161.70	52276.97	66904.65
100%T+ 43%S fertilized by 100% mineral NPK	83849.39	104837.63	29343.24	35270.70	54506.15	69566.93
100%sole tomatoes fertilized by 100% mineral NPK	61630.36	78284.10	29348.24	35270.70	32282.12	43013.40
100%sole sunflower fertilized by 100% mineral NPK	16229.10	19689.84	11933.95	14498.10	4295.15	5191.74
L S D 0.5%	1328.95	1629.78	543.64	558.44	1043.00	1291.51

CONCLUSION

On present study, it is concluded that the intercropping 100% tomatoes + 43% sunflower were fertilized by 50% NPK + 50% FYM are the suitable application for getting the most profitable and economic yield, in addition to the achievement of food security and to some extent, the environment integrity.

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إستجابة الطماطم ودوار الشمس المحملين للأسمدة العضوية والمعدنية

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الملخص

أُجريت تجربة حقلية بمحطة بحوث إيتاي البارود بمحافظة البحيرة، مركز البحوث الزراعية، الجيزة، مصر خلال موسمي 2023 و 2024 لدراسة" تأثير تحميل 100% طماطم (NPK 50% معدني 50% +سماد بلدي، 50% NPK معدني 50% +سماد دواجن، 75% NPKمعدني25% +سماد بلدي، 43% +دوار شمس بالأسمدة العضوية والمعدنية كالاتي NPK 25% معدني 75% +سماد بلدي، 25% NPK معدني 75% +سماد دواجن، 100% NPK معدني، 100% سماد معدني الموصي به للطماطم منفردة، و100% سماد معدني الموصي به لدوار الشمس منفرد ,(على المحصول ومكوناته لكلا المحصولين, نفذت التجربة بتصميم قطاعات كاملة العشوائية (RCBD) في ثلاث مكررات. سجلت زراعة 100%طماطم 43% +دوار المسمدة بـ 50% NPKمعدني 50% +سماد بلدي أعلى محصول ومكوناتهُ للطماطم في كلا الموسمين .أدت زراعة دوار الشمس مع الطماطم إلى انخفاض نسبة ثمار الطماطم التالفة وتأثرها بشكل ملحوظ بحروق الشمس إلى 4.12 و4.45 %, أنتجت زيادة مئوية 15.46 و 15.31% جودةً في ثمار الطماطم الصالحة للتسويق /فدان لمتوسط السبع معاملات تحت التحميل ,مقارنة بالطماطم المنفردة في كلا الموسمين ,على التوالي .زراعة دوار الشمس منفرد المسمد بـ 100% NPKسجل أعلى محصول بذور للفدان في كلا الموسمين .بتحميل 43% دوار الشمس مع 100% الطماطم التي سمدت بـ 50% NPK معدني + 50% سماد بلدي حقق أعلى معدل استغلال الارض (LER), إجمالي العائد وصافي العائد (1.66 و1.66 LER 86804.23و 109299.48 وكذلك 59960.91 و 77111.98جنيها للفدان في كلا الموسمين ,على التوالي .