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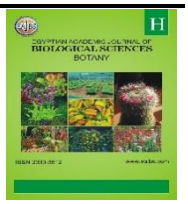

Response of Maize and Soybean to Intercropping Systems and Nitrogen Fertilization

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ABSTRACT

A field experiment were carried out during seasons at Etay El-Baroud, Research Station, El Beheira Governorate, Agriculture Research Center (ARC), Giza, Egypt during 2023 and 2024 to study the effect of four intercropping patterns of soybean *(Glycine max, L.)* cv., Giza 111 with maize *(Zea mays, L.)* cv., Yellow SC 173 i.e. [2 ridges of maize: 2 ridges of soybean (P1), 3 ridges of maize: 3 ridges of soybean (P2), maize was sown in a monoculture crop (P3) and soybean was sown in a monoculture crop (P4) under three N fertilizer points, i.e. (N1: 75 kg nitrogen /feddan, N2: 100 kg nitrogen /feddan and N3: 125 kg nitrogen /feddan) on intercropping patterns and sole crops. The experiments were designed as split plot design in four replicates. Results indicated that sowing maize in pure stand (P3) followed by maize in intercropping pattern (P1) recorded the highest values of yield and its components of maize in 2023 and 2024 seasons. All traits of maize have reached the maximum values with 125 kg nitrogen/feddan (N3) in the two seasons. Kernels yield / feddan was significantly affected by interaction in 2023 and 2024 season, the highest values were obtained when sowing maize in pure stand (P3) followed by grown maize in intercropping pattern (2maize:2soybean) (P1) when it fertilized of 125 kg N/fed (N3). Sowing soybean in a monoculture crop (P4) recorded the maximum values of seed yield / feddan, followed by grown soybean in intercropping (3maize:3soybean) (P2) in both seasons. Soybean was fertilized of 125 kg N/fed (N3) resulted the maximum values for all traits under intercropping patterns in the two seasons. LER and K achieved the highest values by (2maize:2soybean) (P1) and application of 125 kg N/fed which reached 1.343 and 1.380 as well as 6.124 and 9.143 in 2023 and 2024 seasons, respectively.

INTRODUCTION

Maize crop is second gain crop after wheat in Egypt. 2.8 million fed will come from maize. Egypt imports 9.8 million ton of grain yellow corn for concentrated feed from the USA, Brazil and Argentina. Soybean area to 500,000 feds in the 2024 season. In 2021, soybean area reached approximately 40,000 feds, representing 4.4% of the total oil crop area (FAO, 2025).

Intercropping, as a component of permaculture, is a more productive system of pruning crops than growing them separately (Willey, 1979). Intercropping is one of the solutions and a major pillar to reduce imports of grain and oil. Thus, there is a need to

maximize production per unit area to accelerate productivity gains, which may encourage a reduction in the expected food security gap. Intercropping is a component of permaculture, a more productive system than different crops separately (Kumar *et al.*, 2014). Intercropping soybeans with maize by creating soybean-maize patterns to reduce competition between these crops and increased production per unit area (Blessing *et al.,* 2022).

In order to achieve maximum profitability and productivity, specific nitrogen proposals are essential for the cultivation of maize. The optimal nitrogen level for application may differ depending on the variety and environmental circumstances (Sezer and Yanbeyi, 1997). Kara (2006) obtained that nitrogen management treatments (0, 90, 180, 270, and 360 kg per hectare) improved plant height, height of ear, ear length, number of grains per ear, stem diameter, handed grain weight, nitrogen content in the grain and grain yield.

The aim of this study was to study the effect of intercropping systems of soybean with maize and nitrogen fertilization on productivity and land equivalent ratio (LER).

MATERIALS AND METHODS

A field experiment was carried out at Etai El-Barud Experimental station in El-Beheira Governorate, Agriculture Research Center, El-Giza, Egypt during 2023 and 2024 seasons to study the effect of four intercropping patterns of soybean (Glycine max, L.) Giza 111cv. with maize (Zea mays, L.) cv., Yellow SC 173 under three fertilizer of nitrogen levels on the intercropping patterns as follow. Intercropping patterns:

P1: 2 ridges of maize: 2 ridges of soybean. Maize was rarefied on the two plants per hill, while soybean was rarefied on the two plants per hill (100% maize + 50% soybean).

P2: 3 ridges of maize: 3 ridges of soybean. Maize was thinned on the two plants per hill, while soybean was thinned on the two plants per hill (100% maize + 50% soybean).

P3: Maize was sown in a monoculture crop one plant only was thinned in hill with distances 35 cm between the hills (20000/fed).

P4: Soybean was sown in a monoculture crop two plants were thinned in hill with distances 20 cm between the hills (140000/fed). And three fertilizers of nitrogen levels.

N1: 75 kg/fed nitrogen per fed in the form of urea (46.50%).

N2: 100 kg/fed nitrogen per fed in the form of urea (46.50%).

N3: 125 kg/fed nitrogen per fed in the form of urea (46.50%).

Table 1: Physical and chemical analysis of experimental soil during 2023 and 2024 seasons.

Soil properties	Soil texture	Sand%	Silt%	Clay%	PH	Organic matter%	Available N (ppm)	Available P (ppm)	Available K (ppm)	EC (m mhos) cm-1 (1;5)
2023	Clay	7.09	32.50	61.41	7.71	1.99	1.50	0.39	278.86	1.93
2024	Clay	8.59	31.80	59.61	7.79	2.07	1.52	0.38	286.79	1.61

The investigational plan was a split-plot design with four replications. The four intercropping patterns were allocated in the central plots; however the three fertilizers of nitrogen levels were distributed at random in the sub-plots. Super phosphate (P_2O_3, 15.50%) was added during soil preparation, at a rate of 150 kg per fed. Whereas, additional nitrogen on two equal dosses, beforehand the paramount and next irrigation.

The number of ridges in each sub- plot was 12 ridges (60 cm width), the length of ridge was 3 m (0.60 x 3 x 12 =21.60 m2 equal 1/194.44 of fed).

Soybean was planted on 2nd and 3rd May. Whereas, maize was planted on the soaking irrigation of soybean, approved 14th and 15th May in 2023and 2024 seasons, respectively. All the other culture treatments were done according to the recommendation of the Ministry

of Agriculture and Land Reclamation. Soybean was harvested on 2nd and 3rd September, while maize was harvested on 5th and 7th October in 2023and 2024 seasons, respectively.

Studied Characters: -

A- Maize:

At harvest samples were taken of all sub plot to estimate the: numeral of rows / ear, numeral of grains / row, hundred grain weight (g), grain weight per ear (g), while grain yield (ardab / feddan) and biomass yield (ton/fed) were reserved from complete sub-plot plot.

B- Soybean:

At harvest sample of all sub plots were taken to estimate the: numeral of pods / plant, numeral of seeds / pod, hundred seed weight (g), seed weight /plant (g), while seed yield (kg / fed) and biomass yield (ton / fed). Seed yield and biomass were estimated from whole sub-plot plot.

D- Yield and yield benefits:

1. Land Equivalent Relative (LER):

LER is the summation of fractions of the intercropped yield related to their alone crop yields. It is generally assumed that the same level of management must be the same for intercropping as for alone. It was determined according to Willey and Soiree (1972).

$$LER=\frac{Yab}{Yaa}+\frac{Yba}{Ybb}$$

Where: Y_{ab} = yield of crop (a) association with crop (b),Y_{ba} = yield of crop (b) association with crop (a), Y_{aa} = yield of crop (a) as alone crop and Y_{bb} = yield of crop (b) as alone crop.

2. Relative Crowding Coefficient (K):

The relative crowding coefficient (K) is a measure of the relative dominance of one species over the other in a association (Banike *et al.,* 2006). K had resulted according to the following formulation for type (a) in mixture with type (b).

$$Kab=\frac{YabxZba}{(Yaa-Yab)xZab} \quad \text{and} \quad Kba=\frac{YbaxZab}{(Ybb-Yba)xZba}$$

$$K = Kab \times Kba$$

Where: Z_{ab}= seeded percentage of crop (a) in combination with crop (b) and Z_{ba}=seeded percentage of crop (b) in combination with crop (a).

When the values of K and LER were greater than one, there is a yield advantage; when K and LER were equal to one, there is no yield benefits; and, when it is less than one, there is a disadvantage (Dhima *et al.,* 2007).

3. Aggressivity: (Agg):

It gives simple measures of how much comparative yield increase in type (a) greater than for type (b) which is often used to determine the competitive association between two crops used in intercropping (Willey, 1979). The aggressivity was formulated as follows:

$$Aa=\frac{Yab}{(Yaa-Yab)xZab}-\frac{Yba}{(Ybb-Yba)xZba}$$

$$Ab=\frac{Yba}{(Ybb-Yba)xZba}-\frac{Yab}{(Yaa-Yab)xZab}$$

If Aggressivity value = zero it indicates that the component species are equality-for any other situation, both species will have the same numerical value, but the sing of the dominant species will be positive, and the dominated will be negative.

3.2. Statistical Analysis:

The data achieved were examined according to **Snedecor and Cochron (1967)**. The treatments means were compared by using the least significant differences (L.S.D.) at 5% of possibility, where it was computed using CoStat V 6.4 **(2005)** program.

RESULTS AND DISCUSSION

A: Maize:

Data obtainable in Table (2) revealed that yield and its components characters of maize were significantly affect as affected by intercropping patterns of soybean with maize in 2023 and 2024 seasons. The highest values of these characters were recorded by growing maize in a monoculture crop (P5). Except for the hundred grain weight, the highest weight of hundred grain weight was recorded when grown maize in intercropping pattern of 2maize:2soybean. Maize-soybean intercropping significantly increased the yield indices, yield components and hindered grain weight of maize crops. This could be due to the better utilization of the available natural resources such as water, land and nutrients, water and light. Similar results were recorded by Nasar *et al.*, (2020b), Raza *et al.* (2020) and Raza *et al.* (2021). Growing maize in intercropping pattern of 2maize:2soybean (P1) recorded the highest values for yield components and yield after maize alone in 2023 and 2024 seasons. Whereas the lowest values were recorded by growing maize in intercropping pattern of 3maize:3soybean (P2). In general, exposing maize plants to grown in 3maize:3soybean (P2) intercropping patter caused significant reduction in grain yield and it is a fact that, high competition on water, light, nutrients inhibits the dry matter production in the different plant organs, numeral of rows /ear, numeral of grains/ear and hundred grains weight consequently, led to sharp decrease in grain yield. Intensification in grain yield components can be in line for to the datum that lower competition on water, light and improved nutrient availability between maize and soybean, which improve nitrogen and other macro and micro-nutrients absorption as well as enhance the manufacture and translocation of the dry matter content from source to sink. These results were agreement with Rashwan and Zen El- Dein (2017), Abd-Rabboh *et al.* (2020) and Nasar *et al.* (2023).

Table 2: Effects of intercropping patterns and nitrogen fertilizer levels on yield and yield components of maize during 2023 and 2024 growing seasons.

Intercropping patterns (P)	Number of rows/ear		Number of grain/row		100-grain weight (g)		Grain weight (g/ear)		Grain yield (ardab/fed)		Biological yield (ton/fed)	
	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024
P1 (2maize: 2soybean)	11.57b	11.68b	30.10b	31.10b	38.25a	40.83a	134.28b	142.44b	24.67b	26.03b	11.45b	11.62b
P2 (3maize: 3soybean)	11.20c	11.38b	29.46c	29.48c	37.85b	39.33b	126.63c	132.19c	22.88c	23.53c	10.87c	11.13c
P3 (maize alone)	12.07a	12.33a	33.72a	34.32a	37.18c	38.82c	164.29a	166.10a	28.70a	29.10a	13.15a	13.49a
L.S.D. at 5%	0.30	0.56	0.54	0.57	0.24	0.28	1.46	1.36	0.0.68	0.61	0.35	0.37
N fertilizer levels												
N1 (75 kg N /fed)	10.79c	11.13c	28.05c	28.93c	36.93c	38.01c	130.27c	135.80c	23.53c	24.35c	9.56c	10.43c
N2 (100 kg N /fed)	11.56b	11.70b	30.96b	31.57b	37.85b	39.73b	141.01b	145.67b	25.03b	25.72b	11.23b	12.13b
N3 (125 kg N /fed)	12.43a	12.56a	34.27a	34.39a	38.44a	41.24a	153.92a	159.27a	27.69a	28.58a	12.89a	13.68a
L. S. D. at 5%	0.33	0.33	0.55	0.58	0.50	0.56	1.45	1.43	0.45	0.43	0.31	0.33

As revealed in Table (2) maize yield and its components were affected by nitrogen fertilization in 2023 and 2024 seasons. Results of maize yields characteristics i.e. grain, and biomass yields per feddan were taken the same trend of yield components characters in 2023 and 2024 seasons. The highest grain and biomass yield per feddan had resulted when maize plants received 125 kg nitrogen /feddan (N3). This could be due to attributed to the positive effect of increase nitrogen fertilizer level from 75 kg nitrogen /fed to 125 kg nitrogen /feddan on yield components which encourage maize plants to produce more yield, that can be an explanation for grain yield increase under 125 kg nitrogen /feddan. These results were consistent with those found by Kara (2006) and Hassanein *et al.* (2007). In addition,

Sonnewald (2012) and Gao and Meng (2020), suggested that maximum yield and yield components conferred an advantage to grain yield under optimum N fertilizer level, this increased nitrogen use efficiency (NUE).

Yield and its components were significantly affected by the interaction in 2023 and 2024 seasons as shown in Table (3). Growing maize alone achieved the highest values when maize plants were fertilized by 125 kg N/fed (N3), followed by growing in intercropping pattern of 2maize:2soybean (P1), when maize plants were fertilized of the same fertilizer level (N3) in the second season, for grain yield/fed. There was no significance at a level of 5% of significant between maize cultivation in 2maize:2soybean (P1) when it fertilized 125 kg N/fed and maize cultivation a monoculture crop (P3) when it fertilized of 100 kg N/fed, for grain yield/feddan in 2023 season. Whereas the lowest values were noted by growing maize in intercropping pattern of 3maize:3soybean (P2) when maize plants were fertilized of 75 kg N/fed (N1), in 2023 and 2024 seasons. These results were due to inter and intra specific competitive on nutrients, light and water, leads to decrease the production of dry matter content in numeral of rows/ear, numeral of grains/row and hundred grain weight, which led to significant decrease in kernels yield. These findings also agreed with those recounted by Sousa *et al.* (2022), Raza *et al.* (2020), Raza *et al.* (2021) and Nasar *et al.* (2023).

Table 3: The interaction effect on yield and yield components of maize during 2023 and 2024 growing seasons.

Treatments			Number of rows/ear		Number of grain/row		100-grain weight (g)		Grain weight (g/ear)		Grain yield (ardab/fed)		Biological yield (ton/fed)	
			2023	2024	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024
Maize+ soybean	P_1: 2: 2	N1 (75 kg N /fed)	10.83	11.04	27.41f	28.30e	37.85b	38.73d	122.62	131.50f	22.17e	23.94e	9.65	9.73
		N2 (100 kg N /fed)	11.40	11.47	29.50e	31.50d	38.10a	40.60b	132.53	141.33e	24.57d	25.32d	11.42	11.59
		N3 (125 kg N /fed)	12.47	12.53	33.40c	33.50c	38.80a	43.15a	147.69	154.50c	27.28bc	28.82b	13.28	13.53
	P_2: 3: 3	N1 (75 kg N /fed)	10.47	10.59	26.75fg	27.33f	37.23b	37.00e	116.29	123.56h	21.79ef	22.24fg	9.33	9.67
		N2 (100 kg N /fed)	11.00	11.27	28.70e	28.11e	38.05a	39.60c	126.48	129.00g	22.29e	23.02f	10.77	11.09
		N3 (125 kg N /fed)	12.13	12.27	32.92d	33.00c	38.23a	41.40b	137.12	144.00d	24.56d	25.33d	12.51	12.64
P_3: Maize pure		N1 (75 kg N /fed)	11.07	11.77	30.00e	31.17d	35.70c	38.30d	151.91	152.33c	26.64c	26.88c	9.69	11.89
		N2 (100 kg N /fed)	12.27	12.36	34.67b	35.11b	37.40b	39.00cd	164.03	166.67b	28.23b	28.82b	11.51	13.70
		N3 (125 kg N /fed)	12.69	12.87	36.50a	36.67a	38.29a	39.17c	176.94	179.31a	31.22a	31.59a	12.87	14.87
L. S. D at 5%			ns	ns	0.94	0.96	0.86	0.88	ns	2.47	0.96	0.78	ns	ns

B- Soybean

Effects in Table (4) revealed that yield components and yield of soybean were significantly affected by intercropping systems with maize in 2023 and 2024 seasons. Grown soybean in the two intercropping systems resulted in the highest components of yield. Whereas grown soybeans in a monoculture crop achieved the highest seed and biomass yields per feddan in 2023 and 2024 growing seasons. These results are true whereas intercropping soybean with maize controlled by intra and inter competition effect, leads to

high competition between plants of the same crop and the monoculture crop was 100% soybean density, compared to 50% density in intercropping. The results are in harmony by Egbe *et al.* (2010), Hussain *et al.,* (2013) and Zen El-Dein (2015). Followed by growing soybeans in intercropping pattern of 3maize:3soybean (P2) in the two growing seasons. These results may be in line for the increase in competition of inter and intra-specifies between soybean and maize in intercropping system of 2 maize ridges: 2 soybean ridges compared with intercropping system of 3 maize ridges: 3 soybean ridges. These effects are in harmony with those achieved by Abou-Elela *et al.* (2012) and Rashwan and Zen El- Dein (2017).

Table 4: Effects of intercropping patterns and nitrogen fertilizer levels on yield and its components of soybean during 2023 and 2024 growing seasons.

Intercropping patterns (P)	Number of pods/plant		Number of seeds/pod		100-seed weight (g)		Weight Seed (g/plant)		Seed yield (kg/fed)		Biomass yield (ton/fed)	
	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024
P1 (2maize: 2soybean)	70.73b	72.89b	2.61b	2.71b	20.81a	20.67a	24.15b	24.73b	431.56c	444.13c	1.25c	1.30c
P2 (3maize: 3soybean)	93.41a	95.50a	2.78a	2.93a	20.42a	20.28a	27.73a	28.31a	528.95b	547.17b	1.73b	1.79b
P4 (Soybean alone)	65.47c	67.33c	2.75a	2.88a	19.88b	19.74b	20.40c	20.87c	1060.43a	1068.16a	2.98a	3.07a
L.S.D. at 5%	1.52	1.45	0.07	0.08	0.46	0.45	0.42	0.37	19.02	20.05	0.12	0.10
N fertilizer levels												
N1 (75 kg N /fed)	68.42c	70.67c	2.65	2.78	20.06bc	19.91b	22.29c	22.86c	639.12c	661.17c	1.82c	1.89b
N2 (100 kg N /fed)	77.85b	79.94b	2.73	2.84	20.35b	20.22a	24.19b	24.70b	676.85b	684.91b	2.02b	2.10a
N3 (125 kg N /fed)	83.33a	85.11a	2.76	2.90	20.69a	20.56a	25.79a	26.34a	704.97a	713.38a	2.13a	2.17a
L. S. D. at 5%	2.50	2.13	ns	ns	0.40	0.39	0.45	0.44	14.11	17.27	0.08	0.07

Effects in Table (4) revealed that yield components and yield of soybeans were significantly affected by nitrogen fertilizer levels in 2023 and 2024 seasons. 125 kg nitrogen/fed (N3) recorded the maximum values in 2023 and 2024 seasons. Growing nitrogen from 75 to 125 kg of nitrogen/feddan resulted in increased seed yields of soybean under intercropping patterns. These results were consistent with those attained by Jiang *et al.* (2019), Mahmood *et al.* (2020) and Abd-Rabboh *et al.* (2020) recounted that nitrogen affects a variety of physiological and biochemical processes in plant cells that in the end affect the plant growth, yield components and yield.

Results in Table (5) presented that yield components and yield of soybean were significantly affected by interaction in 2023 and 2024 seasons. Sowing soybean as a monoculture crop attained the maximum values of seed and biomass yields under all fertilizer treatments. These results due to monoculture crop were 100% soybean density, compared to 50% density in intercropping soybean agriculture. Shata *et al.* (2007) found that maximum yield of cowpea was obtained when cowpea sown pure stand while lowest yield was achieved when cowpea seeded with millet and maize in all treatments taking the cultivated area into consideration. Followed by grown soybean in intercropping pattern of 3maize:3soybean (P2) under application of 125 kg nitrogen/fed in the first and second seasons. That is intra and inter-competition. Alike results were found by Shao *et al. (*2020) and Nasar *et al.* (2023).

Table 5: The interaction effect on yield and yield components of soybean during 2023 and 2024 growing seasons.

Treatments			Number of pods/plant		Weight Seed (g/plant)		Seed yield (kg/fed)		Biomass yield (ton/fed)
			2023	2024	2023	2024	2023	2024	2024
Maize+ soybean	P_1: 2: 2	N1 (75 kg N /fed)	58.03f	60.33f	21.08f	21.65f	373.67f	394.33f	1.06f
		N2 (100 kg N /fed)	72.95d	75.00d	24.47e	25.01e	428.67e	444.55e	1.38e
		N3 (125 kg N /fed)	81.20c	83.33c	26.89d	27.52bd	492.33d	493.51d	1.45e
	P_2: 3: 3	N1 (75 kg N /fed)	80.89c	83.00c	24.95e	25.74e	473.67d	507.50d	1.59d
		N2 (100 kg N /fed)	95.40b	97.50b	27.71b	28.18b	539.50c	542.50c	1.86c
		N3 (125 kg N /fed)	103.93a	106.00a	30.52a	31.01a	573.67b	591.50b	1.93b
P_4: Soybean pure		N1 (75 kg N /fed)	66.34e	68.67e	20.85g	21.20f	1070.03a	1081.67a	3.01a
		N2 (100 kg N /fed)	65.20e	67.33e	20.39g	20.90fg	1062.37a	1067.67a	3.07a
		N3 (125 kg N /fed)	64.86e	66.00e	19.97gh	20.50g	1048.90a	1055.13a	3.13a
L. S. D at 5%			4.33	3.71	0.78	0.77	24.43	28.99	0.12

D- Yield and Yield Advantages:

1- Land Equivalent Ratio (LER):

Effects in Table (6) showed that intercropping patterns of soybean and with maize and nitrogen fertilizer treatments, exceeded land usage than unit in all treatments in both seasons. Best results in 2023 and 2024 seasons were obtained by using intercropping systems of 2maize:2soybean (P1) and adding of 125% kg nitrogen /fed (N3) which recorded 1.343 and 1.380 when intercropping component was fertilized of 125 kg N/fed (N3) in 2023 and 2024 seasons, respectively. The percentage increase of LER by 34.00% and 38.00% by intercropping maize with soybean compared to maize in a monoculture crop under application of 125 kg nitrogen /fed in 2023 and 2024 seasons, respectively. The reducing of partial LER values of under intercropping pattern 2mize:2soybean (P1) than soybean partial of LER values under intercropping pattern 3mize:3soybean (P2) which accredited to excess ridges of soybean under (P2), caused increasing LER under (P2) than (P1) especially when using of N1 and N2 fertilizer levels, and this data way caused unimportant variation between the two intercropping systems regarding to the total LER. The increase of nitrogen uptake may be referred to as biological nitrogen fixation in soybean and less competition with maize. The use of LER, with such a typical, would result in a biased evaluation of yields towards the intercropping systems. These findings were lined with Shata *et al.* (2007), Echarte *et al.* (2011), Rashwan and Zen El- Dein (2017) and Abd-Rabboh *et al.,* (2020).

2- Relative Crowding Coefficient (RCC):

Results in Table (6) showed that all intercropping systems exceeded than unity in 2023 and 2024 seasons. The maximum results were attained by of 2maize:2soybean (P2) and adding of 125% kg nitrogen/feddan (N3), where K values reached 6.124 and 9.143 in 2023 and 2024 seasons, respectively. It is sure fact that the benefits of expected resources viz. soil moisture, nutrient, light, air, space, etc. were more effective with intercropping than under mono-cropping and fertilizer nutrients. Similar trends were realized by Nawar (2004), Echarte *et al.* (2011) and Iqbal *et al.* (2019).

3- Aggressivity (A):-

Results in Table (6) showed that maize was the dominant, except in the case of 2 maize: 2 soybeans. Also, soybeans were dominated, except in the case of 3 maize: 3 soybeans. Moreover, the lowest values 0.057 and 0.006) were suggested by intercropping pattern of 2 maize: 2 soybeans with intercropping component were received 125 kg N/fed fertilizer level in 2023 and 2024 seasons, respectively, this best competitive values for best production in 2023 and 2024 seasons, respectively. Alike results were gotten by Zen El-Dein (2015), Rashwan and Zen El- Dein (2017) and Abd-Rabboh *et al*. (2020).

Table 6: Land equivalent ratio (LER), relative crowding coefficient (K) and Aggressivity (A) as affected by intercropping patterns of soybean with maize and N fertilizer levels in 2023 and 2024 seasons.

Treatment		Land equivalent ratio (LER)						Relative crowding coefficient (K)						Aggressivity (A)			
		L_{maiz}	L_{soybea}	LER	L_{maize}	L_{soybea}	LER	K_{maize}	K_{sobean}	K	K_{maize}	K_{soybea}	K	A_{maize}	$A_{soybean}$	A_{maize}	$A_{soybean}$
		2023			2.24			2023			2.24			2023		2.24	
P1: 2maize:2 soybean	N1	0.832	0.349	1.181	0.891	0.364	1.255	2.555	1.042	2.662	4.195	1.109	4.652	+0.234	-0.234	+0.167	-0.167
	N2	0.870	0.404	1.274	0.879	0.416	1.295	3.458	1.313	4.541	3.727	1.385	5.162	+0.132	-0.132	+0.107	-0.107
	N3	0.874	0.469	1.343	0.912	0.468	1.380	3.567	1.717	6.124	5.360	1.706	9.143	-0.057	+0.057	+0.006	-0.006
P2: 3maize:3 soybean	N1	0.818	0.443	1.261	0.827	0.468	1.295	2.314	1.542	3.520	2.469	1.707	4.215	-0.063	+0.063	-0.123	+0.123
	N2	0.790	0.508	1.298	0.799	0.508	1.307	1.933	2.003	3.872	2.045	2.005	4.099	-0.297	+0.297	-0.284	+0.284
	N3	0.787	0.547	1.334	0.802	0.561	1.362	1.900	2.343	4.451	2.084	2.477	5.163	-0.417	+0.417	-0.434	+0.434
L.S.D 0.05		P=ns,N=0.005,PxN=0.007			P=ns, N=0.005, PxN=0.007			P=0.308, N=0.011,PxN=0.051			P=0.314, N=0.027,PxN=0.038			P=0.076,N=0.008,PxN=0.011		P=0.46,N=0.011,PxN=0.015	
Maize pure		1.00	---	1.00	1.00	---	1.00	1.00	---	1.00	1.00	---	1.00	1.00	---	1.00	---

CONCLUSION.

Intercropping led to the exploitation of the ground and air resources and harness them to increase production from the unit area. Optimized nitrogen fertilization led to increased production under intercropping patterns. It could be concluded that to obtain the maximum value of productivity, LER and K of intercropping soybean with maize of 2maize:2soybean and fertilizer treatment of 125 kg N/fed.

Declarations:

Ethical Approval: This study did not involve any live animals. It was based solely on experimental laboratory and analysis of plant extracts

Conflict of interest: The authors declare no conflict of interest.

Author's Contributions: I hereby verify that the authors mentioned on the title page has Contributed significantly to the idea and planning of the research, has carefully read the work, attested to the veracity and correctness of the data and its interpretation, and has given their approval for submission.

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