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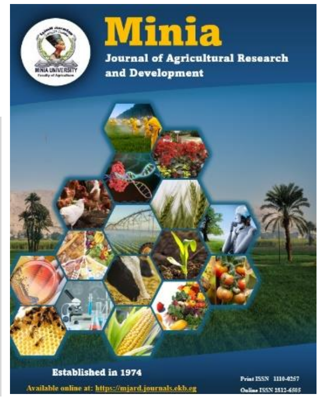

Growth ,Yield And Fruit Quality Of Two Colored Sweet Pepper Hybrids As Affected By Different Sources of Nitrogen Fertilizers

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ABSTRACT

This research was carried out over two successive growing seasons (2022/2023and 2023/2024) at the Experimental Greenhouse, Horticulture Department, Faculty of Agriculture, Minia University which locates in Minia Governorate, Egypt (28.1243667 N, and 30.7289938 E). The study site was situated within the middle Egypt region which has a semiarid climate with considerable temperature differences between day and night. The experiment was conducted inside an ordinary unheated plastic greenhouse. The experiment was laid out in a split-plot design with three replications throught CRBD: Two colored sweet pepper hybrids (OLOM and KARMEN) were distributed in main plot and four nitrogen sources i.e. urea, ammonium nitrate, and ammonium sulphate and bio-organic in sub plot.

The obtained results showed that both colored sweet pepper hybrids were differed each from other on the growth parameters , yield and fruit quality depending on its genetical differences and its reaction with environmental conditions, Also, the results indicated that hybrid OLOM was the best in most of the measuremnt characters compared with KARMEN hybrid under the experimental conditions.

Both growth and yield parameters of pepper plant had differed significantly as the nitrogen sources were differ. Using urea as source of nitrogen fertilizers led to obtain the highest values of plant height and plant fresh weight. On the other hand, applying bio_organic fertilizer resulted in the highest plant dry weight. Whereas, ammonum nitrate gave the heighest value of fruit weight.

Keywords: pepper,hybrids,nitrogen sources,plant growth,yield.

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INTRODUCTION

Sweet pepper (*Capsicum annuum L.*) is recognized as one of the most important and highly valued vegetable crops in the wrold. It cultivates for its immature fruits **(Zou et al.,2022).** Due to its aesthetic appeal and market demand, sweet pepper is extensively grown in protected environments such as greenhouses, where unsuitable seasons enable the production of high commerical quality colored fruits **(Sideman, 2020).** The nutritional value of sweet pepper is great as every 100 grams provide 4.3 g of carbohydrates, 1.3 g of protein, and 24 kcal **(Farooq et al., 2015).** As of 2022, sweet pepper ranked among the most widely cultivated vegetables globally, with global production reached 37 million tonnes across a two million hectares **(FAOSTAT, 2023).**

Sweet pepper is consumed in different ways fresh or cooked vegetable, spices, and even natural coloring agents. Agronomically, they are warm-season, frost-sensitive tropical perennials commonly cultivated as annuals in temperate or short-season climates **(Jimenez-García et al.,2023).** The crop is especially valued for its high content of flavonoids, antioxidants, and vitamins, principally C and A, which participate in both human health and its economic importance in export markets **(Zhang et al.,2020).**

With the global rise in living standards, there is an increasing demand for high-quality and nutritionally rich agricultural production. Pepper (*Capsicum spp.*) which originated in Mexico is recognized as best source vitamin C, carotenoids, carbohydrates, and various secondary metabolites **(Bosland and Votava, 2012 and Mejia et al.,1988).**

Pepper (*Capsicum annuum L.*) is among the most valuable vegetable crops grown in newly reclaimed lands in Egypt due to its high content of nutrients and phenolic antioxidants. These nutrients levels can vary based on genotype, growth stage, and environmental conditions **(Guil-Guerrero and Martinez-Guirado, 2006).**

Its popularity as a greenhouse crop comes from the attractive fruit color, tasted flavor, and rich nutritional content **(Pérez-López *et al.*,2007**). However, challenges in greenhouse cultivation exsist and it appears in the form of nonsemetric fruit set and nonconstant yield, where periods of high production alternate with low price **(Heuvelink et al.,2002; Wubs et al.,2009).and (Bernal Cabrera et al.,2023)** evaluated two commercial sweet pepper hybrids under tropical greenhouse production. The first hybrid showed superior vegetative growth, while second hybrid outperformed in productivity traits such as fruit number, average fruit weight, and total yield Differences in quality traits were also noted, with the second hybrid displaying better pericarp thickness and fruit wall thickness.

Nitrogen (N) is one of the macronutrients required for plants and it plays a critical role in numerous physiological and metabolic processes. It is a main component of nucleic acids (DNA, RNA), proteins, enzymes, chlorophyll, ATP, and various phytohormones such as auxins and cytokinins **(Hawkesford et al.,2012).** Nitrate (NO_3^-) and ammonium (NH_4^+) are the primary forms of nitrogen which are available in soil and have the main effects on plant biochemical processes. When plants are supplied with nitrate, it must first be reduced to ammonium via two energy steps involving nitrate reductase and nitrite reductase enzymes **(Carlisle et al.,2012).** In contrast, ammonium can be directly absorbed through various pathways such as root uptake, biological nitrogen fixation by bacteria, and photorespiration. This process occurs via the glutamine synthetase–glutamate synthetase (GS–GOGAT) pathway, where glutamine synthetase catalyzes the combination of NH_4^+ with glutamic acid to produce more glutamine which subsequently stimulates GOGAT activity **(Piwpuan et al.,2013).**

Nitrogen remains one of the most main macronutrients which is playing vital roles in plant development and physiological functions. Enhancing nitrogen management practices such as aligning supply with crop demand, optimizing fertilizer timing, and selecting suitable nitrogen sources to achieving sustainable productivity **(Hochmuth et al.,1987).**

In Egypt, the most commonly used nitrogen (N) forms in commercial fertilizers are nitrate (NO_3^-), ammonium (NH_4^+), and urea (NH_2CONH_2). The response of pepper plants to different nitrogen forms varies significantly. Several studies showed that nitrate-based fertilization produces taller plants with thicker stems, more green foliage more fruits, and higher yield compared to ammonium-based fertilizers. For instance, nitrate application resulted in a 72–101% increase in yield relative to ammonium **(Owusu et al.,2000;and Sarro et al.,1995).** The same with the highest sweet pepper yield under plastic mulch was recorded when sulfur-coated urea was used it outperformed other N sources such as urea, ammonium nitrate, and ammonium sulfate **(Locascio et al.,1981).**

Moreover, research indicated that ammonium and/or urea-based nutrition may suppress reduce plant growth however, the existance of nitrate can opposite the negative effects. Using mixed nitrogen forms containing urea did not negatively affect mineral content and resulted in higher concentrations of potassium, phosphorus, iron, and boron in the shoots compared to nitrate treatments (**Houdusse et al.,2007).**

The aim of the study

Therefore, the aim of this study was to identify which source of nitrogen would be the best to obtain the highest level growth, yield and quality of colored sweet pepper hybrid under protected cultivation conditions. Also, to study the range of interaction between the two hybrids of colored sweet pepper and different sources of nitrogen.

MATERIAS AND METHODS

This research was carried out over two successive growing seasons (2022/2023and 2023/2024) at the experimental greenhouse, horticulture department, Faculty of Agriculture, Minia University which locates in Minia Governorate, Egypt (28.1243667 N, 30.7289938 E). The study site was situated within the middle Egypt region which has a semiarid climate with considerable temperature differences between day and night. The experiment was conducted inside an ordinary unheated plastic greenhouse and its area was 340 m², 40 m in length and 8.5 m in width. In the first two months the greenhouse was covered with a 64% shade net to reduce light intensity and moderate temperatures during the early growth stages. Then it was replaced with a 200 mm P.V.C film to enhance solar radiation and maintain humidity and temperature levels which are conducive to flowering and fruit setting.

Soil preparation operations were carried out to improve the physical and chemical properties of the soil and create a suitable environment for the growth of sweet pepper plants inside the greenhouse. The soil was plowed twice in perpendicular directions by using a light agricultural plow to break up the soil and enhance its aeration. This process helps root development and reduces problems related to compaction and water retention. All plant residues and weeds were removed to prevent the transmission of pests and diseases to the new crop. Farmyard manure was added into the soil at a rate of 8–10 kg/m², 2.7–3.4 tons for the entire greenhouse. This aimed to improve soil structure and increase its organic matter content and micronutrient availability.

The soil surface was leveled using manual tools to ensure uniform distribution of irrigation water and avoid water accumulation in low areas. The soil was thoroughly mixed with the following fertilizers before transplanting:

• Triple Super Phosphate at a rate of 80–100 g/m².
• Potassium Sulfate at a rate of 20–30 g/m².
• Agricultural Sulfur at a rate of 50 g/m² to improve soil properties and reduce soil humidity.

The greenhouse contains 4 rows each raw was 90cm in width and 70cm between every two rows, two dripper lines were put on each row. Two commercial hybrids colored sweet pepper (*Capsicum annuum L.*) OLMO and KARMEN were used. Seeds were obtained from Shore Company and it was sown in 209-cell plug trays filled with a sterilized peat-perlite mixture. Trays were placed in a controlled-environment nursery with optimal temperature (25–28°C) and relative humidity (70–80%) to ensure uniform germination. After 50 days, vigorous and healthy seedlings of uniform size were transplanted into the greenhouse. Transplanting was done during the early morning hours to reduce transplant shock, and plants were arranged in single rows with 50 cm between plants and 90 cm between rows.

The experiment was laid out in a split-plot design with three replications throught CRBD: Two colored sweet pepper hybrids (OLOM and KARMEN) were distributed in main plot and four nitrogen sources in sub plot (i.e.) urea, ammonium nitrate, ammonium sulphate and mixture of compost + (*Azotobacter chroococum*) biofertilizer

Table (1) Nitrogen fertilizers quantity depending on water requirements according to the Egyptian Ministry of Agriculture...

	Urea	nitrate	sulphate	bioorganic
Sep\Weekly	487.5	675	1091.25	5625
Oct\weekly	813.75	1162.5	1818.75	9375
Nov\weekly	813.75	1162.5	1818.75	9375
Dec\weekly	1301.25	1800	2913.75	14062.5
Jan\weekly	1301.25	1800	2913.75	14062.5
Feb\weekly	1875	2662.5	4275	20625
Mar\weekly	1875	2662.5	4275	20625
Apr\weekly	3112.5	4912.5	24375	2178.75

All treatments were delivered through a drip irrigation system (fertigation) twice weekly, based on standard crop nutrient demand curves. Phosphorus and potassium fertilizers were applied uniformly based on soil test recommendations.

Data Collection and Measurements

At 90 days after transplanting (DAT), vegetative and yield-related parameters were assessed using nine randomly selected plants per experimental plot. The following measurements were recorded:

Vegetative growth parameters

1- Plant height (cm): measured from the soil surface to the apical meristem using a graduated ruler.
2- Number of branches per plant: determined by manually counting all primary branches.
3- Plant fresh weight (g): above-ground fresh biomass was weighed immediately after cutting.
4- Plant dry weight (g): recorded after drying the fresh shoot biomass at 70°c for 72 hours until a constant weight.

Yield and its components:

1- Number of fruits per plant: the total number of marketable fruits per plant was recorded.
2- Total yield per plant: the total weight of fruits per plant was recorded.

Fruit quality

1- Fruit fresh weight (g): weighed immediately after harvest using a digital balance.
2- Fruit wall thickness (mm): assessed at the central cross-section using a vernier caliper.

Statistical Analysis

The experiment data was statistically analyzed using the MSTAT-C software. Analysis of variance (ANOVA) was performed to show the significance of differences among the treatments, hybrids and interaction. When significant differences were detected means comparisons were conducted using the Least Significant Difference (LSD) test at a level of 0.05 to evaluate the effects of different nitrogen sources and hybrids on the studied parameters.

RESULTS AND DISCUSSION

Effect of different nitrogen sources on vegetative growth characteristics of the two colored sweet pepper hybrids.

1. Plant height (cm):

Data presented in Table (2) shows that hybrid OLMO outperformed hybrid KARMEN in plant height in the first season, while hybrid KARMEN outperformed hybrid OLMO in the second season. Plant height values were 120.3 cm and 113.7 cm for OLMO and KARMEN respectively in the first season, while in the second season its values were 108 cm and 116 cm for OLMO and KARMEN respectively. The difference between the hybrids in this character was statistically insignificant in the first season, but it was significant in the second season. The difference in plant height according to hybrids also was reported by **(Kirana et al.,2024)**.

Regarding the effect of nitrogen source, data in the same table (2) shows that in both seasons, urea treatment gave the highest plant height with mean values of 124.8 cm in the first season and 125.3 cm in the second season. These values were significantly higher than those recorded with nitrate and sulphate treatments particularly in the second season. On the other hand, the lowest plant height was recorded with nitrate especially in the second season (99 cm). Meanwhile, bio-organic fertilizer gave an intermediate results with values of plant height (111.5 cm and 113.5 cm) in the first and the second seasons respectively.

Concernning , the interactions between nitrogen sources and hybrids, the combination of hybrid KARMEN with urea achieved the highest plant height in both seasons (125.6 cm and 127 cm), whereas hybrid OLMO with nitrate recorded the lowest values, especially in the second season (96.2 cm). The interaction effects were statistically significant in both seasons.

These results suggest that urea is the most effective nitrogen source for promoting plant height in sweet pepper especially when combined with hybrid KARMEN. Also, the results support the importance of selecting the appropriate hybrid–fertilizer combination to maximize vegetative growth.

Table (2): plant height (cm) of the two colored sweet pepper hybrids as effected by different sources of nitrogen.

	First season 2022 /2023 cm			Second season 2023 / 2024 cm,		
	OLMO	KARMEN	Mean	OLMO	KARMEN	Mean
Urea	124	125.6	124.8	123.8	127	125.3
nitrat	120.8	119.9	120.3	96.2	101.8	99
sulphat	116.3	106.3	111.3	107.3	112.9	110.1
bio-organic	120	103	111.5	104.6	122.4	113.5
Mean	120.3	113.7		108	116	
LSD	A=NS B=3.7 AB=5.1			A=3.3 B=3.1AB=4.5		

2. Number of branches per plant:

Data presented in Table (3) shows that hybrid OLMO was significantly superior as compared with hybrid KARMEN recording 6.4 branches per plant to 5.3 for KARMEN in the first season. Whereas, in the second season hybrid KARMEN significantly outperformed OLMO by averages of 6.1 and 5.3 branches per plant respectively. The difference between the two hybrids was statistically significant in both seasons. Quite similar results was obtained by **(Malik et al.,2011).**

Regarding the effect of nitrogen source, the data in the same table (3) shows that ammonium sulphate treatment had the highest number of branches per plant with mean values of(6.7 and 6.5 in the first and the second season, respectively). These values were significantly higher than the values observed by using nitrate or bio-organic treatments particularly in the second season. On the other hand, the lowest number of branches per plant was obtained from (bio-organic) fertilizer especially in the second season (5.0) indicating its lower effectiveness under the experimental conditions.

The interaction between nitrogen sources and hybrids showed significant differences in both seasons, and the combination of hybrid OLMO and ammonium sulphate gave the highest number of branches per plant in the first season (7.5), while hybrid KARMEN with ammonium sulphate fertilizer achieved the highest value in the second season (6.7).

These results suggest that ammonium sulphate is the most effective nitrogen source for increasing the number of branches in sweet colored pepper,

3. Plant Fresh Weight (g)

As shown in Table (4) the hybrid type had an effect on plant fresh weight in both seasons. Wheares hybrid OLMO recorded the highest average plant fresh weight (157.6 g and 154.3 g in the first and the second season,respectivey). Hybrid effect saying that it was statistically significant in the first season but in the second season the difference was non-significant .

On the other hand, the nitrogen source had a significant influence on plant fresh weight across both growing seasons The highest plant fresh weight was observed with bio-organic fertilizer (170.6 g and 172.2 g respectively in the first and the second season). The lowest value was recorded with urea (130.5 g and 133.8 g in the first and the second season respectively). The differences especially between bio-organic and urea were statistically significant in both seasons. The obtained results agrees with the data which observed by **(Alkharpotly et al,. 2018).** These findings pointout that bio-organic fertilization is better than mineral nitrogen sources in enhancing total plant biomass regardless of hybrid type.

The interaction between nitrogen source and hybrids also had a noticeable impact. As it is shown in the same Table (4) in the first season the highest plant fresh weight (172.6 g) was recorded with bio-organic + OLMO, while the lowest (127.3 g) was found with urea + KARMEN so the differences are statistically significant. In the second season bio-organic + KARMEN produced the highest value (174.4 g), while urea + KARMEN once again gave the lowest value (138 g). The interaction confirms that only large differences, like those which were observed between bio-organic + KARMEN and urea + KARMEN are statistically significant.

Table (3): Number of branch per plant of the two colored sweet pepper hybrids as effected by different sources of nitrogen .

	First season 2022 / 2023			Second season 2023 / 2024		
	OLMO	KARMEN		OLMO	KARMEN	
Urea	5.7	5.2	5.4	6	6	6
nitrat	6.8	5.5	6.2	5	5.8	5.4
sulphat	7.5	5.8	6.7	6.3	6.7	6.5
bio-organic	5.7	4.8	5.3	3.8	6	5
Mean	6.4	5.3		5.3	6.1	
LSD	A=0.6 B=0.4 AB=0.49			A=0.63 B=0.8 AB=0.4		

Table(4): Plant Fresh Weight (g) of the two colored sweet pepper hybrids as effected by different sources of nitrogen

	First season 2022 /2023			Second season 2023 / 2024		
	OLMO	KARMEN		OLMO	KARMEN	
Urea	133.7	127.3	130.5	129.7	138	133.8
nitrat	160.5	153.8	157.1	158	134.5	146.3
sulphat	163.6	157.6	160.6	159.5	131.1	145.3
bio-organic	172.6	168.5	170.6	170	174.4	172.2
Mean	157.6	151.8		154.3	144.5	
LSD	A=3.4	B=9.9	AB=13.9	A=NS	B=12	AB=16.9

4. Plant Dry Weight (g)

Data presented in Table (5) indicate that plant dry weight of colored sweet pepper was affected by hybrid type, where hybrid OLMO recorded higher mean of plant dry weight (37.5 g and 39.0 g in the first and the second season, respectively), as compared with KARMEN (36.2 g and 33.6g in the first and the second season, respectively). However, the differences pointed out statistically significant difference in both seasons. These results suggest that hybrid OLMO have a better capacity for dry matter accumulation in plant particularly under the environmental conditions of the second season.

Nitrogen source had a strong statistically significant effect on plant dry weight in both seasons. However, the highest plant dry weight was obtained from urea (50.1 g and 41.5 g in the first and the second season, respectively).The difference between urea and other nitrogen sources gave a highly significant differences in both seasons. Quite similar results were obtained by **(Alkharpotly et al.,2018)** who found that dry weight of pepper plants were differed according to the nitrogen source.

The interaction between nitrogen source and hybrids showed significant differences in both seasons. The highest plant dry weight (51.3 g and 44.1 g) were observed with urea + OLMO, in the first and the second season, respectively. These finding emphasized that application of urea fertilizer with hybrid OLMO gave the best effect in promoting plant dry biomass under variable seasonal conditions.

Table(5): Plant Dry Weight (g) of the two colored sweet pepper hybrids as effected by different sources of nitrogen.

	First season 2023/2024			Second season 2023/ 2024		
	OLMO	KARMEN		OLMO	KARMEN	
Urea	51.3	48.9	50.1	44.1	39	41.5
nitrat	42.2	41.3	41.8	42.5	32.9	37.7
sulphat	30.1	29	29.6	32.7	31.2	32
bio-organic	26.3	25.7	26	36.7	31.3	34
Mean	37.5	36.2		39	33.6	
LSD	A=0.5	B=2.8	AB=3.6	A=3.2	B=3.2	AB=4.5

5. Number of fruits per plant:

The effect of colored sweet pepper hybrids on fruits number per plant was evident in both seasons as shown in Table (6). In the first season hybrid KARMEN had a significantly higher number of fruits (9.2) than hybrid OLMO (8.2), and the difference was statistically significant. However, in the second season, hybrid OLMO produced slightly more fruits (7.5) than KARMEN (7.2), but the difference recorded a insignificant difference. These results are in agreement with those obtained by **(Komala et al.,2024**).

Nitrogen source significantly affected the number of fruits per plant in both seasons. Data reported in Table (6) ,indicate that in the first season the highest number of fruits (9.2) was recorded with nitrate, followed closely by sulphate and urea (8.8 for each), while the lowest value was obtained with bio-organic fertilizer (7.9). In the second season urea treatment gave the highest fruit number (8.9), followed by sulphate (7.7), while bio-organic again produced the lowest value (5.9)..

The interaction between nitrogen sources and hybrids had a significant effect. In the first season the combination of hybrid KARMEN with urea had the highest fruit number (10.6), while the lowest was recorded for KARMEN with bio-organic fertilizer (7.7). In the second season the maximum fruit number (9.6) was observed with urea + OLMO, while the lowest (5.8) occurred with bio-organic + KARMEN.. These findings showed that both of nitrogen source and hybrid play had a critical role in determining fruit yield.

Table (6): Number of fruits per plant of the two colored sweet pepper hybrids as effected by different sources of nitrogen .

	First season 2022/ 2023			Second season 2023 /2024		
	OLMO	KARMEN		OLMO	KARMEN	
Urea	7.1	10.6	8.8	9.6	8.2	8.9
nitrat	8.7	9.7	9.2	6.2	7.8	7
sulphat	9	8.7	8.8	8.2	7.1	7.7
bio-organic	8	7.7	7.9	6	5.8	5.9
Mean	8.2	9.2		7.5	7.2	
LSD	A=0.6 B=0.8 AB=1.1			A=NS B=1.4 AB=2		

6. Total Yield Per Plant (g):

As shown in Table (7) hybrid type had an influence effect on plant yield across the two growing seasons. In the first season hybrid KARMEN achieved a significant higher mean of yield (1229.1 g per plant) compared to OLMO (1196.6 g per plant). In the second season hybrid OLMO surepassed KARMEN (1029.4 g vs. 948.2 g), and the difference manifested a statistically significant ..

On the other hand, the nitrogen source had a significant impact on plant yield in both seasons.In the first season the highest plant yield was obtained from nitrate (1424.9 g per plant) and it was followed closely by sulphate (1393.7 g), However,. insigificant differences were obtained between the mean values of yield per plant with both nitrate and sulphat In the second season ,sulphate recorded the highest yield (1293.1 g), and the differences between the treatments were statistically significant. These findings refer that nitrate was more effective under the conditions of the first season, whereas, sulphate had superior and more stable performance in the second season.

The interaction between hybrid type and nitrogen source had a significant effect on plant yield across the both seasons.In the first season, the highest plant yield was obtaind with the combination of nitrate + OLMO (1427.5 g), and it was closely followed by nitrate + KARMEN (1422.4 g). The differences between these two combinations were statistically insignificant.In the second season the best performance was obtained from sulphate + OLMO (1330.9 g), followed by sulphate +

KARMEN (1255.4 g), the differences between these two combinations were statistically insignificant.The obtained results are in line with those obtained by obsrved by **(Alkharpotly et al.,2018) .** The response of colored sweet pepper hybrids to the applied nitrogen sources agreed with those obtained by **(Guohua et al.,2001).**

Table (7): Plant Yield (g) of ,the two colored sweet pepper hybrids as effected by different sources of nitrogen

	First season 2022 / 2023			Second season 2023/2024		
	OLMO	KARMEN		OLMO	KARMEN	
Urea	956	989.5	972.7	946.6	888.6	917.6
nitrat	1427.5	1422.4	1424.9	821.2	797.8	809.5
sulphat	1372	1415.5	1393.7	1330.9	1255.4	1293.1
bio-organic	1031	1089.1	1060	1019	850.9	935
Mean	1196.6	1229.1		1029.4	948.2	
LSD	A=20.4	B=54.4	AB=76.9	A=55.5	B=86	AB=122.1

7. Fruit Weight (g)

As shown in Table (8) hybrid had an influence on fruit weight. Hybrid OLMO recorded a significantly higher average fruit weight (330 g and 278.2 g) compared with KARMEN hybrid (253.4 g and 259.5 g) in the first and the second season, respectively. In the first season the difference for hybrid effect had statistical significance.In the second season the difference wa nonsignificant. The previouse results demonstrate the best performance of hybrid OLMO in terms of fruit weight in the second seasons. The data obtaind by **(Rathva et al.,2023)** says almost the same that Hybrid had an influence on fruit weight .

The nitrogen source also showed a significant effect on fruit weight in both seasons. the highest mean fruit weight was recorded with nitrate fertilizer (311.5 g and 288.8 g in the first and the second season, respectively). The difference confirmed a significant effect for the different fertilizer source.These results says that nitrate enhanced fruit weight and gave the highest value making it the most effective nitrogen source for fruit improvement across the two seasons.

The interaction between hybrid and nitrogen source revealed significant differences. The highest fruit weight was obtained with nitrate + OLMO (364.1 g and 307.5 g , in the first and the second season, respesctively). The differences between these combinations were statistically significant in bth seasns. These results highlight the importance of both fertilizer source and hybrid selection in maximizing fruit weight. The combination of nitrate fertilizer and hybrid OLMO was the most effective in enhancing fruit weight in colored sweet pepper.

8. Fruit Thickness (cm)

Data presented in Table (9) shows that hybrid type had an insignificant effect on fruit thickness in both seasons.

The nitrogen source had a significant effect only in the first season. Whereas, in the second season insignificant effect was obtained.

The interaction between hybrid and nitrogen source showed significant effect in the first season only .However, insignificant effect were obtained in the second season.

Table(8): Fruit Weight (g)of the two colored sweet pepper hybrids as effected by different sources of nitrogen .

	First season 2022/ 2023			Second season 2023/2024		
	OLMO	KARMEN		OLMO	KARMEN	
Urea	345.9	252.4	299.2	253.9	236.4	245.1
nitrat	364.1	259	311.5	307.5	270.1	288.8
sulphat	260.3	248.5	254.4	283.3	288	285.6
bio-organic	350	254	302	268.2	243.5	255.9
Mean	330	253.4		278.2	259.5	
LSD	A=33.3	B=35.1	AB=49.6	A=NS	B=27.5	AB=38.9

Table(9): Fruit Thickness (cm) of the two colored sweet pepper hybrids as effected by different sources of nitrogen .

	First season 2022/2023			Second season 2023/2024		
	OLMO	KARMEN		OLMO	KARMEN	
Urea	0.4	0.47	0.435	0.492	0.483	0.487
nitrat	0.5	0.56	0.53	0.517	0.492	0.505
sulphat	0.567	0.51	0.538	0.5	0.487	0.493
bio-organic	0.443	0.353	0.443	0.492	0.478	0.485
Mean	0.5	0.473		0.5	0.485	
LSD	A=NS	B=0.06	AB=0.09	A=NS	B=NS	AB=NS

DISCUSSOIN

The results of our experiment showed that the two hybrids were differed from each other in their growth characteristics, yield, and fruit quality. These differences between hybrids may depend on their genetic characteristics and the interaction of these genetic traits with various nitrogen sources and environmental conditions, such as temperature, light, and humidity inside the greenhouse. The interaction between the genetic characteristics of hybrids and the environmental conditions of the soil affects the physiological processes inside the pepper plant, which in turn influences morphological traits, yield components, and fruit quality.

The results also showed that nitrogen sources differed in their effects on the growth and yield of colored sweet pepper plants in both seasons. These differences may be attributed to the form of nitrogen, its solubility, and its availability in the soil. The results indicated that urea was less effective in the early stages but contributed to an increase in some traits such as plant dry weight and plant height, which may be related to its specific role during vegetative growth.

In contrast, the organic and biofertilizer sources improved root fresh and dry weight and fruit dry weight, possibly due to their role in enhancing soil properties, producing growth regulators (e.g., GA3 and IAA) around the roots, and improving the physiological characteristics of the soil.

Ammonium sulfate improved fruit quantity and quality such as number f fruits per plant, fruit diameter and number of fruit chambers, which may be related to the role of sulfate in reducing soil pH around the roots and increasing the availability of some micronutrients and phosphorus. These actions enhanced growth and yield characteristics, while the slow-release and long-term effects of ammonium nitrate made more affection during the later growth stages of pepper plants and this increased fruit length, fruit weight and total yield.

Moreover, the interaction between hybrids and nitrogen sources was significant in both seasons, indicating that nutritional requirements differ according to the hybrid and the form of nitrogen applied.

It is clear from the results obtained from this experiment, that the fluctuant in data was high from season to the another which may be as result of the huge changes in the environmental conditions particular the change in the climate to higher temperatures during summer, and lower cold temperatures during winter Also, these differences may depend on the genetically differed between the two hybrids and the reaction for this genetically differed with all environmental conditions. These genetic differences between the two hybrids may be a result of a switch on and off for some genes whose role is controlled by biotic and abiotic stress conditions on plant growth .Many researches demonstrated the influence that the gene exert on physiological processes by controlling the mechanism of synthesis of enzymes .

In agricultural systems, applications of inorganic N facilitate higher yields but can be costly and trigger adverse environmental effects . Managing the timing and rates of N applications is complex, as it is influenced by soil properties, crop type, and climatic regions, and its effectiveness is heavily driven by weather. As a result, less than half of applied inorganic N fertilizer has been reported to be taken up by crops and instead is stored in the soil or lost to the environment Nitrate N losses through leaching or surface runoff can significantly affect water quality at multiple scales In some instances, organic amendments as N sources have been used to provide N to the crops and facilitate additional soil functions such as improving soil water holding capacity, nutrient cycling, and structure to promote habitat for soil biota.

CONCLUSION

1- Both two hybrids differed each from other in their respond to climate condition and nitrogen sources.
2- The four nitrogen sources showed different effects on growth, yield and quality of colored sweet pepper. Each one of these sources was suitable and effective in different stage of plant growth. But is general, we can recommend using urea as asurce of nitrogen in vegetative stage, and for good rooting and fruit quality the bio source was the best,while ammounium sulphate and ammounium nitrate were the best in flowering, fruit set and yield stage.

SUMMARY

This study was conducted during two consecutive growing seasons (2022/2023 and 2023/2024) in the experimental greenhouse of the Horticulture Department, Faculty of Agriculture, Minia University,

situated in Minia Governorate, Egypt.This study was conducted to evaluate the effects of different nitrogen sources:urea, ammonium nitrate, ammonium sulfate, and a bio-organic mixture on the vegetative growth, yield, and fruit quality on two colored sweet pepper hybrids (OLMO and KARMEN) grown under protected cultivation conditions. A split-plot design was used throught CRBD, with hybrids in main plots and nitrogen sources to sub-plots.

The results of this experiment can be summarized as following:

The results clearly showed the superiority of hybrid OLMO in most vegetative and productive traits, including plant fresh and dry weight, root development, fruit size, and dry matter content, with relatively more stable performance compared to KARMEN, which only excelled in the number of chambers per fruit.

Regarding nitrogen sources, Urea showed positive effects on vegetative growth but was the least effective in improving economic traits. the bio-organic fertilizer was highly effective in enhancing root development and fruit quality due to its improvement of soil structure and gradual nutrient release. Ammonium nitrate achieved the highest yield in the first season and the highest weight of fruit in both seasons while ammonium sulfate performed better in number of branches per plant, rflecting the impact of environmental conditions on nitrogen uptake efficiency.

The significant interaction between hybrid and nitrogen source highlighted the importance of genetic compatibility with fertilizer type, as OLMO achieved the best results when combined with the bio-organic or ammonium-based fertilizers. These findings emphasize the need to tailor fertilization programs according to hybrid type and seasonal conditions to maximize yield and improve plant quality.

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الملخص العربي

نمو وإنتاجية وجودة ثمار هجينين من الفلفل الحلو الملونين في تأثرهما بمصادر مختلفة من السماد النيتروجيني

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تم تنفيذ هذه الدراسة خلال موسمين زراعيين متتاليين(٢٠٢٢/٢٠٢٣و٢٠٢٣/٢٠٢٤) في الصوبة الزراعية التجريبية التابعة لقسم البساتين، كلية الزراعة، جامعة المنيا، محافظة المنيا، مصر. وقد أجريت هذه الدراسة بهدف تقييم تأثير مصادر النيتروجين المختلفة:اليوريا، نترات النشادر، سلفات النشادر، ومزيج من السماد العضوي والحيوي على النمو الخضري، والإنتاج، وجودة الثمار لصنفين من هجن الفلفل الملون (أولمو و كارمن).

تم استخدام تصميم القطاعات المنشقة خلال تصميم قطاعات كامل العشوائية، حيث وُزعت الهجن على القطاعات الرئيسية، في حين تم توزيع مصادر النيتروجين على القطاعات الثانوية.

يمكن تلخيص نتائج هذا البحث كما يلي:

أوضحت النتائج تفوق هجين أولمو في معظم الصفات الخضرية والإنتاجية، بما في ذلك الوزن الطازج والجاف للنبات، نمو الجذور، حجم الثمار، ومحتوى المادة الجافة، مع أداء أكثر استقراراً نسبياً مقارنة بـالهجين كارمن وفيما يتعلق بمصادر النيتروجين، فقد أظهرت اليوريا تأثيرات إيجابية على النمو الخضري لكنها كانت الأقل فاعلية في تحسين الصفات الاقتصادية. أما السماد الحيوي-العضوي فقد كان فعالاً في تعزيز نمو الجذور وجودة الثمار. وحققت نترات الأمونيوم أعلى محصول في الموسم الأول وأعلى وزن للثمرة في كلا الموسمين، بينما كان أداء سلفات الأمونيوم أفضل في عدد الأفرع لكل نبات.

وقد أبرز التفاعل المعنوي بين الهجين ومصدر النيتروجين أهمية التوافق الوراثي مع نوع السماد، حيث حقق هجين أولمو أفضل النتائج عند دمجه مع الأسمدة الحيوية أو الأسمدة المحتوية على الأمونيوم. وتؤكد هذه النتائج على ضرورة تخصيص برامج التسميد وفقاً لنوع الهجين وظروف الموسم وكذلك استخدام كل مصدر للنيتروجين في المرحلة المناسب لها من حياة النبات لزيادة المحصول وتحسين جودة النبات والحصول على أفضل النتائج.