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IMPACT OF NPK FERTILIZATION LEVEL AND LITHOVIT RATE ON GROWTH AND YIELD COMPONENTS OF HOT PEPPER (*Capsicum annuum*, L.) PLANT

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ABSTRACT: Two field experiments were carried out at Experimental Farm (Ghazala Farm) of Agric. Fac., Zagazig Univ., Egypt during the two summer seasons of 2019 and 2020 to study the effect of NPK fertilization levels (0.0, 75, 100 and 125 % of recommended level), lithovit rates (0.0, 1.0, 2.0, 3.0 and 4.0 g/l) and their combination treatments on plant growth and yield components of hot pepper plant cv. Chillina. The recommended rate (RR) was 90, 32 and 76 kg/feddan of N, P_2O_5 and K_2O, respectively. These experiments were set up in a split-plot design with three replicates. The main plots were occupied by four NPK fertilization levels. While, the sub plots were entitled to five lithovit rates. The combination between the main factor and the sub factor resulted in 20 combination treatments. The obtained results pointed out that using NPK fertilization at 125% RR significantly increased hot pepper height, number of branches/plant, fresh and dry weight of leaves per plant, root length, fruit length and diameter, number of fruits per plant and fruit yield per plant and per feddan compared to control and the other ones under study. The highest values in abovementioned parameters with significant differences were recorded when hot pepper plants sprayed with lithovit at 3.0 g/l compared to control and the lowest rates and the highest one under study. In general, hot pepper plants fertilized with 125% RR of NPK and sprayed with 3.0 g/l lithovit significantly gave the highest values in plant growth and yield components compared to the other combinations under study.

Key words: *Capsicum annuum*, NPK fertilization, lithovit, growth and yield components.

INTRODUCTION

The family Solanaceae contains many important plants, including hot pepper (*Capsicum annuum* L.) plants. It is a widely cultivated species in Egypt that has been utilized since ancient times for human health and as food flavoring (**Milla, 2006**). The dried fruit is utilized as a spice and condiments (**Dagnoko *et al*., 2013**). Hot pepper became a suitable candidate for utilize in poverty reduction programs targeting resource poor households, including women in developing villages. Nutritionally, hot pepper supplies the human body with many of mineral nutrients, A and C vitamins and proteins (**Bose *et al*., 1993**).

NPK fertilizers play serious roles in various physiological processes in the plant which were reported by **Lambers *et al*. (2000)**. The role of nitrogen (N) in protoplasm formation and all proteins e.g. amino acids, many enzymes, nucleic acid and energy transfer materials (ADP and ATP) were described by **Russel (1973)**, the role of phosphorus (P) as a prime nutrient element, where P compounds are absolute necessity for all living organisms, nucleus proteins constituting the main materials of the cell and for development of meristematic tissues and cell division as well as potassium (K) is serious for elongation probably due to its function as an osmaticum and growth and it may react synergistically with IAA. In addition, K encourages CO_2 assimilation and translocation of carbohydrates from the leaves to storage tissues **(Mengel and Kirkby, 1987)**.

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Recently, Nano-fertilizers are utilized as an alternative to conventional fertilizers due to relaxer release and efficacious utilize by plants. Lithovit compound particles contain calcium carbonate ($CaCO_3$) at 80%, magnesium carbonate ($MgCO_3$) at 4.6% and Fe at 0.75%. The beneficial influence of this compound (lithovit) is being contains $CaCO_3$ decomposes to calcium oxide (CaO) and carbon dioxide (CO_2) in leaves stomata and this CO_2 increases process of photosynthesis leading to enhances in carbon uptake and assimilation, thereby improving plant growth (**Carmen *et al.*, 2014**). Furthermore, **Mohammed *et al.* (2021**) suggested that the highest values of plant height, leaves number per plant and total dry weight per plant of cluster bean and roselle as well as sepals yield per plant were achieved by 4 g/l of lithovit compared to the other rates under study.

Therefore, this experiment designed to find a proper level of NPK fertilization as well as lithovit rate for enhancing growth and yield components of hot pepper (*Capsicum annuum* L.) under Sharkia Governorate conditions.

MATERIALS AND METHODS

To evaluate the impact of different NPK levels, lithovit rates and their combinations on growth and yield of hot pepper two field experiments were done at Experimental farm, Faculty of Agriculture, Zagazig University during the two summer consecutive seasons of 2019 and 2020. The NPK fertilization levels were (0.0, 75, 100 and 125 % of recommended rate). The recommended rate (RR) under area conditions was 90, 32 and 76 kg/feddan of N, P_2O_5 and K_2O, respectively. The lithovit rates were (0.0, 1.0, 2.0, 3.0 and 4.0 g/l). Besides, the combination treatments between NPK fertilization levels and lithovit rates (4 × 5 = 20 treatments). The current experiments were set up in a split-plot design with three replicates. The main plots were occupied by NPK fertilization levels. While, the sub plots were entitled to lithovit rates. The physical and chemical properties of the experimental soil are shown in Table 1 according to **Chapman and Pratt (1978)**.

The experimental unit area was 18.90 m^2 (4.50 × 4.20 m) included six ridges. Each ridge was 70 cm wide and 4.50 meters length. The distance between hot pepper plants in the ridge was 40 cm, under surface irrigation system. The hot pepper "cv. Chillina" seedlings were obtained from private nursery in Belbas District, Sharkia Governorate, Egypt. All transplants were similar in development and growth and 13 -15 cm in length. Seedlings were transplanted in the experimental units on 25th and 28th April during the 2019 and 2020 seasons, respectively.

Different levels of NPK fertilization were applied as follows: Nitrogen ammonium nitrate (33% N) and potassium as potassium sulphate (50% K_2O) fertilizers levels were divided into four equal levels and were added to the soil at 30, 60 and 90 days after hot pepper transplanting, also, phosphorus fertilization as calcium superphosphate (15.5% P_2O_5) was applied during soil preparation. In addition, five lithovit rates were applied to hot pepper plants as foliar spray four times at 35, 50, 65 and 80 days from transplanting date. The German foliar fertilizer lithovit was utilized in this work. The lithovit was obtained from Agrolink Company as a powder. All recommended agricultural practices of growing hot pepper plants were done when ever needed.

Recorded Data

Plant growth

After 112 days from hot pepper transplanting date, a sample of 3 plants were randomly taken from each experimental unit and plant growth parameters as plant height (cm), branches number/plant, fresh and dry weights of leaves/ plant (g) and root length were recorded.

Yield and its components

Fruits of hot pepper were harvested every two days intervals, upon reaching 6-10 cm length. At harvesting stage the yield components expressed as fruit length (cm), fruit diameter (cm), fruits number /plant, fruits yield/plant (g) and yield/feddan (ton) were listed.

Statistical Analysis

Collected data of current reseasrch were analyzed according to **Gomez and Gomez (1984)**. Least significance difference (LSD) was used to differentiate means at the at 5% level of probability. The means were compared utilizing computer program of Statistix version 9 (**Analytical software, 2008**).

Table 1. Physical and chemical properties of experimental farm soil (average of the two seasons)

Mechanical analysis				Soil texture
Clay (%)	Silt (%)	Fine sand (%)	Coarse sand (%)	Clay
43.49	11.10	13.52	31.89	

Chemical analysis												
pH	E C m.mohs / cm	Organic matter (%)	Soluble cations (meq. / L)				Soluble anions (meq. / L)			Available (ppm)		
			Mg^{++}	Ca^{++}	K^{+}	Na^{+}	Cl^{-}	HCO_3^{-}	SO_4^{--}	N	P	K
7.87	0.95	0.52	2.8	1.5	1.3	3.8	4.5	1.5	3.4	17.0	8.30	71.0

RESULTS AND DISCUSSION

Plant Growth Parameters

Effect of NPK fertilization

As shown in Tables 2, 3, 4, 5 and 6 that increasing NPK fertilization level gradual significantly increased plant hieght, branches number per plant, fresh and dry weights of leaves per plant and root length in both seasons. Hot pepper plants fertilized with 125 % RR of NPK fertiilzation gave the highest values regard plant growth parameters with significant differences with the other levels under study in the two seasons. The increases in dry weight of leaves per plant were about 22.14 and 19.64 % for 125% RR level over control treatment in the 1st and 2nd seasons, respectively. Generally, all NPK fertilizatioin levels significantly increased hot pepper growth parameters compared to control. These results are in line with those reported by **Alhasan *et al*. (2020)** and **Gavrić *et al*. (2021)** as well as **Lasheen *et al*. (2021)** on *Salvadora persica* plant.

Effect of lithovit

Increasing lithovit from 0.0 up to 3.0 g/l rate gradually increased plant hieght, branches number per plant, fresh and dry weights of leaves per plant and root length, then they were decreased with 4.0 g/l rate in the two tested seasons (Tables 2, 3, 4, 5 and 6). Moreover, the highest values in abovementioned growth parameters were achieved when hot pepper plants sprayed with lithovit at 3.0 g/l rate four times per seasons with significant differences with control and the other rates under study. The increases in number of branches per plant were about 68.88 and 55.84% for 3.0 g/l lithovit rate over control treatment in the 1st and 2nd seasons, respectively. These results are in harmony with those stated by **Dawa *et al*. (2017)** on tomato plant, **Abd El-Aal and Eid (2018)** on soybean plant and **Abdelkader *et al*. (2018)** on coriander plants.

Effect of combination between NPK fertilization and lithovit

Data presented in Tables 2, 3, 4, 5 and 6 reveal that the combination treatment between NPK fertilization at 125% RR and lithovit at 3.0 g/l significantly increased hot pepper growth parameters compared to control and the other ones under study in the two seasons. In addition, increasing lithovit rates up to 3.0 g/l under each NPK fertilization level gradually increased plant hieght, branches number per plant, fresh and dry weights of leaves per plant and root length of hot pepper. Moreover, as mentioned just before, both NPK fertilization and lithovit treatments (each alone) increased plant growth, in turn, they together might maximize their influences leading to tallest plant, more branches per plant as well as heaviest leaves. Likewise, **Ghatas and Mohamed (2018)** demonstrated that spray *Cymbopogon citruts* plants with lithovit 4 times/ season was enhanced the plant growth i.e., plant height, fresh and dry weights of herb (g/plant), and number of tiller per plant) compared to untreated plants. Also, applying NPK fertilizer to basil plant produced the highest growth traits (**Alhasan *et al*., 2020**).

Table 2. Effect of NPK fertilization level (F), lithovit rate (L) and their interaction treatments (F×L) on plant height (cm) of hot pepper plant during the 2019 and 2020 seasons

NPK fertilization level (F)	Lithovit rate (L) (g/l)					
	Control	1	2	3	4	Means (F)
			2019 season			
Control	72.67	76.33	78.33	83.67	81.00	**78.40**
75%RR	76.00	79.00	86.67	95.67	86.33	**84.73**
100%RR	86.00	91.00	96.67	111.33	100.00	**97.00**
125%RR*	92.67	100.67	112.67	124.33	109.67	**108.00**
Means (L)	**81.83**	**86.75**	**93.58**	**103.75**	**94.25**	
LSD at 5%	For (F) = 2.54		For (L) = 2.32		For (F×L) = 4.85	
			2020 season			
Control	70.67	74.67	76.33	82.33	77.67	**76.33**
75%RR	74.67	77.00	85.00	92.67	84.67	**82.80**
100%RR	81.33	88.00	90.67	105.67	102.00	**93.53**
125%RR*	88.33	97.67	108.67	120.67	105.33	**104.13**
Means (L)	**78.75**	**84.33**	**90.17**	**100.33**	**92.42**	
LSD at 5%	For (F) = 0.68		For (L) = 1.30		For (F×L) = 2.42	

*Recommended rate (RR): 90, 32 and 76 kg/fad. of N, P2O5 and K2O, respectively.

Table 3. Effect of NPK fertilization level (F), lithovit rate (L) and their interaction treatments (F×L) on number of branches/plant of hot pepper plant during the 2019 and 2020 seasons

NPK fertilization level (F)	Lithovit rate (L) (g/l)					
	Control	1	2	3	4	Means (F)
			2019 season			
Control	19.33	26.00	31.33	35.00	29.00	**28.13**
75%RR	21.00	27.00	33.00	36.33	31.33	**29.73**
100%RR	24.33	28.67	36.00	38.67	35.00	**32.53**
125%RR*	26.33	32.00	38.67	43.67	38.00	**35.73**
Means (L)	**22.75**	**28.42**	**34.75**	**38.42**	**33.33**	
LSD at 5%	For (F) = 1.40		For (L) = 0.96		For (F×L) = 2.20	
			2020 season			
Control	18.33	24.33	30.33	31.67	28.67	**26.67**
75%RR	20.33	25.67	29.33	35.00	32.33	**28.53**
100%RR	25.00	29.33	35.00	37.00	31.00	**31.47**
125%RR*	27.00	30.33	35.67	37.67	35.00	**33.13**
Means (L)	**22.67**	**27.42**	**32.58**	**35.33**	**31.75**	
LSD at 5%	For (F) = 1.04		For (L) = 0.58		For (F×L) = 1.46	

*Recommended rate (RR): 90, 32 and 76 kg/fad. of N, P2O5 and K2O, respectively.

Table 4. Effect of NPK fertilization level (F), lithovit rate (L) and their interaction treatments (F×L) on fresh weight of leaves/plant (g) of hot pepper plant during the 2019 and 2020 seasons

NPK fertilization level (F)	Lithovit rate (L) (g/l)					
	Control	1	2	3	4	Means (F)
			2019 season			
Control	260.27	319.27	360.27	408.97	372.60	**344.27**
75%RR	278.37	347.27	379.73	427.73	393.27	**365.20**
100%RR	339.47	359.13	396.50	449.47	399.93	**388.90**
125%RR*	363.53	372.73	406.60	460.37	401.20	**400.89**
Means (L)	**310.41**	**349.60**	**385.78**	**436.54**	**391.75**	
LSD at 5%	**For (F) = 2.86**		**For (L) = 6.40**		**For (F×L) = 11.79**	
			2020 season			
Control	254.37	322.62	366.98	399.19	366.31	**341.89**
75%RR	266.58	333.18	372.60	416.37	379.02	**353.55**
100%RR	288.33	354.03	386.83	414.35	403.31	**369.37**
125%RR*	345.96	363.26	406.60	403.11	429.01	**389.59**
Means (L)	**288.81**	**343.27**	**383.25**	**408.26**	**394.41**	
LSD at 5%	**For (F) = 3.07**		**For (L) = 3.98**		**For (F×L) = 7.74**	

*Recommended rate (RR): 90, 32 and 76 kg/fad. of N, P2O5 and K2O, respectively.

Table 5. Effect of NPK fertilization level (F), lithovit rate (L) and their interaction treatments (F×L) on dry weight of leaves/plant (g) of hot pepper plant during the 2019 and 2020 seasons

NPK fertilization level (F)	Lithovit rate (L) (g/l)					
	Control	1	2	3	4	Means (F)
			2019 season			
Control	37.70	45.61	50.07	58.29	51.57	**48.65**
75%RR	38.69	46.78	54.10	64.39	57.66	**52.32**
100%RR	43.28	49.06	58.86	65.68	60.81	**55.54**
125%RR*	50.43	53.40	61.08	69.60	62.62	**59.42**
Means (L)	**42.52**	**48.71**	**56.03**	**64.49**	**58.17**	
LSD at 5%	**For (F) = 0.93**		**For (L) = 1.15**		**For (F×L) = 2.26**	
			2020 season			
Control	37.02	46.48	49.09	54.44	50.02	**47.41**
75%RR	43.30	45.20	51.01	59.67	57.16	**51.27**
100%RR	41.92	47.36	52.85	61.46	61.56	**53.03**
125%RR*	45.98	53.14	54.80	64.41	65.28	**56.72**
Means (L)	**42.06**	**48.04**	**51.94**	**60.00**	**58.50**	
LSD at 5%	**For (F) = 0.63**		**For (L) = 0.71**		**For (F×L) = 1.42**	

*Recommended rate (RR): 90, 32 and 76 kg/fad. of N, P2O5 and K2O, respectively.

Table 6. Effect of NPK fertilization level (F), lithovit rate (L) and their interaction treatments (F×L) on root length (cm) of hot pepper plant during the 2019 and 2020 seasons

NPK fertilization level (F)	Lithovit rate (L) (g/l)					
	Control	1	2	3	4	Means (F)
			2019 season			
Control	26.20	30.97	34.40	39.83	31.97	**32.67**
75%RR	27.13	32.10	34.57	40.13	32.67	**33.32**
100%RR	30.83	32.37	35.47	41.40	34.07	**34.83**
125%RR*	32.07	33.43	35.43	42.37	32.23	**35.71**
Means (L)	**29.06**	**32.22**	**34.97**	**40.93**	**33.48**	
LSD at 5%	**For (F) = 1.44**		**For (L) = 1.01**		**For (F×L) = 2.30**	
			2020 season			
Control	24.30	30.27	35.10	37.73	33.13	**32.11**
75%RR	25.70	32.73	35.87	39.13	35.10	**33.71**
100%RR	29.17	34.03	36.07	40.20	35.40	**34.97**
125%RR*	30.70	34.90	36.40	43.47	37.77	**36.65**
Means (L)	**27.47**	**32.98**	**35.86**	**40.13**	**35.35**	
LSD at 5%	**For (F) = 0.59**		**For (L) = 0.61**		**For (F×L) = 1.24**	

*****Recommended rate (RR): 90, 32 and 76 kg/fad. of N, P2O5 and K2O, respectively.

Yield and its Components

Effect of NPK fertilization

The data given in Tables 7, 8, 9, 10 and 11 suggest that fertilized hot pepper plants with 125% RR of NPK fertilization gave the highest values of fruit length and diameter, number of fruits per plant and fruit yield per plant and per feddan compared to control and the other ones under study. In general, increasing NPK fertilization level gradually increased hot pepper yield components in both seasons. The increases in fruits yield per plant were about 51.03 and 41.83% for 125% RR level over control treatment in the 1st and 2nd seasons, respectively. Generally, all NPK fertilizatioin levels significantly increased hot pepper yield components compared to control. Furthermore, **Jabborova *et al*. (2021)** reported that using NPK fertilizers as macronutrients significantly increased ginger yield rhizome compared to control.

Effect of lithovit

It is quite clear from the data in Tables 7, 8, 9, 10 and 11 that the highest values of fruit length and diameter (cm), number of fruits per plant and fruit yield per plant (g) and per feddan (ton) were achieved when hot pepper plants sprayed with lithovit at 3.0 g/l rate four times per season with significant differences with control and the other rates under study. Moreover, increasing lithovit from 0.0 up to 3.0 g/l rate gradually increased yield components then they were decreased with 4.0 g/l rate in the two tested seasons. The increases in fruits yield per plant were about 61.90 and 68.30% for 3.0 g/ l lithovit rate over control treatment in the 1st and 2nd seasons, respectively. The beneficial lithovit influence is being contains $CaCO_3$ decomposes to CaO and CO_2 in plant leaves stomata, and this CO_2 increases photosynthesis intensity, leading to raise carbon uptake and assimilation, thereby increasing yield components of hot pepper crop (**Carmen *et al*., 2014**). In the same time, **Abd El-baset (2018)** pointed out that sprayed *Echinacea purpurea* (L.) plants with 2g/l lithovit at 30 days interval for 3 times/season led to improve fresh and dry flower yield per plant.

Table 7. Effect of NPK fertilization level (F), lithovit rate (L) and their interaction treatments (F×L) on fruit length (cm) of hot pepper plant during the 2019 and 2020 seasons

NPK fertilization level (F)	Lithovit rate (L) (g/l)					
	Control	1	2	3	4	Means (F)
			2019 season			
Control	5.43	6.77	7.43	8.00	6.80	**6.89**
75%RR	5.80	6.33	7.80	8.57	7.60	**7.22**
100%RR	6.47	7.53	7.97	9.20	7.77	**7.79**
125%RR*	6.46	7.53	8.37	9.90	8.13	**8.08**
Means (L)	**6.04**	**7.04**	**7.89**	**8.92**	**7.58**	
LSD at 5%	**For (F) = 0.16**		**For (L) = 0.30**		**For (F×L) = 0.57**	
			2020 season			
Control	6.93	7.53	8.10	8.40	7.73	**7.74**
75%RR	7.57	7.87	8.40	8.67	8.03	**8.11**
100%RR	7.73	8.03	8.57	9.50	8.30	**8.43**
125%RR*	8.03	8.37	8.77	9.87	8.33	**8.67**
Means (L)	**7.57**	**7.95**	**8.46**	**9.11**	**8.10**	
LSD at 5%	**For (F) = 0.10**		**For (L) = 0.10**		**For (F×L) = 0.21**	

*****Recommended rate (RR): 90, 32 and 76 kg/fad. of N, P2O5 and K2O, respectively.

Table 8. Effect of NPK fertilization level (F), lithovit rate (L) and their interaction treatments (F×L) on fruit diameter (cm) of hot pepper plant during the 2019 and 2020 seasons

NPK fertilization level (F)	Lithovit rate (L) (g/l)					
	Control	1	2	3	4	Means (F)
			2019 season			
Control	2.50	2.83	2.87	3.13	2.77	**2.82**
75%RR	2.87	3.07	3.13	3.33	3.10	**3.10**
100%RR	3.07	3.33	3.33	3.70	3.47	**3.38**
125%RR*	3.17	3.37	3.50	3.80	3.23	**3.41**
Means (L)	**2.90**	**3.15**	**3.21**	**3.49**	**3.14**	
LSD at 5%	**For (F) = 0.25**		**For (L) = 0.21**		**For (F×L) = 0.45**	
			2020 season			
Control	2.77	3.00	3.37	3.47	3.23	**3.17**
75%RR	3.00	3.33	3.53	3.63	3.37	**3.37**
100%RR	3.23	3.47	3.73	4.03	3.70	**3.63**
125%RR*	3.37	3.53	3.87	4.27	3.83	**3.77**
Means (L)	**3.09**	**3.33**	**3.63**	**3.85**	**3.53**	
LSD at 5%	**For (F) = 0.12**		**For (L) = 0.09**		**For (F×L) = 0.20**	

*****Recommended rate (RR): 90, 32 and 76 kg/fad. of N, P2O5 and K2O, respectively.

Table 9. Effect of NPK fertilization level (F), lithovit rate (L) and their interaction treatments (F×L) on number of fruits/plant of hot pepper plant during the 2019 and 2020 seasons

NPK fertilization level (F)	Lithovit rate (L) (g/l)					
	Control	1	2	3	4	Means (F)
			2019 season			
Control	20.00	23.33	25.67	28.33	25.67	**24.60**
75%RR	23.00	28.00	31.33	32.67	28.33	**28.67**
100%RR	27.00	30.00	32.67	36.67	31.67	**31.60**
125%RR*	29.00	32.33	36.00	39.33	34.33	**34.20**
Means (L)	**24.75**	**28.42**	**31.42**	**34.25**	**30.00**	
LSD at 5%	**For (F) = 0.76**		**For (L) = 0.74**		**For (F×L) = 1.52**	
			2020 season			
Control	22.67	25.00	26.67	29.33	27.67	**26.27**
75%RR	22.33	27.33	30.00	31.67	30.33	**28.33**
100%RR	25.33	31.00	33.33	38.67	34.33	**32.53**
125%RR*	28.00	33.00	36.67	40.00	36.33	**34.80**
Means (L)	**24.58**	**29.08**	**31.67**	**34.92**	**32.17**	
LSD at 5%	**For (F) = 0.50**		**For (L) = 0.65**		**For (F×L) = 1.27**	

*****Recommended rate (RR): 90, 32 and 76 kg/fad. of N, P2O5 and K2O, respectively.

Table 10. Effect of NPK fertilization level (F), lithovit rate (L) and their interaction treatments (F×L) on fruit yield / plant (g) of hot pepper plant during the 2019 and 2020 seasons

NPK fertilization level (F)	Lithovit rate (L) (g/l)					
	Control	1	2	3	4	Means (F)
			2019 season			
Control	245.40	311.07	355.53	397.33	324.27	**326.72**
75%RR	284.60	380.43	442.93	494.93	378.53	**396.20**
100%RR	345.67	412.93	472.53	545.17	451.77	**445.61**
125%RR*	388.00	447.83	531.73	608.87	491.03	**493.49**
Means (L)	**315.92**	**338.07**	**450.68**	**511.47**	**411.40**	
LSD at 5%	**For (F) = 17.33**		**For (L) = 16.41**		**For (F×L) = 33.99**	
			2020 season			
Control	281.77	340.90	382.23	424.37	370.67	**359.99**
75%RR	284.40	384.40	439.10	485.70	428.70	**404.46**
100%RR	330.20	441.27	496.57	607.10	510.40	**477.11**
125%RR*	380.63	462.37	547.50	632.03	530.43	**510.59**
Means (L)	**319.25**	**407.23**	**466.35**	**537.30**	**460.05**	
LSD at 5%	**For (F) = 10.53**		**For (L) = 11.92**		**For (F×L) = 23.72**	

*****Recommended rate (RR): 90, 32 and 76 kg/fad. of N, P2O5 and K2O, respectively.

Table 11. Effect of NPK fertilization level (F), lithovit rate (L) and their interaction treatments (F×L) on fruit yield/feddan (ton) of hot pepper plant during the 2019 and 2020 seasons

NPK fertilization level (F)	Lithovit rate (L) (g/l)					
	Control	1	2	3	4	Means (F)
			2019 season			
Control	3.681	4.666	5.333	5.960	4.864	**4.901**
75%RR	4.269	5.707	6.644	7.418	5.678	**5.943**
100%RR	5.185	6.194	7.088	8.178	6.777	**6.684**
125%RR*	5.820	6.718	7.976	9.133	7.366	**7.402**
Means (L)	**4.739**	**5.821**	**6.760**	**7.672**	**6.171**	
LSD at 5%	**For (F) = 0.260**		**For (L) = 0.246**		**For (F×L) = 0.510**	
			2020 season			
Control	4.227	5.114	5.734	6.366	5.560	**5.400**
75%RR	4.266	5.766	6.587	7.286	6.431	**6.067**
100%RR	4.953	6.619	7.449	9.107	7.656	**7.157**
125%RR*	5.710	6.936	8.213	9.481	7.957	**7.659**
Means (L)	**4.789**	**6.109**	**6.995**	**8.060**	**6.901**	
LSD at 5%	**For (F) = 0.158**		**For (L) = 0.179**		**For (F×L) = 0.356**	

*****Recommended rate (RR): 90, 32 and 76 kg/fad. of N, P2O5 and K2O, respectively.

Effect of combination between NPK fertilization and lithovit

Data recorded in Tables 7, 8, 9, 10 and 11 shows that increasing lithovit rates up to 3.0 g/l under each NPK fertilization level gradually increased fruit length and diameter, number of fruits per plant and fruit yield per plant and per feddan of hot pepper. In addition, the combination treatment between NPK fertilization at 125% RR and lithovit at 3.0 g/l significantly increased hot pepper yield parameters compared to control and the other ones under study in the two seasons. Moreover, as mentioned just before, both NPK fertilization and lithovit treatments (each alone) increased yield components, in turn, they together might maximize their influences leading to tallest fruits, more fruits per plant as well as heaviest yield per plant and per feddan.

Conclusion

From above mentioned results, it is preferable to fertilize *Capsicum annuum* plants with NPK at 112.5 kg N + 40 kg P_2O_5 + 95 kg K_2O as well as sprayed with lithovit at 3.0 g/l four times per season to enhance the growth and yield components of this important medicinal plant.

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تأثير مستوى التسميد النيتروجيني والفوسفاتي والبوتاسي ومعدل الليثوفيت على نمو ومكونات محصول نبات الفلفل الحريف

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أجريت تجربتان حقليتان في المزرعة التجريبية (مزرعة غزالة) كلية الزراعة، جامعة الزقازيق خلال موسمي الصيف لأعوام 2019 و2020 لدراسة تأثير مستويات التسميد النيتروجيني والفوسفاتي والبوتاسيوم (صفر ، 75 ، 100 و125% من المستوى الموصى به)، معدلات الليثوفيت (صفر ، 1.0 ، 2.0 ، 3.0 ، 4.0 جم /) لتر) ومعاملات التداخل بينهما على نمو النبات والمكونات المحصولية لنبات الفلفل الحارصنف شيللينا. كان المعدل الموصى به هو 90 و 32 و 76 كجم من النيتروجين وخامس أكسيد الفسفور وأكسيد البوتاسيوم، على الترتيب. تم إجراء هذه التجارب في تصميم القطع المنشقة مرة واحدة في ثلاث مكررات. وزعت مستويات التسميد الأربعة في القطع الرئيسية. بينما وزعت معاملات الليثوفيت الخمسة في القطع الفرعية. كانت معاملات التداخل بين العامل الرئيسي والعامل الفرعي 20 معاملة تداخل. أشارت النتائج المتحصل عليها إلى أن استخدام التسميد النيتروجيني والفوسفاتي والبوتاسيوم بمستوى 125% من المعدل الموصى به أدى إلى زيادة معنوية في ارتفاع الفلفل الحار، وعدد الأفرع/ نبات، والوزن الطازج والجاف للأوراق لكل نبات، وطول الجذر، وطول الثمرة وقطرها، وعدد الثمار لكل نبات، ومحصول الثمار للنبات والفدان مقارنة بالكنترول والمستويات الأخرى قيد الدراسة. تم تسجيل أعلى القيم في الصفات سالفه الذكر أعلاه مع وجود فروق معنوية عند رش نباتات الفلفل الحار بالليثوفيت بمعدل 3.0 جم/لتر مقارنة بالكنترول والمعدلات الأقل والمعدل الأعلى قيد الدراسة. بشكل عام، أعطت نباتات الفلفل الحار التي تم تسميدها بمستوى 125% من المعدل الموصى به من النيتروجين والفسفور والبوتاسيوم مع رشها بـ 3.0 جم/لتر ليثوفيت أعلى القيم لنمو النبات والمكونات المحصولية مع وجود فروق معنوية مقارنة بمعاملات التداخل الأخرى قيد الدراسة.

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