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Improvement of Growth, Yield and Quality of two Varieties of Kohlrabi Plants as Affected by Application of Some Bio Stimulants

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ABSTRACT

Two cultivars of Kohlrabi plants Delikatess weisser and Burble Vina were grown in a sandy soil at the Experimental Station of the National Research Centre in El- Nubaria region, Behira Governorate on the two successive seasons of 2010/2011 and 2011/2012,to study the effect of two varieties and foliar spray of yeast, amino acid and chitosan on growth, yield and chemical content of Kohlrabi plants . Obtained results show that the highest plant height was found by cv. Delikatess weisser with foliar spray of chitosan. Meanwhile, the highest values of dry weight of leaves and tubers were found by Delikatess weisser with foliar spray of yeast. Furthermore, the highest values of leaves number, tuber height and diameter and fresh weight of tubers as well as total yield of tubers of Kohlrabi plants were recorded by cv. Burble Vina with foliar spray of chitosan. Furthermore, The highest amount of N,P and K% in leaves and N% in tubers of Kohlrabi were found by cv. Burble Vina with foliar spray of chitosan.

Key words: Kohlrabi Plants, Varieties , Bio stimulants, Yeast, Amino acid, Chitosan , Growth , Yield, Chemical composition.

Introduction

Kohlrabi (*Brassica oleraceae* var. gongylodes) belongs to family Brassicaceae and considers as a cole crop and its edible portion is enlarged stem (knob). It is well known that, kohlrabi has enormous nutritional and medicinal values due to its high contents of vitamin C, potassium high contents of vitamins (A, B1, B2, B5, B6 and E) minerals (Ca, Mg, Zn and Fe) and antioxidant substances which prevent the formation of cancer causing agents (Beecher 1994). Kohlrabi is widely cultivated in European and American countries. Kohlrabi can be an alternative crop for vegetable growers due to its similarity to other Cruciferae members, having a short growing season and its export possibility. In Egypt, still it is grown in a very limited scattered areas and the total cultivated area is not exactly known.

In recent years, the world focused his attention to minimize environmental pollution and human health impacts, by reducing the use of synthetic fertilizers and chemicals in crops production. Especially, vegetables which eat fresh using natural alternatives, (IFAOM/SOEL, 2000 and FAO/TTC, 2001). Hence, the goal of our research was to improve vegetative growth and yield as well as fruits quality of Kohlrabi plants using some natural extracts which non toxic, environmentally friendly, organic and costless. Therefore, increasing the plant productivity is one of the main targets in Egyptian agricultural policy; this could be achieved through fertilization and /or growth regulators treatments including promoters and retardants.

Yeast extract is a natural component contains many of the nutrient elements and cytokininis, which is safe and non-pollutant. It has a considerable amounts of amino acids (Abou zaid, 1984); mineral elements, carbohydrates, reducing sugars, enzymes and vitamins B1,2,3,12 (Castelfranco and Beale, 1983; Spencer *et al*., 1983; Somer, 1987; Fathy and Farid, 1996 and Khedr and Farid, 2000). Also it is a source of cytokinins and protein that enhance cell division and enlargement (Barnett *et al*., 1990). Moreover, Yeo *et al*., (2000) found that yeast extracts contain trehalose-6-phosphate synthase which is a key enzyme for trehalose bio synthesis. The dry bread yeast (Saccharomyces cerevisiae) is a kind of the used biofertilizers in soil fertilization or in foliar application on the shoots of vegetable crops (El-Ghamriny *et al*., 1999). This is because it's content of many nutrient elements and being productive compounds of semi growth regulator compounds like auxins, gibberellins and cytokinins (Glick, 1995). The positive effects caused by the addition of yeast suspension in improving shoots characteristics might be due to the direct or indirect effect of the yeast throughout its ability in changing the environment of roots, or because the development of the yeast after its analysis into wide groups of amino acids and vitamins. Subba and Rao (1984) mentioned that the yeast induce the absorption of nutrient elements by improving the soil pH into acidity. Ahmed *et al*. (1995) and Glick (1995) recorded that the yeast is capable of increasing the stimulative growth compounds like gibberellins, auxins and cytokinins that act in improving plant cell division and growth. Improving growth and productivity of vegetable crops by application

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of active yeast extract were recorded by Amer (2004), and El-Tohamy and El-Greadly (2007) on beans; Hewedy *et al.* (1996) and El-Tohamy *et al.* (2008) on eggplant, El- Ghamriny *et al.* (1999) and Fathy *et al.* (2000) on tomatoes, Tartoura (2001) and El-Desuki and El-Greadly (2006) on pea, Taha and Omar (2010) and Ahmed *et al.* (2011) on potato plants.

Amino acids is a well known biostimulant which has positive effects on plant growth, yield and significantly mitigates the injuries caused by abiotic stresses (Kowalczyk and Zielony 2008). Saeed *et al.* (2005) on soybean found that treatments of amino acids significantly improved growth parameters of shoots and fresh weight as well as pod yield. El- Zohiri and Asfour (2009) on potato found that spraying of amino acids at 0.25 ml/L significantly increased vegetative growth expressed as plant height and dry weight of plant. Davies (1982) reported that amino acids as organic nitrogenous compounds are the building blocks in the synthesis of proteins, which are formed by a process in which ribosome's catalyze the polymerization of amino acids. The possibilities of using amino acid in modern agriculture have been studied by many researchers (Fawzy *et al*., 2010; Abdel-Mawgood *et al*., 2011; El Awadi *et al*., 2011; Razieh *et al*., 2012).

Chitosan is a natural biopolymer derived by deacetylation of chitin, a major component of the shells of crustacea such as crab, shrimp, and crawfish. It is also found in cuticles of insects as well as in the cell walls of fungi and some algae (Sanford and Hutchings 1987; EPA 1995 and Sandford 2002) Chitosan has been shown to have a potential elicitor of many plant defense responses, including the accumulation of phytoalexins, proteinase inhibitors and chitinases (Walker- Simmons *et al* 1984; Kendra and Hadwiger 1984 and Mauch *et al.,* 1984), and lignifications (Pearce and Ride 1982). Its structure and composition is similar to both cellulose and chitin (Freepons 1991 and Hadwiger and McBride 2006). Chitosan has a strong positive charge and it attracts negatively charged molecules in addition, chitosan treatment stimulates plant growth (Kim *et al*., 2005) and improves storability of post harvest fruits and vegetables (El Ghaouth *et al.,* 1991 and 1992). Chitosan also promoted growth of various crops such as cabbage (Hirano, 1988), soybean sprouts (Lee *et al.,* 2005), sweet basil (Kim, 2005), strawberry (Abd El Mawgoud *et al.,* 2010) and sweet pepper plants (Ghoname *et al.,* 2010). Several experiments on the effects of concentration and frequency of chitosan application were conducted using various crops such as chilli, Chinese cabbage, celery and bitter cucumber (Chandrkrachang *et al.,* 2003 and Boonlertnirun *et al.,* 2005). It is reported that, chitosan concentration and frequency of application significantly increased growth rates of chilli and the harvest yield of Chinese cabbage (Chandrkrachang *et al.,* 2003). Lee *et al.* (2005) found that chitosan treatment increases the yield and marketability of soybean sprouts. However, the mechanism of action of chitosan on plant growth remains unclear.

The aim of the present study was to investigate the effect of some bio stimulants, yeast, amino acid and chitosan on growth, pod yield and quality as well as some chemical composition of two snap bean varieties.

Material and Methods

The present investigation was carried out during the two successive seasons of 2010/2011 and 2011/2012 at the Experimental Station of the National Research Centre in El- Nubaria region, Behira Governorate, to study the effect of two varieties of Kohlrabi (Delikatess weisser and Burble Vina) and foliar spray of yeast, amino acid and chitosan on growth, yield and chemical content of Kohlrabi plants. Seeds of Kohlrabi cv. (Delikatess weisser and Burble Vina) were cultivated in first July in the two seasons. Experimental Design is spelt plot with three replicates.

The experiment included the treatments as follows:

1- Delikatess weisser variety.
2- Burble Vina variety.
3- Foliar spray with water (control).
4- Foliar spray with Yeast.
5- Foliar spray with Amino acid.
6- Foliar spray Chitosan.

Plants were sprayed with yeast, amino acid and chitosan at 6 and 8 weeks after planting. Pest control and other agriculture practices, such as cultivation and irrigation, etc. were applied wherever it was necessary and as commonly recommended in the commercial Kohlrabi production. Harvesting was carried out 90 days after planting in the first and second seasons, respectively.

The experiment was arranged in a split plot design in four replicates. Where two varieties of Kohlrabi (Delikatess weisser and Burble Vina) were randomly arranged within the main plots, while yeast, amino acid and chitosan as a foliar spraying treatments plus control treatment were distributed in the sub-plots. The Six plants of each plot were randomly chosen at 120 days after planting and the following data were recorded.

At harvest, four plants from each plot were randomly taken to evaluate vegetative growth characteristics, i.e., plant length (cm), knob diameter (cm), average weight of knob (g plant-1), total fresh yield (t ha-1).

Vegetative growth:

A random sample of 5 plants from each plot was taken at 90 days after sowing and the following vegetative characters were recorded: plant height, number of leaves as well as fresh and dry weight of whole plant.

Chemical constituents:

Total nitrogen and phosphorus contents were determined using Kieldahl method and colorimetric method using spectrophotometer (SPECTRONIC 20D, Milton Roy Co. Ltd., USA), respectively, according to the procedure described by Cottenie (1982). Potassium content was measured using flame photometer method (JENWAY, PFP-7, ELE Instrument Co. Ltd., UK) as described by Chapman and Pratt (1982).

Statistical analysis:

The obtained data were statistically analyzed according to the method described by Gomez and Gomez (1984).

Results and Discussion

Vegetative growth parameters and total yield of Kohlrabi:

Effect of Kohlrabi varieties:

Data in Table (1) show that kohlrabi varieties in both seasons significantly different in their vegetative growth parameters. Except for tuber height in the first season .Meanwhile, the highest values of plant height and fresh weight of leaves as well as dry weights of leaves and tuber were recorded in cv. Delikatess weisser . However, the highest values of leaves number and tuber diameter, height, and fresh weight of tuber as well as total yield of Kohlrabi were found by Burble Vina. These results held true in the two seasons of the study. The observed differences in vegetative growth of cultivars are mainly due to the genotype of each cultivar.

Table 1: Evaluation some kohlrabi cultivars under newly reclaimed soils during two seasons (2010/2011 and 2011/2012).

Cultivars of Kohlorabi	Plant length (cm)	Leaves No./ plant	Tuber dia. (cm)	Tuber height (cm)	Fresh weight (g/plant)			Dry weight %		Tubers Yield (ton/fed.)	Yield increase	
					Leaves	Tubers	Total	Leaves	Tubers		(ton/fed.)	(%)
First season												
Delikatess weisser	44.3	15.75	7.95	7.28	260.6	253.63	514.23	14.76	9.37	3.04	0.000	0.00
Burble Vina	34.98	17.75	9.5	8.75	129.35	465.55	594.9	12.81	7.28	5.59	2.550	83.88
L.S.D at $_{0.05}$	3.15	1.22	0.95	NS	89.16	112.7	100.93	1.19	1.25	1.37	---	---
Second season												
Delikatess weisser	45.64	16.66	8.38	7.58	283.04	273.73	556.77	14.48	9.07	3.24	0.000	0.00
Burble Vina	34.54	19.04	10.23	9.33	138.75	525.92	664.67	12.17	6.58	5.59	2.350	72.53
L.S.D at $_{0.05}$	7.16	1.64	1.36	1.05	76.58	111.87	94.225	1.27	2.45	1.42	---	---

Vegetative growth parameters and total yield of Kohlrabi:

Effect of foliar spray of yeast, amino acid and chitosan:

Data of the measured vegetative growth parameters and total yield Kohlrabi plants in response to the applied yeast, amino acid and chitosan as a foliar application are presented in Table (2). Generally, application of yeast, amino acid and chitosan as a foliar spray had a significant effect in the vegetative growth parameters (plant length, number of leaves and fresh and dry weight of leaves and tubers) and total yield of Kohlrabi in both seasons of study. Meanwhile, the highest values of plant height, tubers height and diameter and fresh weight of tuber as well as total yield of tubers of Kohlrabi plants were found by using chitosan as a foliar spray. On the

other hand, the highest amount of leaves number, fresh weight of leaves as well as dry of leaves and tubers with recorded by using yeast as a foliar application of Kohlrabi plants. On the contrary, the lowest amount of all growth parameters and total yield of Kohlrabi plants were recorded by control treatment (foliar spray with water).

The major effect of foliar spray of yeast might be due to that yeast induces nutrient minerals absorption through general improvement due to the ability of yeast to increase the production of stimulants for plant growth, especially Gibberellins, Auxins and Cytokinins which act to improve the plant cell division and its growth. Similar results were obtained by Fathy *et al*., (2002) on tomato; Mona *et al*., (2005) on cucumber; Gomaa *et al*., (2005) on potato; El-Tohamy and El-Greadly, (2007) on Snap bean; El-Tohamy *et al*., (2008) on eggplant; Ghaoname *et al*., (2010) on sweet pepper and Fawzy *et al*., (2010) on Snap bean. Likewise, Hussain and Khalaf, (2007) on potato.

The significant effect of foliar spray of chitosan might be due to that chitosan is a new plant growth promoter like GA3 that may have many uses to modify the growth, yield and yield attributes of plant. Application of Chitosan enhances growth and yield attributes in rice and soybean (Chibu *et al*., 2002), in sunflower (Cho *et al*., 2008), in radish, Abdel-Mawgoud *et al.* (2010) on strawberry and Ghoname *et al.* (2010) on sweet pepper

Table 2: Effect of yeast, amino acids and chitosan foliar application on growth and yield of kohlrabi under newly reclaimed soils during two seasons (2010/2011 and 2011/2012).

Foliar application treatments	Plant length (cm)	Leaves No./ plant	Tuber dia. (cm)	Tuber height (cm)	Fresh weight (g/plant)			Dry weight %		Tubers Yield (ton/fed.)	Yield increase	
					Leaves	Tubers	Total	Leaves	Tubers		(ton/fed.)	(%)
First season												
Control	35.35	14.50	7.45	7.05	122.16	221.73	343.89	12.69	7.76	2.660	0.000	0.00
Yeast	38.95	17.50	8.80	7.65	224.05	361.74	585.79	14.70	9.00	4.340	1.680	63.16
Amino acids	39.75	18.00	9.30	8.20	220.43	391.57	612.00	13.60	8.57	4.700	2.040	76.69
Chitosan	44.50	17.00	9.35	9.15	213.28	463.31	676.59	14.15	7.97	5.560	2.900	109.02
L.S.D at $_{0.05}$	2.47	1.69	0.26	0.56	47.88	71.33	59.61	0.33	0.54	0.450	---	---
Second season												
Control	34.99	15.18	7.79	7.31	142.08	235.78	377.86	12.02	7.15	2.790	0.000	0.00
Yeast	39.27	18.75	9.39	8.02	239.54	402.39	641.93	14.41	8.63	4.540	1.750	58.92
Amino acids	40.22	19.34	9.99	8.68	235.23	437.88	673.11	13.10	8.12	4.910	2.120	71.38
Chitosan	45.88	18.15	10.05	9.81	226.72	523.25	749.97	13.76	7.40	5.440	2.650	89.23
L.S.D at $_{0.05}$	3.28	1.67	1.44	1.09	66.67	98.65	82.66	1.02	1.24	0.620	---	---

Vegetative growth parameters and total yield of Kohlrabi:

Effect of the interaction:

The results of the interaction effects of varieties and different foliar application treatments (yeast, amino acid and chitosan) were found statistically significant at 5 % level (Table 3). The highest plant height was found by cv. Delikatess weisser with foliar spray of chitosan. Meanwhile, the highest values of dry weight of leaves and tubers were found by Delikatess weisser with foliar spray of yeast. Furthermore, the highest values of leaves number, tuber height and diameter and fresh weight of tubers as well as total yield of tubers of Kohlrabi plants were recorded by cv. Burble Vina with foliar spray of chitosan.

N, P and K% content of leaves and tubers of Kohlrabi:

Effect of Kohlrabi varieties:

Data in Table (4) show that, kohlrabi varieties in both seasons were not significantly different in their N,P and K content of leaves and tubers. Except for N% and K% in both seasons. Meanwhile, the highest values of N, P and K% content were recorded in cv. Delikatess weisser. Except for N% in leaves of Kohlrabi by Burble

Vina in both seasons. These results held true in the two seasons of the study. The observed differences in vegetative growth of cultivars are mainly due to the genotype of each cultivar.

Table 3: Effect of the interaction between cultivars and foliar applications treatments on growth and yield of kohlrabi under newly reclaimed soils during two seasons (2010/2011 and 2011/2012).

Cultivars of kohlorabi	Foliar application treatments	Plant length (cm)	Leaves No./ plant	Tuber dia. (cm)	Tuber height (cm)	Fresh weight (g/plant)			Dry weight %		Tubers Yield (ton/fed.)	Yield increase	
						Leaves	Tubers	Total	Leaves	Tubers		(ton/fed.)	(%)
First season													
Delikatess weisser	Control	40.20	12.00	7.30	5.90	171.33	177.49	348.82	14.13	8.82	2.130	0.000	0.00
	Yeast	42.50	18.00	7.90	7.90	308.32	274.69	583.01	15.86	10.37	3.300	1.170	54.93
	Amino acids	45.20	19.00	8.80	6.70	311.89	304.96	616.85	14.91	9.87	3.660	1.530	71.83
	Chitosan	49.30	14.00	7.80	8.60	250.87	257.36	508.23	14.12	8.41	3.090	0.960	45.07
Burble Vina	Control	30.50	17.00	7.60	8.20	112.98	265.97	338.95	11.25	6.69	3.190	1.060	49.77
	Yeast	35.40	17.00	9.70	7.40	139.78	448.79	588.57	13.53	7.63	5.390	3.260	153.05
	Amino acids	34.30	17.00	9.80	9.70	128.96	478.17	607.13	12.29	7.27	5.740	3.610	169.48
	Chitosan	39.70	20.00	10.90	9.70	175.68	669.25	844.93	14.18	7.52	8.030	5.900	277.00
L.S.D at $_{0.05}$		3.07	2.37	0.67	0.87	41.66	41.66	44.27	1.12	0.91	0.570	---	---
Second season													
Delikatess weisser	Control	40.76	12.20	7.61	5.94	176.80	183.13	359.93	13.73	8.42	2.150	0.000	0.00
	Yeast	43.50	19.34	8.32	8.32	339.82	298.80	638.62	15.79	10.26	3.540	1.390	54.42
	Amino acids	46.71	20.53	9.39	6.89	344.07	334.82	678.89	14.66	9.67	3.970	1.820	71.16
	Chitosan	51.59	14.58	8.20	9.15	271.46	278.18	549.64	13.72	7.93	3.300	1.150	44.65
Burble Vina	Control	29.22	18.15	7.96	8.68	107.37	288.42	395.79	10.31	5.88	3.420	1.270	49.30
	Yeast	35.05	18.15	10.46	7.73	139.26	505.98	645.24	13.02	7.00	5.530	3.380	151.63
	Amino acids	33.74	18.15	10.58	10.46	126.38	540.94	667.32	11.55	6.57	5.850	3.700	167.91
	Chitosan	40.16	21.72	11.89	10.46	181.98	768.33	950.31	13.79	6.87	7.580	5.430	274.42
L.S.D at $_{0.05}$		5.96	1.85	1.22	1.15	58.55	64.15	61.35	0.92	1.26	1.030	---	---

Table 4: Evaluation some kohlrabi cultivars under newly reclaimed soils during two seasons (2010/2011 and 2011/2012).

Cultivars of kohlorabi	First season						Second season					
	N%	P%	K%	N%	P%	K%	N%	P%	K%	N%	P%	K%
	Leaves			Tubers			Leaves			Tubers		
Delikatess weisser	1.79	0.10	0.80	2.05	0.15	1.36	1.89	0.12	0.80	2.15	0.17	1.47
Burble Vina	1.88	0.10	0.72	1.77	0.13	1.26	2.01	0.11	0.71	1.87	0.15	1.35
L.S.D at $_{0.05}$	NS	NS	NS	0.07	NS	0.03	NS	NS	NS	0.15	NS	0.08

N, P and K% content of leaves and tubers of Kohlrabi:

Effect of foliar spray of yeast, amino acid and chitosan:

Data of the measured N, P and K% content Kohlrabi plants in relation to the applied yeast, amino acid and chitosan as a foliar application are presented in Table (5). Generally, application of yeast, amino acid and chitosan as a foliar spray had a significant effect in the N, P and K% content of leaves and tubers of Kohlrabi in both seasons of study. Meanwhile, the highest values of N, P and K% content of leaves and tubers of Kohlrabi plants were found by using chitosan as a foliar spray. On the contrary, the lowest amount of N, P and K% content of leaves and tubers of Kohlrabi plants were recorded by control treatment (foliar spray with water). Similar results were found by (Abd El Mawgoud *et al.,* 2010) of strawberry and (Ghoname *et al.,* 2010) of sweet pepper plants.

N,P and K content of leaves and tubers of Kohlrabi:

Effect of the interaction:

The results of the interaction effects of varieties and different foliar application treatments (yeast, amino acid and chitosan) were not statistically significant at 5 % level (Table 6) of all parameters(N,P and K% of leaves and tubers of Kohlrabi plants .Furthermore, The highest amount of N,P and K% in leaves and N% in tubers of Kohlrabi were found by cv. Burble Vina with foliar spray of chitosan. Meanwhile, the highest values of P and K% of tubers of Kohlrabi were found by Delikatess weisser with foliar spray of chitosan. These results held true in the two seasons of the study.

Table 5: Effect of yeast, amino acids and chitosan foliar application on growth and yield of kohlarabi under newly reclaimed soils during two seasons (2010/2011 and 2011/2012).

Foliar application treatments	First season						Second season					
	N%	P%	K%	N%	P%	K%	N%	P%	K%	N%	P%	K%
	Leaves			Tubers			Leaves			Tubers		
Control	1.81	0.10	0.81	2.10	0.13	1.31	1.92	0.10	0.81	2.27	0.14	1.39
Yeast	1.51	0.08	0.69	1.89	0.14	1.38	1.56	0.08	0.67	1.99	0.16	1.49
Amino acids	1.65	0.08	0.63	1.40	0.15	1.25	1.73	0.10	0.62	1.44	0.17	1.34
Chitosan	2.38	0.16	0.91	2.24	0.16	1.31	2.60	0.18	0.93	2.35	0.17	1.40
L.S.D at $_{0.05}$	0.17	NS	0.11	0.13	NS	NS	0.23	NS	0.09	0.14	NS	NS

Table 6: Effect of the interaction between cultivars and foliar applications treatments on growth and yield of kohlrabi under newly reclaimed soils during two seasons (2010/2011 and 2011/2012).

Cultivars of Kohlorabi	Foliar application treatments	First season						Second season					
		N%	P%	K%	N%	P%	K%	N%	P%	K%	N%	P%	K%
		Leaves			Tubers			Leaves			Tubers		
Delikatess weisser	Control	1.24	0.11	0.94	2.17	0.12	1.32	2.44	0.12	0.97	2.35	0.13	1.42
	Yeast	1.54	0.08	0.76	2.17	0.16	1.43	1.60	0.09	0.75	2.29	0.18	1.55
	Amino acids	1.4	0.09	0.61	1.61	0.15	1.29	1.44	0.11	0.61	1.69	0.17	1.39
	Chitosan	1.96	0.13	0.87	2.24	0.18	1.39	2.10	0.14	0.89	2.27	0.20	1.50
Burble Vina	Control	1.37	0.08	0.67	2.03	0.13	1.29	1.40	0.09	0.65	2.19	0.14	1.36
	Yeast	1.47	0.07	0.61	1.61	0.12	1.33	1.52	0.07	0.58	1.69	0.14	1.43
	Amino acids	1.89	0.07	0.65	1.19	0.15	1.21	2.02	0.08	0.62	1.19	0.17	1.29
	Chitosan	2.8	0.19	0.95	2.24	0.13	1.22	3.10	0.22	0.98	2.42	0.14	1.30
L.S.D at $_{0.05}$		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Conclusion:

It could be recommended that all applied bio-stimulants have positive promoting effects on growth of Kohlrabi plants. Also obtained results of the present investigation indicated that, foliar application of chitosan, stimulated most of vegetative growth characters and some chemical compounds which led to producing higher total yield of Kohlrabi plants.

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