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Effects of Different Organic Wastes on Mineral Element Content in Organic Strawberry Cultivation CVS Redline Hope and Fern

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Abstract

Composts, which are prepared by using organic wastes in an aerobic environment, are widely used in organic agriculture to ameliorate soil structure in agriculture and support plant-feeding element content. Hazelnut and rice cultivation is commonly practiced in the province Samsun in the Black Sea Region. Every year, a large amount of wastes of these products have dumped into environment. So, this study has intended to determine opportunities of use of hazelnut husk and rice hull composts in organic strawberry cultivation and their effects on productivity and fruit quality.

This research was conducted on the OMU's Faculty of Agriculture Research and Application garden in Samsun between 2009 and 2011. In the experiment, impacts of different organic wastes such as hazelnut husk (H), hazelnut husk compost (HC), rice hull (R), rice hull compost (RC) and farmyard manure on mineral element contents of strawberry cultivars "Redline Hope" and "Fern" were investigated.

Harvesting of plants were performed at the beginning of resting, fluorescence and at the end of harvest during the experiment in order to examine impacts of organic wastes on mineral element contents and N, P, K, Ca, Mg, Fe, Zn and Mn contents were detected in leaf samples extracted from these harvests.

Key Words: Strawberry, organic agriculture, organic waste, farmyard manure, mineral element

INTRODUCTION

The goal in agricultural production is to fulfil the basic food and raw material needs of humans. Therefore, obtained product does not return to soil for the system to balance itself unlike in nature; it leaves the system and reaches consumption centers. Remaining wastes after harvesting and consumption are either utilized as fodder, fuel and etc. or accumulated in waste centers as city refuse. Compost is obtained by processing in various ways the product, which is obtained from vegetative and animal organic matters that we move out of the system [15], [21], [5]. Thus, sources are gained by utilizing wastes, and pollution and degradation of natural resources due to organic wastes are prevented [1].

Compost is frequently used in vegetative production due to the fact that it improves soil nature and structure, increases beneficial organisms in soil and sustains its functions, contributes to mineral nutrient content of soil as well as that plants better and longer benefit from micro and macro nutrient elements applied on soil, biological control of soil-based plant pathogens is ensured and that in tubed and potted production such as ornamental plants, arboriculture and dwarf fruit cultivation, it is an alternative to cultivation settings taken from natural systems such as turf and tuff or obtained in fabrication conditions [3],[22] ,[1], [6], [4].

Tendency towards sustainable agricultural systems in our age has revitalized interest for compost use. Also, rising manure prices and decreasing benefits acquired from manures have also led certain manufacturers to turn to renewable and organic sources [20].

Plant residues appear as a significant environmental problem in regions where cultivation is commonly practiced; tons of plant residues, which form in months of plant harvest, are observed to be burnt and destroyed. These practices cause nutrition loss as well as an important air pollution problem. Hazelnut and rice cultivation are intensely performed in the Black Sea Region. Dry shelled hazelnut at a ratio 1/3 and dry husk at a ratio 1/5 remain from 1 kg of wet hazelnuts in hazelnut cultivation [17]. The average hazelnut production in Turkey is 660 000 tons and average each year 405 263 tons of wet hazelnut husks in average appear [11]. More than half of this production is obtained from the Black Sea Region. Rice is obtained by milling paddy in plants and during milling about 9-10% of paddy is reserved as bran and 20% as hull [23]. The average rice production in Turkey is 740.000 tons and each year 148.000 tons of hulls in average appear. 26% of this production is provided from the Black Sea Region. For this reason the study aimed to determine mineral element contents of N, P, K, Ca, Fe, Mg, Mn and Zn on strawberry leafs.

MATERIALS AND METHODS

Experimental Site and Material

This research was executed on the field of experiment that belongs to The Department of Horticulture in the OMU Faculty of Agriculture between 2010 and 2011. In this region, a moderate climate prevails; summers are hot and winters are warm and rainy; the number of cold days below 0^oC is not more than 20 in total. The average precipitation is 733 mm. The average annual temperature is 15.9 ^oC. Soil of the experimental farm was loam, having pH 7.51, organic matter 4.15%, EC 0.86%.

Frigo seedlings of tested strawberry cv. of "Redline Hope" and "Fern" were planted in triangular plantation system with 30x30 cm distances between 13 and 15 July, 2009. Irrigation was done with drip irrigation system in the experiment.

Treatments

The experiment was set up in six applications such as hazelnut husks (H), hazelnut husk compost (HC), rice hull (R), rice hull compost (RC), farmyard manure (FYM) and garden soil (S). In the experiment, hazelnut husk (H) and rice hulls (R) were openly composted via the Windrow method in aerobic conditions [10]. Hazelnut husk (H), hazelnut husk compost (HC), rice hull (R), rice hull compost (RC) and farmyard manure (FYM) the raised beds in the rates 5 tons per acre and were mixed on the soil. No further fertilization was performed in the later stages of the experiment. Table 1 and Table 2 some physico-chemical properties and mineral element content of experimental materials used in composting are provided in.

The experiment was set up with three replicated and six applications and in a way that will correspond to 30 plants in each replicated. All plots were mulched with black plastic (15-16 December, 2009). Other necessary cultural applications during the experiment were applied equally on all parcels.

Data collected

A total of six were pulled up performed at the beginning of resting, begin flowering and at the end of harvest in the experiment three times in each year of growth. After thoroughly rinsing leafs of pulled up plants in tab water, they were then rinsed with pure water. Plant leafs, which were dried at 70^oC in drying oven for five days, were pounded in a porcelain mortar in a way that they will pass through a 1mm. sieve and N, P, K, Ca, Fe, Mg, Mn and Zn analyses were conducted in leafs [9,8]. Nitrogen was determined according to the Kjeldahl method [14]; P was read in spectrophotometer at a wave length of 430 nm by using the vanadomolybdate phosphoric yellow color method [14] and K, Ca, Mg, Fe, Mn and Zn were determined by reading leaf samples in Perkin Elmer 2280 atomic absorption spectrophotometer after burning them in muffle furnace at 550^oC and solving them with 10 ml of 3N HCl in a solution, which was obtained after filling 25 ml [14].

Statistical Analyses

All data were analyzed by using the SPSS 16.0 statistical package software (SPSS Inc.). Differences among averages were determined according to Duncan's multiple range test at $P \leq 0.05$.

RESULT AND DISCUSSION

Nitrogen (%)

The average values pertaining to total nitrogen measurements conducted on leaf samples of experimented strawberry cv are shown in Table 3. In terms of nitrogen contents in leaf "Redline Hope", there was no significant difference among treatments (Table 3). Significant differences were detected in "Fern" strawberry cultivars in regard to the nitrogen content of the leaves at the end of harvesting (2010), at the beginning of resting and at the end of harvesting in the second year of the experiment (Table 3).

When analyzing the data, it was observed that the highest content of N was attained from the applications of organic wastes. Pritss and Handley [19] reported the sufficiency level of the total nitrogen in the leaves as 2.0-2.8%. Looking at our data in general, it can be seen that especially the values at beginning flowering are sufficient. Nevertheless, there are also available studies which report that different compost applications have no effect on the total nitrogen content in leaves [18,2,13]. This situation is thought to stem from the differentiation of the organic wastes that are used in composting.

Table 1. Contents mineral element of organic wastes, composts and garden soil.

	HC	H	RC	R	FYM	S
N (%)	1.58	0.78	0.26	0.430	1.13	0.18
P (%)	0.03	0.01	0.02	0.003	0.04	0.05
K (%)	0.85	1.38	0.41	0.180	1.87	0.72
Ca (%)	0.80	0.31	0.22	0.040	0.88	0.72
Mg (%)	0.34	0.14	0.20	0.02	0.45	0.09
Fe (ppm)	9247.00	1506.00	5614	454.00	4975.00	16.00
Zn (ppm)	55.20	90.00	45.70	61.60	83.70	4.00
Mn (ppm)	509.80	176.30	303.00	76.80	293.30	47.30

HC: Hazelnut husk compost, H: Hazelnut husk, RC: Rice hull compost, R: Rice hull, FYM: Farmyard manure, S: garden soil

Table 2. Some physicochemical properties of composting materials

	H	R	FYM
Organic carbon (%)	53.0	46.9	37.3
Nitrogen (%)	1.20	1.60	2.80
Moisture (%)	14.0	9.30	53.0
C/N	44.5/1	29.1/1	13.1/1

H: Hazelnut husk, R: Rice hull, FYM: Farmyard manure

Table 3. Effects of different organic wastes on %N in leaves of cultivars strawberry

		2010			2011		
		R	F	HE	R	F	HE
REDLİNE HOPE	HC	1.88	2.55	2.03	1.61	2.28	2.25
	H	1.94	3.4	1.31	1.27	2.15	1.05
	RC	2.14	2.55	1.58	1.98	2.20	1.42
	R	2.14	2.55	1.58	1.52	2.18	1.13
	FYM	1.71	2.22	1.60	1.36	1.89	1.02
	S	2.09	2.60	1.23	0.86	1.87	1.83
FERN	HC	2.23	2.82a	1.82a	1.45abc	2.08	0.87bc
	H	2.26	2.71a	1.55ab	1.35bc	2.29	1.21bc
	RC	2.06	1.61b	1.08b	1.60ab	1.64	0.56c
	R	1.91	3.13a	1.60ab	1.29c	2.47	2.43a
	FYM	2.20	2.71a	1.29ab	1.54abc	2.22	1.51b
	S	2.12	2.72a	1.72ab	1.69a	2.22	0.81bc

z: Mean followed by different letters within columns differ significantly ($p<0.05$)
R: beginning of resting F: beginning flowering HE: end of harvest
HC: Hazelnut husk compost, H: Hazelnut husk, RC: Rice hull compost, R: Rice hull, FYM: Farmyard manure, S: garden soil

Phosphorus (%)

The average values, which pertain to phosphorus measurements conducted on leaf samples that were taken from strawberry types in our experiment, are displayed in Table 4. There was no significant difference among treatments in terms of foliage P content in "Redline Hope" (Table 4). Also, in terms of foliage P content, it was significant difference among treatments in "Fern" (except the HE 2010) (Table 4). May and Pritts [16] stated that phosphorus content in the strawberry varies from 0.25% and 0.40%.

Having examined the data, it can be observed that the P% content in the leaves of the strawberry types is either near the lower level, or at an insufficient level. Arancon et al., [2] reported that there was no difference among vermicompost applications regarding P content. Nonetheless, there are also available studies which report that compost applications also affect the P content in different doses on the leaves [13].

Potassium (%)

The average values, which belong to potassium (%) measurements conducted on leaf samples that were taken from the tested strawberry cv. are displayed in Table 5. The difference in K% content on leafs for the type Redline Hope was not significant (Table 5). For the type Fern, difference in K% content in leafs was significant for the pre-fluorescent period and for the post-harvest period in 2011. Preusch et al. [18] reported that different composts had no effect on K content and K content varied between 0.93% and 1.76%. It is seen that our data appear in these value intervals.

Table 4. Effects of different organic wastes on % P in leaves of cultivars strawberry

		2010			2011		
		R	F	HE	R	F	HE
REDLİNE HOPE	HC	0.20	0.28	0.16	0.19	0.05	0.05
	H	0.24	0.22	0.20	0.16	0.20	0.22
	RC	0.23	0.25	0.11	0.19	0.15	0.25
	R	0.22	0.25	0.15	0.16	0.25	0.34
	FYM	0.35	0.26	0.17	0.17	0.24	0.34
	S	0.18	0.23	0.24	0.18	0.21	0.20
FERN	HC	0.25a	0.27a	0.18	0.12b	0.20c	0.38a
	H	0.19ab	0.23a	0.22	0.21a	0.22abc	0.32a
	RC	0.19ab	0.14b	0.24	0.21a	0.25a	0.33a
	R	0.15b	0.25a	0.21	0.18a	0.25a	0.25b
	FYM	0.21ab	0.31a	0.13	0.17ab	0.22abc	0.37a
	S	0.15b	0.26a	0.20	0.21a	0.21bc	0.35a

z: Mean followed by different letters within columns differ significantly ($p<0.05$)
R: beginning of resting F: begin flowering HE: end of harvest
HC: Hazelnut husk compost, H: Hazelnut husk, RC: Rice hull compost, R: Rice hull, FYM: Farmyard manure, S: garden soil

Table 5. Effects of different organic wastes on % K in leaves of cultivars strawberry

		2010			2011		
		R	F	HE	R	F	HE
REDLİNE HOPE	HC	1.22	1.22	1.03	0.94	0.22	0.21
	H	1.25	1.44	1.68	0.77	0.93	0.97
	RC	1.27	1.58	1.05	2.08	1.07	0.97
	R	1.10	1.23	0.98	1.06	1.77	1.40
	FYM	1.31	1.55	1.06	0.84	1.28	1.42
	S	1.00	1.47	1.62	0.94	1.06	1.02
FERN	HC	0.95	1.70	1.45	1.10	1.43a	1.43a
	H	1.14	1.27	0.99	0.81	1.06ab	1.35a
	RC	0.96	0.98	0.93	1.14	1.10ab	1.49a
	R	0.96	0.98	1.46	0.91	1.09ab	1.05b
	FYM	1.21	1.46	0.85	0.87	1.29ab	1.24ab
	S	0.82	1.15	0.84	1.19	1.03b	1.47a

z: Mean followed by different letters within columns differ significantly ($p<0.05$)
R: beginning of resting F: beginning flowering HE: end of harvest
HC: Hazelnut husk compost, H: Hazelnut husk, RC: Rice hull compost, R: Rice hull, FYM: Farmyard manure, S: garden soil

Calcium (%)

The average values, which belong to calcium (%) measurements conducted on leaf samples that were taken from the tested strawberry cultivars, are displayed in Table 6. In terms of Ca contents in leaf of Redline Hope cultivar, there was no significant difference between treatments. For the type Fern, in terms of foliage Ca content, it was significant difference among treatments (except the F and HE 2010) (Table 6). While May and Pritts [16] stated that the suitable Ca content of the leaves for strawberries is 0.7%-1.7%, Cline [7] reported this value as 0.5-1.5%. It can be seen that our Ca values are at a minimum level compared to these references. Hargreaves et al. [12] stated that urban waste compost and compost teas had no effect on the Ca content and Ca content in leaves varied between 0.37% and 0.68%. Accordingly, it is observed that our data concurs with these studies.

Magnesium (%)

The average values, which belong to magnesium (%) measurements conducted on leaf samples that were taken from the tested strawberry types, are displayed in Table 7. Having examined the Mg% content in the leaves for the Redline Hope, the difference was no significant between the applications in both years. For the Fern, significant differences were determined among the applications regarding the Mg content in the leaves (expect F and HE in 2010) (Table7). Hargreaves et al. [13] reported that the impact of composts and compost teas on Mg content of strawberry leaves was only significant for the first year and Mg content varied between 0.18 and 0.27. Preusch et al.[18] stated that compost applications had an important impact on Mg content of leafs and Mg content varied between 0.34% and 0.41% for these applications. May and Pritts [16] stated that Mg content of strawberry leafs is sufficient between 0.2% and 0.5%.

Table 6. Effects of different organic wastes on % Ca in leaves of cultivars strawberry

		2010			2011		
		R	F	HE	R	F	HE
REDLİNE HOPE	HC	0.31	0.33	0.5	0.62	0.13	0.12
	H	0.36	0.39	0.82	0.59	0.5	0.69
	RC	0.33	0.42	0.49	0.65	0.38	0.55
	R	0.31	0.34	0.51	0.51	0.39	0.72
	FYM	0.3	0.38	0.56	1.07	0.38	0.66
	S	0.34	0.38	0.62	0.71	0.38	0.37
FERN	HC	0.30abc	0.45	0.60	0.52b	0.39ab	0.48b
	H	0.33ab	0.57	0.46	0.73a	0.46ab	0.58b
	RC	0.25bc	0.38	0.62	0.51b	0.57a	0.66ab
	R	0.23c	0.40	0.60	0.48b	0.31b	0.44b
	FYM	0.34a	0.47	0.36	0.56b	0.32b	0.91a
	S	0.25bc	0.42	0.51	0.55b	0.40ab	0.89a

z: Mean followed by different letters within columns differ significantly ($p<0.05$)
R: beginning of resting F: begin flowering HE: end of harvest HC: Hazelnut husk compost, H: Hazelnut husk, RC: Rice hull compost, R: Rice hull, FYM: Farmyard manure, S: garden soil

Table 7. Effects of different organic wastes on % Mg in leaves of cultivars strawberry

		2010			2011		
		R	F	HE	R	F	HE
REDLİNE HOPE	HC	0.14	0.18	0.14	0.32	0.04	0.03
	H	0.18	0.33	0.16	0.30	0.15	0.16
	RC	0.17	0.28	0.12	0.25	0.17	0.28
	R	0.14	0.18	0.11	0.32	0.18	0.15
	FYM	0.18	0.20	0.13	0.12	0.17	0.17
	S	0.14	0.29	0.15	0.18	0.15	0.14
FERN	HC	0.16a	0.24	0.15	0.32ab	0.16b	0.17b
	H	0.12ab	0.32	0.10	0.40a	0.34a	0.24b
	RC	0.11b	0.21	0.15	0.14b	0.15b	0.15b
	R	0.10b	0.20	0.14	0.20b	0.38a	0.37a
	FYM	0.15a	0.47	0.10	0.28ab	0.27ab	0.18b
	S	0.11b	0.42	0.09	0.15b	0.15b	0.14b

z: Mean followed by different letters within columns differ significantly ($p<0.05$)
R: beginning of resting F: begin flowering HE: end of harvest
HC: Hazelnut husk compost, H: Hazelnut husk, RC: Rice hull compost, R: Rice hull, FYM: Farmyard manure, S: garden soil

Iron (ppm)

The average values, which belong to iron (ppm) measurements conducted on leaf samples that were taken from the tested strawberry cultivars, are displayed in Table 8. It was observed that the difference was no significant among applications for Redline Hope regarding iron content in leaves. In terms of Fe contents in leaf of Fern, there was significant difference between treatments (expect R and F in 2011) (Table 8). May and Pritts [16] reported that iron content in leafs for strawberries is sufficient between 70-250 ppm. The data, which belongs to Fe content obtained from our experiment, are seen to be beyond this range.

Manganese (ppm)

The average values, which belong to manganese (ppm) measurements conducted on leaf samples that were taken from plants that were harvested on different dates during the experiment, are displayed in Table 9. For Redline Hope, a statistical difference was not established regarding Mn content. Significant differences were determined among the applications regarding the manganese content on the leaves for the Fern (except for R and F in 2010). Hargreaves et al. [12] stated that different doses of composts and compost teas had no effect on the Mn content of leaves in strawberries and Mn content of leafs varied between 67.7 and 105.5 ppm. Preusch et al. [18] stated that fresh and composted chicken coop waste has no effect on the Mn content in strawberries in different types of soil and it was detected between 40 and 305 ppm during the experiment. May and Pritts [16] reported that Mn content of the leaves in strawberries is sufficient between 50-200 ppm. The data obtained from our experiment are closer to the lower limit or insufficient compared to these references.

Zinc (ppm)

The average values, which belong to zinc (ppm) measurements conducted on the tested strawberry leaf samples, are displayed in Table 10. There were no significant differences between treatments in terms on the leaves for the Redline Hope. Having examined the strawberry cv. Fern, while Zn content in leaves was significant in usually all periods in 2010 (expect HE), it was only significant for the beginning of the resting period in 2011 (Table 10). Hargreaves et al. [12] reported that different doses of composts and compost teas had no effect on Zn content of leafs in strawberries and Zn content of leaves varied between 12.0-25.77 ppm. Preusch et al. [18] detected that fresh and composted chicken coop base had no effect on Zn content for strawberries in different types of soil and Zn content varied between 22 and 99 ppm during the experiment. May and Pritts [16] stated that Zn content of leafs should be between 20 and 50 ppm for normal development and growth of strawberries. Our data concurs with these references.

Table 8. Effects of different organic wastes on Fe (ppm) in leaves of cultivars strawberry

		2010			2011		
		R	F	HE	R	F	HE
REDLİNE HOPE	HC	550.47	635.28	1216.47	1276.50	65.77	65.77
	H	526.98	773.59	189.75	249.46	572.85	243.98
	RC	450.98	798.51	237.40	238.73	520.80	115.28
	R	313.65	953.11	120.93	223.05	862.83	142.87
	FYM	516.36	491.90	263.94	123.16	746.89	138.32
	S	802.61	987.09	449.34	89.74	459.05	400.38
FERN	HC	371.85ab	791.83b	216.39abc	194.42	658.56	247.40ab
	H	319.05b	1674.89a	89.03c	152.32	852.49	256.03ab
	RC	593.18ab	463.83b	283.33ab	268.13	519.50	131.82b
	R	1319.04a	463.83b	298.90a	597.37	540.31	500.65ab
	FYM	578.30ab	858.90b	240.82abc	118.82	625.14	215.72ab
	S	439.30ab	687.69b	124.18bc	392.57	511.68	729.65a

z: Mean followed by different letters within columns differ significantly ($p<0.05$)
R: beginning of resting F: begin flowering HE: end of harvest
HC: Hazelnut husk compost, H: Hazelnut husk, RC: Rice hull compost, R: Rice hull, FYM: Farmyard manure, S: garden soil

Table 9. Effects of different organic wastes on Mn (ppm) in leaves of cultivars strawberry

		2010			2011		
		R	F	HE	R	F	HE
REDLİNE HOPE	HC	34.96	51.48	28.60	34.13	9.46	8.46
	H	43.01	43.42	31.34	42.06	45.24	33.45
	RC	34.72	63.82	25.06	40.28	62.36	27.04
	R	25.09	59.83	22.57	40.19	53.84	30.63
	FYM	40.42	41.39	22.95	37.73	51.82	29.24
	S	42.67	57.56	35.67	31.68	43.16	37.16
FERN	HC	34.60	64.17a	27.70	22.27	28.76	21.52
	H	21.37	82.69a	13.19	34.17	49.34	19.97
	RC	29.97	29.67b	22.72	26.17	51.62	26.95
	R	32.85	53.82ab	31.47	39.37	33.58	30.24
	FYM	32.86	60.90ab	17.31	18.23	38.73	27.83
	S	27.50	54.87ab	29.89	36.88	43.07	24.29

z: Mean followed by different letters within columns differ significantly ($p<0.05$)
R: beginning of resting F: begin flowering HE: end of harvest
HC: Hazelnut husk compost, H: Hazelnut husk, RC: Rice hull compost, R: Rice hull, FYM: Farmyard manure, S: garden soil

Table 10. Effects of different organic wastes on Zn (ppm) in leaves of cultivars strawberry

		2010			2011		
		R	F	HE	R	F	HE
REDLİNE HOPE	HC	14.63	13.68	17.31	8.13	1.77	2.77
	H	21.12	11.52	7.90	7.20	9.51	7.28
	RC	20.39	11.90	6.96	15.35	9.36	8.46
	R	12.74	13.63	4.68	7.52	12.44	8.01
	FYM	22.01	13.26	7.47	5.59	10.69	11.14
	S	13.61	13.21	8.12	9.30	7.76	7.10
FERN	HC	17.41ab	16.81ab	10.07	8.78ab	8.70	9.43
	H	20.82a	24.14a	6.21	12.03a	16.09	11.87
	RC	12.75ab	9.81b	9.95	6.62b	9.41	9.87
	R	12.98ab	14.06b	9.44	7.70ab	11.06	10.39
	FYM	13.96ab	17.13ab	6.19	9.29ab	8.88	10.50
	S	10.67b	15.95ab	4.92	10.30ab	11.80	9.53

z: Mean followed by different letters within columns differ significantly ($p<0.05$)
R: beginning of resting F: begin flowering HE: end of harvest
HC: Hazelnut husk compost, H: Hazelnut husk, RC: Rice hull compost, R: Rice hull, FYM: Farmyard manure, S: garden soil

CONCLUSION

It was observed after analyzing mineral element contents in the experiment that levels of almost all elements for strawberry plant were at the lower tier of the recommended levels or below them. This result makes us think that the amount of organic wastes, which were mixed into soil at the beginning of the experiment, should be increased and if possible they should also be added to soil in the second year. Comparing organic wastes, it was observed that the applications HC and H yielded better results than farmyard manure and other wastes (RC and R) regarding mineral element content. However, it was also observed that it is necessary to designate doses of hazelnut husk and hazelnut husk compost in further studies.

Durations of composting and mixing hazelnut husk into soil are shorter than rice hull and rice hull compost. However, since rice hull and rice hull compost decompose slowly, they are considered to provide positive contribution to physical properties of heavy-structure soils. For this reason, it is presumed that adding them within mixtures that will be used for making composts would be good.

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