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RESEARCH ARTICLE

Effect of some seed treatments during storage on viability of some bread wheat varieties

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Abstract

This study aimed to evaluate the effect of seed treatments (Neem oil 10 ml/kg, Mustard oil 10 ml/kg, Phosphine tablets 0.0125 g/kg) on three varieties of bread wheat grains (Giza 171, Giza 168 and Gimmaza 11) at four storage periods (Fresh grains, 3, 6, and 9 months). The experimental design was a completely randomized design with three replicates. The experiment was performed during the period from Jun 2022 until March 2023. The results demonstrated that all studied traits were significantly impacted by the assessed storage times. Consequently, the highest mean values of seed index, germination power (%), germination percentage (%), shoot and roots length (cm), and seedling dry weight (g) traits were recorded at the begging of storage then a gradual decrease occurred. In addition, treating wheat grains with phosphine resulted in a significant increase in seed index, germination power (%) and germination percentage (%) traits compared to the control (without fumigation), while significant increases in roots length (cm), shoot length (cm) and seedling dry weight (g) were accompanied with treating wheat grains by neem oil compared to the control. Giza 171 Varity surpassed the others in all above traits.

Keywords: wheat, storage periods, viability, neem oil

1. *Introduction*

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops worldwide, and it plays an important role in the human diet. The area planted with wheat is about 222.7 million hectares, which produced about 790.38 million metric tons by productivity reached to 3.55 metric tons/ha (Foreign Agricultural Service/USDA, 2023/2024). Wheat's technological quality is affected by storage circumstances and duration, which also alters the flour's properties (Lukow and White, 1997). The most crucial elements affecting wheat quality are grain moisture content, storage temperature, and storage time. Thus, these elements significantly alter the functional properties of wheat grains that has been preserved (Mis, 2003). Cereal crop storage is a crucial procedure for maintaining grains for sowing, animal feed and human consumption. In order to lessen adverse effects on the environment and human health, natural products are a great substitute for synthetic pesticides. Discovering and commercializing natural items like plant-derived compounds and plant essential oils is made more difficult by the shift to green chemistry techniques and the ongoing need to create new crop protection measures with unique modes of action (Attia *et al*., 2014). Azadirachtin and tetranotriterpenoid limonoid, the active component of numerous neem-based insecticides, are the main beneficial substances found in neem (Azadirachta indica L.) trees (Mordue and Blackwell, 1993). Neem's antifeedant, repellent, growth-disturbing, and larvicidal qualities were presented in all parts of the plant, but particularly in the seed oil (Mathur, 2013). Furthermore, unlike synthetic pesticides, neem derivatives do not acquire insect resistance and are typically not harmful to the agro-ecosystem. Due to its high level of monounsaturated fats and polyunsaturated fatty acids, including omega-3, and lack of trans fats and saturated fats, mustard oil is regarded as healthful. Glucosinolate, a compound found in mustard oil, has anti-carcinogenic qualities and inhibits the growth of malignant tumors. Mustard oil, which

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has no negative effects on the human body when applied to grains, is frequently used as cooking oil and in tiny amounts for seed treatment. The harmful effect of mustard oil's is on eggs and early-stage larvae (Attia *et al*., 2014). Thus the objective of this study was to assess how the vitality of certain bread wheat varieties was affected by seed treatments with natural products, phosphorus fumigation, exposure duration, and storage duration.

2. Materials and Methods:

This experiment was carried out at the laboratory Agronomy Department, Agriculture Faculty, South Valley University, during the period of 22of Jun until 22 March during 2022/2023 season. The experiment was arranged using a complete randomized design with three replicates.
The treatments were as following:

1. Storage periods (fresh grains, 3, 6, and 9 months).
2. Varieties (Giza 171, Giza 168 and Gimmaza 11).
3. Seed treatments (control, neem oil, mustard oil and phosphine fumigation).

2.1. Studied traits

2.1. 1. **Seed index (g):** Thousand grain for each replicate were weighed in grams.

2.1.2**. Germination power percentage (GP%):** It was computed by comparing the number of tested seeds to the number of germinating grains at the first count, which occurred four days after sowing, as explained by Ruan *et al*. (2002).

2.1.3. **Germination percentage (G%):** At the conclusion of the standard germination test (number of grains germinated after 7 days), the normal seedlings of each replicate were counted and expressed as a percentage using the following formula:

$$G\% = \frac{Number - of - normal - seedlings}{Number - of - total - grains} \times 100$$

2.1.4**. *Root length (cm)*:** At the end of the normal germination test, the average root length of ten seedlings, chosen at random for each replication, was measured from the seed's root origin to the root's tip.

2.1.5**. *Shoot length (cm)*:** At the conclusion of the normal germination test, the average shoot length of ten seedlings was measured at random from the seed to the tip of the leaf blade for each replicate.

2.1.6**. *Seedling dry weight (g)*:** Ten random seedlings for each replicate were dried in the oven at 70 ºC until constant weight.

2.2. Statistical analysis**:**

The collected data were analyzed statistically according to Steel *et al*. (1997). The treatment means were compared by least significant difference (LSD) procedures (at 5% level of probability. The data were analyzed by the "MSTAT-C" statistical package on a computer (Freed et al, 1991).

3. Results and Discussion

3.1. Seed index

Averages data presented in (Table 1) demonstrated that the fresh grains were differed significantly with all storage periods regarding the effect on seed index. The minimum mean value of the seed index (44.18 g) was recorded from the S_4 (9 months) treatment. This can be the result of the grains' nutrition depleting as a result of storage times, which agree with those found by Adly *et al*. (2011). In average, Giza 168 recorded higher values of seed index than those of Giza 171 and Gimmaza 11(Table 1). The superiority of Giza 168 in seed index over Giza 171 and Gimmaza 11 could be attributed to the differences in the genetic make-up of these varieties. Differences among sesame varieties in seed index were reported by Adly *et al* (2011), Nabila *et al*. (2016); Rahuma (2017). Results of seed index given in (Table 1) indicated that seed treatments affected significantly seed index. All seed treatments gave the high seed index as compared with control treatment. The minimum of seed index (45.91 g) was recorded from T_1 (control treatment). These findings would suggest that during the examined storage periods, phosphine treatments protected the contents of the interior grains from degradation and damage brought on by insect infestation or nutrient use. These findings are consistent with those found by Kumawat and Naga (2013); Mosalem *et al*. (2023). Data in (Table 1) indicated that the interaction between storage period and variety was detected in seed index trait. The maximum seed index value was recoded for from S_1 V_1 (49.31 g), while the minimum of seed index (42.48 g) was recorded for $S_4 \times V_2$ interaction.

Table1. Averages effect of storage periods, seed treatments, varieties and their interactions on seed index (g)

Storage period (S)	Varieties	Seed treatments				Mean
		T_1	T_2	T_3	T_4	
S_1	V_1	49.53	49.30	48.97	49.43	49.31
	V_2	47.70	47.60	48.03	48.13	47.87
	V_3	46.90	48.20	48.13	47.53	47.69
Mean		48.04	48.37	48.38	48.37	48.29
S_2	V_1	47.93	48.53	50.07	49.30	48.96
	V_2	47.43	47.40	47.70	47.87	47.60
	V_3	46.37	47.60	47.73	46.33	47.01
Mean		47.24	47.84	48.50	47.83	47.86
S_3	V_1	46.60	47.43	47.90	48.07	47.50
	V_2	44.83	43.53	44.43	45.60	44.60
	V_3	43.93	46.33	45.80	45.90	45.49
Mean		45.12	45.77	46.04	46.52	45.86
S_4	V_1	44.93	46.57	46.17	46.93	46.15
	V_2	42.67	41.53	42.37	43.37	42.48
	V_3	42.03	44.80	43.63	45.13	43.90
Mean		43.21	44.30	44.06	45.14	44.18
T × V	V_1	47.25	47.96	48.28	48.43	47.98
	V_2	45.66	45.02	45.63	46.24	45.64
	V_3	44.81	46.73	46.33	46.23	46.02
Mean of T		45.91	46.57	46.74	46.97	46.55
$LSD_{0.05}$						
S	V	T	S × V	S × T	T × V	S×V×T
0.62	0.54	0.62	1.08	NS	NS	NS

Where, NS mean non-significant – S = storage periods (S_1: without storage, S_2: 3 months, S_3: 6 months, S_4: 9 months)- T= Seed treatments (T_1: control, T_2:neem oil, T_3:mustard oil, T_4:phosphine fumigation – V = Varieties (V_1:Giza 171, V_2:Giza 168, V_3:Gimmaza 11)

3.2. Germination power (%)

The germination power was significantly impacted by the storage periods under study, according to the data in (Table 2). Fresh grains without storage treatment had the highest average value of germination power (88.44%). Additionally, when the storage period was extended from control (no storage) to nine months of storage, the germination power percentage gradually decreased. The earlier findings might have been caused by the wheat grains' loss of vitality and the nutrients they had lost throughout the lengthy storage period as a result of fungal and insect infections. These outcomes were consistent with those acquired by Badawi *et al*. (2017); Abdelgwad (2021). Over the storage periods and seed treatments, the difference among varieties was significant (Table 2). Giza 171 and Giza 168 surpassed those of Gimmaza 11 by 13.07% in germination power. The superiority of Giza 171 and Giza 168 in germination power over Gimmaza 11 could be attributed to the differences in the genetic make-up of each variety (Elsayed *et al*., 2018); Tian *et al*., 2019); Hamed, 2021). The results of the effect of seed treatments on germination power were presented in Table 2, indicating that a significant affect in this trait. Treatment of wheat grains before storage by phosphine or neem oil gave the maximum germination power values (89.56, 88.00 %, respectively) with non-significant differences between them.

Table 2. Averages effect of storage periods, seed treatments, varieties and their interactions on germination power (%).

Storage period (S)	Varieties	Seed treatments				Mean
		T_1	T_2	T_3	T_4	
S_1	V_1	89.33	94.67	90.67	94.67	92.33
	V_2	84.00	100.00	97.33	98.67	95.00
	V_3	70.67	85.33	74.67	81.33	78.00
Mean		81.33	93.33	87.56	91.56	88.44
S_2	V_1	89.33	94.67	84.00	93.33	90.33
	V_2	82.67	94.67	82.67	92.00	88.00
	V_3	78.67	92.00	77.33	93.33	85.33
Mean		83.56	93.78	81.33	92.89	87.89
S_3	V_1	77.33	93.33	80.00	90.67	85.33
	V_2	82.67	93.33	84.00	94.67	88.67
	V_3	77.33	77.33	81.33	88.00	81.00
Mean		79.11	88.00	81.78	91.11	85.00
S_4	V_1	85.33	86.67	74.67	89.33	84.00
	V_2	73.33	77.33	86.67	84.00	80.33
	V_3	60.00	66.67	66.67	74.67	67.00
Mean		72.89	76.89	76.00	82.67	77.11
T × V	V_1	85.33	92.33	82.33	92.00	88.00
	V_2	80.67	91.33	87.67	92.33	88.00
	V_3	71.67	80.33	75.00	84.33	77.83
Mean of T		79.22	88.00	81.67	89.56	84.61
$LSD_{0.05}$						
S	V	T	S × V	S × T	T × V	S×V×T
4.22	3.64	4.22	7.31	NS	NS	NS

Where, NS mean non-significant – S = storage periods (S_1: without storage, S_2: 3 months, S_3: 6 months, S_4: 9 months)- T= Seed treatments (T_1: control, T_2:neem oil, T_3:mustard oil, T_4:phosphine fumigation – V = Varieties (V_1:Giza 171, V_2:Giza 168, V_3:Gimmaza 11

The minimum mean value of the germination power (79.22 %) was recorded from the control. These results may explain the effect of phosphine and neem oil in resistant insect pests and maintain their embryo and stored nutrients safe until germination time. These results are in harmony with those detected by Badawi *et al*. (2017); Kandil *et a.l* (2022). Results in (Table 2) showed that an interaction between storage period and varieties for germination power trait was detected. The highest estimate value of germination power trait was obtained from S_1 V_2 (95.00%).

3.3. Germination percentage (%)

Means in Table 3 indicate the superiority of germination percentage (%) achieved with S_1 (fresh grains; 94.89%). The minimum of germination percentage (79.00%) was recorded from S_4 treatment (storage at 9 menthes). Additionally, when the storage period was extended from control (no storage) to nine months of storage, the germination percentage gradually decreased, which indicate that storage could affect the membrane, nucleic acid, proteins, and enzymes. This results in the loss of germination and the embryo's demise. The results obtained are consistent with those obtained by Lokhande *et al*. (2020). Over the studied periods and seed treatments, the difference among the three studied varieties was significant in germination percentage. Giza 168 surpassed those of Giza 171 and Gimmaza 11 by 1.47% and 9.57%, respectively. Germination percentage was significantly influenced by various seed treatments at 5% probability level (Table 3). Applications of T_2 or T_4 resulted in the highest value of germination percentage (91.22 or 91.89%). While the lower value of germination percentage

(84.44%) was recorded for the control. This means that phosphine or neem oil decreased the rate of grain deterioration by lowering metabolic reactions and conserving the grain's nutrients. These outcomes validated those found by Krupnik *et al*. (2022); Mosalem *et al*. (2023). The interaction between all studied factors had not recorded any significant effects on the germination percentage (Table 3).

3.4. Root length (cm)

Averages given in Table 4 show that over seed treatments and varieties, root length of wheat plants under the storage periods at 9 months were significantly shorter than those under other treatments of storage periods. These outcomes can be explained by the weak embryo's poor growth and the nutrients' consumption during storage. An analogous pattern was noted by Lokhande *et al*. (2020).

Regarding the differences between the three studied varieties over storage periods and seeds treatments, Giza 168 roots were significantly longer than other varieties. The superiority of Giza 168 root length over other varieties could be attributed to differences in the genetic make-up of the varieties. Differences among sesame varieties in root length were reported by Lokhande *et al* (2020); Hamed (2021). It is evident from Table 4 that neem oil treatment (T_2) results in the longest roots (12.59 cm) and it surpassed the other studied three treatments. These results may indicate that neem oil treatment preserved the contents of the inner grains from damage and deterioration due to insect infestation or consumption of nutrients during storage periods studied. These results are in accordance with those reported by Bedak *et al*. (2020). Moreover, the interaction between S × T, S × V, T × V and S × T × V did not record any significant effects on root length trait.

Table 3. Averages effect of storage periods, seed treatments, varieties and their interactions on germination percentage (%)**.**

Storage period (S)	Varieties	Seed treatments				Mean
		T_1	T_2	T_3	T_4	
S_1	V_1	93.33	98.67	93.33	100.00	96.33
	V_2	89.33	98.67	97.33	100.00	96.33
	V_3	92.00	96.00	86.67	93.33	92.00
Mean		91.56	97.78	92.44	97.78	94.89
S_2	V_1	92.00	97.33	86.67	94.67	92.67
	V_2	82.67	93.33	90.67	92.00	89.67
	V_3	86.67	96.00	84.00	89.33	89.00
Mean		87.11	95.56	87.11	92.00	90.44
S_3	V_1	84.00	100.00	84.00	98.67	91.67
	V_2	88.00	93.33	94.67	98.67	93.67
	V_3	77.33	85.33	82.67	88.00	83.33
Mean		83.11	92.89	87.11	95.11	89.56
S_4	V_1	85.33	89.33	78.67	89.33	85.67
	V_2	77.33	77.33	86.67	84.00	81.33
	V_3	65.33	69.33	70.67	74.67	70.00
Mean		76.00	78.67	78.67	82.67	79.00
T × V	V_1	88.67	96.33	85.67	95.67	91.58
	V_2	84.33	90.67	92.33	93.67	90.25
	V_3	80.33	86.67	81.00	86.33	83.58
Mean of T		84.44	91.22	86.33	91.89	88.47
$LSD_{0.05}$						
S	V	T	S × V	S × T	T × V	S×V×T
3.81	3.30	3.81	NS	NS	NS	NS

Where, NS mean non-significant – S = storage periods (S_1: without storage, S_2: 3 months, S_3: 6 months, S_4: 9 months)- T= Seed treatments (T_1: control, T_2:neem oil, T_3:mustard oil, T_4:phosphine fumigation – V = Varieties (V_1:Giza 171, V_2:Giza 168, V_3:Gimmaza 11).

3.5. Shoot length (cm)

Table 5 indicates that high storage periods at one month (S_2) results significantly longer shoot (9.92

cm) compared to other storage periods and control. The shortest shoot (7.29 cm) recorded from seeds storage at three months (S_4). This may be due to decreasing of nutrients in the grains that had been affected by storage periods. These results confirmed those obtained by Kibar and Yücesan (2021). Over storage periods and the studied three varieties, data in Table 5 show also that applied of neem oil increased shoot length significantly. The minimum of shoot length (7.75 cm) was recorded from control treatment. These findings are in agreement with those of Bedak *et al* (2020); Osama *et al*. (2020).

Table 4. Averages effect of storage periods, seed treatments, varieties and their interactions on root length (cm).

Storage period (S)	Varieties	Seed treatments				Mean
		T_1	T_2	T_3	T_4	
S_1	V_1	11.16	11.91	9.52	10.96	10.89
	V_2	10.65	11.06	10.65	13.27	11.41
	V_3	10.73	12.85	11.94	12.40	11.98
Mean		10.85	11.94	10.70	12.21	11.43
S_2	V_1	14.60	14.63	13.03	17.37	14.91
	V_2	12.53	9.47	14.43	14.20	12.66
	V_3	10.67	14.87	11.10	10.57	11.80
Mean		12.60	12.99	12.86	14.04	13.12
S_3	V_1	14.23	12.27	12.43	9.63	12.14
	V_2	9.33	12.07	11.37	9.73	10.63
	V_3	12.53	13.67	11.10	9.57	11.72
Mean		12.03	12.67	11.63	9.64	11.49
S_4	V_1	9.30	11.67	13.20	10.60	11.19
	V_2	9.53	15.27	10.47	10.27	11.38
	V_3	9.17	11.30	9.43	9.60	9.88
Mean		9.33	12.74	11.03	10.16	10.82
T × V	V_1	12.32	12.62	12.05	12.14	12.28
	V_2	10.51	11.97	11.73	11.87	11.52
	V_3	10.78	13.17	10.89	10.53	11.34
Mean of T		11.20	12.59	11.56	11.51	11.71
$LSD_{0.05}$						
S	V	T	S × V	S × T	T × V	S×V×T
1.35	0.90	1.00	NS	NS	NS	NS

Where, NS mean non-significant – S = storage periods (S_1: without storage, S_2: 3 months, S_3: 6 months, S_4: 9 months)- T= Seed treatments (T_1: control, T_2:neem oil, T_3:mustard oil, T_4:phosphine fumigation – V = Varieties (V_1:Giza 171, V_2:Giza 168, V_3:Gimmaza 11)

Data in Table 5 indicates also that Giza 168 shoots were significantly increased shoot length as comparing with other varieties. The increases in shoot length of Giza 168 over Giza 171 and Gmmiza 11 attained 14.4% and 8.7%, respectively. Varietal differences in shoot length were reported by Hamed (2021). Like root length, the interaction between S x T, S x V, T x V and S x T x V did not record any significant effects on shoot length trait.

3.6. Seedling dry weight (g)

Regarding seedling dry weight, the storage period at three months gave the highest value of seedling dry weight (0.040 g; Table 6).

Table 5. Averages effect of storage periods, seed treatments, varieties and their interactions on shoot length (cm).

Storage period (S)	Varieties	Seed treatments				Mean
		T_1	T_2	T_3	T_4	
S_1	V_1	9.17	10.02	8.91	8.92	9.25
	V_2	7.00	6.52	8.69	10.00	8.05
	V_3	8.15	9.56	9.69	8.92	9.08
Mean		8.11	8.70	9.10	9.28	8.80
S_2	V_1	10.03	12.33	10.80	12.37	11.38
	V_2	9.03	7.17	10.00	10.53	9.18
	V_3	9.10	9.63	9.87	8.13	9.18
Mean		9.39	9.71	10.22	10.34	9.92
S_3	V_1	6.87	9.53	10.40	8.30	8.78
	V_2	6.03	10.67	8.33	6.67	7.93
	V_3	7.47	9.40	7.37	6.53	7.69
Mean		6.79	9.87	8.70	7.17	8.13
S_4	V_1	6.70	8.30	7.67	6.30	7.24
	V_2	6.67	7.43	6.93	6.43	6.87
	V_3	6.80	8.13	8.37	7.73	7.76
Mean		6.72	7.96	7.66	6.82	7.29
T × V	V_1	8.19	10.05	9.44	8.97	9.16
	V_2	7.18	7.95	8.49	8.41	8.01
	V_3	7.88	9.18	8.82	7.83	8.43
Mean of T		7.75	9.06	8.92	8.40	8.53
$LSD_{0.05}$						
S	V	T	S × V	S × T	T × V	S×V×T
1.00	1.00	1.00	NS	NS	NS	NS

Where, NS mean non-significant – S = storage periods (S_1: without storage, S_2: 3 months, S_3: 6 months, S_4: 9 months)- T= Seed treatments (T_1: control, T_2:neem oil, T_3:mustard oil, T_4:phosphine fumigation – V = Varieties (V_1:Giza 171, V_2:Giza 168, V_3:Gimmaza 11).

In addition, the gradual decrease in seedling dry weight trait occurred with increasing the storage period to nine months of storage. These results are in harmony with those obtained by Kibar and Yücesan (2021). In average, Giza 168 plants recorded higher values of seedling dry weight than those of Giza 171 and Gemmaza 11. Differences among wheat varieties in seedling dry weight were previously reported (Hamed, 2021). Results in Table 6 included that the averages of seedling dry weight as affected by seed treatments. The seed trait with neem oil surpassed in seedling dry weight the seed trait with mustard oil, phosphine fumigation and without trait (Control) by 5.0, 2.5 and 7.5%, respectively. This is to be logical.

Table 6. Averages effect of storage periods, seed treatments, varieties and their interactions on seedling dry weight (g).

Storage period (S)	Varieties	Seed treatments				Mean
		T_1	T_2	T_3	T_4	
S_1	V_1	0.039	0.042	0.038	0.039	0.040
	V_2	0.037	0.038	0.037	0.040	0.038
	V_3	0.039	0.043	0.040	0.040	0.041
Mean		0.038	0.041	0.039	0.040	0.039
S_2	V_1	0.040	0.046	0.042	0.044	0.043
	V_2	0.037	0.037	0.038	0.038	0.037
	V_3	0.036	0.043	0.040	0.041	0.040
Mean		0.038	0.042	0.040	0.041	0.040
S_3	V_1	0.038	0.041	0.038	0.039	0.039
	V_2	0.034	0.037	0.036	0.038	0.036
	V_3	0.038	0.041	0.038	0.037	0.038
Mean		0.037	0.040	0.038	0.038	0.038
S_4	V_1	0.036	0.038	0.036	0.037	0.037
	V_2	0.033	0.036	0.035	0.037	0.035
	V_3	0.037	0.039	0.037	0.034	0.037
Mean		0.035	0.038	0.036	0.036	0.036
T × V	V_1	0.038	0.042	0.039	0.040	0.040
	V_2	0.035	0.037	0.036	0.038	0.037
	V_3	0.038	0.041	0.039	0.038	0.039
Mean of T		0.037	0.040	0.038	0.039	0.038

$LSD_{0.05}$						
S	V	T	S × V	S × T	T × V	S × V × T
0.0011	0.0011	0.0011	NS	NS	NS	NS

Where, NS mean non-significant – S = storage periods (S_1: without storage, S_2: 3 months, S_3: 6 months, S_4: 9 months)- T= Seed treatments (T_1: control, T_2:neem oil, T_3:mustard oil, T_4:phosphine fumigation – V = Varieties (V_1:Giza 171, V_2:Giza 168, V_3:Gimmaza 11).

Same trend was recorded for roots and shoot length. Our results agrees with those reported by Krupnik *et al*. (2022). The first and second interactions between studied factors had not recorded any significant effects on the seedling dry weight.

4. Conclusion

Storage periods had significant influence on seed index, germination power (%), germination percentage (%), roots and shoot length (cm), and seedling dry weight (g). However, the effects of the various varieties on most traits were significant at the 5% level of probability. Moreover, different seed treatments had a significant influence on some traits.The results demonstrated that the fresh grains (without storage) gave the maximum values of all the studied traits, while the minimum value was obtained by storage period till nine months of all the studied traits. In addition, the V1 (Giza-171) recorded the highest mean value of most the studied traits. However, the T4 (Phosphine treatment) gave the maximum mean values of some the studied traits.

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