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# PHYSIOLOGICAL RESPONSES OF *Erythrina verna* SEEDLINGS ON SEED PRE-GERMINATIVE TREATMENTS AND SOWING DEPTH

## RESPOSTAS FISIOLÓGICAS DE PLÂNTULAS DE *Erythrina verna* SOB TRATAMENTOS PRÉ-GERMINATIVOS DE SEMENTES E PROFUNDIDADE DE SEMEADURA

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## ABSTRACT

The objective of this work was to determine the most appropriate pre-germinative treatment of seeds and sowing depth for the production of *Erythrina verna* seedlings. For this, the following pre-germinative treatments were initially studied: control (intact seeds); mechanical scarification on the area opposite to hilum, with the help of sandpaper number 80; mechanical scarification on the raphe region, with the help of sandpaper number 80; soaking in water for 24 hours. In a second experiment, the seeds were sown at the depths of 1, 2, 3, 4, 5 and 6 cm. After 15 days, we evaluated the percentage of emergence, emergence speed index, shoot length and seedling root length, dry weight of shoot and root dry mass of seedlings. The seeds of *Erythrina verna* present coat dormancy that can be broken by mechanical scarification in the area opposite to the hilum. The seedlings present the best physiological quality when seeds are sowing at 1 to 3 cm depth, where the highest percentages of emergence, speed of emergence index, length of shoot and length root and shoot dry mass are obtained.
**Keywords:** Mulungu; dormancy; ornamental species; landscape.

## RESUMO

Este trabalho objetivou determinar o melhor tratamento pré-germinativo de sementes e a profundidade de semeadura mais adequada para a produção de mudas de *Erythrina verna.* Para isso, os seguintes tratamentos pré-germinativos foram estudados: testemunha (sementes intactas), escarificação mecânica na região oposta ao hilo com auxílio de lixa nº 80, escarificação mecânica na região da rafe com auxílio de lixa nº 80, embebição em água por 24 horas. Em um segundo experimento, as sementes foram semeadas nas profundidades de 1, 2, 3, 4, 5 e 6 cm. Após 15 dias avaliou-se a porcentagem de emergência, índice de velocidade de emergência, comprimento da parte aérea e comprimento da raiz das plântulas, massa seca de parte aérea e massa seca de raiz das plântulas. As sementes de *Erythrina verna* apresentam dormência tegumentar que pode ser superada pela escarificação mecânica na região oposta ao hilo. As plântulas apresentam a melhor qualidade fisiológica quando as sementes são semeadas à profundidade de 1 a 3 cm, onde a maior porcentagem de emergência, índice de velocidade de emergência, comprimento da parte aérea e da raiz e massa seca da parte aérea são obtidos.
**Palavras-chave:** Mulungu; dormência; espécie ornamental, paisagismo.

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## INTRODUCTION

By 1940, Roberto Burle Marx, a Brazilian landscape architect, introduced a new Brazilian landscape concept, by valuing the colors and textures of native species (GUERRA, 2002). However, exotic species are yet more frequently used in Brazilian landscaping than native plants (SANTOS et al., 2010). Thus, the identification of native species with ornamental purpose to landscaping use and their insertion in commercial production are important for the appreciation of these plants, contributing for the development of conservation strategies, mainly by the extraction of focus species (STUMPF et al., 2008).

*Erythrina verna*, is a native Brazilian species, distributed predominantly in Atlantic Forest Biome, presents wood and exuberant flowering that stand out among other species, with its deciduous aspect during flowering and fruiting period, a characteristic that has given a height ornamental potential to this plant (Rambo et al., 2013). Its wood is ideal for box production and can be used in the wood market (LORENZI, 2002).

Although there are reports on vegetative propagation of plants of the genus *Erythrina*, the most of works are focused on sexual propagation; this studies have reported the presence of physical dormancy due to a water-impermeable seed coat (physical dormancy), as reported by Silva et al. (2006) and Lazarotto et al. (2011) in *Erythrina crista-galli* L.; Silva et al. (2007) in *Erythrina velutina*; and Matheus et al. (2010) in *Erythrina falcata* and *Erythrina velutina*. However, there are no reports on the presence of impermeability (hard coat) seed of *Erythrina verna* requiring scientific studies to optimize the germination process. Pre-germinative treatments are frequently used in the seeds of native species that present restrictions for germination. There are many techniques used to break seed dormancy and thus improve seedling quality; among these, the physical scarification with sandpaper and soaking water is a simple and safe technique which makes possible good results for breaking dormancy in many species (BRASIL, 2009).

Another key factor for obtaining high quality seedlings is the depth of furrows where seeds are sown, because the soil thermal dynamics and physics affect the process of germination and seedling emergence (TILLMANN et al., 1994). The lowest percentage of emergence and stand establishment on field depends directly on factors such as seed contact with soil, the offset of the point of sowing, sowing depth, excess or scarcity of moisture and loss of seeds and seedlings due to the attack by pathogens or pests (DOUGHERTY, 1990).

The ideal sowing depth varies according to the species and should promote uniform seed germination, speed seedling emergence and high quality on seedling production (BRASIL, 2009). In practice, the recommended sowing depth is 2.5 to 3.0 by size of seed. Cardoso et al. (2008) found that sowing depths between 1.0 and 3.0 cm are indicated for sowing seeds of *Erythrina velutina*, since these depths produced plants with the best quality.

Same reports show that seed germination and seedling production of genus *Erythrina* are limited by physic dormancy. Thus, studies are needed to make possible the use of this species in Brazilian landscaping and wood production, in order to value and protect native plants from extractive activity. Therefore, the objective of this work was to determine the most appropriate pre-germinative treatment of seeds and sowing depth to production of *Erythrina verna* seedlings.

## MATERIALS AND METHODS

The work was conducted in Plant Science Department of Universidade Federal de Viçosa (UFV), in two steps, with seeds of *Erythrina verna* manually collected under mother plants located in Floriculture Sector of UFV, Minas Gerais state.

### Experiment 1. Breaking the dormancy in *Erythrina verna* seeds

The seeds were collected and benefited to remove inert materials and seeds attacked by insects or fiscally damaged. Then, they were submitted to following pre-germinative treatments: control (intact seeds), mechanical scarification on area opposite to hilum with the help of sandpaper number 80, mechanical scarification on raphe region with the help of sandpaper number 80 and soaking in water for 24 hours. After each pre-germinative treatment, the seeds were sown in plastic trays containing sand as substrate and perforated at bottom to allow the drainage of excess water. The experiment was conducted in a greenhouse with average diurnal temperatures of 27°C, and 15°C at night. The substrate was moistened until early drainage occurred. Water was provided through daily irrigations until the end of experiment.

The characteristics evaluated at 15 days after sowing were: percentage of emergence - accomplished by direct counting. The seedlings that presented epicotyls with more than 0.5 cm of length above the substrate were considered emerged. The results were expressed in percentage; emergence speed index – the seedlings emerged were daily counted by 15 days; and the index calculated according to expression proposed by Maguire (1962); length of shoot and root length of seedlings - the primary root and shoots of seedlings were measured with graduated caliper and the results expressed in centimeters per plant; shoot dry mass and root dry mass of seedlings - were obtained by removing the cotyledons. Since it was not used to obtain the dry mass, then the aerial part and root were separated by using bistouries and dried in a kiln at 70°C until constant weight of dry mass. A precision balance of 0.0001 g was used for weighing.

It was used a completely randomized statistical design with four pre-germinative treatments and five replications with 20 seeds each. Five replications randomly taken from each treatment were used for the analysis of the seedlings. The data were subjected to the analysis of variance, and the means were compared by Tukey test at 5% probability.

### Experiment 2. Effect of sowing depth on emergence and physiological quality of *Erythrina verna* seedlings

The seeds were sown in a plastic box filled with sand as substrate and perforated at bottom to allow the drainage of excess water. The maintenance of water occurred daily through as many irrigations as necessary, until the end of experiment. The sowing depths of 1, 2, 3, 4, 5 and 6 cm were used. Fifteen days after the beginning of the test, the emergence percentage, emergence speed index, length of shoot and root, dry weight of shoot and root biomass of seedlings were evaluated. The evaluations were performed according to methods that decrypted the dormancy breaking experiment (experiment 1).

A completely randomized experimental design was used, with six depths of sowing and five replications with 20 seeds each. Five replications randomly taken from each treatment were used for the analysis of seedlings quality. The data were submitted to polynomial regression as a function of sowing depth.

## RESULTS AND DISCUSSION

### Experiment 1. Breaking the dormancy in seeds of *Erythrina verna*

The emergence of *Erythrina verna* seedlings started 8 days after sowing. Regardless of the treatment used, the seedlings of these species stabilized the rapid emergence and emergence 15 days after sowing. The highest percentage of emergence (86%) was obtained by scarification with sandpaper on the area opposite to hilum (Figure 1A). The lowest percentages of emergence, 39% and 33%, were obtained in seeds scarified on raphe region and control, respectively. The seeds submitted to soaking for 24 hours presented intermediate emergence of 56%.

The results this study suggest that seeds of *Erythrina verna* have water-impermeable seed coat, a physical dormancy caused by hard coat. Several authors reported the presence of dormancy in the seeds of several species of genus *Erythrina.* According to Silva et al. (2006), *Erythrina crista-galli* seeds present hard coat that cause dormancy, but can be broken by sulfuric acid. However, mechanical scarification is beneficial, besides promoting higher percentages of germination, averaging 98% and 97% in seeds of *Erythrina velutina* and *Erythrina falcata*, respectively, this technique is safer and ecologically correct because it does not require the use of chemical products (MATHEUS and LOPES, 2007, MATHEUS et al., 2010). The treatments with soaking water did not promote significant increases in *Erythrina variegata* seed germination (MATHEUS and LOPES, 2007). The results were similar to those observed in this work, in which the seeds soaked in water increased only 23% of the value of the untreated seeds. Many tree species have hard coat, which is undesirable for seedling production, since waterproof and impermeable coat restrict the entry of water and oxygen, offer high physical resistance for the growth of the embryo and negatively affects seedling uniformity (MOUSSA et al. 1998).

The highest emergence speed indexes of 47.07 and 33.85 were obtained from seeds scarified on area opposite to hilum and seeds soaked in water for 24 hours, respectively (Figure 2). The lowest emergence speed indexes were observed in seeds scarified on raphe region, with 19.56 and 18.47, in

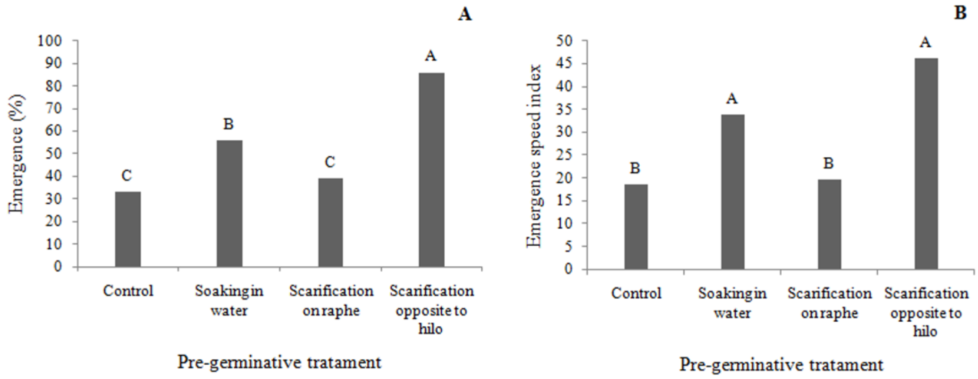


FIGURE 1: Percentage of emergence (A) and emergence speed index (B) of *Erythrina verna* seedlings submitted to different pre-germinative treatments. Means followed by the same letter do not differ by the Tukey test at 5% probability.

FIGURA 1: Porcentagem de emergência (A) e índice de velocidade de emergência (B) de plântulas de *Erythrina verna* submetida a diferentes tratamentos pré-germinativos. As médias seguidas pelas mesmas letras não diferem pelo teste de Tukey a 5% de probabilidade.

control seeds.

The emergence speed index allows distinguishing methods that provide the expression of best potential physiological of seeds to produce high quality seedlings. Therefore, the treatments that lead to the fastest emergence are the most recommended ones for seed germination (MARCOS FILHO, 1999). In addition to physiological expression of seeds, the methodologies that promote rapid emergence and uniform stand are desirable for seedling commercial production. According to Guedes et al. (2009), mechanical scarification using sandpaper provided the emergence speed index of 4.39 to 4.56. In addition to pre-germinative treatments, the type of substrate affected the emergence speed index of seedlings of *Erythrina velutina*. The highest emergence speed index was obtained with sand as substrate (CARDOSO et al., 2008).

There was no significant difference between pre-germinative treatments for the shoot length and root length of seedlings of *Erythrina verna* 15 days after sowing (Table 1). The seedlings obtained from seeds germinated after the mechanical scarification treatment on raphe produced the largest dry mass of shoots. The lowest dry mass of shoots was obtained from seeds soaked in water for 24 hours, which weighed on average 29.34 mg.

There was no significant difference in the shoot dry mass of seedlings obtained from seeds

TABLE 1: Aerial part length (APL), root length (RL), shoot dry mass (SDM), root dry mass (RDM) of *Erythrina verna* seedlings obtained from the germination of seeds submitted to different pre-germinative treatments.

TABELA 1: Comprimento de parte aérea (APL), comprimento de raiz (RL), massa seca da parte aérea (SDM), massa seca de raiz (RDM) de plântulas de *Erythrina verna* obtidas da germinação de sementes submetidas a diferentes tratamentos pré-germinativos.

| Pre-germinative treatments | APL | RL | SDM | RDM |
|---|---|---|---|---|
| Control | 5.42 A | 7.08 A | 24.83 AB | 18.71 AB |
| Water soaking | 4.24 A | 6.82 A | 22.03 B | 20.17 A |
| Scarification on raphe | 4.78 A | 7.40 A | 29.34 A | 16.59 B |
| Scarification opposite to hilum | 4.94 A | 7.76 A | 27.15 AB | 18.17 AB |
| CV (%) | 15.39 | 10.42 | 11.64 | 8.40 |

Where in: Average followed by same letters in columns does not differ by the Tukey test at 5% probability. * Médias apresentadas pelas mesmas letras nas colunas não diferem pelo teste de Tukey a 5% de probabilidade.

scarified on area opposite to hilum or untreated seeds (control) (Table 1). The smallest root dry mass was obtained in seeds scarified on raphe, with 16.59 mg per seedling, and the largest one was achieved in seeds soaked in water, with 20.17 mg per seedling (Table 1).

The vigor tests based in performance of seedlings used in research is standardized in accordance with the Rules for Seed Analysis (BRASIL, 2009). However, there were significant differences for length of shoots or roots of *Erythrina verna*. *Erythrina velutina* seedlings obtained from seedlings in field presented the maximum of 7.6 cm and 10.1 cm in length to shoot and root, respectively; the highest dry weight of roots of these seedlings was 1.44 g and 1.49 g of shoot (GUEDES et al., 2009). The sand substrate provided better results for root length and shoot dry mass, compared to plants of *Erythrina velutina* (CARDOSO et al., 2008). The pre-germinative treatments in seeds of *Erythrina verna* allowed higher percentage of emergence and speed of seedling emergence, but the physiological responses obtained in seedlings 15 days after sowing were less sensitive to pre-germinative treatments.

**Experiment 2. Effect of sowing depth on emergence and physiological quality of seedlings of *Erythrina verna***

Seeds of *Erythrina verna* sown at depths of 1 to 3 cm presented emergence over 95%, but the seeds disposed in substrate at sowing depth greater than 3 cm reduced the percentage of seedling emergence (Figure 2A). The minimum percentage of emergence, 70%, was obtained in 6 cm depth. The percentage of emergence of *Erythrina velutina* decreased with increased sowing depth. Research works demonstrated that lower percentages of emergence were obtained from seeds placed at depths greater than 3 cm (CARDOSO et al., 2008). The sowing of seeds in 2.2 cm depth make possible the emergence percentage of 66.18% of ornamental cedar seedlings (*Cedrela fissilis*) (SANTOS et al., 2009). Sowing at adequate depth provides uniformity of germination and seedling emergence, but sowing in greater depth may delay the emergence, causing stand failures due to physical barriers caused by soil profile on seeds, mainly in less vigorous seeds (SOUSA et al., 2007). However, surface sowing may expose the seeds to environmental variations, such as water deficit or excessive moisture and affect the quality of seedling (TILLMANN et al., 1994). *Erythrina verna* seeds presented better performance when placed more superficially, indicating that this species is little affected by the changes that occur in the substrate surface.

The emergence speed index of *Erythrina verna* was significantly affected by the sowing depth (Figure 2B). High levels, above 40, were obtained in seeds arranged in up to 2 cm below the surface of the substrate. This ratio decreased as sowing depth increased. The lowest emergence speed index of 17.22 was observed in seeds placed at 6 cm of depth. Cardoso et al. (2008) found that the emergence speed index decreased linearly with increasing of sowing depth of *Erythrina velutina* seeds. The largest emergence speed index for tomato seedlings were obtained at the depth of 1.5 cm (TILLMANN

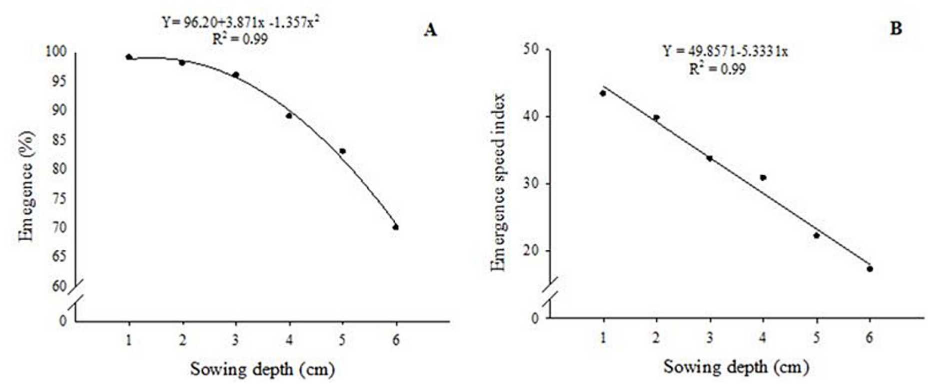


FIGURE 2: Percentage of emergence (A) and emergence speed index (B) of *Erythrina verna* seedlings on different sowing depths of seeds.

FIGURA 2: Porcentagem de emergência (A) e índice de velocidade de emergência (B) de plântulas de *Erythrina verna* sob diferentes profundidades de semeadura de sementes.

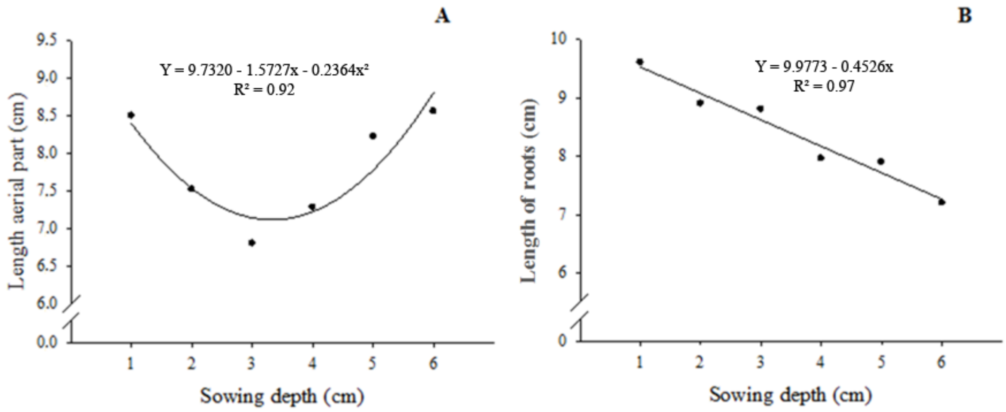


FIGURE 3: Length of aerial part (A) and length of roots (B) of *Erythrina verna* seedlings on different sowing depths of seeds.

FIGURA 3: Comprimento da parte aérea (A) e comprimento de raiz (B) de plântulas de *Erythrina verna* submetidas a diferentes profundidades de semeadura de sementes.

et al., 1994). Seeds placed deeper in substrate need more time to break the physical barrier imposed by the particles that increase the speed of emergence.

The shoot length tended to decrease as depth increased from 1 to 3 cm depth. However, from 4 to 6 cm, shoot length increased (Figure 3A).

The longest epicotyls were observed in response to etiolating of plants to reach the soil surface. Nóbrega and Vieira (1995) reported that epicotyl elongation is higher using furrows more depth because the seedlings need to produce longer stems to break soil surface. Greater depth promoted epicotyl elongation in *Erythrina verna* seedlings because the allocation of reserves for tissue formation and growth of shoots reach the surface and aim to perform photosynthesis to supply the energy needs of seedlings. The etiolating caused by the greater depth was responsible for the tendency of growth of the shoots of seedlings from seeds placed at using furrows more depth than 3 cm.

The root length decreased with increased depth. On average, seedlings from seeds placed at 1 cm from the soil surface reached 9.6 cm in length, while only 7.2 cm in length was observed in those placed at 6 cm depth (Figure 3B).

The dry weight of seedlings decreased with increased sowing depth. However, this effect was more significant at 6 cm depth (Figure 4A).

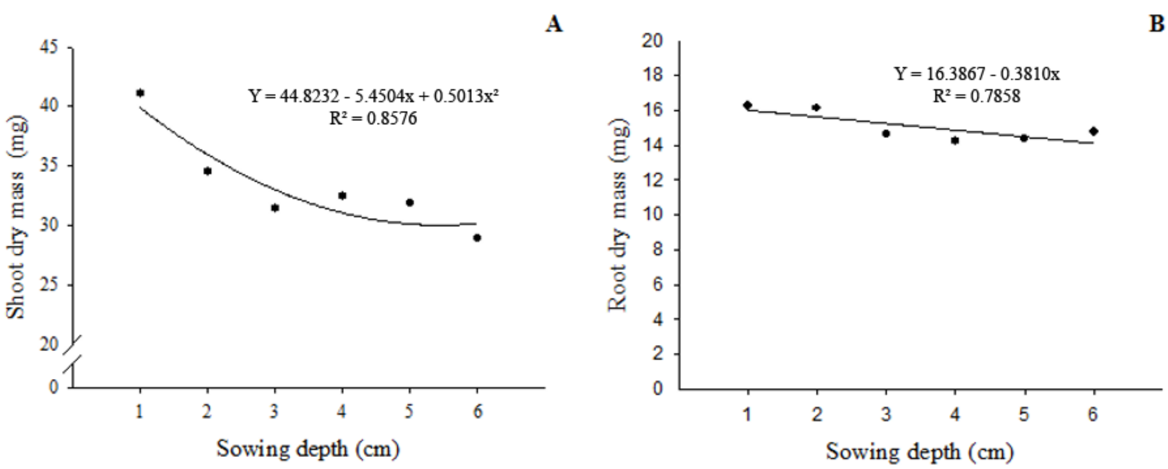


FIGURE 4: Shoot dry mass (A) and root dry mass (B) *Erythrina verna* seeds on different sowing depths of seeds.

FIGURA 4: Massa seca da parte aérea (A) e massa seca de raiz (B) de plântulas de *Erythrina verna* submetidas a diferentes profundidades de semeadura de sementes.

There was low tendency to decrease in dry weight of roots with increased sowing depth, but this effect was less evident (Figure 4B). Root length may have been affected by the remobilization of seed reserves, primarily to epicotyls of seedling. Perez et al. (1999) found no significant effect of sowing depth of up to 5 cm on the dry mass of seedlings of *Peltophorum dubium*. Seedlings of *Amburana cearensis* presented higher dry mass when the seeds were sown at a depth of 3.5 cm and allowed the expression of greater seedling vigor, while in *Moringa oleifera*, no significant differences were observed in dry mass production due to sowing depth (SOUZA et al., 2007, GUEDES et al., 2009).

Similarly to *Erythrina verna* evaluated in this study, *Erythrina velutina* seedlings were less productive when placed in soil at depths greater than 3 cm, as also observed by Cardoso et al. (2008). However, each species has a different behavior related to sowing conditions. So, researches that elucidate this behavior are important for obtaining high quality seedlings.

## CONCLUSIONS

The *Erythrina verna* seeds present physic dormancy caused by hard coat that may be more efficient broken by mechanical scarification on area opposite to hilum.

*Erythrina verna* seedlings have the best physiological quality when seeds are germinated at 1 to 3 cm depth.

The emergence percentage, emergence speed index, shoot length and root and shoot dry weight are the variables most affected by sowing depth.

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