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EFFECTS OF SEED PRE-TREATMENTS AND PLANTING METHODS ON GERMINATION AND EARLY GROWTH OF AFRICAN LOCUST BEAN (Parkia biglobosa)

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Abstract

Parkia biglobosa is an economically important multipurpose tree species having poor performance of early seedlings, and seed dormancy hinders domestication and high-scale multiplication of the plant in sub-Saharan Africa. This experiment determined the impact of pre-treatment of seeds and the media of planting on germination and early growth of P. biglobosa in nursery conditions within Kano State, Nigeria. The study employed a completely randomized design with two factors: seed pre-treatment (mechanical scarification, cold-water soaking, warm water soaking and uncovered control) and planting substrate (river sand and sawdust). The percent germination and initial growth parameters (seedling height, collar diameter, leaves, length of leaves, and breadth of the leaf) were measured, and data were compared using ANOVA at p= 0.05 levels of significance. The germination of the seeds differed greatly between the treatments, with the highest germination being in untreated seeds (53.3%), and the cold-water soaked in river sand (40.0%). Seeds that were sown in sawdust and scarified had the lowest germination (6.7%). The growth of the seedlings was, in most cases, better in river sand than in sawdust. The mean seedling height varied between 9.2 and 9.7 cm in river sand in most treatments, whereas it was 3.6 to 6.2 cm in sawdust. River sand also enhanced leaf growth and scarified seeds germinated to grow up to 9.6 ± 4.2 leaves, but sawdust always gave low growth performance. Interaction effects showed high differences in height and the number of leaves of seedlings between media among some pre-treatments (p < 0.01), but collar diameter and leaf width were not largely affected. The results indicate that P. biglobosa seeds could germinate successfully without pre-treatment, but river sand will offer a more appropriate medium through which young seedlings of the plants will grow.

Keywords: Agroforestry species; Seed dormancy, Substrate suitability; Silvicultural practices; Seedling vigor

INTRODUCTION

Parkia biglobosa (Jacq) Benth, also known as Dorowa (Hausa), African locust bean (English), Iyere (Yoruba), Nere (Bambara), and Nune (Tiv), is a multipurpose economic tree native to Africa (Sacande and Clethero, 2007). The tree endures drought due to its deep taproot system and ability to limit transpiration (Okunlola *et al*., 2011). Increasing attention on economically important tree species, particularly *P. biglobosa*, has focused on sustainable use and integrated management, recognizing its role in providing basic needs, household income, food security, and conserving natural resources (Amonum *et*

al., 2016). *P. biglobosa* is widely used in agroforestry for food, timber, firewood, fodder, medicine, dyes, and soil fertility restoration (Okunlola *et al.,* 2011).

The seeds of *P. biglobosa* exhibit exogenous dormancy, which hinders their prompt and uniform germination (Muhammed *et al.,* 2019; Aondoakaa *et al.*, 2024). Due to *P. biglobosa's* hard seed coat, which prevents rapid germination (Muhammed *et al.,* 2019). The germination process is influenced by factors like temperature, moisture, and light conditions, which can all contribute to suboptimal seedling establishment (Ndiaye *et al.*, 2022). This dormancy contributes to the depletion of natural populations and the loss of genetic diversity. Factors such as impermeable seed coats, low gas permeability, embryo immaturity, and mechanical resistance of the seed coat hinder germination (Amonum *et al.,* 2016). Effective nursery practices, including the production of healthy seedlings and the use of viable seeds, can overcome these challenges. This study aims to examine *P. biglobosa* seed dormancy using different seed pre-treatments and growth media for sustainable forest management.

MATERIALS AND METHODS

Experimental Design

The experiment was conducted at the Forestry Nursery of the Department of Forestry Technology, Audu Bako College of Agriculture, Dambatta, Kano State, Nigeria. This research was conducted to investigate the impact of seed pre-treatments and planting media on the germination and initial development of seedlings of the *Parkia biglobosa* plant under nursery conditions at the Audu Baka College of Agriculture plant nursery in Dambatta, Kano State, Nigeria. Mature seeds were selected, washed, and graded to assess uniformity and viability, and then sown (Muhammed *et al.,* 2019). The viability of the seeds was tested using the Floatation Test Method (FTM). They were left in a water basin and allowed to stay untouched for an hour. The floating seeds were discarded, and those ones which were sunken were gathered. Sinking seeds were of higher specific gravity because they had a higher storage food supply.

There were three seed pre-treatments and an untreated (control) (scarification, cold-water soaking, and warm water soaking). Scarification was done by mechanical abrasion of the seed coat, cold-water and warm-water treatments by soaking seeds in ambient and high temperatures, respectively. The experiment was conducted with one hundred and thirty-five (135) individual polythene bags of 20cm by 5cm with a weight of 3kg of soil in each. The sowing of the seeds was done in two planting media (river sand and sawdust). Seed planting was done as described by Ufere *et al. (*2013) and Kyei (2016). The experiment was presented in a totally randomized design (CRD), with two factors (potting media and pre-treatment). Sowing of the seeds was conducted under a controlled environment, and the study was subjected to the same environmental conditions. Each of the pre-treatment and media combinations was repeated three times to minimize errors and bias.

Data Collection

Germination was monitored periodically, and the percentage of germinated seeds was recorded for each treatment. Early seedling growth variables measured included: i. seedling height (cm), which was measured from the base to the tip of the seedling using a meter rule. ii. The collar diameter (cm) was measured at the base of the stem using a digital calliper. iii. The number of leaves was counted manually for each seedling. iv. Leaf length (cm) and width (cm) were measured using a ruler from the base to the tip and across the widest part of representative leaves. Measurements were taken at regular intervals until the seedlings reached the nursery

stage. All observations were recorded as mean ± standard deviation.

Data Analysis

Data were subjected to analysis of variance (ANOVA) to evaluate the effects of pre-treatments, planting media, and their interactions on germination and early growth parameters. Treatment means were compared using the least significant difference (LSD) test, and significant differences were identified at a p-value of ≤ 0.05. Superscripts within tables were used to indicate statistically significant differences between treatment means.

RESULTS

Based on the result from this finding, Figure 1 shows the germination response of *Parkia biglobosa* seeds under different pre-treatment methods and planting media. The results show considerable variation in germination percentages across the treatments. The untreated seeds exhibited the highest germination rate at 53.3%, indicating that the species can germinate reasonably well without pre-treatment under nursery conditions. Among the pre-treated seeds, cold-water soaking in river sand resulted in a germination rate of 40.0%, followed by scarification in river sand and cold-water treatment in sawdust, both yielding 33.3%. Warm-water treatment in sawdust produced a germination rate of 26.7%, while warm-water treatment in river sand recorded 20.0%. The lowest germination percentage (6.7%) occurred under the scarified-seed and sawdust combination.

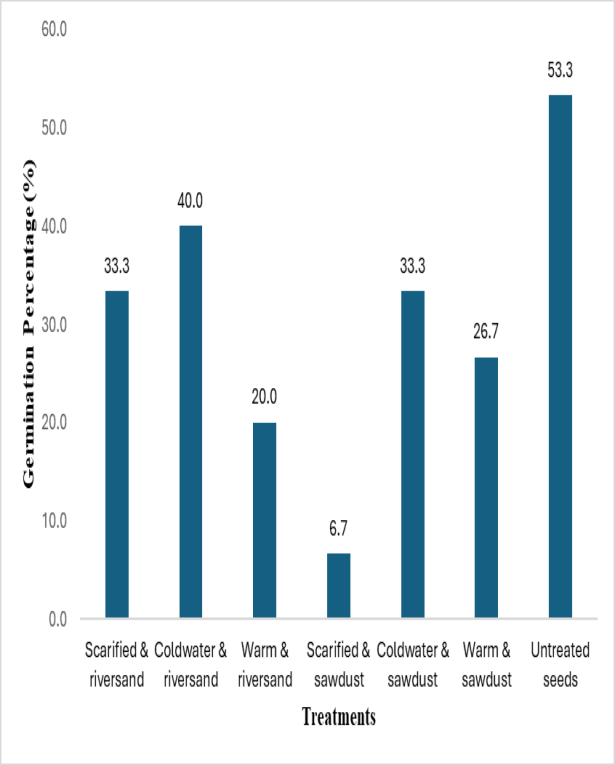

Figure 1: Effect of Pre-treatment on Germination Rate of *P. biglobosa* Seeds at Nursery Stage

Figure 2 shows the effects of different growth media on the early growth characteristics of *Parkia biglobosa* seedlings at the nursery stage. Seedlings grown in the control medium recorded the highest performance across most parameters, with a mean height of 9.6 cm, a collar diameter (girth) of 1.1 cm, an average of 8.9 leaves, a leaf width of 1.3 cm, and a leaf length of 2.6 cm. Seedlings grown in river sand exhibited comparable growth, attaining a height of 9.2 cm, a collar diameter of 1.0 cm, an average of 9.5 leaves, a leaf width of 1.2 cm, and a leaf length of 2.5 cm. This indicates strong support for leaf production and moderate development of other morphological traits. Sawdust medium resulted in the lowest growth measurements across all parameters. Seedlings in this medium achieved a mean height of 5.4 cm, girth of 1.1 cm, an average of 4.3 leaves, leaf width of 1.2 cm, and leaf length of 1.6 cm, reflecting reduced growth performance compared to the control and river sand treatments.

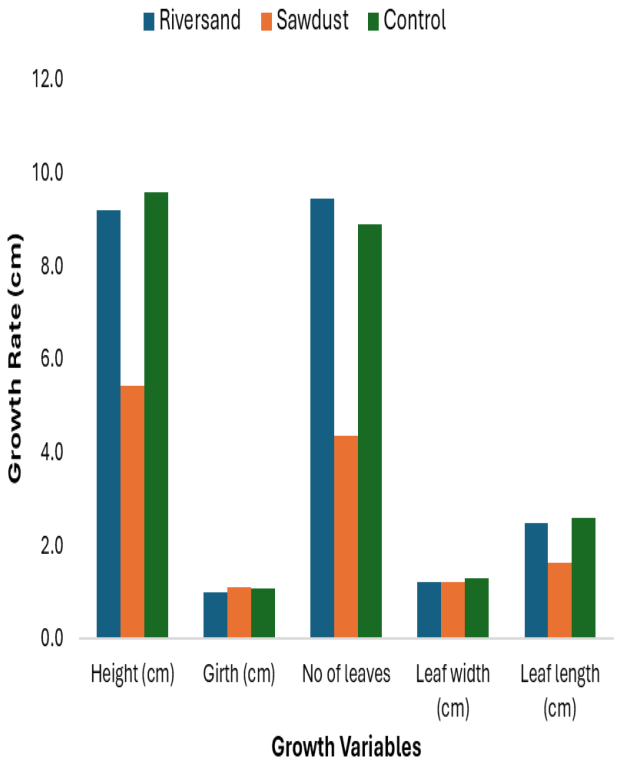

Figure 2: Effect of Growth Media on Growth Characteristics of *P. biglobosa* Seedlings at Nursery Stage

The results show that scarified seeds produced mean collar-diameters of 1.0 ± 0.4 cm in river sand and 1.1 ± 0.3 cm in sawdust. Cold-water-treated seeds recorded collar diameters of 1.0 ± 0.3 cm in river sand and 0.9 ± 0.2 cm in sawdust, with a corresponding p-value of 0.066. Warm-water-treated seeds had collar diameters of 1.0 ± 0.3 cm in river sand and 1.2 ± 0.1 cm in sawdust, and the p-value reported for this comparison was 0.412. For the untreated (control) seeds, collar-diameter values were 1.1 ± 0.2 cm in both river sand and sawdust, and no p-value was provided for this group. Across all pre-treatments, the total p-values for comparisons within each planting medium were 0.408 for river sand and 0.701 for sawdust

Table 1: Interactive Effect of Pre-treatments and Planting Media on Mean Collar-diameter of *P. biglobosa* Seedlings

Pre-treatments	Planting media		*p*-value
	River sand	Sawdust	
Scarified	1.0±0.4^{a}	1.1±0.3^{a}	
Coldwater	1.0±0.3^{a}	0.9±0.2^{a}	0.066
Warmwater	1.0±0.3^{a}	1.2±0.1^{a}	0.412
Control (untreated seeds)	1.1±0.2^{a}	1.1±0.2^{a}	-
***p*-value**	**0.408**	**0.701**	-

Note: Means with different superscripts within columns are significantly different at the 0.5 level.

Scarified seeds produced mean leaf numbers of 9.6 ± 4.2 in river sand and 2.3 ± 1.1 in sawdust, with a p-value of 0.002. Seeds treated with cold water recorded 6.8 ± 3.4 leaves in river sand and 4.1 ± 1.2 leaves in sawdust, and the p-value for this comparison was 0.001. Warm-water treated seeds produced 8.7 ± 4.9 leaves in river sand and 3.4 ± 1.3 leaves in sawdust, also with a p-value of 0.001. For the untreated control seeds, the mean number of leaves was 7.6 ± 4.3 in river sand and 7.5 ± 4.1 in sawdust, and no p-value was reported for this group. Across pre-treatments, the overall p-values within each planting medium were 0.870 for river sand and 0.001 for sawdust.

Table 2: Interactive Effect of Pre-treatments and Planting Media on Mean Number of Leaves of P. *biglobosa* Seedlings

Pre-treatments	Planting media		*p*-value
	River sand	Sawdust	
Scarified	9.6±4.2^{a}	2.3±1.1^{c}	0.002
Coldwater	6.8±3.4^{b}	4.1±1.2^{b}	0.001
Warmwater	8.7±4.9^{a}	3.4±1.3^{bc}	0.001
Control	7.6±4.3^{b}	7.5±4.1^{a}	-

(untreated seeds)			
***p*-value**	**0.870**	**0.001**	-

Note: Means with different superscripts within columns are significantly different at the 0.5 level.

Scarified seeds attained mean heights of 9.2 ± 2.6 cm in river sand and 3.6 ± 1.1 cm in sawdust, with a p-value of 0.004, indicating a significant difference between media (Table 3). Cold-water treated seeds recorded heights of 9.7 ± 4.1 cm in river sand and 6.2 ± 1.3 cm in sawdust, with a p-value of 0.412, showing no significant difference. Warm-water treated seeds reached 8.1 ± 4.5 cm in river sand and 6.0 ± 1.3 cm in sawdust, with a p-value of 0.411, also indicating no significant difference between media. For the untreated (control) seeds, mean heights were identical in both media at 9.4 ± 4.2 cm and 9.4 ± 4.3 cm, with no p-value reported. Across all pre-treatments, the overall p-values were 0.317 for river sand and 0.001 for sawdust.

Table 3: Interactive Effect of Pre-treatments and Planting Media on Height of *Parkia biglobosa* Seedlings

Pre-treatments	**Planting media**		***p*-value**
	Rive sand	**Sawdust**	
Scarified	9.2±2.6^{a}	3.6±1.1^{a}	0.004
Coldwater	9.7±4.1^{a}	6.2±1.3^{a}	0.412
Warmwater	8.1±4.5^{a}	6.0±1.3^{a}	0.411
Control (untreated seeds)	9.4±4.2^{a}	9.4±4.3^{a}	-
***p*-value**	**0.317**	**0.001**	-

Note: Means with different superscripts within columns are significantly different at the 0.5 level.

Table 4 shows that scarified seeds produced mean leaf lengths of 2.2 ± 0.51 cm in river sand and 0.7 ± 0.7 cm in sawdust, with a p-value of 0.001, indicating a significant difference between planting media. Cold-water treated seeds recorded mean leaf lengths of 2.7 ± 0.63 cm in river sand and 1.8 ± 0.26 cm in sawdust, with a p-value of 0.233, showing no significant difference. Warm-water treated seeds had mean leaf lengths of 2.4 ± 0.52 cm in river sand and 2.2 ± 0.26 cm in sawdust, with a p-value of 0.422, also indicating no significant difference. Untreated seeds showed identical mean leaf lengths of 2.4 ± 0.50 cm in river sand and 2.4 ± 1.0 cm in sawdust, with no p-value reported. The overall p-values across pre-treatments were 0.402 for river sand and 0.421 for sawdust.

Table 4: Effect of Pre-treatments and Planting Media on Mean Leaf Length (cm) of P. *biglobosa* Seedlings

Pre-treatments	**Planting media**		***p*-value**
	River sand	**River sand**	
Scarified	2.2±0.51^{a}	0.7±0.7^{a}	0.001
Coldwater	2.7±0.63^{a}	1.8±0.26^{a}	0.233
Warmwater	2.4±0.52^{a}	2.2±0.26^{a}	0.422
Control (untreated seeds)	2.4±0.50^{a}	2.4±1.0^{a}	-
***p*-value**	**0.402**	**0.421**	**-**

Note: Means with different superscripts within columns are significantly different at the 0.5 level.

Table 5 shows that scarified seeds produced mean leaf widths of 1.3 ± 0.3 cm in river sand and 1.2 ± 0.14 cm in sawdust, with a p-value of 0.143, indicating no significant difference between the planting media. Cold-water treated seeds recorded mean leaf widths of 1.2 ± 0.22 cm in river sand and 1.1 ± 0.15 cm in sawdust, with

a p-value of 0.867, also showing no significant difference. Warm-water treated seeds had mean leaf widths of 1.2 ± 0.24 cm in river sand and 1.3 ± 0.19 cm in sawdust, with a p-value of 0.434, indicating no significant variation between media. Untreated seeds exhibited identical mean leaf widths of 1.3 ± 0.27 cm in both river sand and sawdust, with no p-value reported. The overall p-values across pre-treatments were 0.221 for river sand and 0.643 for sawdust.

Table 5: Effect of Pre-treatments and Planting Media on Mean Leaf Width (cm) of P. *biglobosa* Seedlings

Pre-treatments	Planting media		*p*-value
	River sand	Sawdust	
Scarified	1.3±0.3^a	1.2±0.14^a	0.143
Coldwater	1.2±0.22^a	1.1±0.15^a	0.867
Warmwater	1.2±0.24^a	1.3±0.19^a	0.434
Control (untreated seeds)	1.3±0.27^a	1.3±0.27^a	-
***p*-value**	**0.221**	**0.643**	**-**

Note: Means with different superscripts within columns are significantly different at the 0.5 level.

DISCUSSION

This study's results indicate that seed pre-treatment techniques and media used in planting affected the germination and early growth performance of *Parkia biglobosa* under nursery conditions. This finding is contrary to the finding of Aondoakaa *et al*. (2024), who indicated that pretreatment with sulfuric acid was the best. The result of germination shows that untreated seeds showed the highest percentage of germination. This implies that the seeds of *P. biglobosa* have natural viability, which enables the seed to germinate without the use of mechanical or chemical germination if freshly collected. This finding is opposite to the report of Duguma *et al*. (1998), Smith *et al*. (2019) and Aondoakaa *et al*. (2024). As Duguma et al. reported, the percentage of germination was proportionate to the duration of treatment with acid. The greatest percentage of germination was registered by Aondoakaa *et al*. (2024) with Sulfuric acid acting as the seed pretreatment. This is in line with the results of Smith *et al*. (2019), who conducted an experiment on leguminous seeds and discovered that there was a particular pre-germination treatment that increased the germination percentage by a significant margin over other treatments.

The fact that the maximum percentage of germination was achieved with the untreated seeds shows that the P. biglobosa species seeds can germinate efficiently when fresh, hence can be subjected to limited procedures used in the enhancement process. Other pretreatments, however, enhanced germination to moderate levels. Less germination of scarified seeds in sawdust and warm-water conditions in the two media indicates that there are combinations that would inhibit moisture uptake or physiological awakening of the seed embryo. The differences show the need to use a suitable mixture between pre-treatment and planting medium to maximize the process of germination in this species.

The performance of seedlings in the control medium was best, in almost all the morphological parameters measured. The river sand was also conducive to similar early development, and this means that it offers an appropriate texture and aeration in which roots are established. Sawdust, on the other hand, had lower growth values in height, girth, number of leaves and leaf size. Such poor performance may be due to nutrient restriction, decomposition process or moisture retention properties of sawdust substrates. These findings show that *P. biglobosa* seedlings could be cultivated in different media (Aondoakaa *et al*., 2024). The best early growth occurs in media with a balanced ratio of nutrients; however, river sand is a secondary alternative.

Both the interactive effects of pre-treatment and planting media in collar diameter show very few significant differences because of the treatments. The values on collar diameter between treatments in each medium were relatively homogeneous, and the p-values did not show any statistically significant difference in any case except the small difference between cold-water treatments in both media. This shows that collar diameter is not as sensitive to conditions of early-stage treatment as other growth variables (leaf production or height). This result is in accord with the report of Ige *et al*. (2011) who reported that the plant height increased with the length of planting, the increase of collar diameter and the number of leaves. In comparison to collar diameter, height growth, production, and the area of the leaves are usually more responsive and sensitive indicators of early vegetative growth (Ojo *et al*., 2024).

There were great variations between river sand and sawdust in nearly all the forms of pre-treatment, except the untreated seeds. Scarified, cold water, and warm water-treated seeds yielded a higher number of leaves in river sand than sawdust. It means that the type of substrate affects the leaf proliferation to a large extent (De Souza *et al*., 2022). These differences are supported by the low p-values (0.001, 0.002). The absence of a significant difference in the control group means that the pre-treatment times medium interaction is of special significance when the seeds are subjected to external improvement processes.

The leaf number results are reflected in the seedling height trend. The major differences were with the scarified treatment condition, whereby the seedlings in river sand had a much higher height growth as compared to the ones in sawdust. With other pre-treatments, height variations across media were not found to be statistically significant. But the p-value of sawdust (0.001) indicates that there was significant variation in the height of seedlings between pre-treatment methods. This trend suggests that the pre-treatment conditions affect the height performance more with the sawdust, probably because of reduced nutrient availability or changed moisture properties. It means that sawdust can be used as a growth medium or soil additive, but the nutrient supplementation and moisture should be considered to ensure the best results in growth, particularly when it is used with particular pre-treatment regimes (Llonch *et al*., 2021).

Leaf length was also shown to be sensitive to planting media only in scarified seeds, in which river sand supported much longer leaves than sawdust. There was no significant difference among all the other pre-treatments. Also, there were no statistically significant differences in media across the pre-treatment groups in leaf width. These results show that the initial leaf size parameters are less sensitive to pre-treatment-medium interactions, with the exception of the scarified seeds (Madina *et al*., 2025). This could be attributed to the higher initial activity of the mechanically softened seed coats when the condition is favourable, e.g. river sand.

CONCLUSION

The findings revealed that untreated seeds germinated with the highest rate of 53.3 per cent, i.e. the germination of the species is good and does not require any pre-treatment if freshly collected from the mother tree. The germination rate obtained by cold-water soaking on river sand was 40.0 per cent, scarification on river sand gave 33.3, and cold-water treatment on sawdust gave 33.3. In sawdust, warm-water treatment had 26.7, and in river sand, the warm-water treatment had 20.0. The lowest percentage (6.7) of germination was recorded in the scarified seeds in sawdust. The media had a very strong influence on seedling growth, with the control medium having the highest growth. The mean height of the seedlings was 9.6 cm, the collar diameter was 1.1 cm, the number of leaves was 8.9, the width of the leaf was 1.3

cm, and the length of the leaf was 2.6 cm. River sand had the same growth with a height of 9.2 cm, a collar diameter of 1.0 cm, 8.9 leaves, the width of the leaf was 1.2 cm, and the length of the leaf was 2.6 cm.

The leaf number and seedling height were the variables most sensitive to pre-treatment and planting media. Seeds that had been scarified germinated with 9.6 +4.2 leaves in river sand and 2.3 +1.1 leaves in sawdust ($p=0.002$). The height of the scarified seedlings in river sand and the sawdust was 9.2 ± 2.6 cm and 3.6 ± 1.1 cm, respectively ($p = 0.004$). There were less sensitive collar diameter and leaf width across media with a value of 0.9-1.2cm and 1.1-1.3cm, respectively. The difference in leaf length was only significant in the case of scarified seeds (2.2 ± 0.51 cm in river sand and 0.7 ± 0.7 cm in sawdust, $p = 0.001$). These findings show that planting medium is more inclined on the early growth when compared to pre-treatment procedures.

Based on these findings, normal nursery production should be done with untreated seeds freshly collected from the mother tree. Where necessary, cold-water soaking or scarification may be applied. Raising seedlings using control medium or river sand is recommended as they provide more favourable growth: control medium seedlings were the highest height of 9.6 cm and 8.9 leaves, whereas river sand seedlings were the highest of 9.2 cm and 9.5 leaves. Sawdust cannot be considered one of the main media since the seedlings could not grow more than 5.4 cm in height and 4.3 leaves, and this implies poor early growth. As a way of improving its suitability, future studies should aim at ensuring nutrient enrichment of sawdust, such as by combining it with compost or topsoil.

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