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EFFECTS OF FRUIT MATURITY AND PRE-SOWING WATER TREATMENT ON GERMINATIVE PERFORMANCE OF *GMELINA ABOREA* SEEDS

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ADEBISI MA, ADEKUNLE MF & ODEBIYI OA. 2011. Effects of fruit maturity and pre-sowing water treatment on germinative performance of *Gmelina aborea* seeds. The study was initiated to determine the effects of four fruit maturity levels (colour index of maturity: greenish yellow, yellow brown, dark brown, yellow and green) and four pre-sowing water soaking treatments (0, 24, 36 and 48 hours) on five seed germinative performance traits in *Gmelina arborea*. Significant differences were exhibited among the fruit maturity levels and pre-sowing water treatments for all the five traits evaluated. Differences in these five traits between maturity levels were significantly influenced by pre-sowing water treatments. Seeds soaked in water for 48 hours had the highest germinative performance traits. Seeds obtained from yellow brown fruits gave superior germinative performance traits, followed closely by seeds from yellow fruits. Seeds of dark brown fruit had poor germinative performance traits. Standard germination of yellow brown fruit exhibited strong relationships with seedling length, seedling vigour index and germinative index while good relationship was found between plumule length and seedling vigour index under all fruit maturity levels except dark brown fruits. Seeds from yellow brown fruits with the best germinative performance traits when soaked in water for 48 hours were recommended for producing good and robust seedlings in forest plantation establishment.

Keywords: Correlation, fruit colour, maturation level, relationship, seed quality, vigour, soaking

ADEBISI MA, ADEKUNLE MF & ODEBIYI OA. 2011. Kesan kematangan buah dan rawatan air terhadap prestasi percambahan biji *Gmelina arborea*. Kajian dijalankan untuk menentukan kesan empat peringkat kematangan buah (indeks warna bagi peringkat kematangan buah: kuning kehijauan, kuning perang, perang tua, kuning dan hijau) dan tempoh rendaman air (0 jam, 24 jam, 36 jam dan 48 jam) terhadap lima ciri yang mencerminkan prestasi percambahan biji *Gmelina arborea*. Kelima-lima ciri yang dinilai menunjukkan perbezaan signifikan dengan peringkat kematangan dan rawatan air. Biji yang direndam dalam air selama 48 jam menunjukkan prestasi percambahan yang terbaik. Biji daripada buah kuning perang menunjukkan prestasi percambahan terbaik diikuti oleh biji daripada buah kuning manakala biji daripada buah perang menunjukkan prestasi yang lemah. Percambahan standard buah kuning perang menunjukkan hubungan yang baik dengan ketinggan anak benih, indeks kecergasan anak benih dan indeks percambahan. Hubungan yang baik juga diperhatikan antara panjang plumul dengan indeks kecergasan anak benih bagi semua peringkat kematangan buah kecuali buah perang tua. Biji daripada buah kuning perang yang menunjukkan prestasi percambahan terbaik apabila direndam di dalam air selama 48 jam disarankan untuk penghasilan anak benih kuat dalam penubuhan hutan ladang.

INTRODUCTION

Gmelina arborea is a fast growing deciduous tree occurring naturally in India, Thailand, Cambodia and southern provinces of China but planted extensively in Nigeria, Sierra Leone and Malaysia. It is commonly planted as avenue trees, in gardens and also in villages along agricultural land, on village community lands and on wastelands. It is light demanding, tolerant of excessive drought but moderately frost hardy and has good capacity to recover in case of frost injury (Duke 1983).

Gmelina was originally established in Nigeria for the supply of pulpwood for the country's pulp and paper mills (Akachukwu 1993). The pulp and paper industries in Nigeria have all closed down and the species is now used as building material. These plantations are now ready sources of raw logs for conversions into sawn timber of uniform grades and sizes (Adetogun & Omole 2007). The wood is one of the best timbers of the tropics, useful for particleboard, plywood, core

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stock, pit probs, matches and sawn timber for light construction, furniture, general carpentry and packaging (Duke 1983). The wood is also used in carriages, carvings, musical instrument and ornamental work. The root and bark of gmelina are stomachic, galactagogne, laxative and antihelminthic. They improve appetite and are useful in treating hallucination, piles, abdominal pains, burning sensation, fever, tridosha and urinary discharge. The tree has other medicinal properties including the leaf paste which is applied to relieve headache; the juice is used as a wash for ulcers while the flowers are cooling and useful in curing leprosy and blood diseases (Duke 1983).

Many tree planters consider gmelina as a very promising species due to ease and low cost of establishment, rapid early growth, early returns and promising wood characteristics including high durability and good yield and quality of pulp. Other tree planters have had less encouraging experience with the species. It is moderate in durability with service life of less than 15 years (Salim et al. 2002). They reported rapid reduction in increment after 70 years of growth, tendency of the tree to die at young age, problems with uneven wood and slow drying of wood. In general, poor stem and branching characteristics, and difficulty in establishing the wood in pulp mills are some of the problems with gmelina in Nigeria. In addition, attacks by various pests and diseases have prevented its planting on a large scale especially within its natural distribution area (Omoyiola 1974). Unexpected low seed germination rates have been recorded (Omoyiola 1974, Okoro 1983). Okoro (1983), and Hartman and Koster (1975) have suggested the possibility of the presence of inhibitory substances in the fleshy pericarp of gmelina fruit. Fruit colour, size, fermentation, depulping, time of fruit collection and water soaking were identified as factors that could affect germination of gmelina seeds (Woessner 1980, Okoro 1983).

In spite of the enormous resources spent on seedling establishment, there is still problem in seed germination. Many a time seeds have not germinated due to unknown reasons. The inability of gmelina seeds to germinate may be due to overripeness or overfermentation of the pulpy part of the fruit which causes the death of the embryo. In addition, pre-soaking water treatment of seeds was found to affect germination in crop plant species (Copeland 1976).

Though workers have reported on the main effect of fruit colour as well as water soaking treatment on seed germination of gmelina seeds, there is little or no information on the combined influence of fruit ripeness and pre-soaking water treatment on the germination and seedling vigour of gmelina seeds. Data on quality of seeds during fruit ripeness and seed maturation will be useful for maintenance of germplasm. It can also make the cycle of a breeding programme as short as possible. Thus, it will be necessary to determine which fruit maturity stage of gmelina should viable seeds and seeds of good vigour be obtained. This study was, therefore, initiated to determine the effects of fruit maturity levels on germinative performance traits of gmelina seeds after different pre-soaking water treatments.

MATERIALS AND METHODS

Seed collection

Fruits of gmelina (white teak) were collected from Olokemeji Forest Reserve, Olokemeji village, Odeda Local Government area, Ogun state, Nigeria (latitude 7° 37' N, longitude 3° 89' E). Fruits were collected from fruiting trees in January 2007 for the first trial and March 2007 for the second trial. These categories were green, greenish yellow, yellow, yellow brown and dark brown fruits. A total of 600 fruit stones were collected for each level of maturity and seeds were removed from the fruits gently and kept under ambient conditions (28.5 °C and relative humidity 60%) for 14 days. A total of 1200 seeds were used for each maturity status for the two trials. Seeds from each category of fruit colour were soaked in deionised water for 0, 24, 36 and 48 hours. The 100 seed weight and seed volume of fresh seeds of each category of fruits were determined before pre-soaking treatments.

Seed physiological quality evaluation

Standard germination percentage

A total of 100 seeds were counted randomly from each hand graded seed lots in three replications for the two trials. A total 50 seeds from each category of fruit colour were soaked in water for 0, 24, 36 and 48 hours. Seeds from each treatment unit were sown 5 cm deep in plastic pots

(dimensions 30 x 30 cm) filled with sterilised soil with 1 cm spacing between seeds. The pots were arranged in a completely randomised design in the laboratory and germination count of normal (healthy or strong) seedlings were taken at 14 days up to 30 days. Observations on germination were made every three days and percentage of standard germination was determined (ISTA 1995).

Plumule length

The plumule lengths of 10 randomly selected normal seedlings were measured from each treatment unit at 30 days after sowing in each replicate (AOSA 1983).

Seedling vigour index (SVI)

The vigour level of each fruit colour was calculated according to Kim et al. (1994) as percentage of normal germination multiplied by plumule length and divided by 100.

Germination index (GI)

This was recorded according to Alvarado et al. (1987) using the following formula

$$GI = \sum \frac{Gt}{Tt}$$

where Gt is the number of seeds germinated at day t and Tt is the number of days.

Mean germination time (MGT)

This was recorded according to Alvarado et al. (1987) using the formula

$$MGT = \frac{\sum T_1 N_1}{\sum N_1}$$

where N_1 is number of newly germinated seeds at time T_1.

Data analysis

Data collected on standard germination were transformed using arcsine transformation (arcsine = $Sin^{-1}\sqrt{x}$) before analysis. All analyses were carried out using SPSS statistical software version 16. Data on the five germinative performance traits were subjected to combined analysis of variance. Significant differences of treatment means were detected using Duncan's multiple range test at 5% probability level. Correlation coefficients between pairs of traits were determined at each fruit maturity level across water soaking treatments and trials.

RESULTS

The trial effect was highly significant on seedling length and seedling vigour index while the soaking and maturity effects were highly significant on the five seed quality traits examined (Table 1). The interaction between trial and soaking was highly significant on seedling vigour index only whereas interaction effects between soaking and maturity were significant on all the five traits. The three-way interaction (trial x soaking x maturity) were significant on seedling vigour index trait only.

Unsoaked (control) seeds from yellow and yellow brown fruits showed the highest standard germination of 62 and 60% respectively, whereas dark brown fruit seeds had the lowest value of 39% (Figure 1). With soaking time increased to 24 hours, seeds from greenish yellow fruits recorded the highest standard germination of 75% and yellow brown fruits had 60%. Seeds from yellow and green fruits had comparable germination which was higher than 43% that was exhibited by seeds of dark brown fruits. After 36 hours of soaking, seeds from three fruit colours (yellow brown, yellow and greenish yellow) recorded the highest germination values of 76, 76 and 75% respectively but seeds from dark brown recorded the lowest value of 45%. However, when seeds were soaked for 48 hours, seeds from yellow brown and yellow fruits gave the highest germination of 77 and 75% respectively.

Unsoaked (control) seeds from green fruit had the highest mean germination time (MGT) of 24 days while seeds from dark brown and yellow fruits had 23 days which was higher than 20 and 21 days obtained in greenish yellow and yellow brown fruits (Figure 2). After 24 hours of water soaking, seeds of dark brown and green fruits recorded the highest MGT values of 23 days while seeds of yellow brown fruits had the lowest value of 19 days. At 36 hours of soaking, seeds of dark brown and green fruits had the highest MGT of 22 days compared with 20 days recorded on seeds from fruits of the other three colours.

Table 1 Summary of analysis of variance showing the mean square values of germinative performance traits after water soaking of gmelina seeds at different maturity levels

Source of variation	Df	Standard germination (%)	Mean germination time (days)	Germination index	Seedling vigour index	Seedling length (cm)
Replication	2	58.91**	44.51*	0.54 ns	14.72**	4.47 ns
Trial (T)	1	1.88 ns	6.02 ns	1.24 ns	76.62**	39.87**
Soaking (S)	3	1480.33**	12.99*	2.50**	67.58**	75.57**
Maturity (M)	4	2612.16**	35.69**	9.31**	293.25**	68.97**
T × S	3	70.03 ns	4.33 ns	0.80 ns	48.89**	4.50 ns
T × M	4	9.79 ns	4.12 ns	0.31 ns	7.72 ns	5.04 ns
S × M	12	241.64**	10.62**	6.91**	30.72**	26.67**
T × S × M	12	16.25	6.39 ns	0.32 ns	17.64*	3.32 ns
Error	78	16.92	3.91	0.63	12.35	2.89

ns = Not significant, * significant at 0.05 probability level, ** significant at 0.01 probability level

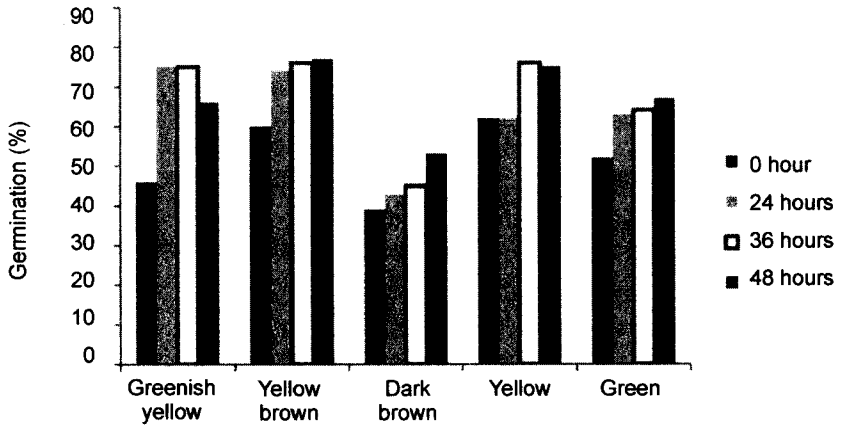

Figure 1 Standard germination of gmelina seeds as affected by fruit maturity level and water soaking time in two trials

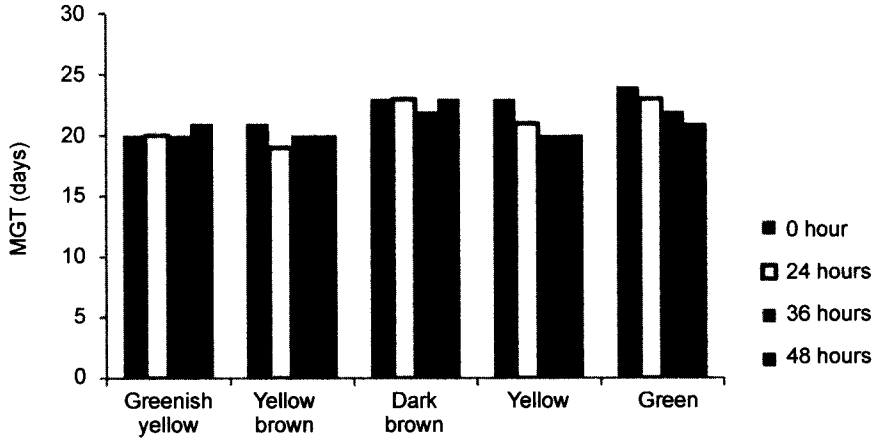

Figure 2 Mean germination time (MGT) of gmelina seeds as affected by fruit maturity level and water soaking time in two trials

After 48 hours of soaking, the highest MGT of 23 days was recorded with seeds of dark brown fruits. Seeds from yellow brown and yellow fruits gave the lowest MGT of 20 days.

After 0 and 24 hours of soaking, seeds obtained from yellow brown and yellow fruits recorded the highest germination index of 3 which was comparable with the value of seeds from greenish yellow fruit after 24 hours of soaking (Figure 3). Increasing the soaking hours to 36 and 48 hours, seeds from yellow brown and yellow fruits had the highest germination index of 3. Seeds from dark brown fruits gave the lowest germination index of 1.

Seeds from green and greenish yellow fruits retained maximum value of 17 cm at 0 and 24 hours of soaking compared with the other treatments (Figure 4). At 36 and 48 hours of soaking, seeds from yellow brown fruits had maximum seedling lengths of 18 and 20 cm respectively.

Seeds from yellow brown and yellow fruits had the highest seedling vigour compared with the other treatments (Figure 5). Seeds obtained from yellow brown fruits had the highest seedling vigour values throughout the soaking durations.

Table 2 reveals that the standard germination of seeds obtained from yellow and yellow brown

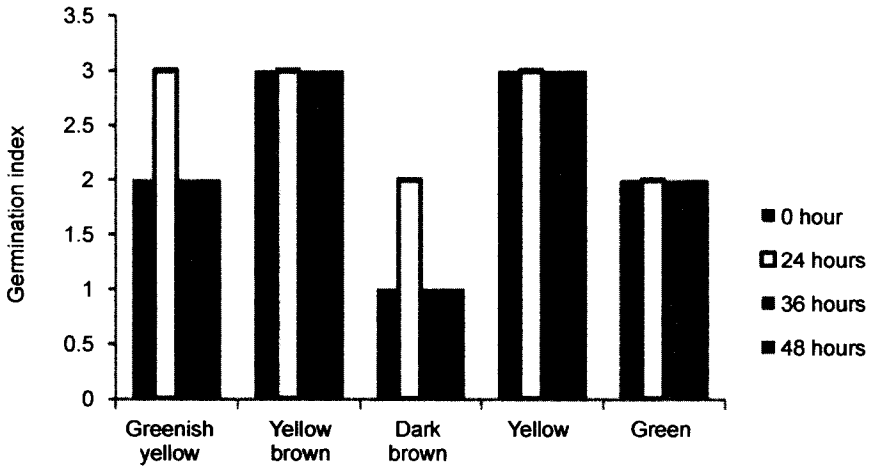

Figure 3 Germination index of gmelina seeds as affected by fruit maturity level and water soaking time in two trials

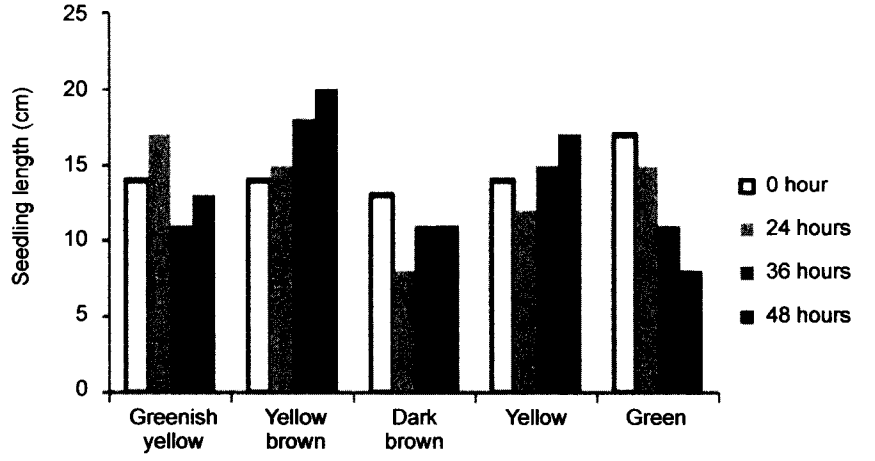

Figure 4 Seedling length of gmelina seeds as affected by fruit maturity level and water soaking time in two trials

fruits recorded significant positive correlations with germination index (r = 0.54, r = 0.45), seedling length (r = 0.43, r = 0.46) and seedling vigour index (r = 0.43, r = 0.45). Standard germination value of seeds from green fruits had positive and significant correlation with germination index (r = 0.57), whereas negative and significant correlation was obtained between MGT and seedling length of seeds from green fruits. Seedling vigour index of seeds from all the five fruit maturity levels recorded significant and positive correlation with germination index. Similar trends were recorded with seedling length except for seeds of dark brown fruits which gave non-significant positive correlation (r = 0.25).

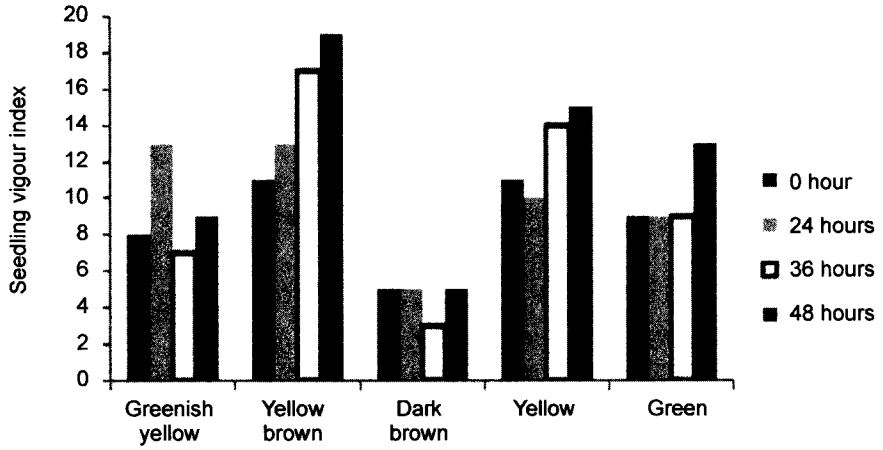

Figure 5 Seedling vigour index of gmelina seeds as affected by fruit maturity level and water soaking time in two trials

Table 2 Correlation analysis between germinative performance traits of gmelina seeds at different maturity levels (n = 24)

Trait	Mean germination time (days)	Germination index	Seedling length (cm)	Seedling vigour index
Standard germination (%)				
Greenish yellow	-0.18 ns	0.19 ns	0.09 ns	0.30 ns
Yellow brown	0.06 ns	0.45*	0.46*	0.45*
Dark brown	0.18 ns	0.04 ns	-0.16 ns	-0.16 ns
Yellow	-0.24 ns	0.54**	0.43*	0.43*
Green	-0.18 ns	0.57**	-0.19 ns	-0.19 ns
Mean germination time (days)				
Greenish yellow		0.14 ns	0.10 ns	0.15 ns
Yellow brown		0.40*	-0.01ns	0.15 ns
Dark brown		-0.31 ns	0.04 ns	-0.25 ns
Yellow		0.04 ns	-0.14 ns	-0.09 ns
Green		0.15 ns	-0.44*	-0.24 ns
Germination index				
Greenish yellow			0.08 ns	0.79**
Yellow brown			0.14 ns	0.55**
Dark brown			-0.30 ns	0.81**
Yellow			0.28 ns	0.72**
Green			-0.17 ns	0.60**
Seedling length(cm)				
Greenish yellow				0.61**
Yellow brown				0.90**
Dark brown				0.25 ns
Yellow				0.86**
Green				0.66**

ns = Not significant, *significant at 5% probability level, **significant at 1% probability level

DISCUSSION

The study revealed that significant differences were observed between trials with regard to seedling vigour suggesting that the environment during seed testing should be given due consideration in evaluating seed vigour of gmelina. Earlier study by Adebisi (2004) pointed out that the prevailing environment during seed quality evaluation was an important factor that can influence seed testing result. Considerable differences were observed among the five fruit maturation levels and four pre-sowing water treatments for the five germinative performance traits. This, therefore, provides opportunity for selection of seeds with good quality traits among fruit maturity levels and pre-sowing water treatments. The results of interaction effects between fruit maturation level and soaking time were significant on the five traits examined, implying that differences in these seed quality traits among the fruit maturation levels were influenced by pre-soaking water treatments.

On the efficacy of pre-sowing treatment, 48 hours of soaking exhibited the highest standard germination, germination index, plumule length and seedling vigour with lowest mean germination time. With regard to fruit maturity level, seeds obtained from yellow brown fruits had the lowest mean germination time and superior germinative performance traits, followed closely by seeds from yellow fruits.

The study also indicated that a consistent higher germinative performance trait was observed at each soaking time with seeds from yellow brown seeds, followed closely by seeds from yellow fruits. Conversely, seeds obtained from dark fruits exhibited consistently poor germinative performance traits with longer germination time at each soaking time. However, seeds from yellow brown fruits had the best germination, seedling vigour, seedling length and germination index as well as faster MGT when soaked in water for 48 hours. Woessner (1980) and Okoro (1983) have earlier pointed out differences in fruit colour as a factor that affects germination in gmelina seeds. The poor germinative performance traits of seeds from dark brown fruits might be due to the possibility of the presence of inhibitory substances in the fleshy pericarp of gmelina fruits (Hartman & Koster 1975, Okoro 1983).

The correlation analysis revealed that standard germination of seeds from yellow brown and yellow fruits recorded strong and positive relationships with seedling length, seedling vigour index and germination index. Therefore, increase in these three traits would lead to an increase in seed germination of gmelina from yellow brown and yellow fruits or vice versa. Similar associations between seed germination, seedling vigour and plumule length have been reported in sesame (Adebisi et al. 2006a), West African rice (Adebisi et al. 2006a) and West African okra (Kehinde et al. 2005). Similarly, seedling vigour level of seeds from different fruit maturity levels was strongly correlated with germination index, indicating that seedling vigour could be considered as an indicator of germination index in gmelina, irrespective of fruit maturation levels. Seedling length was a reliable test of seedling vigour as it showed strong correlation with seedling vigour index under the five fruit maturity levels except for dark brown fruit. This suggests that plants with long seedling length will ordinarily produce high seedling vigour and eventually this will result in good field establishment. Similar findings were reported by Kehinde et al. (2005), Okelola et al. (2007) and Adebisi at al. (2006a, b) in crop species.

CONCLUSION

Gmelina arborea seeds from yellow brown fruits soaked in water for 48 hours gave the best germinative performance.

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