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EFFECTS OF AGE AT TRANSPLANTING ON THE GROWTH AND VIGOUR OF CLEOPATRA MANDARIN (*Citrus reticulata* BLANC) ROOTSTOCK SEEDLINGS.

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Abstract

An experiment was carried out at the National Horticultural Research Institute of Nigeria (NIHORT), Ibadan, Nigeria between August 1999 and March 2000 to examine the effects of age at transplanting on the growth and vigour of the rootstocks and the time the rootstock seedlings attain buddable size in Cleopatra manadarin seedlings. Cleopatra mandarin (Citrus reticulate Bianco) seedlings were transplanted from the pre-nursery to the main nursery at 4, 4 ½, 5, 5 ½. 6, 6 ½ and 7 months after the seeds were sown in the pre-nursery. The rate of seedling survival and increases in stem diameter of four to five months old transplants were higher than seedlings transplanted at five and half to seven month old. Also, younger seedlings (4 to 5 ½ months old) compete favourably with older seedlings (5 ½, to 7 months old seedlings) in rate of increase in height, leaf production and leaf area increase. However, production of branches was higher in older seedlings which is undesirable in citrus seedling production. Since stem diameter is a major growth factor at this stage of citrus development, it is concluded therefore that Cleopatra mandarin rootstock seedling should be transplanted from the pre-nursery to the main nursery between the ages of four to five months to increase rootstock turn over rate.

Introduction

Citrus, family Rutacceae, are aromatic broadleaved, evergreen tree natives to subtropical region of Eastern Asia. The primary species of cultivated citrus are sweet orange (*Citrus sinensis),* the lemon *(Citrus Limon),* the grapefruit (Citrus paradisi), the pumelo (*Citrus grandis*, the Lime (*Citrus aurantifolia*) and the mandarin (tangerine) (*Citrus reticulata*). Citrus are important crops in Nigeria, and it is grown in both the forest and transitional zone. The oil extracted from the peel is used in the production of perfume in both cosmetic and pharmaceutical industries. Frozen concentrate juice of citrus are dispense in cans for export as a foreign exchange earner. Bye-products from citrus juice extraction is important in soft drink production while, the pulp remains is used as livestock feed (Amih, 1980).

The usual method of citrus propagation is by budding virus-free clones on to suitable rootstocks. Rootstocks are seedlings raised for the purpose of supporting the scion budded or grafted on them (Castle, 1982). In Nigeria two major rootstocks are commonly used, these are Cleopatra mandarin for the heavy soils of southern Nigeria and rough lemon for the lighter soils of northern Nigeria (Kolade, 1981).

The selection of rootstock is as important as the selection of citrus varieties in budding. Infact, the selection of rootstock may be considered more important than the selection of scion because it would be more difficult to rectify problems associated with rootstock than with scion, which can be easily changed (Cox, 1993). Rootstocks are raised from seeds which are extracted from matured fruits, washed and dried under shade for 24 hours. The seeds are planted in a raised bed in drills of 30cm apart in pre-nursery. The soil is watered frequently to keep the surface moist. After germination the seedlings are taken care of for at least six months before they are transplanted to the main nursery. In the main nursery, the seedlings are planted at a spacing of 30cm apart. They are nursed until they attain a stem diameter of 0.4 to 0.6 cm when they are ready to be budded (Adigun, 1992). The age and time of transplanting is important in citrus cultivation from the nursery to main garden. Presently, in citrus production before seedling is ready for transplanting to main nursery from the pre-nursery, it must have stayed in the pre-nursery 6 to 7 months. This prolongs the time taken for the rootstock to be budded, nurtured and finally transplanted to the orchard (NIHORT, 1995).

The actual figure of the quantity of citrus seedling demanded and supplied in Nigeria over the past years is difficult to ascertain. However, records, from the marketing and extension sections of NIHORT, Ibadan,

Nigeria shows that the availability of budded citrus seedlings have been a limitation in citrus cultivation in Nigeria (NIHORT, 1995). Therefore, there is the need to shorten the period the seedlings spend in the pre-nursery so as to increase the seedling production turnover. The objective of this study was to examine the effects of the age at transplanting of the rootstock seedling on its vigour and development with a view to determining the best age at transplanting Cleopatra mandarin rootstock seedling from the pre-nursery to the main nursery.

Materials and Methods

Description of the Experimental Site

The experiment was carried out at the National Horticultural Research Institute of Nigeria (NIHORT), Ibadan, Oyo State, between August 1999 and March 2000. The site lies in the northern limit of the lowland rain forest zone of southwestern Nigeria which is located on latitude 7° 30'N and longitude 3°54'E with an elevation of 220 metres above sea level. The experimental site has a bimodal rainfall with a annual rainfall of 1230mm and monthly temperature range of between 21 and 31° C with relative humidity of about 85% in the wet season (March – October) and 60-80% in the dry season (November – March) (Table 1).

Table 1. Some weather variables during the period of the experiment at NIHORT, Ibadan, Nigeria.

Months of The year	Rainfall(mm)	Temperature(^{0}C)	Sunshine (h)	Relative humidity (%)
July	146.3	28.2	4.2	86
August	216.2	29.6	4.1	86
September	355.3	30.2	5.4	86
October	56.8	32.4	6.1	85
November	58.8	32.7	7.8	83
December	50.5	30.6	7.3	73
January	0	31.8	8.1	67
February	5	32.3	8.3	56
March	11	32.8	8.4	49

Source: Meteorological Section: National Horticultural Research Institute, Ibadan.

The soil of the trial site belongs to the Baden series in the broad group of tropical alfisols (Oxic Paleostauf, USDA). These soils are derived essentially from the fine grained biotic genesis and schist parent material and are well drained and high in gravel content.

Land Preparation

The field was manually slashed and all the refuse gathered together and burnt. Pre-planting soil sampling was done from this location in August, 1999. Core samples were taken randomly from surface soil (0 -15 cm) and were subjected to routine chemical analysis.

The experiment was laid out in a Randomized Complete Block Design (RCBD). The treatments were different ages of seedlings in the pre nursery (7, 6 ½,6,5 ½,5 and 4 ½ months old seedlings) before transplanting were allocated at random to the plots and replicated four times. Citrus seedlings were transplanted at 2 x 2 m (54 plants per plot and a total of 132,500 seedlings per hectare).

Planting Materials

Rootstock seeds of Cleopatra mandarin (*Citrus reticulata* Blanco) were sown on pre-nursery bed size (10 x 1 m) and drill at 15 cm apart across the bed at two weeks interval to produce seedlings of seven different ages for transplanting. The seedlings were transplanted to the main-nursery on 10th Sept. 1999 when the seedlings had attained the ages of 4 and 7 months. Weeding of the plot was carried out manually. The first weeding was carried out at three weeks after transplanting (3 WAT). The second and third weeding were done at 6 and 9 WAT respectively. NPK fertilizer 20:10:10 was applied at the rate of 100kg/ha as a basal dressing at 6 WAT. A total of fifty-four seedlings were transplanted to each plot. The survived seedlings were counted and recorded for each plot at weekly interval for 4 weeks commencing at 2 WAT. Five randomly selected plants were tagged in each plot and were used for agronomic data collection which includes: number of leaves, plant diameter

(girth), number of branches and leaf area. The data obtained were subjected to statistical analysis (analysis of variance, ANOVA) for Randomized complete Block Design (RCBD). Differences among treatment means were separated using the least significant difference (LSD) test at $P < 0.05$.

Table 2. Seedlings survival rate at the end of four weeks after planting

Age attransplanting(months)	Number ofseedlingstransplanted	Number ofseedling at4 WAT
7	54	33
6½	54	34
6	54	34
5½	54	38
5	54	44
4½	54	49
4	54	49
LSD	Ns	5.0

Results

Seedling Survival Rate

Survival rate decreased with age at transplanting (as the seedling were delayed in the pre-nursery before planting out in the nursery. At the end of 4 WAT, significant difference was observed in the seedling survival rate. Four and five months old seedlings had higher survival rate (44 to 49 than 5 ½ and 7 month old seedlings (33 to 38) (Table 2). The severity of transplanting shock was observed in the number of leaves per seedling. The number of leaves shed increased as the seedling age in the pre-nursery increased. Shedding of leaves occurred in all the seedlings except in 4 months old seedlings. The number of leaves shed by 6 and 7 month old seedlings was significantly different from 4 ½ to 5 ½ month old seedlings.

Stem Diameter

Generally, stem diameter increased as the seedlings advanced in age. Although, stem diameter varied at the time of transplanting the rate at which the diameter changed over time was the same at 8 WAT (0.01cm/month) in all treatments (across all ages of seedlings that were transplanted). However, at 12, 16 and 20 WAT, 4 and 4 ½ months old seedlings showed greater rate of diameter increase (0.02cm/month). At 24 WATP, 4 months old seedlings were outstanding with a rate of change of 0.04cm/month. Its diameter had increased from the initial 0.09cm as at transplanting time to 0.43 cm/plant. This was closely followed by 4 ½ and 5 ½ months old seedlings with a rate of diameter increase of 0.03cm/month. Six to seven months old seedlings had the least rate of change (0.02cm/month).

Table 3. Effects of age at transplanting on monthly changes in seedling diameter

Age at transplanting (Months)	Stem diameter at transplanting	Weekly increase in diameter					Stemdiameter at24 WATP
		8	12	16	20	24 WAT	
7	0.19	0.01	0.01	0.01	0.02	0.02	0.45
6½	0.18	0.01	0.01	0.01	0.02	0.02	0.43
6	0.18	0.01	0.01	0.01	0.02	0.02	0.45
5½	0.15	0.01	0.01	0.01	0.02	0.03	0.42
5	0.14	0.01	0.01	0.02	0.02	0.03	0.43
4½	0.10	0.01	0.02	0.02	0.03	0.03	0.41
4	0.09	0.01	0.02	0.02	0.03	0.04	0.43
LSD	0.07	ns	Ns	ns	ns	ns	ns

Table 4. The rate of change in seedling height per month as affected by the difference in age of transplanting

Age at ransplanting (Months)	Initial height (cm)	Rate of change in height (weekly)				Final height (cm)(at 24 WAT)
		8	12	16	20WAT	
7	20.31	0.16	0.31	0.39	0.43	24.65
6½	19.63	0.12	0.27	0.41	0.48	24.43
5½	16.90	0.24	0.34	0.46	0.50	23.58
6	17.50	0.30	0.39	0.38	0.42	23.04
4½	11.00	0.19	0.32	0.34	0.43	19.76
5	13.50	0.30	0.36	0.40	0.41	15.04
4	11.00	0.15	0.20	0.26	0.41	14.95
LSD	4.30	ns	ns	ns	ns	4.10

Plant Height

There was a general increase in plant height across the treatments and throughout the growing period (Table 4). At 8 WAT, 5 and 6 months old seedlings had the highest rate of increase in height while the least value was observed in 5 ½, month old seedlings. At 20 WAT, the rate of change in height per month ranged between 0.04 to 0.50cm in all the seedlings. Six months old seedlings had the highest growth rate (Table 4).

Number of Leaves Produced

The numbers of leaves were higher in 6 to 7 month old seedlings than in 4 to 5 ½ month old seedlings. Similar trend was observed at 12, 14 and 16 WAT. At 20 WAT, leaves in 7 month old seedlings had increased from 13 leaves to 65 leaves while the leaves of the 4 month old seedlings increased from 9 to 33. The rate of leaves production was highest in 6 ½ and 7 month old seedlings, followed by 5 ½ to 6 months old seedling . The least value was observed in 4 month old seedling (Table 5).

Table 5. Effects of age at transplants on number of leaves shed by the seedlings

Age at transplanting (Months)	Initial number of leaves attransplanting	Number ofleaves shed at6 WAT
7	26	13
6½	23	13
6	20	9
5½	11	2
5	11	1
4½	9	1
4	9	0
LSD	8.1	6.3

Table 6. The number of leaves produced per moth as affected by7 the difference in age at transplanting

Age at transplanting (Month)	Number of leaves produced (monthly average)				Rate of increase in number of leaves at 20 WAT
	10	12	16	20 WAT	
7	13	17	40	65	5
6½	10	14	38	61	5
6	10	14	27	51	4
5½	8	11	21	48	4
5	10	10	21	36	3
4½	8	10	19	35	3
4	9	12	17	33	2
LSD	NS	1.2	5.9	8.4	ns

Table 7. Effect of different age at transplanting on branching in citrus seedling

Age at transplanting(Months)	Number of branches		
	16	20	24WAT
7	1	3	6
6½	1	2	6
6	1	2	5
5½	1	2	2
5	1	-	2
4½	-	-	1
4	-		1
LSD	NS	0.99	2.15

Table 8. Effects of age at transplanting on monthly changes in seedlings leaf area

Age at transplanting (Months)	Weeks/leaf area (cm^2)					Rate of change in leaf area (cm^2) per month
	4	8	12	16	20	
7	196.3	214.8	264.2	321.6	371.7	45
6½	154.7	162.7	194.2	276.5	331.6	45
6	143.6	157.4	169.6	243.1	319.5	44
5½	128.7	142.7	195.5	214.2	235.5	39
5	99.1	121.4	124.1	187.8	225.8	31
4½	68.5	78.7	121.2	138.7	149.2	22
4	63.6	76.4	101.5	118.2	139.9	20
LSD	43	62	74	80	88	9.4

Number of Branches

Generally, there were no branches in the seedlings during the time of transplanting. However, 5 to 7 months old seedlings began to produce branches at 16 WAT, while younger seedlings delayed till 24 WAT (Table 7). At 24 WAT, six to seven months old seedlings had 5, 6, and 6 branches respectively. Both 4 and 4 1/2 months old seedlings produced only one branch.

Leaf Area

The citrus seedlings recorded increases in plant leaf area with time. However, the rate of leaf area increase was higher in 6 to 7 months old seedlings (44 to 45cm^2) than in 4 to 5 ½ months old seedlings (20 – 30 cm^2). At 4 WAT, 7 month old seedlings had the highest leaf area (196.3cm^2) while the least was recorded in 4 months old seedlings (63.5cm^2). Similar results occurred at 8, 16 and 20 WAT. It was observed that leaf area increased according to the age of the seedling in the pre-nursery (Table 8).

Discussion

The survival rate was higher in younger seedlings than older seedlings. This observation is in confirms the findings of Adelana (1983) who reported that younger seedlings have better chance of recovery from the check in growth resulting from transplanting shock. Damage resulting from transplanting shock, which is greater in older seedlings, is one of the major factors that cause delay in seedling establishment. The severity of transplanting shock was observed in the shedding of leaves which was greater in the seedlings transplanted at older age than seedling transplanted at younger age. Olaniyan (1996) maintained that older seedlings had to shed some of their leaves as a mechanism to reduce the loss of water resulting from high rate of transpiration following transplanting on the field.

The younger seedlings (4-5 months) establish relatively easier than older seedlings (5 ½ to 7 months). This is in agreement with findings of Norman (1977) who attributed the ease of establishment of younger seedlings to smallness and tenderness of their roots which afford the seedlings the opportunity of the use of

shorter period for roots regeneration and formation of new roots. The roots are used in making contact with the soil as well as absorption of water and nutrients uptake for metabolic activities. The period is widened as transplanting age is delayed in the pre-nursery. The rate of root regeneration after transplanting and the resumption of functional activities of roots appeared to have consequences on the rate of survival of in the older seedlings.

Stem diameter is a growth characteristic that is vital in rootstock seedlings production. Kolade (1981) attributed this to the fact that stem diameter (girth) is used to determine the attainment of budding in rootstocks. The high rate of diameter increase in younger seedlings may be attributed to their ease of establishment, low sensitivity of younger seedlings to transplanting shock and high cambium development in the younger seedlings. This may be associated with the younger seedlings early start of physiological functions than older seedlings. High rate of diameter increase in younger seedlings enhances the attainment of buddable stem diameter earlier than older seedlings. Consequently, seedlings can be transplanted from pre-nursery to the main nursery at four months old instead of waiting for seedlings to attain six months in the pre-nursery. This practice will reduce production cost as well as increase the seedling production.

The rate of increase in height was the same in all the seedlings up to 24 weeks after transplanting. The slow increase in height in all the seedlings may be due to damages done to apical bud as a result of transplanting which may affect the rate of cell division. Oseni (1987) analysed short term growth in citrus rootstock seedling in savanna zone of Nigeria and reported that dry matter partitioning was highest in the stems, followed by the root while, the leaves contained the least amount presumably due to the fact that assimilate produced in the leaves are metabolized to sinks (stem and roots). Also, as the seedlings increased in age, the number of lateral buds increases which lead to increase in production of lateral branches in the older seedlings. This may be responsible for the higher number of branches in the older seedlings. This is highly undesirable in seedling production as the nurserymen require extra cost to prune the branches.

The highest rate of leaf production was obtained in the older seedlings than the younger seedlings. This may be probably due to increase in number of branches which consequently, increased the number of leaves produced. Leaf area was found to be greater in older seedlings (6 to 7 months) than the younger ones (4-5 ½ months).

The results of this study showed that seedlings could be best transplanted from pre-nursery to the main nursery between 4 and 5 months after sowing in the pre nursery to obtain vigorous rootstock seedlings. The practice shortens the time taken for seedlings to attain buddable size. In addition, the added cost of maintenance of seedlings above the age of five months is also removed.

Summary and Conclusion

The effects of ages at transplanting on the growth and vigour of Cleopatra mandarin rootstock seedlings were studied at National Horticultural Research Institute (NIHORT) Ibadan, Oyo State, Nigeria between August 1999 and March 2000. The result obtained shows that the seedlings transplanted between 4 and 5 months old were better in survival rate than 5 ½ to 7 months old seedlings. Also, older seedlings suffered more transplanting shock than younger seedlings. Shedding of leaves was higher in older seedlings compared to the younger ones. All the seedlings attain buddable stem diameter at the same time irrespective of their age. Rate of branches production was higher in older seedlings than younger ones. From this result it is clear that as the ages were delayed in the pre-nursery, the growth attribute declined. This experiment shows that it is best to transplant seedlings from the pre-nursery to the main nursery between 4-5 months after seed sowing to obtain a vigorous rootstock seedlings and to shorten the time taken to obtain buddable size. This will also, reduce the cost of maintaining the seedlings above the age of 5 months.

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