EVALUATION OF *MORINGA OLEIFERA* FOR FOOD SECURITY AND ENVIRONMENTAL REHABILITATION IN TANZANIAN RURAL AREAS

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MUNYANZIZA, E. & SARWATT, S. V. 2003. Evaluation of *Moringa oleifera* for food security and environmental rehabilitation in Tanzanian rural areas. Evaluation of *Moringa oleifera* for its potential in food security and environmental rehabilitation has been carried out in Morogoro, Tanzania. For this purpose, three-month-old potted nursery seedlings were transplanted in the field at a spacing of 3 × 3 m where they were left to the prevailing weather conditions. Seven months after field planting, plant total height, branching pattern and root architecture were assessed. The number of pods was also counted. Linear regression analysis was computed to relate pod yield with key growth parameters, namely, total height and stem branching rate. Within a period shorter than a year, the average tree height has reached 4.13 m (SD = 0.86). *Moringa oleifera* yielded enormous amount of edible green beans within the first year. These green beans were borne throughout the long dry season when other sources of vegetables died or became unaffordable for the common people. Owing to its modified roots and probably to other mechanism, this species is drought-resistant. There was a positive correlation between the number of pods and the total number of branches ($p < 0.001$). The relationship between height growth and amount of pods or number of branches was very weak ($p > 0.10$). Any kind of shoot treatment able to stimulate the branching rate will most likely increase pod yield.

Key words: Multipurpose tree - branching rate - pod yield - root architecture - Tanzania

MUNYANZIZA, E. & SARWATT, S. V. 2003. Penilaian *Moringa oleifera* untuk jaminan makanan dan pemulihan alam sekitar di kawasan luar bandar Tanzania. Penilaian *Moringa oleifera* sebagai jaminan makanan dan pemulihan alam sekitar dijalankan di Morogoro, Tanzania. Bagi tujuan ini, anak benih tapak semaian berusia tiga bulan yang ditanam di dalam pasu dipindahkan ke lapangan pada jarak 3 × 3 m dan dibiar terdedah kepada keadaan cuaca pada masa itu. Tujuh bulan selepas ditanam di lapangan, ketinggian keseluruhan pokok, corak cabangan dan bentuk akar dinilai. Selain itu, bilangan lenggai juga dikira. Analisis regresi linear dilakukan untuk menghubungkan hasil lenggai dengan parameter pertumbuhan utama iaitu ketinggian keseluruhan dan kadar cabangan batang. Kurang dari setahun kemudian, purata ketinggian pokok telah mencapai 4.13 m (SD = 0.86). Pada tahun pertama, *M. oleifera* menghasilkan sangat banyak kekacang hijau yang boleh dimakan. Kekacang hijau ini dihasilkan sepanjang musim kering sedangkan pada masa itu, sayur lain telah mati atau menjadi terlalu mahal dan tidak mampu dibeli oleh penduduk biasa. Oleh sebab akarnya yang terubah suai, dan mungkin juga terdapat sebab lain yang tidak diketahui, spesies ini tahan akan kemarau. Terdapat korelasi positif antara bilangan lenggai dan jumlah cabang ($p < 0.01$). Hubungan antara pertumbuhan ketinggian dan jumlah lenggai atau jumlah cabang adalah sangat lemah ($p > 0.10$). Besar kemungkinan, sebarang rawatan pucuk yang dapat menggalakkan kadar percabangan akan dapat meningkatkan hasil lenggai.

Introduction

Efforts to solve environmental problems and food insecurity in the tropics have been directed towards the incorporation of multipurpose trees in farming systems (Khemnark 1994, Munyanziza 1999). Trees or shrubs of higher priority in Africa and particularly in the Southern African Development Community (SADC) region have been mainly nitrogen-fixing legume trees or shrubs or non-nitrogen-fixing fast growing species such as *Eucalyptus* (Maghembe & Prins 1994). While most of the selected species have high growth rate and are able to increase soil fertility (Mafongoya *et al.* 1996, Palm 1995), they do not yield edible fruits to humans. This is one of the reasons why farmers have been often reluctant to plant trees in agroforestry. Incorporation and management of trees or shrubs with edible parts in farming systems are of greater focus in recent and current research activities (Leakey *et al.* 1996). Despite the concerted efforts of researchers hunger still claims victims and environmental degradation proceeds at a rate greater than ever before (Monela & Solberg 1998). There are many under-used fruit trees growing in the wild or in poorly managed farmlands (Leakey *et al.* 1996). *Moringa oleifera* is one of such potential tree species. Known elsewhere for its multiple uses, namely, as food, animal fodder, live fence, soap, ornament, insect repellent, shade, medicine for skin, digestive and respiratory and joint diseases (Caceres *et al.* 1991), *M. oleifera* is gaining greater importance in Tanzania. *Moringa oleifera*, however, remains poorly known to most of the potential Tanzanian users in terms of growth characteristics, yield, phenology and nutritive value. Given its relative high growth rate, the promotion of *M. oleifera* among rural Tanzanians would have a rapid environmental and socio-economic impact.

The objective of the present study was therefore to evaluate the potential of *M. oleifera* for food security and rehabilitation of wastelands in Tanzania.

Materials and methods

Growth rate and phenology

Untreated seeds of *M. oleifera* were first sown in sand in seedbed. Seedlings were then transferred into polythene tubes (7 × 12 cm) filled with nursery soil mixed with sand at a ratio of 3:1. They were allowed to grow in the nursery in the polythene tubes for a period of three months running from 15 December 1999 to

15 March 2000. Throughout this period seedlings were watered twice a day with tap water and their roots regularly pruned to facilitate lifting during transplanting. When the long rains had notably started, seedlings were transferred to the field where they were left to the prevailing weather conditions (Table 1). The planting pits were 30 cm wide and 50 cm deep with spacing of 3 × 3 m. The area where planting was done was regularly weeded mechanically. During the experimental period, trees were observed for flowering, fruit production and loss of leaf. At the end of seven months following planting, trees were measured for height and branching pattern.

Table 1 Weather conditions at the study site in Morogoro during the experimental period in the year 2000 as supplied by the nearby meteorological station

Parameter	Month							
	March	April	May	June	July	August	September	October
Mean maximum daily temperature (°C)	24.3	24.0	25.4	26.1	27.6	27.8	27.3	27.3
Mean minimum temperature (°C)	13.6	13.4	14.0	15.1	16.2	16.0	15.8	15.6
Total monthly rainfall (mm)	92.6	84.6	32.4	12.3	0.0	0.0	0.0	10.9
Mean daily sunshine duration (hour)	5.2	4.8	4.3	10.2	11.0	10.6	9.6	9.8

Yield of green pods

Seven months following field planting, mean height was measured and number of branches counted. A regression analysis was computed to relate the amount of pods produced to growth parameters, namely, total height and number of branches.

Root architecture

Excavation of 10 seven-month-old trees was made. The root architecture as reflected in the branching pattern and the relative proportion of the various root sizes was observed, described and discussed with special reference to the potential of *M. oleifera* for intercropping and drought resistance. Observation of nodulation was made on more than 100 sample trees or seedlings.

Results and discussion

The growth rate of *M. oleifera* was among the highest in the region. By seven months following field planting the mean tree height was over 4 m (Table 2). This value is greater than that achieved by *Eucalyptus* spp., *Acacia* spp., *Leucaena leucocephala*, *Gliricidia sepium*, *Calliandra* and *Sesbania* spp. which are reputed to grow rapidly in the region (Munyanziza & Msalilwa 1999). It should be noted that a significant portion of the observation period constituted the long dry season where there was very little rain or no rain at all. The growth observed, therefore, is most likely far lower than that which can be achieved under optimal weather conditions.

The rapid growth of *M. oleifera* during the dry season was partly a result of its peculiar root architecture (Figure 1). Lacking or having very insignificant fine roots, it comprised an extensive system of modified roots, with shape similar to cassava tubers. Initially prominent and standing alone during early growth, the taproot or primary root was later superseded by or sunk in numerous equally thick or thicker secondary roots (Figure 1). This type of roots is often referred to as modified roots for food and water storage purposes (Fitter 1991, Lynch 1995, Munyanziza & Oldeman 1995). Secondary thickening in roots of *M. oleifera* qualifies it for the rehabilitation of wastelands in semi-arid areas of Tanzania. *Moringa oleifera* was, however, shallow-rooted; more than 75% of the root system lies in the top 10 cm of soil, often causing cracks along the path of roots. This attribute is a disadvantage for *M. oleifera* as an intercropping species. The competition between trees and crops is likely to be high. Moreover, cracks may disturb or uproot shallow-rooted crops.

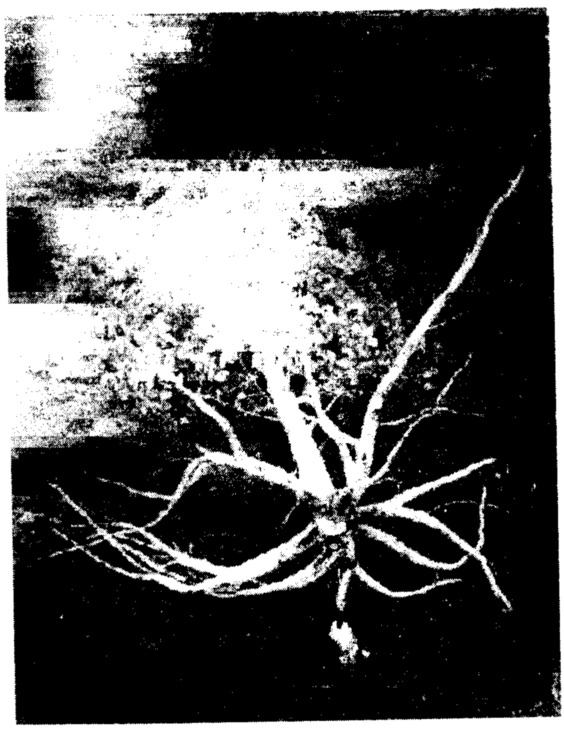

Figure 1 Root growth and root architecture in *Moringa oleifera* in Morogoro, Tanzania: an ecological survival strategy

Table 2 Mean growth in a seven-month-old *Moringa oleifera* grown at plantation in Morogoro, Tanzania

Parameter	Mean	Standard deviation
Shoot height (m)	4.15	0.17
Number of branches per tree	11.12	1.29
Number of pods per tree	146.52	13.44

Most of the former Tanzanian forest lands have now turned into shrub or grass land or bare lands (Anonymous 1998). The factors contributing to this problem include higher demand for charcoal making, conquest of new lands for an expanding population of farmers and town expansion (Ishengoma *et al.* 1995, Monela & Sorberg 1998). From our study, we observed that *M. oleifera* was a good candidate for urgent reforestation programmes. In less than a year, a forest was created at the study site.

Formerly, popular agroforestry trees or shrubs only yielded wood or fodder (Munyanziza 1999) and thus, did not meet the needs of hungry human population. However, besides wood and fodder, *M. oleifera* yields green beans of high nutritive value (Ramachandran *et al.* 1980, Caceres *et al.* 1991) within a short period. The first flowering and concurrently the production of pod were observed in early June and proceeded prominently throughout the dry period (Figure 2). It is interesting that during the study period, *M. oleifera* did not shed its leaves. Most vegetables are annual and produce food in the rainy season and die soon after. In contrast, *M. oleifera* continued to supply enormous amounts of fodder and green beans even when other sources of vegetables were scarce or unaffordable. This qualifies *M. oleifera* as a species of enormous potential for increased food security in rural areas.

Figure 2 Prominent production of edible beans in a seven-month-old *Moringa oleifera* plantation established in a formerly treeless area in Morogoro, Tanzania

The stem of *M. oleifera* was orthotropic and monopodial with lateral branching. There was a strong relationship between number of branches and number of pods, the branch coefficient being highly significant ($p < 0.001$). The effect of stem height on the number of pods was not significant at 5% ($p = 0.067$). The shoot height and the number of branches were not positively correlated ($p > 10\%$). The positive effect of intensity of branching, and not the total shoot height, on pod production is interesting from the management point of view. *Moringa oleifera* is managed for at least two main stem-borne products, namely, pods and leaves for human food or medicine or for animal feed (Caceres *et al.* 1991). Tall trees would be difficult to manage especially when it comes to harvesting of pods or leaves. Climbing would not be practical particularly for trees in their first years because their stems are weak. On the other hand, intensively branched short trees would be easy to manage. The question is how to check height growth while promoting branching. Lopping, or cutting the stem at various heights or subjecting it to various stresses are among the options to look into through research (Munyanziza & Oldeman 1996).

Most of the soils of the miombo woodlands are poor (Munyanziza & Oldeman 1995). The high content of nitrogen (N) in *M. oleifera* foliage or pods (Makkar & Becker 1997) gives one more credit to the species for its potential for the reclamation of wastelands and agroforestry systems in Tanzania. Observation of over 100 seedlings or saplings, however, indicated that *M. oleifera* did not fix N symbiotically as it did not nodulate. This species belongs to the limited group of non-N-fixing, but N-rich plants, such as *Tithonia diversifolia* (Nziguheba *et al.* 1998).

Conclusions

Moringa oleifera is a species of enormous potential in Tanzania where environmental degradation, fodder shortage and food insecurity are becoming chronic problems. *Moringa oleifera* has big potential for the following reasons: (1) with this species, it was possible to create a forest in a formerly bare area within a period shorter than a year, (2) it yielded enormous amount of edible and highly nutritive green beans within the first year, (3) green beans of this species were borne during and throughout the dry season when alternative sources of vegetables usually die or become unaffordable for the common people, (4) it produced foliage of high quality in terms of soil fertility improvement and animal feed, and finally (5) the species, owing to its modified roots and probably to other physiological aspects, was drought-resistant.

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