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Effect of Different Methods of Establishment on Growth and Biomass Yield of Moringa (*Moringa Oleifera* Lam)

Lawal B.A[1*], Olawepo T.F[2], Asaolu V.O[3], Akanbi W.B[1], Jolaoso M.A[4], Ojo A.M[4]

1. Department of Crop Production and Soil Science, Ladoke Akintola University of Technology, Ogbomoso, Nigeria
2. Department of agricultural science Kwara State College of Education, llorin
3. Department of Animal Nutrition and biotechnology, Ladoke Akintola University of Technology, Ogbomoso, Nigeria
4. Raw Material Research and Development Council, Abuja, Nigeria.

Correspondence Author email: balawal@lautech.edu.ng

ABSTRACT: Moringa oleifera is nature's most nutritious vegetable tree with high medicinal value. Despite this, little has been done on the agronomic requirements for the production of the crop. In this study, effects of different methods of establishment on growth and biomass yield of moringa were assessed. The methods of establishment used are direct seed planting, stem cutting and seedling transplanting. Seven establishment treatments arranged in complete randomized block design. They are 20, 30 and 40 cm stem cuttings; seedling transplant at 2, 4, and 6 week old seedlings and direct seed planting replicated three times to give a total of 21 treatment plots. The seedlings were allowed to grow for a period of three months. Data were collected on seedling vigour and survival, stem length, stem girth, number of leaves and fresh and dry biomass yield of stem and leaf. Data collected were subjected to analysis of variance and mean separated using Duncan Multiple Range Test at 5% probability level. The results showed that methods of establishment have significant effects on all the measured parameters. Seedling transplant at four WAP showed superiority in all the parameters taken. The treatment 20 cm and 30 cm moringa stem cutting did not sprout at all while 40 cm stem cutting had 20% sprouting. The 40 cm stem cutting had more branches but performed poorly with regards to all the growth parameters taken. The direct seed planting and 4 week old seedling transplant had the highest biomass yield. Transplanting of seedling at 4 week old could be recommended for optimum biomass yield of moringa.
Key words: Moringa, stem cutting, direct planting, transplanting and biomass yield.

INTRODUCTION

Moringa oleifera (L) a native of India, now grown worldwide and thrives best in tropical climate (Palada and Chang, 2003). Moringa oleifera is fast growing, drought-tolerant and can tolerate poor soil and a wide range of rainfall (25 to 300 cm per annum), soil pH from 5.0 to 9.0 (Santer et al., 2003). These beneficial ecological properties, apart from the medicinal, nutritional and industrial properties which have implications for socioeconomic development of households, suggest that Moringa could be exploited for agro ecosystem sustainability as a strategy to supporting the emerging practice of continuous cultivation for food security. Except in certain regions of the world like India where large scale cultivation of Morniga is practiced, elsewhere the tree receives little or no horticultural attention because it is often regarded as an agro-forestry plant and grown as boundary trees. For instance in Ghana, Moringa is often grown as a live fence or a backyard tree because of its economic and nutritional importance.

Nutritional analysis has shown that moringa leaves are extremely nutritious (Aregheore, 2002). Studies have shown that Moringa oliefera can be a cheap, all year round source of high quality food for both humans and animals. It is also rich in health promoting phytochemicals such as carotenoids, phenolics (chlorogenic acids), flavonoids (quercitin and kaempherol glycosides), various vitamins and minerals (Foidl, et. al., 2001; Richter et. el., 2003). In fact, it contains larger amounts of several important nutrients than the common foods often associated with these nutrients. It is a reservoir of Vitamins minerals such as calcium, phosphorus, iron, magnesium, manganese, potassium and Protein (Foidl et al 2001). All these nutritional health benefits make commercial Moringa oliefera cultivation a good investment option for investors.

Moringa biodiesel meets all the three criteria for environmentally sustainable fuel production; namely social, technical and commercial low cost feedstock with the potential for high oil seed production and the added benefit of an ability to grow on marginal land. These properties support the suitability of this plant for large scale vegetable oil production needed for a sustainable biodiesel industry (Ibironke, 2011). The seeds from the Moringa oliefera tree contain excess of 35% oil. This can also be used for cooking and soap production. Once the oil is extracted, the seeds can be used as a coagulant for water treatment (Ibironke, 2011). Moringa tree produces green pods, which are edible and the leaves and flowers can be used as a relish (Fadiyimu et al., 2011). The trees act as sinks for carbondioxide hence, the Moringa oliefera plantation reduces the amount of this greenhouse gas in the atmosphere (Fuglie and Sreeja, 2001). Ibironke, 2011 reported that Moringa the capacity to rake in millions for those involved in its planting and selling of its leaves and powder.

Despite all these nutritional, environmental, economic and social benefits Moringa oliefera large scale cultivation is low in Nigeria. For large scale production growers therefore need to increase their production by adopting appropriate agronomic strategies and techniques which will lead to sufficient and reliable yields. There is dearth of information on the methods of establishment of Moringa plant to meet the identified numerous benefits it has, hence the objective of this study is to determine the best method of establishment of Moringa oleifera for optimum and economic production of moringa leaf.

MATERIALS AND METHODS

The study was carried out in 2012 on the experimental field of Teaching and Research Farm of Ladoke Akintola University of Technology, Ogbomoso. Ogbomoso lies on latitude $8^0$10' N and longitude $4^0$10' E with elevation of 390 m above sea level. The area had a bimodal rainfall pattern within April-July and September-November. The mean daily maximum and minimum temperatures of the area were about 33 and 20^oC, respectively. The site had been under continuous cultivation of maize and cassava for three years before use for this experiment. Ogbomoso is a derived savannah characterized by extensive grasslands interspersed with a few tree species such as locust bean, shear butter, kolanut and oil palm.

The experimental design used was randomized complete block design (RCBD) with three (3) replications. Each replicate has seven treatment plots for seven treatments randomized in it. Each treatment plot is 2 m by 3 m with plant spacing of 20 cm by 20 cm, which translate to 250,000 plant stands per hectare. Seven methods of establishment of Moringa assessed are Direct seeding (T1), Seedling transplanted at 2 weeks old (T2), Seedling transplanted at 4 weeks old (T3), Seedling transplanted at 6 weeks old (T4), 20 cm stem cutting (T5), 30 cm stem cutting (T6), and 40 cm stem cutting (T7). All the seven treatments were established on the same day because the nurseries for raising the seedlings of different ages were carried out at different time. This was to ensure that the age of the seedlings at transplant tallied with the expected of 2, 4 and 6 weeks old. Other cultural practices were carried as outlined by Asaolu, (2012).

The growth parameters data taken at 4, 8, 12 weeks after establishment (WAE) were plant height, number of leaves, and stem girth (10 cm above the ground). At harvest (3 months) the plants were cut at 20 cm above the ground to determine the yield parameters by measuring fresh and dry biomass yield of the stem and leaf. Analysis of Variance (ANOVA) of the data generated was carried out using the SAS 9.0 software. The differences between treatment means were determined using the Duncan's Multiple Range Test at 5% probability level.

RESULTS AND DISCUSSION

The survival rate of Moringa seedling at 2 weeks after establishment of the experiment showed that seedling transplanted at 2 and 4 weeks old have the highest survival rates (90 and 95% respectively) which was significantly higher than that of others (Table 1). This was followed by direct seed planting. Stem cutting of 40 cm length had 20% survival while 20 cm and 30 cm did not sprout. The seedling vigour was highest for Moringa transplanted at four weeks old (Table 1) while stem cutting of 20 cm and 30 cm, which did not germinate, had zero.

Table 2 presented results on plant height, stem girth, and number of leaves of Moringa seedling in response to different methods of establishment. Across the three parameters, seedling transplanted at four weeks old method of established performed significantly better than other methods of establishment. Performance of 40 cm stem cuttings treatment was next to direct seeding, while 20 cm and 30 cm stem cuttings had zero reading for all the 12 responses because the two failed to germinate.

The biomass yield of Moringa seedling as affected by methods of establishment is presented in Table 3. Similar trend observed in the growth response parameters was also followed. The highest significant dry biomass yield (1.7 and 4.9 ton/ha leave and stem respectively) was obtained from seedling transplanted at four weeks old. This was followed by yield from seedling transplant at two and four weeks old in that order. This was followed by direct seed planting (0.6 and 3.6 ton/ha leave and stem respectively). There was no harvest from 20 cm and 30 cm stem cutting methods of establishment because they failed to sprout. However, the dry biomass yield from the two cutting regimes was not significantly different from the yield obtained from 40 cm stem cutting method of establishment.

The results presented on the influence of methods of establishment of Moringa confirmed that establishment method had significant influence on performance of the crop. This is in agreement with report of Ted (2005) that Moringa can be planted by direct seeding, transplanting and hard stem cuttings. The poor performance and/or none sprouting of some stem cutting regimes confirmed the superiority of direct seed planting over vegetative means of propagation. This is in line with the submission of Palada (1996) that stem cutting is preferable when there is no seed and that it requires high technical skill. He also recommended planting hardwood stem cutting of 45-150 cm. Transplant of seedlings performed best, with the least response from six weeks old seedlings transplant among the seedling transplant regimes. The better response of two and four weeks old transplanted seedling showed that they recovered fast from transplant shock compared with older 6 week seedlings.

CONCLUSION

Growth and biomass yield of Moringa are significantly influenced by method of establishment. Seedling transplant performed best but also influenced by age of the seedling followed by direct seed planting. There is marginal response from 40 cm stem cutting as a method of establishment while shorter cuttings failed to respond. The use of seedling of 4 week old had the best result and it could be recommended for production of high quality Moringa plant in the study area.

Table 1. Effects of method of establishment on percentage survival and seedling vigour of Moringa seedlings

Method of establishment	Survival rate (%)	Seedling vigour
Direct seeding	80b	4.0bc
Seedling transplanted at 2 weeks old	90a	4.3b
Seedling transplanted at 4 weeks old	95a	4.6a
Seedling transplanted at 6 weeks old	78b	3.1d
20 cm stem cutting	0d	0.0e
30 cm stem cutting	0d	0.0e
40 cm stem cutting	20c	2.7d

Vigour ratio scale of 1 – 5 where 1 = poorest while 5 = excellent vigour

Means with the same letter along the column are not significantly different using DMRT at 5% probability level.

Table 2.Effects of methods of establishment on vegetative parameters of Moringa seedlings at 12 WAS

Methods of establishment	Plant height (cm) WAS			Stem girth (cm)			Number of leaves/plant		
	4	8	12	4	8	12	4	8	12
Direct seeding	12.6c	65.8d	130.4cd	0.4bc	0.9cd	1.4a	8a	14b	24b
Seedling transplanted at 2 weeks old	22.6b	75.8ab	140.6cd	0.6a	1.1cd	1.6a	10a	17b	28a
Seedling transplanted at 4 weeks old	32.6a	85.8a	180.1a	0.8a	1.3a	1.7a	12a	24a	34a
Seedling transplanted at 6 weeks old	32.3a	70.3bc	150.3b	0.4bc	0.9b	1.4b	8a	14b	24b
20 cm stem cutting	0.0d	0.0f	0.0f	0.0d	0.0e	0.0e	0.0c	0.0d	0.0d
30 cm stem cutting	0.0d	0.0f	0.0f	0.0d	0.0e	0.0e	0.0c	0.0d	0.0d
40 cm stem cutting	0.0d	35.7e	60.7e	0.1d	0.4cd	0.9cd	4b	10c	20c

Means with the same letter along the column are not significantly different using DMRT at 5% probability level.

Table 3.Effects of methods of establishment on fresh and dry matter yield (ton/ha) of Moringa seedling biomass at 12 weeks after planting

Methods of establishment	Fresh weight		Dry weight	
	Leaf	Stem	Leaf	Stem
Direct seeding	1.6b	4.0c	0.6b	3.6c
Seedling transplanted at 2 weeks old	1.7b	4.6b	0.8b	4.3b
Seedling transplanted at 4 weeks old	2.3a	5.3a	1.7a	4.9a
Seedling transplanted at 6 weeks old	1.8b	4.2bc	0.7b	3.8c
20 cm stem cutting	0.0d	0.0d	0.0c	0.0d
30 cm stem cutting	0.0d	0.0d	0.0c	0.0d
40 cm stem cutting	0.3c	1.2d	0.1c	1.0d

Means with the same letter along the column are not significantly different using DMRT at 5% probability level.

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