INTERNATIONAL JOURNAL OF SCIENCE AND NATURE

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INFLUENCE OF NUTRIENTS ON SEEDLING GROWTH AND BIOMASS PRODUCTION OF *TERMINALIA BELLIRICA* (ROXB) SEEDLINGS; AN IMPORTANT MEDICINAL TREES SPECIES

Mariswamy, K. M., Manjunath, G. O., Patil, S. K., Puttaswamy, H., Vasudeva, R. and Krishna, A.
Part of the M. Sc. Thesis submitted to the University of Agricultural Sciences, Dharwad.
Department of forest products and Utilization, College of Forestry, Sirsi - 581 401.

INTRODUCTION
Experiment was conducted at College of Forestry, Sirsi, to elucidate the influence of nutrients on seedling growth and biomass production of *Terminalia bellirica* seedlings. Among thirteen different fertilizer treatments used, application of 1.0 g NCU + 0.90 g SSP + 0.75 g MOP (T_6) per seedling recorded significantly higher seedling height (55.26 cm), collar diameter (10.03 mm), number of leaves (17.55), total leaf area (1458.95 cm^2), root length (44.08 cm), number of lateral roots (48.08) and also higher dry shoot weight (38.63 g) and dry root weight (50.68 g). This was followed by treatment T_5 consisting of 0.75 g NCU + 0.60 g SSP + 0.50 g MOP (52.43 cm, 9.60 mm, 16.73 and 1253.95 cm^2 respectively for shoot parameters and 41.92 cm, 45.18, 36.25 g and 47.21 g respectively for root parameters). Where as control (T_{13}) recorded the lowest values (29.82 cm, 5.79 mm, 12.27 and 466.14 cm^2 respectively for shoot parameters and 23.91 cm, 23.34, 14.70 g and 15.79 g respectively for root parameters).

KEY WORDS: *Terminalia bellirica*, fertilizer effects, seedling growth, biomass production, triphala

INTRODUCTION

Terminalia bellirica, commonly known as Bahera, is a large deciduous tree grown for timber and now its seedlings being extensively used for afforestation and reforestation activities under social forestry programme. Its fruits are called myrobalan fruits and they are used to prepare medicines for various disease. Viz., triphala is used against stomach disorders, insomnia, high blood pressure, headache, diabetes, ulcer etc. Apart from this, an important Non Timber Forest Products (NTFPS) such as tannin, edible fruits etc., are produced from the tree. The tree is found scattered in the greater parts of India except arid Rajasthan. The tree is a common associate of Sal and Teak forests of the tropical moist and dry deciduous forest types (Ramparkash, 1991).

The efficient use of fertilizer has a vital role to play in the current intensified programmes for rising of forest nurseries and plantations, so it is essential to supply adequate quantity of NPK for vigorous growth of seedlings. However nitrogen in nitrate form is highly mobile and amicable for loss due to leaching especially in containerized seedling production. Such loss can be controlled through use of nitrification inhibitors and they are useful in making efficient use of applied nitrogen. Hence finding out of efficacy of nitrification inhibitors along with two sources of phosphorous is of great significance. In recent days, *T. bellirica* is extensively used in social forestry planting programmes but there is meager scientific information available with respect to nursery techniques and nutrient management to get good quality planting stock for afforestation and reforestation programmes. Hence it is highly essential to study and standardize the right dose of fertilizer for enhancing growth parameters in *Terminalia bellirica* seedlings. Therefore, here an attempt has been made in nursery level.

MATERIALS AND METHODS

The experiment was carried out at College of Forestry, Sirsi in Uttara Kannada district, Central Western Ghats comprising the state of Karnataka. Thirteen different treatments were considered for this study, comprising of three levels of NPK and two sources of N and P each. The experiment was laid out in completely randomized design (CRD) with three replications. Seedlings of two months old were transplanted to polythene bags of size 19 cm x 9 cm filled with 1 kg of potting media of soil, sand and FYM in the ratio of 1:1:0.5 and recommended doses of fertilizers (NPK) were added by mixing with potting media to the respective polythene bags as per the schedule of treatments and 60 polythene bags per treatment were considered for the study. The details of treatment are furnished below.

T_1 - 0.50 g Urea + 0.30 g SSP + 0.25 g MOP
T_2 - 0.75 g Urea + 0.60 g SSP + 0.50 g MOP
T_3 - 1.0 g Urea + 0.90 g SSP + 0.75 g MOP
T_4 - 0.50 g NCU + 0.30 g SSP + 0.25 g MOP
T_5 - 0.75 g NCU + 0.60 g SSP + 0.50 g MOP
T_6 - 1.0 g NCU + 0.90 g SSP + 0.75 g MOP
T_7 - 0.50 g Urea + 0.25 g RP + 0.25 g MOP
T_8 - 0.75 g Urea + 0.50 g RP + 0.50 g MOP
T_9 - 1.0 g Urea + 0.75 g RP + 0.75 g MOP
T_{10} - 0.50 g NCU + 0.25 g RP + 0.25 g MOP
T_{11} - 0.75 g NCU + 0.50 g RP + 0.50 g MOP
T_{12} - 1.0 g NCU + 0.75 g RP + 0.75 g MOP
T_{13} - Control

For convenience in presentation neem cake coated urea, rock phosphate, single super phosphate and muriate of potash are mentioned as NCU, RP, SSP and MOP

respectively. Neem coated urea was prepared by coating liquid coal tar (10 g of coal tar in 20 ml of kerosene) to 1 kg of Prilled urea and this was taken in rotating drum to mix coal tar coated urea and 200 g of neem cake powder (Devakumar, 2005).

Watering was done daily and the observation on seedling height, collar diameter, number of leaves and total leaf area per plant were taken at 180 days (6 months) after planting. Whereas below ground parameters and biomass estimation were taken using three randomly selected seedlings from each replication following destructive sampling and dry weight of seedlings were recorded after drying seedlings in oven at 60^0 C for 48 hr. The data collected on different parameters was subjected to statistical analysis using MSTAT C programme.

RESULTS AND DISCUSSION

In the present study, application of 1.0 g NCU + 0.90 g SSP + 0.75 g MOP (T_6) per seedling recorded significantly higher seedling height (55.26 cm), collar diameter (10.03 mm), number of leaves (17.55) and total leaf area (1458.95 cm^2) at 180 days after planting. This was followed by treatment T_5 consisting of 0.75 g NCU + 0.60 g SSP + 0.50 g MOP (52.43 cm, 9.60 mm, 16.73 and 1253.95 cm^2 respectively). Where as control (T_{13}) recorded the lowest values (29.82 cm, 5.79 mm, 12.27 and 466.14 cm^2 respectively). Application of 1.0 g NCU + 0.90 g SSP + 0.75 g MOP (T_6) per seedling enhanced seedling height, collar diameter, number of leaves and total leaf area by 85.31, 73.23, 43.03 and 212.99 per cent respectively over control. This was 13.79, 9.38, 9.62 and 27.84 per cent respectively over treatment T_3 (1.0 g Urea + 0.90 g SSP + 0.75 g MOP) and 18.63, 14.76, 15.31 and 42.72 per cent respectively over treatment T_{12} constituting 1.0 g NCU + 0.75 g RP + 0.75 g MOP and 65.80, 62.04, 34.59 and 93.29 per cent respectively over treatment T_9 constituting 1.0 g urea + 0.75 g RP + 0.75 g MOP (Table 1).

TABLE 1. Seedling growth parameters at 180 days after planting as influenced by nutrients in *Terminalia bellirica* seedlings

Treatments	Seedling height (cm)	Collar diameter (mm)	Number of leaves	Total leaf area (cm^2)
T_1 - 0.50g Urea + 0.30g SSP + 0.25g MOP	33.00	6.24	12.78	718.16
T_2 - 0.75g Urea + 0.60g SSP + 0.50g MOP	42.32	7.73	13.91	907.04
T_3 - 1.0g Urea + 0.90g SSP + 0.75g MOP	48.56	9.17	16.01	1141.25
T_4 - 0.50g NCU + 0.30g SSP + 0.25g MOP	43.82	8.17	14.55	935.39
T_5 - 0.75g NCU + 0.60g SSP + 0.50g MOP	52.43	9.60	16.73	1253.95
T_6 - 1.0g NCU + 0.90g SSP + 0.75g MOP	55.26	10.03	17.55	1458.95
T_7 - 0.50g Urea + 0.25g RP + 0.25g MOP	31.57	6.33	12.50	570.77
T_8 - 0.75g Urea + 0.50g RP + 0.50g MOP	32.61	6.23	12.51	675.57
T_9 - 1.0g Urea + 0.75g RP + 0.75g MOP	33.33	6.19	13.04	754.79
T_{10} - 0.50g NCU + 0.25g RP + 0.25g MOP	33.25	6.68	12.58	799.37
T_{11} - 0.75g NCU + 0.50g RP + 0.50g MOP	35.91	7.23	13.23	842.75
T_{12} - 1.0g NCU + 0.75g RP + 0.75g MOP	46.58	8.74	15.22	1022.27
T_{13} - Control	29.82	5.79	12.27	466.14
Mean	39.88	7.55	14.07	888.18
SEm±	0.58	0.14	0.21	8.65
CD@5 %	1.70	0.40	0.61	25.15

NCU - Neem cake coated urea, RP - Rock phosphate, SSP - Single super phosphate, MOP - Muriate of phosphate.

All the treatments showed a positive influence on root length, number of lateral roots, dry shoot and root weight due to application of fertilizers in *T. bellirica* seedlings. The treatment T_6 (1.0 g NCU + 0.90 g SSP + 0.75 g MOP) recorded maximum root length (44.08 cm), number of lateral roots (48.08), dry shoot weight (38.63 g) and dry root weight (50.68 g). This was followed by T_5 constituting 0.75 g NCU + 0.60 g SSP + 0.50 g MOP (41.92 cm, 45.18, 36.25 g and 47.21 g respectively). Whereas control showed minimum values (23.91 cm, 23.34, 14.70 g and 15.79 g respectively). The application of 1.0 g NCU + 0.90 g SSP + 0.75 g MOP (T_6) increased root length, number of lateral roots, dry shoot and root weight by 101.09, 106, 162.79 and 220.96 per cent respectively over control. This was 10.20, 14.45, 20.04 and 18.03 per cent respectively over treatment T_3 (1.0 g Urea + 0.90 g SSP + 0.75 g MOP) and 27.99, 39.48, 26.86 and 54.51 per cent respectively over treatment T_{12} constituting 1.0 g NCU + 0.75 g RP + 0.75 g MOP and 74.64, 75.67, 108.36 and 158.57 per cent respectively over treatment T_9 constituting 1.0 g urea + 0.75 g RP + 0.75 g MOP (Table 2).

The increase in seedling growth parameters may be due to coating of urea with neem cake inhibited nitrification process, which resulted in slow release of N without substantial loss due to leaching. This increased the availability of N in root zone, which helped in its greater uptake by plants resulted in higher plant growth. As nitrogen is essential for the formation of proteins in addition to its role in photosynthesis, the higher uptake of nitrogen resulted in higher production and partitioning of photosynthates, along with nitrogen, phosphorous may also have contributed in increasing growth parameters by increasing photosynthesis, cell division and cell enlargement, in which phosphorus role is essential. Whereas, in case of different combination of treatments applied in terms of urea was converted into nitrate form at a faster rate resulting in greater losses of nitrogen which

lead to lower uptake and reduced seedling growth. Similar results of increased plant growth due to effect of nitrification inhibitors were reported by Rastovski (1997) in *Picea abies*, *Pinus sylvestris* and *Abies alba* seedlings and and Jacobs *et al.* (2003) in *Pseudotsuga menziesii* (Douglas fir) seedlings and Vasanthreddy (2005) in *Dalbergia latifolia.*

Even though the nutrient content and dosage remains in T_3 (1.0 g Urea + 0.90 g SSP + 0.75 g MOP) and T_9 (1.0 g urea + 0.75 g RP + 0.75 g MOP) treatments, significant differences was observed for growth and biomass production parameters. Application of 1.0 g Urea + 0.90 g SSP + 0.75 g MOP (T_3) increased seedling height, collar diameter, number of leaves, total leaf area, root length, number of lateral roots, dry shoot weight and dry root weight (45.69, 48.14, 22.78, 51.20, 58.48, 53.49, 73.57 and 119.08 per cent respectively) over treatment T_9. The two treatments differed with respect to the form of 'P' supplied. In T_3 'P' was supplied as single super phosphate, while in T_9 treatment 'P' was supplied as rock phosphate. Hence the observation pattern might be due to higher availability of phosphorous content which might encouraged the seedling growth. The present results are in conformity with reports of Singaram and Kothandaraman (1988), who reported that among the P sources, SSP registered higher available P in the soil than rock phosphate. Similar results were also obtained by Heeralal (2005) in *Albizia lebbeck* seedlings.

From the study it can be concluded that application of 1.0 g NCU + 0.90 g SSP + 0.75 g MOP will produce maximum seedling growth and biomass production in *T. bellirica* seedlings and application of SSP is found to be better in increasing the growth parameters of *T. bellirica* seedlings.

TABLE 2. Root parameters and biomass of seedlings as influenced by nutrients in *Terminalia bellirica* seedlings

Treatments	Root length (cm)	No. of lateral roots	Dry shoot wt (g)	Dry root wt (g)
T_1 - 0.50g Urea + 0.30g SSP + 0.25g MOP	32.49	32.35	17.32	28.88
T_2 - 0.75g Urea + 0.60g SSP + 0.50g MOP	36.64	37.08	26.37	35.49
T_3 - 1.0g Urea + 0.90g SSP + 0.75g MOP	40.00	42.01	32.18	42.94
T_4 - 0.50g NCU + 0.30g SSP + 0.25g MOP	38.03	39.46	28.22	38.75
T_5 - 0.75g NCU + 0.60g SSP + 0.50g MOP	41.92	45.18	36.25	47.21
T_6 - 1.0g NCU + 0.90g SSP + 0.75g MOP	44.08	48.08	38.63	50.68
T_7 - 0.50g Urea + 0.25g RP + 0.25g MOP	23.73	25.32	15.62	17.13
T_8 - 0.75g Urea + 0.50g RP + 0.50g MOP	23.76	25.46	16.60	18.55
T_9 - 1.0g Urea + 0.75g RP + 0.75g MOP	25.24	27.37	18.54	19.60
T_{10} - 0.50g NCU + 0.25g RP + 0.25g MOP	28.61	28.76	21.28	21.39
T_{11} - 0.75g NCU + 0.50g RP + 0.50g MOP	30.73	30.14	23.68	25.37
T_{12} - 1.0g NCU + 0.75g RP + 0.75g MOP	34.44	34.47	30.45	32.80
T_{13} - Control	23.91	23.34	14.70	15.79
Mean	32.58	33.77	24.60	30.35
SEm±	0.50	0.66	0.43	0.53
CD@5 %	1.47	1.91	1.26	1.54

NCU - Neem cake coated urea, RP - Rock phosphate, SSP - Single super phosphate, MOP - Muriate of phosphate

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