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Fruit yield and cost of production in noni (*Morinda citrifolia* L.) as influenced by integrated nutrient management

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Abstract
Noni (*Morinda citrifolia* L.)- A member of the family rubiaceae is an evergreen tropical tree native of South East Asia. It mostly grows as wild in tropical parts of the world and its systematic cultivation is lacking in India. Very little has been done on standardization of agronomic practices in noni. Nutrition is a key factor influencing yield and quality in crop plants. The study was undertaken to evaluate the effect of nutrition on noni fruit yield and the cost economics were worked out. Among Seven treatment combinations, treatment T_5 (50:225:50 kg ha^{-1} NPK wherein 50% of recommended P given through bone meal) and T_7 (50:225:50 kg ha^{-1} NPK wherein 100% of recommended P given through bone meal) have proven best in terms of fruit yield. The treatment T_3 (50:225:50 kg ha^{-1} NPK) recorded highest B:C ratio of 3.85 followed by T_4 (50:100:100 kg ha^{-1} NPK-50% of recommended P through bone meal) i.e. 3.07.

Keywords: Noni, Nutrients, Integrated, Management, Cost, Benefit

Introduction
Noni (*Morinda citrifolia* L.) also called as Indian Mulberry, is a perennial tree belonging to family rubiaceae. The plant is native to south-east Asian countries, Australia and Pacific islands. Noni has distributed in several tropical countries worldwide such as Africa, Australia, Barbados, Cambodia, Florida, Hawaii, India, Jamaica, Java, Malaysia, Philippines, Polynesia, Puerto Rico, Tahiti, Thailand, Vietnam etc. (Mathivanan *et al*., 2005)[1]. The plant is found growing in open coastal regions at sea level and in forest areas up to about 1300 feet above sea level. The fruit and fruit juice of noni have been commercially exploited and is known to possess several medicinal benefits. Polynesians used noni extensively as a source of medicine to cure various illnesses such as arthritis, diabetes, high blood pressure, muscle aches and pains, gastro ulcers, menstrual difficulties, head ache, heart diseases, mental depression, poor digestion, atherosclerosis, blood vessel problems, cancer, AIDS and drug addiction (Muralidharan and Srikanth, 2009) [2]. Noni fruit juice is being commercially exploited as health tonic. The medicinal property of the plant is attributed to the phytochemicals or the secondary metabolites present in the fruit. Several scientific studies have been done on the chemical composition of noni fruit and fruit juice and many clinical trials have also been carried out to prove its beneficial effects on human health, but very little has been done on its cultivation and standardization of agronomic practices. Noni being a hardy species can come up well without much care, but it is a proven fact that application of nutrients externally certainly has positive effects on yield and quality of crop plants. Hence the present investigation was undertaken to study the influence of external application of nutrients on fruit yield and the cost economics was worked out.

Materials and methods
The experiment was conducted in the medicinal block of Horticulture Department at Gandhi Krishi Vignana Kendra, University of Agricultural Sciences, Bangalore, Karnataka state. The study comprised of seven treatments *viz*., T_1- Control (no fertilizer application), T_2- 50:100:100 kg ha^{-1} NPK, T_3- 50: 225:50 kg ha^{-1} NPK, T_4- 50:100:100 kg ha^{-1} NPK - 50% of recommended P through bone meal, T_5- 50: 225:50 kg ha^{-1} NPK - 50% of recommended P through bone meal, T_6- 50:100:100 kg ha^{-1} NPK - 100% of recommended P through bone meal

and T_7- 50: 225:50 kg ha^{-1} NPK - 100% of recommended P through bone meal. Application of FYM @ 5kg/plant was common to all treatments except control. The treatments were arranged in Randomized Complete Block Design and replicated thrice. The fertilizers were given in two equal split doses. The plants were about eight years old and planted at a spacing of 3m X 3m. As the species flowers and bears fruits throughout the year harvesting was done at weekly interval and yield per plant was recorded. The cost incurred over the year for cultivation was calculated by considering the prevailing rates for the labour and inputs.

The data on various biometrical parameters recorded during the study period were subjected to statistical analysis as per the procedure described by Panse and Sukhatme (1967) [3].

Results and discussion

Cumulative yield per tree varied significantly with different sources and levels of nutrients in noni (table 1). Application of NPK @ 50:225:50 kg ha^{-1} wherein 50% of recommended P was given through bone meal (T_5) recorded highest fruit yield of 35.85 kg per plant which was on par with the treatment T_7 (34.43 kg). Per hectare yields were calculated and were 39.81 t/ ha and 38.26 t/ha in T_5 and T_7 respectively. This increase in yield with the above combination of nutrients might be due to the optimum supply of plant nutrients at desired level during the entire period of the crop growth and fruit formation, ultimately resulting in accumulation of more photosynthates leading to more length, breadth, volume and weight of the fruit. This can also be attributed to the increased production of carbohydrates, amino acids and proteins with higher doses of applied nitrogen and formation of more ATP with application of phosphorus (Halvin *et al.*, 2012) [4] that might have helped in additional tree growth and promoted higher yield. The findings are in agreement with that of Nelson (2003) [5] in noni; Kaur & Chahil (2006) [6] in guava; Ghosh and Besra (2010) [7] in sweet orange.

Table 1: Effect of INM on fruit yield of noni (*Morinda citrifolia* L.)

Treatments	Cumulative yield per tree (kg)	Yield per hectare (tonnes)
T_1: Control – no fertilizer application	20.67	22.96
T_2: 50:100:100 kg ha^{-1} NPK	27.07	30.07
T_3: 50:225:50 kg ha^{-1} NPK	31.33	34.81
T_4: 50:100:100 kg ha^{-1} NPK-50% of recommended P through bone meal	31.03	34.48
T_5: 50:225:50 kg ha^{-1} NPK-50% of recommended P through bone meal	35.83	39.81
T_6: 50:100:100 kg ha^{-1} NPK-100% of recommended P through bone meal	31.73	35.26
T_7: 50:225:50 kg ha^{-1} NPK-100% of recommended P through bone meal	34.43	38.26
SEm±	1.17	1.30
CD @ 5%	3.61	4.01
CV (%)	6.70	6.70

The cost economics were worked for noni (table 2) and the total cost of cultivation was found to be highest (₹. 34,959) in T_7 and the least was in T_1 (₹. 16,000). This might be due to the fact that in T_7 (50:225:50 kg ha^{-1} NPK -100% of recommended P through bone meal) 100% of recommended phosphorus was supplied through bone meal which incurred higher cost compared to chemical P fertilizers. Since the inputs cost was meager in T_1 (control) it recorded the least production cost among the treatments.

Table 2: Cost economics as influenced by INM in noni

Treatments	Total cost of cultivation (₹ha^{-1})	Gross income (₹)	Net income (₹)	Benefit: cost ratio
T_1: Control – no fertilizer application	16,000	45,920	29,920	2.87
T_2: 50:100:100 kg ha^{-1} NPK	18,283	60,140	41,857	3.29
T_3: 50:225:50 kg ha^{-1} NPK	18,100	69,620	51,520	3.85
T_4: 50:100:100 kg ha^{-1} NPK-50% of recommended P through bone meal	22,460	68,960	46,500	3.07
T_5: 50:225:50 kg ha^{-1} NPK-50% of recommended P through bone meal	26,530	79,620	53,090	3.00
T_6: 50:100:100 kg ha^{-1} NPK-100% of recommended P through bone meal	26,637	70,520	43,883	2.65
T_7: 50:225:50 kg ha^{-1} NPK-100% of recommended P through bone meal	34,959	76,520	41,561	2.19

The gross income was maximum (Rs. 79620) in T_5 followed by T_7 (Rs. 76520). This is due to the higher yields realized in the treatment. The results are in line with that reported by Kalpana *et al.* (2008) [8] and Rajendra *et al.* (2010) [9].

Highest B:C ratio of 3.85 was recorded in T_3 followed by T_4 (3.07). Though the treatments T_5 and T_7 have recorded significantly higher values for yield the less B:C ratio recorded in these treatments is due to the production cost which is at a higher side compared to other treatments. This in turn was due to inclusion of bone meal in the treatments which incurred higher cost compared to chemical P sources.

Additionally, growing consciousness of both finiteness of resources and deteriorating environmental effects of the artificial fertilizer use have contributed to growing popularity of nutrient recycling.

Conclusion

Noni is a hardy plant that is reported to be growing naturally with no external supplement of nutrients. But the study revealed that the yield can be enhanced with external application of nutrients. For higher benefits the choice of manures and fertilizers should be judiciously done as the awareness about the finiteness of resources and deteriorating effects of artificial fertilizers on soil and environment have necessitated the scientific community to look for alternate nutrient sources and nutrient recycling. Since the literature on

this aspect in noni is limited there is a need to take up further nutrient trials with different combinations of major and minor nutrients on the performance of the crop.

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