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Effect of graded levels of nitrogen on growth, yield of turmeric and nutrient status of soil under *Acacia mangium* based agroforestry system in lateritic soils of Konkan

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Abstract
An experiment was conducted to study the effect of four levels of nitrogen (100%, 80%, 60% and 40% recommended dose of N) along with 100% recommended dose of P and K on growth, yield of turmeric and nutrient status of soil under thirteen year old plantation of *Acacia mangium* based Agroforestry system in lateritic soils of Konkan during *Kharif* 2019. The data obtained revealed that application of 100% N + 100% PK (T_2) recorded the highest rhizome yield to the tune of 30.44 q ha^{-1} and higher values of available macro nutrients, which was found to be at par with 80% N kg ha^{-1} + 100% PK kg ha^{-1} in all cases. Thus, considering the growth and yield of turmeric, application of 80% N kg ha^{-1} + 100% PK kg ha^{-1} was found to be beneficial in lateritic soils of Konkan from the view point of saving 20% nitrogen fertilizer as well as getting higher rhizome yield and maintaining the soil fertility under *Acacia mangium* based Agro-forestry system.

Keywords: Turmeric, *Acacia mangium*, agroforestry, growth, rhizome yield, nutrients

Introduction
Acacia mangium, also known as *mangium*, is one of the most widely used fast-growing tree species in plantation forestry programmes throughout Asia and the Pacific in the tropical humid and sub-humid zones. Its desirable properties include rapid growth, good wood quality and tolerance of a wide range of soils and environments. It is well adapted to a wide range of soils and environmental conditions. It grows rapidly in sites with low levels of soil nutrients, even on acidic soils and degraded sites. It performs well on lateritic soils, i.e. soils with high amounts of iron and aluminium oxides (Otsamo, 2002) [2]. Moreover, under Agro-forestry system, *Acacia mangium* is recommended for building up soil fertility and to be planted as a source of nutrients in lateritic soils of Konkan region (Anonymous, 2017) [1] as it is a N_2-fixing tree legume and became a major plantation tree species. Thus, in addition to being a major pulp-wood producer, the tree has a good potential to restore soil fertility as a fallow species in Agro-forestry systems and as a fuel species.
Turmeric is a non-traditional crop in Konkan region of Maharashtra. However, the climatic and soil conditions seem to be suitable for its cultivation in this region. The successful cultivation of this crop under *Acacia mangium* based Agro-forestry system will not only provide an opportunity to generate income, but will also be an option to restore soil fertility and as a fuel species. Hence, the present experiment was designed to study the effect of nitrogen levels on growth, yield of turmeric and nutrient status of soil under *Acacia mangium* based Agro-forestry system in lateritic soils of Konkan.

Material and Methods
Field experiment was carried out during *Kharif* 2019 at Central Experiment Station, Tetawali Block, Wakawali under Dr. B.S. Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, with four nitrogen levels (100%, 80%, 60% and 40% recommended dose of N) along with 100% recommended dose of P and K, applied to turmeric Cv. Salem at a spacing of 30 x 15 cm grown under thirteen year old plantation of *Acacia mangium* under Agro-forestry system and compared with an absolute control in Randomized Block Design with five treatments and four replications.

The experimental soil was *Typic Ustropepts*, having pH 5.1, organic carbon 23.4 g kg^{-1}, available N, P_2O_5 and K_2O 292.0, 336.0 and 314.0 kg ha^{-1}, respectively. Recommended dose of phosphorus @ 150 kg ha^{-1} and potassium @ 150 kg ha^{-1} were applied in a single dose before the time of planting. Half dose of N was applied at 45 days after planting and rest was top-dressed at 105 days after planting. The N, P and K were applied through urea, single superphosphate and muriate of potash, respectively. Number of leaves per plant was recorded by counting the main and the tiller branches collectively of the five observational plants and the average number of leaves $plant^{-1}$ were worked out and number of tillers per plant was recorded by counting tillers developed to plant; the five observation plants and average number of tillers $plant^{-1}$ should be taken. Treatment wise plots were harvested separately, the rhizome collected from each net plot were weighed and rhizome yield per plot was recorded which was subsequently expressed on hectare basis. Soil samples were collected after the harvest of turmeric and analysed for available N, P and K following standard procedures (Page *et al.* 1982) [3].

Results and Discussion

There was a significant and graded increase in growth parameter *viz*., number of leaves $plant^{-1}$ and number of tillers $plant^{-1}$ recorded at harvest with graded doses of nitrogen, where the highest values were noted with the application of 100% N + 100% PK (T_2) (Table 1). Increase in growth attributes of turmeric with the increased nitrogen application may be attributed to the increased uptake of nitrogen. Nitrogen being active constituent of protoplasm and enzyme is necessary for enzymatic reactions in plants and a necessary component of several vitamins, e.g., biotin, thiamine, niacin and riboflavin. N is part of the nucleic acids (DNA and RNA). Chlorophyll plays a role of catalytic agent in various physiological processes, accelerate cell division and speed up to photo assimilation which in turn boost the plant growth and improve the plant structure. Optimum, rate of N increases photosynthetic processes, leaf area production, leaf area duration as well as net assimilation rate (Ahmad *et al*., 2009) [5].

Table 1: Growth and yield of turmeric as influenced by nitrogen levels under *Acacia Mangium* Agro-forestry system

Treat Code	Treatment	Number of leaves $plant^{-1}$	Number of tillers $plant^{-1}$	Rhizome Yield (q ha^{-1})
T_1	Control	8.56	1.69	16.58
T_2	100% N + 100% PK	9.75	3.13	30.44
T_3	80% N + 100% PK	8.69	2.75	25.70
T_4	60% N + 100% PK	8.75	2.31	21.56
T_5	40% N + 100% PK	8.81	2.00	19.34
S.E.±		0.25	0.12	1.54
C.D. at 5%		0.75	0.38	4.74

The fresh rhizome yield of turmeric varied from 16.58 to 30.44 q ha^{-1} with the application of graded doses of nitrogen under *Acacia mangium* based Agro-forestry system (Table 1). Application of different doses of nitrogen along with recommended doses of P and K (from treatment T_2 to T_5) significantly increased the rhizome yield over control (T_1). The application of 100% N + 100% PK (T_2) recorded the highest rhizome yield to the tune of 30.44 q ha^{-1}, but treatment T_2 was found to be at par with T_3 (*i.e*. 80% N + 100% PK) indicating the saving of 20% nitrogen dose. In remaining treatments, T_4 (60% N + 100% PK) and T_5 (40% N + 100% PK) were at par. The lowest rhizome yield of turmeric *i.e*. 16.58 q ha^{-1} was found in the control treatment (T_1) where no fertilizers was applied.

The increase in yield was attributed to better N uptake, which lead to production of more nitrogenous compounds in plant tissues and resulted in efficient plant metabolism (Borah and Langthasa, 1994) [7]. The improvement in the yield of turmeric may be ascribed to the improved vegetative growth due to N fertilization facilitating photosynthesis thereby increasing translocation of organic food materials towards the sink from stem and leaves which accelerated the formation and development of greater sink size and weight, thus increasing the rhizome yield.

Nutrient status of soil

There was a significant and graded increase in available nitrogen, phosphorus and potassium with graded doses of nitrogen, where the highest value were noted with the application of 100% N + 100% PK (T_2), which was found to be at par with treatment T_3 and T_4 in case of available nitrogen; while with T_3, T_4 and T_5 in case of available phosphorus and potassium (Table 2). Treatment T_1 (control) recorded the lowest values of available N, P_2O_5 and K_2O, which may be due to the cultivation of turmeric crops without any addition of fertilizer, causing reduction in the available nutrient status of the soil**.**

Matali and Metali (2015) [6] stated that the N-fixing ability of the *Acacia* trees produced N-rich leaves, thus resulting in N-enriched soils in the *A. mangium* plantation. Another important reason for the higher amount of N concentration in the *Acacia* plantation was the ability of the plant to fix atmospheric N. Increase in nitrogen, phosphorus and potassium with fertilizer application might be attributed to the direct addition of nutrient through fertilizer to the available pool of the soil. The increase in phosphorous and potassium availability might be also due to synergistic effect of N with phosphorus and potassium which increased the availability of P and K in the soil (Shrivastava, 2002) [4].

Table 2: Primary nutrient status of soil at harvest as influenced by nitrogen levels under *Acacia mangium* Agro-forestry system

Tr. Code	Treatment	Available N	Available P_2O_5	Available K_2O
		(kg ha^{-1})		
T_1	Control	306.4	25.31	220.0
T_2	100% N + 100% PK	421.0	33.80	277.8
T_3	80% N + 100% PK	410.0	29.56	264.2
T_4	60% N + 100% PK	403.0	29.07	256.1
T_5	40% N + 100% PK	365.3	27.84	247.8
S.E. ±		18.50	1.60	11.55
C.D. at 5%		57.01	4.92	35.60

Conclusion

Considering the growth and yield of turmeric and available nutrient status, application of 80% N kg ha^{-1} + 100% PK kg ha^{-1} was found to be beneficial in lateritic soils of Konkan

region of Maharashtra from the view point of saving 20% nitrogen fertilizer, as well as getting higher rhizome yield and maintaining the soil fertility under *Acacia mangium* based Agro-forestry system.

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