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Studies of nutrient content pattern in turmeric at different growth stages as influenced by graded levels of nitrogen under *Acacia mangium* based agroforestry system

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Abstract
An experiment was conducted to study the effect of nitrogen levels on nutrient content pattern in turmeric at different growth stages grown under *Acacia mangium* based Agroforestry system in lateritic soils of Konkan during *Kharif* 2019 with four nitrogen levels (100%, 80%, 60% and 40% recommended dose of N) along with 100% recommended dose of P and K was applied to turmeric Cv. Salem grown under thirteen year old plantation of *Acacia mangium* under Agroforestry system and compared with absolute control. The data revealed that application of 100% N + 100% PK (T_2) recorded the higher values of macro and micro nutrient contents in turmeric plant, which was found to be at par with 80% N kg ha^{-1} + 100% PK kg ha^{-1} in all cases.

Keywords: Turmeric, *Acacia mangium*, agroforestry, nutrient content

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. Its desirable properties include rapid growth, good wood quality and tolerance of a wide range of soils and environments. *Acacia mangium* 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) [5]. 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]. *Acacia mangium* is a N_2-fixing tree legume and has become a major plantation tree species in the tropical humid and sub-humid zones. 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 nutrient content pattern in turmeric at different growth stages grown 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, 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 classified as *Typic Ustropepts*, having pH 5.10, organic carbon 23.4 g kg^{-1}, available N 292.0 kg ha^{-1}, P_2O_5 336.0 kg ha^{-1} and K_2O 314.0 kg ha^{-1}. Recommended dose of phosphorus and potassium each @ 150 kg ha^{-1} were applied in a single dose before the time of planting through single superphosphate and muriate of potash, respectively.

Half dose of N was applied at 45 days after planting and rest was top-dressed at 105 days after planting through urea. Nitrogen, phosphorus and potassium content as well as micronutrients *i.e.* Fe, Mn, Cu and Zn in plant collected at different growth stages *i.e.* 45DAP, 105DAP and at harvest were determined by the procedure outlined by Tandon (1993) [9] and Singh *et al.*, (1999) [6].

Results and Discussion

Significant and graded increase in nitrogen, phosphorus and potassium content in plant at different growth stages were observed with the graded doses of nitrogen (Table 1). The highest NPK content in plant at different growth stages were noted with the application of 100% N + 100% PK (T_2), which further decline with the decreasing dose of N. Similar to NPK content, graded values of micronutrients *i.e.* Fe, Mn, Cu and Zn content in plant at different growth stages were observed with the graded doses of nitrogen (Table 2). The highest micronutrients *i.e.* Fe, Mn, Cu and Zn content in plant at different growth stages were noted with the application of 100% N + 100% PK (T_2), which further decline with the decreasing dose of N. The lowest values of N, P, K as well as micronutrients (Fe, Mn, Cu and Zn) content was exhibited by absolute control, where no fertilizers were applied.

The significant increase in nutrient content in plant with the application of graded doses of nitrogen along with recommended doses of P and K (from treatment T_2 to T_5) under *Acacia mangium* Agro-forestry system could be attributed to increasing availability of nutrients from leaf litter that the leaf litter after decomposition release macro and micro-nutrients to soil solution, besides the direct addition of nitrogen, phosphorus and potassium through fertilizer to the available pool of the soil; which becomes available to the plants, resulting in higher uptake. Furthermore, leaf NPK contents and micronutrients *i.e.* Fe and Cu content declined with increase in age of the plants. This could be attributed to the well known "dilution with growth effect" (Marschner, 2002) [4].

Mn content in plant increased with the growing period irrespective of the different treatments. Tisdale *et al*. (1995) [8] reported that the increasing soil temperature during the growing season improves Mn uptake, presumably because of greater plant growth and root activity. Further, nitrogen sources can influence Mn^{2+} availability in varies ways. The application of $CO(NH_2)_2$ to the soil enhance the uptake of manganese by the plant (Das, 2007) [3].

Zn content initially decreased from 45 DAS to 105 DAS and further increased at harvest irrespective of different treatments. Das (2007) [3] pointed out that the concentration of Zn has been found to be more in the older leaves than that of younger leaves of the plants. This indicates that Zn has a tendency to accumulate in the older than in the younger tissues because of its restricted mobility from the roots to the growing parts. Further, zinc uptake has been found to be greatly reduced by low temperature and metabolic inhibitors. Copper strongly inhibits the uptake of Zn and this may be due to the competition between two ions (Cu and Zn) for the same carrier site.

Table 1: Nitrogen, phosphorus and potassium content (%) in plant of turmeric as influenced by nitrogen levels under *Acacia mangium* Agro-forestry system

Tr. Code	Treatment	Nitrogen (%)			Phosphorus (%)			Potassium (%)		
		45 DAP	105 DAP	At harvest	45 DAP	105 DAP	At harvest	45 DAP	105 DAP	At harvest
T_1	Control	0.73	0.86	0.96	0.78	0.45	0.41	1.07	1.09	1.08
T_2	100% N + 100% PK	1.01	1.04	1.10	0.95	0.65	0.57	1.48	1.49	1.41
T_3	80% N + 100% PK	0.98	1.00	1.04	0.87	0.58	0.54	1.43	1.45	1.40
T_4	60% N + 100% PK	0.91	0.94	1.01	0.86	0.57	0.52	1.41	1.44	1.24
T_5	40% N + 100% PK	0.83	0.88	0.99	0.81	0.52	0.45	1.34	1.37	1.22
S.E.±		0.05	0.024	0.03	0.04	0.04	0.04	0.09	0.08	0.08
C.D. at 5%		0.15	0.12	0.09	0.11	0.12	0.11	0.26	0.23	0.23

Table 2: Micronutrients content (Fe, Mn, Cu and Zn) in plant of turmeric as influenced by nitrogen levels under *Acacia Mangium* Agro-forestry system

Tr. Code	Treatment	Iron ($mg\ kg^{-1}$)			Manganese ($mg\ kg^{-1}$)			Copper ($mg\ kg^{-1}$)			Zinc ($mg\ kg^{-1}$)		
		45 DAP	105 DAP	At Harvest	45 DAP	105 DAP	At Harvest	45 DAP	105 DAP	At Harvest	45 DAP	105 DAP	At Harvest
T_1	Control	26.40	12.18	5.13	35.52	48.16	55.06	0.27	0.24	0.14	0.44	0.21	0.99
T_2	100% N + 100% PK	61.14	16.41	9.86	53.05	57.92	99.21	0.49	0.43	0.38	0.86	0.32	2.02
T_3	80% N + 100% PK	56.93	14.86	9.69	47.00	55.29	96.44	0.47	0.34	0.24	0.61	0.27	1.41
T_4	60% N + 100% PK	42.92	13.86	7.84	45.21	53.16	92.66	0.45	0.32	0.21	0.54	0.25	1.30
T_5	40% N + 100% PK	37.01	12.41	5.77	43.83	49.60	84.95	0.31	0.27	0.17	0.51	0.23	1.12
S.E.±		4.10	0.67	1.00	3.96	3.22	9.25	0.06	0.03	0.02	0.06	0.01	0.13
C.D. at 5%		12.64	2.05	3.08	N.S.	N.S.	28.50	0.17	0.09	0.08	0.17	0.03	0.41

Conclusion

From the study, it is concluded that the higher values of nitrogen, phosphorus, potassium and micronutrients (Fe, Mn, Cu and Zn) content in turmeric Cv. Salem were noted with the application of 100% N kg ha^{-1} + 100% PK kg ha^{-1} under *Acacia mangium* based Agro-forestry system at all period of observations, which was found to be at par with the treatment of 80% N kg ha^{-1} + 100% PK kg ha^{-1} in most of the parameters indicating thereby the essentiality of optimum application of 80% N kg ha^{-1} + 100% PK kg ha^{-1} to turmeric Cv. Salem grown under *Acacia mangium* based Agro-forestry system in lateritic soils of Konkan.

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