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Performance of different varieties of turmeric under the influence of micro nutrient management at the foot hills of Eastern Himalayas

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Abstract
Field experiment was conducted with an objective to increase the productivity and quality of turmeric through micro-nutrient management and variety at College of Horticulture and Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh during the year 2017-18 to 2019-20 in FRBD with four replications. The soil type of the experimental field is sandy loam with pH value of 5.2 having high organic carbon (1.2%), medium in available nitrogen (315 kg N/ha), low in available phosphorus (21 kg P_2O_5/ha) and high in available potassium (360 kg K_2O/ha). Result of the three years of experimention as well as pooled mean indicated that recommended package of practices (120:50:120 kg NPK/ha) + foliar spray of IISR turmeric micronutrient @ 5g per litre at 60 and 90 days after planting recorded significantly higher number of tillers per plant, fresh weight of clump, rhizome yield as compared to recommended package of practices. However, the differences in plant height, days to 80% maturity and dry recovery between the treatments were not significant. Among the three varieties, the variety NDH 98 recorded significantly highest number of tillers, fresh weight of clump and rhizome yield as compared to IISR Pragati and Megha Turmeric-1. Though, the maximum plant height and maturity to 80% were recorded with the vareity NDH 98 but it remained at par to Megha- Turmeric-1. However, significantly highest dry recovery (%) of turmeric was observed with Megha-Turmeric-1. Significantly higher curcumin content was associated with the application of recommended package of practice plus foliar spray of IISR micronutrient in the variety Megha-Turmeric-1.

Keywords: Turmeric, micro-nutrient, variety, yield and quality

Introduction
Turmeric (*Curcuma longa* L.) is a tropical spice crop belonging to the family Zingiberaceae. The rhizomes which are the economic part of the crop, after processing and value addition, are commonly used as a spice, natural dye and in cosmetic and drug industries (Reshma and Vishwanath, 2020) [17]. It is also used in various auspicious and religious occasions in India. The nutritional requirement of this crop is quite high due to its shallow fibrous root system, long gestation period and potential to produce large quantities of dry matter per unit area (Chitdeshwari, 2019) [6]. Addition of micro-nutrients besides the macro-nutrient to the soil plays a major role in the growth and development of crop plants. Zinc plays an important role in chlorophyll, auxin and starch formation. Boron is important for stabilizing certain constituents of cell wall and plasma membrane, enhancement of cell division, and metabolism of nucleic acid, carbohydrate, protein, auxin and phenols. Deficiency of micro-nutrients and their inadequate addition to the soil, may be one of the reasons for low productivity of turmeric. Nutrient deficiencies have become a major yield limiting factor under acidic soils of North eastern hill region of India. Therefore, in order to achieve higher yield and better quality of turmeric, there is a need to study the effect of micronutrients.
The performance of any variety largely depends upon its genetic makeup. Further, the performance of the variety depends upon environment or climatic conditions of the region under which they are grown. As a result, a variety which perform well in one region may not perform well in other regions of varying climatic conditions. Hence, it is very much necessary to select suitable high yielding variety for a given agro-climatic condition. Keeping in view the above fact the present investigation was undertaken.

Materials and Methods
The experiment was conducted at Vegetable Research Farm, College of Horticulture and Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh for three years starting

from the year 2017-18 and ending in 2019-20. The soil of the experimental field was sandy loam in texture with a soil pH of 5.2, high in organic carbon (1.2%), medium in available nitrogen (315 kg/ha), low in available P_2O_5 (21 kg/ha) and high in available K_2O (360 kg/ha). Geographically, it is located at latitude of 280 06'N, longitude 930 32'E and altitude of 153 m MSL, hailing to the subtropical hot humid climatic condition and is one of the major production belts of turmeric. The experiment was laid out in Factorial Randomized Block Design with four replications. The treatment comprised of two nutrient management practices i.e. Recommended package of practice (120:50:120 NPK kg/ha) and Recommended package of practice + IISR turmeric micronutrient (Zn, B) @ 5g/litre and three turmeric varieties namely NDH-98, Megha Turmeric-1 and IISR Pragati. For the inorganic fertilizers, full dose of P_2O_5 (as single super phosphate) and K2O (as muriate of potash) along with 1/3 dose of recommended N (as urea) dose was applied as basal, rest 2/3rd N was applied in two equal splits at 45 and 90 days after planting. The foliar spray of IISR turmeric micronutrient was done at 60 and 90 days after planting. Raised beds of 3 m X 1 m size and 15 cm height were prepared. Healthy rhizomes having 2-3 buds were planted on 7th June, 22nd May and 23rd May of 2017, 2018 and 2019, respectively at 30 cm apart in rows keeping 25 cm plant to plant distance. The entire recommended package of practices was followed to raise a good crop. Five plants were randomly selected from each plot to record observations on quantitative characters like plant height (cm) and number of tillers per clump. The days to maturity, fresh weight of clump, rhizomes yield (t/ha) and dry recovery were observed and workout. The qualitative characters like curcumin (%), essential oil (%) and oleoresin content were also recorded. The curcumin content was estimated as per the methods of ASTA (Anon., 1968) [2] proposed by Manjunath *et al*., (1991) [11].

$$\text{Curcumin content (percent)} = \frac{\text{OD value x 125 x 0.0025}}{\text{0.42 x 0.1 x 1}}$$

The oleoresin content was calculated using the following formula and expressed as percent (AOAC, 1975) [1].

$$\text{Oleoresin content (percent)} = \frac{\text{(air dry) W2 – W1}}{10} \text{ x 100}$$

Where,
W1 = weight of empty beaker
W2 = weight of beaker with air dried oleoresin
The essential oil content was estimated as per the methods suggested by ASTA (Anon, 1968) [2]. The volume was measured and the oil content was calculated as

$$\text{Essential oil content (percent)} = \frac{\text{Volume of oil (ml)}}{\text{Weight of sample (g)}} \text{ x 100}$$

The data for each character were subjected to analysis of variance and critical difference at 5% level of probability for significance of treatments for comparing the means by the method as advocated by Panse and Sukhatme (1978) [13].

Result and Discussion

Result presented in Table 1 indicated that recommended package of practices + IISR turmeric micronutrient @ 5g per litre recorded significantly higher number of tiller per plant in all the three years of study as well as in pooled mean. Halder *et al*. (2007) [8] also noticed progressive increase in the growth contributing parameters of turmeric with increased dosage of combined application of zinc and boron. Datta *et al.* (2017) [7] also reported higher number of tillers per plant in turmeric with the application of micronutrients as compared to control. Bairagi (2022) [4] also recorded the least number of tillers per plant in turmeric with RDF only. However, the differrences in plant height, and days to maturity could not be significantly enhanced by the nutrient management practices in all the three seasons of investigation. Among the varieties significant variation in plant height was observed in all the three years of study and in pooled mean. The tallest plant was recorded in the variety NDH 98 which remained at par to Megha Turmeric -1 but significantly higher to IISR Pragati. The variation in plant height might be attributed to genetic variation among the varieties. Singh *et al*., (2013) [18] and Prasath *et al*., (2016) [14] also reported that the differences in plant height with different varieties. In 2017-18 the highest number of tillers per plant was found in the variety NDH 98 and it showed significant superiority over IISR Pragati and Megha Turmeric 1. The variations in number of tillers among the varieties were reported by earlier workers in turmeric and ginger under different agro-climatic conditions (Babu *et al*., 1993 and Rajyalakshmi and Umajyothi, 2014) [3, 16] However, in the next succeeding two years the differences in number of tillers per plant among the varieties was found to be not significant. The days to maturity in respect to different varieties were not significant.

A perusal of Table 2 reveals that the fresh weight of clump and rhizome yield were significantly influenced by different nutrient management practices in all the three seasons. The highest fresh weight of clump (292, 300, 272, 288 g) and rhizome yield (32.81,31.86,37.77, 34.15 t/ha) was associated with the recommended package of practices + IISR turmeric micronutrient application and it showed significant superiority over the recommended package of practices alone in all the three years of study as well as in pooled mean. Halder *et al*., (2007) [8] and Hnamte *et al*., (2018) [9] reported the beneficial effect of zinc and boron on turmeric yield. Though higher values of dry recovery (%) of turmeric was observed with the recommended package of practices + IISR turmeric micronutrient application however, it did not differ significantly with recommended package of practices.

Among the three varieties, NDH 98 recorded significantly highest fresh weight of clump (401,375,277, 351 g) and rhizome yield (45.02, 40.54, 38.63, 41.40 t/ha). The lowest performing variety in respect of rhizome yield was observed in IISR Pragati. Pirjade *et al*., (2007) [15], Chaturvedi *et al*., (2010) [5] and Negi *et al*., (2012) [12] also reported variability for rhizome yield among the varieties of turmeric. However, higher dry recovery (%) of turmeric was associated with the vareity IISR Pragati (24.36%) and it remain at par to Megha Turmeric-1 during the year 2017-18. In the succeeding two years, the differences in dry recovery was found to be not significant.

Among the quality parameter considered, only the curcumin content was significantly enhanced by the nutrient management (Table 3). The maximum curcumin content was

associated with the application of 120:50:120 NPK kg/ha (recommended package of practices) + IISR turmeric micronutrient. The highest curcumin content was observed with the variety Megha Turmeric 1 and it showed significant superiority over the variety NDH 98 and IISR Pragati. The variation in curcumin content among different varieties could be related to the genetic character of the varieties. The differences in curcumin content among the different varieties was reported earlier by Kamble *et al*., (2011) [10]. Though there was variation in the essential oil and oleoresin content among the varieties, the diffences were not significant.

The interaction between variety and treatment was found to be not significant for all the characters studied.

Table 1: Growth characters of turmeric as influence by micro-nutrient management and variety

Treatment	Plant height (cm)				No. of tillers/plant				Days to 80% maturity			
	2017-18	2018-19	2019-20	Pooled mean	2017-18	2018-19	2019-20	Pooled mean	2017-18	2018-19	2019-20	pooled mean
Micro-Nutrient management(T)												
Rec. POP (120:50:120 NPK kg/ha)	74.6	99.2	128.0	100.6	1.63	2.18	2.33	2.06	213	224	197	214
IISR package	73.9	104.0	130.4	102.7	1.63	2.72	2.78	2.38	212	225	199	214
S.Em±	0.30	0.46	0.33	0.26	0.03	0.02	0.03	0.02	0.45	0.59	0.43	0.28
$CD_{0.05}$	NS	NS	NS	NS	NS	0.43	0.45	0.38	NS	NS	NS	NS
Varieties (V)												
NDH 98	88.9	114.8	136.3	113.4	2.14	2.55	2.74	2.49	216	230	200	216
Megha Turmeric-1	88.7	111.7	133.2	111.2	1.25	2.34	2.38	2.00	214	222	194	215
IISR Pragati	45.3	78.3	118.1	80.5	1.50	2.45	2.55	2.18	209	221	199	211
S.Em±	0.46	0.7	0.5	0.39	0.05	0.04	0.04	0.03	0.67	0.89	0.65	0.43
$CD_{0.05}$	2.78	4.2	3.0	2.35	0.29	NS	NS	NS	NS	NS	NS	NS
Int. (TxV)												
S.Em± (TxV)	0.91	1.4	1.0	0.77	0.10	0.17	0.08	0.06	1.34	1.77	1.30	0.85
$CD_{0.05}$ (TxV)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV %	17.97	19.60	11.93	9.37	9.18	13.75	14.40	11.30	12.40	12.44	13.61	5.44

Rec. POP = 120:50:120 NPK kg/ha; IISR package = Rec. POP + IISR turmeric micronutrient

Table 2: Yield of turmeric as influence by micro-nutrient management and variety

Treatment	Fresh wt. of clump (g)				Rhizome Yield (t /ha)				Dry recovery (%)			
	2017-18	2018-19	2019-20	Pooled mean	2017-18	2018-19	2019-20	Pooled mean	2017-18	2018-19	2019-20	pooled mean
Micro-Nutrient management(T)												
Rec. POP (120:50:120 NPK kg/ha)	243	265	251	253	26.82	27.65	33.37	29.28	23.09	21.52	22.52	22.38
IISR package	292	300	272	288	32.81	31.86	37.77	34.15	22.23	20.98	21.23	21.48
S.Em±	0.87	0.93	0.38	0.61	0.16	0.16	0.17	0.14	0.15	0.13	0.14	0.11
$CD_{0.05}$	15.72	16.76	6.86	10.96	2.85	2.79	3.03	2.43	NS	NS	NS	NS
Varieties (V)												
NDH 98	401	375	277	351	45.02	40.54	38.63	41.40	20.03	21.48	22.73	21.41
Megha Turmeric-1	244	258	261	254	26.98	27.18	34.02	29.39	23.59	21.98	22.10	22.56
IISR Pragati	157	215	246	206	17.44	21.53	34.06	24.34	24.36	20.30	20.80	21.82
S.Em±	1.31	1.40	0.57	0.91	0.24	0.23	0.25	0.20	0.22	0.19	0.21	0.16
$CD_{0.05}$	7.98	8.51	3.48	5.57	1.45	1.42	1.54	1.23	1.33	NS	NS	NS
Int. (TxV)												
S.Em± (TxV)	2.62	2.80	1.15	1.83	0.48	0.47	0.51	0.41	0.44	0.39	0.41	0.32
$CD_{0.05}$ (TxV)	NS	NS	NS	11.13	NS	NS	NS	NS	NS	NS	NS	NS
CV %	11.27	14.32	8.03	19.82	12.12	11.69	11.49	8.29	13.44	11.39	12.44	7.34

Rec. POP = 120:50:120 NPK kg/ha; IISR package = Rec. POP + IISR turmeric micronutrient

Table 3: Quality of turmeric as influence by micro-nutrient management and variety

Treatment	Curcumin content (%)	Essential oil (%)	Oleoresin (%)
Micro-Nutrient management(T)			
Rec. POP (120:50:120 NPK kg/ha)	5.2	6.6	11.5
IISR package	5.6	6.7	11.4
SEm±	0.01	0.03	0.05
$CD_{0.05}$	0.2	NS	NS
Varieties (V)			
NDH 98	5.2	6.8	11.4
Megha Turmeric-1	5.8	6.5	11.3
IISR Pragati	5.2	6.5	11.7
S.Em±	0.02	0.04	0.08
$CD_{0.05}$	0.1	NS	NS

Int. (TxV)			
S.Em± (TxV)	0.04	0.08	0.16
$CD_{0.05}$ (TxV)	NS	NS	NS
CV %	1.46	1.75	3.60

Rec. POP = 120:50:120 NPK kg/ha; IISR package = Rec. POP + IISR turmeric micronutrient

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