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Integrated management of different nutrients with FYM on soil fertility status and nutrient uptake by turmeric in acidic soil of Western Himalayas

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The increase in available P due to integrated effect of farm yard manure and nutrients addition may be because of the fact that upon decomposition, organic matter releases some acids which act as chelates and help in forming coating on sesquioxides, which are common in acidic soils. Turmeric, known for its medicinal properties is gaining popularity in Himachal Pradesh due to good monetary returns and high market demand. The area under this crop in the state is about 150 ha with production of 110 tonnes. The average yield is only 0.73 t/ ha, which is comparatively lower than that of many states like Andhra Pradesh (4.13 t/ha) and Tamil Nadu (3.73 t/ha) (Anon., 2005). High P and K fixation capacity, low rates of organic matter decomposition and N and S mineralization are some of the important limiting factors affecting productivity and nutrients uptake by the crop in the acidic conditions (Sharma *et al.*, 2001). The available N,P,K and S in soil play a significant role in improving the nutrient uptake, productivity and nutrient status in the soil. In general as the dry matter production increases, uptake of nutrients also increases as there is positive correlation between yield and uptake (Subramanian *et al.*, 2001).

Solo use of chemical fertilizers poses serious threat to the sustainability of the crop yields and soil health. Farmyard manure (FYM) forms the major source of organic nutrition to agricultural crops. However, its poor management at the farmers' level limit the use of organic manure only as a supplementary source of nutrients when high yields are targeted. Therefore, it is imperative to study the effect of eco-friendly integrated nutrient management approach in the crop in an acid Alfisol of the state.

Field experiments on turmeric (*Curcuma longa* L.), variety T-12 were conducted during *kharif* 2004 and 2005 at the research farm of Department of Soil Science, Chaudhary Sarwan Kumar, Himachal Pradesh Krishi Vishvavidyalaya, Palampur (Himachal Pradesh.). The soil of the experimental field was silty clay loam in texture, with pH 5.6, organic carbon 11.8 g/ kg, nitrogen 264 kg/ha, available phosphorus 16 kg/ ha, available potassium 204 kg /ha and available sulphur 12 kg/ ha. Eleven treatment combinations were arranged in a randomized block design including control with three replications. The treatments were 20 t FYM /ha as soil incorporation and as soil mulch, 100 % NPK, 100 % NPKS, 100 % NPKS in combination with 10, 15, 20 t FYM/ ha as soil incorporation and with same doses of FYM as soil mulch and control. Uniform mother rhizomes of turmeric were sown in last week of May during both the years with a row to row and plant to plant spacing of 30 and 20 cm, respectively.

Total nitrogen content was determined by micro-kjeldahl's method (Jackson, 1967), total phosphorus content by vando-molybdate phosphoric acid yellow colour method (Jackson, 1967), total potassium content method given by Chapman and Brown (1950) and total sulphur content by turbidimetric method (Chesin and Yien, 1950). The concentration of nitrogen, phosphorus, potassium and sulphur were determined in rhizome and straw (leaf) and uptake was calculated as follows:

Uptake (kg/ ha) = concentration of nutrient (%) x yield of crop (leaf + rhizome q/ ha)

Organic carbon content in soil was determined by Rapid titration method (Walkley and Black,1934), available N- Alkaline permanganate method (Subiah and Asija,1956), available P- 0.5 M $NaHCO_3$ (Olsen *et al*, 1954), available K-Neutral normal ammonium acetate method (Black, 1965) and available S- 0.15 per cent $CaCl_2$, extractable S method (William and Steinberg, 1959).

There was a significant increase in uptake of N, P, K and S by turmeric (rhizome + straw) with addition of 20 t FYM/ha over control. The nutrients uptake also increased significantly with the use of 100 % NPKS with 10, 15 and 20 t FYM/ha as incorporation or mulch over 100 % NPKS (Table 1). The treatment, where 100 % NPK was applied significantly increased the uptake of N, P and K over 20 t FYM/ha, whereas, in case of S uptake, the two treatments were statistically at par with each other. The respective nitrogen, phosphorus and sulphur uptake (rhizome + straw) were found highest (42.5, 15.9 and 10.9 kg/ ha**)** in treatment comprising of 100 % NPKS + 20 t FYM/ ha as soil mulch as compared to the rest of the treatments. Likewise, the highest potassium uptake (62.1 kg/ ha**)** was recorded at 100 % NPKS + 20 t FYM/ ha as soil incorporation as compared to the other treatments. The treatment 100 % NPKS + 20 t FYM/ ha as soil mulch was significantly superior over 100 % NPKS + 20 t FYM /ha as soil incorporation in influencing the P uptake only. The higher N, P, K and S uptake at different nutrient levels over control was mainly due to increase in yield of the crop. Conjoint use of NPKS and farm yard manure influenced the N, P, K and S uptake markedly, which could be because of supply of these nutrients and improvement in physical and chemical conditions of soil. Sharma *et al.* (2001) also reported similar results of integrated fertilization improving the growth of the plants, increasing uptake and accumulating N, P, K and S.

Table 1. Integrated management of different nutrients with FYM on nutrients uptake (kg/ha) by turmeric (pooled data of two years)

Treatments	N uptake	P uptake	K uptake	S uptake
Control	15.4	3.83	22.9	2.8
20 t FYM/ ha (SI)	21.8	5.48	31.6	4.7
20 t FYM /ha (SM)	23.2	7.12	33.1	4.9
100 % NPK	29.5	9.50	43.5	4.1
100 % NPKS	32.3	11.4	47.5	7.3
100 % NPKS + 10 t FYM/ ha (SI)	36.5	13.6	54.2	8.5
100 % NPKS + 15 t FYM /ha (SI)	40.7	14.6	59.1	10.0
100 % NPKS + 20 t FYM/ ha (SI)	42.3	15.7	62.1	10.7
100 % NPKS + 10 t FYM/ ha (SM)	35.9	12.5	52.8	7.9
100 % NPKS + 15 t FYM/ ha (SM)	39.6	14.2	58.5	9.9
100 % NPKS + 20 t FYM/ ha (SM)	42.5	15.9	61.8	10.9
CD (P= 0.05)	1.12	0.18	1.96	0.60

SI: FYM incorporated in the soil at the time of sowing, SM: FYM applied as soil mulch at the time of sowing and incorporated at the time of earthing up

Organic carbon content increased significantly with application of farm yard manure alone @ 20t/ha over control and 100% NPKS + 20 t FYM/ ha as soil incorporation or mulch over 100% NPKS (Table 2). The highest build up in its status (12.2 g/ kg) was recorded in 100% NPKS + 20 t FYM/ ha as soil incorporation, which might be due to addition of organic carbon through FYM and creation of favourable conditions for the growth of soil microorganisms. Available N, P, K and S status of soil enhanced significantly due to addition of 20 t FYM/ ha both as soil incorportion and mulch over the control. Nutrients status (N,P,K and S) increased significantly with alone application 100 % NPKS + 20 t FYM/ ha as soil incorporation or mulch over 100% NPKS. The highest available nitrogen of 278 kg /ha and phosphorus of 22.8 kg/ ha were recorded in 100 % NPKS + 20 t FYM/ ha as soil incorporation. This increase in N status in soil may be due to addition of N thorugh FYM and nitrogen from chemcial fertilizer (Singh *et al.*, 2001). Effect of FYM in increasing P availability is known to be due to reduced phosphate sorption with low bonding energy ultimately leading to an increase in availability of P (Sharma *et al.*, 2001).

Likewise, the highest available potassium (219 kg /ha) and sulphur (22.8 kg/ ha) were recorded at 100 % NPKS + 20 t FYM /ha as soil mulch. The increase in available K status of the soil due to integration might be due to the reason that organic colloids possess greater capacity to hold K ions on the exchangeable sites and help in the constant release of K from the non-exchangeable pool of these colloids (Karthikeyan *et al.*, 2001). Moreover, there is equilibrium between water soluble, exchangeable and non-exchangeable K in soil. (Medda and Hore, 2003). Similarily in case of sulphur, FYM application might have resulted in an increase in the soil microorganism population and these organisms apparently utilize organically bound S for cell synthesis during assimilation of S into microbial protoplasm and convert into inorganic sulphates as has also been reported by Singh *et al.* (2001).

Table 2. Integrated management of different nutrients with FYM on soil properties in turmeric (pooled data of two years)

Treatments	Organic (g /kg) carbon	Available N (kg /ha)	Available P (kg/ ha)	Available K (kg /ha)	Available S (kg /ha)
Control	11.8	223	10.3	163	10.2
20 t FYM/ ha (SI)	12.0	232	12.9	186	14.1
20 t FYM /ha (SM)	12.0	238	13.4	187	13.6
100 % NPK	11.9	249	14.8	205	11.1
100 % NPKS	11.9	254	15.5	202	15.8
100 % NPKS + 10 t FYM/ ha (SI)	12.0	264	18.1	208	18.3
100 % NPKS + 15 t FYM /ha (SI)	12.0	274	21.1	212	20.6
100 % NPKS + 20 t FYM/ ha (SI)	12.2	278	22.8	218	22.1
100 % NPKS + 10 t FYM/ ha (SM)	12.0	255	16.7	213	18.4
100 % NPKS + 15 t FYM/ ha (SM)	12.1	268	18.7	214	20.5
100 % NPKS + 20 t FYM/ ha (SM)	12.0	276	20.7	219	22.8
CD (P= 0.05)	0.09	8.06	1.70	10.07	1.59

SI: FYM incorporated in soil at the time of sowing, SM: FYM applied as soil mulch at the time of sowing and incorporated at the time of earthing up

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