

AVAILABILITY AND UPTAKE IN TOMATO

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Abstract : A pot culture experiment was conducted to study the influence of humic acid on nutrient availability and uptake in tomato. The data revealed that addition of humic acid @ 20 kg ha⁻¹ along with 100% recommended dose of fertilizers improved the availability of major and micronutrients viz., iron and zinc and enhanced their uptake. Soil application of humic acid @ 20 kg ha⁻¹ along with 75% recommended dose of fertilizers improved the availability and uptake of nutrients than 100% recommended dose of fertilizers alone. Foliar spray of humic acid @ 0.1% showed significant increase in uptake of nutrients than the control.

Key words: tomato, humic acid, nutrient availability and uptake

INTRODUCTION

Soil health is a crucial factor for realizing higher yield of vegetables. Excessive application of chemical fertilizers may affect soil health and sustainable productivity. Addition of organic manure, which can supplement nutrient requirement of crops to some extent, releases nutrient in gradual and controlled way allowing greater production of vegetables with minor environmental impact. FYM, which is a common organic source has become a scarce commodity due to decline in cattle population. It is imperative to search for possible alternate organic source that can sustain soil health and crop production. Humic acid from lignite is the most concentrated form of organic material and it is a ready source for carbon and nitrogen. Humic acid improves the physical, chemical and biological properties of the soil and influences plant growth.

Still very little work has been done in the direction of utilization of humic acid in vegetable production. Hence a study aiming at the impact assessment of humic acid on nutrient availability and uptake by tomato was undertaken.

MATERIALS AND METHODS

A pot culture experiment was conducted at Tamil Nadu Agricultural University, Coimbatore, in soil representing Irugur series (Typic Ustropepts), (sandy clay loam in texture, pH 7.1, EC 0.19 dSm⁻¹, low in available nitrogen (248 kg ha⁻¹), medium in available phosphorus (19 kg ha⁻¹) and high in available potassium (390 kg ha⁻¹) in FCRD. The treatments consist of inorganic fertilizers viz., 100% (150: 100: 50 kg N7P2O5, K2O ha⁻¹) and 75% recommended dose of NPK (Factor M) and different doses of humic acid (Factor S).

Treatments

Factor 1 : Fertilizer levels

M₁ : 100% Recommended Dose of NPK (150:100:50 kg N, P₂O₅, K₂O ha⁻¹).

M₂ : 75% Recommended Dose of NPK

Factor 2 : Humic acid levels

S₁ : Control (No humic acid)

S₂ : Soil application of HA @ 10 kg ha⁻¹

S₃ : Soil application of HA @ 20 kg ha⁻¹

S₄ : Foliar spray of 0.1% HA

S₅ : Soil application of HA @ 10 kg ha⁻¹ + Foliar spray of 0.1% HA

The inorganic fertilizers were applied as urea, SSP and MOP. Entire quantity of P_2O_5 and K_2O and half the dose of N were applied basal. The remaining half the dose of N was applied on 30th Day After Transplanting (DAT). Soil application of humic acid @ 10 and 20 kg ha⁻¹ were also applied along with the basal dose of inorganic fertilizers. Foliar spray of humic acid @ 0.1% was done on 30th, 45th and 60th DAT. The experiment was conducted with the tomato variety PKM 1. Soil and plant samples were collected at 50% flowering and harvest stages and analysed for available N, P, K, Fe and Zn following standard procedures. Plant samples were analysed for the content of N, P, K, Fe and Zn adopting standard analytical methods.

RESULTS AND DISCUSSION

Available nitrogen

Soil application of HA @ 20 kg ha⁻¹ along with 100 per cent recommended dose of fertilizers (RDF) recorded the highest available N of 183 and 162 mg kg⁻¹ at flowering and post harvest stages respectively. Soil application of HA @ 10 kg ha⁻¹ along with 75 per cent RDF resulted in higher available N (135 mg kg⁻¹) than 100% RDF alone (126 mg kg⁻¹) at post harvest stage (Table 1). Randhawa and Broadbent (1965) reported that HA produces ligands capable of complexing nutrient elements and the complexed elements remain more available to plant roots as complexation shields them against immobilisation in soil. Inhibition of urease activity by HA (Vaughan and Ord, 1991), led to reduced losses of N by volatilization, as described by Flaig (1984) could have also contributed to increased availability of nitrogen.

Available phosphorus

Soil application of HA @ 20 kg ha⁻¹ along with 100 per cent RDF had the highest available P of soil (18.0 and 10.0 mg kg⁻¹) in flowering and post harvest stages (Table 1).

This is in consonance with the findings of David *et al.*, (1994). The slow and continuous dissolution of phosphate minerals in soil by humic acid may account for its increased availability (Pal and Sengupta, 1985). Malcolm and Vaughan (1979) were of the opinion that the soil phosphatase activity improved by humic acid might have resulted

in increased P availability as phosphatase hydrolyses the phosphate esters into inorganic phosphorus. Heng (1989) reported that HA reduces P fixing capacity of the soil, which closely corroborate with the present study where HA enhanced the P availability.

Available potassium

Soil application of HA @ 20 kg ha⁻¹ along with 100 per cent RDF enhanced the K availability from 98 mg kg⁻¹ in treatment receiving 100% RDF alone to 127 mg kg⁻¹ at post harvest stages (Table 1). The release of fixed K by humic acid (Tan, 1978) may explain its increased availability.

Available iron

Soil application of HA @ 20 kg ha⁻¹ along with 100 per cent RDF recorded the highest available iron content of 5.42 mg kg⁻¹ followed by S₃ and S₂, which were on par with each other (Table 2). Enhanced solubilisation and increased extractability of iron and reduction of non-available higher oxide forms to available forms by humic acid may account for its increased availability.

Available zinc

Soil application of HA @ 20 kg ha⁻¹ along with 100 per cent RDF resulted in the highest available zinc content of 1.24 and 1.23 mg kg⁻¹ at flowering and post harvest stages respectively. The possible reasons for increased availability of zinc by humic acid as concluded by Milap Chand *et al.* (1980) are increased solubility of zinc and ability of humic acid to form stable complexes with zinc.

Nitrogen uptake

The highest N uptake was recorded in S₃ (1290 mg plant⁻¹) followed by S₅ and S₂ in case of 100 per cent RDF (Table 3). Adani *et al.*, (1998) in tomato and Peng Zheng Ping *et al.*, (2001) in *Brassica* also proved the same. The increased N uptake was supposed to be due to the better use efficiency of applied N fertilizers in the presence of humic acid coupled with retarded nitrification process enabling the slow availability of applied N (Guminiski, 1968).

Phosphorus uptake

In case of both 75 per cent and 100 per cent RDF, soil application of HA @ 20 kg ha⁻¹ promoted the P uptake from 140 mg plant⁻¹ and 167 mg plant⁻¹ in control to 253 mg plant⁻¹ and 282 mg plant⁻¹ (Table 3). The increase in P uptake may be due to the prevention of P fixation in the soil and the formation of humophospho complexes, which are easily assimilable by the plants (Raina and Goswami, 1988).

Potassium uptake

The highest K uptake of 3.25 g plant⁻¹ was recorded in the treatment receiving soil application of humic acid @ 20 kg ha⁻¹ along with 100 per cent RDF (Table 3). According to Samson and Visser (1989), humic acid induced increase in permeability of biomembranes for electrolytes accounted for increased uptake of K.

Iron uptake

Uptake of iron was found to be higher in treatment receiving soil application of humic acid @ 20 kg ha⁻¹ along with 100 per cent RDF (5.39 mg plant⁻¹) than any other treatment (Table 3). Protonation reaction of humic acid (Gregor and Powerll, 1988) caused a reduction of Fe³⁺ to Fe²⁺ and made iron chelates, which are readily available to the plants.

Zinc uptake

Perceptible increase in the zinc uptake under the treatment M1S3 (1.94 mg plant⁻¹) was evidenced. It was followed by M2S3 (1.76 mg plant⁻¹) and M1S5 (1.72 mg plant⁻¹). Similar findings were reported by Demir *et al.*, (1999) and Chen *et al.*, (2001) in cucumber. The beneficial effect of humic acid in soil might have prevented the formation of insoluble complexes of zinc and facilitated their uptake by plants.

Yield

Soil application of HA @ 20 kg ha⁻¹ along with 100 per cent RDF recorded the highest fruit yield of 880 g plant⁻¹ compared to 760 g plant⁻¹ in the treatment receiving 100 per cent RDF alone.

In conclusion, increased availability of N, P, K, Fe and Zn conformed the soil fertility

improvement by humic acid addition @ 20 kg ha⁻¹ along with 100 per cent RDF. In the light of uptake of nutrients, soil application of humic acid @ 20 kg ha⁻¹ significantly favoured the uptake of N, P, K, Fe and Zn which ultimately increased the tomato fruit yield.

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Table 1. Effect of humic acid and fertilizers on the availability of N, P, K

Treatments	Available nitrogen (mg kg ⁻¹)				Available phosphorus, (mg kg ⁻¹)				Available potassium (mg kg ⁻¹)			
	Flowering stage		Post harvest stage		Flowering stage		Post harvest stage		Flowering stage		Post harvest stage	
	Mi	M ₂	M ₁	M ₂	Mi	M ₂	M ₁	M ₂	Mi	M ₂	M ₁	M ₂
S ₁	143	137	126	118	15.5	14.0	8.0	7.5	170	169	98	97
S ₂	162	157	143	135	16.5	15.5	9.0	8.5	187	186	112	110
S ₃	183	180	162	155	18.0	17.0	10.0	9.5	206	205	127	124
S ₄	144	138	127	119	15.5	14.0	8.0	7.5	172	171	100	99
S ₅	163	158	143	136	16.5	15.5	8.0	8.5	189	188	112	112
Source	SEd	CD*	SEd	CD	SEd	CD	SEd	CD	SEd	CD	SEd	CD
M	1.28	2.68	1.21	2.52	0.37	0.78	0.18	0.38	1.25	2.62	1.01	2.12
S	2.03	4.24	1.91	3.99	0.59	1.24	0.28	0.60	1.99	4.15	1.61	3.30
MxS	2.87	5.99	2.71	5.64	0.84	1.76	0.40	0.85	2.81	5.87	2.28	4.75

* CD (P = 0.05)

Table 2. Effect of humic acid and fertilizers on the availability of iron and zinc

Treatments	Available iron (mg kg ⁻¹)				Available zinc (mg kg ⁻¹)			
	Flowering stage		Post harvest stage		Flowering stage		Post harvest stage	
	M ₁	M ₂	M ₁	M ₂	M ₁	M ₂	M ₁	M ₂
S ₁	5.29	5.22	5.20	0.96	0.96	0.96	0.94	0.94
S ₂	5.41	5.33	5.31	1.10	1.10	1.10	1.08	1.07
S ₃	5.53	5.42	5.41	1.24	1.24	1.24	1.23	1.22
S ₄	5.30	5.22	5.21	0.97	0.97	0.97	0.95	0.94
S ₅	5.42	5.34	5.33	1.11	1.11	1.11	1.07	1.07
Source	SEd	CD *	SEd	CD	SEd	CD	SEd	CD
M	0.009	0.019	0.007	6.014	0.004	0.009	0.004	0.009
S	0.014	0.03	0.011	0.023	0.007	0.014	0.007	0.01
MxS	0.02	0.04	0.01	0.03	0.01	0.02	0.001	0.02

* CD (P = 0.05)

Table 3. Effect of humic acid and fertilizers on the yield and uptake of nutrients in tomato at harvest stage

Treatments	Nitrogen		Phosphorus		Potassium		Iron		Zinc		Yield	
	(mg plant ⁻¹)		(mg plant ⁻¹)		(mg plant ⁻¹)		(mg plant ⁻¹)		(mg plant ⁻¹)		(g plant ⁻¹)	
	M ₁	M ₂	M ₁	M ₂	M ₁	M ₂	M ₁	M ₂	M ₁	M ₂	M ₁	M ₂
S ₁	724	567	167	141	1.94	1.55	3.04	2.66	1.14	0.99	760	700
S ₂	966	790	221	193	2.52	2.29	4.04	3.67	1.47	1.32	810	750
S ₃	1290	1052	282	253	3.25	2.70	5.39	4.91	1.94	1.76	880	820
S ₄	815	676	193	167	2.13	1.77	3.53	3.19	1.32	1.18	785	720
S ₅	1105	907	242	216	2.81	2.33	4.69	4.27	1.78	1.52	840	775
Source	SEd	CD*	SEd	CD	SEd	CD	SEd	CD	SEd	CD	SEd	CD
M	1.79	3.74	1.43	2.98	0.02	0.04	0.02	0.04	0.019	0.04	3.37	7.02
S	2.83	5.91	2.26	4.72	0.03	0.07	0.03	0.07	0.03	0.06	5.32	11.10
MxS	4.00	8.36	3.2	6.68	0.04	0.10	0.04	0.10	0.04	0.09	7.53	15.70

* CD (P = 0.05)