

# Effect of fortified humic acid on total uptake of primary nutrients (NPK) by Mangalore cucumber and NPK status in postharvest soil

## ABSTRACT

Field experiment was conducted from December (2022) to March (2023) at College of Agriculture, V. C. Farm, Mandya to study the effect of minerals (Ca, Fe and Zn) fortified humic acid on total major nutrient (N P K) uptake by Mangalore cucumber and NPK status of soil after harvest of Mangalore cucumber. The experiment was laid out in Randomized Complete Block Design (RCBD) with fifteen treatments, which involves foliar spray of humic acid ( $T_3$ ), fortified humic acid ( $T_4$  to  $T_7$ ) and inorganic salts ( $T_8$  to  $T_{11}$ ) at 30 and 45 DAS and soil application of fortified humic acid ( $T_8$  to  $T_{11}$ ) at the time of sowing. The data unveiled that foliar application of Ca, Fe and Zn (each @ 50 ppm) fortified humic acid @ 0.25 % ( $T_7$ ) at 30 and 45 DAS recorded significantly higher total uptake of nitrogen ( $53.89 \text{ kg ha}^{-1}$ ), phosphorus ( $17.59 \text{ kg ha}^{-1}$ ) and potassium ( $58.40 \text{ kg ha}^{-1}$ ). Lowest available N,  $\text{P}_2\text{O}_5$  and  $\text{K}_2\text{O}$  status in soil after harvest of Mangalore cucumber has been noticed in absolute control ( $204.42 \text{ kg ha}^{-1}$ ),  $27.27 \text{ kg ha}^{-1}$  and  $204.65 \text{ kg ha}^{-1}$ , respectively and it was followed by treatment  $T_7$  which recorded available N,  $\text{P}_2\text{O}_5$  and  $\text{K}_2\text{O}$  status of 207.48, 49.87 and  $231.17 \text{ kg ha}^{-1}$ , respectively. The results suggested that two foliar spray of Ca + Fe + Zn fortified HA at 30 and 45 DAS along with PoP resulted in higher NPK uptake by Mangalore cucumber.

*Key words: Fortified humic acid, nutrient uptake, soil nutrient status, foliar spray, inorganic salts*

## 1. INTRODUCTION

Humic substances (HS) are remains of decomposed plant and animal materials such as lignin, tannins, cellulose and cutins. Humic substances are classified as humic acids (HA), fulvic acids (FA) and humins based on their solubility in water, acid or alkali. The humic acids are those components of humic substances which are soluble in strong bases but insoluble in strong acids. Humic acid (black gold of agriculture) are complex, brown to black in colour, polymeric organic acids which have more phenolic and carboxylic functional groups. The humic substances are known to play direct and indirect role to improve plant growth and soil properties [1]. Humic acid act as biostimulant [2] and help in improving the vital physiological processes of the crop such as photosynthesis [3] and it also increases the root growth and cell permeability [4] thereby increasing the nutrient uptake results in higher yields and quality [5].

Mangalore cucumber (*Cucumis maderaspatensis* L.) is indeed an important vegetable crop with several nutritional and medicinal properties. Mangalore cucumber is known for its high water content and low calorie count [6]. However growth and development, consequently the nutrient uptake by the crop is influenced by various factors, including soil and its fertility management, climate, agronomic practices and

socio-economic conditions. Each of these factors can impact the nutrient content and overall health of the crops. Among these factors, soil and soil fertility management are highly crucial. Because nutrient-rich soil provides essential elements like nitrogen, phosphorus, potassium, calcium, iron, zinc to plants. These elements are then absorbed by the vegetables and contribute to higher uptake and quality of the crop. In the recent past, there has been decline in soil fertility due to intensive cultivation, erosion of top soil, leaching of nutrients and lack of organic matter application. As a result, there will be decrease in concentration of vital elements in plants and its economic part, rendering them less nutritious. The decline in soil fertility can have severe implications on human nutrition. Nutrient deficiencies in the soil can result in inadequate levels of essential minerals such as potassium, calcium, iron, zinc in the crops. In this backdrop the study was conducted to know the effect of fortified humic acid on primary nutrients (N P K) uptake by Mangalore cucumber and N P K status in postharvest soil.

## 2. MATERIAL AND METHODS

Field study was carried out at the College of Agriculture, V. C. Farm, Mandya, Karnataka, India, from December (2022) to March (2023) with Mangalore cucumber as test crop, Urea (46% N), DAP (46%  $P_2O_5$  18% N) and MOP (60%  $K_2O$ ) fertilizers are used as a source of N, P and K during the experiment. The soils of the experimental sites had Sandy loam texture with a pH of 7.

The fifteen treatments were replicated three times in randomized block design. The treatments consists of  $T_1$  - Absolute control (without recommended dose of FYM and chemical fertilizer);  $T_2$  - Package of practice (PoP) (recommended dose of FYM and chemical fertilizer i.e., 25 t  $ha^{-1}$  + 60- 50- 80 N- $P_2O_5$ - $K_2O$  kg  $ha^{-1}$ );  $T_3$  - PoP + unfortified HA foliar spray @ 0.25 %;  $T_4$  - PoP + Ca fortified HA foliar spray @ 0.25 %;  $T_5$  - PoP + Fe fortified HA foliar spray @ 0.25 %;  $T_6$  - PoP + Zn fortified HA foliar spray @ 0.25 %;  $T_7$  - PoP + Ca, Fe & Zn fortified HA foliar spray @ 0.25 %;  $T_8$  - PoP + Ca foliar spray @ 0.5 %;  $T_9$  - PoP + Fe foliar spray @ 0.5 %;  $T_{10}$  - PoP + Zn foliar spray @ 0.5 %;  $T_{11}$  - PoP + Ca, Fe & Zn foliar spray each @ 0.5 %;  $T_{12}$  - PoP + Soil application of Ca fortified HA @ 5 L  $ha^{-1}$ ;  $T_{13}$  - PoP + Soil application of Fe fortified HA @ 5 L  $ha^{-1}$ ;  $T_{14}$  - PoP + Soil application of Zn fortified HA @ 5 L  $ha^{-1}$ ;  $T_{15}$  - PoP + Soil application of Ca, Fe & Zn fortified HA @ 5 L  $ha^{-1}$ . Commercially available liquid formulation containing 12% humic acid, has been fortified with calcium, iron, and zinc individually and all three in combination at 50 ppm by the use of sources such as calcium nitrate, ferrous sulfate and zinc sulfate. Foliar spray of fortified and unfortified humic acid ( $T_3$  to  $T_7$ ) and inorganic salts ( $T_8$  to  $T_{11}$ ) was done at 30 and 45 DAS. Soil application was done at the time of sowing. The available N,  $P_2O_5$  and  $K_2O$  content of post harvest soil samples were analyzed by standard method.

### 2.1 Nutrient uptake by crop

Nutrient content in fruit, vine and leaf was determined by following standard analytical methods and expressed in percentage. Nutrient uptake ( $\text{kg ha}^{-1}$ ) by Mangalore cucumber was calculated for each treatment using the following formula.

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Nutrient concentration (\%)} \times \text{biomass yield (kg ha}^{-1}\text{)}}{100}$$

**Table 1. Physico-chemical properties of experimental soil**

Particulars	values	Methods
	Physical properties	
Sand (%)	69.60	International pipette method (Piper,1966)[7]
Silt (%)	21.80	
Clay (%)	8.60	
Textural class	Sandy loam	
	Chemical properties	
pH (1:2.5)	7.08	Potentiometric method (Jackson,1973)[8]
EC (1:2.5) (dS m <sup>-1</sup> )	0.20	Conductometric method (Jackson,1973)[8]
Organic carbon (%)	0. 47	Wet oxidation method (WalkleyandBlack,1934)[9]
CEC (cmol (p <sup>+</sup> ) kg <sup>-1</sup> )	9.23	Jackson,1973 [8]
Available N (kg ha <sup>-1</sup> )	242.28	Alkaline potassium permanganate method (SubbaiahandAsija,1956)[10]
Available P <sub>2</sub> O <sub>5</sub> (kg ha <sup>-1</sup> )	35.89	Olsen extract (Jackson,1973)[8]
Available K <sub>2</sub> O (kg ha <sup>-1</sup> )	224.87	Flame photometry (Jackson,1973)[8]
Exchangeable Calcium (c mol (p <sup>+</sup> ) kg <sup>-1</sup> )	5.22	Versanate titration method (Jackson, 1973)[8]
Exchangeable Magnesium (c mol (p <sup>+</sup> ) kg <sup>-1</sup> )	3.21	
Available S (mg kg <sup>-1</sup> )	14.35	Page <i>et al.</i> (1982)[18]
DTPA Fe (mg kg <sup>-1</sup> )	9.43	Page <i>et al.</i> (1982)[18]
DTPA Zn (mg kg <sup>-1</sup> )	6.12	
DTPA Mn (mg kg <sup>-1</sup> )	0.41	
DTPA Cu (mg kg <sup>-1</sup> )	0.38	

### 3. Results and discussion

#### 3.1 Total Primary nutrient uptake(kg ha<sup>-1</sup>) by Mangalore cucumber

##### 3.1.1 Nitrogen uptake

The perusal of the data revealed that significant variation in total nitrogen uptake by Mangalore cucumber (Table 2 and Fig. 1).

Foliar application of Ca, Fe and Zn fortified HA @ 0.25 % along with PoP (T<sub>7</sub>) recorded significantly higher total nitrogen uptake of 53.89 kg ha<sup>-1</sup> and it was superior over T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, T<sub>8</sub>, T<sub>9</sub>, T<sub>10</sub>, T<sub>11</sub>, T<sub>12</sub>, T<sub>13</sub>, T<sub>14</sub> and T<sub>15</sub> but statistically on par with T<sub>4</sub> (48.59 kg ha<sup>-1</sup>), T<sub>5</sub> (47.20 kg ha<sup>-1</sup>) and T<sub>6</sub> (50.28 kg ha<sup>-1</sup>) treatments and lower total nitrogen uptake of 9.75 kg ha<sup>-1</sup> has been noticed in absolute control (T<sub>1</sub>).

##### 3.1.2 Phosphorus uptake

The data indicated that (Table 2 and Fig. 1) higher total phosphorus uptake of 17.59 kg ha<sup>-1</sup> by Mangalore cucumber has been noticed in the treatment T<sub>7</sub> (foliar application of Ca, Fe and Zn fortified HA @ 0.25 % along with PoP), And it was significant with rest of the treatments except T<sub>4</sub> (16.38 kg ha<sup>-1</sup>), T<sub>5</sub> (15.96 kg ha<sup>-1</sup>) and T<sub>6</sub> (16.84 kg ha<sup>-1</sup>) treatments. Control (T<sub>1</sub>) recorded significantly lower phosphorus uptake of 4.38 kg ha<sup>-1</sup>.

##### 3.1.3 Potassium uptake

The potassium uptake by Mangalore showed significant variation due to treatments, as presented in Table 2 and Fig. 1.

The pooled analysis data indicated that significantly higher potassium uptake of 58.40 kg ha<sup>-1</sup> was recorded in the treatment T<sub>7</sub> with foliar application of Ca, Fe and Zn fortified HA @ 0.25 % with PoP and it was on par with T<sub>4</sub> (55.75 kg ha<sup>-1</sup>), T<sub>5</sub> (54.84 kg ha<sup>-1</sup>) and T<sub>6</sub> (56.84 kg ha<sup>-1</sup>) treatments and significant with rest of the treatments. Significantly lower potassium uptake of 9.41 kg ha<sup>-1</sup> was recorded in absolute control (T<sub>1</sub>).

**Table 2: Effect of Ca, Fe and Zn fortified humic acid on total uptake of nitrogen, phosphorus and potassium (kg ha<sup>-1</sup>) by Mangalore cucumber.**

Treatments		Total N uptake	Total P uptake	Total K uptake
T <sub>1</sub>	Absolute control	9.75	4.38	9.41
T <sub>2</sub>	Package of practice (POP)	26.28	9.95	35.00
T <sub>3</sub>	POP + unfortified HA foliar spray @ 0.25 %	34.04	12.00	42.39
T <sub>4</sub>	POP + Ca fortified HA foliar spray @ 0.25 %	48.59	16.38	55.75
T <sub>5</sub>	POP + Fe fortified HA foliar spray @ 0.25 %	47.20	15.96	54.84
T <sub>6</sub>	POP + Zn fortified HA foliar spray @ 0.25 %	50.28	16.84	56.84
T <sub>7</sub>	POP + Ca, Fe & Zn fortified HA foliar spray @ 0.25 %	53.89	17.59	58.40
T <sub>8</sub>	POP + Ca foliar spray @ 0.5 %	38.85	13.40	46.32
T <sub>9</sub>	POP + Ca foliar spray @ 0.5 %	37.05	12.76	44.91
T <sub>10</sub>	POP + Zn foliar spray @ 1.0 %	40.28	13.74	47.15
T <sub>11</sub>	POP + Ca, Fe & Zn foliar spray each @ 0.5 %	43.75	14.60	48.81
T <sub>12</sub>	POP + Soil application of Ca fortified HA @ 5 L ha <sup>-1</sup>	35.51	12.41	43.14
T <sub>13</sub>	POP + Soil application of Fe fortified HA @ 5 L ha <sup>-1</sup>	33.75	11.83	41.73
T <sub>14</sub>	POP + Soil application of Zn fortified HA @ 5 L ha <sup>-1</sup>	37.01	12.69	43.89
T <sub>15</sub>	POP + Soil application of Ca, Fe & Zn fortified HA @ 5 L ha <sup>-1</sup>	38.67	13.57	45.34
S.Em±		0.06	2.28	0.60
CD @ 5%		0.17	6.61	1.75

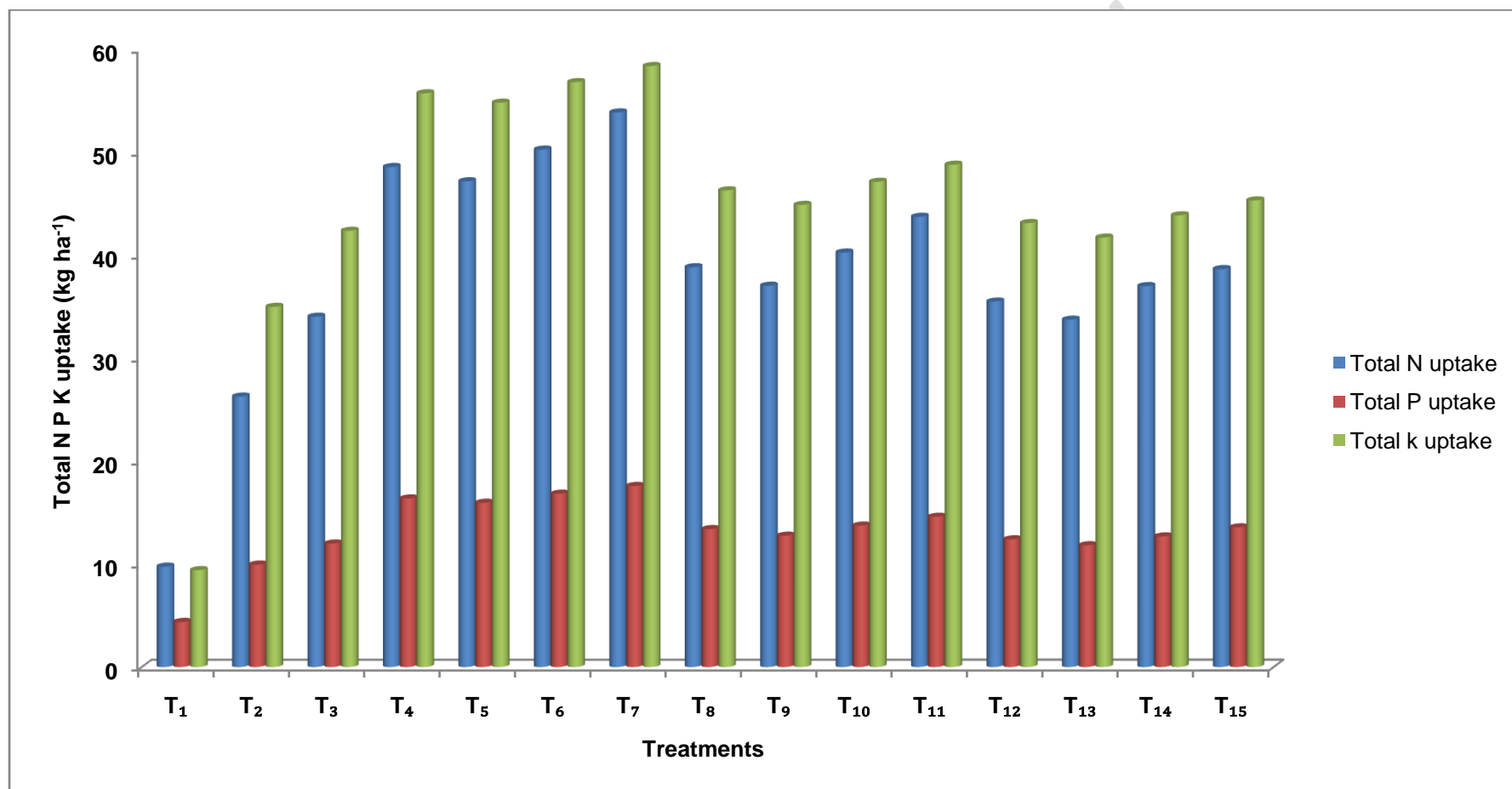


Fig. 1. Total uptake of primary nutrients by Mangalore cucumber as influenced by the application of Ca, Fe and Zn fortified humic acid

Fortification of essential minerals elements (Ca, Fe and Zn) with HA due to its established role as organic chelator results in increased availability of Ca, Fe and Zn elements to plants besides role of HA as biostimulant increased growth and vigour of plants *i.e.*, proliferation of root as well as shoot growth which increased the concentration of primary nutrient content in leaf, vine and fruit of Mangalore cucumber as well as uptake of these essential nutrients. Similar increase in the biomass yield and nutrient content consequently total uptake of nutrients by crops with the application of Zn fortified HA has been reported by Avinash [11] in capsicum, with combined application HA enriched with micro nutrients by Dhanasekaran and Bhuvaneswari [12] and Kazemi [13] in tomato, Ameta *et al.* [14] in cucumber, with Fe humate by Sharma *et al.* [15] in soybean, lettuce and chilli, with Zn humate by Manas *et al.* [16] in pepper, with K- humate in tomato by Rady [17].

### **3.2 NPK status of post harvest soil**

#### **3.2.1 Available Nitrogen**

The data (Table 3 and Fig. 2) on soil available N status after harvest indicated that the higher soil nitrogen was recorded in treatment T<sub>2</sub> (258.12 kg ha<sup>-1</sup>) which was significantly higher than T<sub>1</sub> (204.42 kg ha<sup>-1</sup>), T<sub>4</sub> (212.57 kg ha<sup>-1</sup>), T<sub>5</sub> (214.02 kg ha<sup>-1</sup>), T<sub>6</sub> (210.89 kg ha<sup>-1</sup>) and T<sub>7</sub> (207.48 kg ha<sup>-1</sup>) and it was on par with rest of the treatments.

#### **3.2.2 Available phosphorus**

The data revealed that soil phosphorus in the postharvest soil ranged from 27.27 to 64.57 kg ha<sup>-1</sup>. Significantly higher phosphorus content of 64.57 kg ha<sup>-1</sup> has been recorded in treatment which is supplied with PoP (T<sub>2</sub>) which is significantly higher than T<sub>1</sub> (27.27 kg ha<sup>-1</sup>), T<sub>4</sub> (50.91 kg ha<sup>-1</sup>), T<sub>5</sub> (53.45 kg ha<sup>-1</sup>), T<sub>6</sub> (50.24 kg ha<sup>-1</sup>), T<sub>7</sub> (49.87 kg ha<sup>-1</sup>) and it was on par with all the other treatments (Table 3 and Fig. 2).

#### **3.2.3 Available potassium**

The data of soil available potassium (Table 3 and Fig. 2) revealed that significantly higher potassium content in soil was recorded in T<sub>2</sub> treatment (284.06 kg ha<sup>-1</sup>) which was significantly higher compared to control (T<sub>1</sub>) (204.65 kg ha<sup>-1</sup>), T<sub>4</sub> (236.74 kg ha<sup>-1</sup>), T<sub>5</sub> (238.85 kg ha<sup>-1</sup>), T<sub>6</sub> (233.26 kg ha<sup>-1</sup>), T<sub>7</sub> (231.17 kg ha<sup>-1</sup>) and on par with remaining treatments.

**Table 3: Effect of Ca, Fe and Zn fortified humic acid on available nitrogen, phosphorus and potassium status(kg ha<sup>-1</sup>) of soil after harvest of Mangalore cucumber**

Treatments		Avail. N	Avail. P <sub>2</sub> O <sub>5</sub>	Avail. K <sub>2</sub> O
T <sub>1</sub>	Absolute control	204.42	27.27	204.65
T <sub>2</sub>	Package of practice (POP)	258.12	64.57	284.06
T <sub>3</sub>	POP + unfortified HA foliar spray @ 0.25 %	250.43	61.73	274.47
T <sub>4</sub>	POP + Ca fortified HA foliar spray @ 0.25 %	212.57	50.91	236.74
T <sub>5</sub>	POP + Fe fortified HA foliar spray @ 0.25 %	214.02	53.45	238.85
T <sub>6</sub>	POP + Zn fortified HA foliar spray @ 0.25 %	210.89	50.24	233.26
T <sub>7</sub>	POP + Ca, Fe & Zn fortified HA foliar spray @ 0.25 %	207.48	49.87	231.17
T <sub>8</sub>	POP + Ca foliar spray @ 0.5 %	242.80	58.69	268.47
T <sub>9</sub>	POP + Ca foliar spray @ 0.5 %	238.36	59.36	270.12
T <sub>10</sub>	POP + Zn foliar spray @ 1.0 %	235.89	57.38	265.41
T <sub>11</sub>	POP + Ca, Fe & Zn foliar spray each @ 0.5 %	230.31	56.96	260.12
T <sub>12</sub>	POP + Soil application of Ca fortified HA @ 5 L ha <sup>-1</sup>	245.55	61.12	272.46
T <sub>13</sub>	POP + Soil application of Fe fortified HA @ 5 L ha <sup>-1</sup>	251.28	62.97	275.46
T <sub>14</sub>	POP + Soil application of Zn fortified HA @ 5 L ha <sup>-1</sup>	242.14	60.74	271.85
T <sub>15</sub>	POP + Soil application of Ca, Fe & Zn fortified HA @ 5 L ha <sup>-1</sup>	237.06	59.09	269.24
S.E.m±		0.06	9.47	2.25
CD @ 5%		0.17	27.42	6.53



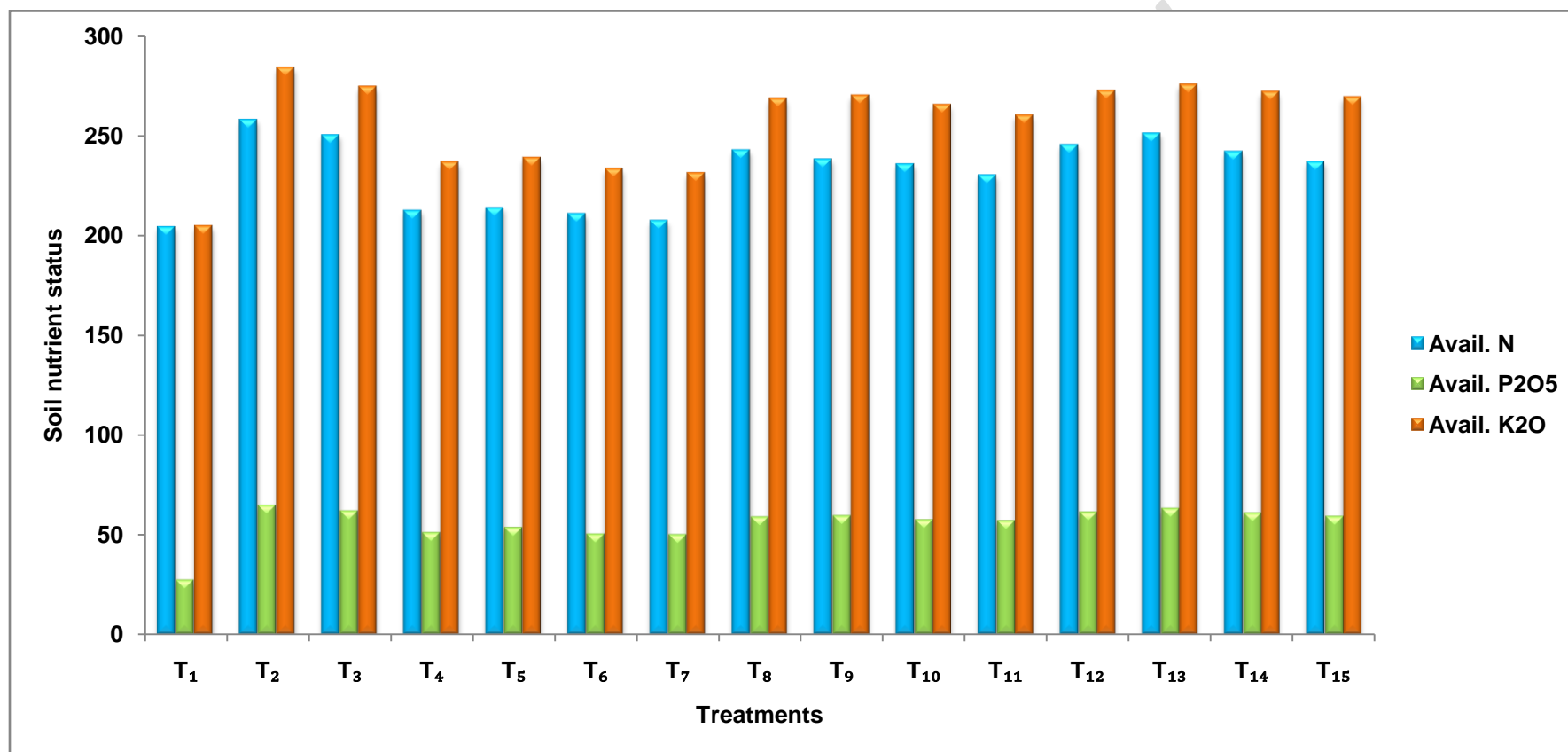


Fig. 2. Available N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O status of post harvest soil of Mangalore cucumber as influenced by the application of Ca, Fe and Zn fortified humic acid

The available nutrient status (NPK) after the harvest of Mangalore cucumber varied significantly, the higher available N P K status was noticed in the treatment (T<sub>2</sub>) which received RDF + FYM (25 t ha<sup>-1</sup>) than all biofortification treatments due to lesser uptake of essential nutrients due to lesser yield and the lower nutrient status was recorded in the treatment T<sub>7</sub> (foliar application of Ca, Fe and Zn (each @ 50 ppm) fortified HA @ 0.25 % + PoP) due higher uptake of essential nutrients due to higher yield.

## Conclusion

Fortification of essential minerals elements with HA results in increased availability of Ca, Fe and Zn for plants besides the role of HA as biostimulant which increased growth and vigour of plants which increased the concentration of primary nutrient content in leaf, vine and fruit of Mangalore cucumber as well uptake of these essential nutrients. Among different biofortified treatments foliar application of Ca, Fe and Zn fortified HA @ 0.25% (T<sub>7</sub>) resulted in significantly higher N P K content and uptake by Mangalore cucumber compared to PoP and absolute control due to which lower available N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O status in post harvest soil was noticed in the same treatment.

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