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# Effect of foliar application of humic acid on nutrient uptake and yield of chilli

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## Abstract
An experiment was carried out to study the "Effect of foliar application of humic acid on nutrient uptake and yield of chilli" during *kharif* 2020-21 at Research Farm, Chili and Vegetable Research Unit, Dr. Panjabrao Deshmukh Krishi Vidhyapeeth, Akola. The experiment had eight treatments replicated thrice in Randomized block design. The treatments included: $T_1$ -Absolute control, $T_2$ - 100% RDF (100:50:50 kg N, $P_2O_5$ and $K_2O$ ha$^{-1}$), $T_3$, $T_4$ & $T_5$ -100% RDF +3 spray of humic acid @ 0.5, 1.0 and 1.5% respectively, $T_6$, $T_7$ & $T_8$ -100% RDF +6 spray of humic acid @ 0.5, 1.0 and 1.5% respectively. Among all the treatments $T_8$ (100% RDF + 6 spray humic acid @ 1.5%) treatment was found most effective treatment and recorded significantly maximum yield and macro-nutrient content and uptake by chilli. However, micro nutrients uptake by chilli showed no significant change in response to humic acid treatment.

**Keywords:** Chilli, humic acid (HA), yield, nutrient uptake, nutrient content

## Introduction
Chilli (*Capsicum annum* L.) belongs to Solanaceae family, is famous for its pleasant aromatic flavour, pungency and high colouring substance. India is the largest producer, consumer and exporter of chilli, which contributes to about 40% of total world production. The origin of chilli is Central America. It has a wide range of diverse uses such as spice, sauce, vegetable and medicinal purposes. It is considered as an important source of nutrients, vitamin A and C as well as phenolic compounds, which are important antioxidants in human diet (Litoriya *et al*., 2014) [1]. The presence of crystalline volatile alkaloid capsaicin makes chilli pungent while red colour of chilli is due to presence of capsanthin (Sindhusha and Rawat, 2020) [2]. In Maharashtra, chilli is cultivated in an area of 0.30 lakh hectares with production of 3.42 lakh tonnes and productivity of 2124 kg per hectare (Anon., 2020) [3]. Humic substances are generated through organic matter decomposition and employed as soil fertilizers in order to improve soil structure and soil microorganisms. Humic acid application along with recommended dose of fertilizers and organic manures plays a greater role in plant biochemical and physiological activities and soil fertility, consequently resulting in better growth and yield of crops (Kalaichelvi *et al*., 2006) [4]. Humic substances with its auxin activity induce hormonal effect on catalytic activity, cell permeability and increases nutrient uptake and dry matter yield (Eshwar *et al*., 2017) [5]. Humic acids as carrier of nutrients have great scope through foliar application for sustainable crop production.

## Material and Methods
The experiment was carried out at Research farm, Chilli and Vegetable Research unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *kharif* season in 2020-21. The trial was laid out in Randomized Block Design with three replications. The experiment was framed with eight treatments *viz*, $T_1$ -Absolute control, $T_2$ - 100% RDF (100:50:50 kg N, $P_2O_5$ and $K_2O$ ha$^{-1}$), $T_3$, $T_4$ & $T_5$ -100% RDF +3 spray of HA @ 0.5, 1.0 and 1.5% respectively, $T_6$, $T_7$ & $T_8$ -100% RDF +6 spray of HA @ 0.5, 1.0 and 1.5% respectively were laid out in plots of 6.00 m x 3.60 m. The soil of the experimental field was slightly alkaline in reaction (pH 8.03), non-saline (0.30 dS m$^{-1}$), medium in organic carbon (6.5 g kg$^{-1}$), low in available N (184.54 kg ha$^{-1}$), moderately high in available $P_2O_5$ (22.42 kg ha$^{-1}$), high in available $K_2O$ (288.56 kg ha$^{-1}$) and deficient in available S (7.26 mg kg$^{-1}$). Among the micronutrients Zinc (0.65 mg kg$^{-1}$), Iron (4.79 mg kg$^{-1}$), Manganese (13.26 mg kg$^{-1}$) and Copper (1.64 mg kg$^{-1}$) are in sufficient range. Healthy seeds of PDKV Hirkani variety selected for sowing. Seedlings of chilli were transplanted to the plots with polythene mulch with 60 cm × 60 cm spacing. The desired plant

population was maintained uniformly by gap filling. Recommended fertilizer dose of 100:50:50 kg N, P and K $ha^{-1}$ were applied through urea, single super phosphate and murate of potash respectively as fertigation in 30 equal splits. Humic acid source used in experiment was prepared from vermicompost at Dr. PDKV soil science and agricultural chemistry laboratory. Spraying of HA with different concentrations include first spray at flowering, second spray at first fruit setting, third spray at 15 days after 1st picking, fourth spray at 15 days after 2nd picking, fifth spray at 15 days after 3rd picking, sixth spray at 15 days after 4th picking. Total yield per hectare was calculated based on the fruit yield per plot and was expressed in ton per ha. Randomly selected twenty fruits of each tagged plant and tagged plant of each treatment in each replication were dried and homogenized in a blender and portions of the homogenate were taken to determine the nutrient content by adopting standard methods. Nitrogen in the fruit and plant samples was determined by Kjeldhal digestion distillation method as described by Sparks (1996) [6]. Digestion of fruit and plant samples was carried out with di-acid mixture containing $HNO_3$ and $HClO_4$ in the ratio of 3:1 and further used for determination of Phosphorus (Jackson, 1973) [7], Potassium (Piper, 1966) [8], Sulphur (Chenshin and Yien, 1951) [9], DTPA extractable Fe, Zn, Mn and Cu (Lindsay and Norvell, 1978) [10]. The data obtained from the experiment were analyzed for analysis of variance (ANOVA) and the difference between treatment means was tested for their statistical significance with appropriate critical difference (CD) at 5% level of probability (Gomez and Gomez, 1984) [11].

## Result and Discussion

### Yield

Effect of humic acid application on chilli yield is given in Table 1 and Figure 1. Significantly maximum yield (267.10 q $ha^{-1}$) was recorded in treatment $T_8$ (100% RDF + 6 sprays of HA @ 1.5%) which was found statistically at par with treatment $T_7$, $T_6$, $T_5$ and $T_3$. While, significantly lowest yield recorded in $T_1$ (Absolute control) i.e. 245.12 q $ha^{-1}$. There were increment of 8.97% over absolute control ($T_1$) and 6.24% increase over RDF ($T_2$). The increase in yield might be due to positive effect of humic acid on availability of plant nutrients and balanced supply of nutrients, efficient translocation of photosynthates and availability of adequate amount of nutrients (Thakur *et al*., 2013) [12]. Similar findings were also reported by Thenmozhi *et al*. (2004) [13] in groundnut and Fathima and Denesh (2013) [14] in table grape.

**Table 1:** Effect of foliar application of humic acid on chilli yield

| Tr | Treatment Details | Yield (Q $ha^{-1}$) | % increase over control | % increase over RDF |
|---|---|---|---|---|
| $T_1$ | Absolute Control | 245.12 | | |
| $T_2$ | 100% RDF (100:50:50 kg N, $P_2O_5$ and $K_2O$ $ha^{-1}$) | 251.42 | 2.57 | |
| $T_3$ | 100% RDF + 3 spray of HA @ 0.5% | 258.33 | 5.39 | 2.75 |
| $T_4$ | 100% RDF + 3 spray of HA @ 1.0% | 260.90 | 6.44 | 3.77 |
| $T_5$ | 100% RDF + 3 spray of HA @ 1.5% | 261.43 | 6.66 | 3.98 |
| $T_6$ | 100% RDF + 6 spray of HA @ 0.5% | 265.10 | 8.15 | 5.44 |
| $T_7$ | 100% RDF + 6 spray of HA @ 1.0% | 266.87 | 8.87 | 6.15 |
| $T_8$ | 100% RDF + 6 spray of HA @ 1.5% | 267.10 | 8.97 | 6.24 |
| SE (m)± | | 4.41 | | |
| CD@ 5% | | 13.51 | | |

*RDF (Recommended doses of fertilizers), HA (Humic Acid)

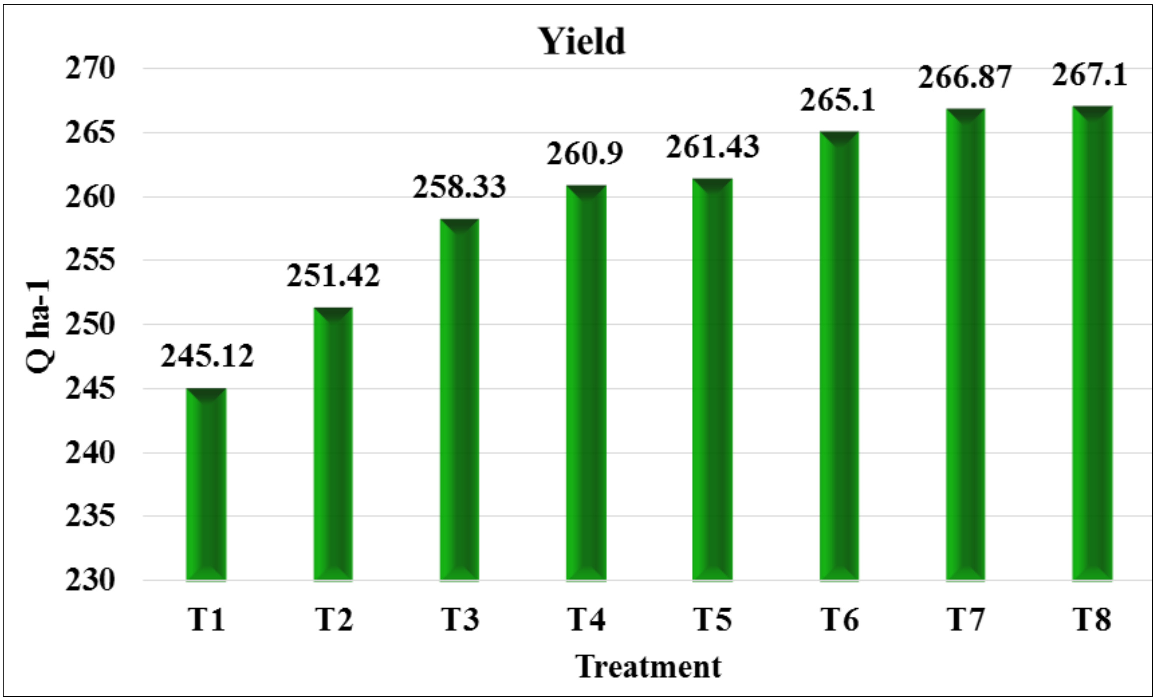


**Fig 1:** Effect of foliar application of humic acid on chilli yield

**Macro-nutrient content in chilli plant**

Effect of humic acid application on N, P, K and S content in chilli plant is given in Table 2 and Figure 2. Significantly highest total nitrogen content in chilli plant (0.53%) was recorded in treatment $T_8$ (100% RDF + 6 spray of HA @ 1.5%) which was found statistically at par with treatment $T_6$ and $T_7$. While, significantly lowest total nitrogen content in chilli plant (0.47%) recorded in $T_1$ (Absolute control). The increase in nitrogen content might be due to positive effect of humic acid on enhanced microbial activity particularly of ammonifiers and nitrifiers will consistently supply nitrogen resulting in improved dry matter accumulation and nutrient content (Savita *et al*., 2018) [15]. Similar findings were also reported by Sumati and Rao (2007) [16] in sunflower and Abd El-Razek *et al*. (2012) [17] in peach. Increasing doses of humic acid increased the total phosphorus content in chilli plant; however, these increases were not significant statistically. The highest total phosphorus content in chilli plant (0.22%) was recorded in treatment $T_8$ (100% RDF + 6 spray of HA @ 1.5%). While, lowest total phosphorus content in chilli plant (0.16%) was recorded in $T_1$ (Absolute control). The increase in total phosphorus content might be due to positive effect of humic acid on availability of plant nutrients due to the better developed root systems and increase nutrient content (Maibodi *et al*., 2015) [18]. Similar findings were also reported by Karakurt *et al*. (2009) [19] in pepper and Raheem *et al*. (2018) [20] in lettuce. Significantly highest total potassium content in chilli plant (0.58%) was recorded in treatment $T_7$ (100% RDF + 6 spray of HA @ 1.0%) and $T_8$ (100% RDF + 6 spray of HA at 1.5%). While, significantly lowest potassium content in chilli plant (0.46%) was recorded in $T_1$ (Absolute control). The increase in total potassium content might be due to the application of humic acid which enhances cell permeability, which in turn made for a rapid entry of minerals into root cells and also resulted in higher plant nutrient content and uptake (Osman *et al*., 2013) [21]. Similar findings were also reported by Shah *et al*. (2016) [22] in potato and El-Nemr *et al*. (2012) [23] in cucumber. Significantly highest total sulphur content in chilli plant (0.19%) was recorded in treatment $T_8$ (100% RDF + 6 spray of HA @ 1.5%) which was found statistically at par with treatment $T_5$, $T_6$ and $T_7$. While, significantly lowest total sulphur content in chilli plant (0.11%) was recorded in $T_1$ (Absolute control). Application of humic acids significantly increased sulphur content of shoot and root because it affects the permeability of shoot and root (Cimrin *et al*., 2010) [24]. Similar finding was also reported by Liu *et al*. (1998) [25] in bent grass.

**Macro-nutrient content in chilli fruit:** Effect of humic acid application on N, P, K and S content in chilli fruit is given in Table 2 and Figure 3. Significantly highest total nitrogen content in chilli fruit (1.03%) was recorded in treatment $T_8$ (100% RDF + 6 spray of HA @ 1.5%) which was found statistically at par with treatment $T_7$ (100% RDF+ 6 spray of HA at 1.0%). While, significantly lowest total nitrogen content in chilli fruit (0.93%) was recorded in $T_1$ (Absolute control). The enhancing effect of humic acid on nitrogen concentrations may be due to better development root systems (David *et al*., 1994) [26], increased permeability of plant membranes (Ulukan, 2008) [27]. Similar findings were also reported by Khaled and Fawy (2011) [28] and Shafeek *et al*. (2016) [29] in cucumber. Significantly highest total phosphorus content in chilli fruit (0.43%) was recorded in treatment $T_8$ (100% RDF + 6 spray of HA @ 1.5%) which was found statistically at par with treatment $T_6$ (100% RDF + 6 spray of HA @ 0.5%) and $T_7$ (100% RDF + 6 sprays of humic acid @ 1.0%). While, significantly lowest total phosphorus content in chilli fruit (0.24%) was recorded in $T_1$ (Absolute control). The increase in phosphorus content may be attributed to the improving role of humic acid on auxin content; in which auxin are involved in the chelating of iron for the plant, improving growth, heaving nutrient intensity of the plant, especially the development of the root system of the plant (Rizk and Mashhour, 2008) [30]. Similar findings were also reported by Fawzy (2010) [31] in lettuce and Nikbakht *et al*. (2008) [32] in gerbera. Significantly highest total potassium content in chilli fruit (1.18%) was recorded in treatment $T_7$ (100% RDF + 6 spray of HA @ 1.0%) and $T_8$ (100% RDF + 6 spray of HA @ 1.5%) which was found statistically at par with treatment $T_5$ (100% RDF + 3 spray of HA @ 1.5%) and $T_6$ (100% RDF + 6 spray of HA @ 0.5%). While, significantly lowest total potassium content in chilli fruit (1.10%) was recorded in $T_1$ (Absolute control). This increase may be due to humic substances may interact with the phospholipid structures of the cell membranes and react as carriers of nutrients through them and increase nutrient content (Khaled and Fawy, 2011) [28]. Similar findings were also reported by Aghaeifard *et al*. (2016) [33] in strawberry and El-Nemr *et al*. (2012) [23] in cucumber. Significantly highest total sulphur content in chilli fruit (0.24%) was recorded in treatment $T_8$ (100% RDF + 6 spray of HA @ 1.5%) which was found statistically at par with treatment $T_7$ (100% RDF+ 6 spray of HA at 1.0%). While, significantly lowest total sulphur content in chilli fruit (0.17%) was recorded in $T_1$ (Absolute control). Increase in sulphur content might be due to positive effect of humic acid on increase in plant growth processes within the leaves and stem leads to increase in the availability of nutrients Liu *et al*. (1998) [25]. Similar finding was also reported by Cimrin *et al*. (2010) [24] in pepper.

**Table 2:** Effect of foliar application of humic acid on N, P, K and S content in chilli plant and chilli fruit

| Tr | Treatments | Macro-nutrient content in chilli plant (%) | | | | Macro-nutrient content in chilli fruit (%) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | P | K | S | N | P | K | S |
| $T_1$ | Absolute Control | 0.47 | 0.16 | 0.46 | 0.11 | 0.93 | 0.24 | 1.10 | 0.17 |
| $T_2$ | 100% RDF (100:50:50 kg N, $P_2O_5$ and $K_2O$ $ha^{-1}$) | 0.48 | 0.17 | 0.53 | 0.13 | 0.96 | 0.28 | 1.11 | 0.18 |
| $T_3$ | 100% RDF +3spray of HA @ 0.5% | 0.49 | 0.18 | 0.54 | 0.15 | 0.97 | 0.31 | 1.13 | 0.19 |
| $T_4$ | 100% RDF +3spray of HA @ 1.0% | 0.50 | 0.19 | 0.55 | 0.16 | 0.98 | 0.36 | 1.14 | 0.20 |
| $T_5$ | 100% RDF +3 Spray of HA @ 1.5% | 0.50 | 0.20 | 0.56 | 0.17 | 0.99 | 0.37 | 1.16 | 0.21 |
| $T_6$ | 100% RDF +6 spray of HA @ 0.5% | 0.51 | 0.21 | 0.56 | 0.18 | 0.99 | 0.40 | 1.17 | 0.22 |
| $T_7$ | 100% RDF +6 spray of HA @ 1.0% | 0.52 | 0.21 | 0.58 | 0.18 | 1.02 | 0.42 | 1.18 | 0.23 |
| $T_8$ | 100% RDF +6 spray of HA @ 1.5% | 0.53 | 0.22 | 0.58 | 0.19 | 1.03 | 0.43 | 1.18 | 0.24 |
| SE (m) ± | | 0.007 | 0.01 | 0.007 | 0.008 | 0.007 | 0.005 | 0.016 | 0.007 |
| CD@ 5% | | 0.022 | NS | 0.020 | 0.022 | 0.022 | 0.017 | 0.04 | 0.022 |

*RDF (Recommended doses of fertilizers), HA (Humic Acid), NS (Not Significant)

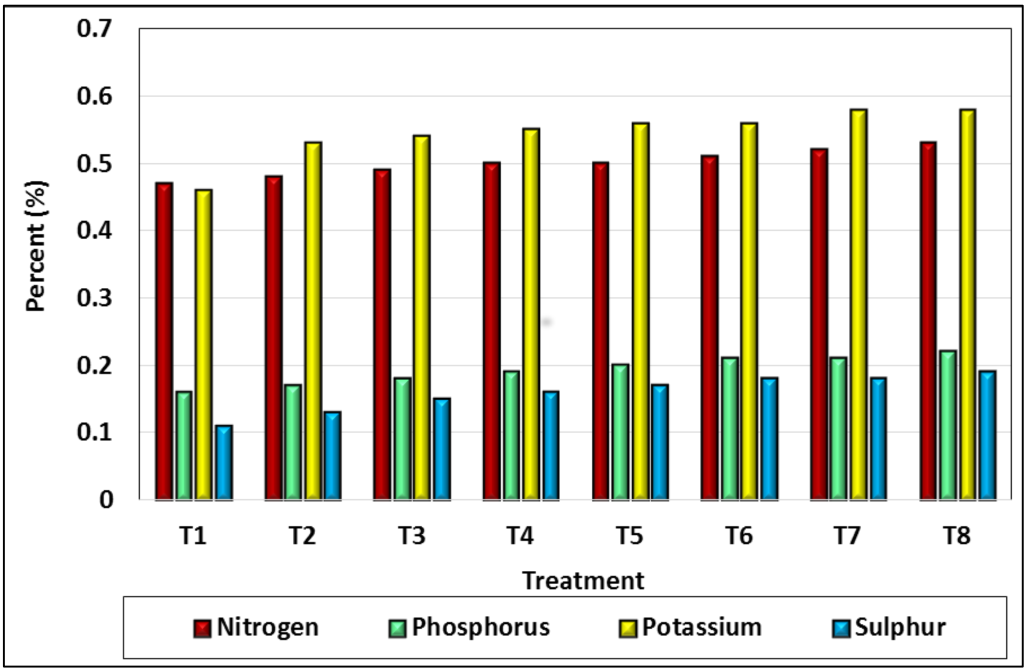


**Fig 2:** Effect of foliar application of humic acid on N, P, K and S content in chilli plant

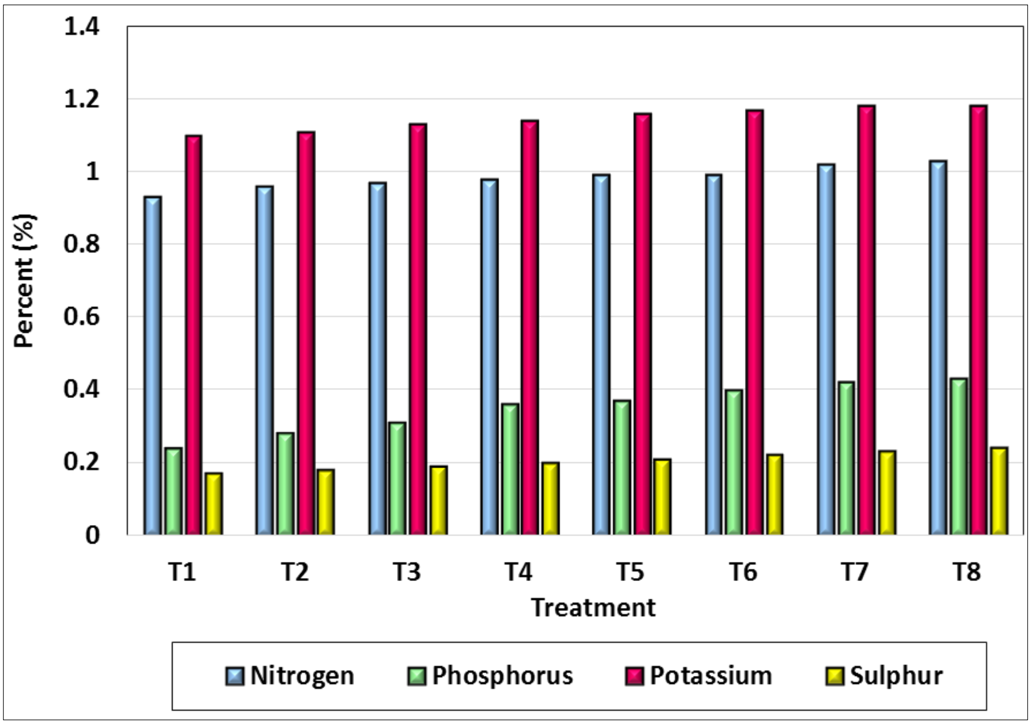


**Fig 3:** Effect of foliar application of humic acid on N, P, K and S content in chilli fruit

**Macro-nutrient uptake by chilli plant**

Effects of humic acid application on uptake of N, P, K and S by chilli plant is given in Table 3 and Figure 4. Significantly highest uptake of nitrogen (29.20 kg $ha^{-1}$) was recorded in treatment $T_8$ (100% RDF + 6 spray of HA @ 1.5%). While, significantly lowest uptake of nitrogen (23.31 kg $ha^{-1)}$ was recorded in $T_1$ (Absolute control). Bhandari *et al*. (2000) [34] stated that the higher nitrogen uptake due to the application of humic acids might be due to increased lateral root emergence and production of smaller but more ramified secondary roots coupled with improved cell permeability and better availability of nutrients in the soil solution Similar finding were also reported by Afifi *et al*. (2010) [35] in faba bean and (2010) Bama (2009) [36] rice. Significantly highest phosphorus uptake (11.44 kg $ha^{-1}$) was recorded in the treatment $T_6$ (100% RDF + 6 spray of HA @ 0.5%) which was found statistically at par with the all treatments except $T_1$. While, significantly lowest uptake of phosphorus (8.42 kg $ha^{-1}$) was recorded in $T_1$ (Absolute control). Guppy *et al*. (2005) [37] stated that the humic acid likely increases P availability and uptake by decreasing calcium phosphate (Ca-P) precipitation rates, competing for adsorption sites and decreasing the number of adsorption sites by promoting dissolution of metal present on solid phases by chelation. Similar findings were also reported by Shreelatha *et al*. (2020) [38] in chickpea and Rizk and Mashhour (2008) [30] in wheat and broad bean. Significantly highest potassium uptake (32.13 kg ha$^{-1}$) was recorded in treatment $T_8$ (100% RDF + 6 spray of HA @ 1.5%) which was found statistically at par with the treatment $T_5$, $T_6$ and $T_7$. While, significantly lowest uptake of potassium (23.09 kg ha$^{-1}$) was reported in $T_1$ (Absolute control). Increase in K content and uptake may be due to the reduced K fixation increased the permeability of bio-membranes for electrolytes with the addition of humic acid and thereby accounted for increased K uptake (Shreelatha *et al*., 2020) [38]. Similar findings were also reported by Taha *et al*. (2016) [39] in lettuce, Ameri and Tehranifar (2012) [40]. Significantly highest sulphur uptake (10.48 kg ha$^{-1}$) was recorded in treatment $T_8$ (100% RDF + 6 spray of HA @ 1.5%) which was found statistically at par with the treatments $T_5$, $T_6$ and $T_7$. While, significantly lowest uptake of sulphur (5.46 kg ha$^{-1}$) was recorded in $T_1$ (Absolute control). Ehsan *et al*. (2014) [41] concluded that the humic acid enhances cell permeability, which in turn made for rapid entry of minerals in leave cells and so resulted in higher uptake of plant nutrients. This effect was associated with the function of hydroxyls and carboxyls in these compounds.

**Table 3:** Effect of foliar application of humic acid on macro-nutrient uptake by chilli plant

| Tr | Treatment Details | Dry matter weight (kg ha$^{-1}$) | Macro-nutrient uptake (kg ha$^{-1}$) | | | |
|---|---|---|---|---|---|---|
| | | | N | P | K | S |
| $T_1$ | Absolute Control | 4952 | 23.31 | 8.42 | 23.09 | 5.46 |
| $T_2$ | 100% RDF (100:50:50 kg N, $P_2O_5$ and $K_2O$ ha$^{-1}$) | 5152 | 24.73 | 9.28 | 27.12 | 6.17 |
| $T_3$ | 100% RDF +3 spray of HA @ 0.5% | 5230 | 25.64 | 9.81 | 28.06 | 6.99 |
| $T_4$ | 100% RDF +3spray of HA @ 1.0% | 5305 | 26.52 | 10.29 | 29.01 | 8.14 |
| $T_5$ | 100% RDF +3 spray of HA @ 1.5% | 5409 | 27.05 | 11.00 | 30.29 | 9.37 |
| $T_6$ | 100% RDF +6 spray of HA @ 0.5% | 5455 | 27.63 | 11.44 | 30.38 | 9.26 |
| $T_7$ | 100% RDF +6 spray of HA @ 1.0% | 5481 | 28.66 | 10.94 | 31.56 | 10.03 |
| $T_8$ | 100% RDF +6 spray of HA @ 1.5% | 5512 | 29.20 | 11.40 | 32.13 | 10.48 |
| SE (m) ± | | 148.29 | 0.005 | 0.83 | 0.64 | 0.43 |
| CD@ 5% | | 445.73 | 0.017 | 2.53 | 1.95 | 1.30 |

*RDF (Recommended doses of fertilizers), HA (Humic Acid)

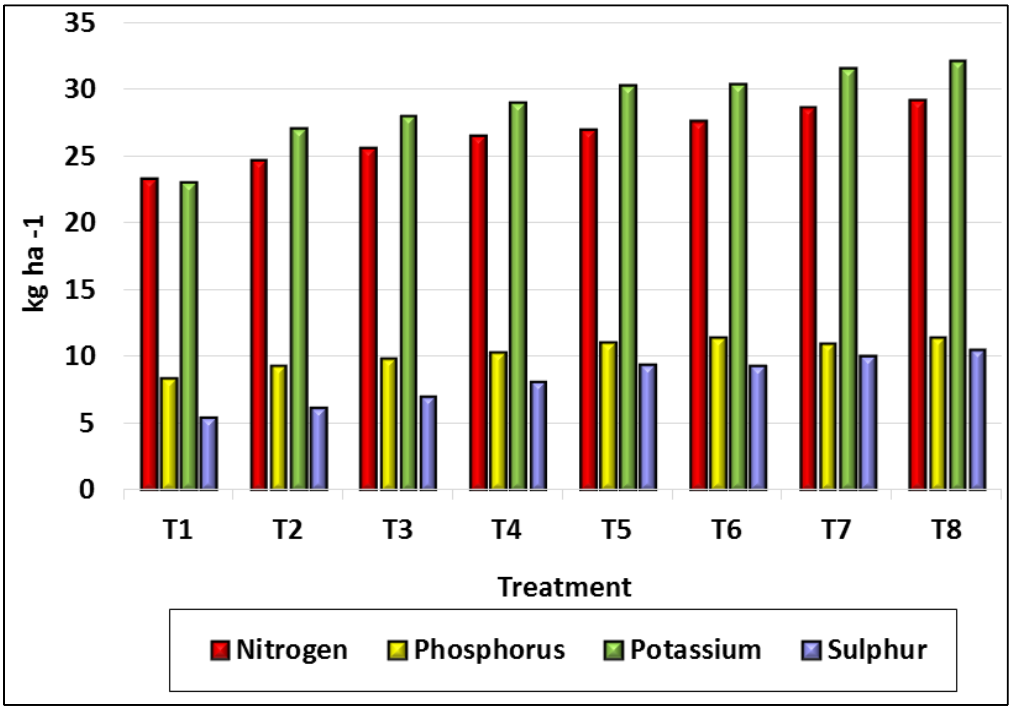


**Fig 4:** Effect of foliar application of humic acid on macro-nutrient uptake by chilli plant

**Micro-nutrient uptake by chilli plant**

Effect of humic acid application on Zn, Fe, Mn and Cu uptake by chilli plant is given in Table 4. Data revealed that the uptake of zinc by chilli plant were ranged from 21.38 to 22.81 mg kg$^{-1}$. Increasing doses of humic acid increased the uptake of zinc in chilli plant; however, these increases were not significant statistically. The highest uptake of zinc (22.81 mg kg$^{-1}$) was recorded in treatment $T_6$ (100% RDF + 6 spray of HA @ 0.5%). While, lowest uptake of zinc (21.38 mg kg$^{-1}$) was recorded in $T_1$ (Absolute control). Data revealed that the uptake of iron by chilli plant were ranged from 125.88 to 128.20 mg kg$^{-1}$. Increasing doses of humic acid increased the uptake of iron in chilli plant; however, these increases were not significant statistically. The highest uptake of iron (128.20 mg kg$^{-1}$) was recorded in treatment $T_8$ (100% RDF + 6 spray of HA @ 1.5%). While, lowest uptake of iron (125.88 mg kg$^{-1}$) was recorded in $T_1$ (Absolute control). Data revealed that the uptake of manganese by chilli plant were ranged from 13.03 to 13.98 mg kg$^{-1}$. Increasing doses of humic acid increased the uptake of manganese in chilli plant; however, these increases were not significant statistically. The highest uptake of manganese (13.98 mg kg$^{-1}$) was recorded in treatment $T_8$ (100% RDF + 6 spray of HA @ 1.5%). While, lowest uptake of manganese (13.03 mg kg$^{-1}$) was recorded in

$T_1$ (Absolute control). Data revealed that the uptake of copper by chilli plant were ranged from 6.64 to 6.91 mg $kg^{-1}$. Increasing doses of humic acid increased the uptake of copper in chilli plant; however, these increases were not significant statistically. The highest uptake of copper (6.91 mg $kg^{-1}$) was recorded in treatment $T_8$ (100% RDF + 6 spray of HA @ 1.5%). While, lowest uptake of copper (6.64 mg $kg^{-1}$) was recorded in $T_1$ (Absolute control).

**Micro-nutrient uptake by chilli fruit**

Effect of humic acid application on Zn, Fe, Mn and Cu uptake by chilli fruit are given in Table 4. Data revealed that the uptake of zinc by chilli fruit were ranged from 33.38 to 34.81 mg $kg^{-1}$. Increasing doses of humic acid increased the uptake of zinc in chilli fruit; however, these increases were not significant statistically. The highest uptake of zinc (34.81 mg $kg^{-1}$) was recorded in treatment $T_6$ (100% RDF + 6 spray of HA @ 0.5%). While, lowest uptake of zinc (33.38 mg $kg^{-1}$) was recorded in $T_1$ (Absolute control). Data revealed that the uptake of iron by chilli fruit were ranged from 149.88 to 152.20 mg $kg^{-1}$. Increasing doses of humic acid increased the uptake of iron in chilli fruit; however, these increases were not significant statistically. The highest uptake of iron (152.20 mg $kg^{-1}$) was recorded in treatment $T_8$ (100% RDF + 6 spray of HA @ 1.5%). While, lowest uptake of iron (149.88 mg $kg^{-1}$) was recorded in $T_1$ (Absolute control). Data revealed that the uptake of manganese by chilli fruit were ranged from 27.03 to 27.98 mg $kg^{-1}$. Increasing doses of humic acid increased the uptake of manganese in chilli fruit; however, these increases were not significant statistically. The highest uptake of manganese (27.98 mg $kg^{-1}$) was recorded in treatment $T_8$ (100% RDF + 6 spray of HA @ 1.5%). While, lowest uptake of manganese (27.03 mg $kg^{-1}$) was recorded in $T_1$ (Absolute control). Data revealed that the uptake of copper by chilli fruit were ranged from 15.64 to 15.91 mg $kg^{-1}$. Increasing doses of humic acid increased the uptake of copper in chilli fruit; however, these increases were not significant statistically. The highest uptake of copper (15.91 mg $kg^{-1}$) was recorded in treatment $T_8$ (100% RDF + 6 spray of HA @ 1.5%). While, lowest uptake of copper (15.64 mg $kg^{-1}$) was recorded in $T_1$ (Absolute control).

**Table 4:** Effect of foliar application of humic acid on micro nutrient uptake by chilli plant and chilli fruit

| Tr | Treatments | Micro nutrient uptake by chilli plant (mg $kg^{-1}$) | | | | Micro nutrient uptake by chilli fruit (mg $kg^{-1}$) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Zn | Fe | Mn | Cu | Zn | Fe | Mn | Cu |
| $T_1$ | Absolute Control | 21.38 | 125.88 | 13.03 | 6.64 | 33.38 | 149.88 | 27.03 | 15.64 |
| $T_2$ | 100% RDF (100:50:50 kg N, $P_2O_5$ and $K_2O$ $ha^{-1}$) | 21.43 | 126.13 | 13.15 | 6.69 | 33.43 | 150.32 | 27.47 | 15.70 |
| $T_3$ | 100% RDF +3spray of HA @ 0.5% | 22.08 | 126.29 | 13.67 | 6.67 | 34.08 | 150.04 | 27.67 | 15.67 |
| $T_4$ | 100% RDF +3spray of HA @ 1.0% | 22.16 | 126.21 | 13.89 | 6.86 | 34.16 | 150.21 | 27.89 | 15.86 |
| $T_5$ | 100% RDF +3 Spray of HA @ 1.5% | 22.33 | 127.44 | 13.91 | 6.87 | 34.33 | 151.44 | 27.91 | 15.88 |
| $T_6$ | 100% RDF +6 spray of HA @ 0.5% | 22.81 | 127.15 | 13.93 | 6.90 | 34.81 | 151.15 | 27.93 | 15.90 |
| $T_7$ | 100% RDF +6 spray of HA @ 1.0% | 22.48 | 127.67 | 13.95 | 6.90 | 34.48 | 151.67 | 27.95 | 15.90 |
| $T_8$ | 100% RDF +6 spray of HA @ 1.5% | 22.58 | 128.2 | 13.98 | 6.91 | 34.58 | 152.20 | 27.98 | 15.91 |
| SE (m) ± | | 0.321 | 0.321 | 0.711 | 0.262 | 0.321 | 0.577 | 0.255 | 0.136 |
| CD@ 5% | | NS | NS | NS | NS | NS | NS | NS | NS |

*RDF (Recommended doses of fertilizers), HA (Humic Acid), NS (Not Significant)

**Conclusion**

Based on the findings of the above investigation it may be concluded that foliar application of 6 spray humic acid @ 1.5% with 100% RDF was found beneficial and enhanced the yield, macro-nutrient content and uptake of chilli under climatic conditions of Akola.

**References**


1. Litoriya NS, Gandhi K, Talati JG. Nutritional composition of different chilli (*Capsicum annuum* L.) varieties. Indian Journal of Agricultural Biochemistry. 2014;27(1):91-92.
2. Sindhusha P, Rawat M. Genetic variability and inter-relationship studies among growth, yield and quality parameters in Chilli (*Capsicum annuum* L.). Journal of Pharmacognosy and Phytochemistry. 2020;9(6):1526-1530.
3. Anonymous. Horticultural Statistics at a glance, Ministry of Agriculture and farmers' welfare, GOI, 2020.
4. Kalaichelvi K, Chinnusamy C, Swaminathan AA. Exploiting the natural resource-lignite humic acid in agriculture - A review. Agricultural Reviews. 2006;27(4):276-283.
5. Eshwar M, Srilatha M, Rekha KB, Sharma SHK. Effect of humic substances (humic, fulvic acid) and chemical fertilizers on nutrient uptake, dry matter production of aerobic rice (*Oryza sativa* L.). Journal of Pharmacognosy and Phytochemistry. 2017;6(5):1063-1066.
6. Sparks DL. Methods of Soil Analysis, 3-chemical methods, SSSA Book Series No.5, SSSA and ASA, Madison, USA, 1996, 921-960.
7. Jackson ML. Soil Chemical Analysis. Prentice Hall of India private Limited, New Delhi, 1973, 69-182.
8. Piper CS. Soil and plant Analysis. Asian, Hans, Bombay. 1966, 368-374.
9. Chesnin L, Yien CH. Turbidimetric determination of available sulphur. Proceedings of Soil Science Society of America. 1951;15:149-151.
10. Lindsay WL, Norvell WA. Development of DTPA soil test for zinc, iron, manganese and copper. Soil science society of American Journal. 1978;42:421-428.
11. Gomez KA, Gomez AA. Statistical Procedures for Agricultural Research.2, John Wiley and Sons, New York, 1984.
12. Thakur H, Rekha KB, Babu SSN, Padmaja G. Effect of humic substances on growth and yield of sunflower (*Helianthus annuus* L.). Journal of Research ANGRAU. 2013;41(4):106-108.
13. Thenmozhi S, Natarajan S, Selvakumari G. Effect of humic acid on growth and yield parameters of groundnut (var. VRI 2). Crop Research. 2004;27(2):210-213.
14. Fathima PS, Denesh GR. Influence of humic acid spray

on growth and yield of chilli (*Capsicum annum* L.). International journal of Agricultural Sciences. 2013;9(2):542-546.
15. Savita SP, Girijesh GK, Dinesh KM, Adivappar N. Effect of humic substances on nutrient uptake and yield of soyabean. International Journal of Chemical Studies. 2018;6(4):1565-1569.
16. Sumathi V, Rao DS. Effect of organic sources of nitrogen with different irrigation schedules on growth and yield of sunflower. Indian Journal of Agronomy. 2007;52(1)-77-79.
17. Abd El-Razek E, Abd-Allah ASE, Saleh MMS. Yield and fruit quality of Florida prince peach trees as affected by foliar and soil application of humic acid. Journal of Applied Sciences Research. 2012;8(12):5724-5729.
18. Maibodi NDH, Kafi M, Nikbakht A, Rejali F. Effect of foliar applications of humic acid on growth, visual quality, nutrients content and root parameters of perennial ryegrass (*Lolium perenne* L.). Journal of Plant Nutrition. 2015;38:224-236.
19. Karakurt Y, Unlu H, Padem H. The influence of foliar and soil fertilization of humic acid on yield and quality of pepper. Acta Agric. Scand. Sec. B Soil plant Sci. 2009;59:233-237.
20. Raheem SM, Al-Jaf HI, Tofiq GK. Influence of foliar and soil application of humic acid on growth and yield of lettuce. Euphrates Journal of Agriculture Science. 2018;10(2):199-204.
21. Osman EAM, El-Masry AA, Khatab KA. Effect of nitrogen fertilizer sources and foliar spray of humic and/or fulvic acids on yield and quality of rice plants. Advances in Applied Science Research. 2013;4(4):174-183.
22. Shah SA, Mohammad W, Shahzadi S, Elahi R, Ali A, Basir A *et al*. The effect of foliar application of urea, humic acid and micronutrients on potato crop. Iran Agricultural Research. 2016;35(1):89-94.
23. El-Nemr MA, El-Desuki M, El-Bassiony AM, Fawzy ZF. Response of growth and yield of cucumber plants (*Cucumis sativus* L.) to different foliar applications of humic acid and Bio-stimulators. Australian Journal of Basic and Applied Sciences. 2012;6(3): 630-637.
24. Cimrin MK, Turkmen O, Turan M, Tuncer B. Phosphorus and humic acid application alleviate salinity stress of pepper seedlings. African Journal of Biotechnology. 2010;9(36):5845-5851.
25. Liu C, Copper RJ, Bowman DC. Humic acid application affects photosynthesis, root development and nutrient content of creeping bent grass. Horticulture Science. 1998;33(6):1023-1025.
26. David PP, Nelson PV, Sanders DC. Humic acid improves growth of tomato seedlings in solution culture. Journal of Plant Nutrition. 1994;17:173-184.
27. Ulukan H. Effect of soil applied humic acid at different sowing times on some yield components in wheat (*Triticum spp*.) hybrids. International Journal of Botany. 2008;4(2):164-175.
28. Khaled H, Fawy HA. Effect of different levels of humic acids on the nutrient content, plant growth, and soil properties under conditions of salinity. Soil and Water Research. 2011;6(1):21-29.
29. Shafeek MR, Helmy YI, Omar NM. Effect of spraying or ground drench from humic acid on growth, total output and fruits nutritional values of cucumber (*Cucumber sativus* L.) grown under plastic house conditions. International Journal of Pharm Tech Research. 2016;9(12):52-57.
30. Rizk AH, Mashhour AMA. Effect of foliar application with potassium humate on growth and uptake of some nutrients by wheat and broad bean plants. Egypt Journal of soil science. 2008;48(4):457-465.
31. Fawzy ZF. Increasing productivity of lead lettuce by foliar spraying of some bio and organic compounds. Egypt Journal of Applied Sciences. 2010;38(1):237-247.
32. Nikbakht A, Kafi M, Babalar M, Xia YP, Luo A, Etemadi NA. Effect of humic acid on plant growth, nutrient uptake and postharvest life of gerbera. Journal of Plant Nutrition. 2008;31:2155-2167.
33. Aghaeifard F, Babalar M, Fallahi E, Ahmadi, A. Influence of humic acid and salicylic acid on yield, fruit quality and leaf mineral elements of strawberry (Fragaria × ananassa Duch.) cv. Camarosa. Journal of Plant Nutrition. 2016;39(13):1821-1829.
34. Bhandari AL, Walia SS, Singh T. Effects of mineralization of organic N in FYM. New Agriculturalist. 2000, 231.
35. Afifi MHM, Mohamed MF, Shaaban SHA. Yield and nutrient uptake of some fababean varieties grown in newly cultivated soil as affected by foliar application of humic acid. Journal of plant production. 2010;1(1):77-85.
36. Bama KS. Foliar application of humic acid for rice yield and nutrition. Journal of Ecobiology. 2009;25(3):241-244.
37. Guppy CN, Menzies NW, Moody PW, Blamey FPC. Competitive sorption reactions between phosphorus and organic matter in soil: A review. Australian Journal of Soil Science. 2005;43:189-202.
38. Shreelatha, Bhat SN, Balanagoudar SR, Kmble AS, Rao S, Beladhadi RV. Response of chickpea to application of humic acid along with vermicompost on uptake of nutrients, yield attributes and yield. International Journal of Current Microbiology and Applied Sciences. 2020;9(1):2306-2312.
39. Taha AA, Omar MM, Ghazy MA. Effect of humic acid and fulvic acids on growth and yield of lettuce plant. Journal of Soil Sciences and Agricultural Engineering 2016;7(8):517-522.
40. Ameri A, Tehranifar A. Effect of humic acid on nutrient uptake and physiological characteristic *Fragaria ananassa* var: Camarosa. Journal of Biological and Environmental Sciences. 2012;6(16):77-79.
41. Ehsan S, Javed S, Saleem I, Habib F, Majeed T. Effect of humic acid foliar spraying and nitrogen fertilizers management on wheat yield. International Journal of Agronomy and Agricultural Research. 2014;4(4):28-33.