
**E-ISSN:** 2618-0618
**P-ISSN:** 2618-060X

NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; 8(10): 85-89
Received: 02-07-2025
Accepted: 08-08-2025

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# Response of Humic acid on soil properties and yield parameters of Chilli (*Capsicum annum* L.)

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**DOI:** https://www.doi.org/10.33545/2618060X.2025.v8.i10b.3956

**Abstract**
The present investigation entitled "Response of humic acid on soil properties and yield parameters of chilli (*Capsicum annum* L.)" was carried out at Horticulture Research Cum Instructional Farm, BTC College of Agriculture and Research Station, Bilaspur (C.G) during *rabi* season of 2024-25. The experiment was laid out in Completely Randomized Design with three replications. The treatments consisted of nine nutrient management practices *viz.*, control ($T_1$), 100% RDF (120:80:60 kg ha$^{-1}$) ($T_2$), 75% RDF ($T_3$), 75% RDF + 10 kg ha$^{-1}$ HA ($T_4$), 50% RDF + 10 kg ha$^{-1}$ HA ($T_5$), 75% RDF + 15 kg ha$^{-1}$ HA ($T_6$), 50% RDF + 15 kg ha$^{-1}$ HA ($T_7$), 75% RDF + 20 kg ha$^{-1}$ HA ($T_8$) and 50% RDF + 20 kg ha$^{-1}$ HA ($T_9$). The present study indicated that significantly highest fresh weight of fruit (419.09 g plant$^{-1}$) was recorded under the treatment ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA. This treatment was statistically at par with ($T_2$) 100% RDF (120:80:60 kg ha$^{-1}$), which was also comparable to ($T_9$) 50% RDF + 20 kg ha$^{-1}$ HA, ($T_6$) 75% RDF + 15 kg ha$^{-1}$ HA and ($T_7$) 50% RDF + 15 kg ha$^{-1}$ HA. The growth parameters like plant height, number of branches and yield parameters like fruit length (7.94 cm), fruit width (0.94 cm) and number of fruits (145.06 plant$^{-1}$) were recorded highest in the treatment ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA. While minimum under ($T_1$) control. Significantly the highest nitrogen content in fruit and Non-significant the highest nutrient content (P and K) in fruit and shoot was estimated under treatment ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA and significantly the maximum nutrient uptake by chilli fruit (0.95 N g plant$^{-1}$) (0.22 P g plant$^{-1}$) and (1.19 K g plant$^{-1}$) was estimated under ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA. The data showed that there were no significant differences in EC, pH, organic carbon, particle density, bulk density and porosity of soil status after harvest of crop. Data presented significantly highest water holding capacity and cation exchange capacity under ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA. Significantly the highest available N, $P_2O_5$ and $K_2O$ were recorded under ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA. Biological properties of soil *viz*., *Azatobactor*, PSB and KMB population significantly recorded highest under the treatment ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA. We can suggest that the soil application of humic acid @ 20 kg ha$^{-1}$ with 75% RDF is significantly give best results on growth and fruit yield of chilli.

**Keywords:** Chilli, humic acid, *Azatobactor*, organic carbon and yield

## Introduction
Soil health is a crucial factor for realizing higher yield of vegetables and spices. Chemical fertilizers recommended may not ensure soil health and sustainable productivity. It is the organic matter that distinguishes the soil from mass of rock particles and allows it to become a living system. Addition of organic matter liberates nutrients in a gradual and controlled way allowing greater production of vegetables with minor environmental impact. Arresting the decline of soil organic matter is the most potent weapon in fighting against unabated soil degradation and imperilled sustainability of agriculture. Organic matter consists of humic and non-humic substances. Non-humic substances include those with still recognizable chemical characteristics such as carbohydrates, proteins, peptides, waxes, resins, pigments and other low molecular weight organic substances. Humus represents 70 per cent of organic matter and humic acid represents 60 per cent of humus (Schnitzer, 2000) [21].
Humic acid plays a significant role in plant growth by influencing plant physiology and enhancing the physical, chemical and biological properties of soil (Vieira, 2017) [28]. It is known to increase the permeability of plant membranes, leading to higher metabolic activity within the plant. This results in more efficient nutrient uptake and overall plant growth.

In terms of improving soil properties, humic acid enhances soil structure, leading to better tilth, aeration and moisture retention. These physical improvements make the soil more conducive to plant growth by ensuring better root penetration and water availability. Chemically, humic acid contributes to soil fertility by increasing the cation exchange capacity (CEC) of the soil. This means that the soil can hold more essential nutrients, making them more available to plants. Additionally, humic acid serves a biological function by providing carbon as an energy source for nitrogen-fixing bacteria, which in turn enhances soil nitrogen levels, promoting healthy plant development. This combination of physical, chemical, and biological effects makes humic acid an essential additive for improving both soil quality and plant productivity (Sure, 2012) [26].

Chilli (*Capsicum annuum* L.), belonging to the Solanaceae family, has a diploid chromosome number of 2n = 2x = 24. It is believed to have originated in Mexico, while Guatemala and Bulgaria serve as secondary centers of origin. Introduced to India by the Portuguese in the 17$^{th}$ century, chilli has become integral to the country's culinary traditions. It is a versatile crop with a wide range of uses, including as a vegetable, spice, condiment, medicine, ornamental plant and culinary supplement. It is an essential component of Indian cuisine, valued for its pungency, flavor and aroma. Chilli fruits are a rich source of vitamins C, A and E, making them nutritionally beneficial. The alkaloid capsaicin, predominantly found in the placenta of the fruit, is the primary compound responsible for chilli's pungency. Capsaicin, chemically identified as N-[(4-hydroxy-3-methoxyphenyl) methyl]-8-methyl-E-6-nonenamide, accounts for over 90% of the total alkaloids present in the fruit. This compound offers numerous preventive and therapeutic benefits in allopathic and ayurvedic medicine (Khungar and Manoharan, 2000). In addition to vitamins, chillies contain small quantities of proteins, lipids, carbohydrates and minerals, making them a well-rounded nutritional source (Rady, 2011) [20]. They are also abundant in oleoresin, which is widely used in the pharmaceutical, food and beverage industries for producing value-added products. Natural color extracts derived from chillies, especially paprika varieties rich in capsanthin and capsorubin, are gaining popularity as substitutes for artificial food colorants. These natural colorants are particularly favored in industrialized countries for their use in culinary and food preparation applications. It is a tropical crop cultivated extensively worldwide, covering approximately 1.78 million hectares globally, with an annual production of about 7.18 million tons. India is the largest producer of chilli, followed by China, with 316.47 thousand hectares under cultivation and a total production of 3,633.99 thousand metric tons (Anonymous, 2022) [2]. Andhra Pradesh dominates chilli production and exports, contributing to 75% of India's chilli exports. The state produces 627,849 tons on 225,000 hectares of cultivated land (Anonymous, 2020) [1]. In Chhattisgarh, chilli production for 2024 is reported at 2.668 thousand tons, cultivated over an area of 8.09 lakh hectares (Anonymous, 2024) [3].

## Materials and Methods

During the *rabi* season of 2024-25, the experiment was carried out at the Horticulture Research Cum Instructional Farm, Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur (C.G.). The location of the Bilaspur district is latitude 22.09˚N and longitude 82.15˚E. This area is classified as India's Eastern Plateau and Hill Region (Agro-climatic zone VII). The state of Chhattisgarh is divided into three agro-climatic zones; Bilaspur is located in the state's plains zone. The experiment was laid out in Completely Randomized Design with three replications. The treatments consisted of nine nutrient management practices *viz.*, control ($T_1$), 100% RDF (120:80:60 kg ha$^{-1}$) ($T_2$), 75% RDF ($T_3$), 75% RDF + 10 kg ha$^{-1}$ HA ($T_4$), 50% RDF + 10 kg ha$^{-1}$ HA ($T_5$), 75% RDF + 15 kg ha$^{-1}$ HA ($T_6$), 50% RDF + 15 kg ha$^{-1}$ HA ($T_7$), 75% RDF + 20 kg ha$^{-1}$ HA ($T_8$) and 50% RDF + 20 kg ha$^{-1}$ HA ($T_9$). Observations on plant height, number of branches, plant dry matter, fruit length, fruit width, number of fruits and fruit weight of chilli crop were recorded at harvest and statistically analyzed. The Plant analysis (after harvest) N, P, K content and uptake by chilli fruit and shoot tested and statistically analyzed. The soil physic-chemical parameters *viz.*, pH, EC (dsm$^{-1}$), Organic carbon, textural analysis, soil porosity, water holding capacity and Available N, P, K in soil were also tested and worked out. The study of Variance (ANOVA) approach was used to do a statistical study of the data.

## Results and Discussion

Plant height and number of branches in chilli was observed at 30, 60 and 90 DAT, revealed that, the highest plant height and number of branches plant$^{-1}$ at 30 and 60 DAT was recorded under treatment ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA, which was statistically at par with ($T_2$) 100% RDF (120:80:60 kg ha$^{-1}$), ($T_9$) 50% RDF + 20 kg ha$^{-1}$ HA, ($T_6$) 75% RDF + 15 kg ha$^{-1}$ HA and ($T_7$) 50% RDF + 15 kg ha$^{-1}$ HA. However at 90 DAT treatments ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA, tallest plant height showed tallest plant height which was being statistically at par with ($T_2$) 100% RDF (120:80:60 kg ha$^{-1}$). The highest number of branches plant$^{-1}$ at 30 DAT was recorded under treatment ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA, which was statistically at par with ($T_2$) 100% RDF (120:80:60 kg ha$^{-1}$), ($T_9$) 50% RDF + 20 kg ha$^{-1}$ HA, ($T_6$) 75% RDF + 15 kg ha$^{-1}$ HA and ($T_7$) 50% RDF + 15 kg ha$^{-1}$ HA. At 60 and 90 DAT, highest number of branches plant$^{-1}$ was recorded under treatment ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA, which was statistically at par with ($T_2$) 100% RDF (120:80:60 kg ha$^{-1}$). Under ($T_1$) Control, the lowest plant height and number of branches was measured. The application of different nutrient sources had a significant effect on dry weight of plant after harvest. The highest plant dry weight (g) after harvest was recorded under treatment ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA, which was statistically at par with ($T_2$) 100% RDF (120:80:60 kg ha$^{-1}$). The lowest dry weight of chilli plants was recorded in the control treatment ($T_1$). Treatment ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA recorded the significantly longest fruit length in chilli, which was statistically at par with ($T_2$) 100% RDF (120:80:60 kg ha$^{-1}$). The shortest fruit length was observed in the control ($T_1$). The results indicated that the widest fruit width of chilli fruits was observed under treatment ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA. This treatment was statistically at par with ($T_2$) 100% RDF (120:80:60 kg ha$^{-1}$). The lowest fruit width of chilli fruit was recorded in the control treatment ($T_1$). Treatment ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA produced the highest number of fruit plant$^{-1}$, which was statistically at par to ($T_2$) 100% RDF (120:80:60 kg ha$^{-1}$). The lowest number of fruit plant$^{-1}$ was recorded in the control treatment ($T_1$). The data indicated that the nutrient sources are significantly affected the fresh and dry weight of chilli fruit. The results revealed that significantly the highest fresh and dry weight of chilli fruit was recorded with application of ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA. Which was statistically at par with ($T_2$) 100% RDF (120:80:60 kg ha$^{-1}$). Under ($T_1$) Control, the lowest fresh and dry weight of chilli fruit was measured.

In fruit and shoot of chilli, significantly maximum N, P and K uptake by chilli under ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA. The

minimum nutrient uptake by fruit and shoot of chilli was recorded under ($T_1$) control. The bulk density, particle density and porosity of soil were recorded at after harvest. Results revealed that there was no significant variation between the nutrient management practices. But, the lowest bulk and particle density and highest porosity in soil were recorded under treatment ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA. After harvest of chilli crop, significantly highest water holding capacity and cation exchange capacity in soil was recorded under the treatment plot ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA, which was at par with ($T_2$) 100% RDF (120:80:60 kg ha$^{-1}$), ($T_9$) 50% RDF + 20 kg ha$^{-1}$ HA, ($T_6$) 75% RDF + 15 kg ha$^{-1}$ HA and ($T_7$) 50% RDF + 15 kg ha$^{-1}$ HA. While, minimum under the treatment ($T_1$) control.

The maximum number of *Azatobactor*, *Phosphorus Solubilizing Bacteria* (PSB) and *Potassium Mobilizing Bacteria* (KMB) colonies in the soil after harvest was recorded under treatment ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA. In case of *Azatobactor* maximum number under treatment ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA, which was statistically at par with ($T_9$) 50% RDF + 20 kg ha$^{-1}$ HA, ($T_6$) 75% RDF + 15 kg ha$^{-1}$ HA and ($T_7$) 50% RDF + 15 kg ha$^{-1}$ HA. In case of *Azatobactor* maximum number under treatment ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA, which was statistically at par with ($T_9$) 50% RDF + 20 kg ha$^{-1}$ HA. Under ($T_1$) Control pot, the lowest number of bacterial colonies in the soil was recorded. These results are underscoring the positive impact of nutrient management, particularly the use of humic acid and proper management fertilizers on soil.

**Table 1:** Effect of different doses of humic acid on plant height of chilli.

| Treatments | Plant height (cm) | | |
|---|---|---|---|
| | 30 DAT | 60 DAT | 90 DAT |
| $T_1$ - Control | 20.13 | 38.45 | 51.57 |
| $T_2$ - 100% RDF (120:80:60 kg ha$^{-1}$) | 29.54 | 56.42 | 82.48 |
| $T_3$ - 75% RDF | 24.05 | 45.03 | 59.92 |
| $T_4$ - 75% RDF + 10 kg ha$^{-1}$ HA | 25.89 | 48.35 | 64.05 |
| $T_5$ - 50% RDF + 10 kg ha$^{-1}$ HA | 25.46 | 47.63 | 62.82 |
| $T_6$ - 75% RDF + 15 kg ha$^{-1}$ HA | 28.72 | 54.86 | 73.14 |
| $T_7$ - 50% RDF + 15 kg ha$^{-1}$ HA | 28.15 | 53.95 | 71.79 |
| $T_8$ - 75% RDF + 20 kg ha$^{-1}$ HA | 29.54 | 56.42 | 83.48 |
| $T_9$ - 50% RDF + 20 kg ha$^{-1}$ HA | 28.96 | 55.31 | 75.83 |
| S.Em (±) | 0.69 | 1.52 | 2.27 |
| CD (5%) | 2.06 | 4.56 | 6.81 |
| CV (5%) | 10.50 | 10.24 | 10.66 |

**Table 2:** Effect of different doses of humic acid on number of branches of chilli plant

| Treatments | Number of branches (plant$^{-1}$) | | |
|---|---|---|---|
| | 30 DAT | 60 DAT | 90 DAT |
| $T_1$ - Control | 1.14 | 2.27 | 3.02 |
| $T_2$ - 100% RDF (120:80:60 kg ha$^{-1}$) | 3.79 | 7.55 | 10.05 |
| $T_3$ - 75% RDF | 2.24 | 3.88 | 5.62 |
| $T_4$ - 75% RDF + 10 kg ha$^{-1}$ HA | 2.45 | 4.38 | 6.19 |
| $T_5$ - 50% RDF + 10 kg ha$^{-1}$ HA | 2.33 | 4.14 | 5.87 |
| $T_6$ - 75% RDF + 15 kg ha$^{-1}$ HA | 3.54 | 5.95 | 8.28 |
| $T_7$ - 50% RDF + 15 kg ha$^{-1}$ HA | 3.46 | 5.73 | 8.08 |
| $T_8$ - 75% RDF + 20 kg ha$^{-1}$ HA | 3.85 | 7.67 | 10.21 |
| $T_9$ - 50% RDF + 20 kg ha$^{-1}$ HA | 3.62 | 6.11 | 8.49 |
| S.Em (±) | 0.21 | 0.38 | 0.49 |
| CD (5%) | 0.64 | 1.13 | 1.48 |
| CV (5%) | 9.71 | 9.43 | 9.79 |

**Table 3:** Effect of different doses of humic acid on dry weight of chilli plant

| Treatments | Dry weight (g) chilli plant after harvest |
|---|---|
| $T_1$ - Control | 23.18 |
| $T_2$ - 100% RDF (120:80:60 kg ha$^{-1}$) | 34.65 |
| $T_3$ - 75% RDF | 26.39 |
| $T_4$ - 75% RDF + 10 kg ha$^{-1}$ HA | 27.11 |
| $T_5$ - 50% RDF + 10 kg ha$^{-1}$ HA | 26.62 |
| $T_6$ - 75% RDF + 15 kg ha$^{-1}$ HA | 30.94 |
| $T_7$ - 50% RDF + 15 kg ha$^{-1}$ HA | 30.26 |
| $T_8$ - 75% RDF + 20 kg ha$^{-1}$ HA | 35.27 |
| $T_9$ - 50% RDF + 20 kg ha$^{-1}$ HA | 31.21 |
| S.Em (±) | 1.02 |
| CD (5%) | 3.06 |
| CV (5%) | 10.35 |

**Table 4:** Effect of different doses of humic acid on Fruit length, fruit width, number of fruit and number of picking of chilli.

| Treatments | Fruit length (cm) | Fruit width (cm) | Number of fruit (plant$^{-1}$) | Number of picking |
|---|---|---|---|---|
| $T_1$ - Control | 4.04 | 0.51 | 71.13 | 3.00 |
| $T_2$ - 100% RDF (120:80:60 kg ha$^{-1}$) | 7.71 | 0.92 | 142.45 | 6.00 |
| $T_3$ - 75% RDF | 5.49 | 0.65 | 92.42 | 4.00 |
| $T_4$ - 75% RDF + 10 kg ha$^{-1}$ HA | 6.14 | 0.69 | 96.23 | 5.00 |
| $T_5$ - 50% RDF + 10 kg ha$^{-1}$ HA | 5.86 | 0.67 | 94.68 | 5.00 |
| $T_6$ - 75% RDF + 15 kg ha$^{-1}$ HA | 7.43 | 0.81 | 119.16 | 6.00 |
| $T_7$ - 50% RDF + 15 kg ha$^{-1}$ HA | 7.36 | 0.79 | 117.04 | 5.00 |
| $T_8$ - 75% RDF + 20 kg ha$^{-1}$ HA | 7.94 | 0.94 | 145.06 | 6.00 |
| $T_9$ - 50% RDF + 20 kg ha$^{-1}$ HA | 7.55 | 0.82 | 121.69 | 6.00 |
| S.Em (±) | 0.42 | 0.03 | 6.68 | 0.32 |
| CD (5%) | 1.27 | 0.09 | 20.06 | 0.95 |
| CV (5%) | 9.19 | 10.94 | 10.52 | 10.83 |

**Table 5:** Effect of different doses of humic acid on fresh & dry weight of chilli fruit.

| Treatments | Weight of fruit (g plant$^{-1}$) | |
|---|---|---|
| | Fresh weight | Dry weight |
| $T_1$ - Control | 351.95 | 58.66 |
| $T_2$ - 100% RDF (120:80:60 kg ha$^{-1}$) | 414.61 | 69.10 |
| $T_3$ - 75% RDF | 368.35 | 61.39 |
| $T_4$ - 75% RDF + 10 kg ha$^{-1}$ HA | 373.79 | 62.30 |
| $T_5$ - 50% RDF + 10 kg ha$^{-1}$ HA | 371.14 | 61.86 |
| $T_6$ - 75% RDF + 15 kg ha$^{-1}$ HA | 394.68 | 65.78 |
| $T_7$ - 50% RDF + 15 kg ha$^{-1}$ HA | 390.78 | 65.13 |
| $T_8$ - 75% RDF + 20 kg ha$^{-1}$ HA | 419.09 | 69.85 |
| $T_9$ - 50% RDF + 20 kg ha$^{-1}$ HA | 397.06 | 66.18 |
| S.Em (±) | 5.01 | 1.14 |
| CD (5%) | 15.03 | 3.42 |
| CV (5%) | 10.27 | 10.09 |

**Table 6:** Effect of different doses of humic acid on nutrient uptake by chilli.

| Treatments | Nutrient uptake (g plant$^{-1}$) | | | | | |
|---|---|---|---|---|---|---|
| | N | | P | | K | |
| | Fruit | Shoot | Fruit | Shoot | Fruit | Shoot |
| $T_1$ - Control | 0.65 | 0.25 | 0.14 | 0.04 | 0.93 | 0.12 |
| $T_2$ - 100% RDF (120:80:60 kg ha$^{-1}$) | 0.92 | 0.43 | 0.19 | 0.07 | 1.17 | 0.18 |
| $T_3$ - 75% RDF | 0.70 | 0.29 | 0.16 | 0.05 | 0.99 | 0.14 |
| $T_4$ - 75% RDF + 10 kg ha$^{-1}$ HA | 0.75 | 0.31 | 0.18 | 0.05 | 1.02 | 0.15 |
| $T_5$ - 50% RDF + 10 kg ha$^{-1}$ HA | 0.72 | 0.30 | 0.18 | 0.05 | 1.01 | 0.14 |
| $T_6$ - 75% RDF + 15 kg ha$^{-1}$ HA | 0.82 | 0.37 | 0.20 | 0.07 | 1.10 | 0.17 |
| $T_7$ - 50% RDF + 15 kg ha$^{-1}$ HA | 0.80 | 0.35 | 0.19 | 0.06 | 1.07 | 0.16 |
| $T_8$ - 75% RDF + 20 kg ha$^{-1}$ HA | 0.95 | 0.44 | 0.22 | 0.08 | 1.19 | 0.20 |
| $T_9$ - 50% RDF + 20 kg ha$^{-1}$ HA | 0.86 | 0.38 | 0.20 | 0.07 | 1.11 | 0.17 |
| S.Em (±) | 0.02 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 |
| CD (5%) | 0.04 | 0.03 | 0.01 | 0.01 | 0.04 | 0.01 |
| CV (5%) | 3.93 | 5.03 | 3.43 | 3.28 | 3.19 | 3.18 |

**Table 7:** Effect of different doses of humic acid on Bulk density, particle density, porosity, water holding capacity and cation exchange capacity of soil.

| Treatments | Bulk density (gm/cm$^3$) | Particle density (gm/cm$^3$) | Porosity (%) | Water holding capacity (%) | Cation exchange capacity (meq/100 gm) |
|---|---|---|---|---|---|
| $T_1$ - Control | 1.31 | 2.54 | 48.42 | 35.21 | 16.00 |
| $T_2$ - 100% RDF (120:80:60 kg ha$^{-1}$) | 1.29 | 2.54 | 49.21 | 38.08 | 21.00 |
| $T_3$ - 75% RDF | 1.28 | 2.53 | 49.40 | 37.87 | 18.00 |
| $T_4$ - 75% RDF + 10 kg ha$^{-1}$ HA | 1.27 | 2.54 | 50.00 | 39.74 | 23.00 |
| $T_5$ - 50% RDF + 10 kg ha$^{-1}$ HA | 1.27 | 2.53 | 49.80 | 39.31 | 22.00 |
| $T_6$ - 75% RDF + 15 kg ha$^{-1}$ HA | 1.26 | 2.54 | 50.39 | 40.12 | 26.00 |
| $T_7$ - 50% RDF + 15 kg ha$^{-1}$ HA | 1.26 | 2.53 | 50.19 | 39.98 | 25.00 |
| $T_8$ - 75% RDF + 20 kg ha$^{-1}$ HA | 1.25 | 2.53 | 50.59 | 41.67 | 29.00 |
| $T_9$ - 50% RDF + 20 kg ha$^{-1}$ HA | 1.25 | 2.53 | 50.59 | 41.43 | 28.00 |
| S.Em (±) | 0.07 | 0.14 | 2.89 | 0.55 | 0.64 |
| CD (5%) | NS | NS | NS | 1.67 | 1.93 |
| CV (5%) | 10.07 | 10.04 | 10.08 | 4.21 | 4.84 |

**Table 8:** Effect of different doses of humic acid on Colony forming units of bacteria in soil.

| Treatments | CFU 10$^6$/gm soil at harvest | | |
|---|---|---|---|
| | *Azatobactor* | PSB | KMB |
| $T_1$ - Control | 2.53 | 1.91 | 1.66 |
| $T_2$ - 100% RDF (120:80:60 kg ha$^{-1}$) | 2.64 | 2.01 | 1.76 |
| $T_3$ - 75% RDF | 2.59 | 1.97 | 1.72 |
| $T_4$ - 75% RDF + 10 kg ha$^{-1}$ HA | 2.76 | 2.59 | 2.54 |
| $T_5$ - 50% RDF + 10 kg ha$^{-1}$ HA | 2.72 | 2.55 | 2.50 |
| $T_6$ - 75% RDF + 15 kg ha$^{-1}$ HA | 2.94 | 2.77 | 2.72 |
| $T_7$ - 50% RDF + 15 kg ha$^{-1}$ HA | 2.91 | 2.74 | 2.69 |
| $T_8$ - 75% RDF + 20 kg ha$^{-1}$ HA | 3.18 | 3.28 | 3.23 |
| $T_9$ - 50% RDF + 20 kg ha$^{-1}$ HA | 2.99 | 3.22 | 3.17 |
| S.Em (±) | 0.13 | 0.12 | 0.11 |
| CD (5%) | 0.39 | 0.34 | 0.33 |
| CV (5%) | 7.89 | 7.74 | 7.80 |

## Conclusion

The present study indicated that significantly highest fresh weight of fruit (419.09 g plant$^{-1}$) was recorded under the treatment ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA. This treatment was statistically at par with ($T_2$) 100% RDF (120:80:60 kg ha$^{-1}$), which was also comparable to ($T_9$) 50% RDF + 20 kg ha$^{-1}$ HA, ($T_6$) 75% RDF + 15 kg ha$^{-1}$ HA and ($T_7$) 50% RDF + 15 kg ha$^{-1}$ HA. The growth parameters like plant height, number of branches and yield parameters like fruit length (7.94 cm), fruit width (0.94 cm) and number of fruits (145.06 plant$^{-1}$) were recorded highest in the treatment ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA. While minimum under ($T_1$) control. Significantly the maximum nutrient uptake by chilli fruit (0.95 N g plant$^{-1}$) (0.22 P g plant$^{-1}$) and (1.19 K g plant$^{-1}$) was estimated under ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA. The data showed that there were no significant differences in particle density, bulk density and porosity of soil status after harvest of crop. Data presented significantly highest water holding capacity and cation exchange capacity under ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA. Biological properties of soil *viz*., *Azatobactor*, PSB and KMB population significantly recorded highest under the treatment ($T_8$) 75% RDF + 20 kg ha$^{-1}$ HA. We can suggest that the soil application of humic acid @ 20 kg ha$^{-1}$ with 75% RDF is significantly give best results on growth and fruit yield of chilli.

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