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INFLUENCE OF HUMIC ACID ON YIELD AND YIELD ATTRIBUTING CHARACTERS OF RIDGE GOURD

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ABSTRACT

Humic acids are organic compounds that enhance agronomic parameters, plant growth, and soil characteristics. Humic acid-based products have recently been utilized in crop production to maintain the sustainability of agricultural output. Humic acid can enhance a variety of physical, chemical, and biological properties of soil, including texture, structure, water-holding capacity, cation exchange capacity, pH, soil carbon, enzymes, nitrogen cycling, and nutrient availability. This study emphasizes the significance of humic acid for crop growth, plant hormone production, nutrient uptake and assimilation, Yield, and protein synthesis. The study deals with the Effect of humic acid on growth, fruit weight, fruit volume, quality of fruit, and Yield per hectare of ridge gourd. The research was studied at the In-check Farm, BCKV, Mohanpur, Nadia, W.B., India, in the pre-kharif season of 2023, following RBD with three replications, seven treatments, and control. Among the treatments, T_6 had the highest fruit yield (127.908 q ha^{-1}), followed by T_5 in second place (109.842 q ha^{-1}) and T_1 in last place (70.480 q ha^{-1}), with a significant difference between them. The average fruit yield and parameters associated with Yield were significantly higher for ridge gourds when 112 kg ha^{-1} of humic acid was applied in conjunction with the recommended dosage of fertilizers (T_6). In all cases except days to flower initiation, T_6 was highest among the other treatments. Hence, the humic acid (112 kg ha^{-1}) along with FYM @ 20 kg ha^{-1}, neem cake @ 600 kg ha^{-1}, N @ 50 kg ha^{-1}, P_2O_5 @ 25 kg ha^{-1}, and K_2O @ 25 kg ha^{-1} fertilizers were recommended for getting the maximum Yield, and quality of ridge guard.

INTRODUCTION

Ridge gourd [Luffa acutangula (L.) Roxb.)] is a "Cucurbitaceae" family member and is cultivated mainly for edible purposes. The ridge gourd originated in India. It is grown throughout the country, viz. Malaysia, Myanmar, Sri Lanka, the Philippines, Indonesia, and Taiwan. Ridge gourds are also grown for commercial purposes. Ridge gourds are tender, green fruits that are used in a variety of dishes. The gelatinous substance "luffing" found in gourd fruits is emetic and has historically been used to treat fever and stomach ailments (Karthick et al., 2017). As the population grows, each nation's need for vegetables progressively rises. Thus, to supply a balanced diet, it is imperative to increase production by developing high-yielding varieties, using improved technologies, and increasing acreage (Kumar & Dwivedi, 2018). A balanced diet is one of the key elements influencing the growth and Yield of vegetable crops. It is equally important to consider the optimal levels at which nutrients should be applied and the source from which they originate. Excessive fertilizer use for higher crop yields will result in nutrient leaching and increase production costs. This will ultimately affect the environment and the health of the soil (Hebbar et al., 2004). Humic acid is an organic substance produced by decomposing plant and animal matter. This biostimulant is a significant part of humus and is the black organic matter that accumulates in soils and other environments. Plants can gain various advantages from humic acid. It contributes to increased nutrient uptake, moisture retention, and soil structure improvement. It stimulates the growth of plants as well. It can be sprayed on leaves or given to plants in liquid or granular form. It is crucial to adhere to the application rates and timing the manufacturer recommends. It is a natural material made from decaying plant and animal stuff. Humic acid is necessary for plants to produce more crops and to be generally healthier. Proper fertilizer is crucial for ridge gourd cultivation to achieve ideal growth (Hebbar et al., 2004). This article will cover the special needs of ridge gourds, particularly the dosage of humic acid, and provide

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professional guidance on increasing ridge gourd yield. The goal of the current study was to determine the ideal dosage of humic acid for improving ridge gourds' growth, Yield, and fruit quality, as there is a shortage and an absence of scientific data on humic acid, particularly concerning ridge gourds. The main objective of this study is to observe the Effect of humic acid on Yield and yield attributing characters in ridge gourd. The literature review section highlights the response of humic acid in ridge gourd and other crops. It usually has a positive response to yields and enhances the biochemical characteristics of the soil. Considering the considerations above, the experiment was carried out in the pre-kharif of 2023 at the In-check Farm, BCKV, Mohanpur, Nadia, West Bengal, India. The treatments details were T_1 = Control (No input); $T_2 = T_1$ + Humic acid @112.0 kg ha^{-1}; T_3 = FYM @ 20 kg ha^{-1}, neem cake @ 600 kg ha^{-1}, N @ 25 kg ha^{-1}, P_2O_5 @ 25 kg ha^{-1}, and K_2O @ 25 kg ha^{-1} applied uniformly to all the treatments before sowing. Apply 25 kg N ha^{-1} thirty days after sowing; $T_4= T_3$ + Humic acid @28 kg ha^{-1}; $T_5= T_3$ + Humic acid @56 kg ha^{-1}; $T_6= T_3$ + Humic acid @112 kg ha^{-1}; $T_7= T_3$ + Humic acid @124 kg ha^{-1}. Based on the results and discussion, it was determined that the optimum doses for achieving the highest Yield in ridge guard were humic acid (112 kg ha-1) combined with FYM @ 20 kg ha^{-1}, neem cake @ 600 kg ha^{-1}, N @ 50 kg ha^{-1}, P_2O_5 @ 25 kg ha^{-1}, and K_2O @ 25 kg ha^{-1}.

LITERATURE REVIEW

Humic acid is one of the most potent biostimulants among humic substances and has many positive effects on growth and development. According to Cao et al. (2010) and Zhang and Shangguan (2007), it effectively encourages the rate of photosynthesis, increased plant growth, more dry matter, and production and accumulation of more organic matter. When humic acid is added to different synthetic fertilizers, plants grow faster and absorb more nutrients. By boosting microbial population and activities, water holding capacity, cation exchange capacity, and enzyme activities in the soil, humic acid can improve the biochemical properties of soil. Humic acid will lead to more effective plant growth and nutrient uptake (Khattak & Dost, 2010). Plant height, the leaf area index (LAI), and the production of biomass through increased photosynthesis are all ultimately impacted by humic acid (Tahir et al., 2011). Numerous scientific studies have shown that Humic acid influences the development of plant roots and shoots and the amount of chlorophyll. According to Rose et al. (2014) and Olaetxea et al. (2020), humic acid enhances the growth of shoots and roots by raising the levels of enzyme activity and growth-promoting hormones, such as auxin and cytokinin, in plants. According to Sivakumar et al. (2007), humic acid application significantly increases N, P, and K uptake in plants, which ultimately influences higher branches, Number of flowers, fruits, Yield, and seed test weight.

MATERIALS AND METHODS

The field experiment was conducted at the In-check Farm, BCKV, Mohanpur, Nadia, West Bengal, India, in the pre-kharif season 2023. The trial site's soil type was a well-drained sandy loam with initial organic carbon of 0.43%, pH of 7.45, EC (Electrical Conductivity) of 0.63 ds m^{-1}, available nitrogen of 0.07%, available phosphorus of 220.2 kg ha^{-1}, and available potassium of 126 kg ha^{-1}. Ridge gourd genotypes "Amta Jhinge" seeds were sown at 1.50 x 0.60m spacing during the last week of April 2023. Three replications of each of the seven treatments were included in the CRD design of the experiment. Before seeding, N, P_2O_5, and K_2O were evenly applied to each treatment @ 25:25:25 kg ha^{-1}, along with the FYM @ 20 t kg ha^{-1} and neem cake @ 600 kg ha^{-1}. Thirty days after sowing, apply 25 kg N ha^{-1}. The treatment information and amount of fertilizer used per treatment are shown in Table 1. Ten plants were randomly selected replication-wise for each treatment, and various growth and yield parameters were recorded. According to the suggested package of practices, all agronomic and plant protection measures were implemented (Prabhakar et al., 2010). The different Yield and yield attributing characters like root length, shoot length, Days to flower initiation, Effect on the Number of flowers plant^{-1}, Effect on the Number of fruits picking^{-1}, Effect on Yield per picking (q ha^{-1}), Effect on total Yield (q ha^{-1}), Average Number of fruits / 2 kg, and Average fruit weight (g). The experimental data were statistically analyzed using the OPSTAT computer programming (Sheoran et al., 1998) and compared using critical difference (CD) at 5%.

Table 1. Treatments Details

Sl. No.	Treatments Details	Dose (kg ha^{-1})
1.	T_1	Control (No input): Without the application of fertilizer and humic acid
2.	T_2	T_1 + Humic acid @112.0 kg ha^{-1}
3.	T_3	FYM @ 20 kg ha^{-1}, neem cake @ 600 kg ha^{-1}, N @ 25 kg ha^{-1}, P_2O_5@ 25 kg ha^{-1}, and K_2O @ 25 kg ha^{-1} applied uniformly to all the treatments before sowing. Apply 25 kg N ha^{-1} thirty days after sowing.
4.	T_4	T_3 + Humic acid @28 kg ha^{-1}
5.	T_5	T_3 + Humic acid @56 kg ha^{-1}
6.	T_6	T_3 + Humic acid @112 kg ha^{-1}
7.	T_7	T_3 + Humic acid @224 kg ha^{-1}

RESULTS

Root length (cm)

The root length of seedlings varied significantly. The root length in T_6 was the longest at 34.000 cm, and the differences between T_6, T_4, T_5, and T_7 were not statistically significant. T_1 (12.630) had the lowest root growth, followed by T_2, T_3, and T_4. All three groups' statistical growth was comparable (Table 2).

Plant height (cm)

Regarding the impact of humic acid on the plant height of ridge gourds, it is evident from the table-2 that the highest growth was recorded by T_6 (1,432.000 cm), followed by T_4 and T_7; in comparison, most dwarf plants were recognized for control (995.333 cm) preceded by T_2 though the non-significant difference was observed among T_2, T_4, T_5, and T_7. The range of plant height was 995.333 cm to 1,432.000 cm. At the same time, after applying various humic acid doses, a notable increase in plant height over control was observed. Sible et al. (2021) observed an analogous type of result.

Days to flower initiation

Days to flower initiation varied non-significantly among the different treatments. The maximum days required for flower initiation were in T_1 (32.667), and the minimum days were represented in T_6 and T_7 (31.333).

Table 2. Root length (cm), Plant height (cm), Days to flower initiation, Total Number of flowers plant^{-1}, and Number of fruits picking^{-1} of Ridge gourds

Sl No.	Treatments	Root length (cm)	Plant length (cm)	Days to flower initiation	Number of flowers planted^{-1}	Number of fruits picked^{-1}
1	T_1	12.630	995.333	32.667	36.253	1.627
2	T_2	12.767	1,260.333	32.667	36.603	1.640
3	T_3	13.433	1,313.333	32.333	39.428	1.765
4	T_4	29.333	1,247.000	31.667	40.747	1.827
5	T_5	32.833	1,203.667	31.667	43.739	1.956
6	T_6	34.000	1,432.000	31.333	47.082	2.108
7	T_7	25.333	1,215.333	31.333	42.890	1.920
C.D. (0.05)		**10.453**	**197.116**	**NS**	**3.201**	**0.133**
SEm (±)		**3.355**	**63.271**	**0.356**	**1.027**	**0.043**
SE(d)		**4.745**	**89.478**	**0.504**	**1.453**	**0.060**
C.V.		**25.373**	**8.851**	**1.932**	**4.344**	**4.020**

Number of flowers plant^{-1}

A maximum number of flowers in plant^{-1} was observed in T_6 (47.082) and the minimum in T_1 (36.253). The Number of flower plants^{-1} varied significantly. Even so, T_1, T_2, T_3; T_5, T_7 showed the non-significant differences.

Number of fruits picking^{-1}

A significant difference existed between the treatments in the Number of fruits picked per day. T_6 had the most considerable Number of fruits picked per day (2.108), while T_1 had the Number pick$^{ed\ per\ day}$ (1.627). T_5 and T_7 showed no discernible differences in fruit production per picking. Yoshida et al. (2011) reported a similar outcome.

Table 3. Treatment-wise Yield (q ha^{-1}) of Ridge gourds from pickings 1 to 5

S.No.	Treatments	No. of picking	Yield (q ha^{-1}) (1st picking)	Yield (q ha^{-1}) (2nd picking)	Yield (q ha^{-1}) (3rd picking)	Yield (q ha^{-1}) (4th picking)	Yield (q ha^{-1}) (5th picking)
1	T_1	10	4.688	7.093	7.263	7.764	8.580
2	T_2	10	6.042	7.150	8.092	8.000	11.593
3	T_3	10	6.875	8.021	10.583	8.674	12.167
4	T_4	10	7.969	9.046	12.740	8.505	13.223
5	T_5	10	8.125	8.819	16.037	9.206	15.180
6	T_6	10	15.938	9.033	15.869	9.578	15.780
7	T_7	10	10.781	9.304	11.977	9.268	13.733
C.D. (0.05)		-	**0.552**	**0.675**	**0.975**	**0.900**	**1.376**
SEm (±)		-	**0.177**	**0.217**	**0.313**	**0.289**	**0.442**
SE(d)		-	**0.251**	**0.307**	**0.443**	**0.408**	**0.625**
C.V.		-	**3.555**	**4.495**	**4.597**	**5.742**	**5.933**

No. of picking

For every treatment, ten pickings were completed.

Yield of 1st picking

The Yield of $^{the\ first}$ picking significantly varied among the treatments. The highest Yield was found in T_6 (15.938 q ha^{-1}), and the lowest Yield was in T_1 (4.688 q ha^{-1}), though T_2 and T_3 showed a non-significant difference.

Yield of 2nd picking

There were notable differences in the second-picking Yield between the treatments. T_7 had the highest Yield (9.304 q ha^{-1}) while T_1 had the lowest Yield (7.093 q ha^{-1}); however, there were no significant differences between T_4, T_6, and T_7.

Yield of third-picking

The third picking yield showed a significant variation between the treatments. T5 recorded the highest Yield (16.037 q ha^{-1}), while T1 recorded the lowest Yield (7.263 q ha^{-1}). Nonetheless, non-significant differences were seen in the data from T_5 and T_6.

Yield of 4th picking

In this instance, the yield ranged from 7.764 q ha^{-1} (minimum-T_1) to 9.578 q ha^{-1} (maximum-T_6). The fourth picking yield showed considerable variation. A few non-significant differences were observed, such as T_1, T_2, T_3, and T_4; T_5, T_6, and T_7.

Yield of 5th picking

The Yield in T_6 was at its maximum (15.780 q ha^{-1}) and its lowest (8.580 q ha^{-1}). There were notable variations in the Yield of 5th picking. Despite this, T_5 and T_6 showed some non-significant differences.

Table 4. Treatment-wise Yield (q ha^{-1}) of Ridge gourds from pickings 6 to 10

S. No.	Treatments	Yield (q ha^{-1}) (6th picking)	Yield (q ha^{-1}) (7th picking)	Yield (q ha^{-1}) (8th picking)	Yield (q ha^{-1}) (9th b picking)	Yield (q ha^{-1}) (10th picking)
1	T_1	5.417	9.413	6.896	6.500	6.867
2	T_2	7.813	12.027	6.979	7.567	7.233
3	T_3	6.458	12.267	7.573	9.167	8.933
4	T_4	8.125	12.880	9.479	9.867	9.767
5	T_5	8.854	14.233	8.958	10.367	10.067
6	T_6	11.667	15.467	11.146	11.867	11.600
7	T_7	8.021	14.733	9.271	10.173	10.007
C.D. (0.05)		**2.647**	**1.121**	**1.768**	**0.874**	**0.646**
SEm (±)		**0.850**	**0.360**	**0.567**	**0.280**	**0.207**
SE(d)		**1.202**	**0.509**	**0.802**	**0.397**	**0.293**
C.V.		**18.279**	**4.793**	**11.289**	**5.190**	**3.901**

Yield of 6th picking

The Yield from the sixth picking was highly variable. T_6 had the highest Yield (11.667 q ha^{-1}), while T_1 had the lowest Yield (5.417 q ha^{-1}). However, T_1, T_2, T_3, T_4, T_5, and T_7 all showed some non-significant differences.

Yield of 7th picking

The yield of the 7th picking significantly varied among the treatments. While there was a non-significant difference between T_2, T_3, T_4, T5, and T7, T_6 had the highest Yield (15.467 kg ha^{-1}), and T_1 had the lowest (9.413 kg ha^{-1}).

Yield of 8th picking

Across the treatments, there was a significant variation in the eighth picking yield. Though there was no statistically significant difference between T_1, T_2; T_2, T_3; T_3, T_5; T_4, T_5, T_7, the maximum yield (11146 kg ha^{-1}) was noted for T_6 and the minimum was for T_1 (6.896 kg ha^{-1}).

Yield of 9th picking

The Yield of the 9th picking significantly varied among the treatments. The Yield of T_6 (11.867 kg ha^{-1}) was the highest, while T_1 (6.500 kg ha^{-1}) was the lowest. Nevertheless, non-significant differences were shown in the T_3, T_4, T5, and T7 data.

Yield of 10th picking

The Yield ranged from 6.867 q ha^{-1} (minimum-T_1) to 11.600 q ha^{-1} (maximum-T_6) in this instance. During the tenth picking, the Yield varied greatly. However, some non-significant differences existed between T_5 and T_7 and T_1 and T_2.

Table 5. Total Yield (q ha^{-1}), the average Number of fruits per 2 kg, and average fruit weight (g) of ridge gourd

S. No.	Treatments	Total Yield (q ha^{-1})	Average Number of fruits / 2 kg	Average fruit weight (g)
1	T_1	70.480	14.500	137.310
2	T_2	82.492	13.900	143.293
3	T_3	90.713	12.867	155.143
4	T_4	101.600	12.533	159.190
5	T_5	109.842	12.433	160.287
6	T_6	127.908	10.167	196.237
7	T_7	107.263	11.167	180.033
C.D. (0.05)		**3.085**	**0.525**	**2.552**
SEm (±)		**0.990**	**0.169**	**0.819**
SE(d)		**1.401**	**0.239**	**1.158**
C.V.		**1.739**	**2.335**	**0.878**

Total Yield

The overall yield varied considerably between the treatments. With a significant difference, T_6 had the highest Yield (127.908 q ha^{-1}), and T_5 came in second (109.842 q ha^{-1}). T_1 had the lowest Yield (70.480 q ha^{-1}) of all the treatments, which was significantly lower. The results of Treatment 2, which applied only 112 kg of humic acid per hectare, showed an increase of more than 17% (82.492 q ha^{-1}) in comparison to the control group (70.480 q ha^{-1}) and only 10% below the recommended dosage (90.713 q ha^{-1}) of fertilization (T_3) for ridge gourd crops.

The Average Number of Fruits per 2 Kg

The control group (14.500) had the highest Number of fruits per 2 kg, followed by T_2, while T_6, T_7, and T_3 had the significantly lowest Number of fruits per 2 kg (Table 5). T_3 and T_4 had non-significantly different numbers.

Average Fruit Weight (g)

In contrast to the recommended practices, which call for T_3 (155.143 g), the average fruit weight, which varied significantly among the treatments, resulted in a 26% increase in T6 (196.237 g).

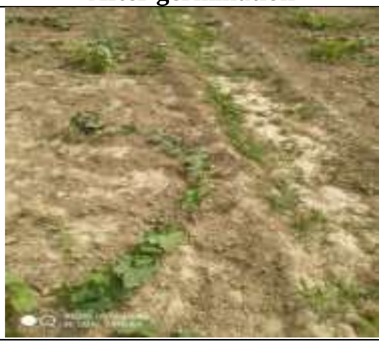
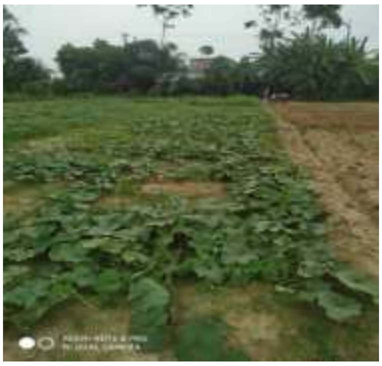
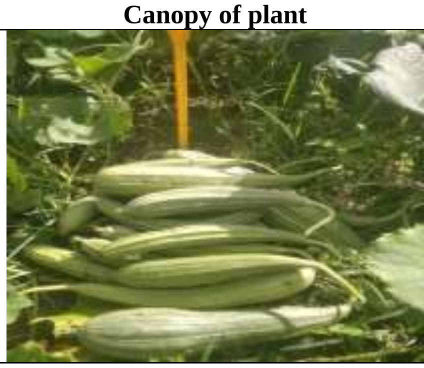
DISCUSSIONS

The results of Treatment 2, which applied only 112 kg of humic acid per hectare without the application of any fertilizer, showed an increase in fruit yield of more than 17% (82.492 q ha^{-1}) in comparison to the control (70.480 q ha^{-1}) and only 10% below the recommended dosage (90.713 q ha^{-1}) of fertilization (T_3) for ridge gourd crops. Interesting to mention that application of 112 kg ha^{-1} of humic acid along with FYM@ 20 kg ha^{-1}; neem cake @ 600 kg ha^{-1}; N, P_2O_5 and K_2O @ 50:25:25 kg ha^{-1} chemical fertilizers) (T_6) increased by 41 per cent without applying any fertilizer (T_1) in the fruit yield of ridge gourds. Less NO_3-N and K have been observed to leach into the deeper soil layer as a result of increased nutrient uptake caused by water soluble fertilizers, and WSF fertigation increased NPK uptake (Singandhupe et al., 2007; Badr et al., 2010; Yoshida et al., 2011). Plants can be treated with humic acid as a foliar spray, liquid, or granule form. For this experiment, it was applied in granular form. The kind of plants being treated and the intended outcome determine the recommended dosage the most. The compositions of humic acid affect the source. However, carbon, hydrogen, and oxygen are present in all forms of humic acid. For instance, humic acids with higher carbon content are more resilient to degradation than those with lower carbon content. Younger plants or stressed plants typically require a higher concentration. Plant type, growth stage, and granular doses are some variables that affect how humic acid affects plants. Younger plants are generally more vulnerable to the effects of humic acid than older ones. High humic acid doses can be particularly harmful to seedlings. Humic acid promotes the metabolism of nitrogen and carbon, which is crucial for plant growth. Humic acid-activated enzymes related to the nitrogen absorption processes, including glutamine synthetase, nitrate reductase, and glutamate dehydrogenase (Canellas et al., 2013). Moreover, humic materials promote the production of nitric oxide (NO) at the lateral root emergence site. Nitric oxide is a bioactive material that plays several functions in a plant's physiological processes, including root development (Lamattina et al., 2003). Humic substances are incorporated to increase NO accumulation, which aids in the morphological changes of the root system, including the growth of secondary roots, an increase in root thickness, and higher fresh weight of roots (Mora et al., 2012). According to research by Canellas and Olivares (2014), humic acid promotes root tissue cell proliferation and the density and length of root hairs. The humic materials enhance the hormonal effects on the root and shoot of plants (Muscolo et al., 2013). Humic compounds can increase H^+ ATPase and ion transport in the root system's plasma membranes (Muscolo et al., 2013). These effects directly affect the plant system's ability to acquire and absorb nutrients. Humic substances have been shown to increase the activities of enzymes involved in the tricarboxylic acid cycle and glycolysis process (Nardi et al., 2007). Pyruvate kinase, phosphofructokinase, glucokinase, and phosphoglucose isomerase are the enzyme activities linked to the glycolysis process; malate dehydrogenase, NADP+-isocitrate dehydrogenase, and citrate synthase are the enzyme activities related to the respiration process. By activating auxins, such as phospholipase A2, a regulator of stomatal opening, humic acid in the root zone can set off physiological responses for shoot development (Russell et al., 2006).

The higher absorption of plant nutrients (micro and macronutrients) via humic acid raises the chlorophyll concentration in the leaf, which benefits the plant's ability to grow shoots (Sible et al., 2021). Plants can absorb more nutrients because of the humic acid's slow release of soil nutrients, which increases the Number of tillers in the plants (Sunarya & Tedjaningsih, 2016). The findings indicate that when added to soil or applied topically, humic acid can significantly enhance growth-related attributes like plant height, tiller count, dry weight, etc. Unbalanced nutrient intake and toxic effects on plant metabolism can impair physiological processes and nutrient uptake. Both soil and foliar application of humic acid have a notable impact on the yield-related traits of the plants. According to Elankavi et al. (2020), humic acid enhances the soil's chemical, physical, and microbial activities and increases hormone activity. These results increased plant nutrient uptake, producing more photosynthate production and more significant source-to-sink translocation of assimilates. Ultimately, this leads to yield and yield attributing characters, such as straw yield and grain test weight. Humic acid application influences N and P and increases plant age, according to Sivakumar et al. (2007). These aids influence yield production and the significant accumulation of dry matter. Furthermore, it is a naturally occurring biostimulant, reducing production losses and enhancing plant resistance to abiotic stresses like salinity and drought. Conversely, humic acid improves nitrogen uptake in the sink, raising the grains' protein content (El-Galad et al., 2013). Humic acid also contributes to the increase in the content of carbohydrates by promoting a faster rate of photosynthesis, which in turn increases the amount of assimilates that are transferred from the source to the sink (Azcona et al., 2011). When humic acid is applied, the plants develop stronger roots and more permeable cell membranes, which improve plant nutrition uptake and ultimately result in higher doses of N, P_2O_5, and K in the plants (Eshwar et al., 2017; Mahmoud et al., 2011). Nonetheless, Sivakumar et al. (2007) state that humic acid applied to the soil up to 115 kg ha^{-1} significantly boosts crop yield; however, due to its harmful effects on plant metabolic processes, yield production is reduced beyond this point.

CONCLUSIONS

Compost and other decomposing organic materials are natural sources of humic acid. Humic acid can be used as a fertilizer to enhance the soil's fertility and structure and to help plants absorb more nutrients. From the experiment, it can be concluded that the application of 112 kg ha^{-1} of humic acid, along with the recommended dosage of fertilizers (Treatment 6) for Ridge gourd crops, had successfully improved the growth (root as well as shoot), Yield, yield attributing parameters (Number of flowers and fruits) and also the average fruit weight of ridge gourds.

		
Seed sowing	**After germination**	**First wedding**
		
First flowering	**2nd wedding**	**Fruit initiation**
		
First harvesting	**The field at first harvesting**	**Canopy of plant**
		
Fruiting stage	**Harvesting**	**Harvesting**

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REFERENCES

Azcona, I., Pascual, I., Aguirreolea, J., Fuentes, M., García-Mina, J. M., & Sánchez-Díaz, M. (2011). Growth and development of pepper are affected by humic substances derived from composted sludge, *Journal of Plant Nutrition and Soil Science*, *174*(6), 916-924. https://doi.org/10.1002/jpln.201000264

Badr, M. A., Abou Hussein, S. D., El-Tohamy, W. A., & Gruda, N. (2010). Nutrient Uptake and Yield of Tomato under Various Methods of Fertilizer Application and Levels of Fertigation in Arid Lands. *Gesunde Pflanzen*, *62*(1), 11-19. https://doi.org/10.1007/s10343- 010- 0219-5

Canellas, L. P., Balmori, D. M., Médici, L. O., Aguiar, N. O., Campostrini, E., Rosa, R. C., Façanha, A. R., & Olivares, F. L. (2013). Combining humic substances and *Herbaspirillum seropedicae* inoculation enhances the growth of maize (*Zea mays* L.) *Plant Soil*, 366, 119–132. https://doi.org/10.1007/s11104-012-1382-5.

Canellas, L. P., & Olivares, F. L. (2014). Physiological responses to humic substances as plant growth promoters. *Chemical and Biological Technologies in Agriculture*, 1, 1-11. https://doi.org/10.1186/2196-5641-1-3

Cao, D., Zong, L. G., Xiao, J., Zhang, Q., & Zhao, Y. (2010). Effects of bio-fertilizer on organically cultured cucumber growth and soil biological characteristics. *Ying Yong sheng tai xue bao= The journal of applied ecology*, *21*(10), 2587-2592.

Elankavi, S., Nambi, J., Ramesh, S., Jawahar, S., & Lavanya, K. (2020). Influence of different doses of fertilizers and foliar spray of nutrients on Yield and yield attributes of rice. *Annals of the Romanian Society for Cell Biology*, *24*(2) 1127-1134.

El-Galad, M. A., Sayed, D. A., & El-Shal, R. M. (2013). Effect of humic acid and compost applied alone or in combination with sulphur on soil fertility and faba bean productivity under saline soil conditions. *Journal of Soil Sciences and Agricultural Engineering*, *4*(10), 1139-1157.

Eshwar, M., Srilatha, M., Rekha, K. B., & Sharma, S. H. (2017). 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*, *6*(5), 1063-1066.

Hebbar, S. S., Ramachandrappa, B. K., Nanjappa, H. V., & Prabhakar, M. (2004). Studies on NPK drip fertigation in field grown tomato (*Lycopersicon esculentum* Mill.). *European. J. Agron*., 21, 117-127.

Karthick, K., Patel, G. S., & Prasad, J. G. R. (2017). Performance of Ridge gourd (*Luffa acutangula* L. Roxb). Varieties and nature of cultivation on growth and flowering attributes. *Int. J. Agril. Sci.*, 9, 3910-3912.

Khattak, R. A., & Dost, M. (2010). Seed cotton yield and nutrient concentrations are influenced by lignitic coal-derived humic acid in salt-affected soils. *Sarhad Journal of Agriculture*, *26*(1), 43-49.

Kumar, A., & Dwivedi, A. K. (2018). Growth and Yield of Ridge Gourd [*Luffa acutangula* L. (Roxb.)] as affected by application of nitrogen and potash fertilizers under the agro-climatic condition of zone prevailing in Bokaro district of Jharkhand., *Int. J. Curr. Microbiol. App. Sci*., 8, 22-28.

Lamattina, L., García-Mata, C., Graziano, M., & Pagnussat, G. (2003). Nitric oxide: the versatility ofan extensive signal molecule. *Annual review of plant biology*, *54*(1), 109-36.

Mahmoud, M. M., Hassanein, A. H., Mansour, S. F., & Khalefa, A. M. (2011). Effect of soil and foliar application of humic acid on growth and productivity of soybean plants grown on a calcareous soil under different levels of mineral fertilizers. *Journal of Soil Sciences and Agricultural Engineering*, *2*(8), 881-890.

Mora, V., Baigorri, R., Bacaicoa, E., Zamarreno, A. M., & García-Mina, J. M. (2012). The humic acid-induced changes in the root concentration of nitric oxide, IAA and ethylene do not explain the changes in root architecture caused by humic acid in cucumber. *Environmental and Experimental Botany*, 76, 24-32. https://doi.org/10.1016/j.envexpbot.2011.10.001

Muscolo, A., Sidari, M., & Nardi, S. (2013). Humic substance: relationship between structure and activity. Deeper information suggests univocal findings. *Journal of Geochemical Exploration*, *129*, 57-63.

Nardi, S., Muscolo, A., Vaccaro, S., Baiano, S., Spaccini, R., & Piccolo, A. (2007). Relationship between molecular characteristics of soil humic fractions and glycolytic pathway and Krebs cycle in maize seedlings. Soil Biology and Biochemistry, *39*(12), 3138-46.

Olaetxea, M., Mora, V., Baigorri, R., Zamarreño, A. M., & García-Mina, J. M. (2020). The singular molecular conformation of humic acids in solution influences their ability to enhance root hydraulic conductivity and plant growth. *Molecules*, *26*(1), 3. https://doi.org/10.3390/molecules26010003

Prabhakar, M., Hebbar, S. S., & Nair, A. K. (2010). Production technology of vegetable crops-A hand book. Indian Institute of Horticultural Research, Hessarghatta, Bangalore, Karnataka, 87-92.

Rose, M. T., Patti, A. F., Little, K. R., Brown, A. L., Jackson, W. R., & Cavagnaro, T. R. (2014). A meta-analysis and review of plant-growth response to humic substances: practical implications for agriculture. *Advances in agronomy*, 124, 37-89. https://doi.org/10.1016/B978-0-12-800138-7.00002-4

Russell, L., Stokes, A. R., Macdonald, H., Muscolo, A., & Nardi, S. (2006). Stomatal responses to humic substances and auxin are sensitive to inhibitors of phospholipase A2. *Plant and Soil*, 283, 175-185.

Sheoran, O. P., Tonk, D. S., Kaushik, L. S., Hasija, R. C., & Pannu, R. S. (1998). Statistical software package for agricultural research workers. Department of Mathematics Statistics, CCS HAU, Hisar, 139-143.

Sible, C. N., Seebauer, J. R., & Below, F. E. (2021). Plant biostimulants: A categorical review, their implications for row crop production, and relation to soil health indicators. *Agronomy*, *11*(7), 1297. https://doi.org/10.3390/agronomy1107129739.

Singandhupe, R. B., James, B. K., Antony, E., Nanda, P., & Behera, M. S. (2007). Response of drip fertigation and mulching on growth and fruit yield of pointed gourd (*Trichosanthes dioica*). *Indian. J Agril. Sci.*, 77(1), 8-13

Sivakumar, K., Devarajan, L., Dhanasekaran, K., Venkatakrishnan, D., & Surendran, U. (2007). Effect of humic acid on the Yield and nutrient uptake of rice. *ORYZA-An International Journal on Rice*, *44*(3), 277-279.

Sunarya, Y., & Tedjaningsih, T. (2016). Increasing nitrogen fertilizer efficiency on wetland rice by using humic acid. *Journal of Tropical Soils*, *20*(3), 143-148. https://doi.org/10.5400/jts.2015.20.3.143

Tahir, M. M., Khurshid, M., Khan, M. Z., Abbasi, M. K., & Kazmi, M. H. (2011). Lignite-derived humic acid effect on growth of wheat plants in different soils. *Pedosphere*, *21*(1), 124-131.

Yoshida, C., Iwasaki, Y., Makino, A., & Ikeda, H. (2011). Effects of irrigation management on the growth and fruit yield of tomato under drip fertigation. *Horticultural Research*, *10*(3), 325-331.

Zhang, X. C., & Shangguan, Z. P. (2007). Effect of nitrogen fertilization on photosynthetic pigment and fluorescence characteristics in leaves of winter wheat cultivars on dryland. *J. Nuclear Agric. Sci*., 21, 299-304.

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