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RESEARCH PAPER

Combination Influence of Humic Acid and Chelated Iron on yield and quality of Broccoli (*Brassica oleracea* L) in Erbil, Iraqi Kurdistan Region.

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A B S T R A C T:

This study was conducted during winter season of 2020, at Murtka farm, Kushtapa, Erbil with GPS reading of (latitude 36. 068 88^0 N, longitude 44. 031 99^0 E) and elevation 413.8 m.a.s.l. to study the role of 5 levels of humic acid(0, 15, 30, 45 and 60 *M*g ha^{-1}), five levels of chelated iron (0, 4, 8, 12 and16 *M*g ha^{-1}) and their combinations on a yield and quality of broccoli (*Brassica oleracea L*).The results indicated significant effect of humic acid and combination between humic acid and chelated iron on broccoli yield, the highest yield values of yield was 21.20 and 22.53 *M*g ha^{-1} were recorded from application of 60Mg ha^{-1} humic acid and combination treatment of HA_4-Fe_3 or adding of 60 Mg ha^{-1} humic acid with 12 *M*g ha^{-1} chelated iron respectively, while the lowest values 15.28 and 15.08 *M*g ha^{-1} were obtained from HA_0 and HA_0-Fe_0 respectively. The highest protein, potassium, phosphorus and Fe (30.25%, 4.10 g $100g^{-1}$, 0.45 g $100g^{-1}$ and 253 mg kg^{-1} head) were recorded from combination treatments of HA_3-Fe_2, HA_4-Fe_2, HA_4-Fe_2 and HA_1-Fe_4 respectively, while their lowest were obtained from control. The combination between humic acid and chelated iron (Fe-EDDHA) caused 1.71,2.37 ,1.60, 2.01 ,1.71 and1.49 times increase in nitrogen, phosphorus, potassium, iron protein content and broccoli yield respectively.

KEY WORDS: Humic acid, Chelated iron, Broccoli yield, Broccoli quality.
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1.INTRODUCTION :

The application of chelated-iron and humic acid are regarding as one of a popular practice for farm management in last decade for improving yield and quality of field crops (El-mogy et al., 2019). Al-Taey (2019) in a field study indicated the role of humic application in increasing yield and quality of broccoli due to improving soil chemical, physical and biological improvement then enhancing soil in additional to decrease in using chemical fertilizers.

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AL-Issawi *et al.*, (2021) explained that humic material obtained from decay of plant residues and animal materials that plays a positive role in increasing yield and quality of plants due to improving soil fertility indirectly such as microbial population increasing soil ion exchange capacity and controlling soil buffering capacity,while the directly effects includes its role in improving the photosynthesis, respiration processes and plant growth stimulation in additional to its great role in increasing nutrient availability for plants.

The agricultural sector focused on application of humic acid due to its low cost, Ecofriending and increasing nutrient availability (Pena-Mendez et al.,2005). Pankaj *et al.*, (20018) indicated that the combination effect of some micronutrient application (Zn, Mn, B and Mo) caused 1.90 times increase in broccoli yield in comparing with control. The significant gap is existing about the effect of iron fertilization on growth yield and quality of broccoli (El-Mogy et al., 2019).

There are some studies that conducted in Iraqi Kurdistan region and Iraq by Omer (2010), Saleh (2016) and AL-Issawi *et al.*, (2021) but none of them included interaction effect of Humic acid and chelated iron, in additional to the shortage of most of nutrients in calcareous soil. Maruf (2019) studied the role of four levels of humic acid in availability of some micronutrients in rhizosphere soil of maize plants in Sulaimani governorate and their effects on yield and quality of maize plant.

Broccoli (*Brassica oleracea* L.) is an annual plant that grow in cool season, the optimum growth temperatures for it is between 13 and 20◦C (Díaz-Pérez, 2009). Its tall reaches to 60–90 cm that forms an upright and branching thick green stalk with leathery, oblong gray-blue to green rosette basal leaves.

The broccoli head is the commonly organ for human consumption. The word broccoli is derived from the Latin word “brachium” (brocco in modern Italian), which means branch and refers to the frequent sprouts making up the head (Nooprom and Santipracha., 2014).

Since there are little or no studies about the role of Humic acid, Chelated -Fe and their combinations on yield and quality of broccoli for this reason the goals included:

The combination influence of Humic acid and chelated-Fe on yield and quality of broccoli.

2. MATERIALS and METHODS

2.1. Location or site of field experiment:

This experiment was carried out at Murtka village, Kushtapa district with GPS reading of 36. 068 88^0 N, 44. 031 99^0 E, and altitude 413.8 meters above sea level, that located on 21 km south of Erbil city. during the winter growing season of 2020-2021 as shown in Figure (2-1).

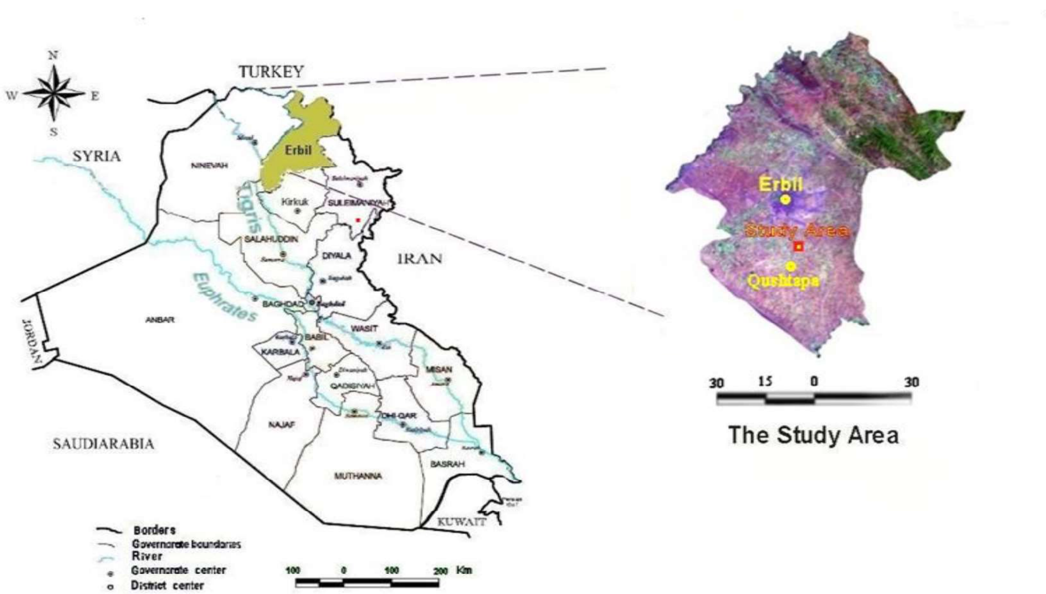

Figure (2.1): Map of the study location:

2.2. Source of seeds, Sowing and Description of the Experiment:

Seeds of the broccoli (*Brassica oleracea)* variety used in this experiment was a premium crop, F1- hybrid (25-62) of Agassi RZ produced by RZ. Rijk zwaan-Holland. On 25th August 2020 the seeds were sown in seedbeds, 85% of seeds were germinated on 31th August 2020. The germination rate of one seedbed was 85% of the seedlings. Peat moss used for sowing seeds. The seedbed contains 105 cell and the area of each cell is 5 cm^2 and one seed was sown in each cell for growing seedlings, then transplanted to the field when the number of leaves reached to 5-6 leaves per seedling.

2.3. Land Preparing and Field experiment:

Soil was plowed horizontally and vertically, by using ILY Bottom plow, spring tyne cultivator and Rotavator to soil smoothing. The factorial experiment was conducted using randomized complete block design (RCBD)with three replicates. Each replicate contained 25 experimental units and the area of each one was 4 m² (2*2 m). The distance between blocks was 2m and between experimental units within each block was 1m. The number of plants per experimental unit was 15 plants and the distance between rows and plants within the row was 50cm. The total area of field experiment was 722m^2.

2.3.1 The studied factors included two factors:

First factor: Types of fertilizers which were humic acid (HA) that contains 85%humic acid, 3% vulvic acid, %12, potassium oxide (K_2O) %12, and 1% organic nitrogen and chelated iron (Fe-EDDHA) which contains 6% Fe.

Second factor: Levels of fertilizers that included 5 levels of humic acid (0,1.50, 3.00, 4.50 and 6.00) g experimental unit^{-1} which equivalent to (0, 15, 30, 45 and 60 kg ha^{-1}, and 5 levels of chelated iron (0, 1.60, 3.20, 4.80 and 6.40) g experimental unit^{-1}, that equivalent to (0, 4, 8, 12 and 16) kg ha^{-1}.

Number of combination treatments = Levels of first factor *Levels of second factor. Number of combination treatments = 5*5 =25

The total number of experimental units = Number of combination treatments * number of replicates = 25*3 = 75 experimental units. Table (3.1) shows some soil properties of the field.

2.4 Physical and Chemical analysis of the investigated soil:

The physical and chemical analysis were done on the 2mm sieving samples, which include the following as shown from (table 2.1):

2.4.1 Soil Physical analysis.

The physical analysis included determination of the following properties.

2.4.1.1 Particle size distribution.

The particle size distribution of the soil was determined according to the international pipette method described in Klute (1986).

2.4.2 Soil chemical Analysis:

The chemical analysis consists of determination of the following properties (table-2.1).

2.4.2.1 Electrical conductivity (EC):

Electrical conductivity of soil was determined by EC-meter (model CM-205) according to Van Reeuwijk (1995).

2.4.2.2 Organic Matter:

Organic matter was determined by Walkly and Black method (wet digestion) as described by Nelson and Sommer's (1982).

2.4.2.3 Soil potential of hydrogen ion (pH).

The potential of hydrogen in the soil saturated extract was measured by pH-meter model (332-Jenway) as described by Van Reeuwik (1995).

2.4.2.4 Equivalent Calcium Carbonate (E$CaCO_3$).

Which involves the dissolution of carbonate in excess of HCl (2*M*) as followed by back titration with (0.1 *M*) NaOH as described in Klute (1986).

2.4.2.5 Catation exchange capacity (CEC).

The CEC was determined by means (1*N*) of sodium acetate CHCOONa then substitution by (1*N*) NaOAC solution according to (Ryan John *et al*, 2001).

2.4.2.6 Total nitrogen(N).

The total (N) was determinerd by kjeldal method as described in Klutr (1986).

2.4.2.7 Available Phosphorus (P).

Extractable (P) has been extracted by Olson's method using ($NaHCO_3$ 0.5*M* at PH8.5) then determined spectrometrically as described in Rowel (1996).

2.4.2.8 Available Potassium (K).

The available (K) was determined by Flam photometer according to Richards (1954).

2.4.2.9 Available Iron (Fe).

The available iron for soil was determined by AAS, using (Ammonium Bicarbonate DTPA)

USING (1*M*) ammonium bicarbonate (NH_4HCO_3, and 0.005 *M* DTPA) extract (Soltanpour and Schwab,1977).

2.4.2.10 Calcium and Magnesium (Ca^{2+}, Mg^{2+}).

The Calcium and Magnesium are determined by titrimetric method using 2Na-EDTA(0.01*N*) as described in (Jacson and Joseph, 1973).

2.4.2.11 Sodium and Potassium (Na^+ K^+).

The Sodium and Potassium were determined by using corning Flame photometer according to Hesse (1971).

2.4.2.12 Carbonate and Bicarbonate ($CO_3^=$, HCO_3^-).

These were determined by titrimetric method using (0.01*N*) HCL and phenolphthalein and methyl indicators according to Richards (1954).

2.4.2.13 Chloride (Cl^-).

The Chloride determined titremetrically by Mohar method according to (Baruah and Barthakue, 1999).

2.5. Fertilization, Transplanting and Irrigation:

After land preparing, on 18th of September, 2020 the fertilization was conducted, then seedlings were carefully uprooted from the seedbed to avoid damage of root system. The field was irrigated one day before and after planting to success seedling transplanting process. On 19th of September the seedlings were translocated to the research field. The irrigation was conducted using both drip and sprinkler irrigation system whenever needed.

2.6. Agricultural Practices:

The Weed and Fungal Control

A week later, on the day 26-9-2020, we carried out the process of prevention with fungal watering. We used the fungal treatment (Proplant + Pilarstin) for thepurpose of the fungal disease control such as (Pythium, Fusarium, wilt of seedlings……)

Table (2.1) Some physio-chemical characteristics of the Murtka field soil before planting:

Soil characteristics		Units		Amount
PSD=Particle Size distribution.	Sand	$g\ kg^{-1}$		185
	Silt			449
	Clay			370
Textural name				Silty clay loam
Soil hydrogen potential (pH)				7.80
ECe		$dS\ m^{-1}$		0.52
CEC		$Cmol_c\ kg^{-1}$		29.30
Soil Organic matter		$g\ kg^{-1}$		9.96
Equivalent $CaCO_3$				330
Active $CaCO_3$				15.20
Total nitrogen		$mg\ g^{-1}$		0.80
Available potassium				320
Available phosphorus		$mg\ kg^{-1}$		6.70
Available iron				1.90
		Ca^{2+}		2.53

Soluble ions	Mg^{2+}	mmolc L^{-1}	1.56
	Na^{+}		0.93
	K^{+}		1.11
	HCO_3^{-}		3.40
	CO_3^{2-}		0.0
	Cl^{-}		2.40

3-Results:

3.1. Influence of humic acid, chelated iron and their combinations on broccoli yield:

Table (3-1) explains the significant influence of humic acid (HA) application and the combination between humic acid and chelated iron on broccoli yield, at $p \leq 0.05$, while chelated iron application was not affected significantly on broccoli yield.

Table (3.1): Combination influence of Humic acid and Chelated Iron on broccoli yield (Mega gram per hectare = *Mg* ha^{-1}).

Fe / HA	Fe_0	Fe_1	Fe_2	Fe_3	Fe_4	
	Yield (*Mg* ha^{-1})					Means
HA_0	15.08^{fg}	14.60^{g}	15.10^{fg}	16.15^{fg}	16.00^{fg}	15.39^{c}
HA_1	17.01^{c-g}	16.67^{e-g}	18.30^{b-f}	16.93^{d-g}	$^{e-a}20.32$	17.85^{b}
HA_2	18.48^{b-f}	20.30^{a-e}	18.35^{b-f}	18.20^{b-f}	18.40^{b-f}	18.75^{b}
HA_3	20.65^{a-d}	18.48^{b-f}	20.58^{a-e}	$^{ab}21.73$	21.03^{ab}	20.49^{c}
HA_4	18.78^{a-f}	20.95^{a-c}	21.85^{ab}	22.53^{a}	21.88^{ab}	21.20^{c}
Means	18.00^{a}	18.08^{a}	18.83^{a}	19.10^{a}	19.53^{a}	

The highest and lowest values 21.20 and 15.39 mg ha^{-1} were obtained from HA_0 and HA_4 treatments respectively or from application of 0 and 60 kg ha^{-1} humic acid. The significant correlation was recorded between levels of applied humic acid and broccoli yield with correlation coefficient value of r=0.99** figure (3.1).

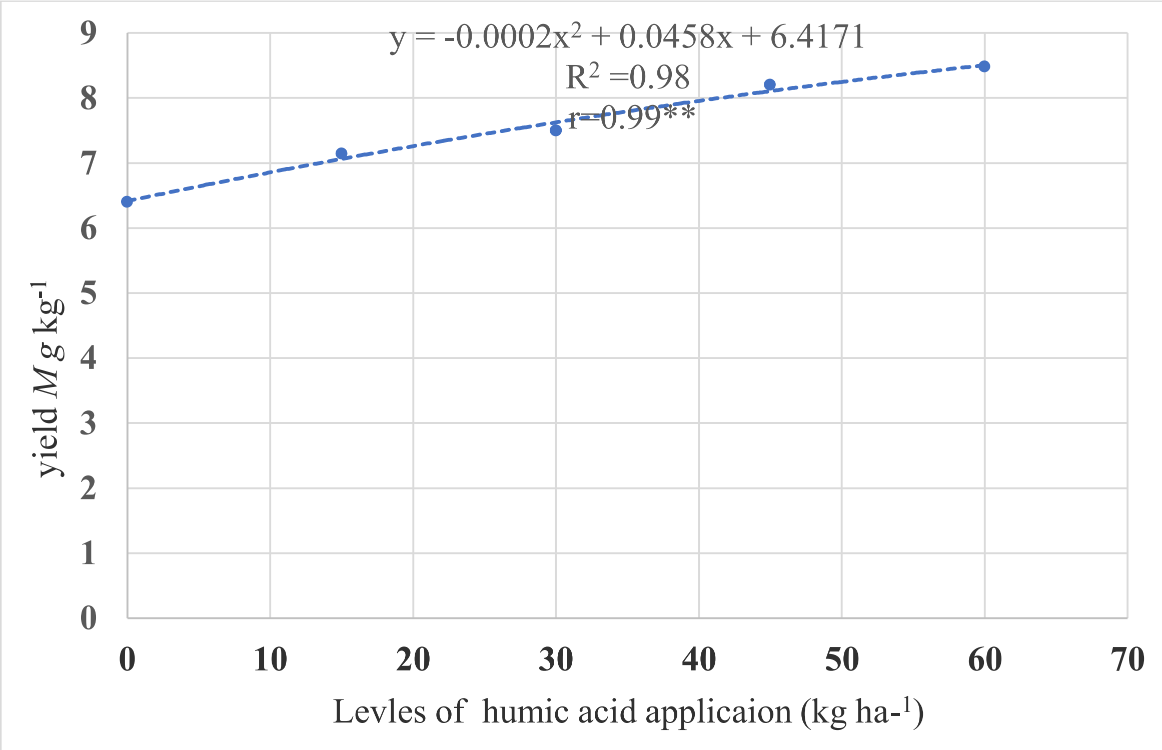

Figure (3.1): The relation between levels of applied humic acid and broccoli yield.

The combination treatments between humic acid and chelated iron caused significant increase in broccoli yield, the highest and lowest values 22.53 and 15.08 *Mg* ha^{-1} were obtained from combination treatments of HA_4-Fe_3 and HA_0-Fe_0 respectively (Table, 3.1). Or the combination between humic acid and chelated iron caused 7.45 *Mg* ha^{-1} increase in yield.

3.2. Influence of humic acid, chelated iron and their combinations on concentration of some nutrients:

Table (3.2) explains the significant effect of himic acid, chelated iron and their combination on nitrogen, phosphorus, potassium and iron concentration of broccoli heads at p value ≤ 0.01.

The highest values of nitrogen, phosphorus, potassium and iron concentration 4.25, 0.37, 353 g 100g^{-1} and 201.80 mg kg^{-1} broccoli head were recorded from application of 60 kg ha^{-1} humic acid (HA_4), while their lowest values 3.30, 0.25, 2.70g 100 g and 175.40 mg kg^{-1} were recorded from control (HA0) treatment respectively.

In case of chelated iron application, its application had significant influence on nitrogen potassium and iron, while not affected significantly on phosphorus concentration. Their highest values (4.14, 3.20 g 100g and 211.67 mg kg^{-1}) were observed from treatments Fe_4, Fe_2 and Fe_4 respectively. While their lowest values (3.13, 2.07 g 100g^{-1} and 141.33mg kg^{-1} were observed from Fe_0, Fe_1 and Fe_0) respectively.

The combination treatments between levels of humic acid and chelated iron also affected significantly on the concentration of nutrients mentioned before. The highest values of them (4.84, 0.45 4.10 g 100g^{-1} and 253.00 mg kg^{-1}) were recorded from combination treatments of HA_3-Fe_4, HA_4-Fe_2, HA_4-Fe_2 and HA_1-Fe_4 respectively. On the other hand, their lowest values (2.83, 0.19, 2.2.57 g 100g^{-1}) and 122 mg kg^{-1} were documented from combination treatments of (HA_0 - Fe_0).

Table (3.2): Influence of humic acid, chelated iron and their combinations on concentration of some nutrients of broccoli heads.

Fe HA	Fe_0	Fe_1	Fe_2	Fe_3	Fe_4	
	N g $100g^{-1}$					HA means
HA_0	2.83^{h}	3.32^{eh}	3.41^{eh}	3.35^{h-e}	3.59^{d-h}	3.30^{c}
HA_1	2.97^{gh}	3.80^{eh}	3.53^{dh}	3.90^{b-e}	3.65^{d-g}	3.49^{bc}
HA_2	3.12^{f-h}	3.76^{cf}	3.43^{eh}	4.22^{a-d}	3.76^{c-f}	3.66^{b}
HA_3	3.41^{e-h}	3.42^{eh}	4.84^{a}	4.45^{a-c}	4.84^{a}	3.98^{a}
HA_4	3.34^{e-h}	3.55^{dh}	3.79^{cf}	4.67^{a}	4.55^{ab}	4.25^{a}
Fe means	3.13^{d}	3.49^{c}	3.49^{b}	4.12^{a}	4.14^{a}	
	P g $100g^{-1}$					HA means
HA_0	0.19^{c}	0.22^{bc}	0.28^{bc}	0.29^{a-c}	0.29^{a-c}	0.25^{c}
HA_1	0.25^{bc}	0.34^{a-c}	0.35^{ac}	0.37^{ab}	0.38^{ab}	0.34^{ab}
HA_2	0.27^{bc}	0.27^{bc}	0.26^{bc}	0.34^{a-c}	0.36^{ab}	0.30^{bc}
HA_3	0.33^{a-c}	0.26^{bc}	0.36^{ab}	0.33^{a-c}	0.33^{a-c}	0.32^{ab}
HA_4	0.37^{a-c}	0.36^{ab}	0.45^{a}	0.37^{ab}	0.35^{a-c}	0.37^{a}
Fe means	0.28^{a}	0.29^{a}	0.34^{a}	0.34^{a}	0.34^{a}	
	K g $100g^{-1}$					HA means
HA_0	2.57^{fg}	2.57^{fg}	2.92^{d-g}	2.47^{g}	2.96^{d-g}	2.70^{c}
HA_1	2.68^{e-g}	2.79^{d-g}	2.81^{d-g}	2.90^{d-g}	2.71^{d-g}	2.78^{c}
HA_2	2.55^{fg}	2.60^{e-g}	2.69^{e-g}	2.81^{d-g}	2.66^{e-g}	2.66^{c}
HA_3	2.95^{d-g}	3.36^{b-e}	3.47^{a-d}	2.68^{e-g}	3.13^{c-g}	3.12^{b}
HA_4	3.75^{a-c}	4.00^{ab}	4.10^{a}	3.33^{b-f}	2.48^{g}	3.53^{a}
Fe means	2.90^{b}	2.07^{b}	3.20^{a}	2.84^{b}	2.70^{b}	
	Fe mg kg^{-1}					HA means
HA_0	122.00^{g}	137.33^{fg}	190.00^{b-f}	210.33^{a-e}	217.33^{a-d}	175.40^{b}
HA_1	122.33^{g}	159.67^{d-g}	152.33^{e-g}	216.33^{a-d}	253.00^{a}	180.73^{ab}
HA_2	142.33^{f-g}	170.00^{c-g}	178.67^{c-g}	193.33^{b-f}	171.67^{c-g}	171.20^{b}
HA_3	168.33^{c-g}	187.33^{b-f}	183.00^{c-f}	192.33^{b-f}	192.67^{b-f}	184.73^{ab}
HA_4	151.67^{e-g}	180.67^{c-g}	245.33^{ab}	207.67^{a-e}	233.67^{a-c}	201.80^{a}
Fe Means:	141.33^{c}	167.00^{b}	189.87^{a}	204.00^{a}	211.67^{a}	

3.3. Influence of humic acid, chelated iron and their combinations on protein percentage of broccoli heads:

The statistical analysis indicated to significant effect of humic acid, chelated iron and their combinations at P-value $\leq$ 0.01 on protein percentage of broccoli heads. The highest value (24.87, 25.86 and 32.13 %) were recorded from HA_4, Fe_4 and HA_3-Fe_4 respectively, while their lowest values (20.63, 19.59 and 17.67 %) were observed from HA_0, Fe_0 and HA_0-Fe_0 respectively (table 3.3).

Table (3.3) Effect of humic acid, iron fertilizers and their interaction of protein content (%) of broccoli head.

Fe / HA	Fe_0	Fe_1	Fe_2	Fe_3	Fe_4	
	Protein %					HA Means
HA_0	17.67^{i}	20.77^{f-i}	21.31^{f-i}	20.92^{f-i}	22.46^{e-h}	20.63^{c}
HA_1	18.56^{hi}	21.13^{f-i}	22.04^{e-i}	24.40^{c-f}	22.81^{e-h}	21.79^{bc}
HA_2	19.48^{g-h}	23.48^{d-g}	21.44^{f-i}	26.35^{b-e}	23.48^{d-g}	22.85^{b}
HA_3	21.33^{f-i}	21.40^{f-i}	30.27^{ab}	27.83^{a-d}	32.13^{a}	26.59^{a}
HA_4	20.90^{f-i}	22.17^{e-i}	23.67^{d-g}	29.19^{ab}	28.44^{a-c}	24.87^{a}
Fe Means	19.59^{d}	21.79^{c}	23.75^{b}	25.74^{a}	25.86^{a}	

3.4. Influence of HA, Chelated-Fe and their combinations on available phosphorus in bulk soil and rhizosphere.

3.4.1 Available phosphorus in bulk soil:

Application of HA and combination between HA and chelated-Fe affected significantly on available P in bulk soil while iron application was not affected significantly (Table 3.4).
In case of HA application, the highest and lowest available P (6.75 and 19.55) mg kg^{-1} soil were recorded from HA_0 the and HA_4 treatments respectively. It means soil application of HA caused 2.90 times increase in available of bulk soil, this explains the positive role of HA in soil fertility improvement. The combination treatments caused increase in available-p from 6.64 to 20.58 mg kg^{-1} soil of bulk soil or (21/6.64 = 3.16) 3.16 times increase in available-p (Table 3.4).As shown from figur (3.4) the significant correlation was recorded between available phoshorus in bulk soil and humic acid application with r = 0.98** this explain the influnce of HA application on phosphorus availability

Table 3.4 Available phosphors in bulk soil.

Fe / HA	Fe_0	Fe_1	Fe_2	Fe_3	Fe_4	
	Available P in Bulk soil mg kg^{-1}					HA means
HA_0	6.64^{f}	6.64^{f}	6.93^{f}	6.70^{f}	6.85^{f}	6.75^{e}
HA_1	7.76^{f}	8.13^{f}	8.30^{ef}	8.93^{def}	9.23^{c-f}	8.47^{d}
HA_2	12.30^{c}	12.03^{cd}	11.94^{cd}	11.43^{c-e}	12.37^{c}	12.01^{c}
HA_3	15.64^{b}	15.40^{b}	16.29^{b}	16.25^{b}	17.21^{b}	16.16^{b}
HA_4	20.43^{a}	20.23^{a}	20.58^{a}	21.00^{a}	15.50^{b}	19.55^{a}
Fe Means	12.55^{a}	12.48^{a}	12.81^{a}	12.86^{a}	12.23^{a}	

3.4.2 Available P in Rhizosphere.

The humic acid application and the combination between HA and chelated-Fe affected significantly at P≤ 0.05 on available-P of rhizosphere soil, while application of chelated iron was not affected significantly on available-p of rhizosphere soil.

Application of HA caused increase in available phosphorus from 12.30 to 35.00 mg kg^{-1} soil or caused 2.85 times increase in available-p of rhizosphere soil (table 3.5). The combination treatments also affected significantly on available P of rhizosphere soil the highest and lowest values 35.00 and 11. 63 mg kg^{-1} soil were recorded from combination treatments of HA_4 Fe_2 and HA_0 Fe_1 respectively.

Table 3.5 Available phosphors in Rhizosphere.

Fe / HA	Fe_0	Fe_1	Fe_2	Fe_3	Fe_4	
	Available P in Rhizosphere mg kg^{-1}					HA means
HA_0	12.30^{hi}	11.63^{i}	12.72^{g-i}	13.67^{f-i}	14.36^{f-i}	12.93^{e}
HA_1	16.33^{e-i}	18.06^{e-h}	16.60^{e-i}	18.22^{e-g}	19.26^{ef}	17.69^{d}
HA_2	19.33^{ef}	20.93^{de}	21.29^{de}	21.66^{de}	22.18^{de}	21.08^{c}
HA_3	25.33^{cd}	28.00^{bc}	28.66^{bc}	29.66^{a-c}	29.62^{a-c}	28.25^{b}
HA_4	29.59^{a-c}	33.33^{ab}	35.00^{a}	32.00^{ab}	27.66^{bc}	31.51^{a}
Fe Means	20.57^{a}	22.39^{a}	22.85^{a}	23.04^{a}	22.62^{a}	

Discussion:

The increase in broccoli yield as a result of humic acid application from 15.28 to 21.20 *M*g ha^{-1} as recorded in table (3.1) may be due to the role of humic acid application in improving soil physical ,chemical and biological properties that caused increase in soil fertility, volume of root system and nutrient availability then increase in yield (Al-Issawi, 2021).The combination effect between levels of humic acid and chelated iron caused increase in broccoli yield from 15.08 to 22.53 *M*g ha^{-1} or increase 7.45 *M*g ha^{-1} of broccoli may be due to creating different growth condition as a result of the mentioned combinations in addition to the single role of humic acid and iron in improving soil properties then increase in yield (Darwesh, 2007 and El-Mogy, et al., 2019). The effect of hiumic acid and its combination with chelated iron in increasing the yield may be due to the increase in available phosphorus in both bulk and rhizosphere soil that caused increase in yield due to the role of phosphorus in increasing root growth then increase in head formation and yield (Mengel and Kikeby,1978).

The increase in nitrogen ,phosphorus, potassium and iron of broccoli heads to adequate concentration or to words the best range this may be due to the role of humic acid in increasing their availability then their concentrations in broccoli heads and role of iron in increasing iron concentration in additional to combination between them caused increase in their concentration .This may be due to the role of humic acid in soil improvement then increase in soil fertility and nutrient availability as mentioned by (Reuter and Robninson,1986).

The highest protein (24.87, 25.86 and 32.13 %) were recorded from HA_4, Fe4 and HA_3-Fe_4 respectively, while their lowest values (20.63, 19.59 and 17.67 %) were observed from HA_0, Fe_0 and HA_0-Fe_0 respectively (table 3.3). This may be due to the nitrogen concentration of broccoli heads since the highest nitrogen concentrations (3.98, 4.14 and 4.8%) were recorded from HA_3, Fe_4 and HA_3-Fe_2 respectively which caused highest protein formation from broccoli heads treated with the mentioned treatments or combination treatments (table 3.2) and the vica versa for the low values. On the other hand, it is a fact that increase in nitrogen concentration causes increase in protein concentration since

protein% =6.255 * Nitrogen%

4- Conclusion:

The results explained that the role of humic acid alone and its combination with chelated iron is more effective than chelated iron. They had superior influence in increasing broccoli growth, yield, nutrient content protein percentage in comparing with using chelated iron only. Humic acid caused increase in available iron and phosphorus in bulk and rhizosphere soil, while chelated iron caused increase in available iron of bulk and rhizosphere soil.

Finally, the combination treatment caused 1.71, 2.37, 1.60, 2.01, and 1.71 time increase in concentration of N, P, K, Fe, and protein of broccoli head. This may be due to the role of combination between HA and Fe-EDDHA in increasing nutrient availability.

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