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The Effect of garlic extract, hybridization, seedling age, and foliar application on the growth characteristics and yield of broccoli plants.

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Abstract

The experiment was conducted during the agricultural seasons of 2021-2022 and 2022-2023 in the field belonging to the Agricultural Research Station at the College of Agriculture, University of Basra, Karima Ali. The aim of the study was to investigate the impact of two hybrids (Matsuri and 2004), three seedling ages (30, 45, and 60 days), and five concentrations of garlic water extract (10, 20 mL L-1 of local garlic variety and 10, 20 mL L-1 of Chinese garlic variety), with a control treatment (0). There were a total of 30 experimental treatments conducted as a split-plot design with two replications using a complete randomized block design.

Matsuri hybrid exhibited significant superiority over the 2004 hybrid in leaf area, leaf count, lateral shoot weight, lateral shoot diameter, and lateral shoot count for both seasons. Moreover, the 30-day-old seedlings showed significant superiority over the other ages in all studied traits for both seasons. Additionally, the treatment with 20 mL L-1 of Chinese garlic extract significantly outperformed the other spray concentrations for both seasons. Some pairwise interactions had significant effects on the study traits, while others were not significant.

Keywords: broccoli plant, hybrid, plant yield, garlic extract, seedling age, growth characteristics.

Introduction

Broccoli (Brassica oleracea L. var. italica Plenck) is a plant of the Brassicaceae family, and it is one of the vegetable crops whose number is estimated at 392 crops around the world, representing 70 families and 225 genera, and their percentage according to the part consumed is estimated at 53%. Vegetables whose leaves or new vegetative growth are consumed, followed by fruit-bearing vegetables at 15%, then vegetables grown for their underground parts at 17% (Hassan, 2017). They are grown for their inflorescences, which are eaten while they are in the stage of vegetative flower buds with their thick, juicy pods (Decoteau, 2000), known since the Roman era and wild species found growing in the Mediterranean region and Asia Minor. It is a winter annual herbaceous plant that resembles cauliflower morphologically (Dixon, 2007). Determining the appropriate seedling age is one of the factors affecting the growth of the broccoli plant, as selecting strong seedlings free of diseases and transferring them to the permanent field at the appropriate age is one of the most important components of the success of growing broccoli plants. (Hassan, 1994). The process of introducing varieties and hybrids is one of the important methods in breeding and improving plants. It is an easy and quick way to achieve good genetic compositions, as they can be tested under the different conditions of the importing country and thus select what suits the environmental conditions (Bhangre et al., 2011). Spraying with organic extracts, including garlic extract, has a positive role in growth characteristics and yield, because it contains a high percentage of amino acids with a high sulfur content, such as Cysteine and Methionine, which have an important role in the vital processes inside the plant cell, in addition to containing volatile oils such as Allicin, vitamins and minerals (Saadoun et al. 2004).

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I. Materials and Methods

The experiment was conducted in the two winter agricultural seasons 2021-2022 and 2022-2023 at the Agricultural Research Station of the College of Agriculture at the University of Basra. Random samples were taken from the soil of the field before planting at a depth of 0-30 cm, and mixed homogeneously to estimate some of its physical and chemical characteristics in the central laboratory. affiliated with the College of Agriculture at the University of Basra (Table 1). The soil of the field was plowed twice perpendicularly, smoothed and leveled, then divided into three sectors. Each sector contained six lines, 25 m long, 0.5 m wide, and 15 cm high, with a distance of 1 m between one line and another. Then each line was divided into five experimental units, each experimental unit containing 10 plants, so that the number of experimental units became 30 in each sector. Seedlings were planted with a distance of 0.5 m between one seedling and another. Agricultural operations were carried out according to the recommendations followed in growing broccoli, and decomposed animal manure was added at a rate of 40 Ton ha^{-1} (Matloub et al., 1989). The experiment included three factors for both seasons: two hybrids of broccoli plants (Matsuri, 2004), three seedling ages (30, 45, and 60 days) and garlic extract taken from the local garlic variety (Zubair garlic) and Chinese (locally produced) at two concentrations of 10 each. (and 20 ml liter-1) in addition to the comparison treatment (0) spraying with distilled water only, provided that the spraying is three times after transplanting in the field, with one week between one spraying and another. A Randomized Complete Block Design (R.C.B.D.) was used for a two-time split factorial experiment (Split Split Plot Design), where the hybrid was considered the main plot, the seedling age was the sub-plot, and the concentrations of spraying with the extract were the sub-sub plot, so the number of coefficients was 30. Factorial treatment with three replicates, so that the number of experimental units was 90 experimental units. The average results were statistically analyzed using the statistical program Genstat, V. 10.3 (2011), and the Least Significant Differences Test (L.S.D.) was used to compare the averages at the 0.05 probability level (Al-Rawi and Khalaf Allah, 1980).

Table (1) shows some physical and chemical characteristics of field soil and irrigation water for the agricultural seasons 2021-2022 and 2022-2023.

Soil properties		The first season 2021-2022	the second season 2022-2023
Degree of electrical conductivity (EC) (deci siemens m^{-1})		8.45	7.80
Soil acidity (pH)		7.61	7.43
dissolved ions (mmol l^{-1})	Na^{+}	24.33	23.17
	Ca^{++}	16.74	15.00
	Mg^{++}	8.11	7.29
	SO_4^{--}	22.60	21.85
	Cl^{-}	62.00	60.10
	HCO_3^{-}	3.1	2.90
Ready nitrogen	ppm	191	187
Ready phosphorus		74	72
Ready		180	215

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potassium			
Organic matter (%)		0.65	0.74
Soil separations (%)			
sand		58.2	63.0
silt		10.0	10.6
clay		31.8	26.4
Soil texture		Sand mixture	Sand mixture
Irrigation water			
season	pH	Degree of electrical conductivity (deci siemens m^{-1})	
2022-2021	7.85	6.10	
2023-2022	7.80	5.34	

1 - Total leaf area of the plant (dm2)

The leaf area was calculated according to Watson and Watson (1953), by taking three leaves from each plant, cutting a known square area from each of the three leaves, and drying the three sections and the remaining leaves in an electric oven at a temperature of 70°C for 48 hours until they set. Weigh and record their dry weight, then the leaf area is calculated as in the following equation:

Plant leaf area (dm2) = Leaf area of the plant (dm2) = number of leaves of the plant * area of the cut part (cm) * dry weight of leaves (g) / dry weight of the cut part (g) * 100

2 - Number of leaves per plant $^{-1}$

The number of large and medium leaves was calculated, the very small ones were neglected, and the average was extracted for each experimental unit.

3 - Weight of side pink tablets (g)

The weight of the lateral floral disc along with the portion of the floral stand was calculated for each experimental unit and the rate was extracted.

4 - Diameter of lateral flower discs (cm)

The circumference of the lateral discs was measured with a tape measure, converted to diameter for each experimental unit, and the average was extracted.

5 - Total yield per plant (kg)

It was calculated by summing the weight of the main disk with the weight of the side disks per plant for each experimental unit and dividing by the number of its plants.

II. Results and discussion:

Table (2) shows the presence of a "significant" effect of the factors under study for both seasons, as the Matsuri hybrid plants were significantly superior in the total leaf area of the plant compared to the other hybrid. It was also noted that the plants grown at 30 days old were superior in this trait, followed by a "significant" difference. Planted at 45 and 60 days old, as shown in the same table, the plants sprayed with garlic extract outperformed the comparison treatment plants, with an increase in area. The

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leaves of the plant increased with increasing spray concentration, and the plants sprayed with Chinese garlic extract at a concentration of 20 ml/l were superior. On other transactions. The results in the aforementioned table showed that there was a "significant" effect of the two-way interaction between the hybrid or seedling age with spraying with garlic extract for both seasons, as the Matsuri hybrid plants that were sprayed with Chinese garlic extract at a concentration of 20 ml L^{-1} outperformed when the hybrid was interacted with spraying with garlic extract with a value of 56.48. And 56.93 dm2, compared to the lowest value observed in the 2004 hybrid plants for the comparison treatment, which amounted to 38.04 and 38.00 dm^2. The binary interaction of seedling age and spraying with garlic extract showed a "significant" effect for this trait with a value of 58.77 and 58.50 dm2 for plants grown at 30 days old, which were sprayed with Chinese garlic extract at a concentration of 20 ml l^{-1}, compared to the smallest diameter for plants in the control treatment grown at 60 days old, which was " 37.17 and 39.72 dm2 for both seasons, respectively, while the double interaction between the hybrid and seedling age did not have a "significant" effect for both seasons. The triple interaction of the study factors showed a "significant" effect in the second season only, as the Matsuri hybrid plants planted at 30 days old outperformed. Which was sprayed with Chinese garlic extract at a concentration of 20 ml l^{-1} in the leaf area of the plant and amounted to 61.70 dm^2 compared to the lowest leaf area in the 2004 hybrid plants grown at 60 days old for the comparison treatment, which amounted to 35.07 dm^2 . Table (3) shows that the study factors had a significant effect on the number of leaves per plant for both seasons. The Matsuri hybrid plants were significantly superior to the 2004 hybrid. It was also noted that there was a significant increase with increasing seedling age, noting that there was no significant difference between the plants grown at the age of 30 and 45 days in this capacity for the second season, and the plants that were sprayed with garlic extract outperformed the plants in the control treatment, with a significant increase as the spray concentration increased, and the plants that were sprayed with Chinese garlic extract (10 or 20 ml l^{-1}) outperformed them with a "non-significant" difference between them. For the second season, followed by plants that were sprayed with local garlic extract (10 or 20 ml l^{-1}) with a non-significant difference for both seasons.

The double and triple interactions for both seasons did not show a significant effect on the number of leaves per plant, with the exception of the interaction between the hybrid and seedling age for the first season. The Matsuri hybrid plants planted at 30 days old gave the highest number of leaves, reaching 23.63 leaves, compared to the lowest number in the 2004 hybrid plants planted at 60 days old. a day", which amounted to 18.95 sheets . Table (4) shows that the Matsuri hybrid was significantly superior in both seasons to the 2004 hybrid in terms of the weight of the lateral disks. The same table also shows that the seedling age was significantly superior in both seasons. It is also clear that the spraying treatment with aqueous garlic extract was superior as the concentration increased for both seasons except the concentration. 10 ml l^{-1} was not significantly superior to the comparison treatment for both seasons.

It is also clear from the same table that the double and triple interactions had a significant superiority in this trait for both seasons, with the exception of the interaction between the hybrid and the age in the second season, which did not significantly affect the aforementioned trait. It is clear from the same table in the first season that the interaction between the Matsuri hybrid plants and the age of 30 days was significantly superior. It gave the highest weight of the side discs, amounting to 110.42 grams, compared to the 2004 hybrid plants planted at 60 days old, which gave the lowest weight of the side discs, amounting to 72.58 grams. The Matsuri hybrid plants also significantly outperformed Chinese garlic when spraying with a concentration of 20 ml L^{-1}, as it gave the highest value for the weight of the side discs, amounting to 129.32 grams compared to With the 2004 hybrid plants that were sprayed with treatment (0), which gave the lowest weight of the lateral discs, amounting to 64.08 g. It is also clear that the interaction between 30-day-old plants and spraying at a concentration of 20 ml L^{-1} Chinese garlic significantly outperformed the weight of the lateral discs, as the highest value reached 148.03 g compared to the lowest. Value for 60-day-old plants and spraying at a concentration of (0) It gave the lowest value of 58.53 grams. As for the triple intervention for the first season, the Matsuri hybrid plants planted at 30 days old when sprayed with a concentration of 20 ml L-1 Chinese garlic outperformed significantly, as it gave the highest value for the weight of the lateral discs, amounting to

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175.97 grams, compared to the 2004 hybrid plants grown at 60 days old when sprayed with a concentration of (0). The lowest value for the weight of the side discs was 55.57 grams. As for the second season interventions, the table shows that the Matsuri hybrid plants were significantly superior when sprayed with a concentration of 20 ml L^{-1} Chinese garlic, as they gave the highest value of 144.63 grams compared to the 2004 hybrid plants when sprayed with the comparison treatment that gave the lowest value. It reached 67.43 g. As for the interaction between age and spraying, the 30-day-old plants significantly outperformed when sprayed with a concentration of 20 ml L^{-1} with a value of 168.82 g compared to the 60-day-old plants when sprayed with a concentration of 10 ml L^{-1} of local garlic. The cultivated Matsuri hybrid plants also outperformed At 30 days old when sprayed with a concentration of 20 ml L^{-1} Chinese garlic, with a weight of 182.17 g, compared to the 2004 hybrid plants grown at 60 days old when sprayed with a concentration of 10 ml L^{-1} of local garlic with a weight of 56.27 g. Table (5) shows that the hybrid treatment was superior in the diameter of the lateral discs in both seasons, as the Matsuri hybrid was significantly superior to the 2004 hybrid. The same table also shows that the seedling age treatment was significantly superior in both seasons, as well as the spraying treatment was significantly superior in both seasons with increasing spray concentration, except The concentration of 10 ml L^{-1} did not outperform the control treatment in both seasons As for the double and triple interactions in the first season, they did not significantly affect the diameter of the lateral discs, except for the interaction between 30-day-old plants and spraying with a concentration of 20 ml L^{-1} of Chinese garlic extract, which was significantly superior with a value of 10.80 cm compared to 60-day-old plants when sprayed with a concentration of (0) as the minimum value of the interference treatment was 5.35 cm. The same table also shows that in the second season, 30-day-old plants significantly outperformed when sprayed with a concentration of 20 ml L^{-1}, with a value of 11.85 cm compared to the lowest value of 5.12 for 60-day-old plants when sprayed with a concentration of (0). The Matsuri hybrid plants grown at 30 days old also outperformed Which was sprayed at a concentration of 20 ml L^{-1} and gave the highest value for the diameter of the lateral discs, reaching 12.10, compared to the lowest value of 5.00 for the 2004 hybrid plants that were planted at 60 days old when sprayed at a concentration of (0). Table (6) shows that the Matsuri hybrid was significantly superior in yield per plant to the 2004 hybrid in both seasons. It is also clear from the same table that the seedling age was significantly superior as it increased for both seasons, and the spray treatment was also significantly superior as the concentration increased for both seasons. As for the double and triple interactions in the first season, the table shows that the Matsuri hybrid plants that were sprayed with a concentration of 20 ml l-1 Chinese garlic were significantly superior in yield per plant, as the highest value reached 1.039 grams, compared to the lowest value that reached 0.532 grams for the 2004 hybrid plants that were sprayed with a concentration of (0). The same table also shows that the plants that were planted at 30 days old and sprayed with a concentration of 20 ml L^{-1} Chinese garlic were significantly superior, as the yield for this treatment reached 1.128 grams, compared to the lowest yield of 0.508 grams for the 60-day-old plants that were sprayed with the comparison treatment. As for the double and triple interactions for the second season, the same table showed that the Matsuri hybrid plants that were sprayed with a concentration of 20 ml L^{-1} Chinese garlic were significantly superior, as the highest plant yield for this treatment reached 1.162 grams, compared to the lowest yield that reached 0.615 grams for the 2004 hybrid plants that were sprayed with a concentration of (0). The 30-day-old plants that were sprayed with a concentration of 20 ml l^{-1} of Chinese garlic also excelled significantly, as they gave the highest plant yield of 1.273 grams, compared to the lowest yield of 0.579 grams for the 60-day-old plants that were sprayed with a concentration of 10 ml of local garlic. As the table shows, the superiority The significance of the triple interaction for the Matsuri hybrid plants that were planted at 30 days old and sprayed with a concentration of 20 ml L^{-1} of Chinese garlic. The highest plant yield was 1.363 g, compared to the lowest yield of 0.518 g for the 2004 hybrid plants that were planted at 60 days old and sprayed with a concentration of 10 ml L^{-1} of local garlic. The results of Tables 2 and 3 show that the Matsuri hybrid plants for both seasons are superior in vegetative growth indicators compared to the 2004 hybrid plants. This may be due to the genetic difference between them, and the extent of their influence and response to the prevailing environmental conditions (Hassan, 2004), and this is in line with Zaki et al. (2015). and Sarker et al. (2022) and Al-Salhi and Mahmoud 2020. The positive effect of the early seedling age (30 days) and its superiority over the rest of the ages in the study (45 and 60 days) may be due to the seedlings at this age being more able to withstand the

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Transplant Shock. It is more rapid and responsive to resuming growth and renewing the root system that may be exposed to wounds and cuts during the transplantation process, and this reflects positively on vegetative growth indicators represented in plant height, stem diameter, number of leaves, and leaf area (Matloub et al., 1989 and Hassan, 1994). These results are in line with Both Soniya et al. (2019) and Pandey et al. (2021) . The superiority of spray treatment with Chinese garlic extract in vegetative growth characteristics may be attributed to the fact that the extract contains amino acids with a high sulfur content, such as Cysteine and Methionine, which have a "major" role in the vital processes within the plant cell, in addition to containing volatile oils such as Allicin, vitamins and minerals, and this is consistent with Hammad et al. (2020) and Mahmood et al. (2021). As the results of Tables 4 and 5 showed, the Matsuri hybrid treatment was superior to the 2004 hybrid in yield indicators and its components. This may be attributed to the difference in genetic composition and the extent of the response of these hybrids to environmental conditions and their reflection on the vital processes within the plant. This may be attributed to the moral superiority of the Matsuri hybrid in vegetative growth indicators. Table (2 and 3) The number of leaves and leaf area, consequently, an increase in the rate of carbon metabolism and its products, which was reflected positively on the weight of the main and lateral discs, plant yield, and total productivity Nassef and Nabeel (2011). These results agree with Omer and Abdul (2013), Sudani (2021), and Allela and Hamdani (2019) . The superiority of 30-day-old plants in yield and its components, represented by side discs, plant yield, and total productivity, may be attributed to the availability of environmental conditions suitable for plants of this age, and this was evident in the number of leaves and leaf area. Consequently, an increase in carbon assimilation processes and the accumulation of manufactured foodstuffs reflected positively on the indicators. The yield and its components. Also, the seedling age of 30 days allowed the plants to be exposed to relatively high temperatures at the beginning of the vegetative growth stage and then exposed to low temperatures for a period sufficient to complete the formation of the flower pods. Trotta and Elia (1994) and this is consistent with Grabowska et al. (2007). and Yaseen and Ahmed (2017) . The superiority of spraying with a concentration of 2 ml l-1 Chinese garlic in yield indicators and components may be attributed to the extract's high components of sulfur compounds and amino acids, which have an important role in many biological processes in the plant, as the sulfur element is involved in the synthesis of protein compounds (electronic carriers).) between the first and second photosystem in thylokoid membranes Martins et al. (2006). The extract also contains relatively high levels of concentrations of macronutrients (NPK) and vitamin C, and this reflected positively on the process of carbon metabolism, thus increasing the accumulation of the products of this process (carbohydrates) in places. It is stored in pink discs by Abo-Hussein et al. (1975), and this is consistent with Khalil and Al-Assaf (2012) and Ahmad (2021).

first season								the second season							
Hybrid	Seedling age day)(	Spraying with garlic) liter $^{-1}$ ml(extract					Hybrid × the age	Hybrid	Seedling age day)(	Spraying with garlic) liter $^{-1}$ ml(extract					Hybrid × the age
		Comparison	Garlic local		Garlic Chinese					Comparison	Garlic local		Garlic Chinese		
		0	10	20	10	20				0	10	20	10	20	
Matsuri	30	11.09	12.62	14.87	17.97	21.56	15.62	Matsuri	30	12.56	12.28	16.88	20.61	23.99	17.26
	45	10.18	11.66	13.51	15.18	17.26	13.56		45	11.73	12.94	12.82	16.71	20.45	14.93
	60	9.69	10.72	12.05	14.06	16.01	12.51		60	10.74	11.28	11.44	17.96	16.92	13.67
2004	30	10.17	11.66	13.82	16.28	18.12	14.01	2004	30	11.72	12.85	12.8	17.74	20.83	15.19
	45	9.73	10.5	11.9	12.6	14.7	11.92		45	10.79	12.0	13.3	13.8	16.5	13.3

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			1	2	7	9				1	6	2	1	
	60	8.18	9.61	10.44	12.13	13.12	10.69		60	9.96	9.12	11.29	12.75	14.47	11.52
RLSD 0.05		NS					NS	RLSD 0.05		1.12					NS
Spraying × Hybrid							Average of hybrid	Spraying × Hybrid							Average of hybrid
Hybrid	Matsuri	10.32	11.67	13.47	15.73	18.28	13.89	Hybrid	Matsuri	11.68	12.17	13.71	18.42	20.45	15.29
	2004	9.36	10.59	12.06	13.69	15.34	12.21		2004	10.83	11.33	12.48	14.77	17.27	13.34
RLSD 0.05		0.55					0.54	RLSD 0.05		0.66					0.58
Spraying×the age							Average of age	Spraying×the age							Average of age
The age	30	10.63	12.14	14.34	17.12	19.84	14.81	The age	30	12.14	12.57	14.84	19.18	22.41	16.23
	45	9.96	11.09	12.71	13.92	16.02	12.74		45	11.26	12.47	13.09	15.27	18.48	14.11
	60	8.93	10.16	11.25	13.1	14.56	11.6		60	10.35	10.2	11.37	15.35	15.69	12.59
RLSD 0.05		0.67					0.40	RLSD 0.05		0.79					0.38
Average of spray		9.84	11.13	12.77	14.71	16.81		Average of spray		11.25	11.75	13.1	16.6	18.86	
RLSD 0.05		0.37						RLSD 0.05		0.46					

Table (2) Effect of two broccoli hybrids, seedling age, and spraying with garlic extract and their dm^2) for the seasons 2021-2022 and 2022-2023(interactions on leaf area

Table (3) Effect of two hybrids of broccoli, seedling age, spraying with garlic extract, and their and 2022-2023 . 2022-2021 for the seasons interactions on the leaf number

first season								the second season							
Hybrid	Seedling age day)(	Spraying with garlic) liter $^{-1}$ ml(extract					Hybrid × the age	Hybrid	Seedling age day)(	Spraying with garlic) liter $^{-1}$ ml(extract					Hybrid × the age
		Comparison	Garlic local		Garlic Chinese					Comparison	Garlic local		Garlic Chinese		
		0	10	20	10	20				0	10	20	10	20	
Matsuri	30	21.50	22.44	23.58	24.00	26.61	23.63	Matsuri	30	21.00	23.07	22.43	24.27	27.43	23.64
	45	19.55	21.33	22.78	23.33	24.24	22.25		45	20.47	21.83	22.27	24.23	24.30	22.62
	60	18.33	19.30	20.66	21.14	23.16	20.52		60	20.70	20.93	22.30	23.07	23.53	22.11
2004	30	18.90	19.68	21.27	20.92	23.14	20.78	2004	30	19.53	19.37	21.43	24.47	25.23	22.01
	45	18.44	19.66	20.44	20.55	22.66	20.35		45	18.47	20.40	20.13	19.47	21.27	19.95
	60	17.44	18.77	19.33	18.66	20.55	18.95		60	16.60	18.33	18.27	21.83	20.33	19.07
RLSD 0.05		NS					1.10	RLSD 0.05		NS					N.S

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Spraying × Hybrid							Average of hybrid	Spraying × Hybrid							Average of hybrid
Hybrid	Matsuri	19.79	21.02	22.34	22.82	24.67	22.13	Hybrid	Matsuri	20.72	21.94	22.33	23.86	25.09	22.79
	2004	18.26	19.37	20.35	20.05	22.12	20.03		2004	18.20	19.37	19.94	21.92	22.28	20.34
RLSD 0.05		N.S					1.42	RLSD 0.05		NS					1.00
Spraying×the age							Average of age	Spraying×the age							Average of age
The age	30	20.20	21.06	22.43	22.46	24.88	22.21	The age	30	20.27	21.22	21.93	24.37	26.33	22.82
	45	19.00	20.50	21.61	21.94	23.45	21.30		45	19.47	21.12	21.20	21.85	22.78	21.28
	60	17.89	19.04	20.00	19.90	21.86	19.74		60	18.65	19.63	20.28	22.45	21.93	20.59
RLSD 0.05		N.S					0.46	RLSD 0.05		N.S					1.58
Average of spray		19.03	20.20c	21.35	21.44	23.40		Average of spray		19.46	20.66	21.14	22.89	23.68	
RLSD 0.05		1.26						RLSD 0.05		1.50					

Table (4) Effect of two broccoli hybrids, seedling age, spraying with garlic extract, and their interactions on weight side flowers disk (gm) for the seasons 2021-2022 and 2022-2023.

first season								the second season							
Hybrid	Seedling age day)(	Spraying with garlic) liter $^{-1}$ ml(extract					Hybrid × the age	Hybrid	Seedling age day)(	Spraying with garlic) liter $^{-1}$ ml(extract					Hybrid × the age
		Comparison	Garlic local		Garlic Chinese					Comparison	Garlic local		Garlic Chinese		
		0	10	20	10	20				0	10	20	10	20	
Matsuri	30	70.73	78.07	95.43	131.90	175.97	110.42	Matsuri	30	82.03	77.40	109.43	160.37	182.17	122.28
	45	69.27	72.53	82.87	98.23	111.77	86.93		45	75.17	83.93	95.30	118.47	141.33	102.84
	60	61.50	69.20	75.53	84.60	100.23	78.21		60	68.03	66.07	80.30	92.20	110.40	83.40
2004	30	68.40	68.27	86.03	100.43	120.10	88.65	2004	30	76.33	90.53	95.47	125.13	155.47	108.59
	45	68.27	67.00	78.07	88.87	99.97	80.43		45	65.60	60.37	80.43	92.23	105.43	80.81
	60	55.57	61.80	69.47	80.37	95.70	72.58		60	60.37	56.27	72.03	97.43	91.53	75.53
RLSD 0.05		14.87					7.32	RLSD 0.05		14.40					N.S
Spraying × Hybrid							Average of hybrid	Spraying × Hybrid							Average of hybrid
Hybri	Matsu	67.17	73.	84.	104.	129.	91.86	Hybri	Matsu	75.08	75.	95.0	123.	144.	102.8

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d	**ri**		27	61	91	32		**d**	**ri**		80	1	68	63	4
	2004	64.08	65.69	77.86	89.89	105.26	80.55		**2004**	67.43	69.06	82.64	104.93	117.48	88.31
RLSD 0.05		**7.93**					**3.67**	**RLSD 0.05**		**8.50**					**8.65**
Spraying×the age							**Average of age**	**Spraying×the age**							**Average of age**
The age	**30**	69.57	73.17	90.73	116.17	148.03	99.53	**The age**	**30**	79.18	83.97	102.45	142.75	168.82	115.43
	45	68.77	69.77	80.47	93.55	105.87	83.68		**45**	70.38	72.15	87.87	105.35	123.38	91.83
	60	58.53	65.50	72.50	82.48	97.97	75.40		**60**	64.20	61.17	76.17	94.82	100.97	79.46
RLSD 0.05		**10.92**					**6.24**	**RLSD 0.05**		**10.22**					**5.87**
Average of spray		65.62	69.48	81.23	97.40	117.29		**Average of spray**		71.26	72.43	88.83	114.31	131.06	
RLSD 0.05		**6.13**						**RLSD 0.05**		**5.72**					

Table (5) Effect of two broccoli hybrids, seedling age, spraying with garlic extract, and their interactions on Radius side flowers disk (cm) for the seasons 2021-2022 and 2022-2023

first season								**the second season**							
Hybrid	**Seedling age day)(**	**Spraying with garlic) liter $^{-1}$ ml(extract**					**Hybrid × the age**	**Hybrid**	**Seedling age day)(**	**Spraying with garlic) liter $^{-1}$ ml(extract**					**Hybrid × the age**
		Comparison	**Garlic local**		**Garlic Chinese**					**Comparison**	**Garlic local**		**Garlic Chinese**		
		0	**10**	**20**	**10**	**20**				**0**	**10**	**20**	**10**	**20**	
Matsuri	**30**	7.10	7.12	8.20	8.90	11.40	8.54	**Matsuri**	**30**	7.06	7.23	10.04	8.74	12.10	9.03
	45	6.71	7.00	7.30	8.55	9.34	7.78		**45**	7.00	7.45	7.93	9.11	9.66	8.23
	60	5.81	6.33	6.50	7.33	8.72	6.94		**60**	5.23	6.50	7.00	7.41	8.93	7.01
2004	**30**	5.50	5.60	6.63	8.83	10.20	7.35	**2004**	**30**	6.85	7.36	7.50	8.93	11.60	8.45
	45	5.10	5.36	6.20	7.41	8.01	6.41		**45**	5.67	5.50	8.41	7.89	8.85	7.26
	60	4.90	5.14	5.60	6.39	7.10	5.82		**60**	5.00	5.45	5.21	6.55	7.33	5.91
RLSD 0.05		**N.S**					**N.S**	**RLSD 0.05**		**1.24**					**N.S**
Spraying × Hybrid							**Average of hybrid**	**Spraying × Hybrid**							**Average of hybrid**
Hybrid	**Matsuri**	6.54	6.82	7.33	8.26	9.82	7.75	**Hybrid**	**Matsuri**	6.43	7.06	8.32	8.42	10.23	8.09
	2004	5.16	5.36	6.14	7.54	8.43	6.53		**2004**	5.84	6.10	7.04	7.79	9.26	7.20
RLSD 0.05		**N.S**					**0.85**	**RLSD 0.05**		**N.S**					**0.86**
Spraying×the age							**Average of age**	**Spraying×the age**							**Average of age**

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The age	**30**	6.30	6.36	7.41	8.86	10.80	7.95	**The age**	**30**	6.43	7.06	8.32	8.42	10.23	8.09
	45	5.90	6.18	6.75	7.98	8.68	7.10		**45**	5.84	6.10	7.04	7.79	9.26	7.20
	60	5.35	5.73	6.05	6.86	7.91	6.38		**60**	6.43	7.06	8.32	8.42	10.23	8.09
RLSD 0.05		**0.83**					**0.47**	**RLSD 0.05**		**0.86**					**0.47**
Average of spray		5.85	6.09	6.74	7.90	9.13		**Average of spray**		6.13	6.58	7.68	8.10	9.74	
RLSD 0.05		**0.47**						**RLSD 0.05**		**0.49**					

Table (6) Effect of two broccoli hybrids, seedling age, spraying with garlic extract, and their plant yield(kg) for the seasons 2021-2022 and 2022-2023 interactions on

first season								**the second season**							
Hybrid	**Seedling age day)(**	**Spraying with garlic) liter $^{-1}$ ml(extract**					**Hybrid × the age**	**Hybrid**	**Seedling age day)(**	**Spraying with garlic) liter $^{-1}$ ml(extract**					**Hybrid × the age**
		Comparison	**Garlic local**		**Garlic Chinese**					**Comparison**	**Garlic local**		**Garlic Chinese**		
		0	**10**	**20**	**10**	**20**				**0**	**10**	**20**	**10**	**20**	
Matsuri	**30**	0.630	0.717	0.845	1.021	1.225	0.888	**Matsuri**	**30**	0.714	0.698	0.959	1.171	1.363	0.981
	45	0.579	0.663	0.768	0.862	0.981	0.770		**45**	0.666	0.735	0.728	0.949	1.162	0.848
	60	0.551	0.609	0.685	0.799	0.910	0.711		**60**	0.610	0.641	0.650	1.020	0.961	0.776
2004	**30**	0.578	0.663	0.785	0.925	1.030	0.796	**2004**	**30**	0.666	0.730	0.727	1.008	1.183	0.863
	45	0.553	0.597	0.677	0.739	0.840	0.681		**45**	0.613	0.682	0.759	0.785	0.938	0.755
	60	0.465	0.546	0.594	0.690	0.745	0.608		**60**	0.566	0.518	0.641	0.724	0.822	0.654
RLSD 0.05		**N.S**					**N.S**	**RLSD 0.05**		**0.064**					**N.S**
Spraying × Hybrid							**Average of hybrid**	**Spraying × Hybrid**							**Average of hybrid**
Hybrid	**Matsuri**	0.586	0.663	0.766	0.894	1.039	0.790	**Hybrid**	**Matsuri**	0.663	0.691	0.779	1.047	1.162	0.868
	2004	0.532	0.602	0.685	0.784	0.872	0.695		**2004**	0.615	0.643	0.709	0.839	0.981	0.758
RLSD 0.05		**0.030**					**0.027**	**RLSD 0.05**		**0.037**					**0.033**
Spraying×the age							**Average of age**	**Spraying×the age**							**Average of age**
The age	**30**	0.604	0.690	0.815	0.973	1.128	0.842	**The age**	**30**	0.690	0.714	0.843	1.089	1.273	0.922
	45	0.566	0.630	0.722	0.801	0.911	0.726		**45**	0.640	0.708	0.744	0.867	1.050	0.802
	60	0.508	0.57	0.63	0.74	0.82	0.659		**60**	0.588	0.57	0.64	0.87	0.89	0.715

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			8	9	4	8					9	6	2	2	
RLSD 0.05		**0.038**					**0.021**	**RLSD 0.05**		**0.045**					**0.021**
Average of spray	0.559	0.632	0.725	0.839	0.955		**Average of spray**	0.639	0.667	0.744	0.943	1.071	
RLSD 0.05	**0.021**						**RLSD 0.05**	**0.026**					

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