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Purple blotch incidence and garlic productivity as affected by irrigation intervals and plant density

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Abstract

Field experiments were carried out in the seasons 2017/2018 and 2018/2019 at Sids Horticultural Research Station, A.R.C. Beni-Suef governorate, under natural infection conditions of purple blotch. The purpose of this research was to evaluate the efficacy of different irrigation intervals and plant density on garlic purple blotch severity and incidence, phyllosphere microorganisms' community, vegetative characters, and productivity of garlic plants. Irrigation intervals (14, 21, and 28 days) and plant density levels (30, 45, and 60 cloves / m^2) significantly affect the disease incidence and severity. Irrigation at 14 days intervals reduced purple blotch severity and incidence on garlic plants at the different plant densities followed by 21- and 28-days intervals. Meanwhile, a high population (60 plants/ m^2) obtained the highest percent of purple blotch incidence and severity compared with both 30 and 45 plant/ m^2. On the other hand, irrigation intervals, plant density, and their interaction significantly also affected the total count of phyllosphere microorganisms as well as garlic growth parameters (plant height, vegetative growth weight, dry weights of bulbs, and loss weight percentage after 6 months).

Keywords: *Alternaria porri*; garlic productivity; Irrigation intervals; plant density; purple blotch and storage loss weight.

INTRODUCTION

Garlic (*Allium sativum* L.) belongs to the family Alliaceae and is a constituent of one of the oldest and most important bulbous vegetable crops in Egypt and the world. It comes after tomatoes, potatoes and onions as important vegetables. Also, garlic has many medical benefits in controlling some bacterial and fungal diseases, and it also has anti-diabetic properties, cancer, ulcers, rheumatism, etc. (Bayan *et al.,*2014). In Egypt, the garlic cultivation area reached about 38483 fed. producing 360113 ton. Knowing that this cultivation was concentrated in the central governorates of Egypt (El-Minya, BeniSuef, El-Fayoum and El-Giza) Anonymous (2019). Garlic Eggaseed-1 is one of the main varieties has purple peel and hard neck, which are grown in Minya and Beni Suef governorates. Youssef and Tony, (2014) found that the lowest incidence of leaf blight in the cultivars with colored crust was the cultivar Eggaseed 1" followed by Colon 24, while the cultivar Sids- 40 recorded the highest rate of infection. On the other hand, the lowest rate of infection was recorded in the "Egyptian" cultivar with white crust compared with color crust cultivars. Cultivar Egaseed-1 surpassed the other genotypes and ranked the highest yield ton/fed compared with Sids- 40 and Colon 24 cultivars which productivity of green crop recorded about 13 tons / fed., and the dry crop is about 7 tons (Youssef and Tony, 2014; Ahmed *et al*., 2019).

Several factors have been a role in the low productivity of garlic in Egypt. The most important factors responsible are the diseases like air born, soil born and storage diseases. Among these diseases, the purple blotch is one of the majors constrains in garlic cultivation and causes severe yield loss (Arunakumara *et al*., 2023). *Alternaria porri* is the cause of purple blotch disease. Garlic purple blotch epidemics are strongly influenced by environmental factors. The main environmental influences are relative humidity, temperature, and light. The pathogen attacks onions, garlic, shallots, and other Allium crops. High relative humidity (RH) (80 - 90%) and optimal temperature (24°C) are required for infection incidence. Srujani and Srikanta (2018) mentioned that under growth chamber conditions (25°C) as well high relative humidity (RH) (95.0%) recorded a high value of conidial germination and germ tube length, respectively. Meanwhile, results of field conditions cleared that temperature and RH play an important role in the development of purple blotch. In favorable conditions, an epidemic may cause the total depression of the crop. High losses were recorded due to purple blotch disease by Vijaykumar *et al.*, (2022) as well as that in onion seed crop has been reported to reach 97% infection Nanda *et al.,* (2016). Irrigation as an agricultural practice can be an important and necessary tool for global food production. Irrigation can also be used as a factor in controlling plant diseases. In fact, irrigation is a useful component in controlling some soil and airborne diseases (Dixon and Tilston 2010). Under irrigation at 10, 12, and 15-day intervals Bhonde *et al.,* (2001) showed that irrigation at 10-day intervals was the best treatments for reducing purple blotch on onion plants compared to 12- and 15-day intervals.

Plant population is one of the production components that have to be optimized. The ideal utilize of dividing or plant population features a double advantage. Plant densities play an imperative part and vital apparatus for worldwide nourishment generation. Subsequently, the garlic plant intra-row populace guarantees the successful utilize of accessible cropland (Awas *et al.,* 2010 ;Khodadadi and Nosrati, 2012). Low planting density reduces competition for light, water and supplements in plants. Rekowska and Skupien (2009) found that an increment of garlic plant density within the row from 8 to 2cm caused a noteworthy increment of the yield.

Therefore, the objectives of this research are twofold were as follow: We first discuss the effects of different irrigation intervals and plant densities on the control of garlic leaf purple blotch disease and its use in integrated pest management systems. Second, the effect of irrigation number and plant density on vegetative properties and garlic yield under field conditions and weight loss during storage.

MATERIALS AND METHODS

The present study was carried out during two successive growing seasons at the A.R.C. Sids Horticultural Research Station Beni-Suef Governorate (Lat.29°04'N,31°06'E,30.40m above sea level). 2017/2018 and 2018/2019.to investigate the effect of irrigation numbers and plant density on severity of purple blotch disease and yield on garlic cultivar Eggaseed-1.

Data in Table 1 show the mean of temperature and relative humidity (%) during the 2017/2018 and 2018/2019—growing seasons which play the main environmental factors on garlic purple blotch disease incidence.

Table 1. Mean temperature and relative humidity (RH) data of the experimental location during the two growing seasons.

Month	First season 2017 /2018		Second season 2018/2019	
	Mean Temp. (°C)	Relative Humidity (%)	Mean Temp. (°C)	Relative Humidity (%)
October	22.9	47.94	24.05	47.16
November	17.17	55.99	18.96	52.57
December	14.93	57.87	13.3	63.34
January	11.85	62.17	11.22	47.16
February	16.62	45.11	13.36	49.09
March	20.61	33.42	15.95	45.28
April	24.6	30.91	18.20	42.54

Source: Central lab. Of agricultural climate-ARC.

1-Field experiments:

The experimental design used during the two growing seasons was split plot in randomized complete block with three replicates. The Eggaseed -1 cv. of garlic cloves was planted on 10- 15 of October in both the growing seasons (2017 /2018 and 2018/2019), respectively. In addition, other treatments practices normal cultural of growing garlic plant were followed. Additionally, other treatment methods common in the growing of garlic plants were also implemented.

The main and secondary sections were divided as follows**:**

Main plots (Irrigation numbers (I):

I1=Plant Irrigation at 14 days intervals (10 irrigations).

I2 = Plant Irrigation at 21 days intervals (7 irrigations).

(Recommended irrigations times)

I3 = Plant Irrigation at 28 days intervals (5 irrigations).

Sub plots (plant densities (D):

Garlic plants were grown at three system densities (5, 7 and 10 cm) spacing between plants within the ridges on either side of the row. Plant density was randomly arranged within subplots. Each plot area was 42 m².

Number of planted cloves/ ridge was distributed as follows:

D1 = 30 cloves/m2 as low plant density.

D2 = 45 cloves/m2 as moderately plant density.

D3 = 60 cloves/m2 as higher plant density. All the cloves depth of planting was about 3-5 cm.

Crop - water relationships:

Irrigation treatments were started30daysafterplanting. All treatments received the same amount of water during the first irrigation. An affixed-dimension immersion flow hole was used to measure the amount of water applied according to the following equation **Michael (1978):**

Q = CA 2 gh

Where:

Q=discharge through orifice, (L/sec).

C=coefficient of discharge, (0.61)

A=cross-sectional area of the orifice, (cm^2)

g=acceleration of gravity, (981 cm/sec).

h=pressure head, causing discharge through the orifice (cm)

Diseases assessment:

A- Disease severity infection (D.S):

Garlic plants were left for natural infection conditions with purple blotch pathogen. Observations of *Alternaria porri* infection were recorded on randomly selected plants from the diseased infected plants after four months from planting (during the 3rdweek of February). Cultivated sample plants taken from each randomized plot to determined disease severity was done on (0 to 5) scale based on leaf area covered by blotches according to the method described by **Sharma (1986).**

$$D.S = \frac{\text{Sum of disease ratings}}{\text{Total number of observations} \times \text{highest disease grade}} \times 100$$

B- Disease incidence infection (D.I)

Infected plants that having a symptom of purple blotch were collected as above method mentioned in disease severitymethod and calculated according to as suggested by **Tarr (1981)** by the following Equation as follows:

$$\text{Disease incidence percent (\%)} = \frac{\text{No. of plants infected with purple blotch}}{\text{Total No. of plants}} \times 100$$

3-Count of pyllosphere microorganisms:

To isolate phyllosphere fungi from garlic leaves, samples were collected monthly during the growing season constant from September to April. The collected healthy green garlic leaves were cut into small pieces (approximately 1cm^2) and dissolvedin100ml of sterile water in a 300 ml bottle and shaken for 20 minutes. One ml of each suspension was diluted with another 100 ml. for fungal isolation, it was diluted to 1/10000 with sterile water, and the latter suspension was further transferred to 100 ml.water to make dilute1/1000000 to isolate bacteria. One ml each of the second dilution (fungal isolation) and third dilution (bacterial isolation) was spread flat on the surface of a9-cm diameter PDA dish. One day after planting, the trays were inverted and incubated at 25°C for 5 days. Colonies of each causal pathogen were counted and tabulated according to Aneja (2003); Abd El-Baky and Abd El-Galil (2014).

4-Vegitative and yield parameters:

Two weeks before harvest, ten plants were taken randomly from each experimental plot to determine plant height (cm) and vegetative fresh weight (g /plant). Garlic plants were harvested on the 17 - 23 of April, in the 2017 /2018 and 2018/2019 seasons, respectively. Yield of fresh bulb (kg/plot) and yield/fed. were calculated (ton/ fed.). The harvested garlic plants were left in the field to be cured for 21 days and the cured yield was weighted and calculated (ton/ fed.).

5-Storage ability:

The percentage of weight loss during storage was calculated using the cured yield of garlic sample plants. Five kilograms of plants were only selected from each experimental plot on May 11 and stored in mesh bags under normal storage conditions. In both seasons, samples were weighed three times at two, four, and six months after storage, and loss garlic bulbs weight percentages were calculated.

6- Statistical Analysis:

Data from both years were combined in a single analysis. Analysis of variance and Duncan's Multiple Range test at 0.05 level means separation tests using MSTST-c (1985). Software C was used to compare the collected data.

RESULTS

A-Effect on the purple blotch incidence and severity:

Data presented in table (2) show that the different irrigation intervals and spacing create significant differences in their effects on disease incidence and severity. Data proved that using irrigation at 14 days intervals (10 irrigations times) reduced the general mean of purple blotch incidence on garlic plants at the different plant densities flowed by 7 irrigations times and then 5 irrigations times which obtained 55.67,58.73and 60.89% during the two seasons. The similar effect was found on purple blotch severity 24.55, 28.26 and 29.30 % respectively.

Table 2. Effect of irrigation intervals, planting density and their interactions on purple blotch disease incidence and severity of Eggassed-1 garlic cultivar during 2017 /2018 and 2018/2019 season.

Irrigation Interval (I)	Plant density (D)	Purple blotch Disease incidence			Purple blotch Disease severity		
		2017/2018	2018/2019	Mean	2017/2018	2018/2019	Mean
I_1	D1	52.00	51.00	51.50	21.34	20.58	20.96
	D2	57.67	53.00	55.34	27.84	22.34	25.09
	D3	63.67	56.67	60.17	30.12	25.08	27.06
	Mean	57.78 B	53.56 C	55.67	26.43B	22.67 B	24.55
I_2	D1	56.33	54.00	55.17	26.69	23.31	25.00
	D2	62.00	56.33	59.17	31.08	25.45	28.27
	D3	64.00	59.67	61.84	34.37	28.66	31.52
	Mean	60.78 A	56.67 B	58.73	30.71 A	25.81 A	28.26
I_3	D1	58.00	55.00	56.50	27.51	25.26	26.39
	D2	62.33	58.67	60.50	31.59	29.00	30.30
	D3	67.66	63.67	65.67	34.30	28.13	31.22
Mean		62.67 A	59.11 A	60.89	31.13 A	27.46 A	29.30
Mean of plant density	D1	55.44 C	53.33 C	54.39	25.18 B	23.05 B	24.12
	D_2	60.67 B	56.00 B	58.34	30.17 A	25.60 A	27.89
	D_3	65.11 A	60.00 A	62.56	32.82 A	27.29 A	30.06

(I1)=14 days intervals (10 irrigations times) **(D1) = 30 cloves/ m² in low plant density.**
(I2)= 21 days intervals (7 irrigations times) **(D2) = 45 cloves/ m² in low plant density.**
(I3) =28 days intervals (5 irrigations times) **(D3) = 60 cloves/ m² higher plant density.**
Means within each column followed by the same letter are not statistically different at 0.05 level (Duncan's range test).

Data also clear that all both of purple blotch incidence and severity were significantly affected by plant densities. Consequently, general mean of the two successful seasons at high population (60 plant/m^2) obtained the highest percent of purple blotch incidence (62.56%) compared with both of 45 and 30 plant/ m^2 which were recorded at 58.34% and 54 39%, respectively. The same trend was found in purple blotch severity, but no significant difference was detected between 45 and 60 plant/m^2. These results were thru in the two growing seasons.

Regarding the interaction effect between irrigation intervals and plant densities on purple blotch incidence and severity. Results indicate that purple blotch incidence was affected by the interaction treatments. In general, plants received 5 irrigations in addition to high population of garlic plants (60 plants/ m^2) gave the highest infection values 67.66% and 63.67% disease incidence and 34.20% and 28.13% disease severity during 2017/2018 and 2018/2019 seasons, respectively. On the contrary, the lowest values of purple blotch severity and incidence were observed at 10 irrigations times in addition to low populations 30 plants / m^2 with significant differences in both growing seasons (Table 2).

B-Effect on the total count community of leaf fungi and bacteria:

In both of 2017 and 2018 season, data presented in table (3) showed that significantly affect was found at 14-, 21- and 28-days intervals of irrigation on the phyllosphere total count of fungi and bacterial colonies on garlic plants. Irrigation every 2 weeks (10 irrigation times) shows an increase in the number of fungi and bacterial colonies with reduced incidence and severity of purple blotch (Table 2 and 3) followed by moderately effect while this number decreased when watering every 3 weeks (7 irrigation times) and then the microbial community showed a decrease in population in when irrigation every 4 weeks (5 irrigation times).

Table 3. Impact of irrigation intervals, planting density and their interactions on phyllosphere fungi and bacteria of Eggassed-1 garlic cultivar during 2017 /2018 and 2018/2019 season.

Irrigation Interval (I)	Plant density (D)	Total count of leaf fungi x10^3			Total count of leaf bacteria x10^6		
		2017/2018	2018/2019	Mean	2017/2018	2018/2019	Mean
I_1	D1	10.33C	14.0DE	12.17	120.67	131.67C	126.17
	D2	18.0 B	22.67 B	20.34	139.33	153.67 B	146.50
	D3	35.33 A	40.33 A	37.83	178.67	174.33 A	176.50
	Mean	21.22 A	25.67 A	23.45	146.22 A	153.11 A	149.67
I_2	D1	6.33 C	15.33 CDE	10.83	67.00	93.33 D	80.17
	D2	16.33 B	16.00 BCDE	16.17	83.00	98.00 D	90.50
	D3	16.67 B	18.67 BCD	17.67	108.33	119.67 C	114.00
	Mean	13.11 B	16.67 B	14.89	86.11 B	103.67 B	94.89
I_3	D1	7.67 C	10.33 E	9.00	36.67	68.67 E	52.67
	D2	8.00 C	21.00 BC	14.50	41.00	72.00 E	56.50
	D3	11.67 C	22.67B	15.62	86.67	73.67 E	80.17
Mean		9.11 C	18.11 B	13.61	54.78 C	71.44 C	63.11
Mean of plant density	D1	8.11 C	13.22 C	10.67	74.78 C	97.89 C	86.34
	D_2	13.11 B	20.00 B	16.56	87.78 B	107.89 B	97.84
	D_3	20.67 A	27.22 A	23.95	124.56 A	122.44 A	123.5

(I1)=14 days intervals (10 irrigations times) **(D1) = 30 cloves/ m^2 in low plant density.**
(I2)= 21 days intervals (7 irrigations times) **(D2) = 45 cloves/ m^2 in low plant density.**
(I3) =28 days intervals (5 irrigations times) **(D3) = 60 cloves/ m^2 higher plant density.**
Means within each column followed by the same letter are not statistically different at 0.05 level (Duncan's range test).

Concerning the garlic plant density effect on the numbers of the leaf microorganisms, data show that high population (60 plants/ m^2) obtained the highest number of the total count community of leaf fungi and bacteria compared with the other plant densities (30 and 45 plant/ m^2).

The interaction effects of irrigation interval and plant density on the overall foliar fungal and bacterial communities of garlic cultivar Egassed-1 are shown in Table 3. Results showed that, during the two growing seasons, a high population of garlic plants (60 plants/ m2) which received 10 irrigations obtained the highest percent of the mean total count of leaf fungi (23.45 x10^3) and bacteria (149.67x106). Meanwhile, the lowest level of microorganisms (13.61 x10^3) for fungi and (63.11 x10^6) for bacteria, was found at 30 plants/ m2with received 5 irrigations (21 days intervals numbers of irrigation) respectively.

C-Effect on plant height, fresh weight and cured yield:

Data tabulated in Table, 4 appear the impact of irrigation intervals on garlic growth parameters like plant height and fresh weight. The results showed that both plant height and fresh weight resulted in significantly increasing when the plant received ten irrigations followed seven and after those five irrigations in both the 2017/2018 and 2018/2019 seasons. Data also clear that garlic cured yield was significantly increased with increasing irrigation numbers from five up ten in both growing seasons.

Table 4. Effect of irrigation intervals, plant densities and their interactions on plant height, fresh weight and cured yield of cultivar Eggaseed-1 during 2017/2018 and 2018/2019 seasons.

Irrigation Interval (I)	Plant density (D)	Plant height (cm)			Fresh weight (gm)			cured yield (ton/fed.)		
		2017 /2018	2018/ 2019	Mean	2017 /2018	2018/ 2019	Mean	2017 /2018	2018/ 2019	Mean
I_1	D1	65.67	71.33	68.50	50.69 A	54.81 A	52.75	4.24 D	4.54 D	4.39
	D2	69.33	74.67	72.00	45.67 AB	49.00B	47.33	4.85 BC	4.98 C	4.92
	D3	73.37	76.40	74.89	40.00C	47.75C	43.88	6.00A	6.57A	6.28
Mean		70.64 A	74.13 A	72.39	45.45 A	50.52 A	47.99	5.03	5.36 A	5.12
I_2	D1	61.00	66.54	63.77	49.33 AB	53.00 AB	51.17	4.25 DE	4.24 E	4.25
	D2	66.00	69.95	67.98	44.08 B	48.67 B	46.38	5.10 C	5.34 C	5.23
	D3	70.00	74.50	72.25	36.23 D	44.92 B	40.58	5.95 B	6.27 B	6.11
Mean		68.09 B	70.30 B	69.20	43.21B	48.86 B	46.06	5.10	5.28 B	5.19
I_3	D1	55.43	60.20	57.82	34.51D	39.85 D	37.18	3.00 F	3.18 G	3.09
	D2	61.00	66.33	63.67	26.20 E	30.40 E	28.30	3.50 E	3.94 F	3.72
	D3	66.00	70.60	68.30	22.30 E	27.55 F	25.43	4.00 DE	4.15 EF	4.08
Mean		61.46 C	65.71C	63.59	27.67 C	32.60 C	30.14	3.50	3.76 C	3.63
Mean of plant density	D1	60.71 B	66.02 C	66.46	44.84 A	49.22 A	47.03	3.83 C	3.99 C	3.91
	D_2	71.22 A	70.32 B	70.77	38.65 B	42.69 B	39.17	4.48 B	4.75 B	4.62
	D_3	71.22 A	73.83 A	72.53	32.84 C	40.10 C	36.47	5.32 A	5.66 A	5.49

(I1)=14 days intervals (10 irrigations times) **(D1) = 30 cloves/ m^2 in low plant density.**
(I2)= 21 days intervals (7 irrigations times) **(D2) = 45 cloves/ m^2 in low plant density.**
(I3) =28 days intervals (5 irrigations times) **(D3) = 60 cloves/ m^2 higher plant density.**
Means within each column followed by the same letter are not statistically different at 0.05 level (Duncan's range test).

Regarding the effect of plant densities on plant height and vegetative growth weight the highest values of plant height were observed with increasing number of plants for area (60 plants/ m^2) in the two study years compared with the widest spaces density (45 and 30 plants/ m^2) respectively. In general, the higher plant density (60 cloves/ m^2.), despite higher disease values, excelled in terms of yield due to a higher plant population compared with the two other plant density systems.

Interaction between irrigation intervals and plant densities significantly affect were observed on plant height and vegetative growth weight in both growing seasons (Table, 4).

E- Effect on weight loss rate of garlic bulbs during storage:

The results in Table 5 show that the highest value of percent weight loss was obtained for bulbs produced from plants that received 10 irrigations. In comparison, the lowest value of percent weight loss was obtained for bulbs produced from plants that received 5 irrigations in both seasons. These results are true with all storage periods.

Regarding the effect of plant density on the weight loss rate of garlic bulbs, the results in Table 5 show that the weight loss rate after 2, 4, and 6 months of storage in both seasons was significantly influenced by plant density. A high population of 60 plant /m^2 significantly reduced the rate of weight loss during storage followed by plant densities of 45 plants / m^2, and then 30 plant / m^2. These results are true during all storage periods in both seasons. Moreover, the interaction impacts among irrigation intervals and plant densities affected garlic storage ability after storage periods during the two seasons. The most noteworthy values of weight loss % were obtained from plants that received 10 irrigations with 30 garlic plants / m^2 compared with plants provided with 5 irrigations with a high number of garlic plants (60 plant / m^2).

Table 5. Effect of irrigation intervals, plant densities and their interactions on loss weight % after2,4 and 6 monthof cultivar Eggaseed-1 during 2017/2018 and 2018/2019 seasons.

Irrigation Interval (I)	Plant density (D)	Loss Weight % after 2 months			Loss Weight % after 4 months			Loss Weight % after 6 months		
		2017/ 2018	2018/ 2019	Mean	2017/ 2018	2018/ 2019	Mean	2017/ 2018	2018/ 2019	Mean
I_1	D1	14.61	6.74	10.68	17.38	11.34	14.36	21.20 A	18.67 A	19.94
	D2	12.00	5.60	8.80	15.64	9.70	12.67	20.38 B	16.34 B	18.36
	D3	10.15	4.35	7.25	13.28	8.30	10.79	19.35 C	16.00 C	17.68
Mean		12.25 A	5.56 A	8.91	15.44 A	9.78 A	12.61	20.31 A	17.00	18.66
I_2	D1	11.45	5.55	8.50	15.41	8.95	12.18	20.88 B	17.56 B	19.22
	D2	10.28	4.15	7.22	13.35	7.63	10.49	20.33 B	16.25 C	18.29
	D3	9.85	3.10	6.48	12.38	6.55	9.47	18.75 D	15.00 E	16.88
Mean		10.53 B	4.27 B	7.40	13.71	7.71 B	10.71	17.34 B	16.27	16.81
I_3	D1	10.53	4.25	7.39	13.67	6.98	10.33	19.40 C	14.89 D	17.15
	D2	9.3	3.60	6.45	11.58	5.57	8.58	17.95 E	13.68 F	15.82
	D3	8.46	2.41	5.44	10.87	4.70	7.79	17.23 E	13.12 G	12.18
Mean		9.43 C	3.42 C	6.43	12.04	5.75 C	8.90	17.19B	13.89	15.54
Mean of plant density	D1	12.20 A	5.51 A	8.86	15.49 A	9.09 A	12.39	20.49 A	17.04 A	18.77
	D_2	10.53 B	4.45 B	7.49	13.53 B	7.63 B	10.58	19.74 B	15.42 B	17.58
	D_3	9.48 C	3.29 C	6.39	12.18 C	6.52 C	9.35	18.44 C	14.71 C	16.58

(I1)=14 days intervals (10 irrigations times) **(D1) = 30 cloves/ m^2 in low plant density.**
(I2)= 21 days intervals (7 irrigations times) **(D2) = 45 cloves/ m^2 in low plant density.**
(I3) =28 days intervals (5 irrigations times) **(D3) = 60 cloves/ m^2 higher plant density.**
Means within each column followed by the same letter are not statistically different at 0.05 level (Duncan's range test).

DISCUSSION

Water Irrigation intervals combined with diverse plant density types are one of the important effective cultural practices for diminishing infection incidence. Our Field experiment was conducted to study the irrigation interval and plant densities on intensity and severity purple blotch of garlic. These are among the critical factors determining the purple blotch resistance on garlic. For the effect of irrigation interval and plant densities on purple blotch disease percentage, our data cleared that the different irrigation intervals create significant differences in their effects on disease incidence and severity. These results are consistent with those of Bhonde *et al.* (2001) who mentioned, the best performance of onions in purple blotch resistance was obtained when irrigated at10-day intervals compared to 12 and15 day intervals. An increase in disease incidence with increasing irrigation interval was also reported by Biswas *et al.* (2010) who stated that irrigation had a slight effect on the occurrence of purple blotch in onions, still, the trend decreased as the frequency of irrigation increased. Soil moisture in the wettest treatment (Irrigation at 10 days intervals) was optimal and might cause low onion leaf purple blotch disease incidence in it. Also, reducing onion Stemphylium blight and downy mildew disease severity was observed in 7 days irrigation interval while the highest was for 10 days interval also increasing yield parameters (Acharya and Shrestha, 2018). In fact, increased plant population is known to change the microclimate, making it more conducive to fungal disease outbreaks and rapid spread, which can lead to epidemics so, and high density of garlic plants per m^2 lead to increase the relative humidity which encourage purple blotch pathogen therefore increase the infection. These findings are in harmony with Mengesha and Tesfaye (2015). According to them, the spacing was varied significantly in disease incidence and severity of garlic rust. The results explained that increasing intra-row spacing's decreased significantly the disease incidence and severity together. Also, our data confirmed by thus suggested by Abou Khadra *et al.* (2017), who found that a significant reduction in the levels of downy mildew and purple blotch in the onion transplant population (30 plants/ m^2) was observed, followed by (45 plants/ m^2).On the other hand, the highest percentage of onion downy mildew and purple blotch was in the 2017/2018 and 2018/2019 seasons due to the plant density (60 plants/ m^2). This may be attributed to the increased number of plants per meter in dense stands, which recognized to increase the moisture between plants at high density leading to high percentage of infection. Therefore, the authors believe that the increment in the incidence and severity of purple blotch disease may be due to an increment within the garlic plants (plant density) not to an increment within the number of irrigations. These results agree with those gotten by Abou Khadrah *et al.* (2017) who detailed that high population of onion plants lead to expanded competition between plants for water, light and supplements which led to a common weakness of plants and thus they are more susceptible to disease.

Generally, increasing the population of garlic plants with low irrigation number increase purple blotch incidence and severity. These may be caused by two factors: first, a high garlic plant population increases competition among plants for resources like water, light, and nutrients, resulting in a general weakening of plants; second, low irrigation number (minimal water) reduce the availability of nutrients for garlic plants, leading to weak plants which more susceptible to disease infection. Similar case was obtained by Biswas *et al.*, (2010) who mentioned that soil moisture in irrigation at 10 days intervals was optimal that might be the cause of less disease incidence in it compared with irrigation at 15,20- and 30-days intervals. In addition, optimal irrigation with well-balanced nutrients resulted in good onion plants that have be less susceptibility to disease infection.

Referring to the results in table 2 and 3 during the two growing seasons, the negative relationship between both (phyllosphere microbial colonies and irrigation times) and the infection percentage of purple blotch disease rate was found. Therefore, the authors believe that the decrease purple blotch infection in spite of an increasing number of irrigations and the increase in the number of microorganisms present on garlic leaves is due to two factors. The first is the power of plants resulting in increased uptake of minerals and carbohydrates by garlic plants, thus increasing photosynthesis and other physiological activities, and secondly, it may be due to the presence of different microbial communities including some fungi and bacteria that encourage an inhibitory effect against *Alternaria porri*. These results are supported by Khanna *et al.* (2015); Abdel-Hafez *et al.,* (2015) who isolated 68 fungal species from healthy and purple blotch diseased onion leaves, representing 29 genera. In this regard, *Epicoccum nigrum, Penicillium oxalicum, and Trichoderma harzianum*, which are connected with non -symptomatic onion leaves showed an effective antagonistic potential against *A. porri* . Also, many researchers supported our present investigation which have discovered that some organisms can be used to control pathogenic fungi (Mishra and Gupta 2012; Moradi-Pour 2021). When the plant density increases (the number of plants/ m2), it leads to an increase in the microbial load on the leaves. From our previous knowledge and studies, an increase in the number of plants per unit area led to an increase in relative humidity (as a biotic factor) which play an important role in the development of purple blotch disease. These confirmed and supported with Suheri and Price (2001) on leeks, Ghebrial and Kenawy (2018) on basal, and Tho *et al*., (2019) and Islam *et al*. (2020) on onion. Generally, increasing density numbers of the garlic plants gradually increased leaf fungi with significant differences. Similar was finding interaction effects of irrigation interval and plant density on foliar fungal and bacterial communities of garlic by Ghebrial and Kenawy (2018) and Mahmoud *et al*., (2018).

The effect of irrigation intervals on garlic growth parameters, such as plant height, fresh weight, as well as cured yield showed that there is a positive relationship, as these factors increase significantly with increasing irrigation numbers. These results agree with those detailed by Mohammad and Rokon, (2017) who reported that, when the period between irrigations becomes three weeks, the absorption of carbohydrates and photosynthesis decreases, which negatively affects the general growth of garlic plants. In expansion, the same authors said that the increment in garlic yield may be due to the role of water when large amount by plants to construct a few components that basic for plant growth and development such as proteins, and chlorophyll lead to expanded bulb quality. Similar findings were detailed by Mohamed *et al.,* (2009); Ahmed and Kasem (2019). In fact, water is very substantial in the process of cell division, and protein biosynthesis explains the positive effect of water, which promotes the absorption of nutrients to ensure good growth and development of bulbs. This may be due to the increased movement of water and nutrients through the soil, which thus expanded mineral take-up and carbohydrate by garlic plants, hence expanding photosynthesis and other physiological exercises forms (Sula, 1990). These results are similar to those of (Ahmed *et al*., 2007; Singh *et al.*, 2007). Also,, the results have confirmed the results obtained by Dhakulkar *et al*., (2009)who stated that, the lower plant densities were subjected to a low degree of competition for space, nutrients and all the other resources and thus, rather than vertically growing plants have grown horizontally producing more number of leaves resulted into increased, absorption and utilization of radiant energy resulting in a higher amount of photosynthesis processes, and showed a positive effect on quantity parameters. Additionally, increasing plant density significantly increased plant height and decreased the weight of cloves per bulb. Therefore, increasing plant density significantly increased total yield and bulb dry weight (Abdalla *et al.,* 2011).

Concerning the cured garlic yield, the results of the current study have confirmed the reports of Rekowska and Skupien ,(2009) Temperini *et al.* (2010); El-Shall *et al.* (2011) and Ahmed (2013) on garlic. Also, Mengesha and Tesfaye (2015) reported that the maximum garlic yield was observed from the plot planted with 10 cm intra row spacing compared with 20 cm which was recorded minimum value of yield. Also, our data was confirmed by thus suggested (Abou Khadrah *et al.,* 2017). In general, the higher plant density (60 cloves/ m2.), despite higher disease values, excelled in terms of yield due to a higher plant population compared with the two other plant density systems.

The storage period (2, 4, and 6 months) of the weight loss rate of garlic bulbs was influenced by the irrigation interval during the two growing seasons. These results agree with those mentioned by Ahmed *et al.* (2009); Mohammad and Rokon (2017) on garlic. In general, the increase in the number of irrigation times lead to an increase in the percentage of weight loss of garlic in the storage during the two experimental seasons. The most noteworthy values of weight loss % were obtained from plants that received 10 irrigations with 30 garlic plants / m^2 compared with plants provided with 5 irrigations with a high number of garlic plants (60 plant / m^2). These results have confirmed the results obtained on garlic by Ahmed and Kasem (2019).

CONCLUSION

According to our data during the experiments, the increase or decrease in the incidence of purple blotch disease on garlic plants is affected by several factors such as weather conditions represented in the relative humidity that is affected by the plant density (number of plants per meter). Plant density is the essential factor in the incidence of purple blotch disease on garlic plants. Meanwhile, number of irrigations may be more effective on vegetative crop, yield and loss weight bulbs during storage more than their effect on incidence of purple blotch infection. On the other hand, it is necessary to conduct many studies of the possibility of benefiting from phyllosphere organisms in the presence of different densities of plants to reduce disease infections. Therefore, the authors suggest that irrigation intervals 21 days and plant density levels 45 cloves / m^2 may be the best system of garlic plantation.

REFERENCES

Abou Khadrah, S.H., El-Sayed A.A, GeriesL.S.M.& Abdelmasieh W.K.L. (2017). Response of onion yield and quality to different planting date, methods and density. *Egyptian Journal of Agronomy*, 39(2), 203 - 219.

Abdalla, M.M. A., Nasr, M. H., Metwaly, A. K. & Ali S. H. (2011). Growth and yield of fifteen garlic ecotypes. *Assiut Journal of Agricultural Science,* 36 (5), 52-65.

Abd El-Baky A.A. &Abd El-Galil, M.A. (2014). Role of Intercropping and Nitrogen Fertilizer on Management of Peanut and Sesame Root-Rot and Wilt Diseases. *Egyptian Journal of Phytopathology,* 42(1), 53-70.

Abdel-Hafez, S.I.I., Abo-Elyousr, K.A.M. &Abdel-Rahim, I.R. (2015). Leaf surface and endophytic fungi associated with onion leaves and their antagonistic activity against *Alternaria porri*. *Czech Mycology,* 67(1), 1–22.

Acharya B. &Shrestha, R.K.(2018).Nitrogen level and irrigation interval on mitigating stemphylium blight and downy mildew in onion.*Journal of applied biology and biotechnology,* 6(1), 17.

Ahmed, H.G., Magaji, M.D., Yakutu, A.I., Aliyu, L. & Singh, A. (2007). Response of garlic (*Allium sativum*L.) to irrigation interval and clove size in semi-arid, *Nigeria Journal of Plant Science,* 2 (2), 202-208.

Ahmed, S.I. (2013) Effect of different genotypes and plant population on garlic productivity in new reclaimed sand soil using drip irrigation system. *Assiut Journal of Agricultural Science,*44(2), 90-104.

Ahmed, S. I. & Kasem, E. S. (2019). Effect of irrigation numbers and plant density on growth, yield of garlic cultivar Eggaseed -1. *Journal of Soil Sciences and Agricultural Engineering, Mansoura University,* 10(11), 711-718.

Ahmed S.I., Samy M.M. & Ezzat A.S. (2019). Evaluation of some horticultural characterstics and allicin content for some garlic genotypes. *Journal of Productivity and Development,* 24(4), 905 – 917.

Aneja, K. R. (2003). Experiments in microbiology, plant pathology and biotechnology. (4th Edition) New Age International (P) Ltd., *Publishers, New Delhi.*

Anonymous, 2019. *Statistical Department of Ministry of Agriculture and Land Reclamation,* El-Giza, Egypt.

Arunakumara K.T., Satyanarayana C & Siddanna T. (2023). Management of purple blotch of garlic caused by *Alternaria porri*. *The Ournal of Pharmaceutical Innovation,* 12(5), 3971-3975.

Awas, G., Abdisa, T., Tolesa, K. & Chali, A. (2010). Effect of intra-row spacing on yield of three onion (*Allium cepa* l.) varieties at Adami Tulu agricultural research center (mid rift valley of Ethiopia). J. of Hort. and Forst. 2(1): 007-011.

Bayan L., Kouliv, P.H. & Gorji, A. (2014). Garlic: a review of potential therapeutic effects.*Avicenna Journal of Phytomedicine,* 4(1), 1- 14.

Bhonde, S.R., Chougule, A.B. & Singh, N.B. (2001). Effect of irrigation and nitrogen level on seed crop performance of onion variety Agrifound Dark Red. News Letter Nat. *Horticulture Research and Development Foun.,* 21(1), 24-26.

Biswas,S.K. ,Khair, A. & Sarker. P.K. (2010). Yield of onion and leaf purple blotch incidence as influenced by different levels of irrigation. *Agricultura Tropica et Subtropica,* 43(2),85-91.

Dhakulkar, N.D., Ghawade, S.M. & Dalal, S.R.(2009).Effect of spacing and clove size on growth and yield of garlic under Akola conditions. *International Journal of Agricultural Science,* (5) 1, 261-262.

Dixon, G.R & Tilston, E.L.(2010).Soil borne pathogens and their interaction with the soil environment. In: Dixon GR, Tilston, EL, editors. Soil Micr.&Sust.Cro. Prod. Springer Science+Business Media B. V., *Dordrecht; Chapter,* 6, p. 197–272.

El-Shal, Z.S., Radwan, E.S. Zaki ,M.F. & Rizk, F.A. (2011).The productivity of garlic plant (*Allium sativum* L.) as affected by plant densities and NPK application. *Journal of Plant Production, Mansoura University,* 2 (7) , 865-875.

Ghebrial, Eman W.R. & Kenawy, A.G.M. (2018). Effect of irrigation intervals and interplant spacing levels on downy mildew epidemic and productivity of basil plants. *Egyptian Journal of Phytopathology,* 46(1) pp, 69-89 .

Islam, M.M, Begum, Fatema, Nahar, N., U. A. Habiba, &Fakruzzaman, K. M. (2020).*In-Vivo* management of purple blotch of onion caused by *Alternaria porri*(Ellis) Cif. through fungicides. *American Journal of Plant Sciences,* 11, 1847-1859.

Khanna, M.R, Devi, G.U.,Sagar, B.V. & Sankar, A.S.(2015). Screen of phyllplane microflora against *Alternaria porri* under in vitro condition. Soci. for Sci. Develop. *In Agricultural Science and Technology,* 10 (3), 1477-1479.

Khodadadi, A. & Nosrati, M.A.E. (2012). Effect of sowing date and planting density on yield and yield components of white garlic of Hamadan. *Seed and Plant Journal,* 27(4), 491-500.

Mahmoud, G. A., Hamd-Alla W.A. & Hefzy M.(2018). Intercropping Faba bean with Some Crops and Its Impact on the Production, Phyllosphere and Rhizosphere Microorganisms Under Modern Irrigation Systems. *AssiutJournal of Agricultural Science,* 49 (4), (44-63).

Mengesha, W. &Tesfaye, A. (2015). Effect of spacing in incidence and severity of garlic rust (*Pucciniaallii*)Rudolphi. and bulb yield and related traits of garlic at Eastern Ethiopia. *Journal of Pathology and Microbiology,* 6 (10), 4PP.

Michael, A.M. (1978). "Irrigation Theory and Practice" Vikas publishing Hourse PVTLTD New Delhi, India.

Mishra, R.K. & Gupta, R.P. (2012). *In vitro* evaluation of plant extracts, bio-agents and fungicides against purple blotch and *Stemphylium* blight of onion.*Journal of Medical and Plant Research,* 6 (45), 5658-5661.

Mohamed, E.A., Nasser, I.A. &Asaad, A. D. (2009). Effect of irrigation frequency and potassium source on the productivity, quality and storability of garlic. *Australian Journal of Basic and Applied Sciences,* 3(4), 4490-4497.

Mohammad, R.I. &Rokon, U.Z. (2017) . Response of garlic yield and storability to varying frequencies of irrigation. *Agriculturae Conspectus Scientificus,* 82 (1), 7-11.

Moradi-Pour, M., Saberi-Riseh R., Esmaeilzadeh-Salestani K., Mohammadinejad R. & Loit E. (2021). Evaluation of *Bacillus velezensis*for biological control of *Rhizoctonia solani* in Bean by Alginate/Gelatin Encapsulation Supplemented with Nanoparticles. *Journal of Microbiology and Biotechnology,* 31(10), 1373–1382.

MSTAT-C, (1985) A software program for the design management, *and Analysis of Agronomic Research Experiments*, (Version 4) Michigan State University.

Nanda S, Chand S K, Mandal P, Tripathi P,& Joshi R K. 2016. Identification of novel source of resistance and differential response of Allium genotypes to purple blotch pathogen, *Alternaria porri* (Ellis) Ciferri. *Plant Pathology Journal,* 32, 519–527.

Rekowska, E. & Skupien , K. (2009).The influence of selected agronomic practices on the yield and chemical composition of winter garlic. *Vegetable Crops Research Bulletin,* 70, 173 – 182.

Sharma, S. R. (1986) Effect of fungicidal sprays on purple blotch and bulb yield of onion. *Indian Phytopathology,* 39, 78-82.

Singh, G.R.K., Shukla, I.N., Singh, J.P. & Kumar, S. (2007) Studies on effect on varying plant density, planting and irrigation time on growth and yield of garlic (*Allium sativum* L.). *Progressive Agriculture,* 7 (1/2), 167-168.

Srujani B.& Srikanta D. (2018). Effect of weather variables on the biology of *Alternaria porri*. of onion under controlled environmental condition. *Journal of Pharmacognosy and Phytochemistry*, 7(4), 315-319.

Suheri, H., &Price, T. (2001). Infection of onion leaves by *Alternaria porri* and *Stemphylium vesicarium* and disease development in controlled environments. *Plant Pathology,* 49(3), 375–382.

Sula, S. (1990). Growth and physiological aspects of garlic under irrigation. *Horticultural Abst.,* (60)8, 6046.

Tarr, S.A.W. (1981). The principles of plant pathology.Macmillan press. London. 632pp.

Temperini, O., Ciancolini, A., Parrano, L., Lacobacci, L. &Colla, G. (2010). Influence of planting density on productivity and marketable quality in garlic (*Allium sativum*L.). *Halus Hortus,* 17 (2), 56 – 58.

Tho,E.K., Brisco-McCann E., Wiriyajitsomboon P., & Mary, K. H.(2019) . Effects of temperature, relative humidity, and plant age on bacterial disease of onion plants. Pl. Health Prog. 20, 200–206.

Vijaykumar, K. N., Shripad K. , Patil , P.V. , Shashidhar, T. R.& Kambrekar, D. N. 2022. Severity and distribution of purple blotch in major garlic growing areas of northern Karnataka. *International Journal of Farm Sciences,* 35(2), (228-237).

Youssef, N. S. & Tony, H. S.H (2014). Influence of different Planting date on the performance of new garlic genotypes grown under El-Minia governorate conditions. *Nature and Science,* 12(5), 47-54.

تأثر حدوث البقعة الأرجوانية وإنتاجية الثوم بفترات الري وكثافة النبات

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أجريت تجربة حقلية بمحطة ألبحوث الزراعية بسدس ،محافظة بني سويف جمهورية مصر العربية وتحت ظروف الإصابة الطبيعية بمرض اللطعة الارجوانيةعلى الثوم خلال موسمي 2018/2017 و 2019/2018. كان الهدف من هذه الدراسة هو تقييم فاعلية التباعد بين فترات الري وكثافة النبات على شدة ونسبة حدوث الاصابة باللطعة الارجوانية على الثوم،عددعشائرالكائنات الدقيقة على المجموع الخضري لنباتات الثوم وكذلك الصفات الخضرية وإنتاجية نباتات الثوم. من خلال نتائج الدراسه وجد ان فترات الري (14 و21 و 28 يومًا) ومستويات كثافة النبات (30 و 45 و 60 نبات / م 2) تؤثربشكل كبيرعلى حدوث مرض اللطعة الارجوانية وشدته. أدى الري على فترات 14 يومًاإلى خفض شدة الاصابة باللطعة الارجوانية ومعدل حدوثهاعلى نباتات الثوم تلاها الرى على 21 ثم الرى على 28 يومًا وذلك تحت ظروف الكثافات المختلفة محل الدراسة. في الوقت نفسه،ادت الكثافة النباتية العالية (60 نبات / م 2) الى حدوث زيادة فى نسبة حدوث مرض اللطعة الارجوانية وشدتها مقارنة بكل من 30 و 45 نبات / م -2من جهة أخرى اثر كل من فترات الري وكثافة النباتات وكذلك التفاعل بينهما معنويا على العدد الإجمالي لعشائرالكائنات الدقيقة على المجموع الخضري وكذلك الصفات الخضرية لنباتات الثوم (طول النبات،وزن النموالخضري،والوزن الجاف للبصيلات،ومقدار (نسبة) النقص فى الوزن بعد 2 و4 و 6 أشهرمن بداية التخزين .

الكلمات المفتاحية: اللطعة الارجوانية، انتاجية الثوم، فترات الرى، الكثافة النباتية، القدرة التخزينية لمحصول الثوم .