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Effect of Saline Water Irrigation and Dilution of Salts on Water Management Water in Green Pepper

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Abstract- **Irrigation has an important role in food production worldwide by increasing crop quality and production. As such, the use of freshwater for agricultural or vegetable products is declining in quantity and quality over the coming decades. A major factor in brine water is abiotic stress, which disrupts efficiency and is one of the major sources of significant crop loss worldwide. The vegetable is the most commonly cultivated vegetable crop in Pakistan, which has wide economic potential, but its productivity and quality, diseases, nutritional deficiencies, and insect pests or stresses include cold, heat, salinity, drought, and mild stress. The main objective of this research is to observe the effect of saltwater irrigation on green paper. Assessment of various salt-water regimes in terms of their impact on plant growth. Detection of salinity levels and salt-water regimes. The research was conducted at the Water Management Research Center Agricultural University, Faisalabad. Experimental Station of the Water Management Research Center in the Punjab (Pakistan) Province during the spring and summer of 2019. The results of this study confirm the utility of salt variation in pepper plants. Plants were classified as salt-tolerant and sensitive based on the parameters studied. NaCl nutrient solutions of less than 2 (g) have been shown to tolerate excess salt in all plants, and other plants have proven to be highly salt-sensitive at all salinity levels. Salinity is the major stressor in all of these stresses due to the lack of drainage water or groundwater used for sewage for irrigation. For every part of the salinity level beyond its limit, the yield of pepper decreases by 14%.**

***Index Terms*— Irrigation,Green pepper,water management,salts,dilution,sewage,crops,saline,water**

I. INTRODUCTION

As the use of fresh water for agricultural or vegetative products is becoming deficient in quantity and quality in the coming decades [1]. Due to the increasing population day by day, so it is a big challenge for the world to meet food requirements. As of the total, only 2.5 % is considered good quality water and the other 97.5 % will be considered high salted water in oceans [2]. With the rapid increase in population growth rate, it is necessary to meet the food requirements of the nation. Alternatively, the production of food crops is difficult to meet the requirement of the world [3]. Saline water is a key factor in abiotic stress that disturbs the efficiency of the growing medium and is one of the main sources of substantial crop damage worldwide. Saline water irrigation destabilizes plant conduct to the specific evaluation of salt feeling of anxiety. Saline water irrigation harms germination %, plant power, and at the appropriate time crop generation [4][5][6].

II. LITERATURE REVIEW

Saline water irrigation has effectively influenced 30% of the flooded land and the other 20% of developed land additionally influenced by soil saltiness around the world [7]. It is anticipated that by the year 2050 world farming needs to harvest 70% more sustain food crops for a further 2.3 billion individuals all around the world [8].while, 50% decrease in fundamental continue food crops harvests yield has been tended to because of the saline water system. In Pakistan, 6 million hectares of developed land is deteriorated because of the saline water system [9]. Irrigation has a significant role in food production overall the world by enhancing crop quality and production. So a high amount of irrigation rates can degrade the soil mainly by enhancing the soil salinity [10]. These areas are facing a high level of evapotranspiration, which results in the concentration of salts, introduced through the excessive application of water. Salt stress and water shortage are significant issues to describe methods of irrigation by minimizing irrigation costs. Therefore salinity stress and drought stress is a significant issue for the sustainability of agriculture and sources of irrigation [11].

The use of hydroponic systems is increasing continuously worldwide for growing crops. The main reasons for developing the systems are the Possibility of getting a high yield, proper use of fertilizers, and control measures for the growing environment, and proper irrigation [12]. Worldwide agriculture is facing insufficiency water resources problems, which force the growers to use the water containing a relatively high concentration of salts for irrigating the crops. There is another reason for forcing the growers to apply more water than the demand-supply for irrigation, as there is variability in water demand between individual plants [13] [14]. Largest pepper producer (1975 Mt) after China (15520 Mt) and Mexico (2131 Mt) (FAOSTAT 2014 a, b). Pepper has a high water requirement crop for the production of good quality fruit [15]. Pepper is considered to be tolerated at moderate salt stress level if there is an increase in salt stress level the biomass of shoot, photosynthesis rate is negatively affected via less transpiration, the potential of water, less opening of stomata [16].

III. RESEARCH METHODOLOGY

Green pepper is a commonly growing vegetable crop in Pakistan, having a broad potential for economically but its productive growth and quality were decreased due to diseases, nutritional deficiency, and insect pests or stresses like cold, heat, salinity, drought, and light stress.

Salt stress is one of the major stress among all these stresses because of the utilization of wastewater for irrigation due to the deficiency of canal water or groundwater. 14% of the pepper yield will be reduced for every raise of salinity level above its limit.

To examine the salinity effects on pepper growth and physiological parameters an experiment was conducted under the topic of "Effect of saline water irrigation on water productivity of green pepper under hydroponic farming" with these objectives:

1. To observe the effect of saline water irrigation on Green Pepper.
2. To evaluate different salt-watering regimes according to their impact on plant growth.
3. To identify feasible salinity levels and salt-watering regime.

The research was carried out at Water Management Research Center PARS University of Agriculture Faisalabad. Experimental Station of Water Management Research Center PARS (42° 23_ N and 2° 05_ W), in the province of Punjab (Pakistan), during the 2019 spring and summer seasons. The experiments are performed in a hydroponic tunnel. Plants of Green Pepper will be selected for this study. The heating and cooling system in the tunnel is controlled by cooling pads and fans, the night temperature set point of 14 °C and the cooling system was started when the inside temperature was higher than 25 °C.

Plants of Green pepper will be grown in seedbeds with a combination of material containing vermiculite, peat moss, and pearlite in the ratio of 2:1:1(v/v/v). Two plants of pepper will be grown per pot. Pots will keep observed under control conditions during germination. During the phase of germination, seeds were watered with Hoagland nutrient solution according to the need of the moisture content and plant need.

The irrigation was applied through manual bucket and hand cups. Electrical conductivity (EC) and pH of the nutrient solution were adjusted and maintained between 2.6–3.4 dS m^{-1} and 5.6–6.0, respectively. The growing medium was perlite, peat moss, and cocopeat in pots with (1:1:2) by volume.

Each pot had one green pepper plant. Green Pepper plants of the cultivar Capsicum annum were transplanted on 20 December 2018. Harvesting started on 3 April 2019 and continued weekly Until 12 June 2019 at the end of the experiment when plants are affected by salinity effect and damage**.**

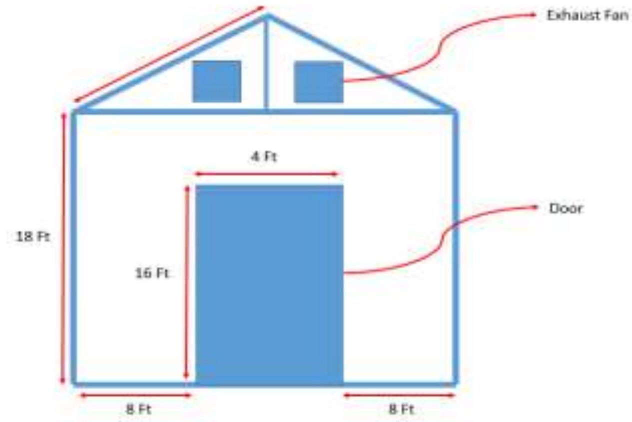

Figure 1: Front view of Hydroponic system

Six saline water irrigation treatments make with equivalent parts of NaCl in the Hoagland Nutrient solution. The treatments used in this experiment; Control, 2g/L, 4 g/L, 6 g/L, 8 g/L, 10 g/L. If the growth of the plant decreases by adding 10 g l^{-1} of NaCl then dilute it by reducing the amount of NaCl in Hoagland Nutrient solution. This will be done the same as for other treatments according to the growth rate of plants and find a suitable regime for plant growth against saline water irrigation. This experiment will be arranged in a completely randomized design with 36 healthy and uniform seedlings from green pepper. This experiment will carry out three replications. Each replicate contains two plants.

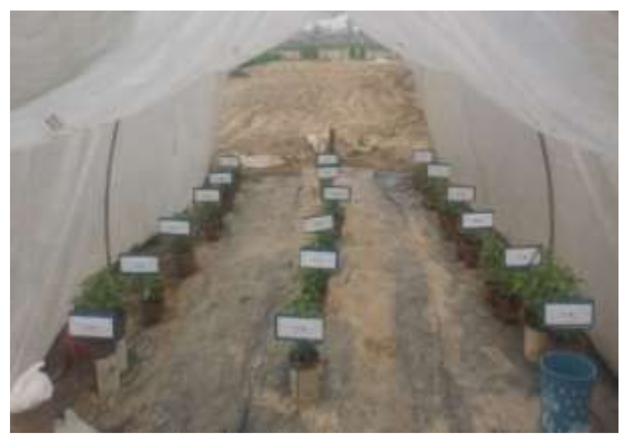

Figure 2: Pepper plant seedlings with Treatments Plan

IV. RESULTS AND DISCUSSIONS

Saline water irrigation is a major problem established in all most all kinds of vegetable crops all over the world. So, all vegetable growing countries feel the threat to encounter the food necessity of the people therefore a study was conducted to identify the physiological and morphological attributes to check out the salinity tolerance in green pepper crops. The study was conducted at the research station of "Water Management Research Center, PARS University of agriculture Faisalabad". The findings of this experiment are described briefly below.

Table 1: Effect of salt stress on germination percentage

Salinity Level (grams)	No of Plants	Germination %
0	1	94.5
0	2	94.9
2	1	99.9
2	2	74.172
4	1	67.108
4	2	70.64
6	1	40.22
6	2	35.1
8	1	20.45
8	2	16.3275
10	1	14.7725
10	2	15.55

Table.2: Completely Randomized AOV for Germination %

Source	DF	SS	MS	F	P
Salinity	5	12023.8	2404.77	40.2	0.0002**
Error	6	359.2	59.86		
Total	11	12383.0			

Mean values are used for each replicate
LSD test is used for Significant value at $P \leq 0.05$ (Significant**)
Nutrient solution irrigation stress level**

Table 3: Salinity effect on pepper shoot length (cm)

Salinity Level (grams)	No of Plants	Shoot length (cm)
0	1	10.5
0	2	9.5
2	1	10
2	2	6.9405
4	1	6.2795
4	2	6.61
6	1	5.082
6	2	4.598
8	1	4.84
8	2	3.4545
10	1	3.1255
10	2	3.29

Table 4:Completely Randomized AOV for Shoot length

Source	DF	SS	MS	F	P
Salinity	5	69.3391	13.8678	13.2	0.0035**
Error	6	6.3253	1.0542		
Total	11	75.6644			

Mean values are used for each replicate
LSD test is used for Significant value at $P \leq 0.05$ (Significant**)
Nutrient solution irrigation stress level**

Table 5:Salinity effect on pepper root length (cm)

Salinity Level (grams)	No of Plants	Root length (cm)
0	1	5.88
0	2	5.32
2	1	5.6
2	2	3.045
4	1	2.755
4	2	2.9
6	1	2.52
6	2	2.28
8	1	2.4
8	2	3.4545
10	1	3.1255
10	2	3.29

Table 6: Completely Randomized AOV for Root length

Source	DF	SS	MS	F	P
Salinity	5	20.5200	4.10400	7.02	0.0172**
Error	6	3.5101	0.58502		
Total	11	24.0301			

Mean values are used for each replicate
LSD test is used for Significant value at $P \leq 0.05$ (Significant**)
Nutrient solution irrigation stress level**

Table 7: Salinity effect on pepper shoot fresh weight (g)

Salinity Level (grams)	No of Plants	Shoot fresh weight (g)
0	1	1.47
0	2	1.33
2	1	1.4
2	2	0.756
4	1	0.684
4	2	0.72
6	1	0.6405
6	2	0.5795
8	1	0.61
8	2	0.5355
10	1	0.4845
10	2	0.51

Table 8: Completely Randomized AOV for Shoot fresh weight

Source	DF	SS	MS	F	P
Salinity	5	1.25138	0.25028	6.74	0.0189**
Error	6	0.22278	0.03713		
Total	11	1.47415			

Mean values are used for each replicate
LSD test is used for Significant value at $P \leq 0.05$ (Significant**)
Nutrient solution irrigation stress level**

Table 9: Salinity effect on pepper shoot dry weight (g)

Salinity Level (grams)	No of Plants	Shoot dry weight (g)
0	1	0.168
0	2	0.152
2	1	0.16
2	2	0.0735
4	1	0.0665
4	2	0.07
6	1	0.063
6	2	0.057
8	1	0.06
8	2	0.042
10	1	0.038
10	2	0.04

Table 10: Completely Randomized AOV for Shoot dry weight

Source	DF	SS	MS	F	P
Salinity	5	0.02155	0.00431	6.37	0.0216**
Error	6	0.00406	0.00068		
Total	11	0.02560			

Mean values are used for each replicate

LSD test is used for Significant value at P ≤ 0.05 (Significant**)

Nutrient solution irrigation stress level**

Table 11: Salinity effect on pepper root fresh weight (g)

Salinity Level (grams)	No of Plants	Root fresh weight (g)
0	1	0.336
0	2	0.304
2	1	0.32
2	2	0.189
4	1	0.171
4	2	0.18
6	1	0.0315
6	2	0.0285
8	1	0.03
8	2	0.0105
10	1	0.0095
10	2	0.01

Table 12: Completely Randomized AOV for Root fresh weight

Source	DF	SS	MS	F	P
Salinity	5	0.18005	0.03601	23.2	0.0007**
Error	6	0.00933	0.00155		
Total	11	0.18938			

Mean values are used for each replicate

LSD test is used for Significant value at P ≤ 0.05 (Significant**)

Nutrient solution irrigation stress level**

Table 13: Salinity effect on pepper root dry weight (g)

Salinity Level (grams)	No of Plants	Root dry weight (g)
0	1	0.084
0	2	0.076
2	1	0.08
2	2	0.0525
4	1	0.0475
4	2	0.05
6	1	0.0315
6	2	0.0285
8	1	0.03
8	2	0.021
10	1	0.019
10	2	0.02

Table 14: Completely Randomized AOV for Root dry weight

Source	DF	SS	MS	F	P
Salinity	5	0.00589	0.00118	15.4	0.0023**
Error	6	0.00046	0.00008		
Total	11	0.00635			

Mean values are used for each replicate

LSD test is used for Significant value at P ≤ 0.05 (Significant**)

Nutrient solution irrigation stress level**

Table 15:Salinity effect on pepper plant height (cm)

Salinity Level (grams)	No of Plants	Plant height (cm)
0	1	29.5
0	2	28.1
2	1	27.9
2	2	26.6
4	1	25.4
4	2	23.5
6	1	22.4
6	2	23.5
8	1	21.2
8	2	19.4
10	1	18.4
10	2	16.5

Table 16: Completely Randomized AOV for Plant height

Source	DF	SS	MS	F	P
Salinity	5	180.387	36.0773	28.3	0.0004**
Error	6	7.660	1.2767		
Total	11	188.047			

Mean values are used of each replicate
LSD test is used for Significant value at $P \leq 0.05$ (Significant**)
Nutrient solution irrigation stress level**

Table 17: Salinity effect on pepper net photosynthetic rate (μmol CO_2 m^{-2} s^{-1})

Salinity Level (grams)	No of Plants	Net photosynthetic rate (μmol CO_2 m^{-2} s^{-1})
0	1	10.8
0	2	8.6
2	1	8.4
2	2	8.3
4	1	6.3
4	2	6.2
6	1	5
6	2	4.9
8	1	3.7
8	2	3.6
10	1	2.97
10	2	2.86

Table 18: Completely Randomized AOV for Net photosynthetic rate

Source	DF	SS	MS	F	P
Salinity	5	70.8230	14.1646	34.7	0.0002**
Error	6	2.4461	0.4077		
Total	11	73.2691			

Mean values are used for each replicate
LSD test is used for Significant value at $P \leq 0.05$ (Significant**)
Nutrient solution irrigation stress level**

Table 19:Salinity effect on pepper Transpiration rate (mmol m^2 s^{-1})

Salinity Level (grams)	No of Plants	Transpiration rate (mmol m^2 s^{-1})
0	1	5.05
0	2	5.04
2	1	4.24
2	2	4.23
4	1	3.65
4	2	3.64
6	1	2.85
6	2	2.84
8	1	2.14
8	2	2.13
10	1	3.1255
10	2	3.29

Table 20: Completely Randomized AOV for Transpiration rate

Source	DF	SS	MS	F	P
Salinity	5	18.2347	3.64694	72939	0.0000**
Error	6	0.0003	0.00005		
Total	11	18.2350			

Mean values are used for each replicate
LSD test is used for Significant value at $P \leq 0.05$ (Significant**)
Nutrient solution irrigation stress level**

Table 21: Salinity effect on pepper water use efficiency (WUE)

Salinity Level (grams)	No of Plants	Water Use Efficiency (WUE)
0	1	5.4075
0	2	4.8925
2	1	5.15
2	2	5.3025
4	1	4.7975
4	2	5.05
6	1	5.103
6	2	4.617
8	1	4.86
8	2	5.1975
10	1	4.7025
10	2	4.95

Table 22: Completely Randomized AOV for Water Use Efficiency (WUE)

Source		DF	SS	MS	F	P
Salinity		5	0.26016	0.05203	0.82	0.5782*
Error		6	0.38180	0.06363		
Total		11	0.64196			

Mean values are used for each replicate
LSD test is used for Significant value at $P \leq 0.05$ (Significant**)
Nutrient solution irrigation stress level**
* Non-significant

Table 23: Salinity effect on pepper stomatal conductance (mmol $m^{-2} s^{-1}$)

Salinity Level (grams)	No of Plants	Stomatal conductance (mmol $m^{-2} s^{-1}$)
0	1	0.1368
0	2	0.144
2	1	0.09595
2	2	0.101
4	1	0.0665
4	2	0.07
6	1	0.04845
6	2	0.051
8	1	0.03895
8	2	0.041
10	1	0.02945
10	2	0.031

Table 24: Completely Randomized AOV for Stomatal conductance

Source	DF	SS	MS	F	P
Salinity	5	0.01731	0.00346	405	0.0000**
Error	6	0.00005	0.00001		
Total	11	0.01736			

Mean values are used for each replicate
LSD test is used for Significant value at P ≤ 0.05 (Significant**)
Nutrient solution irrigation stress level**

Table 25: Salinity effect on leaf water potential Ψ (MPa)

Salinity Level (grams)	No of Plants	Water potential (MPa)
0	1	-0.97
0	2	-0.98
2	1	-1.34
2	2	-1.35
4	1	-1.95
4	2	-1.96
6	1	-2.46
6	2	-2.47
8	1	-2.98
8	2	-2.99
10	1	-3.27
10	2	-3.28

Table 26: Completely Randomized AOV for leaf water potential

Source	DF	SS	MS	F	P
Salinity	5	8.25417	1.65083	33017	0.0000**
Error	6	0.00030	0.00005		
Total	11	8.25447			

Mean values are used for each replicate
LSD test is used for Significant value at P ≤ 0.05 (Significant**)
Nutrient solution irrigation stress level**

Table 27: Salinity effect on stem diameter (cm)

Salinity Level (grams)	No of Plants	Stem Diameter (cm)
0	1	0.4095
0	2	0.3705
2	1	0.39
2	2	0.378
4	1	0.342
4	2	0.36
6	1	0.336
6	2	0.304
8	1	0.32
8	2	0.2835
10	1	0.2565
10	2	0.27

Table 28: Completely Randomized AOV for Stem Diameter

Source	DF	SS	MS	F	P
Salinity	5	0.02432	0.00486	12.9	0.0037**
Error	6	0.00226	0.00038		
Total	11	0.02659			

Mean values are used for each replicate
LSD test is used for Significant value at P ≤ 0.05 (Significant**)
Nutrient solution irrigation stress level**

Table 29: Salinity effect on leaf area

Salinity Level (grams)	No of Plants	Leaf Area (cm^2)
0	1	24.2
0	2	23.6
2	1	22.9
2	2	22.6
4	1	19.2
4	2	20.4

6	1	13.2
6	2	12
8	1	12.6
8	2	10.5
10	1	4.978
10	2	5.24

Table 30: Completely Randomized AOV for Leaf Area

Source	DF	SS	MS	F	P
Salinity	5	544.750	108.950	167	0.0000
Error	6	3.904	0.651		
Total	11	548.654			

Mean values are used for each replicate
LSD test is used for Significant value at $P \leq 0.05$ (Significant**)
Nutrient solution irrigation stress level**

V. CONCLUSIONS

All genotypes showed considerable variation in their response to salt stress. The results of this study confirmed the usefulness of the variations in salt content in pepper plants. The plants were classified as salt-tolerant and sensitive based on the studied parameters. Less than 2 (g) NaCl nutrient plants show a high salt tolerance for all other plants and plants proved to be the most sensitive salt among all levels of salt. Based on the studied parameters it can be concluded that salt stress significantly reduced the growth and growth of pepper plants, which is why we have confirmed it as a salt-sensitive plant. A significant decrease in growth parameters indicates pressure that has resulted in organ damage and a decrease in physical activity and disturbances in plant water relationships. It was found that Ionic poisoning was a major barrier to growth. The high amount of irrigation that can reduce the medium increases mainly by improving the salinity of the soil. The result is a concentration of salt, which is introduced through the excessive use of a nutrient solution. Salt stress and water shortages are important problems for defining irrigation methods and reducing irrigation costs. Thus, salt stress and drought stress are important issues for agricultural sustainability and irrigation resources. To study the effect of saltwater on various stages of pepper growth, one strategy may be to separate all stages of growth, especially fruit set, and fruit, into approximately two weeks or 20 days so that comparison of salt irrigation times is possible. Hydroponic conditions may be ideal for having a complete salt mix in the root zone during salt irrigation. The use of hydroponic systems is increasing globally to grow crops. The policy objectives behind developing the programs are Opportunities for high yield, good fertilizer utilization, control over the growing area, and proper irrigation. Agriculture around the world is facing problems with water scarcity, which is forcing farmers to use water containing too much salt to irrigate crops. As there is variation in the water demand between individual plants. Modern agriculture known as hydroponic systems is used; in this process, water is used in a solution of nutrients rather than irrigation with raw water. An additional amount of nutrient solution is excluded from the roots after each irrigation cycle. Pepper plants responded differently to the photographic dominance of various levels of salt. Throughout the experiment, plants maintained small amounts of behavior at high levels of NaCl solution and harmed photosynthetic rate, which directly impacted plant height, stem diameter, leaf area, shoot height, and root height based on plant growth. and optimization. Salt is one of the major pressures between all these pressures because of the use of wastewater for irrigation due to lack of drainage or groundwater. 14% of pepper fruit will be reduced throughout the increase in the salt level above its limit.

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