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Effects of Pitcher Pot Irrigation on Chilli Production

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Abstract

The field experiment was carried out at Simabandh village, Kakdwip, South 24 Parganas, West Bengal situated at 210. 58 N latitude, 880.11 E longitude, with an altitude of 1.2 m above the mean sea level. The general slope ranged between 0 to 1%, relief and was subnormal with slight to medium runoff. The selected area represents coastal saline soil with high salinity. These soils have high electrical conductivity due to high salt content. Pitcher irrigation with different combinations of sweet water and saline water was given to Chilli (*Capsicum annuum* var annuum) var. Pirek which was used as test crop. The yield and yield components of chilli crop revealed that yield of dry chilli was recorded at 4.27 t/ha, 4.25 t/ha, 4.20t/ha, 4.16t/ha and 2.88 t/ha respectively in the plots of pitcher pot irrigation when treated with 100% sweet water, 75% sweet water +25% saline water, 50% sweet water +50% saline water, 25% sweet water +75% saline water and 100% saline water (control) during summer season. Significantly highest ($p < 0.05$) dry chilli yield was recorded in plots receiving 100% sweet water and 75% sweet water + 25% saline water.

Keywords:

Chilli;
Salinity;
Sweet Water;
Yield;
Pitcher.

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1. INTRODUCTION

Indiscriminate use of saline irrigation water in absence of proper management of water – crop- soil poses a grave risk of endangering the development of salt effected soils accompanying with serious crop damage. Several studies indicate that saline water is to be irrigated in such amount and quality that meets the evapo-transpiration demands of the crop, minimize root zone salinity and selection of suitable crop and varieties tolerant to water and salinity stress [3].

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Some of the available options for saline water use include appropriate irrigation methods and their

scheduling, blending of saline and fresh water, selection of crop varieties resistance to salinity etc. Localized irrigation system becomes one of the most effective innovations for reducing moisture stress and mitigating soil salinity. High energy pressurized system for irrigation like sprinkler and drip although found suitable, but have limitations of high mechanizations and involves huge initial investment beyond reach to the poor farmers. Coastal saline soil of West Bengal suffers from the multi-dimensional production constraints, of which non-availability of good quality irrigation water is the prime one. The high EC content of soil detrimental for plant growth in these regions emphasizes the need for growing salt tolerant crops like rice, chilli, sunflower, sugarbeet etc. of which Chilli (*Capsicum annuum L.)* is considered as most promising for this area. Chilli also known as hot pepper was introduced into India from Brazil in 16th century by the Portuguese. It is considered as one of the most important commercial spice crops named as wonder spice and attains wide attraction due to its pungency, taste, flavour and colour to the dishes. Indian chilli is famous in the world for two important commercial qualities—its colour and pungency levels. Pitcher irrigation, a traditional system of irrigation alternative to drip, is the latest advancement of localized method of irrigation and found suitable where salinity of irrigation water and soil becomes the constraint besides water scarcity. The technique is simple, cheap and believed to have large water saving potential enabling growth of various types of crops and offers benefits of using saline water which is not applicable in conventional irrigation for alleviating root-zone salinity [6].

Pitcher irrigation consists, in its simplest form, of unglazed baked clay pots, which are buried up to the neck in the soil and filled with water [1]. Water gradually seeps out through the pitcher's porous wall into the root zone due to hydraulic and soil matric potential. The present investigation is thus, proposed for using saline water blended with fresh water in various concentrations for irrigation purposes through pitcher method and its efficiencies towards minimization of salt related constraints to enhance crop productivity of chilli in fresh water deficit region.

2. MATERIALS AND METHODS

The field experiment was carried out at the Simabandh village, Kakdwip, South 24 Parganas, West Bengal situated at 210.58 N latitude, 880.11 E longitude, with an altitude at 1.2 m above mean sea level. The general slope of the area ranged between 0 to 1%, relief and was subnormal with slight to medium runoff. Topographically the land was classified as medium class.

The selected area represents coastal saline soil with high salinity in the field. These soils have high electrical conductivity owing to its salt content. The soils have been developed in alluvium on deltaic plain of the river Ganges having 1-2% slope. The soils are deep, imperfectly drained and have light gray strongly acid, silty clay loam texture. CEC ranges from 21.9 to 26.1 meq per 100 g of soil. EC in 1:2.5 water extract ranged between 1.2to 2.0 mmhos /cm. The physicochemical properties of the selected site are given in table-1.

2.1. Experimental Details

The experiment was conducted with the following treatments taking chilli (*Capsicum annuum* var annuum) var. Pirek as test crop.

T1 = Chilli+ Sweet water in pitcher pot

T2= Chilli + Sweet water (25%) + saline water (75%) in pitcher pot

T3= Chilli +Sweet water (50%) + saline water (50%) in pitcher pot

T4= Chilli + Sweet water (75%) + saline water (25%) in pitcher pot

T5 = Chilli + Control plot

Modified pitcher pots were made with proportionate constituents of sand 20%, clay 75% and saw dust 5% which were buried in the soil up to its neck and placed in the middle covering four crops. Placement of sufficient soil mix in the hole was done so that the top of the buried clay pot will be 2 cm above the surface of the surrounding soil. Then the buried clay pots were set in place with the lid on and the space around it was filled with the soil mix. Then buried clay pots were filled with water and lids were used to cover. The clay pots were refilled with water at 10 days interval and were placed at a spacing of 60cmX 60cm with plot size of 64 sq m. The experimental design was RBD with four replications. The recommended dose of fertilizer consisted of N @ 100 kg/ha, P_2O_5 @ 60 kg/ha and K_2O @ 60 kg/ha and 5 ton FYM/ha. Manual harvesting of chillies was carried out. Hand picking is the best method. 3-4 harvest could be done in the life cycle of the crop.

2.2. Soil analysis

Physical properties

1) Soil texture: Particle size distribution of the soils was determined following the hydrometer method as suggested by Piper (1966).[6]

2) Bulk density: Bulk density of soil was determined by collecting the soil using core sampler followed by measuring the volume and weight of the sample. It is calculated by following the relationship given by Piper (1966).[6]

3) Water holding capacity: The water holding capacity (WHC) of the soil is measured with the help of Keen Rackzoskii's box as described by Piper (1966) [6]

4) Porosity: Porosity of the soil is measurement by the relationship of Bulk density and particle density.

5) Mean weight diameter (MWD): Van Bavel (1949), [7] proposed the parameter which is equal to the sum of the products of the products of the mean diameter of the each size fraction and the weight of the sample occurring in corresponding size fractions.

Table 1: Initial soil parameter of the experimental plot

Sl. No.	Particulars	Values
	A)Physical properties	
1	Bulk density (gm/cc)	1.32
2	Porosity (%)	52.50
3	Particle size distribution (%)	
	Sand	44.20
	Silt	16.20
	Clay	39.60
4.	Water holding capacity (%)	42.51
5	Soil aggregates	
a)	Mean weight diameter (mm)	0.706
b)	Structural coefficient	0.514
c)	GMD (mm)	0.426
d)	WAS> 0.25%	58.74
e)	WAS < 0.25%	41.53
	B)Chemical Properties	
1.	Soil pH (1 : 2.5 soil suspension)	6.32
2.	EC (mmhos/cm)	2.43
3.	Organic carbon (%)	0.58

4.	Total nitrogen (kg/ha)	20.80
5.	Available phosphorus (kg/ha)	25.63
6.	Available potassium (kg/ha)	168.33

6) Geometric Mean Diameter (GMD): Muzarak (1950), [4] suggested that geometric mean diameter (GMD) be used as an index of the aggregate size distribution. The geometric mean diameter is calculated approximately by equation.

2.3. Chemical properties:

1) Organic carbon: Organic carbon of the soil was estimated following the back titration method as proposed by Walkley and Black [2].

2) pH: pH of the soil was determined by soil and water suspension ratio 1:2.5 using conductivity pH meter[2].

3) Electrical conductivity (EC): Electrical conductivity (EC) of the soil sample was determined by using soil: water in 1:2.5 ratio with the help at conductivity bridge meter.

4) Available Nitrogen: Total nitrogen contents of the soil samples were determined by the modified Kjeldhal method as described by Jackson (1973), [2].

5) Available phosphorus (P2O5): Available phosphorus contains was estimated by usual procedure of extracting the soils with Olsen's reagent [0.5 (M) NaHCO3] solution with the help of spectrometer [2].

6) Available Potassium (K2O):

Available potassium (K_2O) content of the soil samples was determined by extracting the soil with neutral normal ammonium acetate, as described by Jackson (1973), [2]

2.4. Statistical calculation:

Randomized complete block design with three replications was followed in the field experiment.

3. RESULT AND DISCUSSION

3.1 Yield of Chilli:

The results of chilli yield that was grown in 2013 during pre kharif seasons with application of various combination of saline and sweet water refilling with pitcher pot irrigation is given in Table 2. The dry chilli yield were recorded as 4.27 t/ha, 4.25 t/ha, 4.20t/ha , 4.16t/ha and 2.88 t/ha respectively in the plots of pitcher pot irrigation with treated 100% sweet water, 75% sweet water +25% saline water, 50% sweet water +50% saline water , 25% sweet water +75% saline water and 100% saline water (control). Significantly highest ($p<0.05$) dry chilli yield was recorded in plots receiving 100% sweet water and 75% sweet water +25% saline water. Responses of dry chilli yield over control due to each treatment were 48.26%, 47.56%, 45.83% and 44.44% respectively in 100% sweet water, 75% sweet water +25% saline water, 50% sweet water +50% saline water and 25% sweet water +75% saline water. The yield of dry chilli significantly increased ($P>0.05$) with the application of each of the different type of treatment over control. Results also revealed that green chilli yield (Table 2) was recorded as 18.36t/ha, 18.08t/ha,17.70t/ha , 17.47t/ha and 11.95 t/ha respectively in the plots of pitcher pot irrigation when treated with 100% sweet water, 75% sweet water +25% saline water, 50% sweet water +50% saline water , 25% sweet water +75% saline water and 100% saline water (control). Significantly highest ($p<0.05$) green chilli yield was recorded in plots received 100% sweet water and 75% sweet water +25% saline water. Responses of green chilli yield over control due to each treatment were 53.64%, 51.29%, 48.12% and 46.19% respectively in 100% sweet water, 75% sweet water +25% saline water, 50%

sweet water +50% saline water and 25% sweet water +75% saline water. The yield of green chilli significantly increased (P>0.05) with the application of each of the different type of treatment over control.

3.2 Yield attributes of Chilli:

The results also found that (Table 2) equal number of plant /ha (37000) was found under each and every treatment. Number of mature chilli found to be highest (217.6/plant) under the treatment of 100% sweet water and lowest (163.1/plant) under control. Same trend of results was also found for other biological parameters like weight of a single green chilli, which were recorded as, 2.28 gm, 2.26 gm, 2.23 gm, 2.22 gm and 1.98 respectively for the 100% sweet water, 75% sweet water +25% saline water, 50% sweet water +50% saline water and 25% sweet water +75% saline water treatments. Under each treatment all the above noted biological parameter of chilli crop significantly increased over control. Significantly highest (p<0.05) number of mature and weight a single green chilli were recorded in plots receiving 100% sweet water and 75% sweet water +25% saline water. Number of mature and weight of a single green chilli significantly increased (P>0.05) with the application of each of the different type of treatment over control. Brinjal yield showed a 20% decrease at 12 dS/m compared with the control but was not adversely affected below this level of salinity [5]. Pitcher irrigation is considered more efficient than surface, drip and sprinkler irrigation and produces yields even when saline water is used.

Table 2: Effects of pitcher pot irrigation management on Chilli yield and yield component

Treatment	No. of Plant/ ha	No. of Green Chilli /Plant	Wt. of single Green Chilli (gm)	Yield of Green Chilli (tons/ha)	Yield of Dry Chilli (tons/ha)
Chilli+ Sweet water (100%)	37000	217.6	2.28	18.36	4.27
Chilli + Sweet water (75%) + saline water (25%)	37000	216.2	2.26	18.08	4.25
Chilli +Sweet water (50%) + saline water (50%)	37000	214.5	2.23	17.70	4.20
Chilli + Sweet water (25%) + saline water (75%)	37000	212.7	2.22	17.47	4.16
Chilli+Salinewater(100%) /Control	37000	163.1	1.98	11.95	2.88
SEm(±)		0.098	0.007	0.021	0.009
CD at 5%		0.0320	0.025	0.071	0.032

3.3 Physiological parameter of chilli crop:

The results of the physiological parameters influencing yield and growth of chilli crop due to various treatments presented in Table 3. The number of branches/plant were recorded as 18.9, 17.7, 16.7, 16.6 and 12.8 respectively in the plots of pitcher pot irrigation treated with 100% sweet water, 75% sweet water +25% saline water, 50% sweet water +50% saline water , 25% sweet water +75% saline water and 100% saline water (control). Significantly highest (p<0.05) number of branches/plant was recorded in plots received 100% sweet water and 75% sweet water +25% saline water. Responses of number of branches/plant over control due to each treatment were 47.65%, 38.28%, 30.46% and 29.68% respectively in 100% sweet water, 75% sweet water +25% saline water, 50% sweet water +50% saline water and 25% sweet water +75% saline water. The number

of branches/plant significantly increased (P>0.05) with the application of each of the different types of treatment over control.

Results also revealed that height of plant was found highest under 100% sweet water treatment 56.3 cm. Significantly highest (p<0.05) height of plant was recorded in plots received 100% sweet water and 75% sweet water +25% saline water. Responses of height of plant over control due to each treatment were 12.82%, 12.42%, 11.82% and 10.02% respectively in 100% sweet water, 75% sweet water +25% saline water, 50% sweet water + 50% saline water and 25% sweet water +75% saline water. The height of plant significantly increased (P>0.05) with the application of each of the different types of treatment over control. Same trend were found on 50% flowering and 50% fruiting (days after sowing).

The results of dry matter production and crop growth rate influencing yield and growth of chilli due to various treatments are also presented in Table 3,the results revealed that dry matter weight were found to be 380.6 t/ha, 374.7 t/ha, 339.9t/ha , 318.7t/ha and 250.7 t/ha respectively in the plots of pitcher pot irrigation treated with 100% sweet water, 75% sweet water +25% saline water, 50% sweet water +50% saline water , 25% sweet water +75% saline water and 100% saline water (control). Response of dry matter yield due to application of treatment over control was 51.81%, 49.46%, 35.58% and 27.12% respectively. The dry matter production significantly increased (P>0.05) with the application of each of the different type of treatment over control. Similarly crop growth rate were found to be 3.73gm/day, 3.68gm/day, 3.41gm/day, 3.24gm/day & 2.47gm/day respectively in the plots of pitcher pot irrigation treated with 100% sweet water.

Table 3: Effects of pitcher pot irrigation management on physiological parameter of Chilli crop.

Treatment	No. of branches /plant	Height of the plant during Harvesting(cm)	50% flowering (DAS)/plant	50% fruits (DAS)/plant	Dry Matter production at Harvesting (gm/plant)	Crop Growth Rate(gm/day)
Chilli+ Sweet water (100%)	18.9	56.3	44.1	48.1	380.6	3.73
Chilli + Sweet water (75%) + saline water (25%)	17.7	56.1	45.2	49.2	374.7	3.68
Chilli +Sweet water (50%) + saline water (50%)	16.7	55.8	46.9	50.3	339.9	3.41
Chilli + Sweet water (25%) + saline water (75%)	16.6	54.9	47.2	51.8	318.7	3.24
Chilli+ Saline water (100%)/Control	12.8	49.9	48.8	52.6	250.7	2.47
SEm(±)	0.164	0.309	0.313	0.116	0.077	0.012
CD at 5%	0.537	1.008	1.021	0.379	0.252	0.040

4. CONCLUSION

The result of the effects of various combinations of saline water and sweet water through pitcher irrigation involving the yield and yield components of chilli crop revealedthat yields of dry chilli were recorded

as 4.27 t/ha, 4.25 t/ha, 4.20t/ha , 4.16t/ha and 2.88 t/ha respectively in the plots of pitcher pot irrigation when treated with 100% sweet water, 75% sweet water +25% saline water, 50% sweet water +50% saline water , 25% sweet water +75% saline water and 100% saline water (control) during summer season. Significantly highest ($p<0.05$) dry chilli yield was recorded in plots received 100% sweet water and 75% sweet water +25% saline water. Equal number of plant /ha (37000) was found under each and every treatment. Number of mature chilli found to be highest (217.6/plant) under the treatment of 100% sweet water and lowest (163.1/plant) under control. The number of branches/plant were alao recorded as 18.9, 17.7, 16.7, 16.6 and 12.8 respectively in the plots of pitcher pot irrigation treated with 100% sweet water, 75% sweet water +25% saline water, 50% sweet water +50% saline water , 25% sweet water +75% saline water and 100% saline water (control).More investigations need to be executed in future to interpret this technique in a better way by conducting this type of experiment under different agronomic condition of West Bengal. The application of pitcher irrigation mainly with different combinations of sweet water and saline water are needed to be investigated for different cereal, vegetable, pulses, fruits and plantation crops.

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