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Effect of drip irrigation on yield and water use efficiency of summer rice cultivation in pots

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Abstract
The field experiment was conducted at the Instructional Farm of Faculty of Agricultural Engineering, BCKV, Nadia, West Bengal during the year of 2016-17. The study was conducted with the objectives to determine the water requirements of summer rice under drip irrigation, to compare the water requirements of summer rice under drip and conventional (flooding) irrigation and yield of summer rice cultivation under drip irrigation. In the study, there were four irrigation treatments with four replications. The different irrigation treatments were (i) T_1- Conventional irrigation with 5 cm of water in each irrigation after disappearance of water, (ii) T_2-0.8 E_{pan} under drip irrigation @ 4 l/h at 3 days interval, (iii) T_3-1.0 E_{pan} under drip irrigation @ 4 l/h at 3 days interval and (iv) T_4-1.2 E_{pan} under drip irrigation @ 4 l/h at 3 days interval. The amount of irrigation water required under drip irrigation at 0.8 E_{pan} treatments had been found to be the lowest i.e., 258 mm and the highest value was 365 mm at 1.2 E_{pan} treatments and in conventional irrigation system it was found 600 mm. The water requirements under drip irrigation for all the treatments were less as compared to conventional (flooding) irrigation. The average yield at T_1, T_2, T_3 and T_4 treatments were 2.29 t/ha, 3.10 t/ha, 2.44 t/ha and 2.54 t/ha respectively. It was also observed that the water use efficiency was found to be the highest at the treatment of 0.8 E_{pan} of drip irrigation was 8.126 t/ ha-cm. This indicated that the average yield and WUE were found more under the drip system in compare to conventional system.

Keywords: Summer rice, drip irrigation, pan evaporation, irrigation water, yield and water use efficiency (WUE)

Introduction
Rice is the staple food for more than half of the world's population and plays a pivotal role in food security of many countries. In West Bengal paddy occupied almost 53% of the total agricultural crop areas of the state and it contributed the same 53% towards the total production of all agricultural crops (Ghosh *et al.*, 2014) [5]. Only 4 (Burdwan, Birbhum, Nadia and Hooghly) districts were under high productivity group (Anonymous, 2002) [1]. Among the constraints, water scarcity appears to be a major challenge affecting rice production across the globe. More than 80% of the fresh water resources in Asia are used for agriculture of which about half of the total irrigation water is used for rice production. In the district of Nadia the summer rice is the popular crop cultivated in 1, 04,250 hectare area (Anonymous, 2017) [2]. High demand of water for the summer rice cultivation, the requirement of withdrawal of ground water excess to the amount of water get recharged under natural process during the period of monsoon. The situation is sometime so alarming that the state concerned department become compels to declare some region as black zone to check the excessive withdrawal of ground water. However farmers have high demand for summer rice cultivation due to its characteristics of assured good yield vis-à-vis the economy (Ghosh and Biswas, 2016) [6]. As a result, out of nineteen (19) districts in West Bengal, recently nine (9) districts are arsenic affected where cropping intensities are very high (Das *et al*.,2005) [4]. Drip irrigation helps to achieve both fertilizer and water use efficiency (Sivanappan and Ranghaswami, 2005) [7]. Work on drip irrigation for wide row crops like vegetable, cotton, sugarcane, pigeon pea and maize has already been done but there is no field level adoptable recommendation of drip irrigation for narrow row crops like rice, wheat etc. (Sonit *et al.*,2015) [8]. Pot experiments seem to be an alternative, since these could include a range of different soils. A further advantage will allow experiments to be continued throughout the year if the pots are sheltered from rain. This will reduce the duration of experiments compared to ones carried out in the open field. If pot experiments are carried out correctly, drainage and subsequent leaching of elements can be avoided. The present research work was focused to make an attempt to examine the possibility of drip irrigation in summer rice. Keeping this above fact in view, a field study was conducted with the objectives of estimation of water requirements, yield and water use efficiency of drip irrigation following pot culture in comparison to conventional method of rice cultivation.

Materials and Methods

The field experiment was conducted at the Instructional Farm of Faculty of Agricultural Engineering, BCKV, Mohanpur, Nadia during the year of 2016-17. District Nadia is agriculture based district and is located in the heart of West Bengal. The entire district lies in the rich alluvial zone of the Ganga and its tributaries. The average temperature ranges from 37.6 ºC to 25.4 ºC during summer months and between 23.7 ºC to 8.5 ºC during winter months. Pre monsoon rain is common in the month of April to May. Nadia district has 160 – 170 rainy days each year and an average rainfall of 1300 mm annually. The soils physical characteristics were analyzed for soil's bulk density, porosity, textural class and water holding capacity and soil moisture versus tension. A high yielding variety *Satabdi* (IET-4786) was selected for growing in the experimental plot with drip irrigation systems. Daily Meteorological data from 1st February to 28th May 2017 were collected from Agricultural Meteorology and Physics Department, B.C.K.V., Mohanpur, Nadia (Table 1).

Table 1: Daily meteorological data given by Agricultural Meteorology and Physics Department, B.C.K.V., Mohanpur, Nadia

Date	Rainfall in mm	Evaporation in mm
1-Feb	0	2
2-Feb	0	1.6
3-Feb	0	1.9
4-Feb	0	2
5-Feb	0	2.1
6-Feb	0	2.6
7-Feb	0	2.4
8-Feb	0	2
9-Feb	0	2.9
10-Feb	0	3.1
11-Feb	0	3
12-Feb	0	2
13-Feb	0	2.2
14-Feb	0	1.8
15-Feb	0	2.2
16-Feb	0	2.6
17-Feb	0	3
18-Feb	0	2
19-Feb	0	1.8
20-Feb	0	1.7
21-Feb	0	1.2
22-Feb	0	4.1
23-Feb	0	3.6
24-Feb	0	3.8
25-Feb	0	3.7
26-Feb	0	3
27-Feb	0	5.2
28-Feb	0	4.2
1-Mar	0	3.7
2-Mar	0	3.2
3-Mar	0	4.2
4-Mar	0	4
5-Mar	0	3.6
6-Mar	0	3
7-Mar	0	4
8-Mar	0	3.6
9-Mar	0	1.2
10-Mar	0	1.4
11-Mar	1.3	1.8
12-Mar	0	2.2
13-Mar	0	3.1
14-Mar	0	4.7
15-Mar	0	3.6
16-Mar	0	3.5
17-Mar	0	4.2
18-Mar	0	3.1
19-Mar	0	4.5
20-Mar	2.1	3.3
21-Mar	0	2.1
22-Mar	0	2.6
23-Mar	0	3.4
24-Mar	0	4.3
25-Mar	0	4
26-Mar	0	4.2
27-Mar	0	3.1
28-Mar	3.2	3.8
29-Mar	0	3.9
30-Mar	0	3.5
31-Mar	0	4.7
1-Apr	0	4.9
2-Apr	0	4.8
3-Apr	0	5.8
4-Apr	0	6
5-Apr	0	5.6
6-Apr	0	5.5
7-Apr	0	2.5
8-Apr	1.8	3.8
9-Apr	0	3.1
10-Apr	0	3.9
11-Apr	0	4.5
12-Apr	0	6
13-Apr	0	5.1
14-Apr	0	5.8
15-Apr	0	6
16-Apr	0	5.8
17-Apr	0	4.7
18-Apr	0	4.6
19-Apr	0	5.8
20-Apr	0	6.5
21-Apr	0	4.3
22-Apr	0	59
23-Apr	0	46
24-Apr	8.3	3.8
25-Apr	0	4.5
26-Apr	0	6.3
27-Apr	0	6.1
28-Apr	0	6.5
29-Apr	0	5.2
30-Apr	0	5.1
1-May	18	4.8
2-May	9.9	5.3
3-May	0	4.1
4-May	0	5.4
5-May	0	5.1
6-May	0	6
7-May	0	6.5
8-May	0	7.6
9-May	0	5.8
10-May	47.3	4.8
11-May	0	4.6
12-May	5.2	5.8
13-May	0	4
14-May	3.8	5.8
15-May	0	4.6
16-May	28.1	5.6
17-May	0	4.1
18-May	38	5.4
19-May	0	4.6
20-May	0	4.8
21-May	0	5
22-May	0	6
23-May	0	8.8
24-May	0	5.1
25-May	0	6.2
26-May	0	6.5
27-May	11.4	3.9
28-May	0	6.2

The 1.0 m width and 1.0 m length seed bed was prepared to transplant 490.87 sq. cm areas in 16 numbers of pots. Young rice seedlings of 12 days old were transplanted in each pot at th e rate of 2-3 seedlings per pot. Fertigation dose was maintained constant for all treatments.

The drip irrigation system was installed at the experimental site soon after transplanting of seedlings in pots. The drip unit consisted of 50 mm outer diameter (OD) PVC pipeline, valve, pressure gauge etc. The mainline was of 50 mm OD and sub-main was of 40 mm OD. Lateral lines (16 mm OD LDPE) were laid from the sub-mains parallel to the plant roots in each pots. In-line emitters with a spacing of 45 cm and discharge of 4 l/h were used in the lateral line. After transplanting, one light irrigation of 20 mm depth was given for uniform establishment of the seedlings.

Treatment

Irrigation was done by taking evaporation reading on daily basis. In the study, there were four irrigation treatments with four replications. The different irrigation treatments were follows:

1. T_1- conventional irrigation 5 cm of water in each irrigation after disappearance of water
   At T_2- volume of water (V_2) = 0.8* E_{pan} (cm) * A
2. T_2-0.8 E_{pan} under drip irrigation @ 4 l/h at 3 days interval
   At T_2- volume of water (V_2) = 0.8* E_{pan} (cm) * A
3. T_3-1.0 E_{pan} under drip irrigation @ 4 l/h at 3 days interval
   At T_3- volume of water (V_3) =1.0* E_{pan} (cm) * A
4. T_4-1.2 E_{pan} under drip irrigation @ 4 l/h at 3 days interval
   At T_4- volume of water (V_4) =1.2* E_{pan} (cm) A
   Where, A= area of the pots = 490.87 sq. cm

Due to rainfall during the experiment the irrigation interval was increased, it was not fixed for 3 days anymore; according to amount of rainfall the irrigation interval was changed.

Harvesting

The fully matured rice crop was harvested manually on 112th day and stacked separately according to each pot. Then the harvested crop was dried in direct sun light for two days for further processing like threshing and cleaning.

Water Use Efficiency

Water use efficiency was calculated by the following formula for different treatment and expressed as WUE= Yield of rice / Water requirement (t/ha-cm) (Biswas *et al.*, 1999) [3].

Results and Discussion

Soil Parameters

The Bouyoucous Hydrometer method of determination of soil texture revealed that the relative portions of soil particles for the examined sample were: 34.8% of clay content, 28.0% of silt content and 37.5% of sand content. These percentages were located on a Soil Texture Triangle and the soil was classified as clay loam. The analysis of physical soil characteristics using the Keen Raczkowski box yielded the following results: bulk density of 1.29 g/cm^3, particle density of 2.6 g/cm^3, porosity of 51.15% and Maximum Water Holding Capacity of 52.3%.

Comparison of water requirements between the Drip and Conventional (Flooding) system

It was found that water requirement under drip irrigation for all the treatments were less as compared to conventional (flooding) irrigation (Table 2). In flooding irrigation method, the amount of irrigation water was almost double compared to drip irrigation. It was found that the amount of water requirement for summer rice was 600 mm in conventional irrigation system where as it was 258 mm at T_1 treatment, 298 mm at T_2 treatment and 365 mm at T_3 treatment under drip irrigation.

Table 2: Amount of irrigation of summer rice at conventional and Drip Irrigation

Treatment	Amount of irrigation (mm)
T_1	600
T_2	**258**
T_3	298
T_4	365

The amount of irrigation water required under drip irrigation at 0.8 E_{pan} treatments has been found lowest i.e., 258 mm and highest value was 365 mm at 1.2 E_{pan} treatments it was due to application of different treatments.

Comparison of Yield between the Drip and Conventional (Flooding) system

The average yield was found highest at 0.8 E_{pan} treatment under drip irrigation i.e. 3.10 t/ha, where as lowest yield had observed at conventional irrigation i.e. 2.29 t/ha (Table 3).

Table 3: Average yield at different treatment

Treatments	Average Yield (t/ha)
T_1	2.29
T_2	**3.10**
T_3	2.44
T_4	2.54

Water Use Efficiency

It was observed from the table that the water use efficiency was found to be the highest at the treatment of 0.8 E_{pan} of drip irrigation (Table 4).

Table 4: Water use efficiency in different treatment

Treatments	Water use efficiency (t/ha-cm)
T_1	1.240
T_2	8.126
T_3	5.536
T_4	4.697

Summary and Conclusion

Water is a very fundamental resource in agriculture and it is more or less the very essence of most if not all agricultural practices. However, this “liquid gold” is a resource that is gradually becoming scarce and expensive to access and as result of the impending needs, combined water saving mitigation strategies in all sectors ought to be enforced as a means to minimize water wastage and maximize its output when used. Total water requirement in conventional summer rice cultivation in field is 1583(Anonymous) [3] but it was found that the water requirement in conventional method of pot cultivation was 600 mm. So it has clearly revealed that almost 62% water has been saved in pot cultivation. It was also found that the water requirement in 0.8 E_{pan} of drip irrigation system in pot cultivation was 258 mm so it can be said that the water saving in 0.8E_{pan} has found almost 83% in compare to conventional rice cultivation in field. Due to summer rice cultivation in large area, ground water level is going low day by day as a result arsenic problem is entering

in many blocks of West Bengal. The district of Nadia as a whole the block Haringhata is badly arsenic affected block. Since summer rice cultivation is more in Nadia district so adopting drip irrigation system will be more profitable. But drip irrigation system requires good and proper management and in this system initial cost is very high to maintain that it may be difficult for farmers.

Recommendation

Determining the effects of drip irrigation in rice cultivation in field experiments requires an elaborate infrastructure. Pot experiments seem to be an alternative, since these could include a range of different soils. A further advantage will allow experiments to be continued throughout the year if the pots are sheltered from rain. This will reduce the duration of experiments compared to ones carried out in the open field. If pot experiments are carried out correctly, drainage and subsequent leaching of elements can be avoided. The evaporation loss and percolation loss are also very less in pot culture. The latter can be problematic and difficult to quantify under field condition. In the present study the experiment had been carried out in a very small areas for experimental purpose if the study will carried out in a large areas with good and proper management practices, where water is not available all the time and where field cultivation is difficult or uncultivable land due to problematic soil like rocky areas, pot cultivation under drip irrigation may give better result.

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References

1. Anonymous. Rice in India: A Status Paper. Directorate of Rice Development, Patna, 2002.
2. Anonymous. 2017. http://wbagrimarketingboard.gov.in/block/nadia.html
3. Biswas RK, Rana SK, Mallick S. Performance of drip irrigation in papaya cultivation in new alluvium agro-climatic zone of west Bengal. Annals Agricultural Research. 1999; 20:116-117.
4. Das DK, Garai TK, Sarkar S, Sur P. Interaction of Arsenic with Zinc and Organics in Rice (*Oryza sativa* L.) Cultivated Field in India. The Scientific World Journal. 2005; (5):646-651.
5. Ghosh RK, Senentharagai S, Shamurailatpam D. SRI: A methodology forsubstantially raising rice productivity by using farmers' improve thinking and practice with farmers' available resources. Journal of Crop and Weed. 2014; 10(2):4-9
6. Ghosh U, Biswas RK. Study on Scope of Roof Top Water Harvesting for Recharging Ground Water for Combating Excess Ground Water Withdrawal for Rice Cultivation in the District of Nadia in West Bengal. International Journal of Agriculture, Environment and Biotechnology. 2016; 9(6):987-993.
7. Sivanappan RK, Ranghaswami MV. echnology to take 100 tonnes per acre in sugarcane. Kissan World. 2005; 32:35-38.
8. Sonit anamika, Rathore AL, Hemlata Jha, Deepti Rathour K, Suneel, Nandeha KL. Effect of pressurized irrigation system on productivity, water and energy use efficiency of summer rice. The Ecoscan. 2015; 9(1, 2):249-254.