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Growing of tube rose with different irrigation treatment under alluvial soil of West Bengal

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Abstract
A field experimental was conducted at Departmental Experimental Field, Department of Soil and Water Conservation, with three varieties of tuberose (Prajwal, Calcutta Single, Calcutta Double) along with three irrigation treatments on IW/CPE 0.4, 0.8, 1.0. The experiment showed that the total water requirement of three varieties of tuberose for the period March, 2009 to March-2010 were 626.06mm, 695.62mm and 751.27mm for the Prajwal, Calcutta single and Calcutta double, respectively. The irrigation requirements were 212.97lit, 247.15lit and 278.32lit for the Prajwal, Calcutta single and Calcutta double, respectively. The different irrigation schedules regardless of the crop varieties on the number of spike per plot were significant. The maximum spike per plot was recorded at 1.0 IW/CPE which gave about 33.15 number of spike per plot, which was superior to 0.8 IW/CPE (32.25) and 0.4 IW/CPE (30.57).

Keywords: IW/CPE irrigation, water requirement, yield

Introduction

Tuberose (*Polianthes tuberosa* L.) is more popularly known as 'Rajanigandha' one of the most important commercially grown traditional flower crop in India. The lingering delightful fragrance and its excellent keeping quality are the predominant characteristic this crop. Tube rose belongs to the family Amaryllidaceae and is native of Mexico. At present the total area under tuberose cultivation in the country is estimated at about 15,000ha. (Singh and Singh, 2006) [7]. Among the West Bengal occupied leading position in area 3000 ha (Biswas et al., 2002) [3]. In West Bengal Total production 25.6 cores spikes/ha with the productivity of 1, 26,000 spike/ha (Nabard, 1997) [6]. The tube rose commercial production in West Bengal are Nadia, Ranaghat, Mindapur, Koiaghat, Panskura, Howrah, Hooghly, North and South 24 Parganas. Production of tuberose flower varies with the soil type, climate planting material cultivars and cultivation practices.

Irrigation requirement is the total amount of water applied to the land surface in supplement to the water supply through rainfall and soil profile, to meet the water needs of crops for optimum growth. Optimization and minimization of water to be applied to the crops is essential in any irrigation system. Yields of the crops are adversely affected with excess or inadequate water supply. Yields can be considerably increased by adopting proper irrigation management. For proper irrigation management scheduling of water is essential as stated by Tan (1980) [8]. The amount of water required by plants depends upon the crop water requirement. Allen et al. (1998) [2] refers water requirement as the amount of water that is lost through evapotranspiration. So the evapotranspiration is an important parameter in scheduling of irrigation.

Martials and Methods

The experimental was conducted at Departmental Experimental Field, department of Soil and Water Conservation, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal. The farm where the experiment was conducted is situated at 22°56′ North latitude and 88˚32′ East longitude with an average elevation of 9.75 meter above Mean Sea Level. The planting job was completed on 9th March, 2009 during the kharif season. The soil of the experimental site is sandy loam in texture, well drained with medium fertility. The soil reaction is neutral and the available nutrient status is satisfactory. The experiment site is situated to the sub- tropical humid climate. The average annual rainfall is about 1500 mm. During the experimental period the maximum monthly temperature achieved in highest value in April 2009 (35.560C) and minimum temperature achieved its lowest value is 8.890C in Jan, 2010.

Experimental details

A. Irrigation levels (Treatment)	:	1. 0.4 IW/CPE (Depth of irrigation 3cm)
		2. 0.8 IW/CPE (Depth of irrigation 3cm)
		3. 1.0 IW/CPE (Depth of irrigation 3cm)
B. Varieties	:	(i) Prajwal
		(ii) Calcutta Single
		(iii) Calcutta Double
Number of replications	:	3
Design of experiment	:	Factorial RBD
Total no. of plots	:	3 x 3 x 3 = 27
Size of each plot	:	1.2m x 1.0m = 1.2m^2
Total plot area	:	32.4m^2
Spacing between two plot	:	0.04m
Plant spacing	:	0.03m x 0.03 m
No of plants per plot	:	12

The crop water requirement is mainly depends upon the crop type, stages of growth and its evaporative demand. To calculate the evaporative demand the USWB Class A pan (circular) was used. The evaporation pan provides a measurement of the integrated effect of radiation, Wind, temperature and humidity on evaporation from a specific open water surface studied by Doorenbos and Pruitt (1977) [5]. The estimate of crop water requirement is one of the basic needs for crop planning in common areas and planning of any irrigation project. According to Doorenbus and Pruitt (1977) [5]:

ETc = Kc x ETo ………… (1)

Where, ETc = Crop water requirements to meet actual evaporation demand, Kc = Crop coefficient and ETo = Reference crop evapotranspiration

Again, ETo = Kpan × Epan ……….. (2)

Where, ETo = Reference crop evapotranspiration, Kpan = Pan coefficient, Epan = Pan evaporation

The influence of the climate on crop water needs is given by the reference crop evapotranspiration (ETo). The ETo is usually expressed in millimeters per unit of time, i.e. mm/day, mm/month, or mm/season.

For calculation of ETo of Equation (2), Epan data were collected from All India Coordinated Research Project, Meteorology, B.C.K.V., Mohanpur, Nadia, West Bengal.

The growing period of tuberose were divided into 4 growth stages:

1. The initial stage: This is the period from transplanting until the crop covers about 10% of the ground and it was up to 25 days after planting of bulb. Kc value was considered here as 0.5.
2. The crop development stage: This period starts at the end of the initial stage and lasts until the full ground cover has been reached (ground cover 50%); it does not necessarily mean that the crop is at its maximum height. Duration of the crop developmental stages was 35 days after the initial stage. Kc value was considered here as 0.75.
3. The mid-season stage: This period was divided into three stages:

a) In the 1st stages starts at the end of the crop development stages and Kc valu was considered as 1.05. Duration of this stage was 80 days after the crop development stage.

b) In 2nd stage Kc value was considered as 0.8 and its duration was 40 days from the 1st mid-season stages.

c) In the 3rd stages Kc value was considered as 1 and it continues up to 140 days from the beginning of the last season stage.

4. The late season stage: This period starts at the end of the mid-season stage and lasts until the last day of the harvest stick. Kc value was considered as 0.7. Duration of the late season stages were 66 days after the mid-season stage (Dhal, 1999; Anonymous, 2002) [4, 1].

Irrigation requirement of different varieties of tuberose

The irrigation requirement of crop (IR) can be obtained from the following formula (FAO, Crop water need)

IR = ETc - (M + Gw + ER) ………………….. (3)

Where, M = Available soil moisture content in root zone of crops, Gw = Ground water contribution and ER = Effective rainfall

Ground water contribution (Gw) to meet the irrigation requirement of crop is neglected since in the area under study, water table lies more than 2.5 m below the ground water surface. It is assumed that the carry over moisture content before and after a decision period remain same as it is difficult to get the value of "M" under variable weather condition in farmers' field condition. Thus the net irrigation requirement (IR) is compute as,

IR = ETc – ER ……………………… (4)

So, monthly net volume of water to be applied as irrigation is,

V = (ETc –ER) x A x Wp …………………. (5)

Where, V = Monthly irrigation requirement

A = Area occupied by each plant

Wp = Percentage of canopy area which is assumed as 50% during initial crop growth stage and 75% during other stage (Dhal, 1999; Anonymous, 2002) [4, 1]. The term ETc and ER are defined earlier.

Result & Discussion

The value of crop evapotranspiration (ETc) for three varieties were calculating Eq. (1). Values of ETo of Eq (1) were computed by pan evaporation method. Values of pan coefficient as used in pan evaporation method is assumed as 0.7 as suggested by (www.fao.org). ETo values were computed on daily basis from which monthly values were calculated.

The monthly crop water requirements for tuberose were calculated by multiplying Kc value with ETo for each month. The monthly ETc was converted to volumetric basis ETc requirement per plant by multiplying the ETc computed as above by the canopy area of each plant (Dhal, 1999) [4] and shown in Table 6. All the rainfall that occurs during a crop growing season is not 100% effective. 70% of the rainfall was taken as ER. Monthly ER values were converted to depth basis and volumetric basis availability per plant by multiplying the ER computed as above by the canopy area of each plant during each crop growing stage and is shown in table 2 – 3. Finally, monthly irrigation requirement per plant was computed by using the data of ETc and ER.

It is observed from Table 3 that monthly irrigation requirement of tuberose is lowest in the month of June, 2009 and February, 2010 for three varieties. Thus the seasonal irrigation requirement worked out to be 212.97, 247.15 and 278.32 lit.

The monthly crop water requirements for tuberose were calculated by multiplying Kc value with ETo for that period for three varieties. The monthly ETc was converted to volumetric basis Etc requirement per plant by multiplying the ETc computed as the above by the area occupied by a plant which is 0.30 x 0.30 m^2 (Dhal, 1999) [4] and shown in Table 1.

Table 1: Monthly water requirement ETc value for each month for March, 2009 – March, 2010

Month	ETc /day (mm)			ETc /month (mm)		
	V1	V2	V3	V1	V2	V3
March-2009	0.713	0.793	0.856	22.11	24.57	26.54
April-2009	2.175	2.416	2.609	65.24	72.49	78.28
May-2009	2.282	2.536	2.739	70.75	78.61	84.90
June-2009	2.639	2.933	3.167	79.18	87.98	95.02
July-2009	1.834	2.038	2.201	56.86	63.18	68.24
August-2009	1.387	1.541	1.664	42.99	47.77	51.59
September-2009	1.514	1.682	1.817	45.42	50.47	54.51
October-2009	1.612	1.791	1.934	49.96	55.51	59.95
November-2009	1.386	1.540	1.663	41.58	46.20	49.90
December-2009	1.016	1.129	1.219	31.50	35.00	37.80
January-2010	1.035	1.150	1.242	32.08	35.64	38.50
February-2010	1.132	1.258	1.359	31.71	35.23	38.05
March-2010	1.828	2.031	2.194	56.67	62.97	68.00
Total	20.55	22.84	24.66	626.06	695.62	751.27

Table 2: Monthly irrigation requirement of different varieties of tuberose for different months

Month	Effective Rain (mm)	Monthly IR as required by plant (mm)		
		V1	V2	V3
March-2009	60.52	0.00	0.00	0.00
April-2009	0.00	65.24	72.49	78.28
May-2009	168.73	0.00	0.00	0.00
June-2009	66.64	12.54	21.34	28.38
July-2009	227.89	0.00	0.00	0.00
August-2009	364.14	0.00	0.00	0.00
September-2009	160.48	0.00	0.00	0.00
October-2009	54.40	0.00	1.11	5.55
November-2009	11.90	29.68	34.30	38.00
December-2009	0.00	31.50	35.00	37.80
January-2010	0.00	32.08	35.64	38.50
February-2010	6.46	25.25	28.77	31.59
March-2010	0.00	56.67	62.97	68.00
Total		252.95	291.61	326.10

Table 3: Monthly irrigation requirement of different varieties of tuberose

Month	Area (m^2)	Percent occupied by canopy	Area occupied by canopy (m^2)	Monthly IR /plant (lit)		
				V1	V2	V3
March-2009	1.2	10	0.12	0.00	0.00	0.00
April-2009	1.2	15	0.18	11.74	13.05	14.09
May-2009	1.2	50	0.60	0.00	0.00	0.00
June-2009	1.2	80	0.96	12.04	20.49	27.24
July-2009	1.2	90	1.08	0.00	0.00	0.00
August-2009	1.2	90	1.08	0.00	0.00	0.00
September-2009	1.2	90	1.08	0.00	0.00	0.00
October-2009	1.2	90	1.08	0.00	1.20	5.99
November-2009	1.2	90	1.08	32.05	37.04	41.04
December-2009	1.2	90	1.08	34.02	37.80	40.82
January-2010	1.2	90	1.08	34.65	38.50	41.58
February-2010	1.2	90	1.08	27.27	31.07	34.12
March-2010	1.2	90	1.08	61.20	68.00	73.44
Total				212.97	247.15	278.32

Therefore it is seen from the Table 1 that the total water requirement of three varieties of tuberose for the total year 626.06mm, 695.62mm and 751.27mm for the Prajwal, Calcutta single and Calcutta double, respectively. The irrigation requirements were 212.97lit, 247.15lit and 278.32lit for the Prajwal, Calcutta single and Calcutta double, respectively (Table 3).

Irrigation requirement of a crop refers to the amount of water needed to be applied as irrigation to supplement the water received through rainfall and soil profile contribution in meeting the water needs of the crop for optimum growth and yield. It may be classified into gross and net irrigation requirements.

Irrigation scheduling by furrow irrigation was done by IW/CPE approach with 0.4, 0.8 and 1.0: CPE (IW = irrigation water and CPE = cumulative pan evaporation). In furrow treatment, 30mm irrigation (IW = 30mm) was applied to the crop irrespective of crop growth stage when CPE was 30mm (IW: CPE = 0.4, 0.8 and 1.0). CPE was taken as the sum of daily pan evaporation after deducting the rainfall received subsequent to the previous irrigation. Irrigation was done from a nearby reservoir by ½ inch diameter polyethylene pipe. Measured amount of water was given by volumetric method to each plot according to its treatment. The irrigation requirement for the furrow treatment was found to be 240 mm, 510mm and 630mm with 8, 17 and 21irrigation during its entire crop growth period (Table 4 to 6). The mean water requirement of tuberose crop by furrow irrigation scheduling at 0.4, 0.8 and 1.0 IW/CPE method is earlier reported to be 286mm (Anonymous, 2002) [1].

Irrigation was applied during each operation to wet the entire area occupied by a plant in the furrow which is 0.09m^2 (0.30m x 0.30m). Hence, the irrigation requirement per plant during an operation was compute by multiplying the depth of irrigation with area of 0.09 m^2 and the value in each month as required per plant is shown in Table 4 - 6. It was observed from the Table 4 that the 1st season irrigation need per plant is maximum in the month of May 2009 (0.072m^3) and the minimum in the month of (March, 2009). The reason of variable demand may be due to the variation of number and total depth of irrigation requirement in these months. The total seasonal irrigation requirement of the crop was 0.108m^3/plot by furrow system.

Table 4: Irrigation requirement of tuberose when Irrigation water applied at 0.4 IW/CPE

Month	No. of irrigation	Depth of irrigation (mm)	Volume of irrigation/plot (m^3)
March-2009	1	30	0.036
May-2009	2	60	0.072
November-2009	1	30	0.036
December-2009	1	30	0.036
February-2010	1	30	0.036
March-2010	2	60	0.072
Total	8	240	0.288

In the irrigation treatment experiment of 0.4 IW/CPE ratio from March 2009 to March 2010 irrigation water was applied in 0.288m^3 and the number of irrigation given were 8 (Table 4). In the month of May-2009 and March-2010 irrigation needed twice because evaporative demand was highest for those months.

Table 5: Irrigation requirement of tuberose when Irrigation water applied at 0.8 IW/CPE

Month	No. of irrigation	Depth of irrigation (mm)	Volume of irrigation/plot (m^3)
March-2009	1	30	0.036
April-2009	3	90	0.108
May-2009	1	30	0.036
June-2009	1	30	0.036
July-2009	1	30	0.036
October-2009	1	30	0.036
November-2009	1	30	0.036
December-2009	2	60	0.072
January-2010	1	30	0.036
February-2010	2	60	0.06
March-2010	3	90	0.09
Total	17	510	0.582

Table No 5 depicted that in the total irrigation to be applied was 510 mm or 0.582m^3 and number of irrigation were 17 at 0.8IW/CPE ratio. Here, in the months of April-2009 and March-2010 irrigation needed thrice because evaporative demand was highest for those months.

Table 6: Irrigation requirement of tuberose when Irrigation water applied at 1.0 IW/CPE

Month	No. of irrigation	Depth of irrigation (mm)	Volume of irrigation/plot (m^3)
March-2009	2	60	0.06
April-2009	4	120	0.12
May-2009	1	30	0.03
June-2009	2	60	0.06
October-2009	1	30	0.03
November-2009	2	60	0.06
December-2009	2	60	0.06
January-2010	1	30	0.03
February-2010	2	60	0.06
March-2010	4	120	0.12
Total	21	630	0.630

On the basis of irrigation schedule based on 1.0 IW/CPE the total number of irrigations were given for cultivation of tuberose crop were 21 and the total volume was applied was 0.630m^3. In the month of April-2009 and March 2010 the number of irrigation were applied four for each of those months (Table 6).

Table 7: Irrigation requirement on three irrigation levels in three varieties of tuberose

Irrigation schedule	No. of irrigation	Depth of irrigation/plot (mm)	Total volume of irrigation/plot (m^3)
0.4 IW/CPE	8	240	0.288
0.8 IW/CPE	17	510	0.582
1.0 IW/CPE	21	630	0.630

Note: Depth of irrigation (IW) applied in each irrigation 30 mm

In comparison with three irrigation levels based in IW/CPE ratio (Table 7), the total volume of irrigation water required for 0.4 IW/CPE ratio was 0.288 m^3 followed by 0.8 IW/CPE ratio was 0.582 m^3 and 1.0 IW/CPE was 0.630 m^3.

Table 8: Effects of irrigation levels on spike per plot of three varieties of tuberose

Treatment	Spike /plot			
	Variety			Mean
	V1	V2	V3	
I1	26.30	31.90	33.50	30.57
I2	30.75	32.60	33.40	32.25
I3	31.95	32.65	34.84	33.15
Mean	29.67	32.38	33.91	
SEm(±)	I	V	I x V	
	0.21	0.15	0.41	
CD (5%)	0.64	0.45	1.22	

Note: I1 = Irrigation at 0.4 IW/CPE, I2 = Irrigation at 0.8% IW/CPE, I3 = Irrigation at 1.0 IW/CPE and V1 = Variety Prajwal, V2 = Variety Calcutta single, V3 = Variety Calcutta double

The different irrigation schedules regardless of the crop varieties on the number of spike per plot were significant (Table 8). The maximum spike per plot was recorded at 1.0 IW/CPE which gave about 33.15 number of spike per plot, which was superior to 0.8 IW/CPE (32.25) and 0.4 IW/CPE (30.57). The lowest number of spike per plot was shown by the drier moisture regimes, while the highest number of spike per plot was recorded by the wetted moisture regimes. The number of spike per plot, irrespective of moisture regimes, among the three varieties tested was significant with each other. The maximum number of spike per plot was recorded by Calcutta double (33.91), followed by that of Calcutta single (32.38) and Prajwal (29.67). The interaction between the irrigation schedules and the varieties on the number of spike per plot was significant. However, maximum number of spike per plot (34.84) was recorded by Calcutta double irrigated at the irrigation schedule of 1.0 IW/CPE.

Fig 1

Fig 2

Summery and Conclusion

The experiment comprised of three irrigation levels (IW/CPE at 0.4, 0.8 and 1.0) and three varieties (Prajwal, Calcutta single and Calcutta double) laid in a factorial randomised block

design with three replications. Different biometric observations and the economic yields of the varieties under the different irrigation levels were recorded from time to time. The water requirement, water use and water use efficiency of cultivating tuberose in different moisture regimes were also carried out.
The higher water use was observed at higher levels of irrigation water application. Conversely, the highest water use efficiency was observed at lower levels of irrigation application in comparison to higher levels of irrigation ascribed due to more application of irrigation water to crop.
The economic analysis of tuberose showed that the higher yield was recorded at higher moisture regime (IW/CPE at 1.0) followed by intermediate moisture regime (IW/CPE at 0.8) and lower moisture regime (IW/CPE at 0.4). This indicated that the economic yield of tuberose under higher moisture level was not high enough or optimal in response to the higher irrigation regimes.

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