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Characterisation of rainwater deficit at growth stages of rainfed *kharif* rice for timely and delayed transplanting in the new alluvial zone of West Bengal

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ABSTRACT

To assess the quantity of rainwater deficit during growth stages of rainfed *kharif* rice in new alluvial zone of West Bengal at different risk levels under normal and delayed transplanting situations historical weekly rainfall database pertaining to six different stations of this zone were analysed. A criterion of 50 mm weekly water requirement was utilised to find out weekly rainwater deficit. Incomplete gamma distribution analysis of water deficits accumulated over three crop growth stages was done. At high risk level (75% probability), vegetative, reproductive and maturity stages are likely to face 30—60, 15—106 and 24—130 mm rainwater deficit respectively due to progressive delay in transplanting from the earliest week. Similar projections at moderate risk level (50% probability) are 45—91, 31—133, and 47—145 mm respectively. Distribution of rain is so erratic that even crop transplanted in 28th week is likely to face 69 and 123 mm total rainwater deficit at high and at moderate risk level respectively.

Key words: Rainwater deficit, *kharif* rice, climatic risk

In the new alluvial agroclimatic zone of West Bengal, transplanting of rainfed *kharif* rice is delayed due either to delay in the onset of monsoon or adjustment in the cropping sequence. Though total seasonal rainfall is more than sufficient to grow rainfed *kharif* rice, due to skewed distribution of this climatic parameter the crop faces different degrees of rainwater deficit even when the crop is transplanted at proper time. Since transplanting of *kharif* rice in this zone is done between 28th SMW (9-15th July) at the earliest and 35th SMW (27th Aug – 2nd Sep) at the latest, characterisation of rainwater deficit during vegetative, reproductive and maturity stages under normal and delayed transplanting situations at different risk levels is necessary to help the farmer and/ or planner to decide upon alternative cropping strategy or management options. Using long term historical weekly rainfall database pertaining to six different stations of this zone and a criteria of weekly stable rainfall as described by Singh and Singh (2000) an assessment of the quantity of rainwater deficit at high and at moderate risk levels for different transplanting scenarios starting from 28th to

35th SMW has been made for this agro-climatic zone of the state.

MATERIALS AND METHODS

Historical daily rainfall databases pertaining to different stations, viz, Krishnanagar (1901-1990), Baharampur (1901-1990), Dum Dum (1951-1990), Burdwan (1901-1980), Hoogly (1969-1988) and Howrah (1961-1980) of new alluvial zone of West Bengal were collected from National Data Centre, India Meteorological Department, Pune, which was subsequently converted to total rainfall on standard meteorological week (SMW) basis for this study. Considering 3-4 mm daily ET loss and 3-4 mm daily percolation loss from rice field in the eastern Indian region, Singh and Singh (2000) have assumed that a weekly rainfall of 50 mm is sufficient/ stable to meet the water requirement of rice crop. Since the average bund height maintained by the farmer is around 50 mm, which is maximum allowable submergence, it was considered that any weekly rainfall above this quantity is ineffective and is going to be lost as run-off. Taking this into consideration, effective rainfall (£ 50 mm/ week) for each week of the *kharif* rice crop growing season of the entire database was calculated which was subsequently subtracted from 50 mm to obtain weekly water deficit. Entire growth period of rice after transplanting was divided into three stages, viz, vegetative (6 weeks), reproductive (4 weeks) and maturity (4 weeks). However, during maturity stage rainwater deficit was analysed only up to 3 weeks since later weeks require dryness for good harvesting operation. Cumulative rainwater deficit for each of the three crop growth stages were summed up for eight different possible transplanting periods (28th to 35th SMW). Time series of such values were subjected to incomplete gamma distribution analysis (Thom, 1958) as described by India Meteorological Department (1995). Minimum expected rainwater deficit at 3 out of 4 years (75% probability) was considered as high risk level since the estimated deficit is lower and that in 1 out of 2 years (50% probability) was considered as moderate risk level since the estimated deficit is comparatively higher. Thus all the deficits during vegetative stage were compared against a rainwater requirement of 300 mm (50 mm X 6 weeks). Similarly deficits during reproductive and maturity stages were compared against a rainwater requirement of 200 mm (50 mm X 4 weeks) and 150 mm (50 mm X 3 weeks) respectively.

RESULTS AND DISCUSSION

Rainwater deficit at different growth stages

Accumulated rainwater deficit during vegetative, reproductive and maturity stages for the rain-fed *kharif* rice crop transplanted from 28th to 35th SMW under high (75% probability) and at moderate (50% probability) risk level for different stations of new alluvial zone of West Bengal are presented in Figure 1 and 2 respectively. With successive delay in transplanting time from 28th to 35th SMW accumulated rainwater deficit during three different

Table 1 : Seasonal rainwater deficit (mm) at two risk levels for *kharif* rice transplanted at different times in new alluvial zone of West Bengal.

Trans planting	Dum Dum		Krishnanagar		Burdwan		Baharampur		Hoogly		Howrah		Mean for zone	
(Met.week)	High	Mod.	High	Mod.	High	Mod.	High	Mod.	High	Mod.	High	Mod.	High	Mod.
28th	67.9	120.1	64.9	125.9	58.2	112.6	62	118.7	78.7	130.7	79.4	131.1	68.5	123.2
	(921.5)*		(728.1)		(810.0)		(779.7)		(893.9)		(886.6)		(836.6)	
29th	67.2	131.3	72.3	140.5	65	126.8	69.9	133.7	76	143.1	77.7	144.6	71.4	136.7
	(873.6)		(682.1)		(752.3)		(740.2)		(850.8)		(849.1)		(791.4)	
30th	87.1	155	92	163.7	84.5	150.1	89.6	156.3	103	171.8	102.7	171.7	93.2	161.4
	(838.6)		(640.9)		(695.7)		(700.3)		(786.6)		(810.0)		(745.3)	
31st	122.2	189.2	115.8	193.5	109.1	180.2	115.5	187.6	128.7	198.8	131.5	201.4	120.5	191.8
	(774.6)		(586.0)		(629.6)		(638.9)		(733.0)		(743.7)		(684.3)	
32nd	154.3	224.9	158.2	233.9	149.7	218.5	156.4	226.5	151.3	227.1	154.6	230.4	154.1	226.9
	(694.6)		(530.9)		(571.5)		(584.5)		(669.1)		(652.8)		(617.2)	
33rd	185.6	271.2	191.7	281	184.4	263.9	192.1	271.7	207.3	287.2	209	289.8	195.0	277.5
	(651.5)		(474.0)		(503.4)		(522.8)		(621.7)		(589.7)		(560.5)	
34th	238.3	317	236.3	322.1	227.5	306.4	235.2	312.4	256	328.4	259.3	331.7	242.1	319.7
	(582.6)		(411.0)		(434.6)		(460.7)		(558.9)		(528.2)		(496.0)	
35th	293	363.7	284.3	365	275.7	349.6	282.2	354.6	298	373.6	296.6	372.4	288.3	363.2
	(503.2)		(365.7)		(385.3)		(397.8)		(484.8)		(487.0)		(437.3)	

*Figures in parenthesis indicate total seasonal rainfall for the 13- week growth period)

growth stages of rainfed rice increased progressively. When studied across different stations, it was revealed that at high risk level vegetative stage is likely to face 30 to 60 mm deficit whereas reproductive and maturity stages are likely to face 15 to 106 mm and 24 to 130 mm rainwater deficit respectively as transplanting is delayed from 28th to 35th SMW. At moderate risk level similar deficit during vegetative, reproductive and maturity stages are 45 to 91 mm, 31 to 133 mm and 47 to 145 mm respectively. Analysis also highlights that each weeks delay in transplanting from 28th SMW vegetative stage of the crop is supposed to be exposed to another 4.3 mm rainwater deficit at high risk level. Similar deficit for reproductive and maturity stages were 13 mm and 15.2 mm respectively per one week delay in transplanting. It is also evident that vegetative stage is not likely to face significant rainwater deficit whereas maturity stage is likely to face maximum deficit followed by reproductive stage due to successive delay in transplanting. Transplanting on 29th SMW leads to minimum water deficit in vegetative stage, however, crop transplanted in the earliest week (28th SMW) leads to minimum water deficit in both reproductive and maturity stages. When studied across the stations it is evident that pattern of relative water deficit during different stages with delay in transplanting were almost similar which indicates similar temporal pattern of rainfall distribution during crop growth stages across the stations studied.

Total seasonal rainwater deficit

At high risk level total rainwater deficit is likely to vary from 68.5 mm (transplanted at 28th SMW) to 288.3 mm (transplanted at 35th SMW) causing four times increase in deficit due to extreme delay in transplanting (Table 1). However, similar increase at moderate risk level is about three times (from 123.2 mm to 363.2 mm). It is interesting to compare these deficits against total growing season rainfall (for 13 weeks) and growing season rainwater requirement, i.e., 650 mm (50 mm X 13 weeks). Analysis shows that total growing season rainfall across the stations is highly variable whereas difference in total rainwater deficit is not significant; had the distribution been uniform, crop transplanted upto 31st -32nd SMW could have faced little or no water deficit. Skewness of rainfall distribution in this agroclimatic zone can also be appreciated by the fact that even crop transplanted in the earliest week (28th SMW) was likely to face 69 mm and 123 mm total rainwater deficit at high and at moderate risk levels respectively against a total growing season rainfall of 837 mm which is 187 mm more than that required (650 mm = 50 mm X 13 weeks). It is also interesting to note that relative difference between water deficits at two risk levels is wider in early transplanted crop. However, as the transplanting is delayed these differences became much narrower which might be due to consistent low rainfall towards the end of growing season.

Depending upon the extent of delay

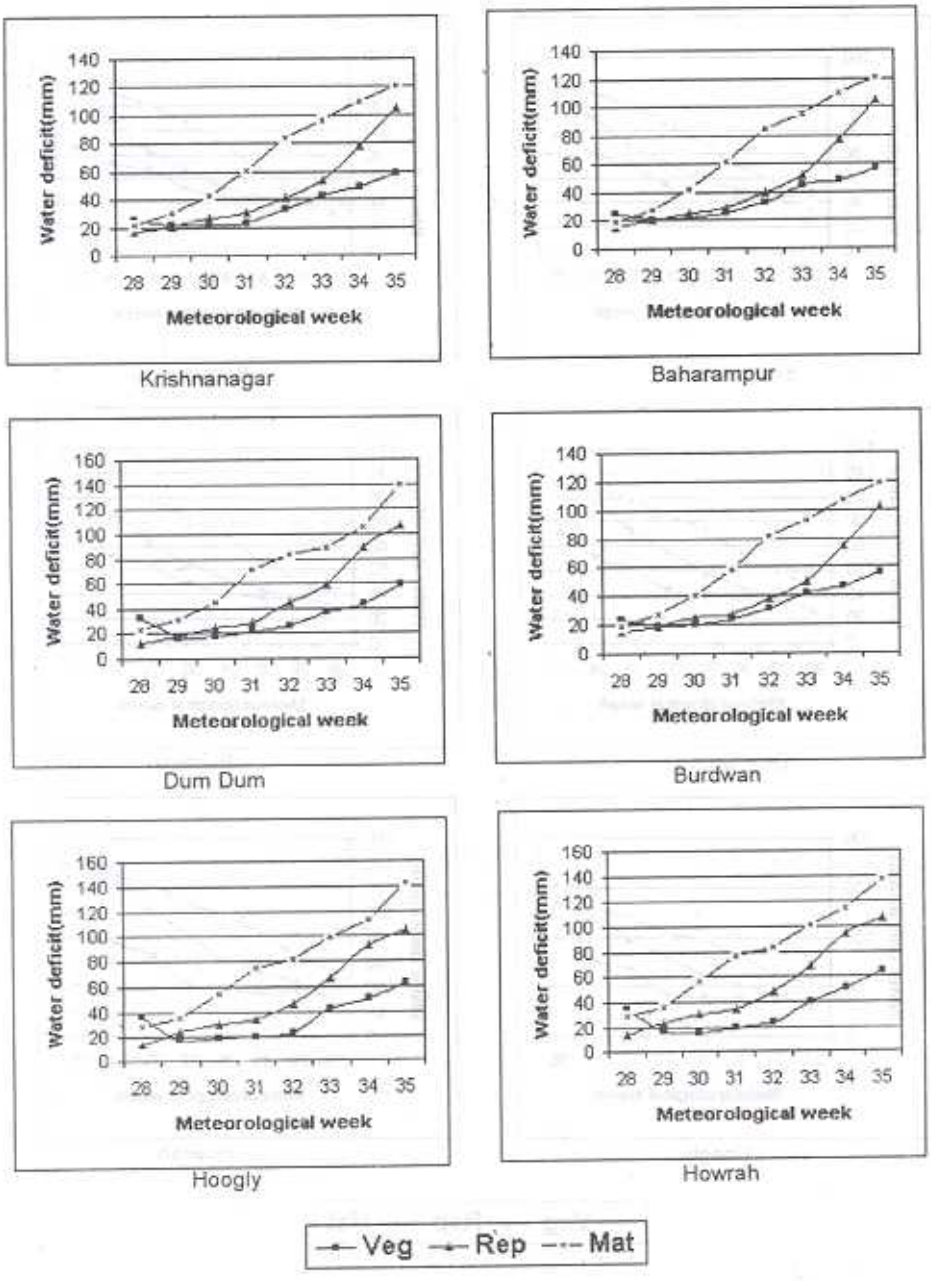

Fig. 1: Rainwater deficit during growth stages of *kharif* rice in the new alluvial zone of West Bengal at high(75%) risk level

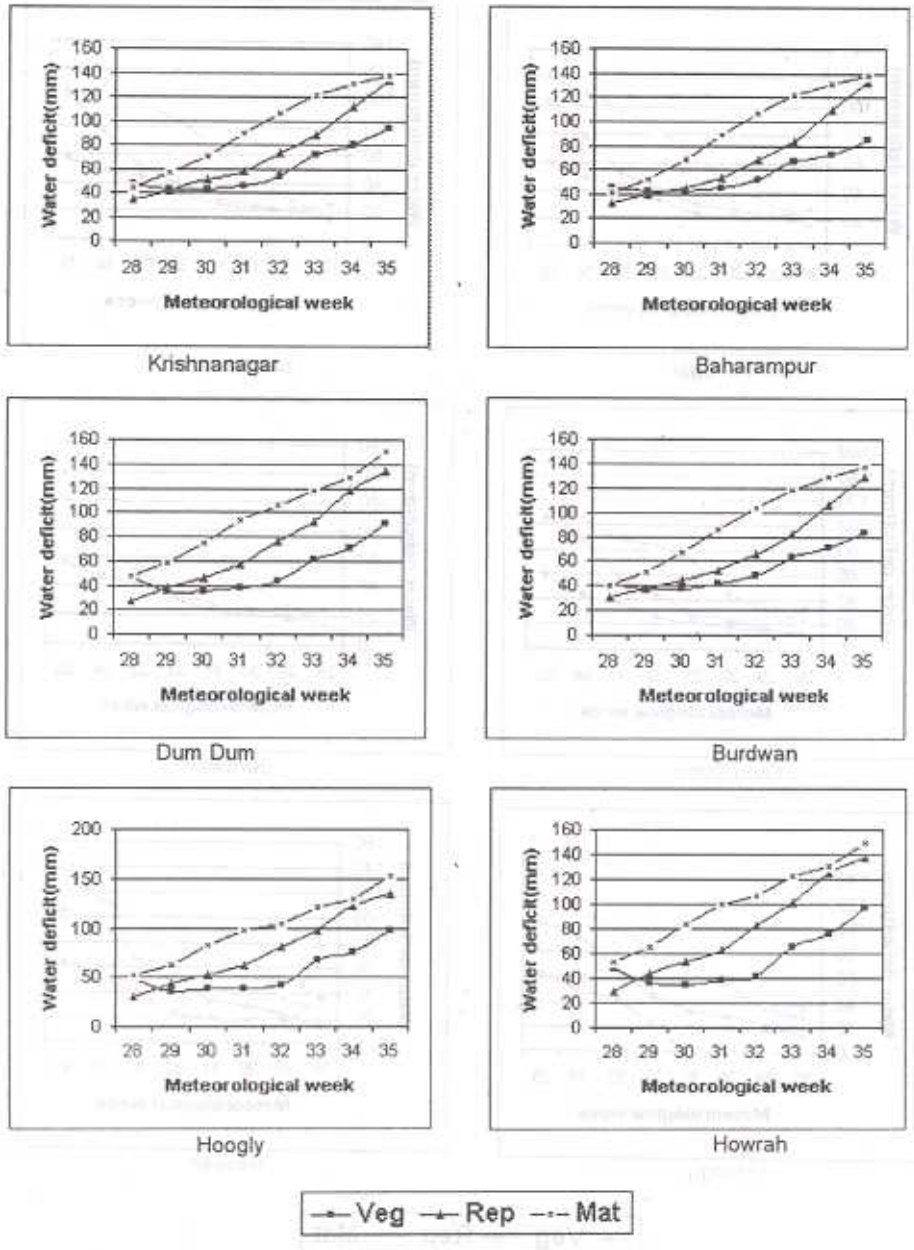

Fig. 2: Rainwater deficit during growth stages of *kharif* rice in the new alluvial zone of West Bengal at moderate (50%) risk level

in transplanting due to various reasons and based on their risk bearing ability farmers/ planners can assess the quantity of expected rainwater deficit to which the *rainfed* rice crop is likely to be exposed and make decision about the feasibility of any contingent measures or alternate cropping strategies.

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