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National Academy of Agricultural Science (NAAS) Rating : 3. 03

Study of Rainfall Characteristics like Duration Intensity Classification, Frequency – Distribution of Rainy Days, Kinetic-Energy of Rain Storms and Erosion Index

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ABSTRACT: *A field experiment was conducted during the kharif season 2012-13 as on evaluation at Model Watershed of Agro-Ecology and Environment Centre, College of Agric. Engineering and Technology, Dr. P.D. KrishiVidyapeeth, Akola. To Study rainfall characteristics like duration intensity classification, frequency – distribution of rainy days, kinetic-energy of rainstorms and erosion index.There were total five treatments viz., Contour cultivation with opening of ridges and furrows (T_5) was more effective than cultivation across the slope with opening of alternate furrow (T_4) over other treatments viz., T_3 and T_2 in reducing soil and nutrient loss. Contour cultivation with opening of ridges and furrows (T_5) reduced the peak discharge rate and cumulative runoff over treatments T_4, T_3, T_2 and treatment T^1.*

Keywords: *Cultivation, H-flume, Runoff, Soil erosion, Soil loss, Sorghum, Stage hydrograph.*

INTRODUCTION

Indian agriculture mostly depends upon the monsoon rains receiving during June to September. Water is crucial input for augmenting agriculture production towards sustainability. Water is most limiting natural source in arid and semiarid region. In most of the areas only water available is rain water. Due to inadequate and uneven distribution of rainfall during growth span of crop, it becomes essential to adopt in-situ soil moisture conservation measures for sustainable crop production in rain fed agriculture. Soil and water conservation measures are predominantly applied to control runoff and thus prevent loss of soil by soil erosion, to reduce soil compaction, to maintain or to improve soil fertility, to conserve or drain water, to harvest (excess) water. There are several soil and water conservation measures for reduction of runoff and soil loss such as strip cropping, contour farming, contour and graded bunding etc. which not only controls the runoff more efficiently but also curtails the soil loss and enhanced the crop yield. In order to have the sustainable agriculture, maintaining soil properties in favourable proportion for a long time conservation practices are necessary to overcome this problem. This can be feasible integration of managing the land on water basis.

Keeping the above facts in views, the present investigation has been planned for sorghum crop. The study was conducted to evaluate the *in-situ* soil and water conservation effect through various land configurations forsorghum (*Sorghum bicolor)* crop.

MORPHOLOGICAL STUDY OF WATERSHED

Location of Watershed

The agriculture watershed of Agro-ecology and Environment Centre is located at Central Research Station of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. Which is located at an altitude of 307.4 m above mean sea level.

Climate

Agro-ecologically the watershed area lies in sub region. The climate is semi-dried masonic characterized by three distinct seasons. Akola district falls in assured rainfall zone of Maharashtra having an average annual rainfall of 700mm.

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Table 1
Treatment details

Sr. No.	*Treatment*	*Description of treatment*	*Size (m × m)*	*Area (ha)*
1.	T_1	Cultivation along the slopes	125 × 10	0.10
2.	T_2	Cultivation along the slope with opening of tide furrow (30 DAS)	129 × 28	0.36
3.	T_3	Cultivation across the slope	125 × 10	0.10
4.	T_4	Cultivation across the slope with opening of alternate furrow	122.25 × 28	0.10
5.	T_5	Contour cultivation with opening of ridges and furrow	124.49 × 28	0.34

Rainfall Characteristics

Recording type rain gauge was installed in the observatory located at the Agro-ecology and Environment Centre and data pertaining to rainfall and rainfall intensity classification was done onthe basis of depth of rainfall for the year 2012-2013. South West monsoon had commenced in this area from 22 meteorological week, which was useful for seed bed preparation, however the adequate rains received in 28 meteorological week were useful for sowing . The rainfall during the season was 625.3mm with 47 Rainy days (> 2.5 mm day^{-1}), mainly during the month of June, July, August, and September. Out of total rainfall, 625.3 mm (*i.e.* 100%) rainfall was received during the month of June to September.

Table 2
Frequency distribution of rainy days during the year 2012-13

		Daily rainfall mm					
Month	*Rainfall (mm)*	*<25*	*25-50*	*50-75*	*75-100*	*> 100*	*Rainy days*
Jun	95.9	5	1	–	–	–	6
July	283.2	18	4	–	–	–	22
August	108.1	16	–	–	–	–	16
September	138.1	12	1	–	–	–	13
Seasonal total	625.3	41	6	–	–	–	47
October	31.5	02	–	–	–	–	02
January	29.4	02	–	–	–	–	02
February	2.5	01	–	–	–	–	01

The data in Table 2 revealed that out of 47 days of rainfall, 41 rainy days were commenced with rainfall < 25 mm and 6 rainy days were in the range of 25-50mm.

Rainfall Erosive Index (*R*)

The rainfall erosive factor (*R*) in the universal soil loss equation is the number of rainfall erosion index unit EI_{30} for a particular location. The method suggested by Wischmeir (1959) was used for estimating the erosion index values of each storm. The EI_{30} is expressed as

$$El_{30} = \frac{\text{K.E.} \times I_{30}}{100}$$

Where,

EI_{30} = Erosion index

K.E = Kinetic energy of storm mtha^{-1}cm^{-1}

I_{30} = Maximum 30 min rainfall intensity of the storm cm hr^{-1}

For computing the Kinetic Energy for the storm, the equation proposed by Weishmeir and Mannering (1969) in metric unit was used

$$\text{K.E.} = 210.3 + 89 \log_{10} I$$

Where,

K.E. = Kinetic energy mtha^{-1} cm^{-1}

I = Rainfall intensity in cm hr^{-1}

Maximum Rainfall (P) and Storm Intensity (I)

Month wise daily rainfall was recorded with recording type rain gauges which were installed in the observatory located at the Agro-ecology and Environment centre (AEEC). Maximum precipitation (P) for particular time period, such as 5,10,15,30 and 60 minutes for each rainfall event was observed and noted as P_5, P_{10}, P_{15}, P_{30} and P_{60} in terms of cm.

Storm intensity (I) cmhr^{-1} was determined for particular date of each rainfall event for particular month and time period such as 5, 10, 15, 30 and 60 minutes.

Experimental Details

Location : AEEC, Dr. P. D. K. V. Akola
Crop : Sorghum (*Sorghum bicolor*).
Variety : CSH-9
Land slope : Main-1.6 percent
Lateral-0.7 percent
Soil type : Medium deep
Monitoring device : H' flume with SLR (Daily type)
(i) Date of Sowing : 3 July, 2012
(ii) Date of harvesting : 22 October 2012
(iii) Duration : 111(days)

Table 3(a)
Maximum rainfall (mm) and rainfall intensity (cm hr^{-1}) for the selected time duration, June 2012.

		5 minute		*10 minute*		*15 minute*		*30 minute*		*60 minute*	
Date	*Total rainfall, (mm)*	P_5	I_5	P_{10}	I_{10}	P_{15}	I_{15}	P_{30}	I_{30}	P_{60}	I_{60}
11/6/2012	3.1	1.5	1.8	2.0	1.2	2.0	0.8	2.5	0.5	2.7	0.3
16/6/2012	10.9	3.2	3.8	3.5	2.1	5.5	2.2	8.0	1.6	8.0	0.8
17/6/2012	4.0	1.0	1.2	1.0	0.6	1.5	0.6	1.5	0.3	2.0	0.2
18/6/2012	44.5	4.5	5.4	4.5	2.7	5.0	2.0	7.5	1.5	11.0	1.1
19/6/2012	17.2	2.0	2.4	3.0	1.8	4.5	1.8	5.0	1.0	5.5	0.56
30/6/2012	16.2	5.0	6.0	7.0	4.2	8.0	3.2	12.0	2.4	13.5	1.4
Total	95.9										

Details about the treatment T_1, T_2, T_3, T_4 and T_5 were shown in following table 1.

Rainfall

The daily rainfall for the year 2012-2013 was recorded at the Model Watershed of Agro Ecology and Environment Center, C. R. S., Dr. P. D. K. V Akola with the help of automatic recording type rain gauge.

Runoff

The runoff from each plot concentrated at the outlet of runoff plot was measured by H-flume of 0.30m depth installed as a runoff measuringdevice. The float type automatic stage level recorder was installed at the outlet of each gauging site.

The runoff chart obtained from Stage Level Recorder gives a continuous record of depth of flow over the flume with respect to time. This stage graph was subsequently processed to obtain the runoff rates and Peak rate of runoff volumes which was later used for further analysis.

Stage Hydrograph Analysis

Stagehydrograph is graphical representation of instantaneous discharge of field plots plotted with time. After the storm commences, the initial losses like interception and infiltration are met and then the surface flow begins. The stage hydrograph gradually rises and reaches its peak value after a time measured.The intensity of rainfall is inversely proportional to its duration of occurrence and directly proportional to return period. The relationship between rainfall and peak runoff was represented by many empirical formula.

RESULS AND DISCUSSION

Rainfall and Season

Recording type rain gauge was installed in the observatory located at the Agro Ecology and Environment Centre and data pertaining to rainfall on the basis of monthly rainfall for the year 2012-2013 are incorporated in Table 2. South West monsoon had commenced in this area from 22nd meteorological week, which was useful for seed bed preparation, however the adequate rains received in 28th meteorological week were useful for sowing.

Rainfall Erosive Index (*R*)

Maximum rainfall (*P*) was determined by analysis of rainfall charts obtained from recording type rain gauge installedat the Agro Ecology and Environment Centre. Likewise *P* and *I* were determined for each rainfall event occurred in particular month. Rainfall intensity was calculated and incorporated in Table 3(a). Earlier this rainfall intensity was used for determining erosion index (E_I).

Table 3(b)
Month wise erosion index (EI) of rainfall for selected time duration during the year 2012-13

Month	*Rainfall mm*	*Total KE (metric unit)*	EI_5	EI_{10}	EI_{15}	EI_{30}	EI_{60}
June	95.9	1038.88	110.3	77.21	58.82	44.12	24.81
July	276.2	5598.89	671.86	503.90	425.51	246.31	139.97
August	105.9	2039.53	146.87	73.43	53.03	36.71	20.39
Sept	134.9	2819.59	338.35	372.18	183.55	130.52	77.50
Grant total	612.9	12296.39	1267.38	1026.72	721.91	457.66	262.67
Octo.	31.5	755.64	51.0	36.72	30.22	19.94	9.97
Jan	29.8	792.65	40.18	47.55	31.70	22.82	10.31
Total		13844.68					

Table 3(b) revealed that the erosion index for 5 min (EI_5) was maximum (*i.e.* 671.86) for the month of July while minimum (*i.e.* 110.3) for the month of June. Erosion index (EI_{10}) is maximum (*i.e.* 503.90) for the month of July while minimum (*i.e.* 73.43) for the month of August. Likewise erosion indices for 15, 30, and 60minutes *i.e.* EI_{15}, EI_{30} and EI_{60} were maximum in July and minimum in the month of August.

Daily Rainfall and Rainfall Intensity

It is revealed that 57.3 mm of total rainfall received with 0-10 mm h^{-1}, rainfall intensity for the duration of 8 hr 38 min and 16.7mm of total rainfall received with 10-20mmh^{-1} rainfall intensity for the duration of 55 min. Likewise 8.5 mm for 20min under 20-30 mm h^{-1} rainfall intensity, 8.9mm for 15min under 40-50mm h^{-1} rainfall intensity, 4.5mm for 5min under 50-60mm h^{-1} rainfall intensity in month of June 2012.

CONCLUSIONS

The rainfall commenced from 11th June 2012. The season was favourable for germination and intercultural operations as there were continuous showers. The last two showers were of 4.5mm on 15th Nov. and 2.4mm on 18th Nov. 2011, and thereafter there was withdrawal of monsoon. Thus due to early withdrawal of monsoon the crops were badly suffered due to the moisture stress.

In-situ recharge of rainwater needs reform in cultivation practices so maximum rainfall gets infiltrated in to the soil profile which reduces the runoff, soil loss and nutrient losses. This enhanced moisture level become available to the crop during prolonged monsoonic break.

During the season 2012-13 four runoff producing storms were recorded by stage level recorded installed at the outlet of each gauging site, from four stage hydrographs, single peaked stage hydrograph was selected for the study of different components of storm hydrograph.

From the Results Following Conclusions Were Drawn

1. Contour cultivation with opening of ridges and furrows (T_5) and Cultivation across the slope with opening of alternate furrow (T_4) followed by T_3 and T_2 over treatment of cultivation along the slope (T_1) were seen effective in reducing runoff, soil loss and nutrient loss.
2. Contour cultivation with opening of ridges and furrows (T_5) reduced the peak discharge rate and cumulative runoff over treatments T_4, T_3, T_2 and treatment T_1.
3. From rainfall analysis it revealed that out of 47 rainy days, 41 rainy days were commenced with rainfall < 25 mm and 6 rainy days were commenced with 25-50mm rainfall.
4. The erosive index EI_{30} (246.31) was maximum for a month of July.

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