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EVALUATION OF RUNOFF CHARACTERISTICS FOR VERTISOL ON ONE PER CENT SLOPE AT PARBHANI

1. Surface runoff depends upon (*i*) amount and intensity of precipitation (*ii*) structural status and type of soil (Kdrev 1988). Coarse textural and medium deep soils have moderately low runoff potential while textured deep soils and clay soils have high runoff potential (Adkine and Kulkarni 1986). On assessing water balance at Parbhani, Ramakrishna Rao *et al.* (1978) estimated that the water loss through runoff was about 15 per cent of the total seasonal rainfall. Bharambe *et al.* (1990) evaluated runoff losses at Parbhani as only 4 to 5 per cent rainfall received during the crop growth period. However, his study was limited only for two years 1985-86 and 1986-87 with an average 450 mm of rainfall.

2. Runoff plots (30.46 m × 1.65 m at 1 per cent slope) located at the Department of Agricultural Meteorology, Marathwada Agricultural University, Parbhani since 1983, were used in this study. Parbhani is situated at Lat. 19° 16′ N and Long. 74° 47′ E at 409 m above mean sea level (msl) and receive about 971 mm of annual rainfall. Soils are calcareous vertisols. Topography is flat to rolling plains. Sorghum and cotton are main crops of this region.

2.1. Runoff was collected in downstream collection tanks using multi-slot divisor. Soyabean, groundnut, pigeon pea, cotton, sorghum, sorghum-pigeon pea inter-cropping and cultivated bare fallow were tested in the present study. Contouring and rotation of treatments on different plots were followed during the period of study.

2.2. Rainfall and runoff data for 10 years, from 1983 to 1992, was analysed for runoff coefficients in percentage of rainfall, peak intensity of rainfall, time of concentration, peak rate of runoff (Q) and return period (T).

TABLE 1

Study of some of the individual rainfall events during a decade from 1983 to 1992 at Parbhani

Date of storm	Rainfall depth (D) (mm)	Duration of rainfall (t) (hrs)	Average intensity (I) (mm/hr)	Amount of runoff (R) (mm)	Runoff coefficient (C) (%)	Peak intensity (i) (mm/hr) for t_c=1.63 min	Peak rate of runoff (Q) (mm/min)	Return period (T) (year)
19 Aug 1983	68	0.85	80	36	53	144	2.5	3.4
7 Oct 1983	113	7.53	15	28	25	125	1.9	3.0
14 Jul 1984	37	1.48	25	15	39	60	0.1	0.2
28 Jul 1984	66	3.68	18	32	48	82	2.2	0.7
15 Aug 1985	50	1.88	26	13	27	74	0.9	0.5
18 Jul 1986	87	12.14	7	12	14	92	0.8	0.7
8 Aug 1987	85	11.81	7	14	16	90	0.9	0.6
20 Jun 1988	50	1.52	33	24	48	81	1.7	0.6
17 Jul 1989	85	2.00	43	10	12	124	0.7	3.6
24 Jul 1989	236	9.00	26	156	66	255	10.8	47.8
25 Sep 1990	105	3.00	35	34	32	137	2.3	5.7
11 Jul 1991	77	9.30	8	16	21	83	1.1	0.5
20 Jun 1992	158	4.30	17	37	23	189	2.5	20.0

2.3. Considering an individual rainfall storm, the peak intensity of rainfall (i) for the time of concentration is given by (Richards 1944),

$$i = \frac{D}{t}\left(\frac{t+1}{t_c+1}\right) \qquad (1)$$

Where,

i = the peak intensity of rainfall (cm) per hour,

D = depth of storm (cm),

t = duration of storm (hrs),

t_c = time of concentration (hrs) given by,

$t_c = 0.00033\ L^{0.77}\ S^{-0.385}$, as,

L = length (m) and

S = slope (%) (Kirpich 1940).

2.4. The estimation of peak rate of runoff (Q) from the total runoff (R) of the storm is given by,

$$Q = \frac{0.0208\ AR}{t_p} \qquad (2)$$

Where,

Q = peak rate of runoff (m^3/sec),

A = area (hec),

t_p = time to peak (hrs), given by

$t_p = t_c^{0.50} + 0.6\ t_c$

R = total runoff of the storm (cm).

2.5. Powell (1932) proposed an equation for rainfall depth of the storm, D(mm), in time t hours and recurrence interval T years is given by,

$$D = K\ (t \times T)^{0.25} \qquad (3)$$

where K is the constant which depends on location, calculated and graphed as a function of mean annual rainfall (PMA) in mm.

TABLE 2

Average monthly runoff coefficient at Parbhani

Month	Average rainfall (mm)	SD	Average runoff (mm)	SD	Runoff coefficient (%)	SD
June	155	±79	21	±20	13	±14
July	239	±148	51	±51	21	±11
August	248	±161	44	±52	18	±10
September	135	±137	11	±15	8	±5
October	71	±60	6	±9	9	±7

TABLE 3

Runoff losses and runoff coefficient for different crops on vertisol with 1 per cent slope at Parbhani

Crop	Data averaged for the years	Average rainfall during crop period (mm)	Average plant population (lac-hec)	Average runoff during crop period (mm)	Average runoff coefficient (%)	SD	CV	Average grain yield (kg/hec)
Sorghum	1983 to 1989, 1991 & 1992 (9 years)	745	1.48	86	11	6.3	0.58	1930
Cotton	1983 to 1989, 1991 & 1992 (9 years)	745	0.77	135	17	6.4	0.39	897
Groundnut	1983, 1985, 1986, 1988, 1989, 1991 & 1992 (7 years)	825	2.20	120	15	6.1	0.41	750
Pigeonpea	1985 to 1989, 1991 & 1992 (7 years)	740	1.40	109	14	5.9	0.41	1057
Soyabean	1984 to 1989, 1991 & 1992 (7 years)	740	4.40	97	12	5.6	0.49	1150
Sorghum + Pigeonpea	1984 to 1989, 1991 & 1992 (8 years)	696	2.20	67	9	4.8	0.50	1849
Cultivated Fallow	1983 to 1989, 1991 & 1992 (9 years)	745	—	179	24	8.7	0.36	—

$K = 46+0.006\ PMA$ (Hargreves *et al.* 1985).

2.6. Some of the individual rainfall storms, for the period from 1983 to 1992, were studied and rainfall depth (D) in mm, duration of rainfall (t) in hours, average intensity (I) mm/hr amount of runoff (R) in mm, runoff coefficient (C) in per cent, peak intensity (i) mm/hr, peak rate of runoff (Q) mm/minute, and return period (T) in years, are presented in Table 1.

3. It is found that peak rate of runoff (Q) mm/minute of the storm was found to be correlated with its rainfall depth (D) in mm, as

$$Q = -1.9 + 0.04\ D\ (r = 0.8) \qquad (4)$$

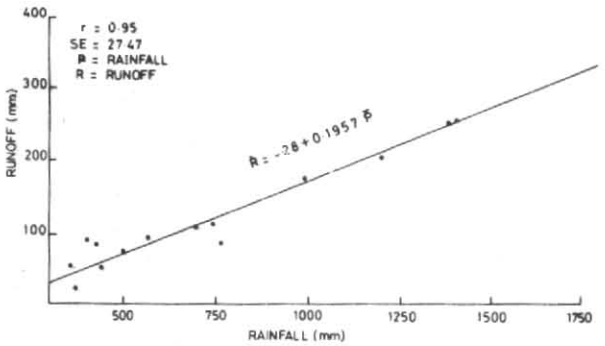

Fig. 1. Linear regression of rainfall-runoff for Parbhani (1983-92)

3.1. Highest rainfall depth of 236 mm was recorded for the storm dated 24 July 1989, with 156 mm of runoff. Its peak rate of runoff was estimated as 10.8 mm/minute and the return period was calculated as 47.8 years.

3.2. The total amount of runoff averaged for the years 1983-92 ($\bar{R}$) in mm, was 16 per cent of the average seasonal rainfall ($\bar{P}$) mm of the period. A significant correlation was obtained between $\bar{R}$ and $\bar{P}$ (Fig. 1).

3.3. Table 2 presents average monthly runoff coefficient ($\bar{C}$) at Parbhani, for the period from 1983 to 1992. $\bar{C}$ was found to be highest in July (21 per cent) and lowest in September (8 per cent).

3.4. The average runoff loss (mm) and average runoff coefficient (per cent) of rainfall, for different crops, on vertisol with 1 per cent slope at Parbhani is presented in Table 3. It indicates that sorghum-pigeon pea inter-croppings have produced higher yield (1849 kg/hec), with lowest value of runoff coefficient (C = 9)with plant population 2.2 lac/hec, followed by sole crop sorghum (plant population 1.48 lac/hec), with yield 1930 kg/hec and C = 11. Cotton crop had the highest runoff coefficient (C = 17) among all crops and its plant population was 0.77 lac/hec. Cultivated fallow allowed the maximum runoff with highest runoff coefficient (24 per cent). Similar results were obtained on clay soil with 1 per cent slope at Bangalore by Ramachandran and Narayan (1988) and by Varma *et al.*, (1990) at Kota. Table 3 also reveals that about 24 per cent of seasonal precipitation was lost through runoff from cultivated fallow.

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