4. The mean daily aerodynamic term which is calculated from the data of wind speed and actual and saturation vapour pressure for each standard week is shown in Fig. 1 (b). Aerodynamic term increases from 1st to 26th week (25 June to 1 July) afterwards it shows almost decreasing trend upto 45th week (5 to 11 November) except from 31st to 33rd week (30 July to 19 August) when it shows an increasing trend. It has been observed that the actual vapour pressure over Madras increases after 26th week. The increase of actual vapour pressure ultimately reduces the vapour pressure gradient after 26th week. Thus, the overall decrease of aerodynamic term after 26th week is due to the reduction of vapour pressure gradient and subsequent appearance of weak westerlies and weak easterlies in the morning and afternoon respectively in the southwest monsoon season and weak westerlies in the month of October. The increase in aerodynamic term after 45th week is mainly due to the strengthening of easterlies in the active northeast monsoon season.

5. In each standard week, contribution of energy term of PET is much higher than that of aerodynamic term. Ranges of energy and aerodynamic term throughout the year are 81.9 to 96.0 percent and 5.8 to 12.2 percent respectively. Besides, march of mean daily energy term and mean daily PET for each standard week throughout the year is almost same. This indicates that energy term is the main contributing factor for PET over Madras throughout the year and contribution of aerodynamic term is negligible.

References


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556.16

EVALUATION OF RUNOFF CHARACTERISTICS FOR VERTISOLS 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. Bharatmbe 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. Soya-bean, 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

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

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

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

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

$$Q = \frac{0.0208 \times A R}{t_p}$$

(2)

Where,

- $Q$ = peak rate of runoff (m$^3$/sec),
- $A$ = area (hec),
- $t_p$ = time to peak (hrs), given by
  $$t_p = t_c^{0.50} + 0.6 \times t_c$$
- $R$ = 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,

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

(3)

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

TABLE 2

Average monthly runoff coefficient at Parbhani

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

TABLE 3

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

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

\( K = 46 + 0.006 \text{ PMA} \) (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

\[ Q = -1.9 + 0.04D \quad (r = 0.8) \] (4)
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 ($C$) at Parbhani, for the period from 1983 to 1992. $C$ 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.

References


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