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Short communication

Probability analysis for prediction of annual maximum daily rainfall at Panvel*

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Probability analysis can be used for prediction of occurrence of future events from available records of rainfall (Kumar and Kumar,1989). Based on theoretical probability distributions, it would be possible to forecast the rainfall of various magnitudes with different return periods. Several distributions have been used for hydrological analysis as given by Chow (1951), Youjivich (1972), and Kottegoda (1980).

Theoretical probability distributions frequently used to estimate the rainfall frequency are Log Pearson Type –III, Log Normal and Gumbel. Several attempts have been made at different places for frequency analysis of annual maximum daily rainfall (Agarwal *et.al.*, 1988; Anil Kumar, 2000; Bhatt *et.al.*,1996). This study is an attempt to identify best theoretical frequency distribution out of the three based on Chi-square test of goodness of fit and graphical representation with the observed annual maximum daily rainfall data of Panvel.

The daily rainfall data were obtained from the Meteorological Observatory of Khar Land Research Station, Panvel (M.S). Annual maximum daily rainfall for 25 years from1975 to 1999 were arranged in descending order and the return period was obtained using Weibull's formula-

$$T = \frac{n+1}{m} \quad \text{..... (1)}$$

where, T is the return period in years, n is the total number of years of records, and m is the rank of observed rainfall values. The probability of exceedence of rainfall value is the reciprocal of the calculated return period.

According to Log – Pearson Type –III distribution, the expected rainfall value R can be obtained by relationship:

$$\text{Log } R = M + KS \quad \text{..... (2)}$$

where, M is the mean of the logarithm values of observed rainfall and S is standard deviation of these values. The frequency factor, K, corresponding to the coefficient of skew ness of transformed variate.

For log normal distribution, the values of rainfall X is replaced by its natural logarithm. The expected rainfall R can be obtained by the formula :

$$R = \overline{X}\,(1 + C_v\, K) \quad \text{..... (3)}$$

where $\overline{X}$ is the mean of X values, and C_v is the coefficient of variation of Log_e X values. The K –values corresponding to the skew ness coefficient.

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1.19 t ha^{-1} under unweeded condition for cultcivers IR 26 and Mahamaya, respectively.

There was not much difference between line sowing and broadcast in Mahamaya. But in case of IR 36 with optimum plant population in line sowing and higher plant population in broadcast system, the productivity was higher in line sowing by about 0.50 t ha under weeded condition and by about 0.20 t ha^{-1} in unweeded condition. In broadcast system there was competition among the rice plants for water and nutrition and hence the yield decreased.

The response for higher fertilizer dose was better in IR 36 than Mahamaya. For example in a better drought management conditions, that is weeded and line sown conditions, the increase in yield in IR 36 for higher fertilizer was 0.44 t ha^{-1} while the same in Mahamaya was 0.14 t ha^{-1}. This clearly indicates that cultivate Mahamaya was not responsive for higher fertilizer doses under drought conditions.

Under prolonged drought condition weeding the field increased the crop yield by reducing the evapotranspiration losses. Mere weeding of the plot at the beginning of reproductive stage increased the productivity of both the varieties by about 0.30 t ha^{-1}.

Table 1 : Chi – square test of goodness of fit for theoretical distributions for annual maximum daily rainfall data of Panvel.

Sr. No	Probability	Return period, yrs	Observed rainfall, mm	Expected rainfall, mm			$(O-E)^2/E$		
				Log Pearson Type-III	Log Normal	Gumbel	Log Pearson Type III	Log Normal	Gumbel
1.	96	1.04	124.2	129.6	126.2	124.8	0.225	0.031	0.002
2.	84.6	1.18	149.4	149.8	153.6	148.2	0.001	0.114	0.009
3.	73	1.36	154.8	150.7	172.4	160.7	0.111	1.790	0.217
4.	61.5	1.62	172.8	190.5	201.7	215.8	1.644	4.140	8.568
5.	50	2.00	202.4	215.3	230.2	223.6	0.772	3.357	2.010
6.	38.4	2.66	221.0	224.7	248.5	251.8	0.060	3.043	3.767
7.	30.7	3.25	229.9	238.2	273.3	263.6	0.289	6.891	4.358
8.	19.2	5.20	248.6	261.7	301.0	293.4	0.655	9.122	6.840
9.	11.5	8.66	301.4	310.8	325.9	340.5	0.284	1.841	4.489
10.	3.8	26.00	329.0	341.0	366.1	353.9	0.422	3.759	1.751
$\Sigma \frac{(O-E)^2}{E}$							4.464	34.088	32.010

According to Gumbel distribution, the expected rainfall R is computed as

$$R = X + K \cdot S_v \quad \text{..... (4)}$$

where, S_v is the standard deviation of observed rainfall. The K –values based on statistical parameters.

The Chi- square values C can be calculated as :

$$C = \Sigma \frac{(O-E)^2}{E} \quad \text{..... (5)}$$

where, O and E are the observed and expected values, respectively. The distribution with the least sum of C values was adjudged the best.

The record of rainfall data for 25 years (1975 – 1999) of Panvel gives annual average value of 2827.31 mm, (minimum 2050 mm and maximum 3670mm). The annual maximum daily rainfall varied from 124.2 mm in 1997 to 329 mm in 1987.The return periods and corresponding probabilities of exceedence were calculated using Eq.(1). The return period, expected rainfall three methods are given in Table 1 with chi-square value.

The sum of Chi- square values for Log Pearson Type – III, Log Normal and Gumbel distributions were found to be 4.464, 34.088 and 32.010, respectively. Therefore, Log Person Type – III distribution gives best fit for predicted annual maximum rainfall values at Panvel.

Fig. 1 also confirms the closeness of curve for Log Pearson Type –III distribution values with that of observed ones.

Hence, appropriate planning and hydrological design of soil conservation and drainage structure at Panvel can be effectively carried out on the basis of predicted values of annual maximum daily rainfall using Log Pearson Type –III

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