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# Estimation of Useful Rain for Groundnut Crop (*Arachis hypogaea* L.) in Saurashtra Region

K. R. Patel[1] and P. D. Mistry[2]


## ABSTRACT

**Effect of rainfall distribution on groundnut crop was studied by employing the concept of "Useful Rain" which was determined on daily basis. Reported yield for groundnut in Rajkot, Keshod, Mahuwa, Bhavnagar and Jamnagar in Saurashtra Region was found linearly related with useful rain. The correlation coefficient (R) between reported and estimated yield for above places was found to be 0.696, 0.557, 0.715, 0.666 and 0.849, respectively. The relationship was highly significant for all places except Keshod where it was only significant. The use of useful rain as a parameter in rainfall crop yield relationship is observed to be better than total rain.**


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## INTRODUCTION

In India, the area under groundnut cultivation is reported to be about 69.0 lakh hectares with an average yield of 840 kg/ha and thus accounts for about 37% of world average area and 33% of world production (Anonymous, 1975). In Gujarat alone this crop is sown in 15.82 lakh hectares of which approximately 85% is covered in Saurashtra region mainly in Junagadh, Jamnagar, Rajkot, Bhavnagar and Amreli districts and produces on an average 785 kg/ha (Anonymous, 1974). The success of any *Kharif* crop depends on amount of rainfall and frequency of rain days with effective rainfall in respect of the availability of water to the plant during the crop growing season. It becomes even more important for groundnut cultivation in areas with untimely and scarce rainfall. Singagi (1964) carried out a study to know the effect of rainfall distribution on the yield of groundnut in Raichur tract of Mysore State and summerised that well distributed rainfall ranging from 575 mm to 625 mm appeared to be quite sufficient to get good yield of wheat crop at crop weather observatories located at Parbhani, Niphad, Powerkhera, Dharwar and Jalgaon where the crop is entirely rainfed. They concluded that, about 75% of the total variation in yield could be accounted for by the rainfall distribution constant. Joshi and Kabaria (1973) carried out the study and observed that only once in three years, the distribution of rainfall was favourable for the bunch variety of groundnut in Saurashtra region.

In view of varying rainfall with respect of amount. time and space, an attempt was made to assertain useful rainfall for groundnut cultivation in Saurashtra region.

1. Associate Research Scientist, Regional Sugarcane Research Station, GAU, Navsari.
2. Head of department of Physics, Maths and Agricultural Engineering and Professor of Agricultural Meteorology, GAU, Anand Campus, Anand.

## MATERIALS AND METHODS

**Location :** The geographical situation of various stations under study are give in (Table 1).

*TABLE 1*

**Location of various stations under study of groundnut growing area (Saurashtra Region).**

| *Sr. No.* | *Station* | *District* | *Latitude* | *Longitude* |
|---|---|---|---|---|
| 1. | Rajkot | Rajkot | 22°.18'N | 70°.47'E |
| 2. | Keshod | Junagadh | 21°.18'N | 70°.15'E |
| 3. | Mahuwa | Bhavnagar | 21°.05'N | 71°.47'E |
| 4. | Bhavnagar | Bhavnagar | 21°.45'N | 72°.12'E |
| 5. | Jamnagar | Jamnagar | 22°.29'N | 70°.04'E |

### Source and Period of data:

Daily temperature data for the period 1960-61 to 1974-75 were collected from the India Meterological Department, Poona and Meterological Station (Air Port), Ahmedabad. The daily rainfall and crop yield data were obtained from the office of the Director of Agricultuer, Gujarat State, Ahmedabad. The data on soil physical characteristics (Table 2) utilized in this study were taken from the record of different trial -cum-demonstration farms situated in respective districts.

*TABLE 2*

**Soil physical characteristics data of various stations under study.**

| *Depth of effective root zone, mm* | *Depth of water at field capacity (FC) and permanent wilting percentage (PWP), mm* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *RAJKOT* | | *KESHOD* | | *MAHUWA* | | *BHAVNAGAR* | | *JAMNAGAR* | |
| | *FC* | *PWP* | *FC* | *PWP* | *FC* | *PWP* | *FC* | *PWP* | *FC* | *PWP* |
| 150 | 54.6 | 30.9 | 58.0 | 32.5 | 57.6 | 25.4 | 49.7 | 25.3 | 54.2 | 23.2 |
| 300 | 128.3 | 72.9 | 116.9 | 65.1 | 113.4 | 46.8 | 101.8 | 54.6 | 106.5 | 47.7 |
| 450 | 202.6 | 114.9 | 188.3 | 97.6 | 172.4 | 70.3 | 153.3 | 83.8 | 161.9 | 77.5 |
| 600 | 274.9 | 156.9 | 251.1 | 130.2 | 234.0 | 96.5 | 205.4 | 112.3 | 211.0 | 93.8 |

### Useful rain:

Useful rain for the purpose of this study was defined as the amount of rainfall, which charged the soil moisture storage in plant root-zone after deducting the potential evapotranspiration loss. The rainfall in excess of field calacity of root-zone received during the day after deducting potential evapotranspiration, was considered as combined loss due to runoff, percolation and deep drainage (Lewin, 1972). The remaining amount of rainfall after deduction of these combined losses was considered as useful rain. This moisture is stored in the root-zone of soil for subsequent use in the dry period. In other words useful rain has been formuleted as

$$RU = TP - [(TP - FC) - PE]$$

Where:

RU = Useful rain in mm

TP = Total preciption received in mm

PE = Potential evapotranspiration in mm

FC = Field capacity in mm

### Potential Evapotranspiration:

The daily potential evapotranspiration was calculated by using formula of Thernthwaite (1948), and was adjusted by multiplying with the day length factor 'l' for different months of the monsoon season, corresponding the latitudes of different stations to obtain the adjusted potential evapotranspiration.

### Book-keeping procedure:

In a simple book-keeping procedure, the depth of effective root-zone (0-60 cm) for groundnut crop was considered periodically (Table 3). The depth-wise maximum water holding capacity was considered at field capacity as mentioned in (Table 2). Excess of precipitation over maximum water holding capacity (amount of water held at field capacity in root-zone) was discarded as the combined loss in runoff, percolation and deep drainage.

*TABLE 3*

**Root depth at different phases of bunch groundnut crop.**

| *Stage of plant growth* | *period, days* | *Root depth, cm* |
|---|---|---|
| Germination and vegetative development | 0–22 | 15 |
| Flowering and pegging | 23–50 | 30 |
| Full pegging to pod development | 51–80 | 45 |
| Maturity | 81–100 | 60 |

### Relating yield with estimated useful rain:

The expected yields were estimated for each station by fitting the trend equation of the form $y = a + bx$. The agreement between the estimated yield and reported yield was tested by the correlation coefficient 'R'.

## RESULTS AND DISCUSSION

The useful rain varied from 106 to 582.8 mm, 103.3 to 606 mm, 220.6 to 582.8 mm, 103.3 to 538.9 mm and 97.6 to 593.1 mm at Rajkot, Keshod, Mahuwa, Bhavnagar and Jamnagar, respectively. The data of Mahuwa station showed that not only the amount of average useful rain was higher than other stations but the lower limit of useful rain was also high. This meant that more amount of precipitation is contributed in accumulation of soil moisture at this station. From the results of availability of useful rain, it can be fairly assumed that, for the purpose of growing the groundnut, the rainfall distribution pattern would rank the stations in the descending order as –Mahuwa, Bhavnagar, Keshod, Rajkot and Jamnagar.

### Relationship of useful rain with yield:

The relationship between computed useful rain and the reported average yield (District average) was found fairly linear ($R > 0.557$) fitting a linear equation of the form $Y = a + b x$ (Table 4).

*TABLE 4*

**Linear equation and the values of correlation coefficient (R) for different stations under study.**

| *Station* | *Linear equation* | *'R'* | *'R'²* |
|---|---|---|---|
| Rajkot | Ye = 49.95 +1.530 RU | 0.696** | 0.484 |
| Keshod | Ye = 322.42+1.558 RU | 0.557* | 0.310 |
| Mahuwa | Ye = (–70.35)+1.497 RU | 0.715** | 0.511 |
| Bhavnagar | Ye = 94.14+1.286 RU | 0.666** | 0.444 |
| Jamnagar | Ye = (–71.62)+2.270 RU | 0.849** | 0.721 |

*Significant at 5% and **at 1% level

Ye=Expected yield, kg/ha.

RU=Depth of useful rain per unit area, mm.

The value of 'R' indicating the closeness of fit was highly significant for all the stations except Keshod, where it was observed only significant. Similar findings have also been reported by the other research workers. Gangopadhyaya and Sarkar (1970) concluded that about 75 per cent of the total variation in yield could be accounted for the rainfall distribution constant. Lewin (1972) estimated soil moisture from the total rainfall by considering the water losses in the same way as considered in this study and observed that the decrease in the soil moisture below the critically chosen level (10.6%) on a day during the growth period reduced the yield by one-half of a per cent of the potential yield. Lahane and Staple (1965) have shown that rainfall distribution during the season gave better estimation of yield than equation using total seasonal rainfall only. Joshi and Radder (1975) in a field experiment observed very low yield of groundnut mainly due to reduction in the total amount of precipitation as well as long dry spell in the month of September coinciding with the peak period of pod development.

*TABLE 5*

**Total and estimated useful rainfall of the season for the various stations under study during 1960-61 to 1974-75, mm.**

| *Year* | *Rajkot* | | *Keshod* | | *Mahuwa* | | *Bhavnagar* | | *Jamnagar* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Total rain* | *Useful rain* | *Total rain* | *Useful rain* | *Total rain* | *Useful rain* | *Total rain* | *Useful rain* | *Total rain* | *Useful rain* |
| 1960-61 | 523.0 | 312.6 | 525.0 | 347.7 | 413.3 | 393.5 | 422.0 | 281.1 | 296.1 | 207.8 |
| 1961-62 | 742.6 | 480.8 | 1233.0 | 606.0 | 672.9 | 582.8 | 455.7 | 399.8 | 952.4 | 593.1 |
| 1962-63 | 339.7 | 299.9 | 742.4 | 456.0 | 532.1 | 366.1 | 349.2 | 276.6 | 275.4 | 257.3 |
| 1963-64 | 470.5 | 381.0 | 624.6 | 384.4 | 584.1 | 410.4 | 601.4 | 409.7 | 221.3 | 206.9 |
| 1964-65 | 751.8 | 401.2 | — | — | 682.4 | 550.6 | 494.0 | 313.7 | 563.9 | 321.4 |
| 1965-66 | 450.8 | 273.4 | 515.4 | 351.3 | 441.6 | 372.3 | 394.1 | 377.6 | 304.3 | 263.9 |
| 1966-67 | 435.5 | 373.0 | 518.5 | 339.5 | 274.3 | 220.6 | 516.2 | 394.7 | 260.6 | 244.6 |
| 1967-68 | 426.8 | 307.0 | 816.4 | 490.9 | 521.5 | 398.9 | 558.9 | 428.5 | 727.3 | 322.7 |
| 1968-69 | 589.4 | 308.3 | 574.8 | 246.1 | 446.3 | 300.0 | 719.5 | 254.7 | 374.5 | 208.2 |
| 1969-70 | 306.1 | 256.3 | 649.5 | 308.7 | 618.9 | 409.1 | 455.6 | 342.4 | 280.6 | 193.9 |
| 1970-71 | 1149.8 | 503.5 | 784.5 | 478.6 | 871.5 | 564.9 | 1371.0 | 538.9 | 713.2 | 441.2 |
| 1971-72 | 533.0 | 366.6 | 889.9 | 402.9 | 802.2 | 551.5 | 527.7 | 395.7 | 694.9 | 319.4 |
| 1972-73 | 342.3 | 167.0 | 483.1 | 130.3 | 307.2 | 262.4 | 191.9 | 141.3 | 229.6 | 112.2 |
| 1973-74 | 319.5 | 291.7 | 800.3 | 276.5 | 637.6 | 438.6 | 808.0 | 431.5 | 494.6 | 453.3 |
| 1974-75 | 106.0 | 106.0 | 330.0 | 338.0 | 266.8 | 257.7 | 106.0 | 106.0 | 110.5 | 97.6 |
| Average | 499.12 | 321.86 | 678.24 | 368.41 | 538.18 | 405.29 | 339.48 | 339.48 | 433.28 | 282.90 |

The results obtained in this study are in contrast to those obtained by Joshi and Kabaria (1973), who found that neither the total rainfall nor the number of rainy days had any relationship with the yield of groundnut. However, they mentioned that only once in three years, the distribution of rainfall was favourable for the bunch groundnut in Saurashtra region. It is inconceivable for the rainfed crop like groundnut to accept that the rainfall has no relation with yield. What is more important is consideration of rainfall in terms of the apporpriate parameter contributing the effective rainfall for the purpose of the crop performance.

Though correlation coefficient is statistically significant under the Null hypothesis R = O, the regression equation fitted explained the total variation of only 48.4, 31.0, 51.1, 44.4 and 72.1 per cent for Rajkot, Keshod, Mahuwa, Bhavnagar and Jamnagar, respectively. Eventhough in comparision with the conventional parameters like total rainfall and the number of rainy days, the useful rain parameter was observed to be better in rainfall-crop-yield relationship than the total rain. The reason for the better behaviour of the parameter 'useful rain' lies in the fact that it is based on consideration of Soil Physical Parameters concerned with the soil moisture available for plant growth. Hence careful analysis of temporal distribution of rainfall, preferably on a daily basis, was essential for realistic assessment of soil moisture accumulation.

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