CHAPTER 1

AGROMET STUDIES

1.1 INTRODUCTION

The suitability of a crop to a particular region as well as its yield potential mainly depends on climate. The major variation in growth and yield of crop is due to difference in climatic parameters such as rainfall, temperature, evaporation, humidity as well as solar radiation. Hence, it is necessary to assess the climatic parameters through different indices that effects on crop yield.

1.2 AGRO CLIMATIC INDICES

The different indices are used to assess the climatic parameters are given below:

Sl. No	Indices	Sl. No	Indices
01	Effective rainfall	13	Moisture index
02	Effective rainfall use efficiency	14	Growing degree day
03	Total rainfall use efficiency	15	Photo thermal units
04	Probability analysis of rainfall	16	Helio thermal units
05	Dependability of rainfall	17	Heat use efficiency
06	Coefficient of variation of rainfall	18	Relative temperature disparity
07	Index of wetness	19	Absolute humidity
08	Evapo-transpiration use efficiency	20	Specific humidity
09	Potential evapotranspiration	21	Relative humidity
10	Moisture availability index	22	Relative humidity disparity
11	Aridity index	23	Interception of PAR
12	Moisture deficit index	24	Radiation use efficiency

1.2.1 EFFECTIVE RAINFALL (ER)

Rainfall is the most important meteorological parameters that decide the economy of the country. All water received from rainfall is not always effective. Portion of rain water may be lost from the soil by runoff, deep percolation and evaporation. Only, the water retained in the root zone can be used by the plants and represents the amount of effective rain fall. Effective rainfall is a part of rainfall received by a cropped field during the growing period of the crop that is available to meet the consumptive use of the crop. There is no universally accepted method for estimating the effective rainfall. In India, 70 per cent of average seasonal rainfall is assumed as effective in arid and semiarid regions, while 50 percent in humid regions. According to Dastane (1974) for estimating effective rainfall that if total rainfall of any day is less than 6.25 mm and over 75 mm are treated as ineffective rainfall.

Effective rainfall (ER) = Total rainfall- (Surface runoff + Evaporation + Deep percolation)

The following methods are used to determine the effective rainfall:

- Soil moisture balance method
- Soil moisture depletion method
- PET/Precipitation ratio method
- Soil moisture change method

1.2.1.1 SOIL MOISTURE BALANCE METHOD

Suppose,

Initial soil moisture status of root zone before planting of crop = X mm

Rainfall of first day of sowing or planting of crop = Y mm

Total soil moisture status of root zone in the first day of planting = X + Y mm

Evapo-transpiration (ET) of first day of sowing or planting of crop = Z mm

Soil moisture balance of root zone in the first day of sowing or planting = (X + Y) – Z mm

Likewise, soil moisture balance of root zone in the succeeding days during cropping period are calculated by using soil moisture balance of root zone in the proceeding day.

If soil moisture balance of root zone in the particular day is less than the storage capacity of root zone, the amount of rainfall is received is equal to effective rainfall.

If soil moisture balance of root zone in the particular day is more than the storage capacity of root zone, then excess amount of moisture of this particular day is called surplus water. The effective rainfall is equal to total rainfall minus surplus water

Effective rainfall (ER) = Total rainfall – Surplus water

In this manner, calculate the effective rainfall during cropping period

Example 1. The initial soil moisture status and storage capacity of root zone are 82 mm and 110 mm, respectively. Calculate the effective rainfall between 15th April to 25th April, 2020 from the following observations:

Date	Rain fall (mm)	ET (mm)
15.04.2020	-	4.5
16.04.2020	10	4.3

Date	Rain fall (mm)	ET (mm)
17.04.2020	12	4.2
18.04.2020	-	4.7
19.04.2020	-	5.2
20.04.2020	8	4.6
21.04.2020	45	4.3
22.04.2020	-	4.7
23.04.2020	-	4.8
24.04.2020	30	4.7
25.04.2020	-	4.3

Solution:

Initial soil moisture status in the root zone = 82 mm

Moisture storage capacity of soil in the root zone = 110 mm

Date	Rain fall (mm)	ET (mm)	Balance soil moisture (mm)	Surplus soil moisture (mm)	ER (mm)
14.04.2020	-	-	82	-	-
15.04.2020	-	4.5	77.5	-	-
16.04.2020	10	4.3	83.2	-	10
17.04.2020	12	4.2	91	-	12
18.04.2020	-	4.7	86.3	-	-
19.04.2020	-	5.2	81.1	-	-
20.04.2020	8	4.6	84.5	-	8
21.04.2020	45	4.3	110	15.2	29.8
22.04.2020	-	4.7	105.3	-	-
23.04.2020	-	4.8	100.5	-	
24.04.2020	30	4.7	110	15.8	14.2
25.04.2020	-	4.3	105.7	-	-
Total	105			31	74

Example 2. The initial soil moisture status and storage capacity of root zone are 100 mm and 100 mm, respectively. Calculate the effective rainfall between 15[th] April to 25[th] April, 2019 from the following observations:

Date	Rain fall (mm)	Irrigation (mm)	ET (mm)
15.04.2019	30	-	4.5
16.04.2019	-	-	4.3
17.04.2019	-	-	4.2
18.04.2019	-	-	4.7
19.04.2019	-	-	5.2
20.04.2019	-	-	6.6
21.04.2019	-	-	5.3
22.04.2019	-	-	5.7
23.04.2019	-	-	5.8
24.04.2019	-	40	4.7
25.04.2019	20	-	4.3

Solution:

Initial soil moisture status in the root zone = 100 mm

Moisture storage capacity of soil in the root zone = 100 mm

Date	Rain fall (mm)	Irrigation (mm)	ET (mm)	Balance soil moisture (mm)	Surplus soil moisture (mm)	ER (mm)
14.04.2019	-	-	-	100	-	-
15.04.2019	30	-	4.5	100	25.5	4.5
16.04.2019	-	-	4.3	95.7	-	-
17.04.2019	-	-	4.2	91.5	-	-
18.04.2019	-	-	4.7	86.8	-	-
19.04.2019	-	-	5.2	81.6	-	-
20.04.2019	-	-	6.6	75		
21.04.2019	-	-	5.3	69.7		
22.04.2019	-	-	5.7	64	-	-
23.04.2019	-	-	5.8	58.2	-	
24.04.2019	-	40	4.7	93.5		
25.04.2019	20	-	4.3	100	9.2	10.8
Total	50				34.7	15.3

1.2.1.2 SOIL MOISTURE DEPLETION METHOD

$$\text{Moisture deficit (MD)} = \frac{M_{FC} - M_{BI}}{100} \times BD \times D$$

Where,

M_{FC} = Moisture content (%) in field capacity at particular depth of soil

M_{BI} = Moisture content (%) before irrigation at particular depth of soil

BD = Bulk density of soil at particular depth

D = Depth of soil

(i) If amount of rainfall received > Amount of moisture deficit

Effective rainfall = Amount of moisture deficit

Deep percolation = Amount of rainfall received – Amount of moisture deficit

(ii) If amount of rainfall received ≤ Amount of moisture deficit

Effective rainfall = Amount of rainfall received

Deep percolation = Nil

Example 3. Calculate effective rainfall (ER) and deep percolation (DP) of two experimental field from the following observation:

Soil depth (cm)	Field-A			Field-B		
	M_{BI} (%)	M_{FC} (%)	B.D. (g/cc)	M_{BI} (%)	M_{FC} (%)	B.D. (g/cc)
0-30	15.5	22.6	1.45	11.5	19.6	1.43
30-60	16.7	22.8	1.47	10.7	17..8	1.44

Fields are surrounded by bunds to check run off water

Amount of rainfall received = 6.53 cm

Solution:

Soil depth (cm)	Field-A	Field-B
	Moisture deficit	Moisture deficit
0-30	$\frac{22.6 - 15.5}{100} \times 1.45 \times 30 = 3.08\,\text{cm}$	$\frac{19.6 - 11.5}{100} \times 1.43 \times 30 = 3.47\,\text{cm}$
30-60	$\frac{22.6 - 16.7}{100} \times 1.47 \times 30 = 2.69\,\text{cm}$	$\frac{17.8 - 10.7}{100} \times 1.44 \times 30 = 3.06\,\text{cm}$
Moisture deficit (0-60 cm)	3.08 cm + 2.69 cm = 5.77 cm	3.47 + 3.06 = 6.53 cm
ER	5.77 cm	6.53 cm
DP	0.76 cm	Nil