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Study on south-west monsoon rainfall characteristics in arid zone of Haryana

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सार – दक्षिणी पश्चिमी मानसून की विशेषताओं का पता लगाने के लिए तीन स्थानों नामतः हिसार, भिवानी और सिरसा में शुष्क क्षेत्रों के पचास वर्षों (1946 से 1995) की अवधि के दौरान प्रतिदिन के वर्षा आँकडों का विश्लेषण किया गया है। हिसार और भिवानी में क्रमशः 7 से 9 दिनों के मानक विचलन के साथ मानसून के आरंभ की औसत तारीख 4 जुलाई पाई गई जबकि सिरसा में 9 दिनों के मानक विचलन के साथ मानसून के आरंभ की तारीख 7 जुलाई पाई गई है। मानसून के आरंभ की तारीख, विश्लेषण किए जाने वाले सभी स्थानों में हुई वर्षा की राशि से विपरीत रूप से संबंधित है। दक्षिणी–पश्चिमी मानसून की वापसी की तारीख तीनों स्थानों में 9 दिनों के मानक विचलन के साथ हिसार और भिवानी में 15 सितंबर और सिरसा में 11 सितंबर थी। मानसून की वापसी की तारीखें, वर्षा की राशि के साथ विपरीत और महत्वपूर्ण सहसंबंध दिखाती हैं। हिसार, भिवानी और सिरसा में वर्षा के दिनों की औसत संख्या 5, 6 और 6 दिनों के मानक विचलन के साथ क्रमशः 18, 17 और 13 है।

ABSTRACT. The daily rainfall data of arid zone for a period of 50 years (1946-95) at three locations. Hisar, Bhiwani and Sirsa were analyzed to find out characteristics of south-west monsoon. Mean onset date was observed 4 July at Hisar and Bhiwani with standard deviation of 7 to 9 days respectively, whereas 7 July at Sirsa with standard deviation of 9 days. The onset date of monsoon was inversely related to amount of rainfall at all stations under study. The mean withdrawal dates of south-west monsoon were 15 September at Hisar and Bhiwani and 11 September for Sirsa with standard deviation of 9 days at all three locations. The withdrawal dates also showed inverse and significant correlation with rainfall amount. The mean number of rainy days at Hisar, Bhiwani and Sirsa were 18, 17 and 13 with standard deviation of 5, 6 and 6 days, respectively.

Key words – Onset, Withdrawal, Rainy days, South-west monsoon, Arid zone.

1. Introduction

A large portion of south-west Haryana comes under arid zone, as the mean moisture index for different locations in this region varies from –74.0 to 83.0 (Thornthwaite and Mather, 1955). Low and erratic nature of rainfall, extremes of temperatures and high atmospheric demand for water are major constrains for growing crop in this region. Most of the rainfall in this region (80 to 85 per cent) occurs from south-west monsoon (June to September) (Table 1). In arid zone the sowing of kharif crops done after onset of monsoon crops depends on amount of rainfall received during crop period. Characteristics of rainfall with respect to amount, distribution, onset, withdrawal, length of rainy season, number of rainy days and extreme values and its dependability forms are important parameters to evolve suitable cropping patterns for stabilizing crop yield and increasing productivity.

Keeping these points in view, the present investigation was undertaken to assess south-west monsoon rainfall characteristics for arid zone of Haryana.

2. Material and methods

Haryana stage lies between the latitude of 27° 39′ and 30° 45′ 30″ North and longitude of 74° 27′ 48″ and 77° 36′ 30″ East. In present study, three locations *i.e.*, Hisar, Bhiwani and Sirsa were selected in arid zone of Haryana (Fig. 1).

The daily rainfall data of these stations for a period of 50 years (1946-95) were collected from "Sadar Kanungo" of each district and Department of Agricultural Meteorology, Chaudhary Charan Singh Haryana Agricultural University, Hisar. Data were analyzed to find out onset and withdrawal dates, length of rainy season, number of rainy days and amount of rainfall during south-

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TABLE 1

Mean monthly period rainfall (mm) at different locations in arid region of Haryana (1946-95)

Month	Amount of rainfall (mm)					
	Hisar		Bhiwani		Sirsa	
January	14.3	(3.2)	15.6	(3.5)	9.9	(3.1)
February	13.8	(3.1)	11.6	(2.6)	11.4	(3.1)
March	9.9	(2.2)	10.9	(2.4)	10.6	(3.3)
April	9.5	(2.1)	3.9	(0.9)	2.4	(0.7)
May	20.0	(4.5)	14.5	(3.2)	13.7	(4.2)
June	35.0	(7.9)	32.9	(7.3)	26.6	(8.2)
July	131.0	(29.6)	136.5	(30.4)	103.9	(31.8)
August	125.5	(28.3)	133.7	(29.8)	84.3	(25.8)
September	64.5	(14.6)	75.6	(16.8)	50.9	(15.6)
October	9.8	(2.2)	6.3	(1.4)	6.3	(1.9)
November	4.8	(1.1)	3.7	(0.8)	2.5	(0.8)
December	5.3	(1.2)	3.6	(0.8)	3.6	(1.1)
Annual	443.3		448.8		326.1	

Figures in parenthesis are in percentage of annual rainfall.

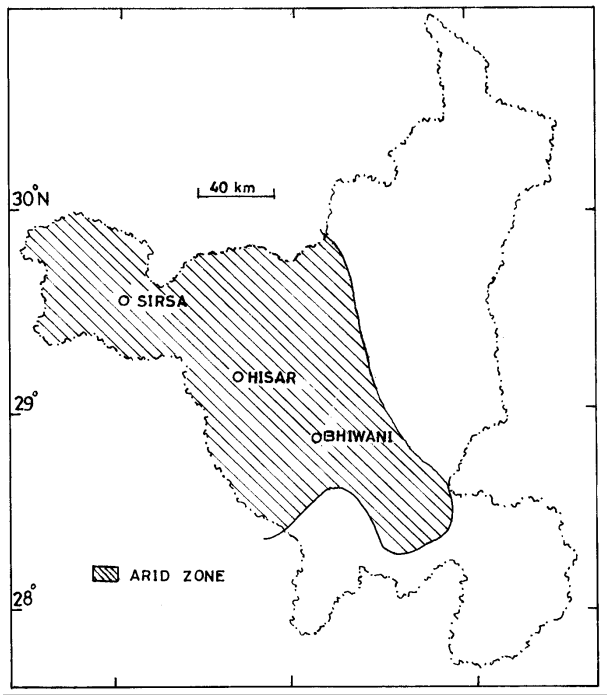


Fig. 1. study locations in arid zone of Haryana

west monsoon season. The criteria adopted by Sharma *et al*., (1987) that the date of onset of south-west monsoon is taken when rainfall occurs 2.5 mm or more in a day and continues atleast three to four days with a total amount of 25.0 mm rainfall and there is a significant increase in relative humidity in the region was followed. For withdrawal also, Sharma *et al*. (1987) criteria *i.e.* the weakening of south-westerly winds, significant decrease in relative humidity, cessation of rains and when occurrence of long dry spells was adopted. The length of rainy season was calculated as the period between onset and withdrawal of south-west monsoon. In present study, the rainy day was considered as a day having rainfall 2.5 mm or more as adopted by India Meteorological Department.

The following criteria adopted by Das and Mohanty (1992) was also followed:

Early onset/withdrawal = Mean date of onset/ withdrawal – standard deviation

Normal onset/withdrawal = Mean date of onset/ withdrawal ± standard deviation

Late onset/withdrawal = Mean date of onset/ withdrawal + standard deviation

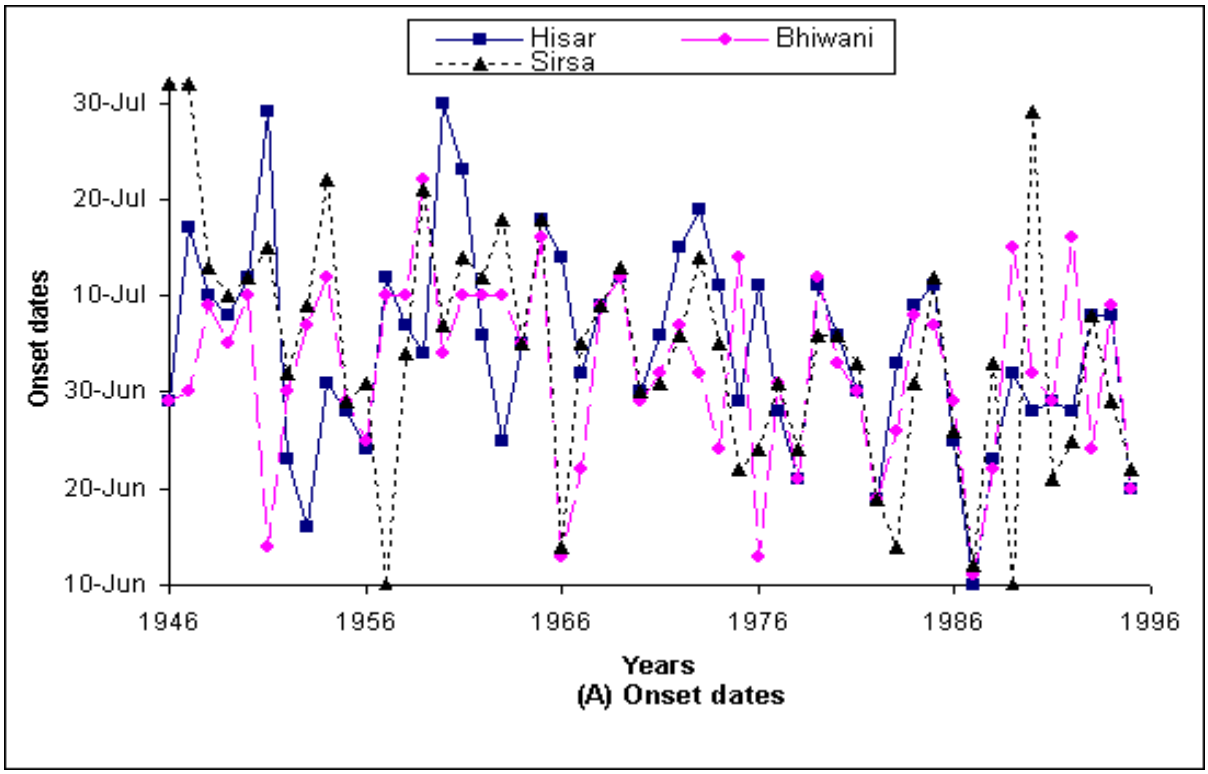
3. Results and discussion

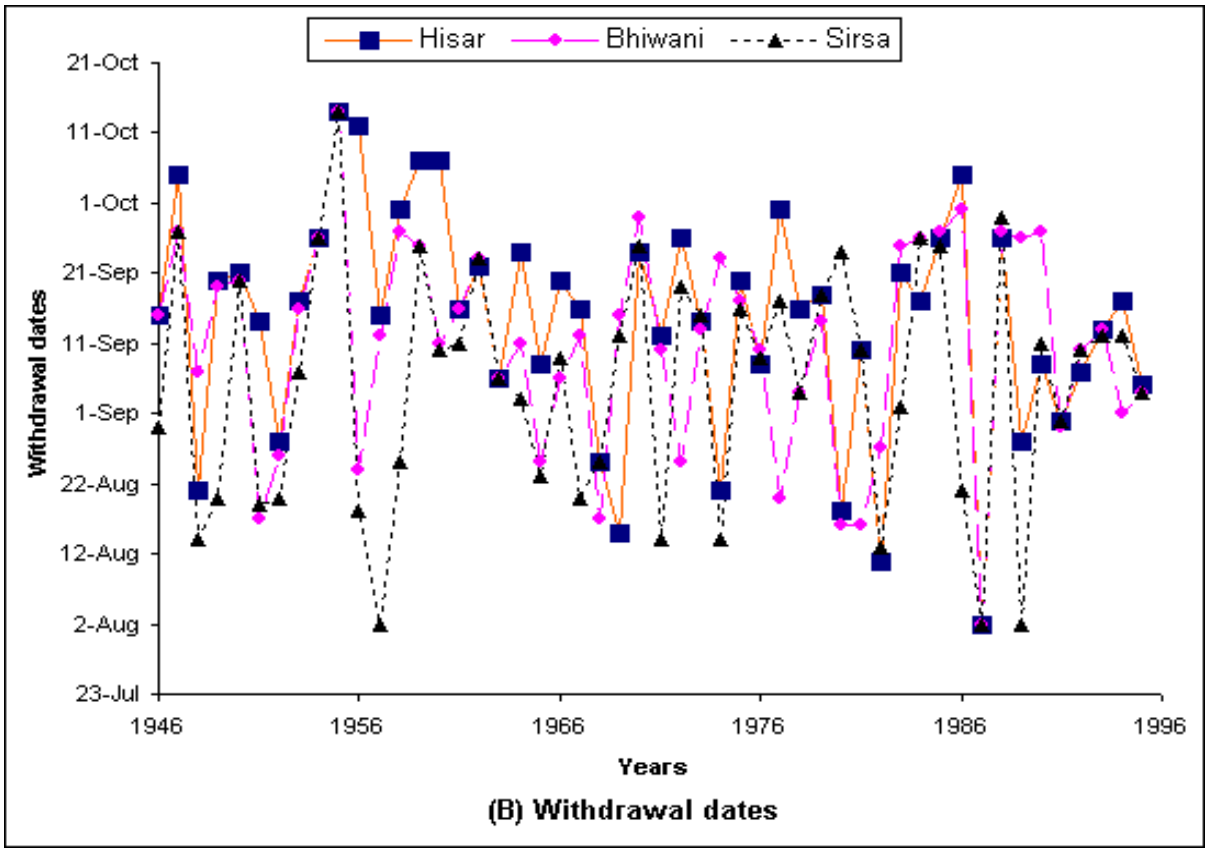
3.1. *Annual rainfall distribution*

The annual rainfall received over an area is an important factor in assessing the amount of water available to meet the demand of agriculture, industry, irrigation and other human activities. The distribution of rainfall in time and space is, therefore, an important factor in national economy. The mean annual rainfall during 50 year at Hisar, Bhiwani and Sirsa were 443.3, 448.8 and 326.7 mm, respectively (Table 1). It was observed that more than 80 per cent of annual rainfall was received during south-west monsoon period (June to September). The highest rainfall was received during month of July and lowest rainfall received during November and December months at all three locations.

3.2. *Seasonal rainfall distribution*

The seasonal rainfall (between onset and withdrawal dates) at Hisar, Bhiwani and Sirsa were 332.8, 340.4 and 235.9 mm with a standard deviation of 130.8, 173.6 and





Figs. 2(a&b). (a) Onset and (b) withdrawal dates at selected stations during period 1946-95

TABLE 2

Mean values of rainfall characteristics with standard deviation at three stations

	Hisar	Bhiwani	Sirsa
Onset date	4 July	4 July	7 July
Standard deviation	7	9	9
Withdrawal date	15 September	15 September	11 September
Standard deviation	9	9	9
Length of rainy season (days)	73	73	66
Standard deviation	16	15	19
No. of rainy days	18	17	13
Standard deviation	5	6	6
Amount of rainfall (mm)	332.8	340.3	234.9
Standard deviation	130.8	173.6	143.1

TABLE 3

Probability of occurrence (%)of early, normal and late onset and withdrawal of south-west monsoon at different locations in arid zone of Haryana during 1946-95

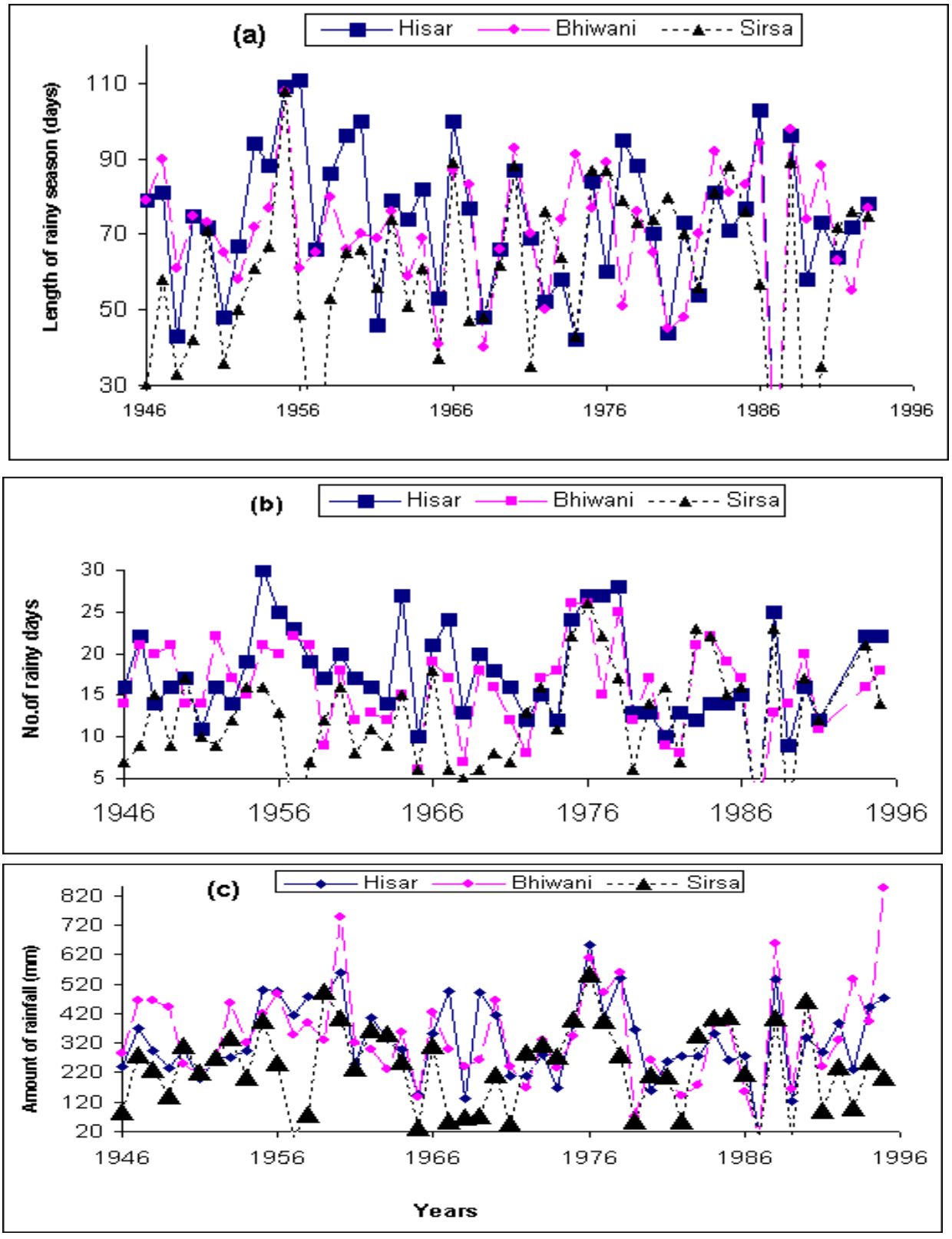
Locations	Onset			Withdrawal		
	Early	Normal	Late	Early	Normal	Late
Hisar	22.0	70.0	8.0	18.0	68.0	14.0
Bhiwani	20.4	69.4	10.2	24.5	69.4	6.1
Sirsa	21.3	61.7	17.0	23.4	63.8	12.8

143.1 mm, respectively (Table 2), which is about 75 per cent of the annual rainfall in this region. Similar results were reported by Raman (1974) for Maharashtra state. The highest and lowest rainfall during south-west monsoon season at Hisar were 654.1 mm and 123.4 mm in 1976 and 1989, respectively, while those were 847.7 mm and 71.0 mm in 1995 and 1978 at Bhiwani Fig. 3 (c). However, variation of monthly, annual and seasonal rainfall is lowest at Sirsa. Further, inter-annual fluctuations of rainfall were common in this region.

3.3. *Onset of south-west monsoon*

The dates of onset of south-west monsoon at three locations are given in Fig. 2 (a). The mean onset date was 4 July at Hisar and Bhiwani, whereas it was 7 July at Sirsa with the standard deviation of 7, 9 and 9 days, respectively (Table 2). Despande *et al*. (1986) have shown that the mean onset over Kerala is 1 June and the standard deviation is 7 days. The normal dates of onset varied between 27 June to 11 July at Hisar, 25 June to 13 July at Bhiwani and 28 June to 16 July at Sirsa. Das and Mohanty (1992) also found similar type of results over Kerala and Orissa. The earliest onset of monsoon at Hisar was 14 June in 1996 and latest on 29 July in 1951. At Sirsa the earliest date also 14 June in 1966 but latest was on 1 August in 1946-47. Whereas, the earliest date was 13 June in 1966 and latest was 22 July in 1960 at Bhiwani station during 50 years [Fig. 2 (a)]. Thus, there was a wide variability in the onset date of monsoon in arid zone of Haryana, but it is clear that the south-west monsoon sets somewhat earlier at Hisar and Bhiwani than Sirsa. The probability of occurrence of early onset was higher at Hisar (22.0 per cent) followed by Sirsa (21.3 per cent) and Bhiwani (20.4 per cent), which is significant at $P \leq 0.05$. Similarly, the probability of normal onset was highest at Hisar (70.0 per cent) and lowest at Sirsa (61.7 per cent) followed by Bhiwani (10.2 per cent) and Hisar (8.0 per cent) (Table 3).

The amount of rainfall decreased upto 31 to 40 per cent with delayed onset on monsoon in the south-western part of Haryana. The relationship between dates of onset



Figs. 3(a-c). (a) Length of rainy season, (b) No. of rainy days and (c) Amount of rainfall at three station during the period 1946-95

of south-west monsoon to amount of rainfall was worked out at Hisar, Bhiwani and Sirsa. A linear decrease in amount of rainfall with delay in onset of monsoon was observed at these locations. The R^2 values varied between 0.31 and 0.41, which are significant at $P \leq 0.05$. The regression equations developed for each location are as follows:

$Y = 491.12 - 8.30\ X, \quad R^2 = 0.31$ (Hisar)

$Y = 601.82 - 11.29\ X, \quad R^2 = 0.41$ (Bhiwani)

$Y = 363.24 - 4.73\ X, \quad R^2 = 0.32$ (Sirsa)

Where

Y = Amount of rainfall (mm)

X = onset date

3.4. *Withdrawal of southwest monsoon*

The mean dates of withdrawal of southwest monsoon were 15 September at Hisar and Bhiwani and 11 September as Sirsa with standard deviation of 9 days at all the locations under study (Table 2). The withdrawal of monsoon occurs first at Sirsa followed by Hisar and Bhiwani. The earliest date of withdrawal of monsoon was 11 August in 1982 at Hisar, 6 August, 1966 at Bhiwani and 6 August, 1971 at Sirsa while the latest date of withdrawal was 14 October, 1955 at all three locations during 50 years Fig. 2 (b).

The probability of normal withdrawal of south-west monsoon at Hisar, Bhiwani and Sirsa was 68.0, 69.4 and 63.8 per cent, respectively. The corresponding probabilities of early withdrawal were 18.0, 24.5 and 23.4 per cent and the probability of late withdrawal was 14.0, 6.1 and 12.8 per cent at Hisar, Bhiwani and Sirsa, respectively (Table 3).

The withdrawal date of monsoon was correlated with amount of rainfall received during southwest monsoon. A direct and linear relationship was observed between withdrawal date and amount of rainfall at all the locations. The amount of rainfall increased with delay in withdrawal of monsoon. The R^2 values varied between 0.29 to 0.49, which remained significant at $P < 0.05$. The regression equations are as under:

$Y = 212.41 + 4.93\ X, \quad R^2 = 0.49$ (Hisar)

$Y = 276.46 + 2.77\ X, \quad R^2 = 0.29$ (Bhiwani)

$Y = 137.75 + 5.01\ X, \quad R^2 = 0.31$ (Hisar)

Where

Y = Amount or rainfall (mm)

X = withdrawal date

3.5. *Duration or rainy season and number of rainy day*

The mean durations of rainy season *i.e*. period between onset and withdrawal of summer monsoon, were 73, 73 and 66 days at Hisar, Bhiwani and Sirsa with a standard deviation of 16, 15 and 19 days, respectively (Table 2). Singh *et al*., 1991 have reported similar results over arid Kutch region. This clearly indicates that short duration kharif crops can be grown successfully in these areas. The duration of longest rainy season was 111 days at Hisar in 1956 while smallest rainy season of 30 days was observed at Sirsa in 1946 among the locations under study. In 1955, the length or rainy season was more than 100 days at each location [Fig. 3 (a)].

The average number of rainy days were 18, 17 and 13 days at Hisar, Bhiwani and Sirsa with standard deviation of 5, 6 and 6, respectively during 50 year period (Table 2). The maximum and minimum number of rainy days was 30 (1955) and 9 (1989) days at Hisar, 30 (1988) and 7 (1968) at Bhiwani and 26 (1976) and 6 (1979) at Sirsa, respectively Fig. 3 (b). Hisar and Bhiwani had more rainy days as compared to Sirsa.

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