Comparison of Onset and Withdrawal of Monsoon using TSMOM (Triggering Soil Moisture for Onset of Monsoon) and Conventional Method

A. D. Bhagat[1], S. D. Gorantiwar[2], M. G. Shinde[3], S. A. Kadam[4] and M. A. Patil[5]

[1,2,3,4,5] *Centre for Advanced Agricultural Science and Technology (CAAST) for Climate Smart Agriculture and Water Management (CSAWM) (World Bank aided ICAR-NAHEP Programme), Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar*

Corresponding author: arunbhagat02@gmail.com

Abstract: To investigate the appropriateness of the conventional techniques of drought characterization such as onset and withdrawal of monsoon that does not consider the soil and crop characteristics on which the onset and withdrawal based crop planning depends. Therefore, the study was undertaken to analyse and compare the onset and withdrawal of monsoon by proposed TSMOM and conventional method to update the desired modifications. The proposed TSMOM method for different soils of Ahmednagar station of Western Maharashtra revealed that; for heavy soil; onset and withdrawal was delayed and advanced by 3-4 weeks, for medium soil; by 2-3 weeks and for light soil; by 1-2 weeks respectively compared to conventional method. This is due to the consideration of soils and crops; and maintenance of sufficient soil moisture in the root zone to effect onset of monsoon compared to consideration only rainfall by conventional method.

Keywords: Onset of Monsoon; Withdrawal of Monsoon; TSMOM; Conventional Method

1. Introduction

Agricultural operations in rainfed area start with the onset of southwest monsoon. It is essential to forecast the calendar of onset of effective monsoon since a slight delay in sowing of rainfed crops may lead to drastic reduction in grain yield and adversely affects the next crop too. The duration of the *Kharif* crops depends on the withdrawal of monsoon rainfall. It has been experienced that quite often the crops suffer from terminal drought due to the early cessation of rainfall. The knowledge of withdrawal of monsoon is also required for the planning of *Rabi* season crops based on residual moisture in the root zone. Therefore it is necessary to know the onset and withdrawal of monsoon for appropriate crop planning and planning of water sources available for protective irrigation. There are enumerable criteria for deciding onset and withdrawal of monsoon Morris and Zandesta, (1979) and Babu and Laxminarayana, (1997). The information of onset and withdrawal of monsoon is mainly required for crop planning based on the moisture content in the root zone. Some criteria adopted in the literature consider only rainfall and some consider rainfall and evapotranspiration. However only rainfall and evapotranspiration do not reflect the optimum availability of moisture in the root zone for sowing/planting. For this purpose it is necessary to consider water holding capacity of soil which varies with soil type and perform the soil water balance in the root zone. In this study, new criteria based on above facts is therefore proposed and compared with the existing criteria for Ahmednagar station in Ahmednagar district of western Maharashtra.

2. Material and Methods

Climatological Data

The climatological data of 30 years of Ahmednagar station of Western Maharashtra are collected from Indian Meteorological Department, Pune.

Determination of Onset and Withdrawal of Rainy Season by Conventional Method

There are several approaches for determining onset and withdrawal of monsoon. All these approaches are based on the precipitation amount. The more widely adopted approach based on precipitation amount is given by Morris and Zandesta, (1979) for onset of monsoon and Babu and Laxminarayana, (1997) for withdrawal of monsoon. These were adopted as the conventional methods in this study.

Onset of Monsoon

The method proposed by Morris and Zandesta, (1979) was used. In this method, the weekly rainfall is summed by forward accumulation (20+21+…+52 weeks) until a certain amount of rainfall is accumulated. 75 mm of accumulation rainfall has been considered as the onset time for the growing season for dry seeded crops and land preparation.

Withdrawal of Monsoon

The withdrawal of rainy season is determined by backward accumulation of weekly rainfall (48+47+46+…+30 weeks). 30 mm of accumulation of rainfall was chosen for the end of rainy season, which may be sufficient for ploughing of fields after harvesting of crops Babu and Lakshminarayana, (1997).

Proposed TSMOM (Triggering Soil Moisture for Onset of Monsoon) Method

Onset and withdrawal of monsoon by triggering of soil moisture (TSMOM) is the new need based concept proposed in this study. The onset of monsoon for crop planning is when; there is sufficient moisture for the sowing/planting in the root zone of crop and the withdrawal of monsoon is when there is just sufficient moisture in the root zone which can be used as residual moisture for the *Rabi* crops. All these not only depend on rainfall but also on water holding capacity of the soil which varies as per soil type and weather parameters (temperature, relative humidity, wind speed and sunshine hours) governing soil evaporation. Therefore the onset and withdrawal of monsoon calculated by the conventional method based on only rainfall amount may not be useful for crop planning in *Kharif* and *Rabi* seasons. Therefore in this study the new method has been proposed and is described below that considers the above stated facts.

Onset of Monsoon

The onset of rainy season was computed from weekly water balance in the soil root zone i.e. moisture gained due to rainfall and moisture depleted due to soil evaporation from root zone depth considered for sowing/planting using forward accumulation.

The weekly (rainfall-soil evaporation) was summed up by forward accumulation (20+21+…+52 weeks) until an amount equivalent to TSMOM is accumulated and is considered as the onset of rainy season. This was compared with the method proposed by Morris and Zandesta, (1979) for onset of monsoon.

In the proposed method it is considered that the soil moisture within root zone of crop at the time of planting/sowing should be equivalent to the water holding capacity of the soil and is referred to as triggering soil moisture for onset of monsoon (TSMOM). This is computed by;

$$\text{TSMOM} = (\phi f - \phi wp) * \text{Rzs}$$

Where,

TSMOM= Triggering soil moisture for onset of monsoon, mm m^{-1}

ϕf= Moisture content at field capacity, mm m^{-1}

ϕwp= Moisture content at wilting point, mm m^{-1}

Rz_s= Root zone depth considered for sowing/planting, m

Withdrawal of Monsoon

The withdrawal of rainy season was determined by backward accumulation of weekly (rainfall-soil evaporation) (48+47+46+…+30 weeks). The week when backward accumulation of (rainfall-soil evaporation) is equivalent to half of the TSMOM was chosen as the end of rainy season which is sufficient for ploughing of fields after harvesting of crops. This was compared with the existing criteria by Babu and Laxminarayana, (1997) for withdrawal of monsoon.

3. Result and Discussion

Onset of Monsoon by TSMOM for Heavy Soil, Medium Soil, Light Soil and Conventional Method of Ahmednagar Station

In this study, soil water balanced model (SWAB) developed by Gorantiwar (1995) was used for the calculation of onset and withdrawal of monsoon by TSMOM for Ahmednagar as representative case. The comparison of onset and withdrawal of monsoon by conventional method and proposed method for different soils *viz.* heavy, medium and light soils are also discussed in this section. The values of field capacity (FC), permanent wilting point (PWP) and albedo for heavy, medium, and light soils considered for TSMOM in SWAB soil water balance model are shown in Table 1. The initial root zone depth of crop was considered as 150 mm.

Table 1 The values of albedo, FC and PWP for heavy, medium and light soils for TSMOM

Sr. No.	Soil	Albedo	FC	PWP
1.	**Heavy**	0.13	40 % (60 mm)	22 % (33 mm)
2.	**Medium**	0.2	32 % (48 mm)	16 % (24 mm)
3.	**Light**	0.35	10 % (15 mm)	6 % (09 mm)

(Note: Values in brackets are FC and PWP in 150 mm depth of root zone)

The onset of monsoon by TSMOM for heavy soil, medium soil, light soil and conventional method for years 1983 to 2012 of Ahmednagar district are presented in Table 2. The comparison of onset of monsoon by TSMOM and conventional method of onset of monsoon (Morris and Zandesta, 1979) is also shown in Table 2 and Figure 1. From Table 2, it is revealed that, for heavy soil, onset of monsoon by TSMOM is delayed by 3-4 weeks compared to conventional method for Ahmednagar station. For medium soil, onset of monsoon by TSMOM is delayed by 2-3 weeks compared to conventional method for Ahmednagar station. For light soil, onset of monsoon by TSMOM is delayed by 1-2 weeks compared to conventional method for Ahmednagar station. This is due to the consideration of soils and crops; and maintenance of sufficient soil moisture in the root zone to effect onset of monsoon compared to consideration only rainfall by conventional method. The comparison of onsets by TSMOM and conventional method for heavy, medium and light soils is shown in Figure 1. It is seen from Figure 1 that the onset of monsoon varies as per the soil type according to new proposed criteria which is rational as compared to conventional method. In general the onset condition comes earlier for light soil followed by medium and heavy soils. This is due to the fact that less moisture is required in the root zone of the light soil to reach to field capacity compared to medium and heavy soils.

Table 2: Comparison of onset of monsoon by TSMOM and conventional method for heavy soil, medium soil and light soil for Ahmednagar station

Year	Onset by TOSOM method for Heavy Soil	Onset by TOSOM method for Medium Soil	Onset by TOSOM method for Light Soil	Onset by Conventional method
1983	29	29	28	26
1984	33	30	30	29
1985	30	28	28	26
1986	29	26	26	24
1987	30	29	29	26
1988	35	34	32	30
1989	29	27	23	23
1990	24	24	24	23
1991	24	24	24	23
1992	26	26	26	25
1993	30	29	28	27
1994	28	28	25	24
1995	31	29	29	28
1996	25	25	25	24
1997	29	28	28	24
1998	29	27	25	24
1999	24	24	24	24
2000	27	24	24	23
2001	24	24	24	24
2002	27	27	27	26
2003	35	33	33	30
2004	29	27	24	24
2005	34	31	30	29
2006	28	26	26	25
2007	27	26	26	24
2008	35	33	33	32
2009	30	30	26	25
2010	31	26	25	25
2011	31	29	28	27
2012	29	27	26	27
Average	**29**	**28**	**27**	**26**

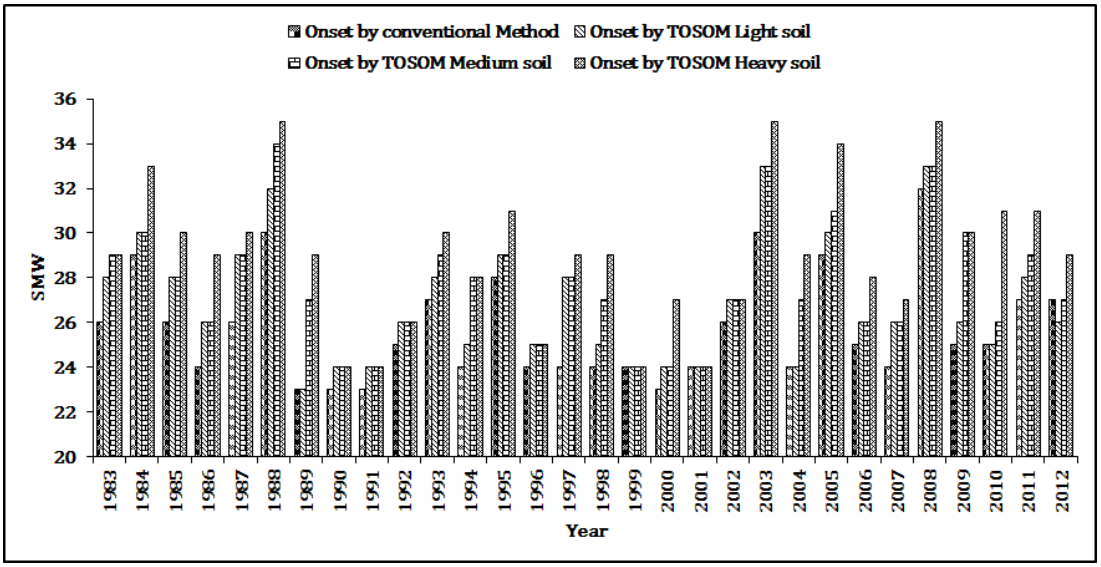

Figure 1: Comparison of Onset of monsoon by TSMOM for heavy, medium and light soils with Conventional method of onset of monsoon for Ahmednagar station

Withdrawal of Monsoon by TSMOM for Heavy Soil, Medium Soil, Light Soil and Conventional Method of Ahmednagar Station

The withdrawal of monsoon by TSMOM for heavy soil, medium soil, light soil and conventional method for years 1983 to 2012 of Ahmednagar are presented in Table 3 and Figure 2. From Table 3 it is revealed that, for heavy soil, withdrawal of monsoon by TSMOM is advanced by 3-4 weeks compared to conventional method for Ahmednagar station. For medium soil, withdrawal of monsoon by TSMOM is advanced by 2-3 weeks compared to conventional method for Ahmednagar station. For light soil, withdrawal of monsoon by TSMOM is advanced by 1-2 weeks compared to conventional method for Ahmednagar station. This is due to the consideration of soils and crops; and maintenance of sufficient soil moisture in the root zone to effect withdrawal of monsoon compared to consideration only rainfall by conventional method. The comparison of withdrawal by TSMOM and conventional method for heavy, medium and light soils is shown in Figure 2. It is seen from Figure 2 that the withdrawal of monsoon varies as per the soil type according to new proposed criteria which is rational as compared to conventional method. In general the withdrawal condition comes earlier for light soil fallowed by medium and heavy soils. This is due to the fact that less moisture required in the root zone of the light soil to reach to half the field capacity compared to medium and heavy soils.

Table 3: Comparison of withdrawal of monsoon by TSMOM and conventional method for heavy soil for Ahmednagar station

Year	Withdrawal by TSMOM method for heavy soil	Withdrawal by TSMOM method for medium soil	Withdrawal by TSMOM method for light soil	Withdrawal by Conventional method
1983	38	38	38	40
1984	40	40	40	41
1985	39	39	39	40
1986	37	37	37	38
1987	39	39	39	46
1988	37	37	38	39
1989	38	38	38	40
1990	42	42	42	43
1991	36	36	37	38
1992	34	34	34	40
1993	41	41	41	42
1994	34	34	34	35
1995	40	40	40	42
1996	42	42	42	43
1997	45	45	47	48
1998	39	39	39	41
1999	40	40	40	41
2000	40	40	40	41
2001	30	39	40	41
2002	33	34	34	42
2003	33	33	37	38
2004	38	38	39	41
2005	41	41	41	42
2006	38	38	39	40
2007	37	37	37	38
2008	40	40	40	41
2009	39	44	44	46
2010	38	38	45	46
2011	34	34	34	39
2012	39	39	39	40
Average	**38**	**39**	**40**	**41**

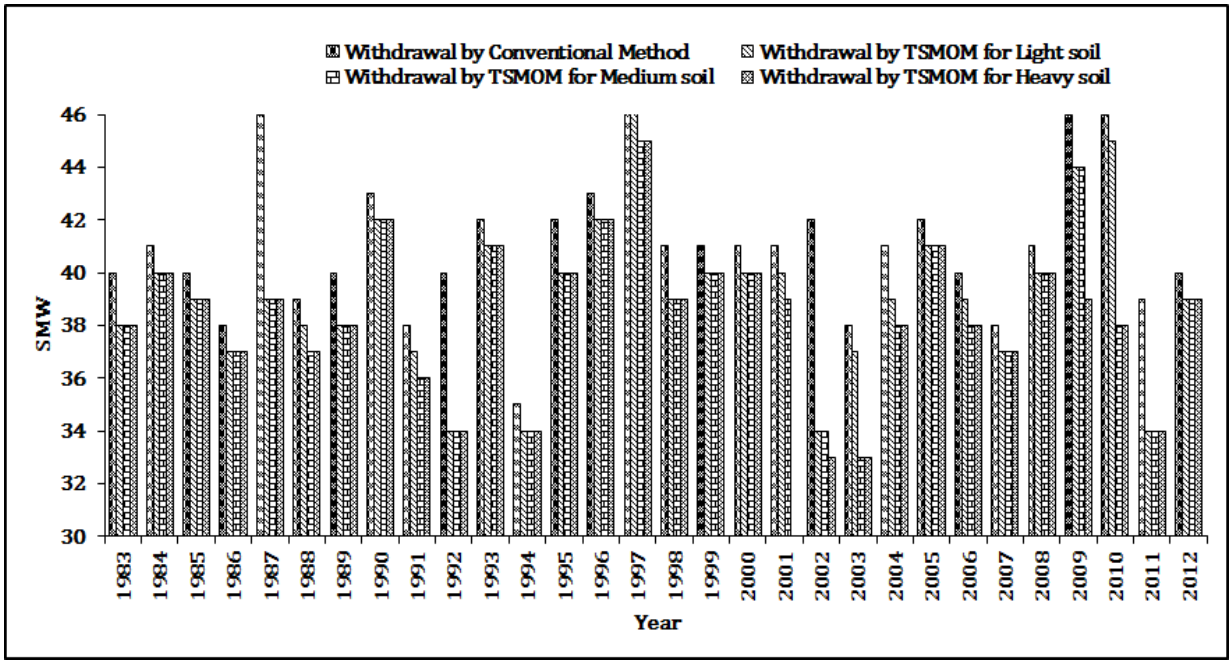

Figure 2 Comparison of withdrawal of monsoon by TSMOM for heavy, medium and light soils with conventional method of withdrawal of monsoon for Ahmednagar station

4. Conclusion

The onset and withdrawal of monsoon varied as per the soil type according to new proposed criteria which is rational as compared to conventional method. In general the onset and withdrawal condition occurred earlier for light soil followed by medium and heavy soils. This is due to the fact that less moisture is required in the root zone of the light soil to reach to field capacity compared to medium and heavy soils. The new method proposed to estimate the onset and withdrawal of monsoon is found suitable compared to the traditional method (that considers only meteorological parameters) as proposed method considers the crop and soil parameters along with meteorological parameters.

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