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Agroclimatology for optimization of sowing time of sunflower

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ABSTRACT

Influence of rainfall and moisture availability during the growing period on the seed yield of sunflower genotype Morden under Bijapur conditions of Northern Dry Zone of Karnataka was analysed from the data of widely varying weather situations in nine years between 1988 and 1997. The analysis revealed positive association of rainfall and mositure availability index in the establishment stage. The negative influence of rainfall during the ninth week after sowing (WAS) is ascribed to pollen washout and low pollen dehiscence which resulted in reduction of seed yield. The 3rd and 4th WAS were identified as the most crtical periods in terms of moisture requirement. Superposition of the above results on normal weekly rainfall distribution revealed early-September as the optimum time for sowing of sunflower genotype Morden.

Key words: Sunflower, Moisture availability index, Sowing time, Rainfall

Sunflower has established itself as a major oilseed crop in the Northern Dry Zone of Karnataka. In Bijapur district alone its coverage is to the extent of 3,53,000 ha with a total production of 1,21,000 Kg. The sowing of sunflower in the Zone has been recommended and practised from middle of August to first week of October. Over years, the large fluctutations in yield has been ascribed to the time of sowing and the prevailing weather situations.

Numerous studies have been carried out on the effect of time of sowing on sunflower seed yield in different agrolimatic regions (Bhattacharya *et al.*, 1977; Chaudhary and Anand, 1978; Bhalerao *et al.*, 1994). Similar work in the Northern Dry Zone of Karnataka has brought out that the period August to early-October as the favourable time for sowing (Anonymous, 1995). However, this interval seems to be too large and overlaps with sowing of other crops like sorghum and safflower. As regards the meteorological influence on seed yield, Venkatesh *et al.* (1999) brought out the dominance of rainfall, temperature, relative humidity and moisture availability index at different crop growth stages. They also developed yield prediction models. An attempt is made here through agroclimatic analysis to optimize the sowing time of sunflower for maximum production.

MATERIALS AND METHODS

The popular sunflower cultivar Morden was grown for nine years during 1988-1997 at the Regional Research Station, Bijapur (16° 50' N; 75° 43' E, 594 m AMSL), Karnataka. The date of sowing in different years varied from middle of August till the beginning of October, with other management practices being followed as per the package of practices recommended for the region.

Correlation analysis between seed yield and rainfall and moisture availability index (MAI), which was computed using the climatic potential evapotranspiration determined by Penman's equation in the modified water budgeting technique of Thornthwaite and Mather (1955) was performed. The sowing dates in nine years of experimentation were grouped into three categories, namely, mid-August, early-September and late-September (Table 1), and the moisture availability profiles of the crop growing season in the various years were superposed on the rainfall patterns to arrive at optimum sowing time for highest seed yield.

RESULTS AND DISCUSSION

Mean rainfall during crop season in the years of experimentation was 371.8 mm (C.V. 52%) in the range of 67.9 mm and 631.0 mm. The seed yield of sunflower varied between 217 and 889 Kg ha^{-1} with a mean of 560 Kg ha^{-1} and variability of 39 per cent.

Association of agrometeorological variables with seed yield

Correlation analysis between sunflower seed yield and weekly rainfall and moisture availability index (Table 2) shows that rainfall in the 3rd WAS was significantly correlated with final seed yield. Similarly, significant influence of MAI in both the 3rd and 4th WAS is noticed. The period 5-7 WAS, coinciding with vegetative stage is least sensitive to the weather conditions. Moisture availability in the eighth WAS, i.e., flowering initiation stage, has positive influence on yield. The negative effect of rainfall in the ninth WAS, when pollination is at its peak, is ascribed to wash out of pollen and low pollen dehiscence resulting in poor seed setting and thereby reducing yield. Predominant influence of moisture factor is once again noticed in the 11th WAS. Favourable moisture condition in the second fortnight after sowing is therefore identified as the critical moisture requirement period for sunflower genotype Morden (Venkatesh *et al.*,1999) in this region. This hypothesis is tested for different dates of sowing and used for optimizing the sowing time.

Moisture availability, sowing time and yield

Sowing of sunflower could be performed during three years in each of categories of sowing time, viz., mid-August, early September-end. The average seed yield for these sowing periods were 593, 721 and 366 Kg ha^{-1} respectively (Table 1). The temporal profiles of moisture availability index during crop growing season for the above sowing periods are shown respectively in Figs. 1 to 3. It is noticed that, wherever the moisture availability was high during the third and forth weeks after sowing, the final seed yield was high, irrespective of the time of sowing. Further, whenever, the MAI increased in the 11th WAS, the yield was slightly boosted. Conversely, the yield was reduced greatly in years of low MAI in the 3rd and 4th WAS. High MAI was attained during the 3rd and 4th WAS in two of the three years of sowing during mid-August. Only one such condition arose for crop sown in late-September, while the crop was successful during all the three years when sown in early-September. Hence the order priority of sowing could be fixed as early-September, mid-August and September-end.

Weekly rainfall patterns and sowing time

It is well known that the rainfall

Table 1: Year-wise time of sowing and yield of sunflower Cv. Morden

Year	Date of sowing	Sowing category	Seed yield(Kg ha^{-1})
1988	Aug. 22	Mid-August	569
1989	Sept. 5	Early-September	661
1990	Aug. 27	Mid-August	378
1991	Sept. 29	Septemeber-End	376
1993	Sept. 3	Early-September	614
1994	Oct. 4	Septemeber-End	507
1995	Sept. 14	Early-September	889
1996	Aug. 18	Mid-August	831
1997	Sept. 27	Septemeber-End	217

Table 2 : Correlation coefficients for sunflower seed yield with rainfall and moisture availability during crop growing period

	Week after sowing										
Parameter	1	2	3	4	5	6	7	8	9	10	11
Rainfall	0.50	0.15	0.76*	0.31	0.47	0.30	0.37	0.21	-0.48	0.47	0.77*
MAI	0.40	0.25	0.81*	0.79*	0.34	0.25	0.45	0.68*	0.28	0.51	0.68*

(* Significant at 0.05 level)

distribution rather than the total rainfall is more important for successful crop production, and Venkatesh (1998) has suggested that the rainfall probability profiles could be made use of in selection of cropping systems. The weekly rainfall pattern at Bijapur (Fig. 4) indicates mild rainfall peaks in the 30th, 33rd and 35th to 37th Meteorological Standard Weeks (MSW) and high peaks from 38th to 41st MSWs. After this, practically no rainfall occurs. Comparing these periods with the recommended time of sowing of sunflower, it is realised that the rainfall during the MSW numbers 30, 33 and 35-40 have to be utilised for the purpose.

From the above, it is concluded that the 3rd and 4th WAS are the critical period of moisture requirement for sunflower. The crop can experience this condition only when

Fig 1 .Temporal profile of moisture availability index for Mid-August sown sunflower

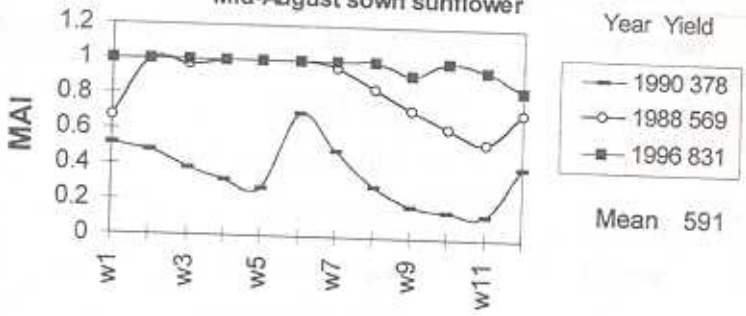


Fig 2 .Temporal profile of moisture availability index for Early-September sown sunflower

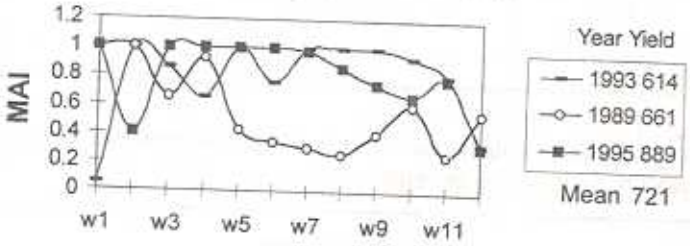


Fig 3 . Temporal profile of moisture availability index for September-end sown sunflower

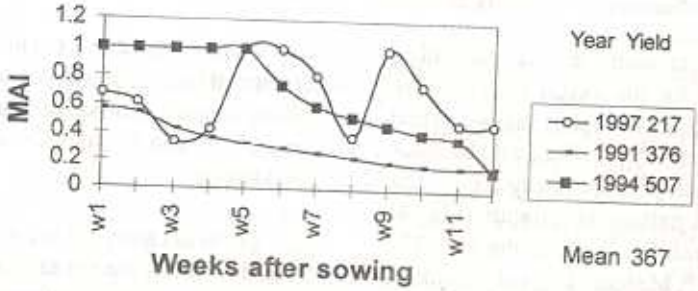
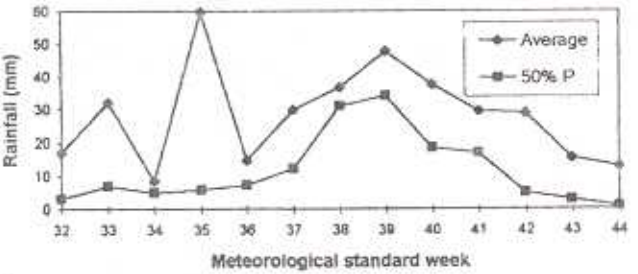


Fig.4 Weekly rainfall distribution



rainfall is received in the 3rd WAS. From Fig.4, it is evident that 38-41 MSWs are weeks of highest and most assured rainfall at Bijapur. This rainfall can benefit the crop in the 3rd and 4th WAS, only if it is sown in the 35-37 MSWs i.e. early-September (Fig. 2). In contrast, the crop sown after 39th MSW (September-end), during the period of high rainfall, will not experience good moisture availability conditions in the critical period, and hence is bound to yield less, as was noticed in Fig.3. In case of mid-August sown crop, the chances of success of high moisture availability in the critical period are variable, and hence the yield levels could be moderate. Further, if rainfall occurs beyond the 41st MSW, pollination may be affected around the 9th WAS. Hence early-September is identified as the optimum sowing time for sunflower, with highest reliability of favourable conditions of high moisture in the 3rd and 4th WAS and low rainfall in the 9th WAS. Thus, the agroclimatology of sunflower has helped not only in determining the critical stages of its moisture requirement, but also in esta- blishing the optimum time of sowing of cultivar Morden.

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