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S6-07

Crop weather relationship in *kharif* sunflower *Helianthus annus* L

BY

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Sunflower is one of the fastest growing oilseed crop in India.



CROP WEATHER RELATIONSHIP: SUNFLOWER (Rainy season)

Objectives :

i) Possibility of growing sunflower under aberrant weather situation.

ii) To study the effect of weather parameters on the growth and development of sunflower.

iii) To study the effect of weather parameters on dry matter accumulation and its partitioning in sunflower.

iv) To develop and validate suitable crop growth model for sunflower.

Status

In India, nine annual oilseeds are cultivated in 27.86 million hectares with a production of 27.98 million tonnes and productivity of 1004 kg/ha (2005-06)

India Accounted for World's

- 15.6% of oilseeds area
- 9.2% of oilseeds production
- 6.8% of oil meal production
- 5.9% of oil meal export
- 6.1% of vegetable oil production
- 9.0% of vegetable oil import
- 9.3% of edible oil consumption

2005-06

Area, Production and Productivity of Annual Oilseed Crops in the World (2006)

Crop	Area (m.ha)	Production (m.t)	Productivity (kg/ha)
Groundnut	23.47	37.21	1585
Rapeseed-Mustard	27.45	48.91	1782
Soybean	92.44	177.93	1925
Sunflower	22.37	30.45	1361
Sesame	7.60	3.31	436
Safflower	0.91	0.71	784
Castor	1.42	1.38	971
Linseed	3.18	2.89	909
Total	178.84	302.79	1693

India's Share (%) in World's Area and Production of Oilseeds (FAO, 2006)

Crop	Area	Production
Soybean	8.4	3.4
Sunflower	**10.1**	**4.9**
Linseed	20.0	8.0
Rapeseed-Mustard	26.6	13.9
Sesame	24.4	20.5
Groundnut	28.1	19.4
Safflower	41.7	29.4
Castor	56.1	62.9

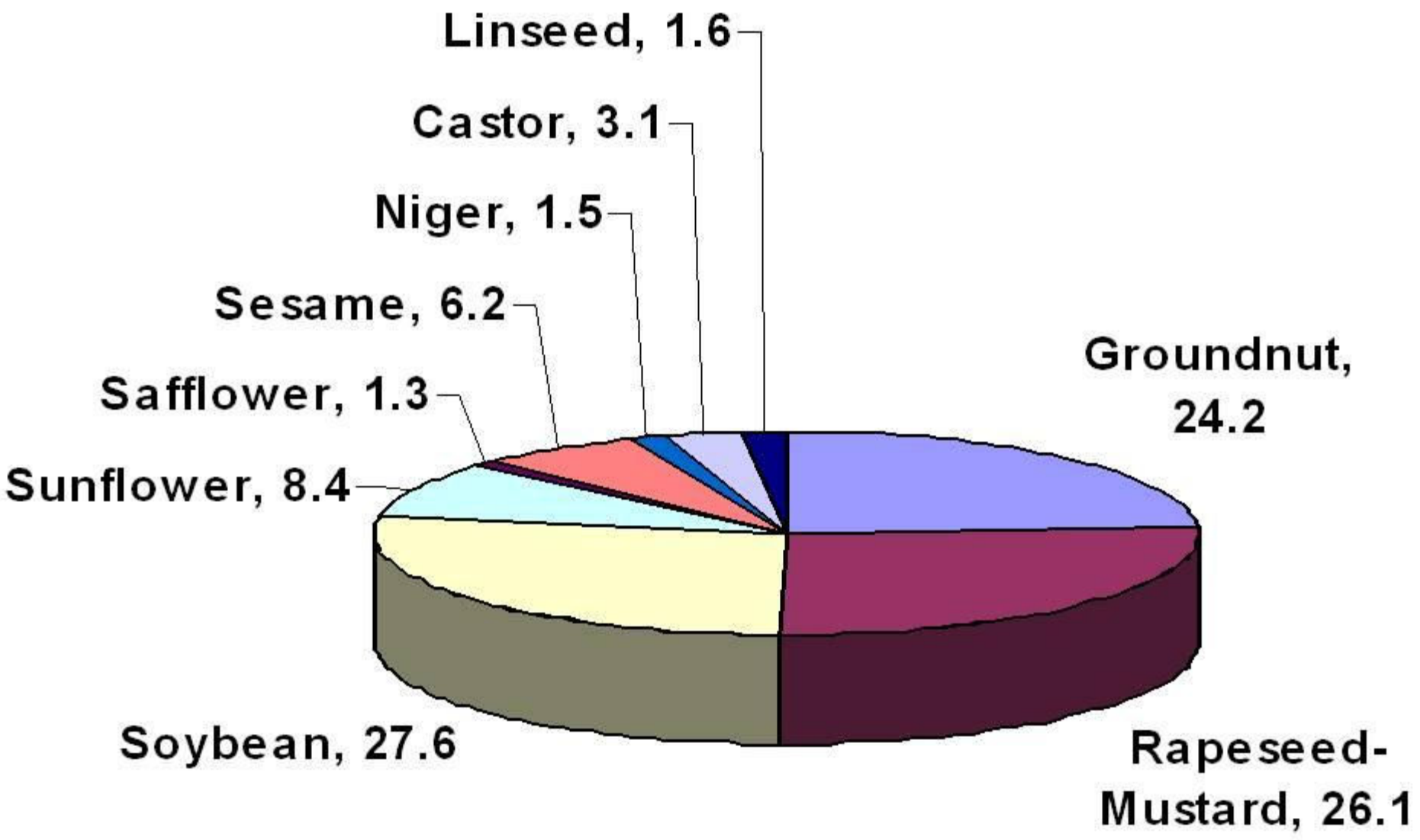
India's Position in Area and Production of Oilseeds in the World (2005-06)

Crop	Area	Production
Groundnut	I	II
Rapeseed-Mustard	I	III
Soybean	V	V
Sunflower	III	VII
Sesame	I	I
Safflower	I	II
Castor	I	I
Linseed	III	IV

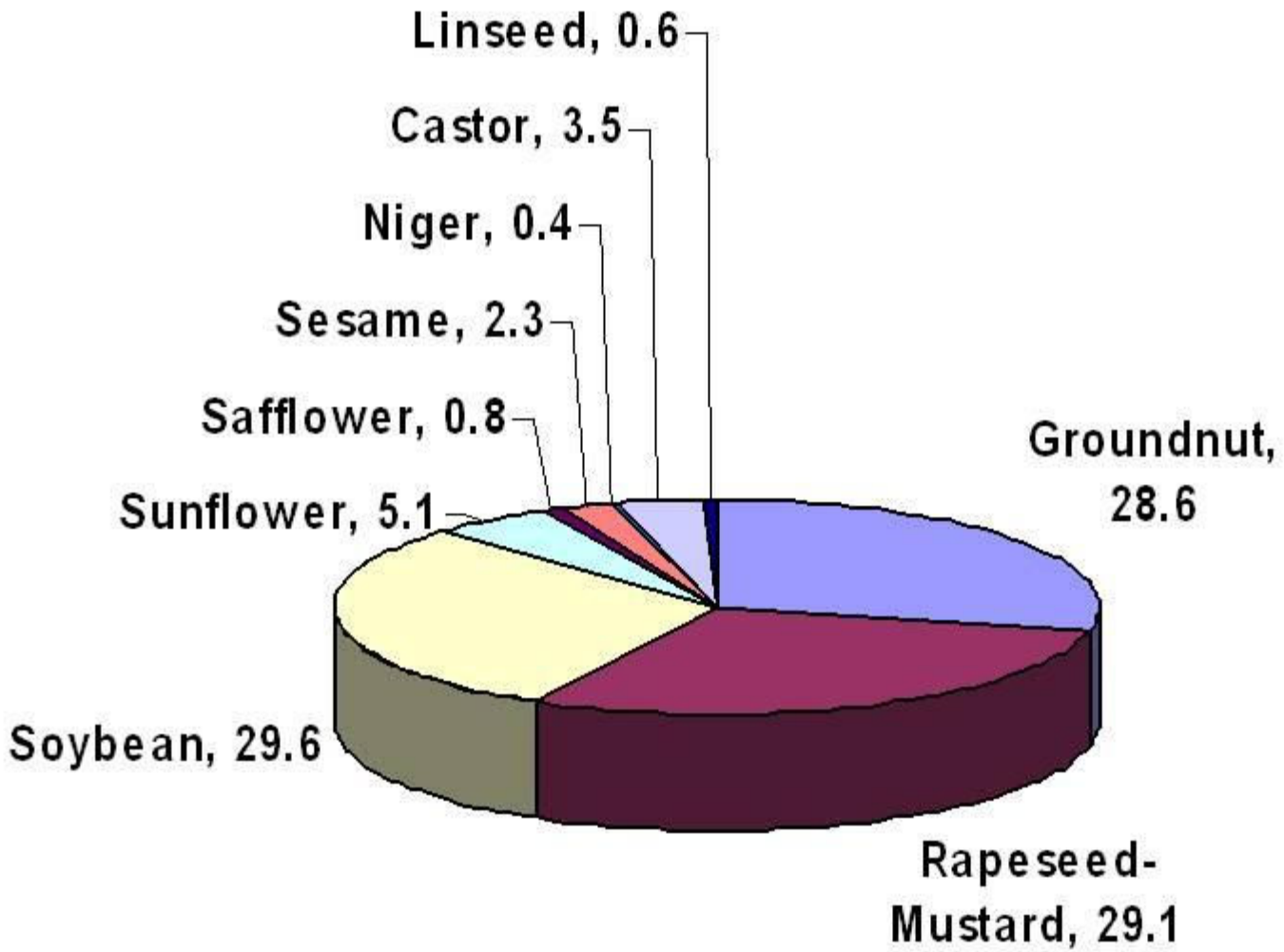
Oilseeds Productivity (kg/ha) in India and World (2006)

Crop	India	World	Country with highest productivity
Groundnut	1187	1585	5900 (Israel)
Rapeseed-Mustard	1117	1782	4258 (Belgium)
Soybean	1073	1925	3630 (Italy)
Sunflower	615	1361	2989 (Switzerland)
Sesame	372	436	3125 (Lebanon)
Safflower	627	784	2667 (China)
Castor	1146	971	1589 (Ecuador)
Linseed	395	909	2136 (Tunisia)

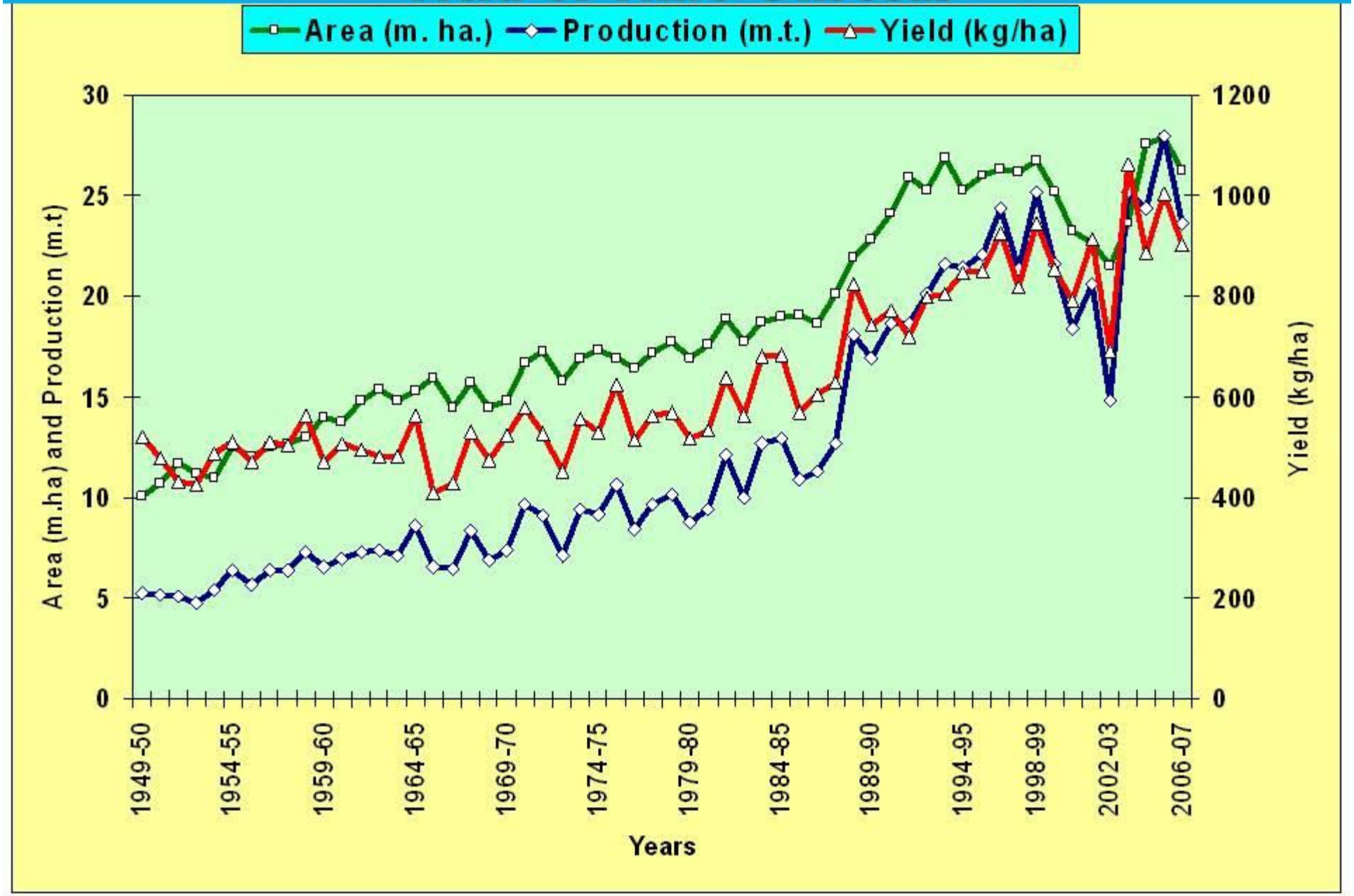
Contribution(%) of Different Oilseeds to Area in India (2005-06)



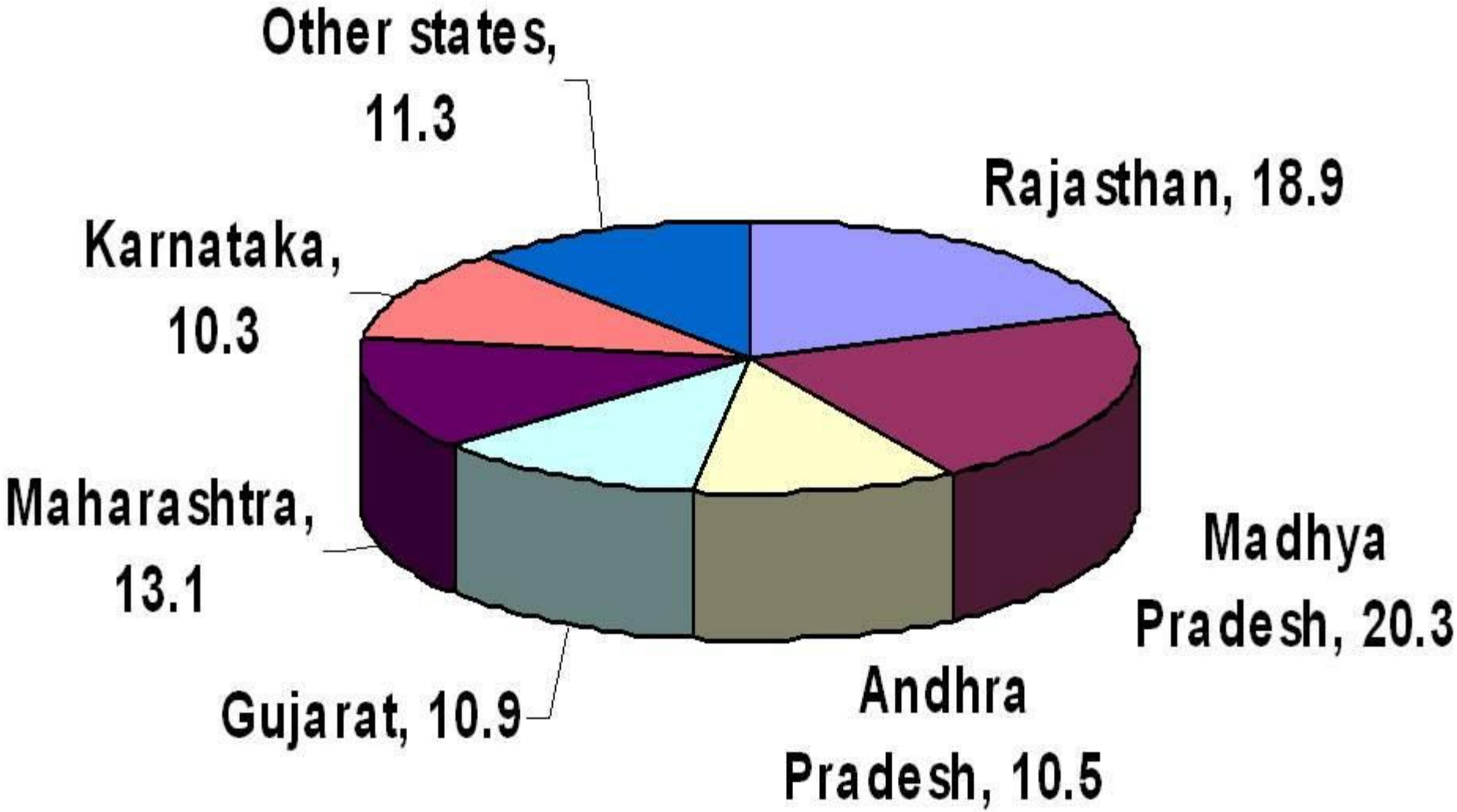
Contribution(%) of Different Oilseeds to Production in India (2005-06)



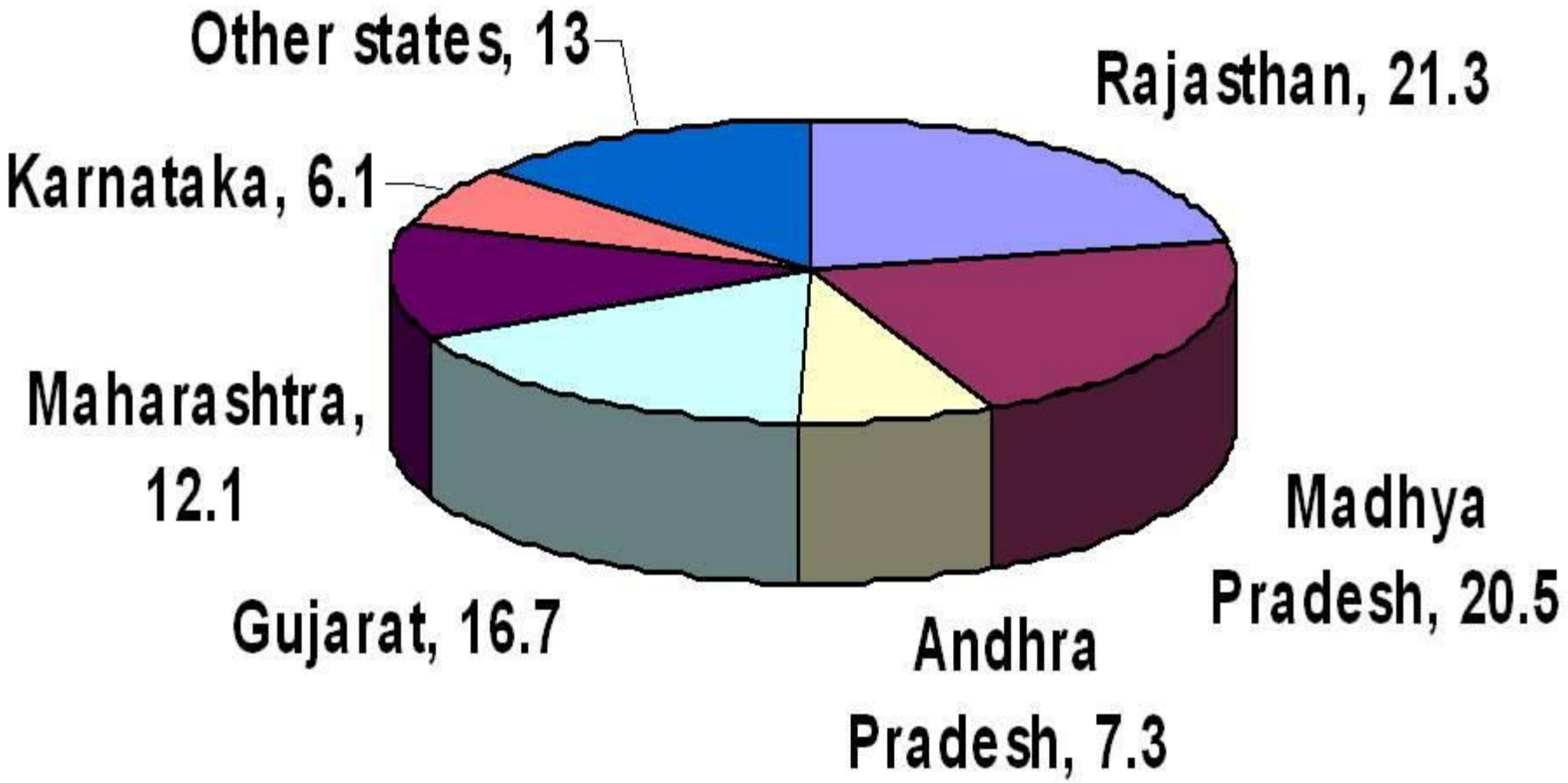
Trends in All India Area, Production and Yield of Nine Oilseeds



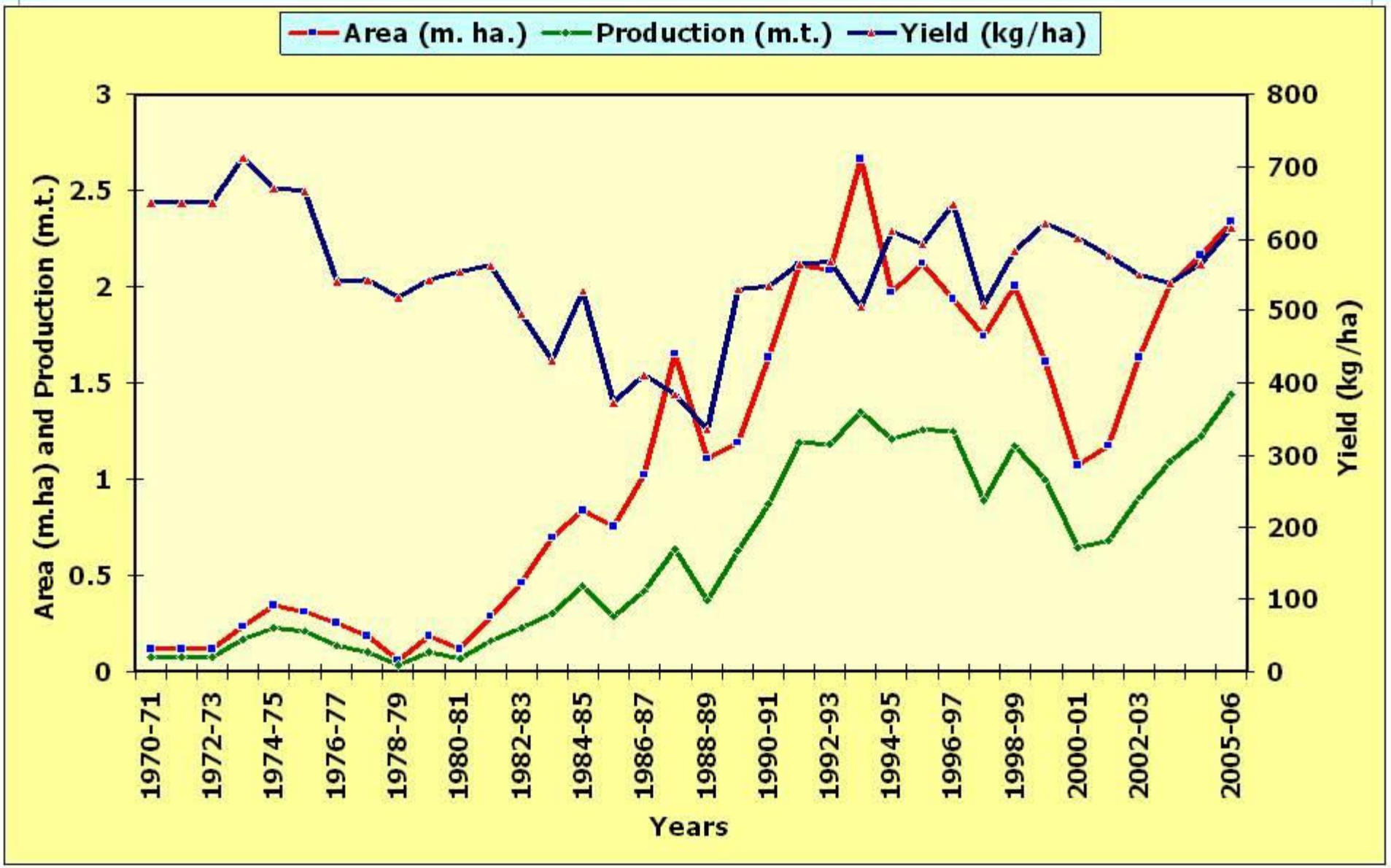
Contribution (%) of Different States to Area of Oilseeds in India (2005-06)



Contribution (%) of Different States to Production of Oilseeds in India (2005-06)

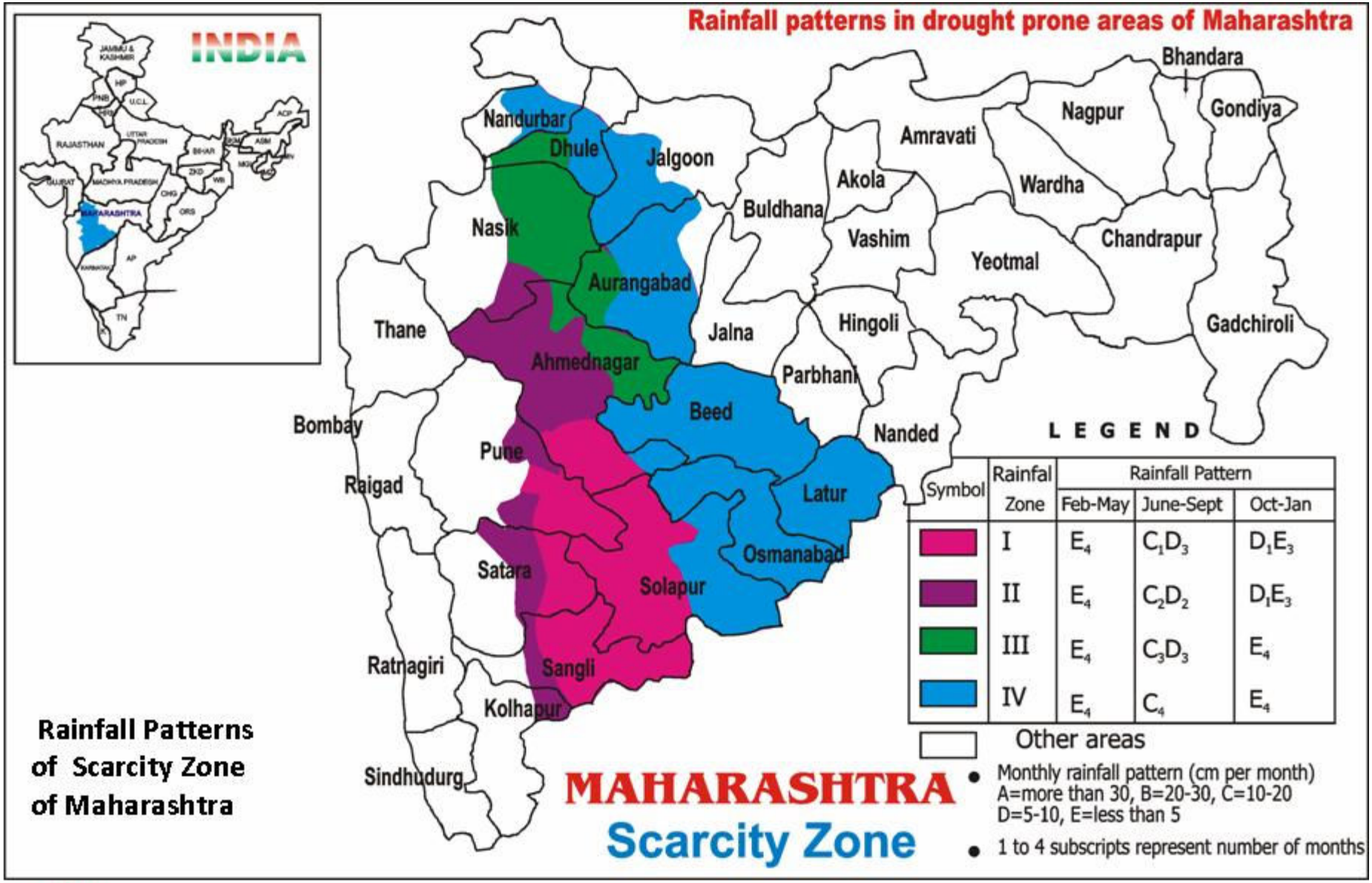


Trends in All India Area, Production and Yield of Sunflower



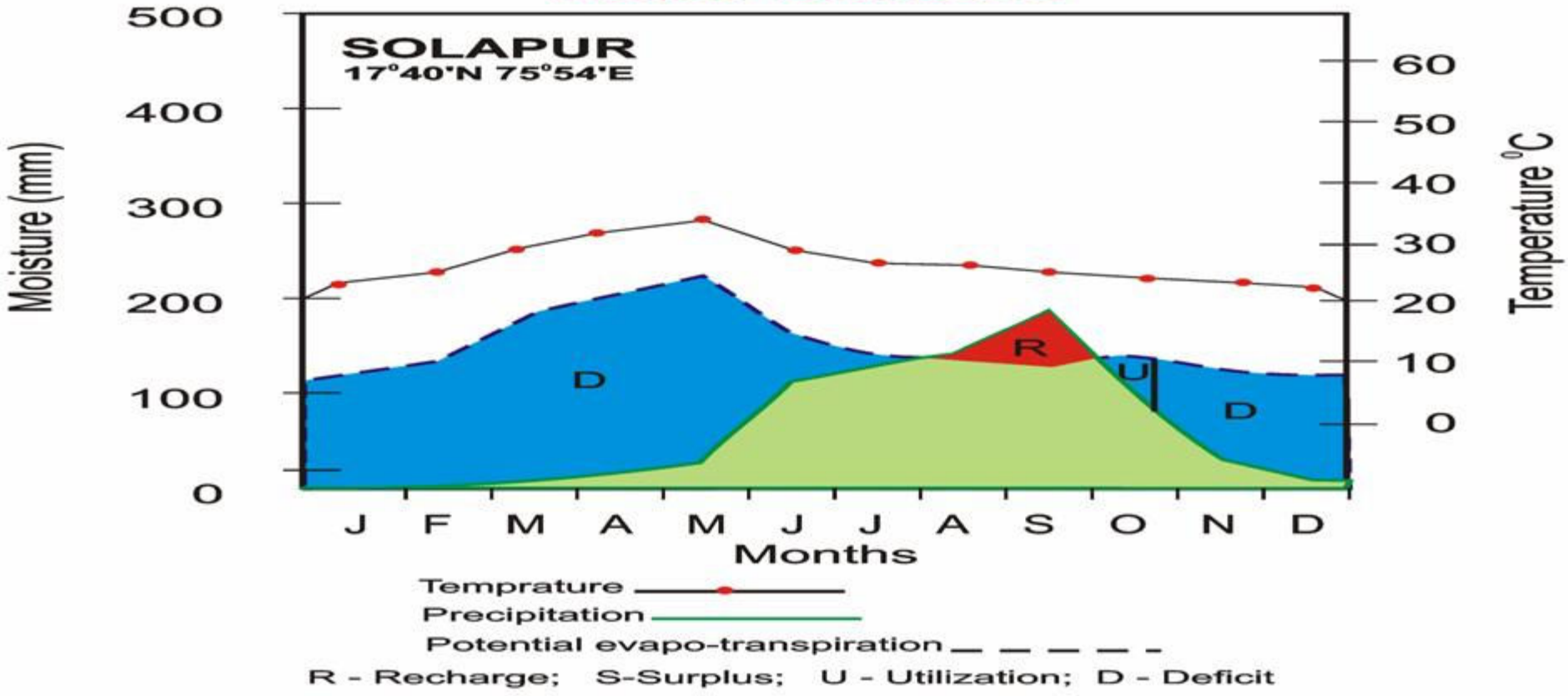


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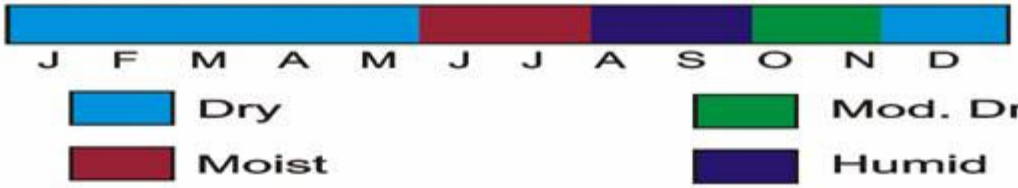
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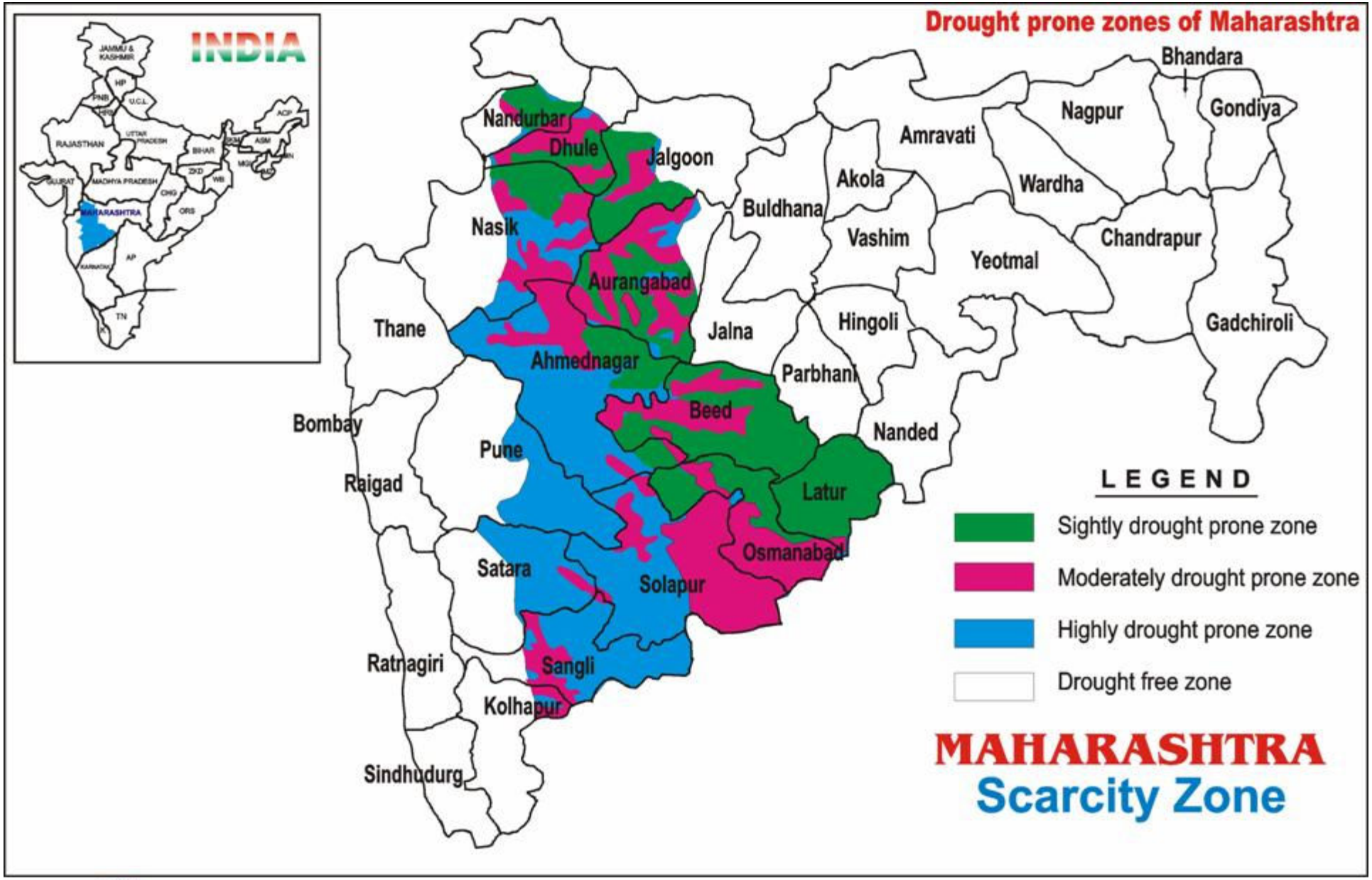
Water Balance



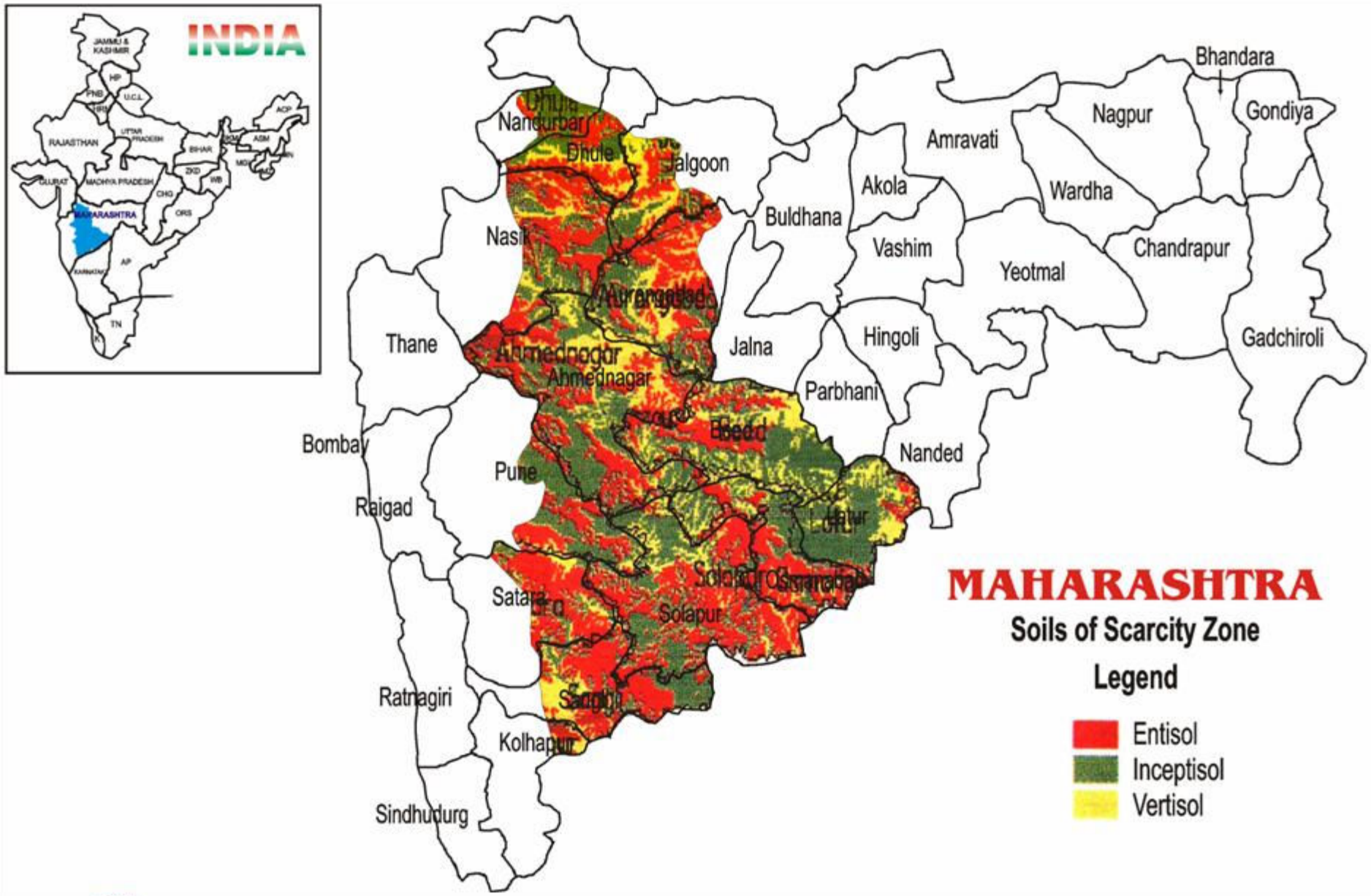
Water balance and moisture availability period at ZARS, Solapur

Moisture Availability Period (LGP)





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Methodology :

Four sowing dates:

S_1 (MW 28) (09 - 15 July)
S_2 (MW 30) (23 - 29 July)
S_3 (MW 32) (06 – 12 August)
S_4 (MW 34) (20 – 26 August) and

Two genotypes :

V_1 (SS-56) Variety
V_2 (MSFH- 17) Hybrid

Experiment was conducted: 1999 to 2004
The year 2003 was drought year

Design: Split plot design, four replications.

Soil of the expt:

Low in organic carbon (0.34%)
Medium in phosphorus (17.7 kg ha^{-1})
High in potash content (542 kg ha^{-1})
Neutral pH (7.1)
The crop was fertilized with
50:25:0 kg NPK ha^{-1}

Rainfall situation at ZARS, Solapur (1999 -2004)

Parameter	1999	2000	2001	2002	2004
Rainfall (mm)	511.5	630.6	600.2	644.3	638.4
RD	40	46	37	49	43
+/-	-29 %	-13%	-17%	-11%	-12 %
Kharif Rain (mm) (days)	316.4 (25)	439.4 (29)	198.5 (16)	472 (35)	405 (26)
Rabi: rain (mm) (days)	100 (7)	113.2 (9)	3 46.7 (16)	98.5 (7)	82 (9)
Onset of monsoon	Timely MW 24	Early MW 22	Timely MW 24	Timely MW 23	Timely MW 24

Rainfall situation at ZARS, Solapur (1999 -2004)

Parameter	1999	2000	2001	2002	2004
Dry spell	Two MW 25-26 11 days MW 28-29 19 days	Two MW 26-27 21 days MW 29-31 21 days	Two MW 25-30 43 days MW 33-35 19 days	Two MW 25-26 10 days MW 27-28 15 days	Two MW 25-26 17 days MW 33-34 12 days
Moisture availability in weeks	7	13	11	13	13

Grain yield as influenced by sowing dates and varieties in *kharif* sunflower (1999-2004)

Treatment	1999	2000	2001	2002	2004	Mean	SYI
Main=Sowing dates							
S_1 MW-28, (9-15, Jul)	145	1185	200	472	706	541	0.10
S_2 MW-30, (23-29, Jul)	165	546	273	293	617	379	0.16
S_3 MW-32, (6-12, Aug)	175	545	762	189	527	439	0.16
S_4 MW-34, (20-26, Aug)	223	293	310	285	475	317	0.19
Mean	177	642	386	310	581	419	
S.E.$\pm$ (SD)	9.08	57.31	12.14	30.44	15.92	97.37	
C.D. at 5 %	29.05	183.33	38.83	97.36	50.93	N.S.	

Grain yield as influenced by sowing dates and varieties in *kharif* sunflower (1999-2004)

Treatment	1999	2000	2001	2002	2004	Mean	SYI
Sub=Varieties							
V_1 = SS-56	199	547	336	279	503	373	0.31
V_2 = MSFH-17	154	737	437	340	659	465	0.31
Mean	177	642	386	310	581	419	
S.E.± (Varieties)	3.97	22.04	7.27	15.82	13.88	16.51	
C.D. at 5 %	12.23	67.93	22.40	48.76	42.78	49.50	
S.E.± (SD X V)	7.94	44.09	14.54	31.65	27.76	33.02	
C.D. at 5 %	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	

Agronomical parameters as influenced by sowing dates and varieties in *kharif* sunflower (1999-2004)

Treatments	GY (kg ha^{-1})	TBM (q ha^{-1})	TMR (Rs. ha^{-1})	CUM (mm)	MUE (kg $ha^{-1}mm^{-1}$)
Main sowing dates					
S_1: MW 28	541 (0.10)	35.44 (0.48)	7175 (0.19)	210.5	3.36
S_2: MW 30	379 (0.16)	31.07 (0.35)	5233 (0.20)	207.2	2.86
S_3: MW 32	439 (0.16)	30.26 (0.26)	5734 (0.23)	194.8	3.28
S_4: MW 34	317 (0.19)	29.13 (0.29)	4460 (0.21)	180.7	3.31
Mean	419	31.47	5655	198.3	3.20
S.E. $\pm$	97.37	2.20	1054		
CD 5 %	N.S.	N.S.	N.S.		

Figures in parentheses indicates the SYI and SVI

Agronomical parameters as influenced by sowing dates and varieties in *kharif* sunflower (1999-2004)

Treatments	GY (kg ha^{-1})	TBM (q ha^{-1})	TMR (Rs. ha^{-1})	CUM (mm)	MUE (kg ha^{-1}mm^{-1})
Sub: Varieties					
V_1= SS-56	373 (0.31)	27.97 (0.29)	5012 (0.29)	192.2	3.32
V2=MSFH 17	465 (0.31)	34.98 (0.40)	6249 (0.32)	204.4	3.09
Mean	419	31.47	5655	198.3	3.20
S.E. ± Var	16.51	0.50	194	-	-
C.D.	49.50	1.51	581	-	-
S.E. ±Int.	30.0	1.0	387	-	-
C.D. Int	N.S.	N.S.	N.S.	-	-

Figures in parentheses indicates the SYI and SVI

Agrometeorological parametrs of *kharif* sunflower as influenced by various sowing dates and varieties (1999-2004)

Treatments	GDD	HTU	TDM ($g\ m^{-2}$)	LAI	RUE ($g\ mj^{-1}$)	Days for Phys.Mat
Main : Sowing dates						
S_1 : MW 28	1373	38071	779.5	2.00	2.07	84
S_2 : MW 30	1390	40082	360.3	2.01	2.08	81
S_3 : MW 32	1390	47640	390.1	1.85	2.00	81
S_4 : MW 34	1322	50846	376.7	1.74	1.86	80
Sub : Varieties						
V_1 : SS-56	1319	41428	358.4	1.81	1.95	78
V_2 : MSFH-17	1419	46891	594.8	2.00	2.06	85
Mean	1369	44160	476.6	1.91	2.00	82

Correlation coefficient between grain yield and different weather parameters on *Kharif* sunflower sown at 28 MW (1999-2004)

Pheno	Individual correlation of weather parameters with yield at MW-28							
Phase	T max	T min	RH1	RHII	WS	BSS	Rain	E pan
P_1	-0.61	-0.67*	0.02	-0.06	0.02	0.09	0.54	-0.21
P_2	0.13	-0.48	0.86***	0.95***	-0.95***	0.46	0.59	-0.01
P_3	-0.20	-0.87***	0.45	0.66*	-0.45	0.22	0.76**	-0.35
P_4	-0.38	-0.53	0.11	0.75*	-0.85***	0.21	0.56	-0.70*
P_5	0.04	-0.28	0.63*	0.77**	-0.72*	-0.05	0.57	-0.59
P_6	0.32	0.11	0.22	0.44	-0.51	-0.44	0.64*	-0.26

* Significant at 5 % level (r^2= 0.63)

P_1=Emergence to 4 leaf P_2=4 leaf to button

P_3=Button to 50% flowering P_4=50 % Flowering to soft dough

P_5=Soft dough to hard dough P_6=Hard dough to phy. maturity

Multiple regression between grain yield and different weather parameters on *Kharif* sunflower sown at 28 MW (1999-2004)

	Weather parameter	R square	Regression coefficient
	Intercept a	-	2743.99
X_1	Wind speed at emergence to 4leaf	0.04	49.30*
X_2	Minimum temperature at button to 50% flowering	0.51	-120.36*
X_3	Afternoon relative humidity at soft dough to hard dough	0.28	11.05*
X_4	Pan evaporation at soft dough to hard dough	0.33	-103.70*

$$\text{Yield} = 2743.99 + 49.30X_1 - 120.3659X_2 + 11.05X_3 - 103.70X_4 \quad R^2 = 0.70$$

Weekly MAI and yield correlationship with sunflower sown at 28 MW (1999-2004)

Weeks after sowing	1	2	3	4	5	6	7	8	9	10	11	12
Met week No.	28	29	30	31	32	33	34	35	36	37	38	39
Period	09	16	23	30	06	13	20	27	03	10	17	24
	15-Jul	22-Jul	29-Jul	05-Aug	12-Aug	19-Aug	26-Aug	02-Sep	09-Sep	16-Sep	23-Sep	30-Sep
Yrs												
99					0.27							
00	0.97				1.00	0.47	1.00	1.00				
01					0.71	0.49						
02		0.72			1.00	1.00	1.00	1.00				0.07
04	1.00				1.00	1.00	0.57					
Correlation	0.85	-0.06	-0.50	-0.43	0.71	0.06	0.77	0.61	0.79	-0.81	-0.22	0.49

Poor	Satisfactory	Good	Excellent
0-0.25	0.26-0.50	0.51-0.75	0.76-1.0

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Conclusions :

The crop sown at MW 28 (9-15 July) produced

- Maximum grain yield (541 kg ha^{-1})
- Total Mon. Returns (Rs. 7175 ha^{-1})

- **Consumptive use of moisture (210.53 mm) and moisture use efficiency(3.36 kg $ha^{-1}mm^{-1}$) was recorded highest by crop sown at MW 28.**

Conclusions :

- Consumptive use of moisture (210.53 mm) and moisture use efficiency(3.36 kg $ha^{-1}mm^{-1}$) was recorded highest by crop sown at MW 28.

- Genotype SS-56 recorded highest value of MUE(3.32 kg $ha^{-1}mm^{-1}$).
- Weekly MAI from flowering to Hard dough stage showed significant correlation with the yield

- The crop sown at MW 28 take more days (84 days) to attain physiological maturity.
- Hybrid MSFH-17 takes more days (85 days) to attain physiological maturity than the SS-56.
- Early sown *kharif* sunflower recorded highest value of cumulative growing degree days, total dry matter, leaf area index and radiation use efficiency than late sown crops.
- Cummulative HTU was recorded highest by late sown crops than early sown crops.

- 50% flowering to soft dough stage found more sensitive in relation to weather parameter with grain yield.

- Wind speed and afternoon relative humidity positively and minimum temperature and pan evaporation negatively regressed with grain yield.



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Recommendation:

Considering the significant contribution of weather parameters on growth and yield, sowing of *kharif* sunflower can be under taken in second week of July (28 MW) (9-15 July) in medium soil (45-60 cm) for rainfall zone-IV of scarcity zone of Maharashtra.

Future

Improving Production and Productivity of Oilseeds in India

Favourable Policy Framework

Area Expansion

- Replacing non-remunerative crops
- Contingency plan
- Intercropping
- Water scarce situations
- Value addition as an incentive

Productivity Improvement

- Quality seed
- Protective irrigation
- Crop zoning
- Increased fertilizer us
- Farm mechanisation
- Efficient crop management
- Effective technology transfer
- Over coming biotic/abiotic stresses


Thank you