

# Choice of Sunflower Cultivar and Breeding Objectives for different growing conditions in North-East India

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## **Abstract**

Assam along with six other states namely Tripura, Meghalaya, Manipur, Mizoram, Nagaland and Arunachal Pradesh located at the North-Eastern part of India has tremendous potentiality of growing Sunflower under different agricultural situations. This part of India is characterized by damp humid climate unlike the Sunflower growing states of Southern India.

Sunflower was introduced to Assam a few years back by the Department of Agriculture, Assam and some public sector organisations like Assam Branch of Indian Tea Association ( ABITA ) by way of demonstration in the farmers field. Simultaneously research on varietal front was carried out by the Regional Agricultural Research Station, Shillongani, Nagaon under Assam Agricultural University.

Considering the wide plasticity of the crop for growing under various conditions and rainfall distribution pattern in Assam, there are atleast two seasons/ situations in which Sunflower can successfully be cultivated in this part of India with desired type of cultivar. They are (a) Post Rainy Season (October - February) and (b) Late Winter Season ( December - March). During summer season ( March - May) rainfall at critical growth stage adversely affect the crop resulting in poor seed setting. Normal rainfall during this season is about 650 mm. Again its cultivation is limited by the high rainfall in the monsoon season ( June - September) showering normally about 1700 mm during this period. Moreover there blows strong wind frequently during these two seasons causing breakage of the plants to yield very low.

## **Choice of cultivar and Breeding objectives :**

**(a) Post Rainy Season :** Majority of the area during this season, for any crop, is cultivated under rainfed situations, thereby uncertainties in crop growing environment are usually expected. For such area, open pollinated varieties are more preferred in view of their low seed cost and inherent tolerance in terms of withstanding moisture stress and attack of disease - pests. Using open pollinated variety like Morden, seed yield of 1500 kg/ha was obtained in the farmers field by the Deptt. of Agriculture, Assam.

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For such conditions breeding objective should include medium head diameter (15-20 cm), medium plant height (90-120 cm) and self compatible types since seed setting continues to be a problem. As the average humidity during this season is very high ranging from 93 to 96 % with an average temperature of about 24<sup>0</sup>C during early crop growth stage, plants with more height and bigger head break because of succulent stem and heavier head.

Alternatively hybrids possessing the above plant characters may also be successfully grown during this season. The Regional Research Station, Nagaon has recorded seed yield up to 3000 kg/ha using hybrid like AH-04. However, the

potential area of 0.3 million hectare is mostly covered by Rapeseed mustard being the traditional crop, although realising the oil quality and net monetary return, many farmers have come up for sunflower cultivation in this season.

**(b) Late Winter Season :** This is the most potential season (December - March) for popularising sunflower in this part of India. There are about 1.7 million hectares of land under winter paddy majority of which remain vacant from December to March after harvest of winter paddy since no crop could be successfully grown during December. As such the land remains fallow year after year. In such situation, open pollinated varieties bred with shorter duration (90-100 days), medium dwarf plant (80-100 cm) and medium sized head (15-20 cm) will do wonder for popularising sunflower in Assam. Under this situation, the Deptt. of Agriculture, Assam has demonstrated variety like Morden and realised seed yield up to 1200 kg/ha just in 90 days. Crop in this season must escape the pre-monsoon showers of April.

Considering the perception that something is better than nothing, the farmers will accept the technology for utilizing the otherwise fallow land for sunflower cultivation. The rice-fallow in North-East India is a major concern for the persons directly or indirectly involved in agricultural research and development in India.

## **INTRODUCTION**

Sunflower being the third important oilseed crop in the world was introduced to India in late 1960s, although it's commercial production with four Russian varieties made a starting in 1972. However, significance of sunflower as an important oilseed crop in India was visualised during 1980s. The major sunflower growing states are Karnataka, Maharashtra, Andhra Pradesh and Tamilnadu although it is gaining momentum in Punjab, Haryana, Uttar Pradesh and Gujarat. The crop has also been introduced to North-East India during mid nineties.

Assam along with six other North-Eastern states namely Nagaland, Manipur, Tripura, Mizoram, Arunachal Pradesh and Meghalaya have tremendous potentiality of growing sunflower under different agricultural situations / conditions. However, choice of cultivar with desired plant characteristics along with selection of safe and suitable season would play a great role in popularising sunflower in this part of India which is characterised by damp humid climate resulting from high rainfall, unlike the major sunflower growing states of southern India having hot and dry climate.

Considering the wide plasticity of the crop for growing under various situations / seasons, the present paper is intended to deal with the varying growing conditions prevailing in one of the north- eastern states namely, Assam for facilitating choice of appropriate cultivar and effective breeding objectives for specific situation / conditions. Evaluation of cultivars both hybrid and open pollinated population has been in progress in the Regional Agricultural Research Station ( RARS ), Nagaon under the Assam Agricultural University since 1995-96. Before discussing the results it would be relevant to have a glimpses over the rainfall distribution pattern in North-Eastern states in general and Assam and RARS, Nagaon in particular since rainfall largely determines the climate of this region.

## **DISTRIBUTION OF RAINFALL IN NORTH-EAST INDIA**

The seven states of North-East India receive varying amount of annual precipitation with intensity of rainfall varies from region to region within a state. For example, rainfall in eastern, central and northern regions of Assam varies from 1000-2000mm, while it is 1000-3000mm in western region (Table 1). In southern region of Assam rainfall upto 5000mm is obtained. Likewise rainfall in Nagaland, Manipur and Mizoram ranges from 1000-3000 mm from region to region, the same being 2000-3000mm for Tripura. Comparatively higher rainfall ranging from 1000-5000mm is experienced in various regions of Arunachal Pradesh. Highest intensity of rainfall is seen in Meghalaya from 2000mm (Eastern region) to more than 7000mm (Southern region).

## **CLIMATE OF ASSAM**

Assam is situated in the extreme North-Eastern region of India between 24<sup>0</sup> and 28<sup>0</sup>N latitude and 89<sup>0</sup>50" and 96<sup>0</sup>E longitude falling in the sub-tropical zone. Its climate is mainly influenced by South-West monsoon from Bay of Bengal and largely determined by the hills of lower Himalayas and surrounding hills of Assam Himalayas. There are three distinct seasons based on rainfall and temperature.

- 1 Summer Season. (March to May)
- 2 Rainy Season. (June to September)
- 3 Post Rainy Season. (October to February) which also includes the winter season.
- 4 (December to February).

The normal rainfall in the summer season is 649mm, 1702mm in rainy season, 234mm in the post rainy season and 66mm in the winter season (Table 2) with an average normal annual precipitation of 2585mm. The average minimum temperature of the state is about 10<sup>0</sup>C observed in December/January and maximum is about 32<sup>0</sup>C in July/August. Average relative humidity exceeds 80% for the entire state, even does not go beyond 75% during the winter months (Anonymous, 1989). Similar trend in weather parameters recorded at RARS, Nagaon is depicted in Table 3.

## **EVALUATION OF CULTIVARS**

Both open pollinated population and hybrids were evaluated for seed yield and other important traits in rainy as well as post rainy season at the Regional Agricultural Research Station, Nagaon, Assam.

## **EVALUATION IN RAINY SEASON**

During the rainy season of 1997 eight open pollinated strains, 21 initial hybrids and 15 advance hybrids were evaluated to study their yielding behaviour. The materials were laid on 06.08.1997 (open pollinated strain) and 25.08.1997 (hybrid). A perusal of the data in Table 4 indicates that on an average the open pollinated strains produced seed yield of 842 kg/ha in 112 days with head diameter ranging from 7.5-8.9 cm. Highest yield was registered by IV-87 (882 kg/ha) with a head diameter of 8.9 cm. Similar average performance was observed for the hybrids (Tables 5 and 6) also in terms of yield (814 kg/ha for the initial hybrids and 612 kg/ha for the advance hybrids), duration (113 days) and head diameter (7.1 cm for initial hybrids and 6.3 cm for advance hybrids).

Rainfall, relative humidity and temperature during the crop season (Table 7) indicate that the open pollinated strains were affected by rain and high humidity during maturity stage in November and moisture stress conditions during flowering stage in October. The normal rainfall in October is 115.3 mm, but it was 2.8 mm in October 1997. During this season sunflower does not seem to be a profitable crop as indicated by the poor seed yield and growth specially the head diameter (<10 cm for any of the population).

## **EVALUATION IN POST RAINY SEASON**

During winter season of 1995-96, 1996-97 and 1997-98 a total of 43 hybrids of initial stage and 17 hybrids of advanced stage were evaluated for seed yield and other important characters by sowing during third week of November. During 1995-96 average yield of the 19 initial hybrids was recorded to be 850.3 kg/ha (Table 8) with a range of 634.3 kg/ha (IH-318) to 1259.3 kg/ha (IH-328). The crop was affected by comparatively higher rainfall (83mm) at the time of maturity (March) as against the normal rainfall of 35mm in March (Table 9) resulting in lower yield.

During 1996-97 mean performance of the 9 hybrids of initial stage was 1715.8 kg/ha, the highest being 2208.3 kg/ha recorded for IH-334 with head diameter of 17.7 cm (Table 10). Performance of the advance hybrids was even better than the initial hybrids registering an average yield of 1948.9 kg/ha, the highest being recorded for AH-04 giving yield of 3000 kg/ha with a head diameter of 17.4 cm (Table 11). A perusal of the weather data during the crop season (Table 12) indicates that moderate rainfall (around 20mm) during flowering and seed filling stage coupled with low rainfall (14 mm) at maturity stage were congenial for crop growth and development, ultimately contributing for much higher yield. However it was observed, some of the plants with head diameter more than 20 cm with thick succulent stem tended to break.

Fifteen initial hybrids screened during 1997-98 produced on an average seed yield of 2013.5 kg/ha, highest given by IH-347 (2370.5 kg/ha) with a head diameter of 11.9 cm (Table 13). On the other hand, the 8 advance hybrids (Table 14) exhibited comparatively poor performance (average yield 1346 kg/ha), highest 1725 kg/ha obtained for AH-05) chiefly because of poor plant stand (Table 15).

## **CONSTRAINTS FOR GROWING IN SUMMER AND RAINY SEASON**

Although a good crop growth is observed in summer grown sunflower, high rainfall during flowering and seed setting stages adversely affects the crop resulting in poor seed setting. Normal rainfall during this season is about 650mm (Table 2). The most potential risk of growing sunflower in summer season is that frequently there blows strong wind during April-May which breaks the plants especially those with heavier heads. Moreover, the crop might be affected by diseases like head rot, root rot etc. due to excessive wet condition at various critical growth stages.

Cultivation of sunflower in rainy season is directly limited by the high rainfall (1700mm, Table 2) affecting the crop right from seedling stage to harvesting stage. It is observed that seed yield in post rainy season is satisfactory (> 1500 kg/ha for many of the hybrids) with proper growth of the head (15-20cm).

## CHOICE OF CULTIVAR AND BREEDING OBJECTIVES

**Post Rainy Season** : Majority of the area during this season, for any crop, is cultivated under rainfed conditions, thereby uncertainties in crop growing environment are usually expected. For such situations open pollinated varieties are to be more preferred in view of their low seed cost and inherent tolerance to withstand moisture stress and attack of disease-pests (Seetharam and Virupakshappa, 1993). Using open pollinated variety like Morden the Department of Agriculture, Assam has obtained average seed yield of 1500 kg/ha in farmers field of Nagaon district (Anonymous, 2001).

Normal rainfall during this season is about 234mm (Table 2) during which months like November, December, January are mostly free from excess rainfall. However humidity is high (above 75%). For such situations breeding objectives ought to include medium head diameter (15-20 cm), medium plant height (90-120 cm) and self compatible types since seed setting continues to be a problem. High humidity along with congenial temperature (above 20<sup>0</sup>C) for growth in early stage facilitate the plants to have succulent stem and heavier head which might break if the plants are tall.

Alternatively hybrids possessing the above plant characters may also be grown successfully during this season. Seed yield up to 3000 kg/ha was obtained for hybrid AH-04 during 1996-97 with head diameter of 17.4 cm within 123 days. However, the potential area of 0.3 million hectares is mostly used for growing Rapeseed-Mustard being the traditional crop of the state.

Owing to high input cost for seeds and fertilizers for hybrids coupled with meagre/nil marketing facility of the produce, the farmers show reluctance to go for sunflower in this season. However, realising about the quality of oil and high price compared to mustard seeds many of the farmers have come up for cultivating sunflower during this season.

**Late winter season** : This is the most potential season/period for popularising sunflower in this region of India. There are about 1.7 million hectares of land under winter paddy, majority of which remain fallow after harvest of winter paddy since no crop could successfully be grown after December 15 because of low temperature. In such conditions open pollinated varieties bred with shorter duration (90-100 days), medium dwarf plant (80-100 cm) and medium sized head (15-20 cm) will do wonder for popularising sunflower in Assam. The crop must escape pre-monsoon showers of April. Under this situation the Department of Agriculture, Assam was able to realise seed yield up to 1200 kg/ha with open pollinated variety Morden in farmers field.

Considering low input cost for growing open pollinated variety and the perception that something is better than nothing, the farmers will accept the technology/new crop for utilizing the otherwise fallow land for growing sunflower. But the government has to create the marketing/processing facilities in the sunflower growing pockets to ensure the economy of the farmers. Once the farmers are benefited from the open pollinated variety, they may be slowly motivated for growing hybrids of similar traits so that seed yield per unit area is increased and thereby Assam become self sufficient in oilseed production. The rice-fallow in North-East India is a major concern for those who are directly or indirectly involved in agricultural research and development in India.

### Acknowledgement

The author thankfully acknowledges the Department of Agriculture, Assam for providing valuable information. Thanks are also to the Project Coordinating Unit, ICAR, University of Agricultural Sciences, Bangalore for providing the sunflower seeds. Deep sense of gratitude is also expressed to the authority of Assam Agricultural University, Jorhat and the RARS, Nagaon for providing facilities to conduct the trials.

### CITATIONS

Anonymous, 1995-96. Annual Report, Regional Agricultural Research Station, Assam Agricultural University, Shillongani, Nagaon, Assam

Anonymous, 1996-97. Annual Report, Regional Agricultural Research Station, Assam Agricultural University, Shillongani, Nagaon, Assam

Anonymous, 1997-98. Annual Report, Regional Agricultural Research Station, Assam Agricultural University, Shillongani, Nagaon, Assam

Anonymous, 1989. Status Report, Central Brahmaputra Valley Zone of Assam. Regional Agricultural Research Station, Assam Agricultural

Anonymous, 2000-01. Status Paper (Agriculture), Nagaon district, District Agricultural Office, Nagaon, Assam.

Giriraj, K.1988. Strategies for increasing sunflower production in India. Proc. National Seminar on Strategies for making India self reliant in vegetable oils, Hyderabad, pp. 245-248

Seetharam, A. and Virupakshappa, K. 1993. Present status and future direction of Sunflower breeding in India. Proc. National seminar on oilseed research and development in India : Status and Strategies, Hyderabad, pp. 54-61.

Virupakshappa, K. 1993. Strategies for sustainable sunflower production in India. Proc. National seminar on oilseed research and development in India : Status and Strategies, Hyderabad, pp. 580-581.

**Table 1. Distribution of Annual Rainfall in North - East India**

Sl. No.	North - Eastern States	Range of Annual Rainfall (mm)
1	(A) <b>Assam</b> (i) Eastern, Central and Northern Region (ii) Western Region (iii) Southern Region	1000-2000 1000-3000 2000-5000
2	(B) <b>Nagaland</b> (i) North-Eastern and Western Region (ii) South-Eastern Region	1000-2000 2000-3000
3	(C) <b>Manipur</b> (i) Northern, Eastern and Southern Region (ii) Western Region	1000-2000 2000-3000
4	(D) <b>Mizoram</b> (i) Northern Region (ii) All other Region	2000-3000 1000-2000
5	(E) <b>Tripura</b> (i) Whole of the State	2000-3000
6	(F) <b>Arunachal Pradesh</b> (i) South-Eastern Region (ii) North-Eastern Region (iii) North-Western Region (iv) Northern Region (v) Western Region	1000-2000 2000-4000 3000-4000 4000-5000 1000-3000
7	(G) <b>Meghalaya</b> (i) Eastern Region (ii) Northern and North-Western Region (iii) Central Region (iv) Southern Region	1000-2000 2000-4000 4000-6000 6000-7000 (>7000)

Source : Status Report, Central Brahmaputra Valley Zone, Assam, 1989 published by Regional Agricultural Research Station, Assam Agricultural University, Shillongani, Nagaon

**Table 2. Seasonwise Normal Rainfall (mm) in various districts of Assam**

Sl. No.	District	Winter Season (Dec.-Feb.)	Summer Season (Mar.-May)	Rainy Season (Jun.-Sep.)	Post Rainy Season * (Oct.-Feb.)	Total
1	Goalpara	33.3	624.0	2156.1	191.5	2971.6
2	Dhuburi	33.3	624.0	2156.1	191.5	2971.6
3	Kokrajhar	33.3	624.0	2156.1	191.5	2971.6
4	Bongaigaon	33.3	624.0	2156.1	191.5	2971.6
5	Barpeta	45.7	554.5	1418.9	153.9	2127.3
6	Nalbari	45.7	554.5	1418.9	153.9	2127.3
7	Kamrup	45.7	554.5	1418.9	153.9	2127.3
8	Darrang 57.3	520.6	1444.3	207.7	2172.6	
9	Sonitpur 57.3	520.6	1444.3	207.7	2172.6	
10	Lakhimpur	103.8	583.7	1765.6	277.2	2626.5
11	Dhemaji 103.8	583.7	1765.6	277.2	2626.5	
12	Dibrugarh	103.8	583.7	1765.6	277.2	2626.5
13	Tinsukia 103.8	583.7	1765.6	277.2	2626.5	
14	Jorhat	97.4	590.7	1409.7	244.1	2244.5
15	Golaghat	97.4	590.7	1409.7	244.1	2244.5
16	Sibsagar 97.4	590.7	1409.7	244.1	2244.5	
17	Nagaon	57.7	400.2	1195.3	176.7	1772.4
18	Morigaon	57.7	400.2	1195.3	176.7	1772.4
19	Cachar	72.9	961.8	2039.0	311.7	3312.5
20	Karimganj	72.9	961.8	2039.0	311.7	3312.5
21	Hailakandi	72.9	961.8	2039.0	311.7	3312.5
22	Karbi-Anglong	69.1	920.3	1994.5	329.7	3244.5
23	N.C. Hills	69.1	920.3	1994.5	329.7	3244.5
	<b>State Average</b>	<b>66.2</b>	<b>648.9</b>	<b>1702.7</b>	<b>233.6</b>	<b>2584.5</b>

\*Figures include rainfall of Winter Season also.

Source: Basic Agricultural Statistics, Assam. 1997-98.  
Directorate of Agriculture, Assam.

**Table 3. Normal Weather Parameters at Regional Agricultural Research Agricultural University, Nagaon, Assam**

Station, Assam

Sl. No.	Month	Rainfall No. of (mm)	Temperature(°C)		Relative Humidity (%)			
			Rainy days	Max.	Min.	Morning	Evening	Average
1	January	14.4	2	23.4	10.5	95.2	58.9	77.1
	February	21.3	4	25.4	12.7	91.2	51.8	71.6
3	March	35.1	6	29.3	16.4	88.0	47.7	68.9
4	April	141.7	13	30.4	20.1	87.9	58.6	73.3
5	May	207.0	16	31.3	22.4	90.4	68.8	79.6
6	June	296.4	19	32.1	25.0	91.5	73.9	82.7
7	July	400.2	23	32.3	25.6	93.1	76.3	84.7
8	August	322.0	19	32.5	25.7	92.5	75.1	83.8
9	September	236.6	16	31.7	24.8	93.6	74.9	84.3

10	October	115.3	7	30.5	22.3	94.9	71.6	83.3
11	November	18.9	2	28.0	16.9	95.6	64.8	80.2
12	December	10.2	1	24.7	12.0	96.6	60.3	78.5
<b>Total</b>		<b>1819.1</b>	<b>128</b>	<b>29.3</b> (Av.)	<b>19.5</b> (Av.)	<b>92.6</b> (Av.)	<b>65.2</b> (Av.)	<b>79.0</b> (Av.)

Rainfall & Relative Humidity : Average of 31 years (1968-1998)

Temperature : Average of 28 years (1971-1998)

Source : Annual Report 1999-2000 RARS, AAU, Nagaon (Assam)

**Table 4. Performance of open pollinated strains of Sunflower grown during Rainy Season, 1997**

Sl. No.	Strain	Days to 50% flowering	Days to Head maturity	Plant Stand diameter (cm)	Plant Stand ('000/ha)	Seed Yield (kg/ha)
1	IV-83	58.8	112.0	7.7	51.5	854.3
2	IV-84	58.3	112.3	8.0	52.4	801.9
3	IV-85	58.5	111.8	8.2	53.7	849.6
4	IV-86	58.0	111.5	7.9	54.6	845.0
5	IV-87	58.5	112.5	8.9	53.7	882.0
6	IV-88	58.6	112.8	8.0	51.9	847.2
7	IV-89	58.5	112.3	7.8	52.8	817.2
8	IV-90	58.5	112.3	7.5	53.3	838.0
General Mean :		58.5	112.2	8.0	53.0	842.0
CD at 5% :		NS	NS	NS	NS	NS
CV (%) :		0.75	0.48	10.6	4.5	8.9

**Table 5. Performance of Sunflower hybrids grown during Rainy Season, 1997 : Set- I**

Sl. No.	Hybrid	Days to 50% flowering	Days to Head maturity	Plant Stand diameter (cm)	Plant Stand ('000/ha)	Seed Yield (kg/ha)
1	IHM-339	60.0	112.5	7.8	53.3	768.5
2	IHM-340	60.8	112.5	7.6	52.4	875.0
3	IHM-341	60.5	112.8	6.6	51.9	768.5
4	IHM-342	60.8	113.0	6.7	52.4	796.3
5	IHM-343	61.0	113.0	6.6	53.3	773.2
6	IHM-344	60.0	112.5	6.8	55.2	861.1
7	IHM-345	60.5	112.8	6.5	52.4	810.2
8	IHM-346	60.5	113.3	6.9	52.6	838.0
9	IHM-347	60.5	113.8	6.8	52.6	791.7
10	IHM-348	61.0	112.5	6.7	55.2	777.8

11	IHM-349	60.0	112.5	8.0	53.7	842.6
12	IHM-350	60.5	112.8	7.9	53.7	810.2
13	IHM-351	60.3	113.8	7.0	51.9	847.2
14	IHM-352	61.0	113.5	6.6	53.7	835.7
15	IHM-353	60.8	112.3	6.7	54.3	784.8
16	IHM-354	60.0	112.3	7.2	53.7	814.8
17	IHM-355	60.3	113.0	9.0	52.8	828.7
18	IHM-356	61.5	113.0	6.9	51.9	838.0
19	IHM-357	61.3	113.3	6.8	54.3	828.7
20	IHM-358	61.3	113.0	6.5	53.7	798.7
21	IHM-359	60.5	112.5	7.5	53.7	810.2
General Mean :		60.6	112.9	7.1	53.3	814.0
CD at 5% :		0.3	NS	NS	NS	NS
CV (%) :		0.9	0.5	17.0	3.2	6.7

**Table 6. Performance of Sunflower hybrids grown during Rainy Season,**

**1997 : Set- II**

Sl. No.	Hybrid	Days to 50% flowering	Days to Head maturity	Plant Stand diameter (cm)	Plant Stand ('000/ha)	Seed Yield (kg/ha)
1	AH-01	60.0	113.0	6.6	52.8	593.9
2	AH-02	61.3	112.8	6.6	53.1	639.2
3	AH-03	60.8	112.5	6.0	54.4	604.4
4	AH-04	61.3	111.8	6.1	53.7	625.0
5	AH-05	60.8	113.0	6.4	52.2	593.9
6	AH-06	60.0	112.0	6.0	53.7	625.3
7	AH-07	60.8	113.0	6.4	53.7	627.8
8	AH-08	60.8	113.3	6.9	52.2	590.6
9	AH-09	61.5	113.3	6.6	53.7	611.4
10	AH-10	60.8	113.0	6.6	52.8	615.3
11	AH-11	60.0	112.0	6.1	52.0	616.4
12	AH-12	60.8	112.8	6.1	54.2	614.8
13	AH-13	61.0	112.5	6.2	52.8	587.2
14	AH-14	61.0	113.5	5.9	51.7	618.3
15	AH-15	61.0	113.0	6.2	54.4	623.7
General Mean :		60.8	112.8	6.3	53.3	612.4
CD at 5% :		0.9	NS	NS	NS	NS
CV (%) :		1.1	0.8	12.0	3.9	6.4



**Table 7. Rainfall, Relative Humidity and Temperature during the crop season of Sunflower grown in Rainy Season, 1997**

Sl. No.	Month	Rainfall (mm)		Relative Humidity (%)				Normal Temp.( <sup>0</sup> C)	
				Morning		Evening		Max.	Min.
		1997	Normal	1997	Normal	1997	Normal		
1	Aug.	231.8	322.0	89.7	92.5	71.8	75.1	32.5	25.7
2	Sept.	186.8	236.6	84.2	93.6	75.5	74.9	31.7	24.8
3	Oct.	2.8	115.3	95.2	94.9	64.7	71.6	30.5	22.3
4	Nov.	24.0	18.9	96.7	95.6	60.3	64.8	28.0	16.9
5	Dec.	22.4	10.2	97.7	96.6	61.2	60.3	24.7	12.0

Normal Rainfall and Relative Humidity : Average of 31 years (1968-1998)  
Normal Temperature : Average of 28 years (1971-1998)

**Table 8. Performance of Sunflower hybrids grown during Winter Season, 1995-96**

Sl. No.	Hybrid	Days to 50% flowering	Days to Head maturity	Plant Stand diameter (cm)	Plant Stand ('000/ha)	Seed Yield (kg/ha)
1	IHT-312	60.8	112.8	11.1	61.1	657.4
2	IHT-313	63.3	114.3	11.9	55.6	1150.5
3	IHT-314	61.0	111.3	10.2	59.8	1055.6
4	IHT-315	61.0	111.8	12.3	56.1	685.2
5	IHT-316	61.0	113.0	9.2	53.3	754.6
6	IHT-317	63.5	113.5	11.2	58.9	898.1
7	IHT-318	60.3	110.0	12.8	58.0	634.3
8	IHT-319	61.3	111.3	9.0	56.1	838.0
9	IHT-320	59.5	109.0	11.4	54.6	893.5
10	IHT-321	63.5	113.8	12.2	56.1	930.6
11	IHT-322	62.8	114.0	11.3	55.0	819.4
12	IHT-323	62.4	113.8	13.7	58.0	1037.0
13	IHT-324	63.0	114.3	12.0	58.3	791.7
14	IHT-325	63.0	113.8	13.0	55.0	800.9
15	IHT-326	60.5	111.0	11.8	56.9	800.9
16	IHT-327	64.5	114.5	11.2	58.0	699.0
17	IHT-328	60.5	114.0	12.0	56.5	1259.3
18	IHT-329	60.5	113.5	11.1	54.3	694.4
19	IHT-330	62.3	113.5	10.2	56.9	754.6

General Mean : 61.9      112.8      11.4      57.0      850.3  
CD at 5% : 1.3      1.0      NS      NS      105.4  
CV (%) : 1.5      0.6      17.0      8.1      8.4

**Table 9. Rainfall, Relative Humidity and Temperature during the crop season of Sunflower grown in Winter Season, 1995-1996**

Sl. No.	Month	Rainfall (mm)		Relative Humidity (%)				Normal Temp.(0C)	
		1995-96	Normal	Morning		Evening		Max.	Min.
				1995-96	Normal	1995-96	Normal		
1	Nov.'95	35.2	18.9	95.5	95.6	63.3	64.8	28.0	16.9
2	Dec.'95	Nil	10.2	95.4	96.6	60.3	60.3	24.7	12.0
3	Jan.'96	13.8	14.4	95.7	95.2	57.4	58.9	23.4	10.5
4	Feb.'96	12.0	21.3	89.8	91.3	48.4	51.8	25.4	12.7
5	Mar.'96	83.0	35.1	85.8	88.0	54.5	47.7	29.3	16.4

Normal Rainfall and Relative Humidity : Average of 31 years (1968-1998)  
 Normal Temperature : Average of 28 years (1971-1998)

**Table 10. Performance of Sunflower hybrids grown during Winter Season, 1996-97 : Set- I**

Sl. No.	Hybrid	Days to 50% flowering	Days to Head maturity	Plant Stand diameter (cm)	Plant Stand ('000/ha)	Seed Yield (kg/ha)
1	IH-331	63.8	120.5	18.2	53.9	2047.2
2	IH-332	64.0	120.5	17.6	52.0	1201.4
3	IH-333	64.5	121.5	18.9	55.3	1920.9
4	IH-334	63.0	121.0	17.7	55.3	2208.3
5	IH-335	64.0	121.8	13.8	54.4	1918.1
6	IH-336	63.8	121.3	13.6	51.7	636.1
7	IH-337	64.0	124.0	18.3	53.7	1938.9
8	IH-338	64.0	123.3	19.4	54.4	2063.9
9	IH-339	63.8	122.0	15.5	53.3	1507.0
General Mean :		63.9	121.8	17.0	53.8	1715.8
CD at 5% :		NS	2.3	2.6	2.3	183.6
CV (%) :		2.2	1.3	10.6	2.9	7.3

**Table 11. Performance of Sunflower hybrids grown during Winter Season, 1996-97 : Set- II**

Sl. No.	Hybrid	Days to 50% flowering	Days to Head maturity	Plant Stand		Seed Yield (kg/ha)
				diameter (cm)	('000/ha)	
1	AH-01	65.2	121.3	18.9	55.2	1775.8
2	AH-02	66.0	122.3	14.8	55.6	2277.8
3	AH-03	67.0	122.5	16.8	54.6	1869.0
4	AH-04	66.5	122.8	17.4	55.6	3000.0
5	AH-05	67.3	123.3	13.2	55.0	1573.8
6	AH-06	67.3	123.3	17.8	54.2	1944.8
7	AH-07	66.5	123.3	14.6	54.8	1513.9
8	AH-08	65.8	121.8	11.3	53.8	1651.8
9	AH-09	65.8	122.5	11.4	54.4	1932.5
General Mean :		66.4	122.5	15.1	54.8	1948.9
CD at 5% :		1.3	NS	2.2	0.8	129.6
CV (%) :		1.4	0.7	10.1	1.0	4.6

**Table 12. Rainfall, Relative Humidity and Temperature during Crop season of Sunflower grown in Winter Season, 1996-97**

Sl. No.	Month	Rainfall (mm)		Relative Humidity (%)				Normal Temp.( <sup>0</sup> C)	
		1996-97	Normal	Morning		Evening		Max.	Min.
				1996-97	Normal	1996-97	Normal		
1	Nov.'96	Nil	18.9	93.1	95.6	61.0	64.8	28.0	16.9
2	Dec.'96	Nil	10.2	95.1	96.6	52.3	60.3	24.7	12.0
3	Jan.'97	20.0	14.4	95.6	95.2	53.5	58.9	23.4	10.5
4	Feb.'97	21.0	21.3	92.4	91.3	58.7	51.8	25.4	12.7
5	Mar.'97	14.0	35.1	88.4	88.0	42.5	47.7	29.3	16.4
Normal Rainfall and Relative Humidity :		Average of 31 years (1968-1998)							
Normal Temperature		: Average of 28 years (1971-1998)							

Table 13. Performance of Sunflower hybrids grown during Winter Season,

1997-98 : Set-I

Sl. No.	Hybrid	Days to 50% flowering	Days to Head maturity	Plant Stand diameter (cm)	Plant Stand ('000/ha)	Seed Yield (kg/ha)
1	IH-340	45.3	94.7	10.3	46.9	2345.7
2	IH-341	43.8	92.7	11.4	46.3	1605.0
3	IH-342	44.2	93.3	13.3	42.6	2222.0
4	IH-343	43.0	92.0	11.2	38.3	1802.4
5	IH-344	41.8	93.0	13.3	43.9	2092.5
6	IH-345	42.6	92.3	11.0	44.4	2163.5
7	IH-346	45.0	93.0	12.8	46.9	2123.5
8	IH-347	43.3	92.0	11.9	46.9	2370.5
9	IH-348	44.3	93.0	8.9	48.2	1851.9
10	IH-349	46.7	94.0	11.7	45.0	1855.0
11	IH-350	45.2	90.7	14.0	41.3	1376.5
12	IH-351	48.6	94.7	13.4	43.9	2302.4
13	IH-352	45.2	94.3	12.5	39.4	166.7
14	IH-353	48.2	94.3	13.2	39.4	2092.5
15	IH-354	47.4	95.3	13.0	44.4	2327.2
General Mean :		45.0	93.8	12.2	43.9	2013.5
CD at 5% :		2.3	2.1	2.6	6.1	220.4
CV (%) :		3.5	1.4	13.0	8.3	6.6

Table 14. Performance of Sunflower hybrids grown during Winter Season,

1997-98 : Set-II

Sl. No.	Hybrid	Days to 50% flowering	Days to Head maturity	Plant Stand diameter (cm)	Plant Stand ('000/ha)	Seed Yield (kg/ha)
1	AH-01	48.2	94.0	11.9	25.9	1569.4
2	AH-02	45.3	93.8	11.8	27.2	1372.2
3	AH-03	45.2	93.3	11.9	30.9	1136.1
4	AH-04	46.7	93.3	9.1	24.2	972.2
5	AH-05	49.0	94.5	13.9	28.1	1725.0
6	AH-06	44.1	93.5	11.9	28.7	1360.0
7	AH-07	46.2	94.3	12.7	25.0	1594.4
8	AH-08	45.8	93.3	10.8	24.2	1038.9
General Mean :		46.3	93.7	11.7	26.8	1346.0
CD at 5% :		NS	NS	NS	0.3	110.4
CV (%) :		3.5	1.1	16.0	4.4	5.6

Table 15. Rainfall, Relative Humidity and Temperature during Crop season of Sunflower grown in Winter Season, 1997-98

Sl. No.	Month	Rainfall (mm)		Relative Humidity (%)		Normal Temp.( <sup>0</sup> C)
		1997	Normal	Morning	Evening	

<b>98</b>			<b>1997-98</b>		<b>Normal</b>		<b>1997-98</b>		<b>Normal</b>		<b>Max.</b>	<b>Min.</b>
1	Nov.'97	24.0	18.9	96.7	95.6	60.3	64.8	28.0	16.9			
2	Dec.'97	22.4	10.2	97.7	96.6	61.2	60.3	24.7	12.0			
3	Jan.'98	12.6	14.4	97.0	95.2	62.4	58.9	23.4	10.5			
4	Feb.'98	12.8	21.3	91.8	91.3	48.0	51.8	25.4	12.7			

Normal Rainfall and Relative Humidity : Average of 31 years (1968-1998)  
Normal Temperature : Average of 28 years (1971-1998)