Evaluation of sunflower hybrids for their suitability in North Eastern Hill Regions of India

A AZIZ QURESHI, R K SINGH[1], D SEN[2], L K BAISHYA[3], A P SINGH[4], A VISHNUVARDHAN REDDY, R K AVASTHE AND D PATI

ICAR-Indian Institute of Oilseeds Research, Rajendranagar, Hyderabad-500030, Telangana

(Received: February 23, 2018; Revised: May 15, 2018; Accepted: June 5, 2018)

ABSTRACT

Five sunflower hybrids and a variety were evaluated in four different centres of North Eastern Hill (NEH) regions to study their suitability in terms of growth, yield and oil content to tap the potential rice fallow areas in NEH regions (Jharnapani, Medziphema, Tadong, and Lembucherra). Uniform layout was adopted at four locations to conduct field trials with RBD design. The soils of the region except Lembucherra were found to be acidic (ranged between 4.6 and 5.7 pH) and therefore requires regular lime application for obtaining high seed yields of sunflower. The location Tadong was on high altitude (1300 m MSL) and recorded less number of average sunshine hours (2.5 hours/day) during the sunflower crop period was responsible for lanky growth of sunflower with low oil content. However, Lembucherra was highly suitable for growing sunflower as weather conditions were highly favourable. Further, assessment of various growth and yield parameters it was found that average yield of sunflower in Tadong location was the highest (1814 kg/ha) but had low average oil content (28.6%) and attained average maturity in 135 days. While Lembucherra centre recorded seed yield of 1532 kg/ha with average oil content of 37.1 per cent and found to complete crop cycle at the earliest over other centres by attaining maturity on an average in 113 days. Among all the hybrids, DRSH-1 showed highest oil content in all the locations and mean value across the centres was 39.6 per cent.

Keywords: Hybrids, North Eastern Hill Regions of India, Suitability, Sunflower

Environmental variables, especially temperature is the key factor which affect plant growth, development and productivity (Kaleem *et al*., 2009). Differences in yield attributes to varying seasons might be due to the different climatic conditions that are based on temperature prevailing during the crop life cycle (KII and Altunbay, 2005). Most crop species are adapted to a particular set of temperature, as temperature is a major environmental factor that not only modifies plant phenology, but also causes many physiological and qualitative changes. Environmental variations affect crop growth, development, yield, oil and fatty acid accumulation through agronomic, physiological and qualitative functions of crop plant (Kaleem *et al.,* 2010). A number of plant's developmental and physiomorphic adaptations to the environment, influence sunflower yields and oil quality (Hassan *et al.,* 2005). Although, sunflower is temperate zone crop, it can perform well under various climatic and soil conditions. Sunflower is a C_4 plant having higher physiological activity but it is sensitive to cold temperatures, prevailing during autumn planting and is called a warm season plant when compared to C_3 plants (Bruder *et al.,* 2008). Sunflower growth and productivity is affected in relation to prevailing growing environment and crop will be influenced with the environmental variables like temperature, photoperiod, rainfall and relative humidity (Paramasivan and Selvarani, 2016). This study was thus, planned to investigate performance of sunflower hybrids with the objectives of assessing the growth parameters of sunflower hybrids in NEH region during rabi season, understanding location effect on yield parameters and oil content of sunflower and relating weather parameters for suitability of sunflower in NEH region.

[1]ICAR-National Organic Farming Research Institute, Tadong, Sikkim-737 102; [2]Agriculture College, Lembucherra, Tripura-799 210; [3]ICAR-North Eastern Hill Research Complex, Jharnapni Regional Centre, Medziphema, Nagaland-797 106; [4]School of Agril. Sciences and Rural Development, Nagaland University, Medziphema campus, Nagaland-797 106

MATERIALS AND METHODS

The field trials aimed to evaluate five ruling hybrids (DRSH-1, KBSH-41, KBSH-44, KBSH-53 and LSFH-171) and a variety (DRSF-113) of sunflower hybrids for their suitability were conducted during November to April 2016-17 at 4 centres in NEH region after the harvest of the rice crop. Experiment was laid out in randomized block design with genotypes of sunflower as treatments and with three replications. The gross treatment plot measured 5.8 m x 4.8 m, with 9 rows and a spacing of 60 cm x 30 cm was adopted uniformly in all the locations. The site details are mentioned in Table 1. The soils of the region was either sandy loam or loamy sand type mainly dependent on land topography with steep slopes. The detailed initial soil fertility status of the four locations is shown in Table 1. The soils of all the centres were acidic in reaction (pH1:2.5) and low in

soluble salt content (EC1:2). The organic carbon content of all the soils was in the higher range i.e., > 0.75%, and highest value of 2.3% was recorded in the soils of Lembucherra, Tripura state followed by Medziphema (1.54%) Nagaland state. The available nitrogen content in the soils varied from a low value (188 kg/ha) in Jarnapani, Nagaland state to medium value (402 kg/ha) in Lembucherra, Tripura state and Tadong, Sikkim state. Soil in Jarnapani and Medzipherma had medium level of available phosphorus except in Tadong (48 kg/ha) and Lembucherra (59 kg/ha) which were high. Available potassium content was high in the soils of Tadong and Medziphema (i.e. > 260 kg/ha), medium in Lembucherra (between 110-260 kg/ha) and low in the soils of Jarnapani (i.e., <110 kg/ha). Sunflower was sown between last week of November 2016 and first week of December 2016 at all the four centres. The date of sowing and harvesting for each location has been depicted in Fig. 1. On the basis of initial soil test, fertilizers were applied to meet the nutrition requirement of sunflower @ 60:60:30 kg/ha NPK at all centres except in Tadong where nutrient requirement was met through only organics. The soils were acidic in nature and therefore uniform lime application was recommended @ 500 kg/ha. Hand weeding was carried out at 30 and 45 days after sowing followed by top dressing and earthing up. Irrigation and pest management was practiced based on their requirement. At maturity stage, growth and yield parameters were recorded. After harvest, in each treatment the test weight, plot yield and total yield were recorded. Oil content in the seed was analyzed by NMR equipment at Biochemistry laboratory at IIOR, Hyderabad. The data were tabulated and statistically analyzed adopting MSTAT programme to derive ANOVA for important variables (Freed and Eisensmith, 1986).

Table 1 Site details of experimental locations in NEH regions for evaluation of sunflower during 2016-17

Centre/Parameter	Jarnapani, Nagaland	Lambuchera, Tripura	Tadong, Sikkim	Medziphema, Nagaland
pH	5.40	5.95	5.74	4.60
EC (dS/m)	0.21	0.07	0.25	0.18
OC (%)	0.80	2.29	1.00	1.54
Av N (kg/ha)	188	433.5	402	288
Av. P (kg/ha)	20.0	58.8	48.0	19.2
Av. K (kg/ha)	48.0	132.2	324	257
Soil type	Sandy loam	Loamy sand	Loamy sand	Sandy loam
Latitude	25°45'24"N	23°54'46.34" N	27°32' N	25° 45'43"N
Longitude	93°50'26"E	91°19'02.13" E	88°60' E	95° 53'04"E
Altitude	295m	38 m	1300 m	310 m

RESULTS AND DISCUSSION

Meteorological data of trial centres in NEH Region: The standard meteorological data during the crop duration depicted in Figure 1(a-d) was obtained from all the four centres after the harvest of sunflower trials. The crop season at Jarnapani centre in Nagaland was between 49 and 14 standard meteorological weeks (SMW) during 2016-17. The average maximum and minimum temperature of this centre was 26.9° and 11.5° C and average maximum and minimum relative humidity was 93.6 and 49.2 percentage, respectively. The total rainfall during the crop period was 298 mm and most the rain was received between 10 and 14 SMW when the crop was in seed filling and maturity stages (Fig 1a). At Tadong centre in Sikkim, the crop period was between 49 and 22 SMW indicating the longest duration in NEH region. The mean maximum and minimum temperature of this centre was 22.7° and 12.3°C (Fig 1b). The maximum temperature throughout the crop period was below 30°C indicating the coolest weather among all the centres and prolonged growth period. The total rainfall of this location during crop period was 100.6 mm majorly distributed between 18 and 22 SMW. At Lambuchera centre in Tripura, the sunflower was grown between 49 and 19 SMW (Fig. 1c). The average maximum and minimum temperature of this location was 30° and 15.1°C and average maximum relative humidity was 75.5%. At initial stages, the crop was almost without rainfall. The actual rainfall was received between 13 and 18 SMW. The total rainfall received during sunflower crop period was 409 mm. The average sunshine hours at this centre was 6.0 hours, the maximum amongst all centres. At Medziphema in Nagaland, the sunflower crop was grown between mid of November 2016 and mid of April 2017. The mean maximum and minimum temperature of this location was 27.5° and 13.1°C, the maximum and minimum relative humidity was 93 and 52.3 percentages, respectively (Fig. 1c). The total rainfall received in the crop period was 492mm and the maximum amount was rain was received in March and April months during 2017.

Plant height: The data for plant height of sunflower hybrids grown at different locations in NEH region has been presented in Table 2. The trend in plant height of sunflower hybrids at 4 locations was in the following order

Lembucherra > Tadong > Medziphema > Jarnapani. At Jarnapani, non significant effect among the hybrids was noticed for plant height. At remaining three locations of NEH region, significant variation in growth of sunflower hybrids with respect to plant height was noticed. At Lembucherra, DRSH-1 was found to grow tallest (193cm) which was on par with KBSH-53 (187cm). At Tadong centre, hybrids KBSH-41 (175cm) and KBSH-53 (165cm) had grown tallest and were on par to each other. At Mezdiphema, though hybrid KBSH-53 had recorded 101cm plant height but the variation within the hybrids was found non-significant. Across the centres, KBSH-41 was tallest (126cm) and hybrid LSFH-171 (109cm) was shortest. The performance of sunflower crop as a whole in terms of plant height was compared across the NEH region and the tallest sunflower crop was noticed at Lembucherra location. This might be due to the fact that this location recorded about 6.0 hours of sunshine during the crop period.

Head diameter: The effect of locations on the growth and development of head diameter among sunflower hybrids was found significant in all centres except Medziphema (Table 2). At Jarnapani, though there was significance difference among the hybrids, the maximum diameter was recorded in DRSH-1 (11 cm) and minimum head diameter was recorded in LSFH-171 (6 cm). At Lembucherra centre the highest diameter was found in the hybrid KBSH-1 (17 cm) which was significant over KBSH-53 and LSFH-171 however it was found to be on par with DRSH-1 and KBSH-44. And this might be due to the fact that Lembucherra is located at an altitude of 86 m above MSL and received about 6 hours average sunshine during crop growth period. In Tadong centre the head diameter among different hybrids was above 11 cm. The highest head diameter of 19cm was recorded in KBHS-44 and LSFH-171 and was significantly higher over observed in DRSH-1 and KBSH-53. However, they were on par with KBSH-41 (18.6). Interestingly it was noticed that the head diameter of all the hybrids grown at Medziphema were above 15cm but there was no significant difference among them. Amongst all the hybrids, the top 3 hybrids in terms of head diameter across the centres were KBSH-44 (15.2 cm) followed by KBSH-41 (15.0 cm) and DRSH-1 (14.7 cm). The performance of sunflower crop as a whole in terms of head diameter was compared across the NEH region and the sunflower crop with largest head diameter was noticed at Medziphema > Tadong > Lembucherra > Jarnapani locations.

Maturity: It was essential to study the length of growing period to know the suitability of sunflower in NEH regions. Except in Medziphema centre, the sunflower hybrids showed variation in number of days to maturity at different locations (Table 3). Among all the hybrids, DRSH-1 recorded minimum number of days to mature across all the centres. All the hybrids showed more than 140 days to mature and for this character showed non significant variation at Medziphema, while, at Lembucherra most of the hybrid matured in 111 days (DRSH-1, KBHS-53 and LSFH-171). This may be due to the prevailing high temperature and sunshine hours during growth period (Fig. 1). The shortest duration for sunflower was noticed in Lembucherra centre with a mean maturity of less than 120 days for sunflower hybrids.

Seed yield and oil content: The performance of different sunflower hybrids in terms of seed yield was found significant and recorded variation in their oil content at different NEHR locations (Table 3). All the hybrids except KBSH-44 produced more than 15 quintals of seed yield per hectare at Tadong centre and the highest yield was recorded in KBSH-41 (2250 kg/ha). At Lembucherra centre, the seed yield ranged from lowest in KBSH-53 (1014 kg/ha) to highest in KBSH-41 (1932 kg/ha). This location also recorded highest oil content for different hybrids ranging between 33 % (in KBSH-44) and 41% (in DRSH-1). This may be due the fact that mean average weather conditions *viz*., minimum-maximum temperature, relative humidity and average sunshine hours (>5.5 hours) were more favourable compared to Tadong centre which had cold conditions and the maximum temperature during crop period was below 30°C (Fig. 1) and also had received low sunshine hours (2.5 hrs per day) during crop period. Similarly it was reported by Hassan et al. (2005), Kaleem et al. (2009) and Kumar et al. (2008). Though Jarnapani centre recorded low seed yield for hybrids, highest oil content of 41.8% (in DRSH-1) at this centre which might be due to high temperature prevailing in crop period. Such findings were also corroborated by Qadir et al. (2006). The performance of sunflower crop in terms of seed yield across NEH locations was in the following order: Tadong > Lembucherra > Medziphema > Jarnapani (Fig. 2d). Among all the hybrids, DRSH-1 showed highest oil content in all the locations and it might be due to the expression of its genetic trait as this hybrid has been reported to record highest oil content.

This study was conducted to evaluate sunflower hybrids in North Eastern Hill Regions to find the suitability for growing in the rice fallow areas. The potential of sunflower hybrids depends upon their performance in terms of growth, days to mature, seed yield and oil content as influenced by different locations. It was found that average yield of sunflower in Tadong location was highest (1814 kg/ha) but had low average oil content (28.6%) and it took on an average 135 days to mature. While Lembucherra centre recorded seed yield of 1532 kg/ha with average oil content of 37.1 per cent and completed maturity on an average in 113 days. Hence, in the present study, Lembucherra could be best suitable for tapping the potential of sunflower in rice fallow areas.

Meteorological data in standard meteorological week (SMW) and month wise of the trial centres at NEH Region

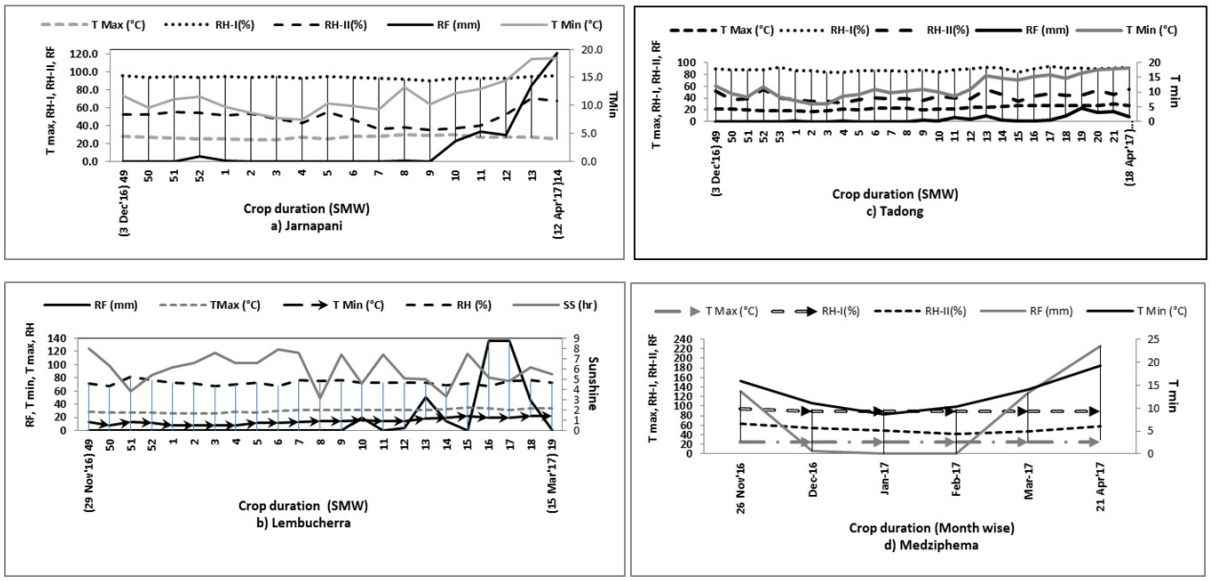

Fig. 1(a-d). Indicating the meteorological data at 4 locations in NEH regions during growth period of sunflower during 2016-17

Table 2 Plant height, head diameter and days to maturity of sunflower hybrids in different NEH Regions (locations)

Hybrid	Jarnapani			Lembucherra			Tadong			Medziphema		
	PH (cm)	HD (cm)	DM (days)	PH (cm)	HD (cm)	DM (days)	PH (cm)	HD (cm)	DM (days)	PH (cm)	HD (cm)	DM (days)
DRSH-1	53	11	127	193	15	111	135	15	134	92	18	151
KBSH-41	52	9	134	179	17	117	175	18.6	138	99	17	147
KBSH-44	55	10	130	167	15	117	165	19	137	90	17	144
KBSH-53	55	10	140	187	14	111	132	12	137	101	17	144
LSFH-141	53	6	130	154	14	111	146	19	135	86	16	148
Mean	53.6	9.2	132.2	176	15.0	113.4	150.6	12.9	136.2	93.6	17.0	146.8
CD (0.05)	NS	0.67	1.7	17.7	2.1	4.3	8.5	2.0	3.7	NS	NS	NS
CV (%)	6.35	4.1	0.72	9.4	8.8	3.2	2.7	6.1	2.1	10.5	16.4	11.4

PH = plant height; HD = head diameter; DM = No. days to maturity

Table 3 Effect of location on the seed yield of sunflower hybrids in NEH region

Sunflower (Hybrid/ Variety)	Medziphema (Nagaland)	Lembucherra (Tripura)	Tadong (Sikkim)	Jarnapani (Nagaland)	Pooled analysis for yield (across locations)
DRSH-1	1001.3 (39.6)*	1854.0 (41.0)	1970.0 (36.0)	848.0 (41.8)	1418.3
KBSH41	1142.6 (37.6)	1932.0 (39.0)	2250.0 (34.8)	1026.0 (40.0)	1587.6
KBSH44	1083.3 (31.1)	1633.0 (33.0)	1490.0 (28.4)	1426.0 (30.4)	1416.6
KBSH53	1219.6 (34.6)	1017.3 (38.9)	1520.0 (23.2)	1026.0 (39.6)	1195.7
DRSF113	972.3 (38.1)	921.0 (36.9)	1780.0 35.5)	833.0 (37.6)	1126.5
LSFH171	1019.3 (32.0)	1228.0 (33.4)	1840.0 (30.8)	709.0 (31.4)	1199.0
Mean	1073.0	1430.8	1808.3	983.7	--
SE m±	51.3	115.3	34.9	4.1	1.95
CD(P=0.05)	154	346	100	11.5	5.58
CV (%)	7.9	30.4	30	0.64	0.51

*Values in parentheses indicate percentage of oil content of pooled replication without statistical analysis

ACKNOWLEDGEMENTS

Authors acknowledge the Indian Council of Agricultural Research, New Delhi for funding under NEH Scheme to take up evaluation trial of oilseeds for identify the suitability of ICAR-IIOR mandate crops at NEHR locations. The cooperation of Join Directors and Station heads of the NEH locations for facilitating the conduct of trials is acknowledged. Also, the help rendered by Biochemistry laboratory for oil estimation is also appreciated.

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