Pak. J. Bot., 37(4): 859-864, 2005.

GROWTH AND DEVELOPMENT OF SUNFLOWER IN RESPONSE TO SEASONAL VARIATIONS

FAYYAZ-UL-HASSAN, GHULAM QADIR *MUMTAZ AKHTAR CHEEMA

Department of Agronomy, University of Arid Agric. Rawalpindi,
**Department of Agronomy, University of Agric. Faisalabad*
Corresponding Author: E-mail. drsahi@hotmail.com

Abstract

Field experiments were conducted to quantify the growth and development of sunflower in response to seasonal variation over two seasons i.e. spring and autumn. Sunflower hybrids were sown in a randomized complete block design. Growth and development parameters i.e. stem girth, plant height and dry matter accumulation m^{-2} were recorded at the time of maturity. Stem girth of spring crop was observed to be larger than that of autumn crop. The hybrid Suncorss-42 showed the maximum stem girth in spring which was significantly different from that of XF-263 showing the lowest stem girth in both the seasons. Plant height also followed the similar pattern like stem girth. The hybrid Suncross-42 produced the tallest plants with maximum dry matter and achene yield in both the seasons. Overall superiority of spring crop in terms of stem girth, plant height, dry matter accumulation and achene production over autumn crop may be attributed to the environmental factors prevailing during the crop life cycle and duration of crop in the field.

Introduction

Growth and development of a plant are a combination of many events at many different levels, from biophysical and biochemical to tissue and organ levels. Growth can be measured as increase in length, width, volume, fresh or dry weight of a plant (Bidwell, 1979.) Various environmental variables affect the plant growth and development differently and it had been concluded that temperature regulates the plant growth and development (Ritchie & Ne Smith, 1991).

Sunflower is a temperate zone crop but it can perform well under varying climatic and soil conditions. It can withstand early frost in autumn that usually kills maize and soybean. Amir & Khalifa (1991) reported that sunflower seeds can germinate and grow successfully across a wide range of climatic environments including hot tropical climates. Similarly, Khalifa *et al*., (2000) concluded that this wide geographic, morphological and habitat wise diversity of sunflower extending from very hot areas in the south west of US to very cold areas in eastern Canada, might have developed the unique characteristics of sunflower tolerance to both low and high temperatures and accounted for wide adaptation of the crop.

Experimental and farm research trials have indicated that sunflower can be successfully grown in two seasons (spring and autumn) in Pakistan due to its wide range of adaptability (Rana *et al*., 1991). In spring season, sunflower is sown under low temperature of January and February and grows vegetatively under a range of low to medium temperature of February and March, before entering into reproductive stage. The reproductive stage develops under high temperature of May while it matures and is harvested under high temperature of June/July. Contrary to spring, autumn crop is sown at high temperature and high humidity of July - August. Its germination and early vegetative growth undergoes high to medium temperature of August and September before entering into reproductive stage. The reproductive phase of autumn crop takes off at medium temperature of October. It matures and is harvested under low temperatures of

November. So, the two opposite sets of environmental conditions prevail from germination to maturity of sunflower when grown during spring and autumn. Being grown in contrasting environmental conditions all phases are affected accordingly. Germination and vegetative stage of spring crops takes relatively longer time due to lower temperature as compared to autumn crop where germination and vegetative growth takes place under high temperature taking less time and completes this cycle very shortly (Khalifa *et al.*, 2000). Keeping in view the opposite set of environmental conditions where sunflower is grown, present study was carried out to evaluate the seasonal variation effects on growth and development of sunflower hybrids.

Materials and Methods

Field experiments were conducted at the University of Arid Agriculture, Rawalpindi, during spring and autumn 2002 to evaluate the effects of seasonal variations on growth and development of sunflower. Five sunflower hybrids viz., Parsun 1, Suncross-42, XF, 263, SMH-9706 and SMH-9707 were sown in Randomized Complete Block Design with three replications. Planting was done by dibbler placing 3-4 achenes per hill at a depth of 3-5 cm in the soil. The spring and autumn crop was sown on 23rd February and 18th August, 2002, respectively. After germination, one seedling per hill was maintained after manual thinning. A uniform dose of fertilizer @ 120 kg N and 60 kg P_2O_5 per hectare was applied in the form of Urea and DAP and mixed with soil during land preparation.

From central two rows, 10 plants were randomly selected for the measurement of stem girth and plant height just before harvesting on 16th June and 11th November, 2002 of spring and autumn crops, respectively. Stem girth was measured with the help of thread and meter rod at three places of each plant i.e., bottom, middle and top of sample plants and averages were worked out. Plant height was measured in centimeters from ground level to the receptacles of the head. Harvested plants were sun dried for few days. Plants were oven dried for 48 hours for dry matter determination as described by Jenkins & Leitch (1986). Heads were threshed manually and yield was recorded on per plot basis and then converted on hectare basis. Recorded data were analysed using Microcomputer MSTAT, separately for both the seasons (Freed & Eisensmith, 1986). Duncan' s New Multiple Range Test was used for separation of treatment means (Duncan, 1955).

Results and Discussion

Wide variations in stem girth were observed in the spring crop. The hybrid Suncross-42 produced the maximum (9.96 cm) stem girth which was two fold higher than the lowest (4.50 cm) produced by XF-263 (Table 1). However, the differences among the rest of the hybrids were neither wide nor significant. In autumn differences were narrow. The maximum (6.36 cm) stem girth was produced by Parsun-1 in contrast to the spring crop while the smallest (4.26 cm) was again produced by XF-263. The possible reasons of having thick stem girth from spring crop than the autumn could be the presence of crop for longer period of time in the field. The spring crop remained in the field for more than 112 days compared to autumn crop which remained in the field for 85 days. The higher temperature of autumn might have encouraged the induction of reproductive stage leaving less time for thickness of the stem. Doddamani *et al.*, (1997) found significant correlation of stem girth with environmental factors. In this study, smooth and gradual increase of temperature during crop life cycle of spring crop might have favoured good stem development which ultimately produced thick stem. However, in addition to environmental factors thickness of stem in sunflower is influenced by plant height (Fig.1).

Table. 1. Effect of seasonal variations on growth and development of sunflower.

nts	Stem girth(cm)		Plant height(cm)		Dry matter(g m^{-2})		Yield (kg/ha)	
	Seasons							
	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn
‑1	7.13 a*	6.36 a*	136.61 b*	110.53 b*	2953.20 a*	1491.93 a*	1757 b	1628 b
06	7.40 a	6.23 a	148.21 ab	123.91 a	3183.62 a	1435.70 a	2122 a	1631 b
07	7.10 a	6.06 a	137.63 b	108.84 b	3223.03 a	1467.38 a	1738 b	1353 c
SS-42	9.96 a	5.86 a	156.73 a	126.83 a	3355.86 a	1600.63 a	2175 a	1827 a
	4.50 b	4.26 b	86.41 c	72.98 c	1182.01 b	787.50 b	940 c	768 d

means sharing a common letter are non significant at 5% level of probability.

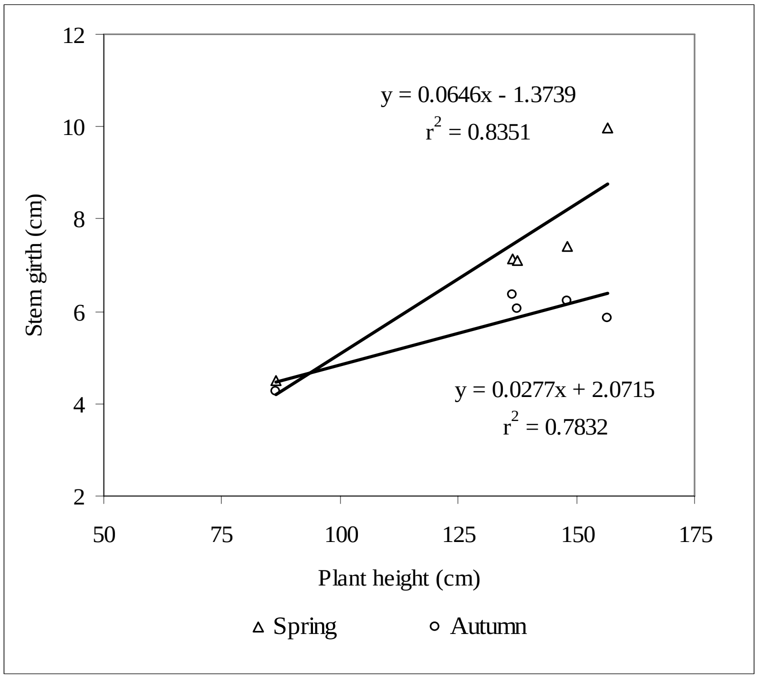

Fig. 1. Relationship between plant height (cm) and stem girth (cm).

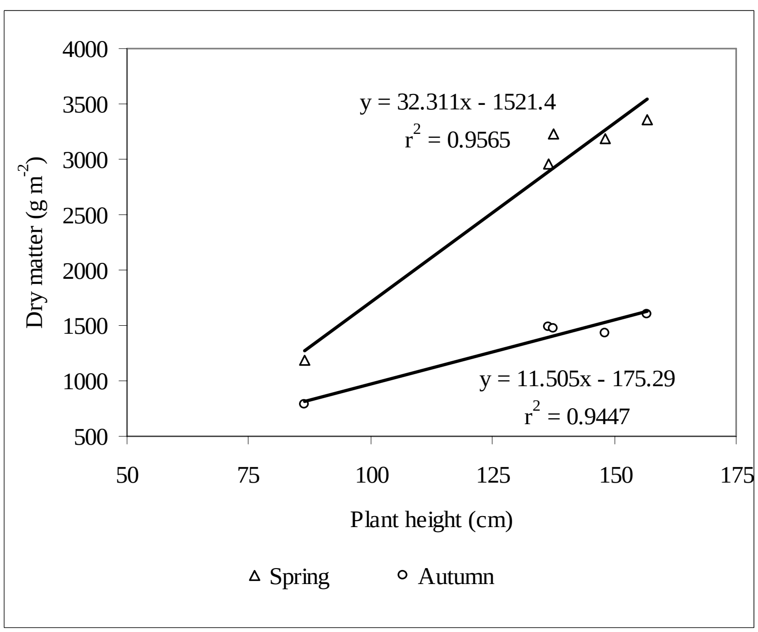

Fig. 2. Relationship between plant height (cm) and dry matter (g m^{-2}).

In spring, plant height exhibited by different hybrids varied widely (Table 1). The hybrid Suncross-42 produced the tallest (156.73 cm) plants which were significantly different from rest of the hybrids except that of SMH-9706. Hybrid XF-263 produced the smallest plants (86.41 cm). Plant height of all the hybrids decreased during autumn. The tallest (126.83 cm) plants were again produced by Suncross-42 which was again significantly different from rest of the hybrids except from that of SMH-9706. Plant height is considered as genetically controlled character. However, environmental conditions may have modified this genetic potential, which is clear from the Table 1. Pillai *et al*., (1995) concluded that plant height is dependent upon the environmental factors. The taller plants produced in spring could be attributed to the total duration of the crop in the field and favorable environmental conditions during vegetative growth period. Smaller plants produced by all the hybrids during autumn might have been the effect of early induction of reproductive phase. The significant linear relationship between plant height and stem girth (Fig. 1) for both the seasons provide good evidence that taller plants would require thicker stems to withhold those in the field safely.

Hybrids evaluated in this experiment produced different amount of dry matter. Suncross-42 produced the maximum (3.36 kg/m^2) dry matter in spring which was significantly different from XF-263 but statistically at par with rest of the hybrids (Table 1). Hybrid XF-263 produced the minimum (1.18 kg/m^2) quantity of dry matter. During autumn, dry matter produced by all the hybrids decreased as compared to that of spring. However, the pattern of dry matter production was similar to that of spring. Again, Suncross-42 gave the maximum (1.49 kg/m^2) value which was significantly different from XF-263 but was at par with rest of the hybrids. Hybrid XF-263 produced the minimum (0.79 kg/m^2) dry matter during autumn. Significant linear relationship (Fig. 2) between plant height and dry matter per unit area favors the view point of Tekelwold *et al*., (2000) who reported that tall plants supporting many leaves could increase total biomass through increased carbon fixation that can ultimately be partitioned. Higher dry matter production by spring crop could also be related to the life cycle of the crop and total heat units accumulated by the crop. In linseed dry matter production has been reported to be directly dependent upon the duration of crop in the field (Hassan & Leitch, 2001). However, Villalobos *et al*., (1996) reported that sunflower biomass production is positively correlated with temperature and photoperiod.

Maximum achene yield was produced by Suncross-42 like all other parameters in both the seasons. The higher yield obtained from spring crop confirms the earlier results of Habibullah *et al*., (1983), who reported that spring crop have the overall advantage of better plant structure, better environmental condition during crop growth period and maturity over the autumn crop. Better environmental conditions of spring crop are considered to be the slow and gradual rise of cumulative growing degree days.

References

Amir, H.A. and F.M. Khalifa. 1991. Performance and yield of sunflower cultivars under rainfed and irrigated conditions in Sudan. *Jour. Agric. Sci. Cambridge*, 116: 245-261.

Bidwell, R.G.S. 1979. *Plant Physiology*. Macmillan Pub. Co. Inc. New York. pp. 379-387.

Doddamani, I.K., S.A. Patil and R.L. Ravikumar. 1997. Self-compatibility and seed set in selected genotypes of sunflower. *Crop Improvement*, 24: 207-212.

Duncan, D.B. 1955. Multiple range and multiple F test. *Biometrics*, 11: 1-42.

Freed, R.D. and S.P. Eisensmith. 1986. MSTAT microcomputer Statistical Program. Michigan State University of Agri. Michigan, Lansing, USA.

Habibullah, B.T., S. Mamickam, P. Multruuel and R. Chamy. 1983. Effects of planting date on production of sunflower. *Madras Agric. J*., 70(6): 382-384.

Hassan, F.U. and M.H. Leitch. 2001. Dry matter accumulation in Linseed. *J. Agron & Crop Sci*., 187: 83-87.

Jenkins, P.D. and M.H. Leitch. 1986. Effects of sowing date on the growth and yield of oilseed rape (*Brassica napus*). *J. Agric. Sci. Camb*., 105: 405-420.

Khalifa, F.M., A.A. Schnetter and E.I. El-tayeb. 2000. Temperature-Germination response of sunflower (*Helianthus annuus* L.) genotypes. *HELIA*, 23(33): 97-104.

Pillai, M.A., P. Ramalingam, C.S. Sridharan, S. Murugan and C. Vanniarajan. 1995. Stability analysis for seed yield and its components in Sunflower hybrids. *Annuals of Agric Res*., 16: 409-412

Rana, M.A., M.A. Khan, M. Yousaf and M.S. Mirza. 1991. Evaluation of 26 Sunflower hybrids at Islamabad. *HELIA*, 14: 19-28.

Ritchie, J.T. and D.S. Ne Smith. 1991. Temperature and crop development. *Am. Soc. Agron*., 31: 5-29.

Tekelwold, A., H. Jayarmaiah and B.N. Jagadesh. 2000. Correlation and path analysis of physio-morphological characters of sunflower (*Helianthus annuus* L.) as related to breeding method. *HELIA*, 23(32): 105-114.

Villalobos, A.J. Hall, J.T. Ritchie and F. Orgos. 1996. Seasonal impact on growth, development and yield model of sunflower crop. *Agron. J*., 88: 403-415.

(Received for publication 23 June 2005)