Pertanika J. Trop. Agric. Sci. 26(2): 109 - 113 (2003) ISSN: 1511-3701

The Influence of Seasonal Variations on Yield Components of Sunflower

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Keywords: *Helianthus annus*, head diameter, yield components, seasonal variation, non-conventional

ABSTRAK

Kelebihan upaya penyesuaian tumbuhan dan kepelbagaian cuaca di Pakistan akan memungkinkan pertumbuhan dua jenis bunga matahari dalam setahun. Kajian lapangan pada musim bunga dan musim luruh dijalankan di University of Arid Agriculture, Rawalpindi, Pakistan untuk menilai pengaruh variasi bermusim ke atas hasil bunga matahari dan komponennya. Empat kacukan pokok bunga matahari ditanam dalam blok rawak dengan tiga sampel. Dua barisan tengah sampel tersebut dipetik untuk mengukur hasil serta komponennya. Ia menunjukkan saiz pucuk pada musim bunga lebih lebar daripada tanaman pada musim luruh dan dianggap sebagai keputusan keseluruhan bagi struktur tumbuhan, kepanjangan kitaran hayat tumbuhan, pertumbuhan perlahan dalam darjah hari-hari terkumpul yang lebih baik. Tidak seperti pucuk tersebut, ribuan benih tanaman yang ditanam pada musim luruh lebih banyak ditemui berbanding tanaman pada musim bunga. Kekurangan benih tanaman pada musim bunga mungkin disebabkan oleh persaingan dalam penyerapan yang mengakibatkan banyak benih tidak mendapat cukup khasiat yang disebabkan oleh pengenapan awal. Walau bagaimanapun, hasil tanaman pada musim bunga melebihi dari hasil tanaman musim luruh. Ini menyebabkan penanaman pada musim bunga adalah lebih baik. Walau bagaimanapun, penanaman pada musim luruh boleh memberi penambahan dalam pengeluaran minyak bijirin.

ABSTRACT

The wider adaptability of the crop and wide range of climatic conditions of Pakistan make it possible to have two crops of sunflower in a year. Field experiments, one in spring and one in autumn were conducted at the University of Arid Agriculture, Rawalpindi, Pakistan to evaluate the influence of seasonal variation on yield and yield components of sunflower. Four sunflower hybrids were planted in randomized complete block design with three replications. Two central rows were harvested for the measurement of yield and yield components. It was observed that head size of spring crop was larger than autumn crop which was considered to be the result of overall better plant structure, length of crop life cycle, slow and gradual rise in cumulative degree days. Contrary to head size, thousand seed weight of autumn crop was found to be more than that of spring crop. Lesser seed weight of spring crop may be the result of competition for assimilates which left many seeds malnourished as larger head might have encouraged the initial setting of seeds. However, final yield of spring crop was greater than that of autumn crop. It led to the conclusion that having spring crop is the best option, however, autumn crop could be supplementary one to increase the production of oilseeds.

INTRODUCTION

The major sources of edible oil production in Pakistan are the conventional oilseed crops (cottonseed, rapeseed, mustard and sesame) and non-conventional oilseed crops (sunflower and soybean). Except for cotton, the rest of the traditional oilseeds are grown on marginal lands which is why the gap between consumption and local production is widening every year. Among the non-conventional oilseed crops, sunflower has the potential to narrow the existing gap between production and consumption of edible oil. Sunflower grown in the country has the potential to yield up to 3,000 kg ha^{-1}, however, average yield in Pakistan is 1400 kg ha^{-1} (Govt. of Pakistan 2001).

Though sunflower is a temperate zone crop, it can perform well under various climatic and soil conditions. The wider adaptability of the crop and wide range of climatic conditions of

Pakistan make it possible to have two crops of sunflower in a year. Amir and Khalifa (1991) concluded that sunflower can germinate and grow successfully across the wide range of climatic environments including hot tropical climates. Similarly, Khalifa *et al.* (2000) concluded that wide geographic, morphological and habitat wise diversity of sunflower extending from very hot to very cold areas might have developed the unique characteristics of sunflower tolerance to both low and high temperature and accounted for wide adaptation of the crop.

Experimental and farm research trials have indicated that sunflower can successfully be grown in two seasons (spring and autumn) in Pakistan due to its wide range of adaptability (Rana *et al.* 1991). In spring, sunflower is sown under the low temperatures of January and February. It grows vegetatively under the range of low to medium temperatures of February and March, before entering into the reproductive stage. The reproductive stage develops under the high temperature of May while it matures and is harvested under the high temperature of June/July. Contrary to spring, the autumn crop is sown at high temperatures and high humidity conditions of July-August. It germinates and grows vegetatively during the high to medium temperatures of August and September before entering into the reproductive stage. The reproductive phase of the autumn crop takes off at the medium temperature of October. It matures and is harvested under the low temperatures of November. So the two opposite sets of environmental conditions prevail from germination to maturity of the sunflower when it is grown in two seasons i.e. spring and autumn. The overall length of crop life cycle is affected accordingly. The germination and vegetative stage of spring crops takes a relatively longer time due to lower temperature as compared to autumn crops where germination and vegetative growth take place under high temperatures taking less time and completing their cycle very shortly.

Being grown in opposite environmental conditions, all phases are affected accordingly. The present study was contemplated to evaluate the seasonal variation effects on yield and yield components of sunflower hybrids.

MATERIALS AND METHODS

Field experiments were conducted at the University of Arid Agriculture, Rawalpindi during spring and autumn 2000 to quantify the effects of seasonal variations on yield and yield components of sunflower. The spring crop was sown on 23rd February while the autumn crop was sown on 18th August. Five sunflower hybrids viz. Parsun-1, Suncross-42, SMH-9706, SMH-9707 and XF-263, were sown in randomized complete block design with three replications. There were 4 rows of 5 m-length, 75 cm apart in each plot making a plot size of 5 m x 3 m. Plant to plant distance was maintained at 25 cm. 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. Planting was done by dibbler placing 3-4 achenes per hill was maintained by manual thinning. Weeding and earthing up was done manually when needed.

Cumulative growing degree days was calculated by the equation of Dwyer and Stewart (1986).

$$\text{CGDD} = \sum_{t_1}^{t_2} [(T_{Max} + T_{Min})/2 - 10]$$

where $[(T_{Max} + T_{Min})/2 - 10] \geq 0$

$T_{Max} + T_{Min}$ are daily maximum and minimum air temperatures in degrees centigrade and t_1 and t_2 are the time intervals. The base temperature for sunflower was 8°C (Sadras and Hali 1988).

Two central rows from each crop were harvested on 16th June and 11th November, 2000 of spring and autumn, respectively. Ten heads were randomly selected for the measurement of head diameter. Head diameter was measured with measuring tape (Sublime Sports Ltd. Sialkot, Pakistan) and the average was calculated. All the heads were thrashed manually. Three lots of 1000 seeds were weighed with an analytical balance (Technio Instrument Ltd. UK) separately and yield was calculated on hectare basis. The data collected were subjected to statistical analysis appropriate to randomized complete block design by using microcomputer MSTAT separately for both the seasons (Freed and Eisensmith 1986). Duncan's Multiple Range Test (Duncan 1995) was used for separation of treatment means.

RESULTS AND DISCUSSION

All the hybrids produced the heads of different sizes in spring. Hybrid SMH-9707 produced the largest (17.63 cm) head while XF-263 produced the smallest (13.43cm) head (Table 1). Hybrid SMH-9707 was significantly different (p=0.5) from Parsun-1 and XF-263 while it was at par with the rest of the hybrids i.e. SMH-9706 and Suncross-42.

Head diameter of all the hybrids decreased in autumn as compared to the spring. However, variations in head diameter of the autumn crop were narrow. The largest head (15.58 cm) was produced by Suncross-42 while XF-263 again produced the smallest (10.37 cm) one. All the hybrids were significantly different from XF-263 while those were at par with each other.

Reduction in head size of the autumn crop varied from 3 to 22%. The minimum (3%) reduction was observed in suncross-42 while the maximum (22%) in XF-263. The next to minimum (9%) was recorded in SMH-9607, while it was 13% and 15% in SMH-9606 and Parsun-1, rrespectively.

The reduction of head diameter in all the hybrids may be the combined function of LAI, plant structure (plant height & dry matter), and environmental factors. The better plant structure (leaf area index, plant height & dry matter), of the spring crop might have encouraged the development of large sized heads. Ujjinaiah *et al.* (1987) found smaller heads from that of the autumn crop than that of the spring crop, while Ahmad (2001) reported the significant relationship of plant height and head diameter in spring (r2=0.62) and autumn (r2=0.90) respectively. Longer crop life cycle of the spring crop with more cumulative degree days might also have contributed into the development of larger heads. However, the autumn crop got a short period of time in the field and accumulated less number of degree days, so it developed the smaller heads.

Thousand seed weight (TSW) of all the hybrids varied in the spring crop. Hybrid Suncross-42 produced the maximum (36.43 g) TSW, which was significantly (p=0.05) different from XF-263 while it was at par with rest of the hybrids. Hybrid XF-263 produced the minimum (21.27 g) TSW (Table 1).

Thousand seed weight of the autumn crop increased as compared to that of the spring crop in all the hybrids. Contrary to other parameters, those showed a decline. Hybrid Suncross-42 produced the maximum (45.08 g) 1000-seed weight, which was significantly different from XF-263 while, it was at par with others. Hybrid XF-263 produced the minimum (27.81 g) TSW.

Increase in TSW of the autumn crop ranged from 8 to 31 percent. The minimum (8%) increase was recorded in Parsun-1 while maximum (31%) in XF-263. The increase of TSW in the rest of the hybrids was 17.9, 18.19 and 23.16% in SMH-9606, SMH-9607 and Suncross-42 respectively.

Relatively large heads of the spring crop encouraged the setting of more numbers of seeds per head and those required greater amount of assimilates which was not possible for the plant to supply, creating a competition for assimilates. The competition for assimilates and rapid rise in cumulative degree days (*Fig. 4*) at the time of seed development and maturation might have left many seeds malnourished resulting in lesser thousand seeds weight from that of the spring crop. Small heads of the

TABLE 1
Influence of seasonal variation on yield and yield components of sunflower

Hybrids	Parameters					
	Head diameter (cm)		TSW (g)		Seed yield (kg ha-1)	
	Seasons		Seasons		Seasons	
	Spring	Autumn	Spring	Autumn	Spring	Autumn
PARSUN-1	15.83 b	13.42 a	35.58 a	38.53 a	1757 b	1628 b
SMH-9706	16.10 ab	14.64 a	35.73 a	42.33 a	2122 a	1631 b
SMH-9707	17.63 a	15.26 a	34.63 a	40.85 a	1738 b	1353 c
SUNCROSS-42	16.13 ab	15.58 a	36.43 a	45.08 a	2175 a	1827 a
XF-263	13.43 c	10.37 b	21.27 b	27.81 b	940 c	768 d

Treatment means followed by the same letter are not significantly different at P=0.05 (Duncan's Multiple Range Test).

autumn crop would have allowed less number of seeds to be produced in the limited space. Less number of seeds would have the adequate amount of assimilates for proper development and maturity. Teklewold *et al.* (2000) concluded that increase in head size simultaneously increases the husk percentage and incidence of empty seed increases, reducing the TSW. The significant linear relationship between head diameter and thousand seed weight (*Fig. 1*) support the view that thousand seed weight is directly dependent upon the head size.

The seed yield of sunflower sown in spring showed variation in all the hybrids. Hybrid Suncross-42 produced the highest (2175 kg/ha) seed yield, which was significantly (p=0.5) different from all other hybrids except SMH-9706. Hybrid XF-263 produced the lowest (940.30 kg/ha) yield (Table 1).

The seed yield of all the hybrids decreased in autumn as compared to spring. Hybrid Suncross-42 produced the maximum (1827 kg/ha) yield, while XF-263 gave the minimum (740 kg/ha) yield. The hybrid Suncross-42 was found to be significantly different from all the hybrids in contrast to the spring but it was at par with SMH-9706.

The overall reduction in yield ranged between 7 to 23%. Minimum (7%) reduction was recorded in Parsun-1 while maximum (23%) in SMH-9607. In other hybrids it was 22, 16 and 18% in SMH-9606, Suncross-42 and XF-263, respectively.

Seed yield is the combined function of different components. The comparison of both the parameters i.e. head size and thousand seed weight revealed that final yield dependence is more inclined towards thousands seed weight as compared to that of head size. Chaudhary and Anand (1993) observed the high positive direct influence of head diameter on seed yield. However, Patil *et al.* (1996) reported low positive direct effect for head diameter on seed yield. The significant linear relationship between thousand seed weight and final yield (*Fig. 2*) contradicts the earlier hypothesis. The non-significant relationship between head diameter and final seed yield (*Fig. 3*) support the earlier findings of Patil *et al.* (1996). The higher yield obtained from the spring crop confirms the earlier results of Habibullah *et al.* (1983), those reported that spring crop have the overall advantage of better plant structure, better environment conditions during crop growth

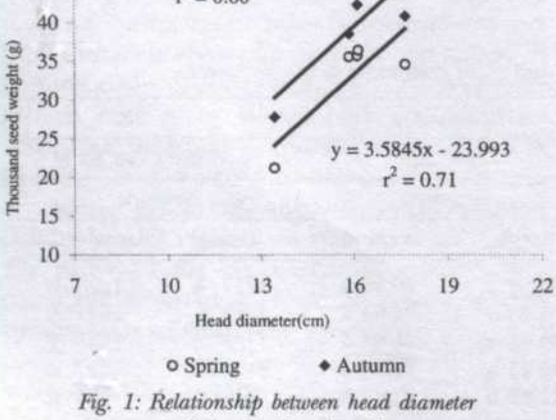

Fig. 1: Relationship between head diameter and thousand seed weight

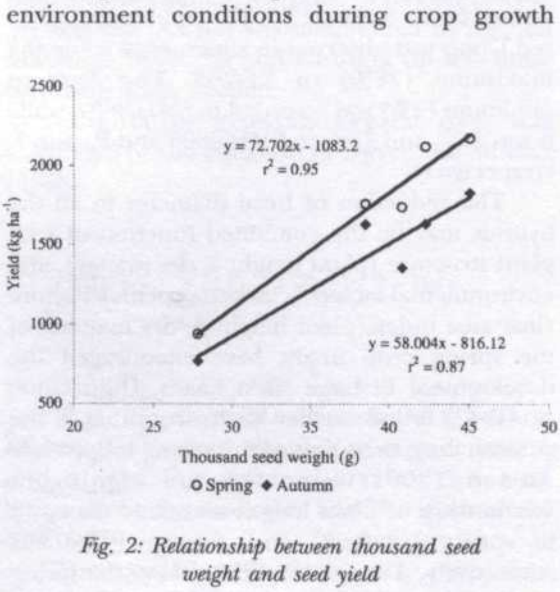

Fig. 2: Relationship between thousand seed weight and seed yield

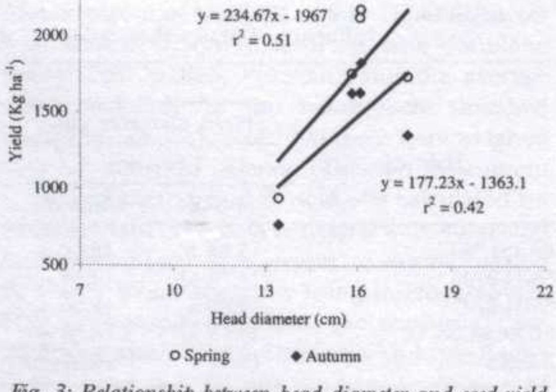

Fig. 3: Relationship between head diameter and seed yield

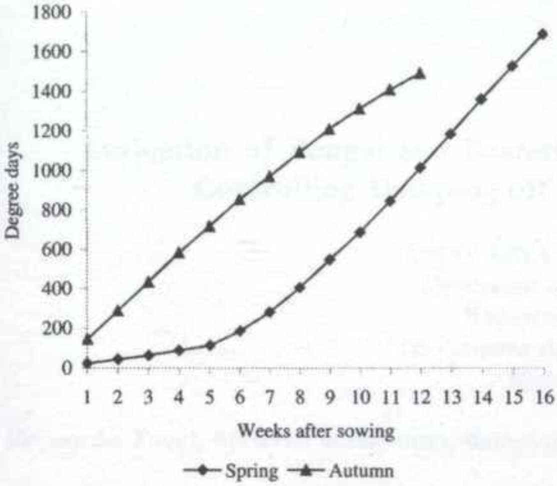

Fig. 4: Degree days accumulated during crop life cycle

period and maturity over the autumn crop. Better environmental conditions of the spring crop are the slow and gradual rise in cumulative growing degree days. Degree days accumulated during crop life cycle are presented in *Fig. 4*.

It can be concluded from the above findings that spring crops have the superiority over autumn in terms of yield. However, autumn crops could be fitted well in the present cropping system of Pakistan to oversoe the deficiency of edible oils.

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(Received: 4 January 2002)
(Accepted: 1 November 2003)