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EFFECTS OF SEASONAL VARIATIONS ON OIL AND FATTY ACID PROFILE OF SUNFLOWER

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SUMMARY

To investigate seasonal variation effects on oil contents and fatty acid profile of some commonly grown sunflower hybrids, field experiments were conducted at the University of Arid Agriculture, Rawalpindi, Pakistan, during spring and autumn 2000. Five sunflower hybrids were sown in a randomized complete block design replicated thrice. Spring crop was planted in February and harvested in June, while autumn crop was planted in August and harvested in November. Results showed reduction of oil contents and oleic acid in autumn crop as compared with those of spring crop. However, palmatic and linoleic acid percentages increased more in autumn than in spring crop. It is concluded from this study that spring crop accumulated higher oil contents than of autumn crop with higher percentage of oleic acid. However, autumn crop produced seeds having higher percentage of linoleic acid.

Key words: seasonal variations, oil contents, oleic acid, linoleic acid, relationship

INTRODUCTION

Sunflower can be grown over two seasons i.e., in spring and autumn because of its photo- and thermo-intensitive nature and adaptability to all types of soil. It is a short duration crop maturing in less than 100 and 120 days. Sunflower is a temperate zone crop but it can perform well under various climatic and soil conditions. Khalifa *et al*. (2000) concluded that wide geographic, morphological and habitat wise diversity of sunflower extending from very hot areas in the southwest of US to very cold areas in eastern Canada, might have developed the unique characteristics of sunflower tolerance to both low and high temperature and accounted for wide adaptation of the crop. Because of this it fits many cropping sequences like groundnut-sunflower and cotton-sunflower and rice-sunflower cropping systems (Praveena *et al*., 2000).

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The studies conducted at research stations and at farmer's field have indicated that sunflower can successfully be grown in two seasons (spring and autumn) in Pakistan (Rana *et al*., 1991). In spring seasons, sunflower is sown at low temperatures of January and February. It grown vegetatively under the range of low to medium temperatures of February and March, before entering into reproductive stage. The reproductive stage develops under high temperatures of May while it matures and is harvested under high temperatures of June / July. Contrary to spring, autumn crop is sown at high temperature and high humidity conditions of July-August. Its germination and vegetative grown proceed during high to medium temperatures of August and September before entering into productive stage. The reproductive phase of autumn crop takes off at medium temperatures 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 it is grown in two seasons. Temperature variations particularly at the time of maturity affect the total oil accumulation and fatty acid profile. Ahmad and Hassan (2000) found higher oil contents in sunflower hybrids that matured and were harvested at higher temperatures of June as compared with those that matured and were harvested in April. Similarly, Demurin *et al*. (2000) concluded that oleic acid content is essentially influenced by temperature during seed development. Each 1°C increase of temperature leads to about 2% increase of oleic acid. They also reported a strong negative correlation between oleic and linoleic acid percentage. A low oleic acid phenotype would essentially be high linoleic.

Keeping in view the different sets of environment in which sunflower can be grown, the present study was contemplated to quantify the seasonal variation effects on oil content and fatty acid composition in some hybrids commercially grown in Pakistan.

MATERIAL AND METHODS

Field experiments were conducted at the University of Arid Agriculture, Rawalpindi, Pakistan, during spring and autumn 2000, to evaluate the effects of seasonal variations on oil content and fatty acid profile of sunflower. The spring crop was sown on 23rd February while autumn was sown on 18th August. Five sunflower hybrids *viz*. Parsan 1, Suncross-42, XF-263, SMH-9706 and SMH-9707 were sown in randomized complete block design with three replications. 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 at a depth of 3-5 cm in the soil. After germination, one seedling per hill was maintained by manual thinning. Weeding and hilling were done manually when needed.

Heads from two central rows were harvested on 16th June and 11th November, 2000 of spring and autumn crops, respectively. Heads were sun dried for ten days

prior to threshing. The percentage of oil was estimated using a NMR spectrometer (Joanne Warnsely, 1988), while the fatty acid in oil was analyzed by a gas chromatograph (AIML-NUCON) after intersterilification with methanolic KOH (Paquot, 1988). The data collected were analyzed using Microcomputer MSTAT, separately for the seasons (Freed and Eisensmith, 1986). Duncan's new multiple range test (Duncan, 1955) was used for separation of treatment means.

RESULTS AND DISCUSSION

During spring, seeds of hybrid Suncross-42 accumulated the highest oil contents, while XF-263 accumulated the lowest. All the hybrids remained significantly (P=0.05) different from XF-263 while those were at par with each other (Table 1).

Table 1: Effects of seasonal variation on oil and fatty acid in sunflower

Hybrid	Season							
	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn
	Oil (%)		Palmitic acid		Oleic acid		Linoleic acid	
Parsan-1	36.86 a	32.98 a	6.46 NS	7.61 NS	47.4 b	17.35 NS	32.73 NS	71.25 NS
SMH-9707	37.12 a	34.83 a	5.66	6.72	54.77 a	14.71	35.53	74.22
SMH-9706	37.69 a	35.02 a	5.80	7.56	54.79 a	18.93	34.62	70.79
Suncross-42	38.19 a	34.88 a	6.57	7.16	56.92 a	19.06	34.46	71.53
XF-263	29.73 b	27.20 b	5.64	7.06	50.91 ab	19.94	39.14	68.38

Any two means not sharing common letter in a column differ significantly at 5% level of probability
NS: non-significant

In autumn, seeds of hybrid SMH-9706 produced the highest oil contents, while XF-263 retained its position of accumulating the lowest oil contents, which was significantly less than the rest of hybrids.

Oil contents of spring crop were higher than those of autumn crop. Reduction of oil contents of all hybrids in autumn could be related to the temperature prevailing at the time of heading to maturity. Significant positive relationships between average temperature from flower initiation to harvesting and oil contents in spring and significant negative relationship in autumn (Figure 1a and 1b) support the earlier finding of Ahmad and Hassan (2000) who reported higher oil accumulation at high temperature and reduction at low temperature.

The oil of hybrid Suncross-42 gave the highest (6.57) percentage of palmitic acid, which was significantly (P=0.05) different from the rest of hybrids, except Parsan-1 (Table 1). The lowest (5.64) percentage of palmitic acid was recorded in XF-263, which was at par with hybrid SMH-9707.

Palmitic acid percentages of all the hybrids were non-significant in autumn. The highest (7.61) palmitic acid percentage was observed in Parsan-1 and the lowest (6.72) in SMH-9707.

The palmitic acid percentage increased in autumn crop compared with spring crop. This increase might be due to environmental factors, especially temperature during the period of seed development and maturation. Spring crop matured at an average temperature of 31.89ºC while autumn crop matured at an average temperature of 22.28ºC. This variation in temperature might have caused increase of palmitic acid in autumn. Similar finding have been reported by Gupta and Wagle (1986).

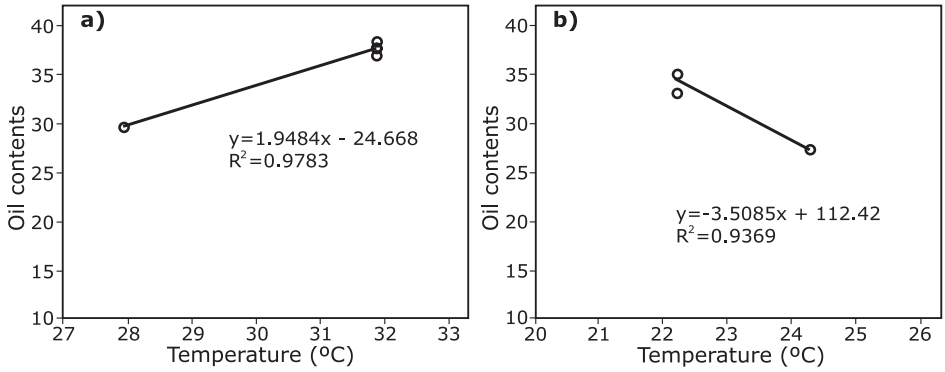

Figure 1: Relationship of average temperature and oil content during (a) spring and (b) autumn

Wide variations were observed among all the hybrids for oleic acid in spring. The oleic of hybrid Suncross-42 accumulated maximum (56.92) oleic acid, which was significantly (P=0.05) different from XF-263 and Parsan-1 while non-significant with rest of the hybrids. The hybrid Parsan-1 produced oil with the lowest oleic acid (47.48) (Table 1). Though variation was observed in autumn crop too, the hybrids remained non-significant in respect to each other. The highest oleic acid was recorded in XF-263, which was harvested earlier than the rest of the hybrids. The lowest (14.71) oleic acid was observed in SMH-9707.

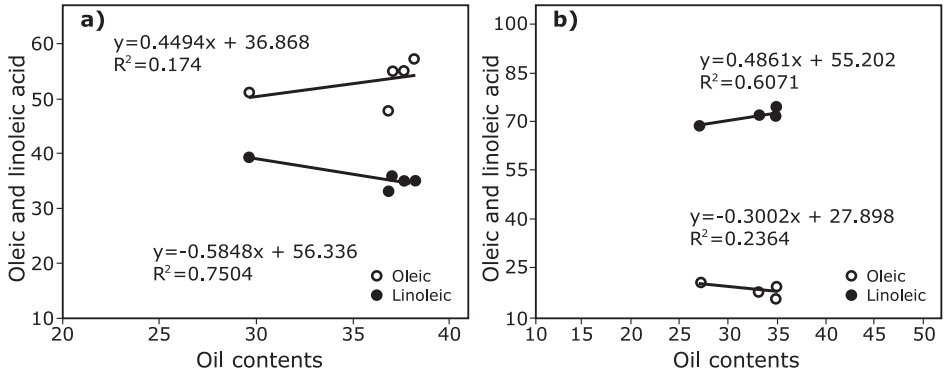

Figure 2: Relationship between oil content, oleic and linoleic acids during (a) spring and (b) autumn

The oleic acid percentage in autumn crop oil showed almost 39% decrease compared with spring crop. This decrease is considered to be due to temperature prevailing during maturity. These observations support the earlier findings of Demurin *et al*. (2000) who concluded that oleic acid content is essentially influenced by temperature during seed development. Each 1°C increase of temperature leads to about 2% increase of oleic acid. The non-significant relationship (Figures 2a, 2b) of oil content and oleic acid provides the clue that oleic acid is not dependent on oil content.

In spring, hybrids showed different percentage of linoleic acid. Though variation was there, it remained statistically (P=0.05) non-significantly. Hybrid XF-263 accumulated the highest (45.14) percentage of linoleic acid, while Parsan-1 the lowest (32.73) (Table 1).

Variation of linoleic acid was also recorded in autumn crop but its pattern was different. Hybrid XF-263 that accumulated the highest percentage of linoleic acid in spring accumulated the lowest percentage of linoleic acid in autumn. Differences among the hybrids remained statistically non-significant. The non-significant differences among the hybrids show that this parameter is more controlled by environment than by the genotype. Overall percentage of linoleic acid accumulated in spring crop exceeded folds that in autumn crop.

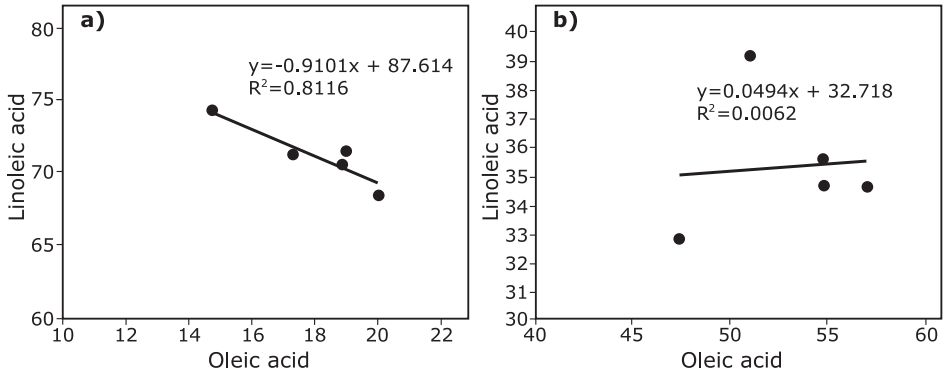

Figure 3: Relationship between oleic and linoleic acid during (a) autumn and (b) spring

Increase of linoleic acid in autumn and decrease of oleic acid look inversely proportional to each other. Significant negative relationships between oleic acid and linoleic acid during autumn (Figure 3a) supports the earlier finding of Demurin *et al*. (2000) who reported a strong negative correlation between oleic and linoleic acid percentage. A low oleic phenotype would essentially be high linoleic one. However, non-significant relationship (Figure 3b) in spring may be due to narrow difference between the two fatty acids. Significant relationship (Figures 2a and 2b) between oil content and linoleic acid support the observations that linoleic acid is a sensitive fatty acid. Contrary to oleic acid, linoleic acid was observed to be dependent on other variables like oil content and oleic acid.

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INFLUENCIA DE LAS VARIACIONES DE TEMPORADA EN EL PERFIL OLEAGINOSO Y DE ÁCIDOS GRASOS DE GIRASOL

RESUMEN

Durante la primavera y el otoño del año 2000, en la Universidad de Agricultura Árida de Rawalpindi (Pakistán), fue realizado el ensayo de campo, con el fin de determinar la influencia de las variaciones de temporada en el contenido de aceite y en el perfil de ácidos grasos de varios híbridos de girasol frecuentemente cultivados. Cinco híbridos de girasol fueron sembrados por el sistema bloque de azar con tres repeticiones. La plantación de primavera fue plantada en febrero, y cosechada en junio, mientras que la de otoño, fue plantado en agosto, y cosechada en noviembre. Los resultados han demostrado que se ha produjo la disminución de contenido de aceite y del porcentaje del ácido oleico en la plantación de otoño, en comparación con la de primavera. El porcentaje del ácido palmítico y del ácido linólico, por otro lado, era mayor en la plantación de otoño. Se ha concluido que la plantación de primavera acumula mayor contenido de aceite y mayor porcentaje del ácido oleico, que el de otoño. Pero, la semilla de la plantación de otoño, tiene mayor porcentaje del ácido linólico.

EFFET DES VARIATIONS SAISONNIÈRES SUR LE PROFIL OLÉAGINEUX ET LE PROFIL EN ACIDES GRAS DU TOURNESOL

RÉSUMÉ

Au cours du printemps et de l'automne de l'année 2000, une expérience a été faite à l'Université d'Agronomie pour les régions arides de Rawalpindija (Pakistan) pour déterminer l'effet des variations saisonnières sur le contenu

d'huile et le profil en acides gras de quelques hybrides de tournesol souvent cultivés. Cinq hybrides de tournesol ont été semés selon le système de bloc aléatoire; ce processus a été répété trois fois. Les semailles de printemps ont été faites en février et la récolte en juin alors que les semailles d'automne ont été faites en août et la récolte en novembre. Les résultats ont montré qu'il y avait eu diminution du contenu d'huile et du pourcentage d'acide oléique dans la production obtenue en automne par rapport à celle du printemps. Cependant, le pourcentage d'acide palmitique et d'acide linoléique était supérieur dans la production d'automne. Il a été conclu que les semailles faites au printemps permettaient l'accumulation d'un plus grand contenu d'huile et d'un plus grand pourcentage d'acide oléique que les semailles d'automne. Les semences obtenues en automne, par contre, produisaient un plus grand pourcentage d'acide linoléique.