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PRODUCTIVITY OF SUNFLOWER CULTIVARS IN RELATION TO PLANT DENSITY AND GROWING SEASON IN NORTHERN TAMAULIPAS, MEXICO

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SUMMARY

A study was conducted to evaluate the response of sunflower cultivars and plant densities grown in two diferent growing seasons of northern Tamaulipas. Two sunflower hybrids (De kalb G-100 and G-101) and two varieties (Rib-77 and Victoria) were evaluated under 3 plant densities: 27,500, 41,250 and 62,500 plants/ha. In 1994, the planting was in the "late" annual season (P-V) and in 1995 was in the "early" annual season (O-I). The highest yield was obtained during the "early" growing season, 2,170 kg/ha, while the lowest yield was 1,678 kg/ha during "late" season. In both seasons, the hybrids and variety Rib-77 had significantly higher yields than the variety Victoria. At low densities, increases in seed weight per head, stem and head diameter, and 100-seed weight were observed.

Key words: Sunflower, cultivars, plant density, growing season, north Tamaulipas.

INTRODUCTION

The agroclimatic conditions of northern Tamaulipas México allow for two planting seasons per year. The first main season is called "early" when corn, sorghum, and cotton are planted in February and March. In the "late" season, crops such as corn and dry bean are planted in August.

Previous studies with sunflower from the Río Bravo Experimental Station, INIFAP, showed that this crop can be produced during both "early" and "late" seasons. Optimum production was obtained in the "early" season partially due to favorable temperature conditions (Ortegón and Escobedo, 1987). Other study (Ortegón et al., 1990) indicated that sunflower hybrids had better yields during the "early" season, whereas varieties and hybrids showed similar yields in the "late" season.

In the center of Tamaulipas, the best sunflower yields were obtained when planting from April to May, compared with August planting (Elizondo, 1987). Unger

(1980) reported non-significant differences between planting dates from March to early June in Texas; The lowest yields, were registred from late June to July. Johnson and Jellum (1972) in a three year study concluded that the best planting date for sunflower in the Southeast USA is between March and April.

The relation between plant density and yield is a complex interaction that involves different factors such as genetic diversity, weather, soil, and cultural practices (Vranceanu 1982). The sunflower has the capacity to compensate for low planting density by producing larger heads and seeds (Mohamed et al., 1986; Vannozzi. et al., 1990; Ujjanaiah et al., 1993).

Jančić and Vrebalov (1978) reported differences in yield among open pollinated cultivars at high planting densities. Ortegón and Escobedo (1994) reported higher yields with Rib-77 variety at high plant densities, 62,500 and 75,000 plants/ha, which were statistically similar.

Considering the relatively low cost of open pollinated seed, even at high plant densities, it is important to investigate the factors asociated improved yield (Robinson et al., 1978). The purpose of this study was to compare the yield and other agronomic characteristics of sunflower cultivars under three different plant densities in two planting seasons of Northern Tamaulipas.

MATERIALS AND METHODS

Experiments were conducted in 1994 and 1995 at the Rio Bravo Experimental Station, INIFAP, Rio Bravo, Tamaulipas. Sunflower hybrids Dekalb G-100 and Dekalb G-l0l, and open pollinated varieties Rib-77 and Victoria (from INIFAP) were evaluated at plant densities of 31,250, 41,660 and 62,500 plants/ha, in two different growing seasons. In 1994, the planting was in the "late" season (Aug.10) and in 1995 was in the "early" season (Apr.15). In 1994, maximum/minimum means temperature in August and September (late plantings) were 36/23ratures during October and November were 31/20esponding to the late stages (development and filling of the grain). In 1995, temperature in April and May (early planting) were 31/20 early stages, and 35/23gs were fertilized with 80N-40P fertilizers. Preplant irrigations were applied in 1994 with one aditional irrigation while in 1995 two supplemental irrigations were applied; besides the precipitation ocurried during the vegetative cycles in both seasons were 280mm and 139mm respectively.

The experimental design was split-plot with 4 replications; factor A was cultivars, and factor B was plant densities. Plots were four rows 5 m long x 0.80m wide. The distance between plants was 40, 30 and 20 cm, respectively. Both plantings were fertilized with 80N-40P fertilizers. Preplant irrigations were applied in 1994 with one aditional irrigation while in 1995 two supplemental irrigations were applied.

Yield was estimated from the two center rows. Other plant characteristics observed were: days to plant maturity, plant height, head diameter, stem diameter

(20 cm from soil level), seed weight per head, and 100-seeds weight. Data were analyzed by a combined analysis of variance, and means compared by the Tukey test (P (≤0.05).

RESULTS AND DISCUSSION

Seed yield (SY). Seed yield showed significant difference between planting seasons, cultivars and plant densities. The interaction season x cultivar was also significant. No other interactions were significant (Table l).

The 1995 yield average was 29.3% higher during the "early" season then the "late" season. This is mainly attributed to favorable temperatures during the period from emergence to flowering.

There were significant differences in yield between cultivars. The average yield of hybrids was higher than that of varieties in both planting seasons. An exception was the variety Rib-77 wich had statitically similar yield to the hybrids.

Feoli et al. (1993) reported a significant interaction between sunflower cultivars x environment, and indicated that the differences were due to the moisture availability during the critical period 20 days before /20 days after flowering. In our study, the significant interaction between season and cultivars was mainly attributed to temperature because water was supplied by irrigation; other factors were not considered. An economic analysis is needed to determine hybrid-variety benefits in both seasons.

Seed yield became progressively higher as the plant densities increased. Similar results were obtained in studies with plant densities from 25,000 to 80,000 plants/ ha (Robinson et al., 1976; Jancic and Vrebalov, 1978; Janagoudar et al., 1986; Ortegón and Escobedo 1994). The non-interaction of season and plant density indicated that the plant density effect was similar in both seasons. The was also true for the cultivar x plant density interaction.

Oil (O). Seed oil content was highly significant for the seasons, cultivars, and plant densities, with no interactions observed (Table 1). The average oil content was higher during the "early" season compared with the "late" season (Table 2). Hybrids had the highest oil content which increased with increased plant density in both seasons. Oil content was not severely influenced by high temperature when optimun soil humidity conditions were maintained. Similar results were observed by Vranceanu et al. (1982) for plant densities. Unger (1980) reported an increase in oil content when sunflower was planted early exposing it to high temperatures during the seed formation stage. The opposite was observed with low temperatures and late planting. The oil content is influenced by a complex group of environmental factors including temperature (Anderson et al., 1978).

Physiological maturity (PM). Highly significant differences were detected between seasons, cultivars, and plant densities and the season x cultivar interaction

(Table1). The number of days from planting to physiological maturity was significantly shorter (87days) during the "late" season compared with the "early" season (93 days). Hybrid G-100 had the longest maturity, 96.5 days, while the variety Victoria variety had the shortest period of 80.3 days. Plant densities did not have an influence on maturity (Table 2).

Plant height (PH). No differences in plant height were obseved among yhe "early" and "late" seasons. Highly significant differences for PH were detected between cultivars (Table 1). The tallest and shortest plants were G-100 (177 cm) and Victoria (131 cm), There were no statistical differences between plant densities, although higher plants were observed at high planting densities (Table 2). Acording to Vranceanu et al. (1982), high densities cause an increase in plant height and reduction of stem diameter probably because of the competition; these modifications in plant architecture may induce susceptibility to diseases and lodging.

Head diameter (HD).The diameter of the heads was similar between season and cultivars, although a significant interaction between season x cultivar was observed. Higly significant differences in head diameter was detected between plant densities, and a significant interaction between season x plant density was observed (Table 1). The largest head diameter (16.6 cm) was produced under low plant density, whereas the smallest (14.9 cm) was observed at the highest plant density (Table 2). Similar results have been reported in others studies (Mathers and Stewart, 1982; Mohammad Yousaf et al., 1986; Vannozzi et al., 1990; Ujjanaiah et al., 1993). These results suggest that the sunflower plant can compensate for the yield by producing larger heads and seeds at lower densities..

Table 1: Analysis of variance of agronomic characteristics of hybrids and cultivars from two seasons grown at Northern Tamaulipas, México

	Variation source						
Variable	Season (S)	Cultivar (Cv)	Plant density Pd	S x Cv	S x Pd	Cv x Pd	CvxSxPd
PM	**	**	*	**	NS	NS	NS
PH	NS	**	NS	NS	NS	NS	NS
HD	NS	NS	**	**	*	NS	NS
SD	NS	*	*	NS	**	NS	NS
SW	**	**	**	NS	NS	*	NS
100SW	NS	*	NS	**	NS	NS	NS
SY	**	**	**	*	NS	NS	NS
O	**	**	**	NS	NS	NS	NS

NS, *, **. nonsignificant and significant at $P \leq 0.05$ and 0.01 level of probability, respectively

Stem diameter (SD). Significant differences were detected among cultivars and plant densities but not seasons. The season x plant density interaction was higly significant (Table 1). Hybrids and open pollinated Rib 77 had the greatest stem diameter. The lowest plant density (31,250 plants/ha) showed the greatest stem diameter (Table 2).

Table 2: Average of agronomic characteristics of four sunflower cultivars grown under three plant densities and two growing seasons at Northern Tamaulipas , México

FACTOR	PM	PH	HD	SD	SW	100SW	OIL	SY
Season	days		cm			g	%	kg/ha
"Late"	87.0 b	154	16.0	1.95	34.1 b	4.6	40.2 b	1678 b
"Early"	93.0 a	164	16.5	2.06	48.9 a	4.3	42.2a	2170a
Cultivar								
G-100	96.5 a	177 a	15.8	2.08 a	46.1 a	3.9 b	43.3a	2076a
G-101	89.9 b	160 b	16.2	2.07 ab	45.7 ab	4.5 ab	42.9a	2093a
Rib-77	87.3 c	168 ab	15.5	2.00 ab	36.9 ab	4.6 ab	40.0 b	1944a
Victoria	80.3 d	131 c	15.5	1.88 b	35.8 b	4.9 a	38.6 b	1584 b
Density								
31 250	88.9 a	156	16.6 a	2.09 a	46.4 a	4.7	40.3 b	1658 c
41 660	88.0 b	160	15.9 a	1.98 ab	42.5 a	4.5	41.3ab	1936 b
62 500	88.6 ab	161	14.9 b	1.95 b	35.6 b	4.3	42.1a	2179a

Means followed by the same letter are not significantly different (Tukey $P \leq 0.05$)

Seed weight/ head (SW). Statistical differences were observed between seasons, cultivars, and plant densities. The cultivars x plant density interaction was also significant (Table 1). Seed weight per head was higher during 'early' season (48.9 g) compared with the ´late´ season (34.1 g). Hybrids had higher seed weight compared with varieties (Table 2). The low competition between plants at low plant densities compared with high densities allowed for a better use of soil nutrients. Plants growing under low plant density were more vigorous and had higher seed weights. However, yield per hectare is compensated for by a higher number of heads under high plant density. Vannozzi et al. (1990) obtained similar results of seed weight per head with four planting seasons, two densities and two years. Vranceanu et al. (1982) found a correlation between stem diameter, head diameter, and seed weight per head in three plant densities during two years. Ortegón and Escobedo (1994) observed similar correlations. These results indicated that a higher yield is obtained at a higher plant density.

One hundred seeds weight (100 SW). Statistical significance was observed between cultivars and season x cultivar interaction (Table 1). The lowest seed weight (3.9 g) was observed in G-100, and Victoria had the highest weight (4.9 g). Sunflower hybrids produced smaller seeds, higher seed number per head and fewer unflilled seeds compared with varieties. A progressive increase in 100 SW was observed as plant density decreased (Table 2). In other studies, Robinson et al. (1978) increased plant density from 17,000 to 62,000 plants/ha, causing a decrease in seed number/head (1223 to 826), and seed weight/head. In a similar study, Mohammad et al. (1986) concluded that when plant density is increased, the weight of 1000 seeds is decreased.

CONCLUSIONS

Several characteristics, such as seed yield, oil content, seed weight per head and physiological maturity were significantly different in both the "early" and "late" growing season. The cultivars were statistically different except for head diameter of plant density; only plant height and 100-seed weight were statistically similar. There was no difference in yield between the open pollinated Rib-77 and the hybrids in both growing seasons. It was confirmed that a decrease in plant density caused an increase in seed weight per head, stem and head diameter, and 100-seed weight.

REFERENCES

Anderson, W.K., Smith, R.C. and McWilliam, J.R., 1978. Effect of temperature and radiation on growth and yield. Field Crops. Research 1: 153-163.

Elizondo, J. 1987. Resultados y avances cultivos oleaginosos. Informe de labores Campo Experimental Las adjuntas. Abasolo, Tam.

Feoli, C.E., Schneiter, A.A. and Johnson, B.L., 1993. Agronomic performance of dwarf and conventional height sunflower hybrids grown at five plant population under rainfall conditions. Helia, 16: 19-30.

Janagoudar, B.S., Patil, C.V. and Muniraj Appa, R., 1986. Productivity of sunflower hybrids in relation to plant density and irrigation. Helia 9: 57-60.

Jančić, V. and Vrebalov, T., 1978. Effect of planting density and mode on biological and biochemical characters of sunflower. In: 8th Int. Sunflower Conf. Minneaplolis, Minn. USA. P-364-371.

Johnson, B.J. and Jellum, M.D., 1972. Effect of planting date on sunflower yield, oil and plant characteristics. Agr. Jour. 64:747-748.

Mathers, A.C. and Stewart, B.A., 1982. Sunflower nutrient uptake, growth, and yield as affected by nitrogen or manure, and plant population. Agr. Jour. 74: 911- 915.

Mohammad, Y., Akhtar Beg and Shakoor, A., 1986. Effect of spacing and nitrogen on the yield and yield components of sunflower under rainfed conditions. Helia 9: 53-56.

Ortegón, M.A. S. y Escobedo, A., 1987. Desarrollo de tecnología para el cultivo de girasol. Informe de resultados y avances 1978-1985. p. 6-23.

Escobedo, A. y Sevilla, E., 1990. Rendimiento de grano, contenido y calidad del aceite de girasol *Helianthus annuus* L. en el norte de Tamaulipas, según la fecha de siembra. Agricultura Técnica en México. 16 p. 81-95.

________, 1993. El girasol en relación con su ambiente y técnicas de producción. En 'El Girasol' ed. Trillas México. p. 21-44.

Robinson, R.G., Rabas, O.L., Smith, L.J., Warnes, D.D., Ford J. H. and Lueschen W. E., 1976. Sunflower population, row width and row direction. Minnesota Agric. Exp. St. Misc. Rep. 141: 1-24.

Robinson, R.G., Ford, J.H., Lueschen, W.E., Rabas, D.L., Smith, L.J., Warnes, D.D. and Wiersma, J.V., 1978. Response of sunflower to plant population. Agr. Jour. 72 p. 869-871.

Unger, P. W. 1980. Planting date effects on growth yield and oil irrigated sunflower. Agr. Jour. 72. p. 914-916.

Vranceanu, A. V. 1977. El Girasol. Siembra y mantenimiento del cultivo. Trad. A. Guerrero. Ed. Mundi-Prensa. Madrid, Espana. p. 266-274.

Vranceanu, A.V., Stoenescu, F.M. and Terbea, M., 1982. Tolerance of sunflower hybrids to competition among plants. Helia, 5 : 23-26.

Vannozzi, G.P., Salera, E. and Baldini, M., 1990. Sunflower yield characteristics as affected by weed control, plant density, nitrogen level and sowing time. Helia, 13: 73-86.

Ujjanaiah, V.S., Thimmegowda, S., Sridhara, S. and Prasad, T.G., 1993. Effect of moisture, plant population and fertilizer regimen on yield of sunflower, Helia, 18: 77-82.

PRODUCTIVIDAD DE CULTIVARES DE GIRASOL EN RELACION A LA DENSIDAD DE PLANTAS Y CICLO DE CRECIMIENTO EN EL NORTE DE TAMAULIPAS, MEXICO

RESUMEN

El objetivo de este trabajo fue el de observar diferencias entre cultivares de girasol bajo tres densidades de poblacion en dos ciclos de siembra sujetos a las condiciones climáticas del norte del estado de Tamaulipas, México. Se evaluaron dos híbridos de girasol (Dekalb G-100 y G 101) y dos variedades de polinización libre (Rib-77 y Victoria), en tres densidades de población (31,250, 41,660 y 82,500 plantas/ha). En 1994 la siembra se estableció en el mes de agosto considerado como de ciclo tardío y en 1995 se estableció la siembra en el mes de abril como siembra de ciclo temprano. En ambos ciclos se utilizó un arreglo de parcelas divididas en un diseño de bloques al azar con 4 repeticiones; la parcela mayor correspondió a los cultivares y la parcela menor a las densidades de población. Resultados obtenidos en el ciclo de tardío mostraron un rendimiento promedio de grano de 1,678 kg/ha, mientras que en el ciclo de temprano fue de 2,170 kg/ha. Los híbridos y la variedad Rib-77 estadisticamente fueron iguales en ambos ciclos. Entre densidades se mantuvo la relación de a menor densidad de población mayor peso de grano por capítulo, mayor diámetro de tallo y de capítulo y de peso de 100 semillas.

PRODUCTIVITÉ DE CULTIVARS DE TOURNESOL EN RELATION AVEC LE PEUPLEMENT ET LA SAISON DE CULTURE DANS LE NORD TAMAULIPAS, MEXIQUE

RÉSUMÉ

Une étude a été conduite pour évaluer la réponse de cultivars de tournesol au peuplement durant deux saisons de culture dans le Nord de la Province de Tamaulipas. Deux hybrides de tournesol (Dekalb G-100 et G-101) et deux variétés (Rib-77 et Victoria) ont été évalués à trois densités de peuplement: 27500, 41250 et 62500 plantes /ha. En 1994, le semis a été effectué en saison "tardive" (P-V) et en 1995 celui ci a été réalisé en saison "précoce" (O-I). Le rendement le plus élevé a été obtenu durant la saison de culture "précoce", tandis que le rendement le plus bas était de 1678 kg/ha en saison de culture "tardive". Dans les deux saisons, les hybrides et la variété Rib-77 ont présenté des rendements significativement supérieurs à la variété Victoria. Aux faibles peuplements, on a observé une augmentation du poids de semences par capitule, du diamètre de la tige et du capitule et du poids de 100 grains.