DRY MATTER AND OIL PARTITIONING IN SUNFLOWER ACHENES AS A FUNCTION OF CULTIVARS AND PLANT DENSITY

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ABSTRACT

In order to evaluate dry matter and oil distribution in sunflower achenes as a function of plant density and cultivar, two experiments were carried out in the state of Rio Grande do Sul, Brazil. In the first experiment, the treatments were two cultivars (Contisol 711 and GR-10) and four plant densities (30, 50, 70 and 90 thousand plants/ha). In the second one, eighteen cultivars were evaluated at the density of 50 thousand plants/ha. In both cultivars, achene dry weight decreased, in a type of quadratic response, with the increase in plant density. However, only in Contisol 711 cultivar ocurred reduction in husk percentage and in the husk:kernel ratio, and an increase in achene kernel percentage when the plant density increased. In the same way, only in this cultivar total oil content in the achene increased as plant density increased and showed negative correlations with achene weight ($r = -0.70$) and husk:kernel ratio ($r = -0.77$). In the second experiment, it was also observed negative correlations between oil content in the achene and husk:kernel ratio ($r = -0.87$) and between total oil content and achene weight ($r = -0.58$). The data indicate that breeding methods with the objective of improving total oil content in sunflower achenes can be based on reduction of the husk:kernel ratio. Depending on the cultivar, plant density is a practice that can be used to alterate the husk:kernel ratio.

INTRODUCTION

Oil content in sunflower achenes presents a great variability with the genotype and the environment on which it is exposed. The factors which are responsible for the change in the oil content are humidity and air temperature, phytosanitary, nitrogen fertilization and plant density (Harris et al, 1978).

Plant density is known as a factor that does not affect so much oil content in the achenes. This fact moved VRANCEANU (1977) to affirm that, with the plant density increase, independent of the cultivar, is possible to obtain a little increase in the oil content, because of the development of achenes with less size and with less husk percentage in relation to kernel. Although, Almeida & Silva (1989) have obtained increase of 18% in oil content when they varied plant density from 30 to 70 thousand plants/ha, confirming the results obtained from Robinson et al (1980) and Silva & Nepomuceno (1991).

Occurrence of genetic variability in oil content in the achenes is characterized by continues selection processes with the objective of increasing oil content (Dedio, 1982; Fernández - Martinez & Dominguez - Gimenez, 1985). However, Fick & Zimmerman (1973) say that in modern cultivars the genetic component is responsible for little differences in oil content, attributing the variations to the environmental conditions effective during the plant growing and development.

This reasearch was conducted to evaluate dry matter and oil distribution in sunflower achenes as a function of plant density and cultivars.

MATERIAL AND METHODS

Two experiments were carried out, with irrigation, at the Experimental Station of Federal University of Rio Grande do Sul, during the 1989/90 and 1990/91 growing seasons. In the first experiment (1989/1990) the treatments were two sunflower cultivars: Contisol 711 and GR-10 and four plant densities (30, 50, 70 and 90 thousand plants/ha), arranged in randomized complete blocks, in split-splot design, with three replications. In the second one (1990/91) the treatments were eighteen cultivars, arranged in randomized complete blocks, with three replications.

To separate the achene into two parts (husk and kernel) was used all the sample of 50 grams. This was made by hand with the help of a stiletto. After, the husk, was puted to dry (60°C) and then, weighed. With the dry weight of the husk and kernel was possible to calculate the weight percentage of each part to the total weight of the achene. The ratio husk: kernel was obtained by the division of the husk dry weight towards the kernel weight.

To determine the oil content were used the husk and kernel previously separated. For the determination of total oil content of the achenes,

supplemental samples were used. The determination of oil content was made with Twillsemann equipment, on which oil extraction occurs by draging with sulfuric ether.

RESULTS AND DISCUSSION

In both cultivars, the achene dry weight decreased in a quadratic type of response as plant density increased (Figure 1). However, only in Contisol 711 cultivar it was observed correlation between achene weight and husk percentage ($r = +0.92$) and between achene weight and kernel percentage ($r = -0.92$).

Response of the husk:kernel ratio to plant density depended on the cultivar (Figure 2). While in Contisol 711 the husk:kernel ratio decreased in a quadratic form with the increase in plant density, in GR-10 there was no variation in this parameter, keeping steady around 0.33.

Plant density effect on total oil content of the achenes also depended on the cultivar tested (Figure 3). While this parameter increased in Contisol 711 cultivar with the plant density increase, in GR-10 there was no response.

Oil content in kernel did not vary with plant density in both cultivars, with average values of 53.3% and 58.9%, respectively, for cultivars Contisol 711 and GR-10. Considering that the components of the total oil percentage in achenes are the husk and oil content in the kernel (Dedio, 1982), it is possible to say that the utilization of plant density as a practice with the objective of increasing oil content is more associated with the modification in husk and kernel percentages than with modifications in kernel oil content, once it is not affected by plant density. The data of the second experiment also showed less variation in kernel oil content between cultivars, in relation to the variation verified in the percentages of husk and kernel in the achene and in the husk:kernel ratio (Table 1).

In the analysis of linear correlation coefficients for the cultivar Contisol 711, the oil content showed a negative correlation with the achene weight ($r = -0.70$), husk percentage ($r = -0.79$) and husk:kernel ratio ($r = -0.77$). Although, in cultivar GR-10 the correlation coefficients for oil content were low and not significant. The correlation data of the experiment carried out in 1990/91 indicates that total oil content in the achenes is more associated to the husk:kernel ratio ($r = -0.87$), than with the grain weight ($r = -0.58$).

The relation between oil content in the achenes and husk:kernel ratio is better characterized by the analysis of the Figure 4, were is observable that, for the 18 cultivars tested, when the husk:kernel ratio increases, the oil content in the achenes decreases in a linear way.

The data indicate that the breeding methods used to increase the total oil content in the sunflower achenes can be based on the reduction of the

TABLE 1. Characteristics of achenes of 18 sunflower cultivars, Eldorado do Sul, RS, Brazil, 1990/91.

Cultivar	Color's husk	Oil content of achene - % -	Oil content of kernel - % -	Dry weight of achene - g -	Husk percentage - % -	Kernel percentage - % -	Husk:kernel ratio
AGC 90145	Black	57.0 A*	63.4 A*	48.9 BCDE*	17.3 F*	82.0 A*	0.21 I*
AGC 90008	Black	54.3 AB	64.8 A	48.2 BCDE	18.0 F	81.7 A	0.22 HI
AGC 90148	Black	52.4 BC	61.7 AB	48.0 BCDE	25.3 CD	74.7 CD	0.34 EF
Cargill 4	Black	51.7 BC	60.2 AB	44.9 CDE	25.0 D	75.0 CD	0.33 EF
PM 8001	Black	51.4 BC	60.6 AB	52.7 ABCD	23.0 DE	76.3 BCD	0.30 EFG
M 702	Black	51.3 BC	63.6 A	45.5 CDE	22.3 DE	77.7 BC	0.29 EFG
AGC 90007	Black	50.2 BC	60.1 AB	42.7 DE	24.3 D	75.7 CD	0.32 EF
GR - 18	Black	50.1 C	58.8 AB	46.6 CDE	23.7 DE	76.0 CD	0.31 EFG
AGC 90147	Black	50.1 C	61.8 AB	49.7 BCDE	22.3 DE	77.3 BCD	0.29 FGH
Viki	Black	50.0 C	60.7 AB	43.0 DE	24.0 D	76.0 CD	0.32 EF
Cargill 3	Black	49.7 C	56.4 AB	41.1 E	20.0 EF	80.0 AB	0.25 GHI
Citosol 4	Black	49.2 C	61.3 AB	40.6 E	23.7 DE	76.3 BCD	0.31 EFG
Citosol 3	Black	48.6 CD	58.9 AB	43.5 DE	29.0 BC	70.7 EF	0.41 CD
AGC 90146	Black	48.4 CDE	60.8 AB	48.2 BCDE	26.0 CD	73.7 DE	0.35 DE
ICI Ex 9001	Stripe	44.6 DEF	62.4 A	58.9 AB	32.7 AB	67.3 FG	0.49 AB
Contisol 711	Black	44.3 EF	52.4 B	55.2 ABC	30.0 B	69.0 F	0.44 BC
M 734	Stripe	44.1 FG	56.3 AB	63.1 A	30.0 B	70.0 EF	0.42 C
Dekalb 180	Stripe	40.0 G	60.7 AB	61.8 A	35.0 A	65.0 G	0.54 A
Mean		49.3	60.3	49.0	25.1	74.7	0.34
CV (%)		2.76	5.10	7.58	5.02	1.66	6.33

*Significant at 5% of probability.

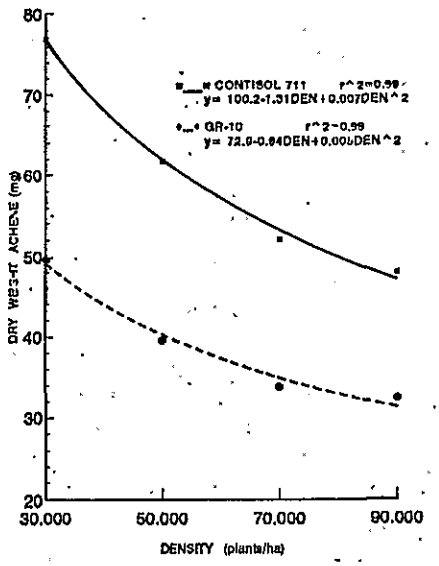

FIGURE 1 - Effect of plant densities on dry weight achene in two sunflower cultivars.

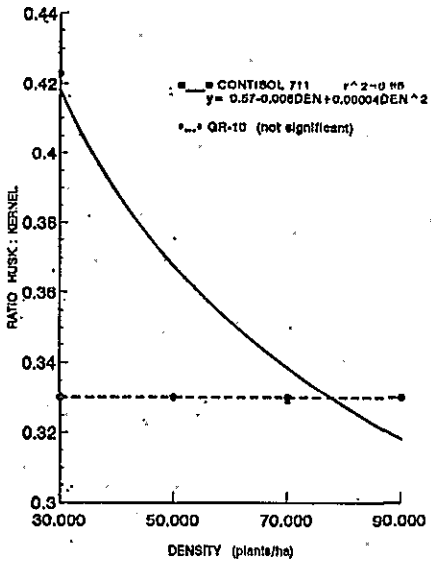

FIGURE 2 - Effect of plant densities on ratio husk:kernel in the achene in two sunflower cultivars.

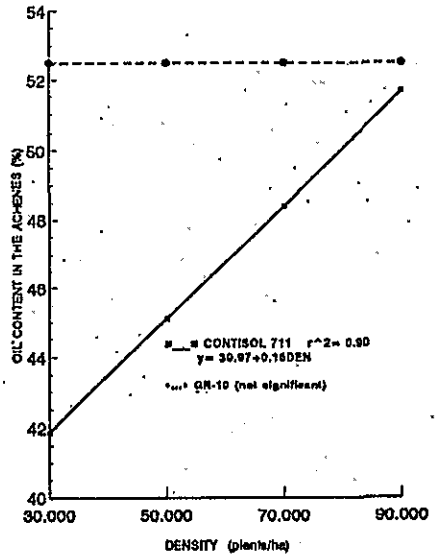

FIGURE 3 - Effect of plant densities on oil content in the achenes in two sunflower cultivars.

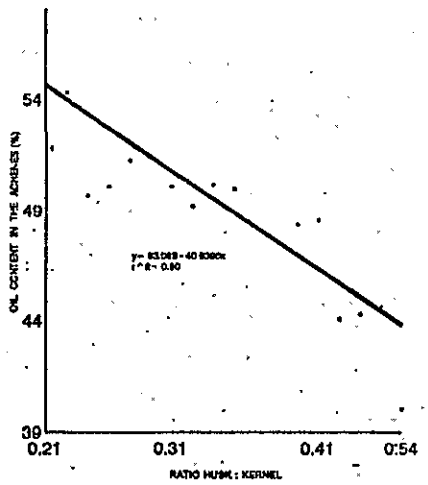

FIGURE 4 - Relation between ratio husk: kernel in the achenes and oil content in 18 cultivars sunflower.90/91.

husk:kernel ratio. Depending on the cultivar, plant density is a practice that can be used to alterate total oil content in the achenes.

CONCLUSIONS

1. When the husk:kernel ratio in the achenes decreases, oil content increases in a linear way.

2. Depending on the cultivar, plant density is a practice that can be used to modify the husk:kernel ratio and total oil content in the achenes.

REFERENCES

ALMEIDA, M.L. de; SILVA, P.R.F. da. Interaction among plant density, planting date and soil fertility in sunflower. I. Grain and oil yields and components. In: SUNFLOWER NATIONAL RESEARCH MEETING, 7, Ijuí, 1989. ABSTRACTS... Ijuí, RS, CTC - COTRIJUÍ. p.22-23, 1989.

DEDIO, W. Variability in hull content, kernel oil content, and whole seed oil content of sunflowers hybrids and parental lines. Canadian Journal of the Plant Science, Ottawa. v.62, p.55-60, 1982.

FERNANDEZ-MARTINEZ, J.; DOMÍNGUEZ-GIMENEZ, J. Variability evaluation in seed caracters of a world sunflower collection. In: INTERNATIONAL SUNFLOWER CONFERENCE, 11, Mar del Plata, 1985. PROCEEDINGS... Mar del Plata, Argentina, International Sunflower Association. p.535-540, 1985.

FICK, G.N. and ZIMMERMAN, D.C. Variability in oil content among heads and seeds within heads of sunflowers. Journal of the American Oil Chemists'l Society, Illinois, v.50, p.529-31, 1973.

HARRIS, H.C.; McWILLIAM, J.R.; MASON, W.K. Influence of temperature on oil content and composition of sunflower seed. Australian Journal of Agricultural Research, Melbourne, v-29, n.2, p.1203-12, 1978.

SILVA, P.R.F. da; NEPOMUCENO, A.L. Effect of plant arrangement on grain yield, yield components, oil content and weed control in sunflower. Pesquisa Agropecuaria Brasileira, Brasília, v.26, n.9, p.1503-1508, 1991.

ROBINSON, R.G.; FORD, J.H.; LUESCHEN, W.E.; RABAS, D.L.; SMITH, L.J.; WARNES, D.D.; WIERSMA, J.V. Response of Sunflower to Plant Population. Agronomy Journal, Madison, v.72, p.869-871, 1980.

WRANCEANU, A.V. Sunflower. Madrid, Edicions Mundi-Prensa, 1977. 179p.