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Effect of four tillage methods and two forms of urea placement in an ultisol of savanna on vegetative and flowering traits of three sesame cultivars, *Sesamum indicum* L.

Efecto de cuatro métodos de labranza y dos formas de colocación de urea en un ultisol de sabana sobre caracteres vegetativos y reproductivos de tres cultivares de ajonjolí

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Abstract

The main objective of this study was to determine the effect of four tillage methods and placement of urea on four vegetative and one flowering traits of three sesame cultivars. The experiment was carried out at Estación Experimental de Sabana, de la Universidad de Oriente, in a sandy loam soil. The statistical design was a split-plot with special arrangement of treatments, and they were assigned to the main plots.These four tillage methods (TM) were: a) Chisel (C): a pass of chisel plow 30 days before sowing and a pass of rotary cultivator one day before sowing (DBS), b) Harrow (H): three passes of H at 30 and 15 days plus one DBS (conventional method), c) minimum tillage (MT): a pass of rotary cultivator one d) Chisel + Harrow: a pass of C 30 days before sowing and three passes of H at 30 y 15, days plus one day before sowing. The subplots were constituted by a factorial arrangement of three cultivars (Cu) *viz.*, 'Glauca', 'Acarigua' and 'Blanca' and two forms of urea placement (FUP), 200 kg/ha 30 days after sowing: banded into the soil and superficial, for a total of 24 treatments with three replications. A dose of 500 kg/ha of 12-24-12 was applied at the moment of sowing. The weed control was carried out applying Dual, Linurex and Gramoxone at 2.0; 0.5 and 3,0 L/ha respectively one day after sowing, in all the treatments. The results showed that there was not any significant effect for the FUP and none of their interactions with TM and Cu. The biggest plant height (PH) and effective length of loading (ELL) were registered in the TM of C and H for the 3 Cu, while the lowest height to first capsule (HFC) was recorded in the TM of C+H y MT for

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'Glauca' y 'Acarigua' and C+H for 'Blanca', the biggest stem diameter (SD) for Cu were in H for 'Glauca', C and H for 'Acarigua' and C for 'Blanca'. On the other hand, 'Glauca' had the biggest PH, 'Blanca' had the lowest HFC and the biggest SD and 'Acarigua' had the biggest ELL. 'Blanca' had earlier blooming and 'Glauca' had later one, and for the TM, plants had earlier blooming in H and later blooming in MT
Key words: Tillage methods, urea placement, sesame, *Sesamum indicum*, cultivars

Resumen

El presente trabajo tuvo como objetivo principal determinar el efecto de cuatro métodos de labranza y la forma de aplicación del reabono nitrogenado (urea) sobre cuatro caracteres vegetativos y uno reproductivo de tres cultivares de ajonjolí. El experimento se llevó a cabo en la Estación Experimental de Sabana de la Universidad de Oriente, en un suelo francoarenoso. El diseño estadístico utilizado fue el de parcelas divididas con arreglo sistemático de los tratamientos aplicados a las parcelas principales, estando constituidas estas por cuatro métodos de labranza (ML): a) Cincel (C): un pase de arado de cincel 30 días antes de la siembra y un pase de rotativa un día antes de la siembra; b) Rastra (R): tres pases de rastra a los 30, 15 y un día antes de la siembra (método convencional); c) Labranza mínima (LM): un pase de rotativa un días antes de la siembra y d) Cincel + Rastra: un pase de arado de C 30 días antes de la siembra y tres pases de R a los 30, 15 y un días antes de la siembra. Las subparcelas estuvieron constituidas por un arreglo factorial de tres cultivares (Cu): 'Glauca', 'Acarigua' y 'Blanca' y dos formas de colocación de urea (FCU), 200 kg/ha 30 días después de la siembra: bandas enterrada y superficial, para un total de 24 tratamientos con tres repeticiones. Se aplicó una dosis de 500 kg/ha de 12-24-12 al momento de la siembra. El control de malezas se realizó aplicando Dual, Linurex y Gramoxone a razón de 2,0; 0,5 y 3,0 L/ha respectivamente un días después de la siembra, en todos los tratamientos. Los resultados indicaron que no se encontró ningún efecto significativo para la FCU y ninguna de sus interacciones con ML y Cu. Las mayores altura de planta (AP) y longitud efectiva de carga (LEC) se registraron en los ML de C y R para los 3 Cu, mientras que la menor altura de la primera cápsula (APC) se presentó en los ML de C+R y LM para 'Glauca' y 'Acarigua' y en C+R para 'Blanca', el mayor diámetro del tallo (DT) se presentó en R para 'Glauca', C y R para 'Arawaca' y C para 'Blanca'. En cuanto a los Cu, la mayor AP se encontró en 'Glauca', la menor APC y el mayor DT en 'Blanca', la mayor LEC en 'Acarigua'. El Cu con la floración mas precoz fue 'Blanca' y el más tardío 'Glauca', para los ML, las plantas fueron mas precoces en R y mas tardías en LM.
Palabras clave: Métodos de labranza, colocación de urea, ajonjolí, *Sesamum indicum*, cultivares

Introduction

The effect of tillage methods on the sesame crop in savannas of Monagas and Anzoátegui States (Venezuela) is not well known. The savanna soils are generally poor in fertility, with a low cationic exchange capacity and a low water retention. According to Millán *et. al.* (15) land preparation is an essential component in the establishment and development of the crops and also, it is a vital part in the integrated pest and disease management. With a good soil preparation, the destruction of weeds is achieved; and usually diseases and insect pests are destroyed. While, Mazzani (12) indicated that reduced dimensions of sesame seeds and slow plant growth in the first weeks after sowing require a perfect soil preparation and the soil has to be finely crumbled.

Sánchez (22) reported that the soil for sesame crop must be well pulverized according its very small seed size and its advisable one plowing at 20 cm of depth and two harrow passes. The main objective of the present work was to determine the effect of four tillage methods and the best form of placement of urea 30 days after sowing on four vegetative characters and a reproductive one in three sesame cultivars.

Materials and methods

The present work was carried out at the Estación Experimental de Sabana de la Universidad de Oriente, in Jusepín, Monagas State, located at 09º 41' 33" NL and 63º 28' 00" WL with a height of 174 m under sea level, an annual precipitation of 1,050 mm and annual mean temperature of 27.3 ºC Martínez (11). Evaluation was conducted in the rainy season in a sandy loam soil. The statistical design was a split-plot with special arrangement of treatments assigned to the main plot, being four tillage methods: a) chisel: a pass of chisel plow 30 days before sowing and a pass of rotary cultivator one days before sowing; b) harrow: three passes of harrow at 30, 15, days plus one day before sowing (conventional method); c) minimum tillage: a pass of rotary cultivator one day before sowing and d) chisel + harrow: a pass of chisel 30 days before sowing and three passes of harrow at 30 and 15 days plus one day before sowing. The subplots were constituted by a factorial arrangement of three cultivars *viz.*, 'Glauca', 'Acarigua' and 'Blanca' and two forms of urea placement, 200 kg/ha 30 days after sowing: banded into the soil and superficial, for a total of 24 treatments with three replications. The analysis of conventional variance was carried out, detecting differences among treatments by Duncan's multiple range test. The level of probability was 10 %. For the case of F's, high values of the tillage methods, their means only were reported without the application of the Duncan's test.

A dose of 500 kg/ha of 12-24-12 was applied at sowing. The weed control was carried out applying Dual, Linurex and Gramoxone at 2.0; 0.5

and 3 L/ha, respectively one days after sowing, in the treatments. Each experimental unit was constituted by three rows of 5 m. The space was 0.70 m in-row and 0.05 m intra-row. Twenty plants of the central row were selected to determine the vegetative characters, *viz*, plant height, height to first capsule, effective length of loading and stem diameter at 10 cm of the soil. The reproductive trait, number of flowering plants at the 40 DAS, was recorded and it was expressed in percentage.

Results and discussion

Plant height (cm). The analysis of variance showed significant differences among the cultivars and also for the interaction cultivars × tillage methods. The coefficient of variation was 6.41 %. The table 1 shows the Duncan's test for this character. The biggest plant height in all the cultivars was registered in the chisel and harrow treatments. The plant height was smaller in the treatments of minimum tillage and chisel+harrow. For the cultivars, the biggest plant height was showed by 'Glauca' in all the tillage methods, although 'Acarigua' presented a plant height statistically similar to 'Glauca' in chisel+harrow and minimum tillage.

The sesame seed is small. The soil preparation should be carried out in a such form so that a good sowing bed can be produced for helping seed germination and later seedling development. The results indicated that a better plant development is detected when a single tillage implement was applied. The combination of chisel with the harrow had a negative effect in the plant height; similar results minimum tillage. Different results were reported

Table 1. Means for plant height (cm) of three sesame cultivars, *Sesamum indicum* L. under four tillage methods in the savanna of Jusepín, during the rainy season.

	Plant height (cm) †		
Tillage Methods	Sesame Cultivars		
	Glauca	Acarigua	Blanca
Chisel	175.73^{Aa}	166.57^{Ab}	131.59^{Ac}
Chisel + Harrow	147.85^{Ba}	148.55^{Ba}	109.49^{Bb}
Minimum Tillage	133.60^{Ca}	142.47^{Ba}	116.83^{Bb}
Harrow	181.58^{Aa}	172.19^{Ab}	135.64^{Ac}

† Duncan's multiple range test at the 10% level of probability. a, b, c, Means followed by the same letters are not significantly different. Uppercase letters for vertical comparisons, lowercase letters for horizontal comparisons.

by González (6) working in the savanna of Jusepín, he found that highest plants of sesame cv. 'Arawaca' were obtained with a pass of chisel plow plus three only passes of harrow, and a pass of disc plow plus three passes of harrow in comparison with four passes of harrow. Peña (18), carried out an experiment in a silt loam soil in the Colonia Agrícola de Turen, Portuguesa State, Venezuela, and he found that the highest plants of sunflower cv. 'M-734' at 30 days after sowing occurred under the system of minimum tillage followed by the treatment of 3 harrow passes, the smallest plants were achieved under the system with chisel plow. At 90 days, the minimum tillage and three harrow passes had similar means but higher than chisel plow. The differences among these trials could be attributed to different soil textures and/or the use of different crops. On the other hand, Heilman (7), found that in row chiseling increased the height of the cotton plant in comparison to non-chiseled plots in a clay soil. Lindsay *et al.* (9) carried out two trials in a clay soil and they found that the conventional tillage produced corn plants taller than non-tillage, and minimum tillage.

It has reported in other experiments an increment of the plant height with zero and minimum tillage. Ojeniyi (16), studied the effect of zero tillage and also the effect of 1, 2, and 3 passes of a disc plow on the growth of two corn cultivars on 3 places in the Southern Guinea savanna zone of Nigeria and he found that the non-tillage and two passes of the disc plow produced a greater plant height than 3 passes of the disc plow. Fadayomi (4) in Nigeria found that the plant height of the cowpea cv. 'Ife Brown' was significantly larger in the non-tillage system instead of the conventional tillage system. Different results were reported by Hesterman *et. al.* (8), who found discovered that the plant height of corn was greater for conventional tillage than non-tillage system. Sharma *et. al.* (24), found that in a clay loam soil, the conventional tillage increased significantly corn plant height about 42% as compared with no tillage, whereas for the mungbean *Vigna radiata* cultivated in two types of soil: clay loam and sandy loam, the conventional tillage increased the plant height 18% as averaged over two sites and two years in comparison with no tillage. Sharma (23) reported in a two year field experiment that the plant height of fodder oats was significantly lower under minimum tillage than under reduced or conventional tillage.

On the other hand, in other experiments, plant height differences have not been reported for different crops among the different tillage systems. Barrón-Contreras *et. al.* (3), did not find significant differences in the plant height of corn and French bean due to the tillage systems evaluated (conventional, semi-conventional, minimum and zero tillage). Aulakh and Gill (2) found in field trials carried out during 1984-87 in acid clay soils that the plant height of wheat cvs. 'Whydah' and 'Hornbill' was not affected by tillage treatments: non-tillage, minimum tillage, conventional disc harrowing + cultivation, deep plowing, deep chiseling, late harrowing and straw removal. Al-Darby (1), did not find significant differences in the corn

plant height cultivated in two soil types, a silt loam and a sandy loam during 1982-84 under different tillage systems: tillage plant, chisel, no tillage and conventional mouldboard tillage. Faungfupong and Sakhunkhu (5), reported that the corn plant height was similar for the four tillage types applied including zero tillage, conventional tillage and minimum tillage.

In relationship to cultivars, similar results were reported by Méndez-Natera *et. al.*. (13), who did not find significant differences for the plant height in the cultivars 'Glauca' and 'Acarigua' with a general mean of 165.2 cm, while Rattia (20), found that 'Glauca' and 'Acarigua' had plant heights of 133.1 and 114.6 cm respectively, in the Mesa de Guanipa, Anzoátegui State. Milano (14), found plant heights of 133.4 and 100.8 cm respectively, for the same cultivars in the savanna of Jusepín, Monagas State, and low values in comparison with those obtained with this experiment.

Non significant effects of the form of urea placement at 30 days after sowing was found on the plant height. Similar results were obtained by Reeves *et al.* (21) but working with corn, he found that nitrogen fertilization applied at the moment of sowing both banded into the soil or banded superficially improved the corn plant growth, irrespectively of the tillage systems (conventional and conservation) in two soil types viz., silt loam and sandy loam. Faungfupong and Sakhunkhu (5), found that fertilizer application methods of N and P, including broadcasting and four different methods of banding did not differ significantly in their effects on all corn plant characters recorded. However, Marcano and Ohep (10) found that plant height of corn had significant diferences for the interactions year × form of urea application and methods of soil preparation × form of urea application.

Height to first capsule (cm). The analysis of variance indicated significant differences between the cultivars and the interaction cultivars × tillage methods. The coefficient of variation was 8.36%. Table 2 shows the Duncan's test for this character. The smallest height to first capsule was presented in the tillage methods chisel+harrow and minimum tillage in the cultivars 'Glauca' and 'Acarigua' and also in chisel+harrow for 'Blanca'. In relation to cultivars, the smallest height to first capsule was registered by 'Blanca' in all the tillage methods, although cultivar 'Acarigua' had a height to first capsule statistically similar to 'Blanca' in minimum tillage.

The height to first capsule followed a similar trend to that observed in the plant height, suggesting that, these two characters were highly correlated and that the different tillage systems affected similarly both characters. In relation to cultivars; 'Blanca' had the smallest height to first capsule, followed by 'Acarigua', while 'Glauca' had the biggest height. Similar results were reported by Méndez-Natera *et al.* (13), Rattia (20) and Milano (14), who found that cultivar 'Acarigua' had a smaller height to first capsule that 'Glauca'.

Effective length of loading (cm). The analysis of variance indicated significant differences between cultivars and the interaction cultivars

Table 2. Means of height to first capsule (cm) of three sesame cultivars, *Sesamum indicum* L. under four tillage methods in the savanna of Jusepín, during the rainy season.

Tillage Methods	Height to first capsule (cm) † Sesame cultivars		
	Glauca	Acarigua	Blanca
Chisel	102.16^{Aa}	77.94^{Bb}	69.57^{Ac}
Chisel + Harrow	91.69^{Ba}	75.39^{BCb}	58.68^{Bc}
Minimum Tillage	86.36^{Ba}	70.58^{Cb}	65.94^{Ab}
Harrow	107.13^{Aa}	87.00^{Ab}	72.68^{Ac}

† Duncan's multiple range test at the 10 % level of probability. a, b, c: Means followed by the same letters are not significantly different. Uppercase letters for vertical comparisons, lowercase letters for horizontal comparisons.

× tillage methods. The coefficient of variation was 9.49 %. Table 3 shows Duncan's test for this character. The biggest effective length of loading of all the cultivars was registered in the chisel and harrow treatment, being smaller the effective length of loa-ding in the treatments of minimum tillage and chisel+harrow. Acording to cultivars, the biggest effective length of loading was for 'Acarigua' all the evaluated tillage methods. The effective length of loading followed a diffe-rent trend the plant height and height of first capsule according to cultivars, but similar trend in relation to tillage systems.

Similar results obtained in this experiment have been reported by other researchers. Méndez-Natera *et al.* (13), indicated that 'Acarigua' had the biggest effective length of loading with 100.9 cm in a experiment with four sesame cultivars where cultivar 'Glauca' was included, whereas from the data of Rattia (20), the effective length of loading for 'Acarigua' and 'Glauca' was 58.5 and 30.5 cm, respectively, while Milano (14) reported values of 76.3 and 71.4 cm, respectively for these cultivars.

Stem diameter (cm). The analysis of variance indicated significant differences for the cultivars and the interaction cultivars * tillage methods. The coefficient of variation was 9.40 %. Table 4 shows the Duncan's test for this character. The biggest stem diameter was obtained in chiseling and harrowing for 'Acarigua', in harrowing for 'Glauca' and in chiseling for 'Blanca' indicating a differential behaviour of the cultivars to the different tillage systems being smaller the stem diameter in the treatments of minimum tillage and chisel+harrow.

The response of the stem diameter to different tillage systems was not very clear in sesame and other crops. Lindsay *et. al.* (9), reported in

Table 3. Means for the effective length of loading (cm) of three sesame cultivars, *Sesamum indicum* L. under four tillage methods in the savanna of Jusepín, during the rainy season.

Tillage Methods	Effective length of loading (cm) † Sesame cultivars		
	Glauca	Acarigua	Blanca
Chisel	71.70^{Ab}	84.80^{Aa}	60.14^{Ac}
Chisel + Harrow	54.89^{Bb}	68.79^{Ba}	49.41^{Bb}
Minimum Tillage	45.94^{Cb}	67.48^{Ba}	48.82^{Bb}
Harrow	72.84^{Ab}	82.72^{Aa}	60.99^{Ac}

† Duncan's multiple range test at the 10% level of probability. a, b, c: Means followed by the same letters are not significantly different. Uppercase letters for vertical comparisons, lowercase letters for horizontal comparisons.

corn that conventional tillage produced plants with more stem dry matter that minimum tillage and zero tillage. Fadayomi (4), found that the stem circunference of the cowpea cultivar 'Ife Brown' was significantly bigger in the non-tillage plots than in the conventional tillage ones in Nigeria, while Ortolani *et. al.* (17), in field trials with corn cv. 'HDM 7974' reported that the stem diameter was significantly greater in the methods of conventional tillage using plow, disc and harrow and direct drilling with use of a rotary cultivator with 19.7 and 19.3 mm respectively than other treatments viz.

Table 4. Means for the stem diameter of three sesame cultivars, *Sesamum indicum* L. under four tillage methods in the savanna of Jusepín, during the rainy season.

Tillage Methods	Stem diameter (cm) † Sesame cultivars		
	Glauca	Acarigua	Blanca
Chisel	0.971^{Bb}	0.925^{Ab}	1.193^{Aa}
Chisel + Harrow	0.699^{Cc}	0.806^{Bb}	0.942^{Ca}
Minimum Tillage	0.700^{Cc}	0.796^{Bb}	0.912^{Ca}
Harrow	1.066^{Aa}	0.883^{ABb}	1.082^{Ba}

† Duncan's multiple range test at the 10% level of probability. a, b, c: Means followed by the same letters are not significantly different. Uppercase letters for vertical comparisons, lowercase letters for horizontal comparisons.

Subsoiler+heavy disc harrow, heavy disc harrow only and direct drilling.

According to Table 4, for the cultivars, the biggest stem diameter was for 'Blanca' in all tillage methods, although 'Glauca' had a stem diameter statistically similar to 'Blanca' in harrowing. Milano (14) reported values of 1.02 and 0.73 cm for cultivars 'Glauca' and 'Acarigua' respectively.

Percentage of blooming at 40 days after sowing. The analysis of variance indicated significant differences between cultivars. The coefficient of variation was relatively high (25.29 %).

Figure 1.A indicates that percentage of blooming at 40 days after sowing was in the following order: harrow > chisel > chisel+harrow > minimum tillage with 75.44; 70.50; 66.83 and 52.22%, respectively. Similar results but in corn have been reported by Hesterman *et. al.* (8), they indicated that corn silking occurred earlier in conventional tillage than in no tillage plots at both locations in both years in 33 corn hybrids cultivated in two locations (18 hybrids in East Lansing and 15 hybrids in Kellogg Biological Station during 1985-86). Al-Darby (1) reported that the days from sowing to 50 % silking of corn plants for non-tillage systems, were significantly delayed by 2-3 and 4 days for the silt loam and loamy sand soils, respectively, in comparison with other tillage systems (tillage plant, chisel and conventional mouldboard). Philbrook (19), reported that conservation tillage delayed maturity of the soybean plants in comparison with conventional tillage. Different results to those obtained in this experiment were reported by Faungfupong and Sakhunkhu (5), who found that zero tillage caused corn plants to flower earlier than conventional tillage practices.

Cultivars figure 1.B shows Duncan's test for the percentage of blooming at 40 days after sowing. The earlier cultivar was 'Blanca' followed by 'Acarigua'. The later cultivar was 'Glauca'. Similar results were reported by Méndez-Natera *et al.* (13), they indicated that the earlier flowering cultivar was 'Acarigua' in comparison with 'Glauca' (35.4 and 39.9 days at 50% of flowering plants, respectively) and Milano (14), found values of 33.0 and 41.0 days to 50 % of blooming for 'Acarigua' and 'Glauca', respectively.

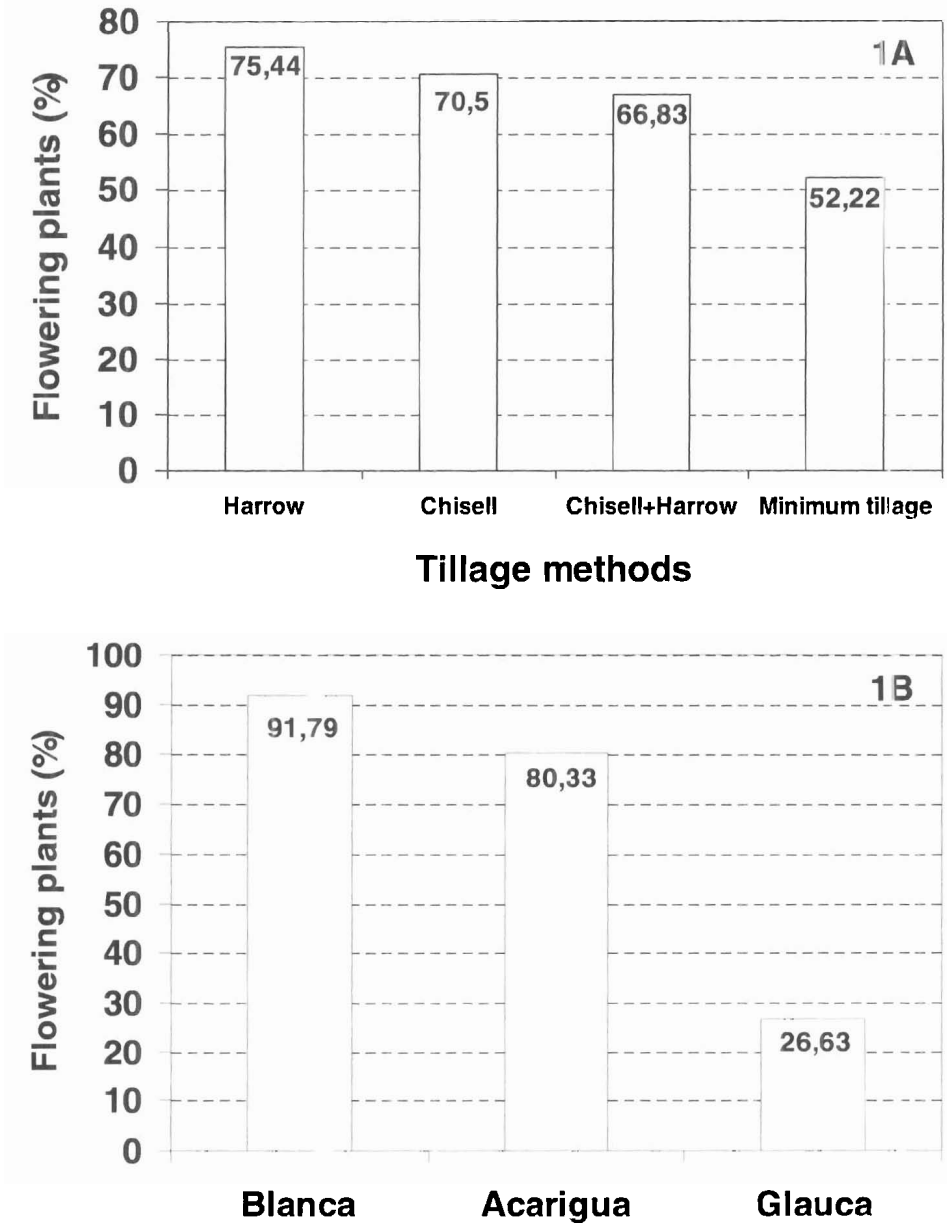

Figure 1. Means for the percentage of flowering plants at 40 days after sowing of three sesame cultivars (*Sesamum indicum* L.) under four tillage methods in the savanna of Jusepín, Monagas State, during the rainy season. (1.A) Effect of the tillage methods and (1.B) Effect of the cultivars.

Conclusions

The form of urea placement at 30 days after sowing, banded into the soil or in superficial bands did not affect the characters studied, as well as they did not have significant interactions with tillage methods and/or sesame cultivars.

The largest plant height and the effective length of loading for all cultivars were obtained by the chisel and harrow tillage methods. The lar-gest plant height was obtained by 'Glauca' in all tillage methods. 'Acarigua' had a similar plant height to registered by 'Glauca' in the chisel+harrow and in minimum tillage. The largest effective length of loading was showed by 'Acarigua', for all the tillage methods evaluated.

The smallest height to first capsule was found with tillage methods of chisel+harrow and minimum tillage for 'Glauca' and 'Acarigua' and in chisel+harrow for 'Blanca'. According to cultivars, the smallest height to first capsule was registered by 'Blanca' for all the tillage methods. 'Acarigua' had a similar height to first capsule to that of 'Blanca' with the minimum tillage method.

The largest stem diameter was obtained by chiseling and harrowing for 'Acarigua' and by 'Glauca' with horrow and by 'Blanca' with chisel. This may be are indicating a differential behaviour of the cultivars for the different tillage systems. The largest stem diameter was demostrated by 'Blanca' for all the tillage methods. 'Glauca' had a similar stem diameter to 'Blanca' with harrowing.

The percentage of blooming at 40 days after sowing was 75.44; 70.50; 66.83 and 52.22 % for harrow; chisel; chisel+harrow and minimum tillage, respectively. The earlier cultivar to blooming was 'Blanca', followed by 'Acarigua'. The latest blooming cultivar was 'Glauca'.

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Literature cited

1. Al-Darby, A. M. 1986. The effect of three conservation systems on corn (*Zea mays* L.) growth and productivity. Dissertation Abstracts International, B. Sciences and Engineering 47 (4): 1333B. (Abstract: Field Crops Abstracts 1988 041-02234).

2. Aulakh, B. S. and K. S. Gill. 1987. Tillage effects on rainfed wheat production and soil bulk density. p. 224-231. *In* Fifth Regional Wheat Workshop for Eastern, Central and Southern Africa and the Indian Ocean, 1987. (Abstract: Field Crop Abstracts 1939 042-02351).

3. Barrón-Contreras, J. L., J. Vera-Graziano y J. Romero-Nápoles. 1987. Efecto de sistemas de labranza primaria sobre plagas y malezas en maíz y frijol de secano en Durango. Agrociencia 67: 41-56.

4. Fadayomi, O. 1989. Effects of two tillage systems on crop performance and weed control. Turrialba 39 (1): 46-51.

5. Faungfupong, S. and S. Sakhunkhu. 1985. Effect of tillage and methods of fertilizer application on maize production. Kasetsart Journal 19 (3): 173-179.

6. González, M. D. 1991. Efecto de diferentes prácticas de labranza sobre el rendimiento y otros caracteres agronómicos en el cultivo del ajonjolí *Sesamum indicum* L. cv. 'Arawaca' en un Ultisol de sabana del Estado Monagas. Resúmenes de Trabajos de Grado 1991. Oriente Agropecuario (15-17): 69-70.

7. Heilman, D. 1988. In row chisel ploughing: Effect on plant growth and properties of clay soils. Journal of Soil and Water Conservation 43 (2): 202-204.

8. Hesterman, O. B., F. J. Pierce. and E. C. Rossman. 1988. Performance of commercial corn hybrids under conventional and non-tillage systems. Journal of Production Agriculture 1 (3): 202-206.

9. Lindsay, J. I., S. Osei-Yeboah., and F. A. Gumbs. 1983. Effect of different tillage methods on maize growth on a tropical inceptisol with impeded drainage. Soil and Tillage Research 3 (2): 185-196.

10. Marcano, F. y C. Ohep. 1997. Respuesta del cultivo de maíz a tres prácticas de labranza, dos fuentes nitrogenadas y tres formas de aplicación del nitrógeno. Agronomía Tropical 47 (1): 61-85.

11. Martínez, L. 1977. Clima del área de Jusepín, Edo. Monagas. Trabajo de Ascenso para Profesor Agregado. Universidad de Oriente, Escuela de Ingeniería Agronómica, Jusepín, Venezuela. 66 pp.

12. Mazzani, B. 1983. Cultivo y mejoramiento de plantas oleaginosas. Fondo Nacional de Investigaciones Agropecuarias (FONAIAP). Caracas, Venezuela. p. 169-224.

13. Méndez-Natera, J. R., A. Amatima. J. F. Merazo. A. Gil. y L. Khan. 1996. Efecto de tres frecuencias de riego sobre algunos parámetros de la planta y de la cápsula de cuatro cultivares de ajonjolí *Sesamum indicum* L. p. 77-78. En Resúmenes del III Congreso Científico de la Universidad de Oriente, Maturín, Estado Monagas. U. D. O. del 03 al 07 de noviembre de 1996.

14. Milano R, T. M. 1993. Comportamiento agronómico de 16 cultivares de ajonjolí *Sesamum indicum* L. en condiciones agroecológicas de sabana en época de lluvias: con especial referencia a la resistencia y/o tolerancia a manchas foliares fungosas. Tesis de Grado. Universidad de Oriente. Escuela de Ingeniería Agronómica. Jusepín, Venezuela. 248 pp.

15. Millán, A., M. Oliveros, y D. Villaroel. 1996. La preparación de tierras y su importancia en la producción de cultivos. FONAIAP Divulga 52 (1): 4-5.

16. Ojeniyi, S. O. 1986. Effect of zero-tillage and disc ploughing on soil water, soil temperature and growth and yield of maize *Zea mays* L. Soil and Tillage Research 7 (1-2): 173-182.

17. Ortolani, A. F., O. Coan., O. J. Ayala., y D. A. Banzatto. 1981. Avaliacao da resistencia do milho *Zea mays* L. so acamamento, em diferentes sistemas de preparo do solo. Científica 9 (2): 215-219.

18. Peña, J. 1995. Efectos de diferentes sistemas de labranza sobre el comportamiento del cultivo de girasol *Helianthus annuus* L. p. 209-217. En Memorias del V Congreso Venezolano de Ingeniería Agrícola. Maracaibo, Estado Zulia, septiembre 1995.

19. Phibrook, B. D. 1989. Harvest date, tillage, and other agronomic management effects on yield and seed quality of solid-seeded soybeans. Dissertation Abstracts International, B. Sciences and Engineering 49 (11): 4615B. (Abstract: Field Crops Abstracts 1989 042-07929).

20. Rattia, J. 1982. Comportamiento agronómico de 12 variedades de ajonjolí *Sesamum indicum* L. en la Mesa de Guanipa. Tesis de Grado. Universidad de Oriente. Escuela de Ingeniería Agronómica. Jusepín, Venezuela. p. 13-30.

21. Reeves, D. W., J. T. Touchton, and C. H. Burmester. 1986. Starter fertilizer combinations and placement for conventional and non-tillage corn. Journal of Fertilizer Issues 3 (3): 80-85.

22. Sanchez, A. 1988. Cultivos oleaginosos. Ajonjolí. Editorial Trillas. Sexta reimpresión, México, D. F. p. 23-32.

23. Sharma, B. R. 1985. Response of irrigated fodder oats to nitrogen fertilization as influenced by tillage. Soil and Tillage Research 6 (1): 69-77.

24. Sharma, P. K., S. K. Datta, and C. A. Redulla. 1988. Response of maize *Zea mays* L. and mungbean *Vigna radiata* L. to tillage in relation to water table depth in tropical lowland rice soils. Soil and Tillage Research 12 (1): 65-79.