PRODUCTION OF ALFALFA (*Medicago sativa* L.) II. INFLUENCE OF GRAZING MANAGEMENT[1] /

*E. E. LUTZ**
*F. H. W. MORLEY***

Compendio

La producción de materia seca de cuatro cultivos de alfalfa sembrados en cuatro diferentes espaciamientos entre surcos fue cuantificada en un experimento realizado en Canberra, Australia (Lutz y Morley, 1980). El experimento incluyó tres velocidades de rotación para el mismo grupo de carneros: (1) G 9/R 26, (2) G 5/R 30 y (3) G 7/R 28, donde G representa los días de pastoreo y R los días de descanso entre pastoreos. Estos tratamientos simularon tres sistemas de pastoreo de 4, 7 y 5 dehesas con 29, 17 y 23 carneros/ha respectivamente.

El promedio del rendimiento total de alfalfa cosechada inmediatamente antes del pastoreo aumentó significativamente ($P < 0.05$) con la subdivisión incrementada. Esta tendencia existe para todos los lotes experimentales y los espaciamientos entre surcos.

El sistema de manejo no afectó la densidad de las plantas en los diferentes espaciamientos entre surcos de los diferentes lotes experimentales los cuales se diferenciaron en cuanto a supervivencia.

Los sistemas de pastoreo impuestos parecen haber suprimido el potencial de retoñar y extenderse en el caso de la variedad Cancreep.

Introduction

Continuos grazing of alfalfa throughout the year may be detrimental to the survival of alfalfa plants (3, 4, 8, 17, 21, 23, 27, 28, 29) and some degree of subdivision and management is essential.

Alfalfa pastures should be grazed at infrequent intervals, for high production and to secure plant survival (2, 3, 4, 8, 23, 29, 31). Therefore, a suitable grazing practice should be devised from each particular environment where alfalfa is grown.

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* Professor-Dept. Agrc. Sciences, U.N.S. 8 000 Bahía Blanca, Argentina.

** S.R.F. Vet. Clinical Centre-Univ. of Melbourne-Werribee, 3 030 Victoria, Australia.

In any rotational grazing system the frequency of grazing can be controlled by: a. number of paddocks in the rotation, b. number of grazing days. From the biological standpoint both should vary with the environmental conditions; fewer paddocks would be required in conditions favourable for alfalfa growth.

Mc Kinney (16) found that the length of the grazing period was less important than the length of the spelling period in preserving alfalfa density and production. However Langer and Steinke (11) suggest that long grazing periods may reduce root size, which decrease regrowth potential, and Peart (22) found that under grazing condition the length of the grazing period reduces alfalfa production. Constable *et al.* (5) support the management principle of keeping the grazing period of alfalfa to a minimum.

There is evidence (18) that a multiple paddock subdivision –10 paddocks or even more– will not permit the annual species to persist in stands of perennials. This may not be important if the climate permits sufficient growth of alfalfa itself in winter to support the stocking rate used for the rest of the year. In other situations the loss of annuals could be costly, not only in winter but in dry autumns.

In Canberra three simulated management systems were compared over a range of alfalfa cultivars sown at 4 different row spacings. Results from the first year of this experiment are reported here.

Materials and methods

They were described in a previous paper (15). Briefly, the different simulated grazing management systems resulted from the strict rotation of the same number of sheep (5) on plots for different grazing periods (in turn 9, 9, 5, 5, 7 days). Thus, different stocking rates in different number of paddocks were simulated by moving the one group of animals through the one sequence of plots. For example, 5 sheep grazing one plot of 0.043 ha for 9 days was taken to represent one part of a 4 –paddocks system with 27 days spelling time and overall stocking rate of 29.2 weaners/ha; 5 sheep grazing one plot for 5 days represents a 7 –paddock system with 30 days between grazings with 16.7 weaners/ha overall; and 5 sheep grazing one plot for 7 days was considered equivalent to one part of a 5 –paddock system, 28 days spelling time and 23.4 weaners/ha. In these simulated systems stocking rate and number of subdivisions are confounded.

For the comparison of pasture production in each system, systems and time of measurement are also confounded, the first measurements being made on the 4 –paddock system, then on the 7, and finally on the 5. By summing production over long periods this confounding should become unimportant. If this assumption is accepted the effects of management on pasture production can be determined.

Results

The mean total yield of alfalfa harvested immediatly before grazing increased significantly ($P < 0.05$) with increased subdivision (or decreasing stocking rate) (Figure 1). This trend exists for all cultivars and row spacings (Figure 2).

The management system did not affect density at the different row spacings or of the different cultivars which themselves differed in survival. Uruguay and Hunter River were significantly denser than Cancreep and Du Puits in both grazing managements (Table 1).

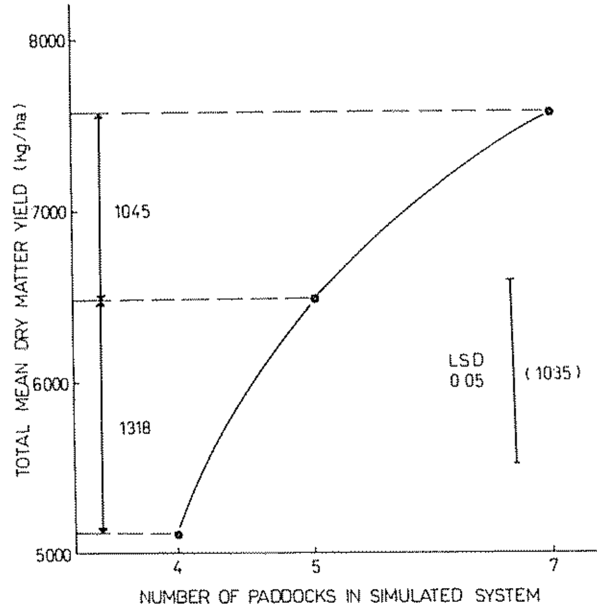

Fig. 1 Influence of management on harvested yields of alfalfa

The total dry matter production from the three management systems is presented in Figure 3. Although the data for alfalfa (Figures 1 and 2) covered all 10 grazing cycles, only the last 6 cycles are considered here, because it was only in these that botanical composition measurements were associated with individual cultivars (15). The results have the limitation that, being restricted to the first year of different grazing systems, they do not reflect changes which could occur in subsequent years through the influence of grazing intensity in seed production and establishment, especially of annual species. The results are presented because some effect of management on botanical composition might be expected after the winter period of stress on both pasture and animals.

The subterranean clover component increased markedly as the stocking rate decreased (or subdivision increased) and was mainly responsible for the increase in total dry matter production recorded. The grass and alfalfa components were relatively less sensitive to management in this first year (Figure 4). Even so, the effect of management in alfalfa production had increased with time. In these last 6 cycles total harvested yields under the 4, 5 and 7 paddocks systems were aproximately 3060; 4140 and 5160 kg/ha respectively, a difference of 69% brought about by management. Alfalfa yield for the first four cycles totalled 2040; 2260 and 2340 kg/ha for the same treatments; a total difference of only 15%.

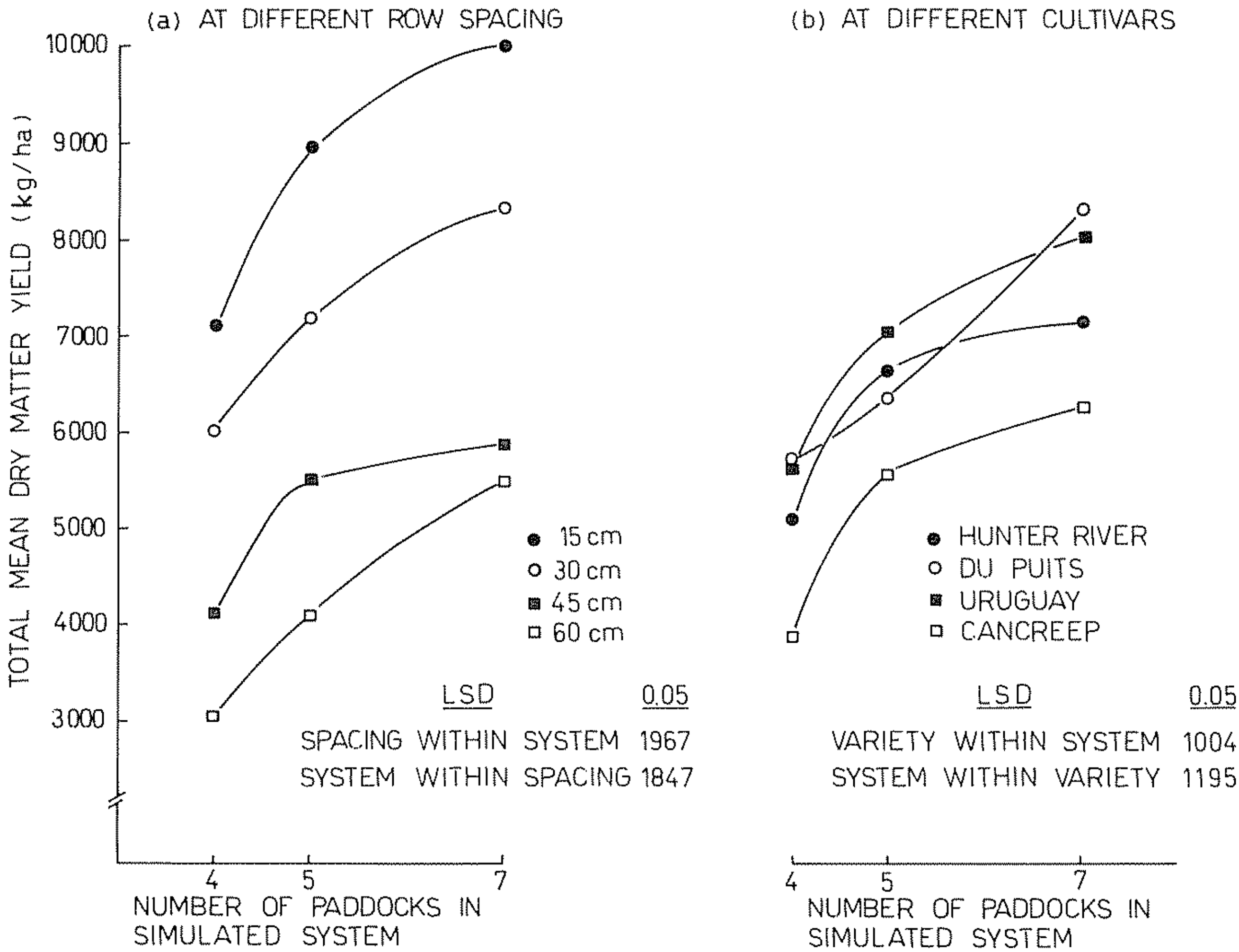

Fig. 2 Effect of management on yields of alfalfa at different row spacing (a) and at different cultivars (b).

Table 1. Density of alfalfa cultivars at different spacings under two management systems.

		Number of plants/60 cm of row									
	CULTIVAR	H. RIVER		DU PUITS		URUGUAY		CANCREEP		MEAN	
	No. of Paddocks	7	4	7	4	7	4	7	4	7	4
SPACING cm	15	9.0	9.3	7.1	5.8	12.5	8.5	6.2	6.2	8.7	7.4
	30	7.9	9.1	4.0	5.3	8.7	8.6	6.1	7.4	6.6	7.6
	45	7.1	8.8	5.1	5.1	9.7	7.0	5.3	6.7	6.8	6.9
	60	9.2	9.1	6.0	5.0	9.1	11.7	4.9	6.1	7.3	8.0
	MEAN	8.3	9.1	5.5	5.3	10.0	8.9	5.6	6.6	7.3	7.5
LSD (P = 0.05)		No. of Paddocks mean						6.4			
		Space within same No. paddock						2.6			
		Cultivar within same No. paddock						1.4			
		No. paddock any space-cult. comparisons						3.2			

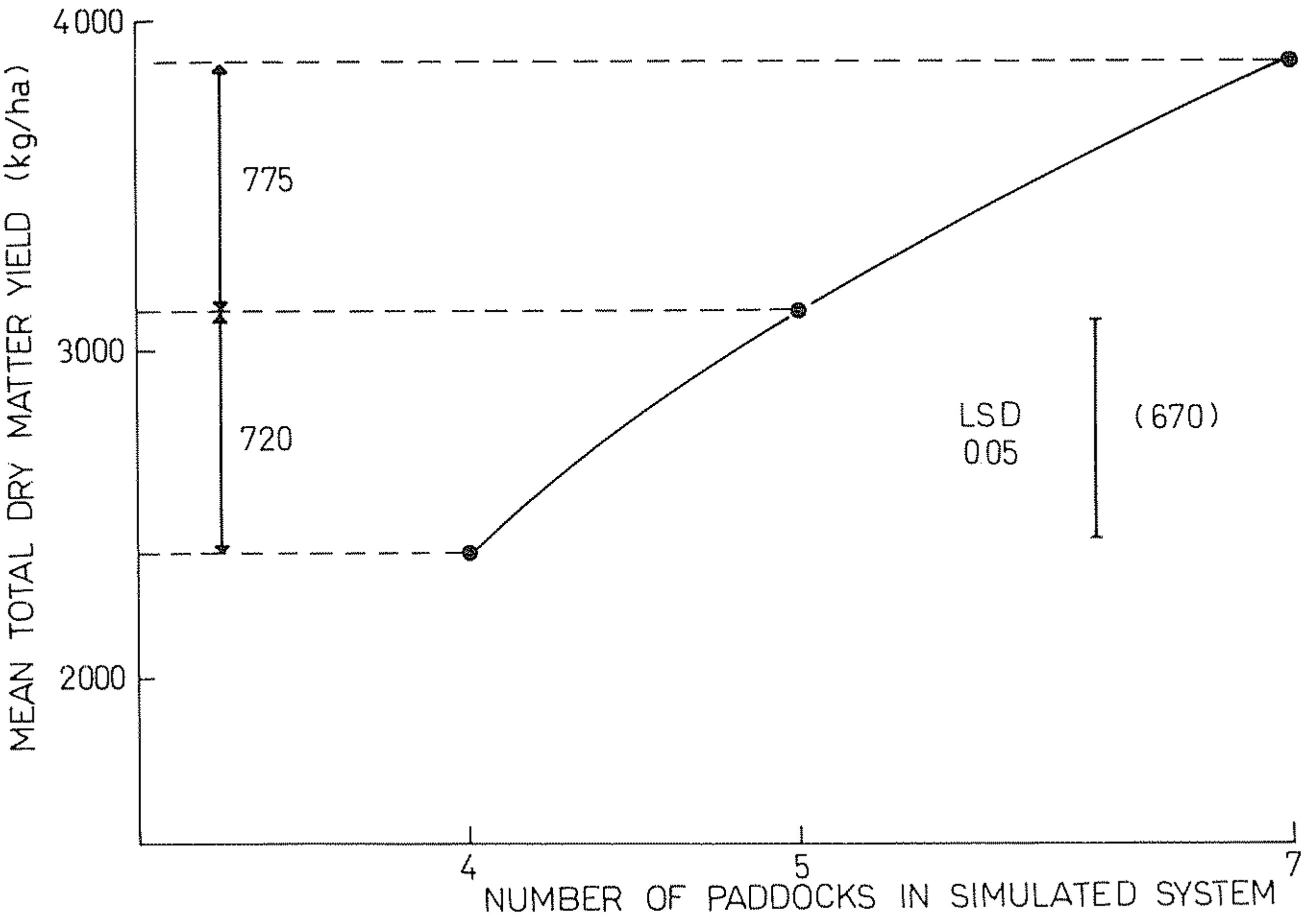

Fig. 3 Influence of management on yield of pasture harvested (last six grazing cycles).

At the end of this experiment, thirty months after sowing, there was no sign of creep in the Cancreep cultivar at any row spacing.

Discussion

The total yield of harvested alfalfa was significantly affected by the three management systems (Figure 1); this resulted entirely from production during spring and summer (last 6 cycles), and whether it was due to subdivision or stocking rate is not easily resolved because of confounding.

The management systems differed both in duration of grazing and in period of regrowth free of grazing (some growth would take place during the grazing period). Although Mc Kinney (16) found alfalfa production to be sensitive to spelling time over a range of 10 to 90 days, the small difference between extremes in this study (26 and 30 days) are unlikely to have caused measurable effects on mean growth rates. It is more likely that differences in production resulted from differences in duration of grazing, all at 5 sheep per plot, which varied relati-

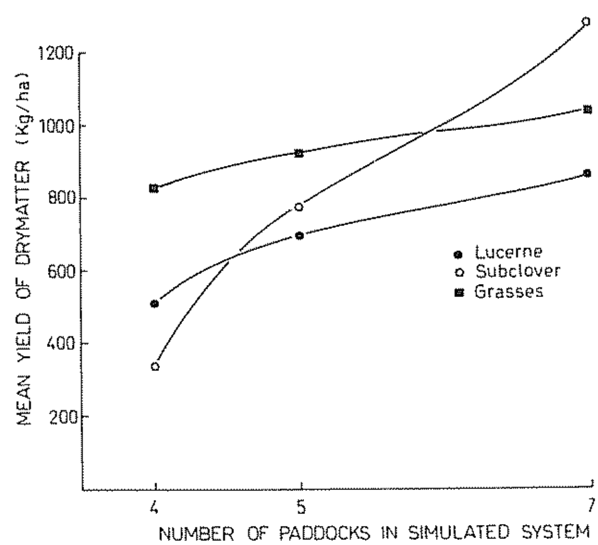

Fig. 4 Influence of management on the components of yield over the last six grazing cycles.

vely more – from 10 to 18 days in winter, and 5 to 9 days at other times. However, Leach (14) observations support the relative unimportance of the duration of grazing over quite a wide range.

At the stocking densities during grazing in this study (85 to 145 sheep/ha), alfalfa was selectively grazed and virtually completely eaten in the first few days. The relevance of different lengths of the grazing period is that the longer this is, the more frequent are new shoots removed as they expand.

When a plant is completely defoliated, new shoot growth relies particularly on the use of non-structural carbohydrate reserves, especially those of the roots. It may be more than a week after defoliation before current photosynthesis contributes significantly to the production of shoots (26) although some assimilate is traslocated to the roots before this (9). Until current photosynthesis is sufficient to provide for shoot growth root reserves must continue to be depleted. The longer grazing continues, the longer will regrowth be grazed, the more must root reserve be depleted, and the less can they contribute to growth in the period immediatly following removal of sheep. Therefore growth rates must be reduced unless root reserves are really substantial. Repeated severe defoliation must eventually exhaust reserves, leading to slow recovery or even death (21, 30).

Daday *et al.* (6) had already concluded that the creeping rooted cultivar Rambler, one parent of Cancreep, was "of no value in its present form." Now the extent of the improvement in Cancreep over its parent must be questioned: in all grazing management systems employed in the present experiment its yields were consistently the lowest of all cultivars.

Daday *et al.* (7) claimed that the discrepancies between his results and these, concerning the expression of creep may be due to the constant high rates of seed per unit length of row in this experiment. According to Daday "the number of plants per 100 cm of row counted after 12 months establishment were 32, 27, 35 and 26 from sowing rates of 5.3, 2.8, 1.9 and 1.4 kg/ha respectively;" but this is not correct as the results of Hutching (10 and personal communication) shows that the number of alfalfa plants surviving were in average 7 plants per 100 cm of row and neither row spacing (sowing rate) nor grazing treatments significantly affected survival.

That means that when this experiment began all sowing rates treatments had similar densities of alfalfa plants than those treatments of Daday *et al.* (7) at intermediate sowing rates, which in turn resulted with the highest percentage of creeping-rooted plants.

Daday (1970, personal communication) claimed that two requirements are needed for Cancreep to express its creeping habit:

a. Time, at least two and a half years after sowing,
b. Low density of plants.

Both conditions were satisfied in this study and, at the end of the experiment, there was no sign of creep at any row spacing; this suggests that a third factor may be needed for Cancreep to creep. This may be some grazing management, but what kind of management is yet unknown.

That grazing management had no effect on alfalfa survival deserves some comments. Mc Kinney (16) working with a dense stand found the interval between grazing as the most important component of the grazing system for alfalfa survival after four years, however since the middle of that period the stand densities were in equilibrium with the management imposed. Other authors working with intermediate (13, 29) and low (3, 8) density stands of alfalfa and comparing the effect of different components (grazing days and spelling interval) of the grazing system on alfalfa survival, found small differences in absolute terms due to them. However, in all those experiments (3, 16, 29) where continous grazing was included the alfalfa disappeared.

It seems reasonable, considering the persistence patterns of alfalfa pasture due to several causes. According to Leach (12): "Initial losses of plants largely represent an adjustment to a suitable population density, as in the large losses from high sowing densities." "Later losses may also represent density adjustment, particularly when stands are exposed to drought." How other factors (grazing management among them) may interact with those adjustments is not fully understood. But once the density is adjusted to the environment, it seems necessary to apply extremes treatments to produce significant effects on alfalfa survival.

It is premature to predict the influence of management on botanical composition before effects on the reseeding of annuals could be noted. But the increase in subclover content with shorter periods of grazing deserves comment, as the proportion of clover usually increases with intensity of grazing (19, 20, 24). Presumably intensive grazing of a mixed pasture, by removing all leaf cover, offers an advantage to subclover because its leaves tend to expand horizontally to intercept more fully the incident light. Rossiter and Pack (25) showed that grazed annual pastures contained much higher proportions of subclover than ungrazed pastures. However, in studies over a range of commercial stocking rates and 1 to 9 subdivisions, with sheep Morley *et al* (18) showed only slight effects on the proportion of subclover, although subdivision markedly affected the proportion of annual grasses. When grazed by cattle, or sheep Bennet *et al* (1) disclosed little or no effect of stocking rate on the proportion of subclover in Phalaris – subclover pastures.

Because the proportion of subclover decreased with decreasing simulated subdivision, the same reasons may apply to its response as to that of alfalfa. Again it can be argued that it was the duration of the grazing period that had most influence. Subclover was observed to be selectively grazed in preference to grasses and miscellaneous species, not alfalfa. The consequent repeated removal of all laminae –especially during the double grazing time of winter– must have adversely affected its growth, mainly in the system with the longest grazing duration.

Summary

The dry matter production of four alfalfa cultivars sown at four different row spacings were measured within an experiment conducted at Canberra, Australia (Lutz and Morley, 1980). The experiment included three speeds of rotation for the same group of weaners: (1) G 9/R 26, (2) G 5/R 30 and (3) G 7/R 28, where G represents the days of grazing and R the days of rest between grazings. These treatments simulated three grazing systems of 4, 7 and 5 paddocks with 29, 17 and 23 weaners/ha respectively.

The mean total yield of alfalfa harvested immediatly before grazing increased significantly ($P < 0.05$) with increased subdivision. This trend exists for all cultivars and row spacings.

The management system did not affect plant density at the different row spacings or of the different cultivars which themselves differed in survival.

The grazing systems imposed seem to have suppressed the creeping potential of the Cancreep cultivar.

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INSTITUTO INTERAMERICANO DE COOPERACION PARA LA AGRICULTURA*

Febrero de 1981

En virtud de que el IICA ha adoptado el Sistema Internacional de Unidades, nos permitimos anotar a continuación para los autores y colaboradores de las Revistas Turrialba y DRELA, así como para otras series de publicaciones del Instituto, las siguientes reglas principales.

En 1960, la Conferencia General de Pesas y Medidas (CGPM) y la Oficina Internacional de Pesas y Medidas (BIPM) decidieron por unanimidad en París, sede del BIPM, crear un sistema internacional de unidades de pesas y medidas (SIU). En 1975 había ya 44 países miembros del BIPM cuya tarea principal es asegurar la unificación mundial en torno del SIU. Hoy día los Estados Unidos de América e Inglaterra han adoptado también el uso del SIU.

Por ejemplo, el kilogramo es unidad de masa, y ya no de peso; el recurso al concepto de peso queda abolido, pues corresponde en realidad a la fuerza de atracción debida a la gravedad, y, por lo tanto, los cuerpos en el espacio interplanetario no tienen peso, pero sí conservan su masa. La unidad de fuerza es el newton (N), que corresponde a la necesaria para producir una aceleración de un metro por segundo sobre una masa de un kilogramo. La unidad de presión o esfuerzo es el pascal (Pa) y equivale a la noción abolida de kilogramos (fuerza) por centímetro cuadrado: 9 806 650 kg (fuerza)/m^2 = 1 Pa.

Reglas principales para la consignación de las unidades SI

1. No se usan las mayúsculas en los nombres de unidades. Unica excepción: grados Celsius.
2. Los símbolos no se escriben con mayúsculas. Excepciones: los derivados de nombres de personas.
3. Los prefijos métricos no se escriben con mayúsculas. Excepciones: tera T, giga G, mega M.
4. Los símbolos se escriben siempre igual, sean singular o plural, ej.: 5 mm, no 5 mms.
5. Cuando se escriben los nombres de unidades completos, se pluralizan normalmente, ej.: 10 kilogramos, 55 hectáreas.
6. No se usan los prefijos solos, sino acompañados de la unidad, ej.: 15 megawatts, no 15 megas.
7. No se usa el punto después del símbolo (24 m, no 24 m.), excepto al final de un párrafo.
8. Siempre se deja un espacio entre el número y el símbolo o unidad, ej.: 10 cm, no 10cm.
9. No se usan comas ni puntos para separar números largos; se deben separar de tres en tres. El punto marca el principio de la fracción decimal, ej.: 1 000 005.34, 30 000 y no 1,000,005.34 ó 30,000.
10. Siempre se coloca un cero a la izquierda del punto decimal, ej.: 0.77 y no .77.
11. Cuando se expresan unidades compuestas como kilómetros por hora, se usa la diagonal, ej.: 78 km/h, 50 m/s. Si se trata de newton metros se usa el punto, ej.: 5 N.m.

Continuación en la página 42