J. King Saud Univ., Vol. 4, *Agric. Sci.* (2), pp. 247-257 (A.H. 1412 / 1992).

Effect of Row Spacing and Speeding Rate on Alfalfa (Hassawi) Seed Yield and Two Related Traits

Ahmed Abdul Rahman Al-Noaim and Younes Saadawi Koriem
College of Agricultural and Food Sciences, King Faisal University, Al-Hassa, Saudi Arabia and College of Agriculture, Alexandria University, Egypt

Abstract. A field experiment was conducted at King Faisal University Research and Experimental Station, Al-Hassa during 1984 to 1987 to study the effect of row spacing and seeding rate on the seed yield of Hassawi alfalfa. The experiment included six row spacings: 15, 30, 45, 60, 75 and 90 cm and four seeding rates: 5, 10, 20 and 40 kg/ha. An early seed crop was taken in the summer of the first year (1985) and two seed crops (early and late) were obtained in the summer of each of the second and third years (1986 and 1987). In the early seed crop of 1985, the 60 and 75 cm row spcaings gave the highest seed yeilds, producing 426 and 436 kg/ha, respectively. For the overall means of early and late seed crops of 1986 and 1987, the 30 and 75 cm row spacings produced the highest seed yields, giving 364.5 and 372.5 kg/ha, respectively. Lowest seed yields were obtained from either 15 or 45 cm row spacings, being 295.5 and 318.5 kg/ha, respectively. With respect to seeding rate, the seed yields obtained in 1985, 1986 and 1987 were not significantly affected by the seeding rate treatments, although the 20 kg/ha seding rate gave the highest seed yield. In the late seed crop of 1986, the 75 row spacing gave significantly the highest 1000-seed weight. In the early seed crop of 1985, the 90 cm spacing produced a significantly higher number of seeds per pod than the 15 cm spacing and in the late seed crop, the 90 cm gave a significantly higher number of seeds per pod than the 30 cm spacing. In the late seed crop of 1987, the seeding rate of 40 kg/ha gave significantly higher 1000-seed weight than the other seeding rate treatments. The seeding rate of 5 kg/ha produced a significantly higher number of seeds per pod than 40 kg/ha seeding rate.

Introduction

Al-Hassa is one of the most important agricultural areas in Saudi Arabia. In this region, the local Hassawi alfalfa cultivar (*Medicago sativa* L.) is the major forage crop. Seed average yield/ha/year (around 100-150 kg) of Hassawi alfalfa is very low, compared to about 550 kg/ha/year in California, U.S.A. [1]. Zaleski [2] stated that the main factors beside climate, which affect seed yield in alfalfa were the variety, row width and pre-cutting in the spring. Fesko and Vazhov [3], in USSR, showed that alfalfa grown in wider rows gave higher seed yield than in narrow rows; the seed yields were 534 and 456 kg/ha, respectively. Also, Zhuravlev and Savelev [4] in

USSR, found that seed yield of alfalfa grown in rows 60 cm apart, and at 5 or 10 kg/ha seeding rate, was significantly higher than those obtained from 15 and 30 cm rows. Similarly, Timergaziv [5], in Romania, obtained the highest seed yield of 520 kg/ha/year when alfalfa was grown in rows 60 cm apart, using a seeding rate of 7.5 kg/ha. The use of wide rows allowed light penetration in the canopy and increased seed setting. no previous work has been published in Saudi Arabia concerning the factors affecting alfalfa seed production.

The increase in the production of alfalfa seed yield should help to provide sufficient supply of local alfalfa seed, which would decrease the dependence on imported seed.

The main objective of this study was to determine the optimum row spacing and seeding rate to increase Hassawi alfalfa seed yield under Al-Hassa climatic conditions.

Materials and Methods

A field experiment was carried out at King Faisal University Research Station in Al-Hassa, Saudi Arabia. An experimental field was selected close (a few meters) to the University Apiary (which included fifty bee hives), thus ensuring sufficient insect pollination and good seed setting.

The soil was a sandy loam with relatively low available phosphorus, organic matter and nitrogen. The electrical conductivity (EC) and pH of the soil were 2.4 mmhos/cm and 7.8, respectively. The means of maximum and minimum daily temperature and relative humidity, over a period of sixteen years, are given in Table 1.

The experiment was laid out in a split-plot design with six row spacings in the main plots and four seeding rates in the sub-plots with four replications. Row spacing treatments were 15, 30, 45, 60, 75 and 90 cm. The seeding rate treatments were 5, 10, 20 and 40 kg/ha. The experiment was sown on 20 November 1984.

Throughout the period of the experiment, flood irrigation was applied using a 3-5 day interval during the period from May to October and 6-9 day interval during the period from November to March. The electrical conductivity of the water was 1.98 mmhos/cm.

The last cut before the seed crop was at the end of March in each of 1985, 1986 and 1987. In the summer of 1985, one early seed crop was obtained. Two successive seed crops (early and late) were taken during July and September in 1986 and 1987. Two related traits; namely 1000-seed weight and number of seeds per pod, were also determined.

Table 1. Mean monthly temperature and relative humidity during the period 1969-1985.

Month	Temperature (°C)		Relative humidity (%)	
	Maximum	Minimum	Maximum	Minimum
January	20.5	8.2	81.2	39.7
February	22.8	8.1	79.9	33.9
March	27.5	13.3	74.1	28.9
April	33.2	17.5	67.7	25.9
May	38.1	21.5	54.0	21.2
June	42.0	24.2	42.1	18.1
July	42.8	25.5	46.2	19.6
August	42.5	24.6	53.7	20.1
September	40.4	21.9	67.5	21.4
October	34.8	17.7	72.9	23.4
November	28.3	13.4	46.4	33.3
December	22.5	8.8	80.6	40.6

A combined statistical analysis over all seed crops obtained in 1985, 1986 and 1987 and overall years was performed [6]. The data included seed yield, 1000-seed weight and number of seeds per pod.

Results and Discussion

Effect of row spacing on seed yield and related traits

In 1985 and 1986, the 75 cm row spacing gave the highest significant seed yield in the early crop (Table 2). Their respective mean values are 436 and 198 kg/ha. In 1987, the highest seed yields were obtained from 60 cm (332 kg/ha) and 75 cm (237 kg/ha) row spacings, but the differences in seed yield among them and the other row spacings (15, 30, 45 and 90 cm) were not significant (Table 2). The mean values for the three years indicated that the highest significant seed yields were produced by the 60 and 75 cm spacings, being 269.5 and 282.75 kg/ha, respectively.

Moreover, for the late seed crop, in 1987, the 60 and 75 cm row spacings produced the highest seed yields (Table 2). However, the mean values of 1986 and 1987 for the late seed crop showed that the 30 cm and 75 cm row spacings gave the highest significant seed yields. Their respective mean values were 167.13 and 154.75 kg/ha.

With respect to the total (early and late) seed yield obtained in 1986 and 1987 and for the overall means of 1986 and 1987, Table 3 reveals that there were significant

Table 2. Mean effect of row spacings (S) and seeding rates (R) on Hassawi alfalfa seed yield obtained during the early (July) and late (September) summers of 1985, 1986 and 1987 and their names.

Treatments	Early seed yield (kg/ha)				Late seed yield (kg/ha)		
	1985	1986	1987	Mean	1986	1987	Mean
Row spacings (S) (cm)							
15	378ab[1]	90c	223	242.33c	194b	84c	138.75b
30	375b	181ab	214	251.67bc	235a	99bc	167.13a
45	354b	146b	223	240.67c	170bc	98bc	133.75b
60	426ab	151b	232	269.50ab	146c	130a	138.0b
75	436a	198a	237	282.75a	185b	125ab	154.75ab
90	359ab	155b	223	256.67bc	175bc	87c	131.00b
Seeding rate (R) (kg/ha)							
5	398	170b	228	265.33	160a	89b	128.33b
10	389	178ab	214	260.33	163a	95b	136.50b
20	393	210a	233	278.66	134b	111ab	160.33a
40	372	180ab	226	272.66	157a	121a	150.42ab
Interaction NS[2] (SXD)		NS	NS	NS	NS	NS	NS

(1) Means of each factor within each column followed by the same letter are not significantly different according to LSD test at 0.05 level.

(2) NS = Not significant

Table 3. Mean effect of row spacings (S) and seeding rates (R) on Hassawi alfalfa total seed yields obtained in 1985, 1986 and 1987.

Treatments	Seed yield (kg/ha)			
	Early (only) (1985)	Early & late (1986)	Early & late (1987)	Overall means of early and late 1986 and 1987
Row spacings (S) (cm)				
15	378ab[1]	284c	307b	295.5b
30	375b	416a	313ab	364.5a
45	354b	316bc	321ab	318.5b
60	426ab	297c	362a	329.5b
75	436a	383a	362a	372.5a
90	359ab	330b	310b	320.0b
Seeding rates (R) (kg/ha)				
5	398	330	317	323.5
10	389	341	309	325.06
20	393	344	344	344.0
40	372	337	347	342.0
Interaction (SXR)	NS[2]	NS	NS	*[3]

(1) Means of each factor followed by the same letter within each column are not significantly different according to LSD test at 0.05 level.
(2) N.S. = Not significant
(3) * = Significant at 0.05 level

differences due to row spacing treatments. It was shown in this Table that, in 1986 the 30 and 75 cm row spacings produced the highest significant seed yields (being 416 and 383 kg/ha, respectively) and also for the overall means of early and late 1986 and 1987. However, in 1987, the 60 and 75 cm row spacings gave the highest seed yields (their respective values were 362 and 362 kg/ha). The above results agreed with those obtained by Zaleski [2] and Timergaziv [5].

Timergaziv [5] indicated that the use of wider rows allowed light penetration in the plant canopy of alfalfa and increased soil and air temperature, all of which favored nectar secretion and encouraged insect pollination that might increase seed production.

The mean values of agronomic traits, related to seed production, are presented in Table 4 which reveals that row spacing did not show any significant effect on the 1000-seed weight in the early seed crop of 1985, 1986 and 1987. However, significant variations in the 1000-seed weight were found among row spacings in the late seed crop. In 1986, the highest significant 1000-seed weight (3.57 gm) was that of 75 cm row spacing. However, much value was produced by the 30 cm row spacing in 1987.

Table 4 further indicates that row spacing had a significant effect on the number of seeds/pod in the early seed crop of 1985. The 90 cm spacing produced a significantly higher number of seeds per pod (4.23) than the 15 cm (3.71) spacing but, there were no significant differences among 15, 30, 45, 60 and 75 cm row spacings. However, in the early crop of 1986 and 1987 and their overall mean, the number of seeds per pod was not significantly affected by the varying row spacing.

For the late seed crop of 1986, row spacings had no significant effect on the number of seeds per pod, but in 1987, significant variations were recorded due to spacing treatments (Table 4). The 90 cm gave a significantly higher number of seeds per pod (3.96) than the 30 cm spacing (3.45). However, there were no significant differences among the other spacing treatments (Table 4).

Concerning the overall mean of the late (September) crop of 1986 and 1987, row spacings did not show any significant effect on the number of seeds per pod.

Effect of seeding rate on seed yield and related traits

Table 2 shows that increasing seeding rates from 5 to 40 kg/ha did not result in any significant difference for the seed yield in the early crops of 1985 and 1987. However, in 1986, seeding rate of 20 kg/ha produced the highest seed yield (210 kg/ha), while the 5 kg/ha seeding rate resulted in the lowest significant seed yield (170 kg/ha). Also, for the overall means of 1985, 1986 and 1987, there were no significant differences among the seeding rate treatments. But, the 20 kg/ha gave the highest nonsignificant seed yield, being 278.7 kg/ha.

For the late seed yield of 1987 and the overall mean of 1986 and 1987, the seeding rates of 20 and 40 kg/ha gave the highest significant seed yields (Table 2), compared to the other rates.

Furthermore, Table 3 shows that seed yield per year was not significantly influenced by seeding rates, although the seeding rate of 20 kg/ha gave marginally the highest non-significant seed yield in 1986 (344 kg/ha) and also for the overall mean of the early and late crops of 1986 and 1987 (344 kg/ha).

Table 4. Mean effect of row spacings (S) and seeding rates (R) on some agronomic traits related to seed production obtained during the early and late seed crops of 1985, 1986 and 1987 and the overall mean.

Treatments	1000-seed weight (gm)							Number of seeds/pod						
	Early (July)				Late (September)			Early (July)				Late (September)		
	1985	1986	1987	Overall mean	1986	1987	Overall mean	1985	1986	1987	Overall mean	1986	1987	Overall mean
Row spacing (S) (cm)														
15	3.184[1]	4.10	4.83	4.04	3.37cd	3.63c	3.50c	3.71b	4.2	2.52	3.48	3.6	3.78ab	3.71
30	3.228	4.10	4.88	4.07	3.47b	3.96a	3.71a	3.75ab	4.3	2.73	3.46	3.2	3.45b	3.47
45	3.028	4.10	4.78	3.97	3.37d	3.76bc	3.56bc	3.98ab	4.4	2.41	3.59	3.2	3.66ab	3.68
60	3.256	4.10	4.78	4.04	3.32d	3.79b	3.55bc	3.83ab	4.9	2.23	3.65	3.1	3.59ab	3.48
75	3.227	4.08	4.75	4.02	3.57a	3.76c	3.68ab	4.19ab	4.2	2.19	3.52	3.2	3.60ab	3.51
90	3.208	4.20	4.66	4.02	3.41bc	3.71bc	3.56bc	4.23a	4.8	2.14	3.72	3.3	3.96a	3.62
Seeding rates (R) (kg/ha)														
5	3.219a	4.1	4.86	4.06	3.4	3.63c	3.51b	3.95	4.6	2.19	3.58	3.3	3.89a	3.7
10	3.177a	4.2	4.86	4.08	3.4	3.77b	3.61ab	3.91	4.8	2.47	3.72	3.2	3.65ab	3.6
20	3.240a	4.1	4.85	4.06	3.4	3.77b	3.59ab	4.07	4.2	2.38	3.55	3.2	3.66ab	3.5
40	3.238a	4.1	4.73	4.04	3.4	3.90a	3.64a	3.86a	4.4	2.20	3.48	3.4	3.49b	3.5
Interaction (SXR)	NS[2]	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

(1) Means followed by the same letter within each column for each factor are not significantly different according to LSD test at 0.05 level.

(2) NS = Not significant

The data in Table 4 revealed that, both the 1000-seed weight and number of seeds per pod were not significantly affected by the varying seeding rates for the early crop of 1985, 1986 and 1987 and the overall mean of the three years. The same effect was found for the late crop of 1986, for both traits. The reverse of that was found in the late crop of 1987, the seeding rate of 40 kg/ha gave significantly higher 1000-seed weight (3.64 gm) than the other seeding rate treatments. Moreover, in the late crop of 1987, the seeding rate of 5 kg/ha, produced a significantly higher number of seeds per pod (3.89) than the 40 kg/ha seeding rate treatment (3.49). The overall mean of early and late seed crops were not significantly affected by seeding rates for both traits (Table 4).

Effect of row spacing X seeding rate interaction

The interaction (SXR) for the early and late seed yields in 1985, 1986 and 1987 and their means was not significant (Table 2). This indicates that the response of seed yield to row spacing was the same, irrespective of the different seeding rate treatments. Similarly, for the total seed yield obtained in 1985, 1986 and 1987, the interaction between row spacing and seeding rate was not significant (Table 3), except, for the overall mean of the total seed yields of 1986 and 1987, where it was significant. The highest (407 kg/ha) and the lowest (259.5 kg/ha) overall mean values were those of 30 cm row spacing and 20 kg/ha seeding rate on one hand and 15 cm row spacing and 5 kg/ha seeding rate, respectively (Table 4). This suggests that the response of total seed yield per year to row spacing changes with the variation of the level of seeding rate.

In addition, the results in Table 4 demonstrated that the (S X R) interaction was not significant either for the 1000-seed weight or the number of seeds per pod in all cases. This indicates that the response of the two traits to row spacing did not change with the variation of the levels of seeding rate.

Among the various row spacings and seed rates compared, the 75 cm spacing and the 5 kg/ha seeding rate were found to be the best treatments for seed yield. This suggests that spacing less than 75 cm is not recommended for seed production and the seeding rates of more than 5 kg/ha are considered wasteful.

Acknowledgment. The author expresses his deep gratitude to King Abdulaziz City for Science and Technology, Saudi Arabia, for giving him the opportunity to conduct this study under grant. Thanks are due to Dr. Mohammad S. Al-Kahtani, the President of King Faisal University, for facilities provided for this investigation. The author also thanks Mr. Ahmed Khatter for his technical assistance in this study.

References

[1] Metcalfe, D.S. Forage Statistics. In: *Forages*. Heath M.E., D.S. Metcalfe and R.E. Barnes. (Eds.). Ames, Iowa: The Iowa State University Press, 1975.

[2] Zaleski, A. "Lucerne Investigation. 1. Identification and Classification of Lucerne Varieties and Strains." *J. Agric. Sci.* Vol. 44, (1954), 199.

[3] Fesko, K.Y.A. and Vazhov, V.M. "Effect of Irrigation and Fertilizers on Seed Yields of Lucerne Sown by Different Methods." 1978. Abstracted from Herbage Abstracts. Vol. 51, No. 8 (1981), 422.

[4] Zhuravlev, A.A. and Savelev, G.D. "Effect of Plant Spacing on Lucerne Seed Yields in the Non-chernozem Zone." U.S.S.R. 1979. Abstracted from Herbage Abstracts, Vol. 51, No. 8 (1981), 112.

[5] Timergaziv, C. "New Aspect of Lucerne Production." *Cercetari Agronomice in Moldova* (1976), 81-84. (Cited after Soils and Fertilizers 1977: Abst. No. 3271).

[6] Steel, R.G.D. and Torri, J.H. *Principles and Procedures of Statistics*. 2nd ed. New York: McGraw Hill, 1980.

تأثير مسافة الزراعة ومعدل التقاوي على المحصول البذري وصفتين مرتبطتين بمحصول البرسيم الحجازي (الحساوي)

أحمد عبدالرحمن النعيم و يونس سعداوي كريم

كلية العلوم الزراعية والأغذية، جامعة الملك فيصل، الأحساء، المملكة العربية السعودية، وكلية الزراعة، جامعة الإسكندرية، جمهورية مصر العربية

ملخص البحث. *أجريت تجربة حقلية بمحطة الأبحاث الزراعية بجامعة الملك فيصل بالأحساء خلال أعوام ١٩٨٤-١٩٨٧م لدراسة تأثير المسافة بين السطور ومعدل التقاوي على المحصول البذري للبرسيم الحساوي. تضمنت الدراسة ست مسافات هي ١٥، ٣٠، ٤٥، ٦٠، ٧٥، ٩٠سم، وأربعة معدلات تقاوي هي ٥، ١٠، ٢٠، ٤٠كجم/هكتار. في صيف السنة الأولى تم أخذ محصول بذري واحد (مبكر) بينما في صيف كل من السنتين الثانية والثالثة (١٩٨٦ و١٩٨٧م) تم أخذ محصولين من البذور (مبكر ومتأخر) ودلت النتائج على أن المحصول البذري المبكر في ١٩٨٥م قد سجل أعلى إنتاج عند استخدام مسافتي ٦٠، ٧٥سم، وكان متوسط المحصول الناتج منها ٤٢٦، ٤٣٦كجم/هكتار على التوالي. وبالنسبة لمتوسط المحصول البذري المبكر والمتأخر لعامي ١٩٨٦، ١٩٨٧م قد أظهرت المسافتان ٣٠، ٧٥سم تفوقًا في المحصول البذري على المسافات الأخرى والتي أعطت ٣٦٤,٥، ٣٧٢,٥كجم/هكتار على الترتيب بينما سجل أقل محصول بذري عند استخدام مسافتي ١٥، ٤٥سم حيث كان ٢٩٥,٥، ٣١٨,٥كجم/هكتار على التوالي. وفيما يختص بمعدل التقاوي فقد أظهرت النتائج عدم وجود فروق معنوية في المحصول البذري بين المعاملات في السنوات الثلاث، غير أن معدل ٢٠كجم/هكتار أعطى أعلى محصول من البذور للهكتار.*

ولقد دلت نتائج موسم ١٩٨٦م للمحصول البذري المتأخر على أن استخدام مسافة ٧٥سم بين السطور أظهرت تفوقًا معنويًا في وزن الألف حبة وفي محصول ١٩٨٥م المبكر أعطت المسافة ٩٠سم إنتاجًا أعلى من عدد البذور في القرن بالمقارنة مع ١٥سم بين السطور، وفي المحصول المتأخر لعام ١٩٨٧م فإن المسافة نفسها نتج عنها عدد أكبر من البذور في القرن من المسافة ٣٠سم بين السطور، كما دل ناتج

المحصول المتأخر لموسم ١٩٨٧م على أن معدل التقاوي ٤٠كجم/هكتار أدى إلى زيادة معنوية في وزن الألف حبه عن بقية المعاملات، بيد أن المعدل ٥٠كجم/هكتار قد أظهر تفوقًا معنويًا عن معدل ٤٠كجم/هكتار في عدد البذور في القرن.