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SEEDING RATE EFFECT ON SEED YIELD AND YIELD COMPONENTS OF ALFALFA (*Medicago sativa*)

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ABSTRACT

A four year field experiment was conducted at the Research Site of Tehran Province Agricultural and Natural Resources Research Center in Varamin, Iran to study the effect of seeding rate on seed yield and seed yield components of alfalfa (*Medicago sativa*) during 2005-2008 growing seasons. Seeding rate treatments were 2.5 kg ha^{-1} (SR_1), 5.0 kg ha^{-1} (SR_2), 7.5 kg ha^{-1} (SR_3), 10.0 kg ha^{-1} (SR_4) and 12.5 kg ha^{-1} (SR_5). Seed yield and seed yield components (number of pods per m^2, number seeds per pod and 1000-seed weight) were determined for all treatments. The statistical results of the study indicated that seeding rate significantly (P = 0.01) affected seed yield and number of pods per m^2, but there was no significant difference in number seeds per pod and 1000-seed weight. The maximum value of seed yield (805.0 kg ha^{-1}) and number of pods per m^2 (6610) was obtained in case of SR_1 treatment. Conversely, the minimum value of seed yield (605.7 kg ha^{-1}) and number of pods per m^2 (4620) was observed in case of SR_5 treatment. Therefore, 2.5 kg ha^{-1} was found to be more appropriate seeding rate in improving seed yield of alfalfa in the semi-arid lands of Varamin, Iran.

Keywords: alfalfa, seeding rate, seed yield, semi-arid, Varamin, Iran.

INTRODUCTION

Alfalfa (*Medicago sativa*) is an ancient crop. Charred seeds has been found in archeological sites in Iran dating back 8000 years, and charred from small seeded legumes and grasses collected by people 12000 years ago in present day Syria has also been unearthed. It is speculated that alfalfa was used as forage crop and its seed was eaten by humans (Russelle, 2001).

Additionally, alfalfa is a nutrient rich forage crop that is productive and beneficial agronomically and environmentally in the world (Azarfard, 2008). Alfalfa improves and protects the soil as a result of its robust and perennial root system, fast growing protective canopy and ability to fix atmospheric nitrogen (Shahriari *et al.*, 2007). Its deep and extensive root system reduces erosion by holding soil together, improves water infiltration and contributes to a rhizosphere conducive to growth of beneficial microorganisms (Rezaee-Danesh *et al.*, 2007). Because of its perennial nature, annual tillage is reduced. Its vigorous growth combined with annual harvest during the growing period provides excellent weed control (Martens, 2001). Alfalfa's pesticide requirements are much lower than for other crops (often none). Alfalfa's residual benefit to succeeding crops has been shown to range from 5 to 13 percent probably from disease suppression and fixed nitrogen (Peel, 1998).

Moreover, wildlife enhancement goes hand in hand with alfalfa production. It provides direct feed for deer, upland birds and rodents. It also provides protective habitat for these wildlife and as a consequence, it provides hunting opportunity for predators. Alfalfa also provides feed and habitat to honey bees and other beneficial insects as well as insects that provide feed for birds, reptiles, bats and other small mammals (Putman *et al.*, 2001).

Under normal conditions, 50% to 60% of planted alfalfa seeds emerge and 60% to 80% of emerged seedlings die the first year. A reasonable goal for alfalfa plant density in a year old stand after the first winter is 130 plants per m^2. Math based on the above survival rates leads to a seeding rate of 17.0 kg ha^{-1}. However, research in Wisconsin shows that under good seeding conditions there is no advantage in stand establishment to planting more than 6.0 kg ha^{-1} (Undersander, 1999). Taking into consideration that not all seeding conditions are ideal, extension seeding rate recommendations have been in the range of 14.0-17.0 kg ha^{-1}. Over the years, seeding rates have continued to creep upwards. In addition, seed cost for alfalfa varieties has continued to increase over the years along with the increased seeding rates (Undersander *et al.*, 1999).

Considering the importance, a new look at the effect of seeding rates on long-term alfalfa seed production is necessary to see if reducing seeding rates is an economically viable option to help cut input costs, without sacrificing seed yield and income. At this time, a wide range of seeding rates is being used in Iran without evaluating their effects on seed yield and seed yield components of alfalfa. Therefore, the purpose of this study was to investigate the effect of different seeding rates on seed yield and seed yield components of alfalfa (var. Bami) in the semi-arid lands of Varamin, Iran.

MATERIALS AND METHODS

Experimental site: The experiment was carried out for four consecutive growing seasons (2005-2008) at the Research Site of Tehran Province Agricultural and Natural Resources Research Center in Varamin, Iran. The site is located at latitude of 35° 19' N and longitude of 51° 39' E and is 1000 m above mean sea level, in semi-arid climate in the center of Iran, where the summers are dry and hot while the winters are cool. The soil of the experimental site is a fine, mixed, thermic, Typic Haplocambids sand loam soil.

Soil sampling and analysis: In order to determine soil chemical properties of the experimental site, a composite soil sample was collected from 20 points in the entire plot during each year of study. All soil samples were collected by bulking augured core (internal diameter 7.5 cm) from 0-30 cm soil layer. Soil depth of 30 cm is the average depth for expansion of roots (active crop root zone). The composite soil sample was analyzed in the laboratory for N, P, K, Fe, Mn, Zn, pH and organic carbon. Total N (%) was determined by the macro-Kjeldahl method (Bremner, 1982). Available P (ppm) was found using Bray II method according to Olsen (1982). The exchangeable cations were calculated by the method described by Thomas (1982). Soil pH value was obtained by using a HI9813-5 portable pH/EC/TDS/°C meter (HANNA instruments, Romania, 2002). Soil organic carbon was determined by Walkley-Black procedure (Nelson and Sommers, 1982). Details of soil chemical properties of the experimental site during the study years (2005-2008) are given in Table-1.

Table-1. Soil chemical characteristics of the experimental site during the study years 2005-2008.

Date	Depth (cm)	OC (%)	pH	N (%)	P (mg kg^{-1})	K (mg kg^{-1})	Fe (mg kg^{-1})	Mn (mg kg^{-1})	Zn (mg kg^{-1})
2005	0-30	0.62	7.2	0.06	10.5	263	2.84	9.9	2.95
2006	0-30	0.71	7.3	0.07	11.1	277	2.61	9.4	2.92
2007	0-30	0.80	7.2	0.08	11.4	284	2.52	8.9	2.87
2008	0-30	0.85	7.4	0.08	12.1	295	2.45	8.6	2.83

Field methods

The experiment was laid out in a randomized complete block design (RCBD) having four replications. The experiment comprised of five seeding rate treatments, i.e. 2.5 kg ha^{-1} (SR_1), 5.0 kg ha^{-1} (SR_2), 7.5 kg ha^{-1} (SR_3), 10.0 kg ha^{-1} (SR_4) and 12.5 kg ha^{-1} (SR_5). 'Bami' alfalfa variety was planted on May 1, 2005. Alfalfa seeds were planted with a small-plot cone-type drill with 9 rows, 15-cm row spacing. The germination of the seed was 75 percent. The field was rolled after planting. The size of each plot was 4.20 by 10.0 m, while harvested area was approximately 5.0 m^2. A buffer zone of 5.0 m spacing was provided between plots. Recommended levels of N (200 kg ha^{-1}), P_2O_5 (100 kg ha^{-1}) and K_2O (100 kg ha^{-1}) were used as Urea, TSP (triple super phosphate) and SOP (sulphate of potassium), respectively. In the first year of the study (2005) they were incorporated in tillage practices, and surface applied in the second, third and forth years of the study (2005, 2006 and 2007, respectively). Pest and weed controls were performed according to general local practices and recommendations. All other necessary operations were kept normal and uniform for all the treatments.

Weather parameters

The mean monthly rainfall and temperature data of the experimental site for 2005-2008 are given in Figure-1.

Observation and data collection

In the first year of study (2005), the alfalfa was harvested with a sickle bar forage plot harvester and aftermath from the plots was swathed, raked and baled to clear the plots. In the second, third and forth years of study (2005, 2006 and 2007, respectively), number of pods per m^2 was determined by counting the number of pods in one square meter area of each plot at harvest. Number of seeds per pods was determined from the 100 samples taken randomly from each plot. Thousand seed weight was determined by counting 1000 seeds for each plot and weighing them on an electronic balance of 0.01 g sensitivity to give the weight of 1000 seeds. Seed yield was determined by harvesting seed from an area of 5.0 m^2 from each plot, and the total seed yield per hectare was estimated.

Data analysis

The data were analyzed statistically using Completely Randomized Block Design (RCBD) according to the procedure described by Steel and Torrie (1984), and Duncan's Multiple Range Test (DMRT) at 1% probability was performed to compare the means of different treatments by using the computer software SPSS 12.0 for Windows (SPSS Inc., 233 S Wacker Drive, Chicago, IL, USA).

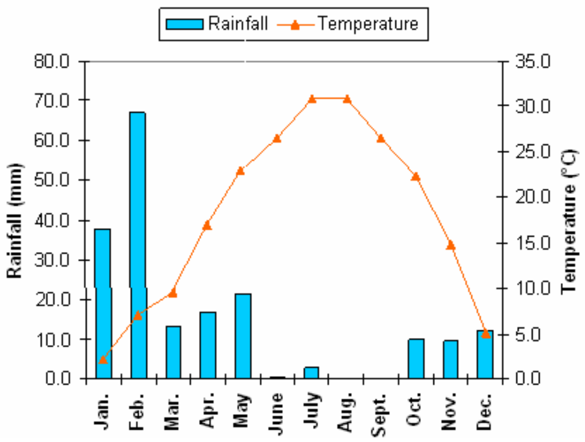

Figure-1. Mean monthly rainfall and temperature data of the experimental site during the study years 2005-2008.

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RESULTS AND DISCUSSIONS

In this study, effect of different seeding rates on seed yield and seed yield components of alfalfa was investigated. The salient components of seed yield such as number of pods per m^2, number of seeds per pods and 1000-seed weight were studied to analyze the effect of different seeding rates on seed yield and seed yield components of alfalfa.

Seed yield

Different seeding rates had a significant effect on seed yield of alfalfa during the years of study (Table-2). The highest seed yield of 805.0 kg ha^{-1} was observed in the SR_1 treatment and lowest (605.7 kg ha^{-1}) in the SR_5 treatment, and seeding rate affected seed yield of alfalfa in the order of $SR_1 > SR_2 > SR_3 > SR_4 > SR_5$ (Table-3). Undersander (1999), Undersander *et al.* (2000), Bohle and Bafus (2007), Bohle and Simmons (2007) and Idris (2008) realized that the prime effect of increasing seeding rate more likely to be due to altered competition within adjacent plants.

Number of pods per m^2

Seeding rate showed a significant effect on number of pods per m^2 during the study years (Table-2). The highest number of pods per m^2 of 6610 was obtained in the SR_1 treatment and lowest (4620) in the SR_5 treatment, and seeding rate affected number of pods per m^2 in the order of $SR_1 > SR_2 > SR_3 > SR_4 > SR_5$ (Table-3). Undersander (1999) and Undersander *et al.* (2000) reported that the number of pods per m^2 appeared to be the least stable yield components in alfalfa, and the increase in the number of pods per m^2 with decreasing seeding rate may be the result of higher net assimilation rates and reduction of competition in lower seeding rates. Stutzel and Aufhammer (1992) and Idris (2008) reported similar findings.

Number of seeds per pod

The effect of seeding rate on number of seeds per pod was not significant during the years of study (Table-2). However, the highest number of seeds per pod of 5.7 was obtained in the SR_1 and SR_2 treatments and lowest (5.5) in the SR_4 and SR_5 treatments (Table-3). These results are in agreement with those of Stutzel and Aufhammer (1992), Undersander (1999), Undersander *et al.* (2000) and Idris (2008) who concluded that number of seeds per pod is a relatively stable character in many crops.

1000-seed weight

The effect of seeding rates on 1000-seed weight was not significant during the study years (Table-2). However, as a general trend, and in contrast to the number of seeds per pod, the highest seeding rate gave the heaviest weight. The highest 1000-seed weight of 2.29 g was obtained in the SR_5 treatment and lowest (2.24) in the SR_1 and SR_2 treatments (Table-3). These results support the findings of Stutzel and Aufhammer (1992), Undersander (1999), Undersander *et al.* (2000) and Idris (2008) that, seed weight is negatively correlated with the number of seeds per pod in many crops. Furthermore, pod abscission in higher seeding rates creates favorable filling conditions for the remaining pods.

Table-2. Mean squares from the analysis of variance of seed yield and seed yield components of alfalfa under different seeding rate treatments (mean of 2005, 2006 and 2007).

Source of variation	Df	Mean square			
		Seed yield	**Number of pods per m^2**	**Number of seeds per pod**	**1000-seed weight**
Replication	3	15.367 ^{NS}	934.583 ^{NS}	119.59 ^{NS}	0.265 ^{NS}
Treatment	4	26403 **	2644308 **	132.57 ^{NS}	0.027 ^{NS}
Error	12	4.867	311.667	57.769	0.049
C.V. (%)	---	3.6	10.0	7.6	5.5

** = Significant at 0.01 probability level
NS = Non-significant

Table-3. Effect of different seeding rate treatments on seed yield and seed yield components of alfalfa (mean of 2005, 2006 and 2007).

Treatment	**Seed yield** (kg ha^{-1})	**Number of pods per m^2**	**Number of seeds per pod**	**1000-seed weight** (g)
SR_1	805.0 a	6610 a	5.7 a	2.24 a
SR_2	709.6 b	5660 b	5.7 a	2.24 a
SR_3	706.3 b	5535 b	5.6 a	2.26 a
SR_4	616.3 c	4700 c	5.5 a	2.28 a
SR_5	605.7 d	4620 c	5.5 a	2.29 a

Means in the same column with different letters differ significantly at 0.01 probability level according to DMRT.

CONCLUSIONS

It can reasonably be concluded that the results of this study showed that seeding rate had significant effect on seed yield of alfalfa in the semi-arid lands of Varamin, Iran. Accordingly, for economical and best seed yield, alfalfa should be planted at 2.5 kg ha^{-1}.

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REFERENCES

Azarfard F. 2008. Effect of Prangos ferulacea replacement for alfalfa on growth performance and carcass characteristics of Lori lambs. Int. J. Agri. Biol. 10: 224-226.

Bohle M. and Bafus R. 2007. Seeding rate effect on irrigated three-cut alfalfa forage production. http://extension.oregonstate.edu/catalog/html/sr/sr1072-e/26.pdf.

Bohle M. and Simmons R. 2007. Seeding rate effect on four-cut alfalfa forage production. http://extension.oregonstate.edu/catalog/html/sr/sr1072-SR1072.pdf.

Bremner J.M. 1982. Total Nitrogen. In: Page A.L. Miller R.H. and Keeny D.R. (Eds.), Methods of Soil Analysis. Part 2, 2nd ed. Agronomy Monograph No. 9. ASA and SSSA, Madison, WI. pp. 915-928.

Idris A.L.Y. 2008. Effect of seed size and plant spacing on yield and yield components of faba bean (*Vicia faba* L.). Res. J. Agri. Biol. Sci. 4: 146-148.

Martens G. 2001. Economics of rotations. In: Proceedings from the 13th annual meeting, conference and trade show of the Saskatchewan Soil Conservation Association. http://ssca.usask.ca/2001 proceedings/01-proce.htm.

Nelson D.W. and Sommers L.E. 1982. Total Carbon, organic carbon and organic matter. In: Page A.L. Miller R.H. and Keeny D.R. (Eds.), Methods of Soil Analysis. Part 2, 2nd ed. Agronomy Monograph No. 9. ASA and SSSA, Madison, WI. pp. 539-579.

Olsen S.R. 1982. Phosphorus. In: Page A.L. Miller R.H and Keeny D.R. (Eds.), Methods of Soil Analysis. Part 2, 2nd ed. Agronomy Monograph No. 9. ASA and SSSA, Madison, WI. pp. 403-430.

Peel M. 1998. Crop Rotations for Increased Productivity, EB-48. NDSU Extension Service. http://www.ext.nodak.edu/extpubs/plantsci/crops/eb48-1.htm.

Putman D. Russell M. Orloff S. Kuhn J. Fitzhugh L. Godfrey L. Kiess A. and Long R. 2001. Alfalfa, wildlife and the environment. California Alfalfa and Forage Association. http://alfalfa.ucdavis.edu/subpages/Wildlife/BrochureFINAL.pdf.

Rezaee-Danesh Y. Mohammadi-Goltapeh E. Alizadeh A. Varma A. and Mukerjii K.G. 2007. Arbuscular-mycorrhizal fungi associated with alfalfa rhizosphere in Iran. American-Eurasian J. Agri. & Environ. Sci. 2: 574-580.

Russelle M.P. 2001. Alfalfa: After an 8000-year journey, the 'Queen of Forages' stands poised to enjoy renewed popularity. American Scientist On-Line. 89 (3) May-June. http://www.americanscientist.org/template/IssueTOC/issue/390.

Shahriari M.H. Savaghebi-Firoozabadi G.R. Azizi M. Kalantari F. and Minai-Tehrani D. 2007. Study of growth and germination of *Medicago sativa* (Alfalfa) in light crude oil-contaminated soil. Res. J. Agri. Biol. Sci. 3: 46-51.

Steel R.G.D. and Torrie J.H. 1984. Principles and Procedures of Statistics. A Biometrical Approach. McGraw Hill Book Co., Inc., New York, USA.

Stutzel H. and Aufhammer W. 1992. Grain yield in determinate and indeterminate cultivars of (*Vicia faba* L.) with different plant distribution patterns and population densities. J. Agri. Sci., Camb. 118: 343-352.

Thomas G.W. 1982. Exchangeable cations. In: Page, A.L., R.H. Miller and D.R. Keeny (Eds.), Methods of Soil Analysis. Part 2, 2nd ed. Agronomy Monograph No. 9. ASA and SSSA, Madison, WI. pp. 159-165.

Undersander D. 1999. Seeding rate of different alfalfa seed lots. Agronomy Advice FC 12.2.1 Aug. University of Wisconsin Cooperative Extension. http://www.uwex.edu/ces/forage/pubs/seed rate.html.

Undersander D. Martin N. Cosgrove D. Kelling K. Schmitt M. Wedberg J. Becker R. Grau C. Doll J. and Rice. M. 2000. Alfalfa Management Guide. NCR547, American Society of Agronomy.