



EFFECT OF DIFFERENT CHEMICAL FERTILIZERS ON SEED YIELD AND SEED YIELD COMPONENTS OF ALFALFA GROWN UNDER STRESS ENVIRONMENT OF WESTERN SAUDI ARABIA

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ABSTRACT

A study was conducted in Hada Al-Sham Research Station, King Abdul Aziz University in Jeddah, Saudi Arabia for two consecutive years (2009-2010) to evaluate the effect of some chemical fertilizers (N, P, K, and NPK) on seed yield and seed yield components of alfalfa grown under stress environment of irrigation water salinity and poor soil. The treatments consisted of N in the form of urea, P in form of superphosphate, K in form of KNO₃ and NPK, all applied at a rate of 50 kg/ha. Significant differences ($P \leq 0.05$) for the fertilizer treatments compared to the control were reported for seed production. Nitrogen in form of urea increased seed yield over the control by 41%, corresponding increments for P, K and NPK over the control were 66%, 37% and 47%, respectively. The effect of treatments on seed yield components was significant for number of pods per raceme but not for number of racemes per plant. Fertilization of alfalfa by N, P, K or their combinations increased seed production of alfalfa under stress environment of western Saudi Arabia.

KEY WORDS: water salinity, alfalfa seed yield, seed yield components, chemical fertilizers.

INTRODUCTION

Arid lands are characterized with fragile ecosystems, low land productivity, limited and/or scarcity of good quality irrigation water and non-sustainable farming systems. The Kingdom of Saudi Arabia entirely lies within arid and semi-arid dry land, with an annual rainfall ranging from 00 to 100mm/annum. The range and forest resources that provide grazing and browsing resources for livestock are also limited. There is a reasonable number of animal resources in the kingdom that is estimated to be over sixteen million heads (camels, sheep, goats and cattle), in addition to a reasonable number of other domestic and game animals. However the main and most traditional approach to livestock production in Saudi Arabia is grazing desert livestock year-round, but mostly during 3 to 4 months of better rangeland productivity and the rest are supplemented by cultivated hay fodders (alfalfa, sorghum, grasses and straw). These high quality forages are available in the market but with increasing prices during the period of low quantity and quality rangeland forages as the dry season begins, as well as, during the peak of livestock marketing times (during *Ramadan*, the two *Eids* and *Al-Hajj*). The strategy of forage production in the Kingdom (Ministry of Water and Agriculture, KSA, 2002) indicated that rangeland produces 20.7 million tons dry matter, of which only 10.35 million tons are palatable and available for animal feed. The study also indicated that this feed is enough for only 2.3 million animal units which represents 50% of the animal units in the Kingdom. Therefore, there is a feed gap of variable magnitude according to the region. For example, the Riyadh area ranked top, followed by Medina and then Najran area with respect to feed shortage.

Leguminous crops constitute a major group of crops in the world. They provide food, feed and fiber for the welfare of humans. Their nutritional value as a source of protein has long been recognized. Only recently, however, leguminous crops have risen to prominence in the KSA (Al-Tahir *et al.*, 1989). The statistics released by the Ministry of Water and Agriculture, KSA (2009) revealed that forage production sector represents 23% of the total cropping area and the area planted with alfalfa in year 2009 was about 102 million ha that produced 2 million tons of dry matter. Area planted with other forages for the same year was 60,400 ha that produced 1021 tons of dry matter. The Riyadh area contributed 47.7% of the total forage produced in the Kingdom, followed by Kasseem area (11.3%), and the Jof area (9.1%). Moreover, the Kingdom imports about 80% of its feed requirements to bridge the forage gap.

As alfalfa represents the most important forage crop in the Kingdom and the bulk of the imports is alfalfa hay in addition to the rising costs of alfalfa seeds, the objective of this study was to evaluate the effect of different chemical fertilizers on seed yield and seed yield components of alfalfa under the stresses of soil and environment in western Saudi Arabia.

MATERIALS AND METHODS

Site Characteristics

The study was carried out in the Experimental Station of the Faculty of Meteorology, Environment and Arid Land Agriculture of King Abdul Aziz University in Hada Al-Sham. The site is located about 40 km north-east of Mecca (21° 48' 3" N, 39° 43' 25" E), at approximately 240 m asl. The site soil has a very poor productivity, with pH ranging from 7.1 to 7.99. The organic matter, calcium carbonate

and cation exchange capacity are low (Al-Solaimani,2003 and Al-Solaimani *et al.*, 2003). Details soil chemical characteristics are presented in Table 1. During the last decade, average monthly temperatures ranged between 23° C in January (winter) and 36° C in July (summer).

Average annual rainfall was low and irregular at the site (100mm/annum). Mean relative humidity ranged between 57% (January) and 20 % or less (June-July) with an average dry season of about 8 months during the year.

TABLE 1. Soil chemical analysis of the experimental site

Soil depth	Chemical analysis								
	pH	EC ds ⁻¹	O.M. %	N (mg/kg)	P (mg/kg)	K (mg/kg)	Ca (mg/kg)	Mg (mg/kg)	Na (mg/kg)
0-30cm	7.89	1.61	0.50	0.32	0.129	2.5	3.6	6.3	16.8
30-60cm	8.25	0.38	0.41	0.30	0.108	2.2	0.9	1.4	6.60
60-90 cm	8.17	0.39	0.41	0.28	0.400	2.0	1.5	5.9	3.80

Land Preparation

The experimental site was ploughed, leveled, ridged 80 cm apart, then flattened of ridges to form a flatten bed between ridges. Plot size was 3X3.2 m, each plot consisted of 3 ridges.

Treatments

Treatments consisted of four chemical fertilizers in addition to the control. These were :

50 kg\ha of urea (46% N) denoted as N

50 kg\ha of triple super phosphate (46% P) denoted as P

50 kg\ha of NPK (20:20:40) denoted as NPK

50 kg\ha of KNO₃ denoted as K

In addition to the control (no fertilizer added)

A Randomized Complete Block Design (RCBD) with three replications was used.

Alfalfa cultivar *Siriver* (from Australia) was used as a test crop, planted in November 2009, cut for forage in 2009-2010 and left for seed production in 2011. Seeding rate was 20 kg\ha of inoculated seeds with *Rhizobium meliloti* prior to planting.

Irrigation

Surface irrigation with plastic pipes running along each ridge and perforated to allow free and uniform flow of water was installed. Irrigation was applied every 3 or 4 days according to weather condition. Borehole water containing 3000 TDS (ppm) was the source of irrigation .Detailed chemical analysis of the irrigation water is presented in table 2.

TABLE 2. Chemical analysis of the irrigation water

pH	Ec ds ⁻¹	Na ⁺ (mg/l)	K ⁺ (mg/l)	Ca ⁺⁺ (mg/l)	Mg ⁺ (mg/l)	Cl ⁻ (mg/l)	SO ₄ ⁻ (mg/l)	NO ₃ ⁻ (mg/l)	HCO ₃ ⁻ (mg/l)	CO ₃ ⁼ (mg/l)
7.40	1.58	164	24.6	160	41	246	221.6	123	246	0

Parameters measured

The parameters measured during the 3rd year study for seed production were number of racemes per plant , number of pods per raceme and total seed yield(kg/ha).

Data analysis

Data were analyzed using the SAS 2000 software and means were separated using the LSD method (Gomez and Gomez, 1984)

RESULTS AND DISCUSSION

Seed yield components

Significant differences (P≤0.05) in the number of pods per raceme for P, K and NPK fertilizer treatments over the control were reported (Table 3). Nitrogen applied in the form of urea , though not significantly different from the control in number of pods per raceme, yet it produced almost double the number of pods per raceme compared to the control.

No significant differences with respect to the number of racemes per plant were reported for the different treatments, yet the fertilized treatments produced more racemes per plant in comparison to the control (Table 3)

TABLE 3. Effect of treatments on seed yield and seed yield components of alfalfa

Treatments	No. of racemes per plant	No. of pods per raceme	Seed yield (kg/ha.)
Control	4.67 a	04.33 b	173.33 b
N	10.00 a	07.67 ab	244.44 a
P	16.00 a	10.33 a	280.33 a
K	07.00 a	09.33 a	237.78 a
NPK	13.33 a	10.00 a	254.44 a
LSD at 0.05	10.54	03.91	49.53
C.V	58.76	24.93	11.05

Figures followed by the same letter(s) within each column are not significantly different at 0.05 level of probability using the LSD Test.

Seed yield (kg/ha)

Alfalfa fertilization with N,P, K or NPK significantly ($P \leq 0.05$) affected seed yield under stress environment of western Saudi Arabia (Table 3). All fertilized treatments produced significantly higher seed yield compared to the control. Phosphorus fertilization increased seed yield of alfalfa by 66% over the control. Corresponding increments for N, K and NPK over the control were 41%, 37% and 47% ,respectively.

It was obvious from the results of table 3 that fertilization of alfalfa with N, P, K or NPK had positive effects on seed yield and seed yield components of the crop under the prevailing conditions of soil salinity (Table 1) and water salinity (Table 2) of the experimental site. It is a well known fact that addition of phosphorus to leguminous forages increases both forage and seed productivity (Ali *et al*,1999; Abusuwar and Mohamed, 1997 in alfalfa; Abusuwar and Abdella, 2001 in Clitoria, and Mohamed Abusuwar 1996 ; Jin *et al*, 1992 in legumes in general). Addition of other fertilizers, *viz.* N,K, and NPK responded positively to seed yield and seed yield components of alfalfa. This might be explained on the poor conditions of the soil and irrigation water available to the site (De Luca *et al*, 2001). It is worth mentioning here that significant responses were reported for forage productivity (Abusuwar and Bakhshwain, 2011) and nutritive value (Bakhshwain and Abusuwar, 2011) of the crop .

CONCLUSION

It can be concluded from the results of this study that application of chemical fertilizers of N, P, K and NPK to alfalfa under the adverse environment of salinity in western Saudi Arabia increased seed production of the crop.

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