The 2nd International Conf. on Water Resources & Arid Environment (2006)

Establishment of acacia plantation in the Central part of Saudi Arabia with the aid of DRiWATER

I. M. Aref[1], L. I. El-Juhany[1] and M. N. Shalby[2]

[1] *Plant Production Dept., College of agric., King Saud Univ., Saudi Arabia*
[2] *Institute of Natural Res. and Environ.King Abdulaziz City for Science and Technology, Saudi Arabia*

Abstract

Six months old seedlings of *Acacia seyal, A. ampliceps, A. gerrardii* var. *najdensis, A. iraqensis, A. farnesiana* and *A. salicina* were planted in a site near Al-Qaseem that is the region in the central part of Saudi Arabia. Zero, two and four DRiWATER refills of a liter each were added to the soil of each species using a randomized complete block design with five blocks. The study was designated to investigate the efficacy of DRiWATER substance on the growth of some acacia trees in the most arid part of the country. The results showed enhancing the growth of acacia species significantly with adding DRiWATER substance. However, no significant increases in the growth traits measured were noticed with increasing the number of DRiWATER refills from two to three. Acacia species responded differently to adding DRiWATER substance. Adding DRiWATER to the newly planted trees in arid and semi-arid regions is important because it increases survival of trees and assists in saving irrigation water added to the plants.
Keywords: Acacia seyal**,** A. ampliceps, A. gerrardii var. najdensis, A. iraqensis, A. farnesiana and A. salicina, DRiWATER, growth.

Introduction

Deserts comprise the major part of the area of Saudi Arabia. Large areas of the country are subjected to continuous sand movement resulted from strong winds during summer. Northwest winds loaded with sand and dust seriously affects many regions of the country and threatening cities, villages, high ways, railways and people's social live. There is no doubt that the issue of planting trees in arid regions has become drawn a deserve attention. This due to the great environmental, economical and social importance of trees and to the difficulties face planting trees in such regions. The constrains that encounter planting trees in arid regions are water scarcity and/or its availability over long intervals, low relative humidity, winds loaded with sand and dust, high temperature, sand movement and lake of protection for trees, particularly in regions with limited forage and fuel woods. Establishment of new tree plantation requires a proper species selection before starting and ensuring suitable irrigation water in its quality and quantity during the early ages of plant's

life. There are three issues should be taken in account for achieving desirable success of afforestation projects. Using tree species suitable for site conditions and/or modifying the site in terms of improving its soil surface, water availability and status of nutritional elements and applying strict protection to minimize all sorts of damage on the site and its plants. In this regard, DRiWATER is a substance has appeared in the markets during the last decade and it said that it is water in a gel form that time releases when it comes in contact with soil. It consists of about 98% water and 2% food grade ingredients. When added to the soil of plants DRiWATER works through breaking down the cellulose Gum by enzyme cellulase which is produced by bacteria naturally found in the soil and then water releases.

The present study aims at examine the possibility of using DRiWATER in establishment some acacia species under prevailing conditions of the central part of Saudi Arabia.

Materials and Methods

Site characteristics

The Experiment was carried out at Al-Grain site in Al-Qaseem region on Al-Qaseem-Al-Madinah Al-Monouwarah high way and lasted 12 months, from February 2001 to February 2002. The site is 75 km south of Buridah City in Al-Qaseem region in the cintral part of Saudi Arabia and has the following characters: 26° 01` 30.81`` N, latitude; 43° 24` 21.69`` E, longitude, 610 m altitude. The soil of the site is sandy loam with average content of 78, 12 and 10% for sand, silt and clay, respectively (Aref *et al*. 2000).

Site preparation

A fence enclosing the site of the experiment for protection from animals was established and 50 × 50 × 50 cm pits were dug in the location before planting.

Plant material

Six months old seedlings of *Acacia seyal* Del., *Acacia ampliceps* Maslin., *Acacia gerrardii* var. *najdensis* Chudhary., *Acacia iraqensis* Rech.f. (K), *Acacia farnesiana* (L.) Willd and *Acacia salicina* Lindly. were used to examine their response to adding DRiWATER substance in the present experiment. These seedlings were produced from seeds after boiling them in water for three to five minuets according to species. The produced seedlings were left in the nursery under normal silvicultural practice for six months before transforming them to the location of the experiment.

DRiWATER substance

DRiWATER as presented by DRiWATER INC. (1993) is water in a gel form that time releases when it comes in contact with soil. It consists of 97.85% water and 2% food grade ingredients. These are cellulose Gum (2%) and Aluminum sulfate (0.15%). DRiWATER works through breaking down the cellulose Gum by enzyme cellulase which

is produced by bacteria naturally found in the soil. These species of bacteria converts DRiWATER back into liquid water. The capillary activity of the soil carries and maintains moisture throughout the root zone for an extended period of time. DRiWATER substance is marketing often in cylindrical refills enclosed within clear polyethylene bags of one liter each.

Treatments and statistical design

DRiWATER substance was added to the soil of each acacia species trees at the rate of zero, two and four refills that represent three treatments in a randomized complete block design with five blocks. In addition to DRiWATER the trees were irrigated every 15 days depending on the field capacity of the soil that was measured before starting the experiment. The amount of water added to each tree was changing over the seasons according to the following regime:

10 liter per tree in each watering time in March, April and May,
20 liter per tree in each watering time in June, July and August,
10 liter per tree in each watering time in September, October and November,
5 liter per tree in each watering time in December, January and February.

Measurements

Stem height and diameter of each tree were measured every three months over the course of the experiment. Relative growth rate (RGR) of both height and diameter was calculated from the conventional equation as the following:

Height RGR = $(\log H_2 - \log H_1) / t_2 - t_1$ = cm cm^{-1} $month^{-1}$,
Diameter RGR = $(\log D_2 - \log D_1) / t_2 - t_1$ = cm cm^{-1} $month^{-1}$,
Where: H_1 and H_2 were the heights at times t_1 and t_2,
D_1 and D_2 were the diameters at times t_1 and t_2 and,
t_1 and t_2 were time at the beginning and the end of each period

Biomass production

Three trees from each treatment were chosen randomly and severed at soil surface and divided into roots, stem, branches and leaves. Number of branches and root length of each tree was measured. Leaves, branches, stem and roots of each tree were dried in an oven at 70 °C for leaves and at 102±3 °C for roots, stem and branches then their dry weight were determined.

Statistical analysis

The collected data were analyzed statistically using analysis of variance procedure through SAS computer program (SAS Institute 1987). The differences between means of treatments and species for each variable measured were distinguished using LSD method.

Results

Adding DRiWATER to the soil of acacia trees in early stage enhanced their growth markedly. Stem diameter and height of the trees increased by 25 and 38% and by 21 and 35% with adding two and four DRiWATER refills, respectively (P<0.0001). However, the

values of both traits did not increasing significantly with increasing DRiWATER refills added from two to four (Table 1). Relative growth rate (RGR) of both stem diameter and height increased with adding DRiWATER refills and had a trend was similar to that of both traits (P<0.0001) (Table 1). Number of branches of the trees increased steadily and by 38 and 62% with adding two and four DRiWATER refills, respectively (P<0.0001) (Table 1). Root length showed a trend was similar to that of both stem height and diameter (P=0.0006) (Table 1).

Table 1. Effects adding zero, two and four DRiWATER refills averaged across Acacia seyal, A. ampliceps, A. gerrardii var. najdensis, A. iraqensis, A. farnesiana and A. salicina trees on diameter (cm tree^{-1}), height (cm tree^{-1}) and their relative growth rates (cm cm month^{-1}), number of branches and root length. Values are means of 30 observation.

Trait	Number of DRiWATER refills added		
	Zero	Two	Four
Diameter (cm tree^{-1})	*9.79^{b}	12.21^{a}	11.84^{a}
Height (cm tree^{-1})	84.22^{b}	114.11^{a}	116.33^{a}
Diameter RGR (cm cm month^{-1})	0.449^{b}	0.534^{a}	0.580^{a}
Height RGR (cm cm month^{-1})	0.836^{b}	1.124^{a}	1.165^{a}
No. branches (branch tree^{-1})	15.39^{c}	21.28^{b}	24.89^{a}
Root length (cm tree^{-1})	59.11^{b}	75.44^{a}	80.83^{a}

*Means followed by the same superscript letters are not significantly different at P<0.05 according to Duncan's multiple test.

Dry matter production of acacia trees increased significantly as a result of adding DRiWATER, with no significant differences between the values of total tree dry weight or its components with increasing DRiWATER refills added from two to four. Leaf, stem and branches, roots and total dry weight increased by 311, 276, 234 and 282% with adding two DRiWATER refills, while increased by 408, 304, 243and 299% with adding four DRiWATER refills, respectively (P<0.0001) (Fig. 1). Root to shoot dry weight ratio decreased significantly with adding two DRiWATER refills added (P<0. 01); with no much change with increasing DRiWATER refills added from two to four (Fig. 3). In all the growth characteristics measured for acacia species there no significant increase was found with increasing the number of DRiWATER refills from two to four, except for the number of branches.

Acacia species varied significantly in their response to adding DRiWATER refills. For mean stem diameter, A. ampliceps, A. farnesiana and A. salicina had similar value that were significantly greater than those of the rest of acacia species (P= 0.005) (Table 2). Stem diameter values ranged between 9.75 cm (A. seyal) and 12.40 cm (A. farnesiana). Although A. seyal had significantly the lowest diameter value however, its mean stem height and number of branches were the greatest among all acacia species, while A. farnesiana had significantly the lowest stem height (P<0.0001) (Table 2). A. gerrardii var. najdensis and A. iraqensis had similar relative growth rates of stem diameter which were greater than those of all other species (P<0.0001). The greatest relative growth rate of stem

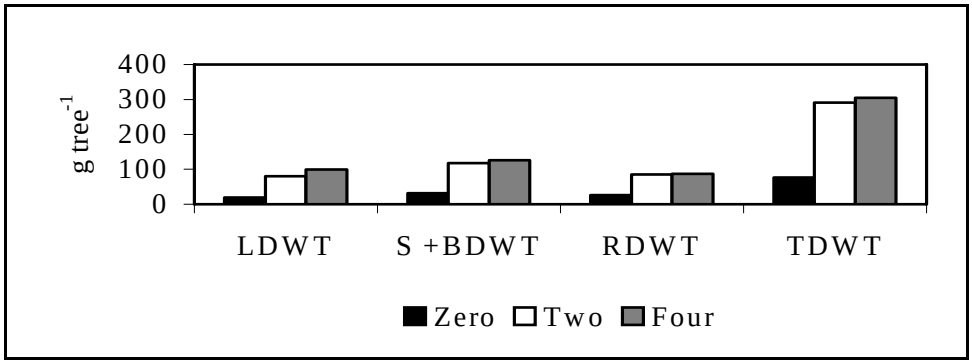

Figure 1. Effects of adding zero, two and four DRiWATER refills on leaf (LDWT), stem and branches (S+BDWT), root (RDWT) and total (TDWT) dry weight production averaged across Acacia seyal, A. ampliceps, A. gerrardii var. najdensis, A. iraqensis, A. farnesiana and A. salicina. Values are means of 18 observation.

height among acacia species was that of A. iraqensis while the lowest was that of A. salicina (P=0.003) (Table 2). Leaf, stem and branches and consequently total dry weight were greater in A. ampliceps than all other species (P<0.0001), (P<0.05) and (P=0.0004), respectively, while the greatest root dry weight was that of A. gerrardii var. najdensis (P=0.006). The lowest values in of total tree dry weight and its components were those of A. iraqensis (P=0.0004) (Fig. 2). Root/shoot dry weight ratio of both A. gerrardii var. najdensis and A. iraqensis were similar and almost five and 1.5 times as much as that of Acacia ampliceps and those of A. seyal, A. farnesiana and A. salicina (P<0.0001) (Fig. 4).

Table 2. Diameter and height (cm tree^{-1}) and their relative growth rates (cm cm month^{-1}), number of branches and root length of Acacia seyal, A. ampliceps, A. gerrardii var. najdensis, A. iraqensis, A. farnesiana and A. salicina averaged across zero, two and four DRiWATER refills added to their soils. Values are means of 15 observation.

Trait	Acacia species					
	Acacia seyal	Acacia amplecips	Acacia gerrardii var. najdensis	Acacia farnisiana	Acacia iraqensis	Acacia salicina
Stem diameter (cm tree^{-1})	*9.75^{b}	11.80^{a}	10.98^{ab}	12.40^{a}	11.00ab	11.75^{a}
Stem height (cm tree^{-1})	140.00^{a}	96.44^{c}	91.56^{cd}	122.89^{b}	81.22^{d}	97.22^{c}
Diameter RGR (cm cm month^{-1})	0.444^{b}	0.476^{b}	0.625^{a}	0.476^{b}	0.596^{a}	0.509^{b}
Height RGR (cm cm month^{-1})	0.972^{cd}	0.988^{bcd}	1.142^{ab}	1.170^{a}	1.087^{abc}	0.893^{d}
No. branches (branch tree^{-1})	41.0^{a}	16.6^{b}	18.2^{b}	17.3^{b}	14.8^{b}	15.2^{b}
Root length (cm tree^{-1})	71.67^{a}	73.78^{a}	80.11^{a}	74.78^{a}	65.44^{a}	65.00^{a}

*Means followed by the same superscript letters are not significantly different at *P*<0.05 according to Duncan's multiple test.

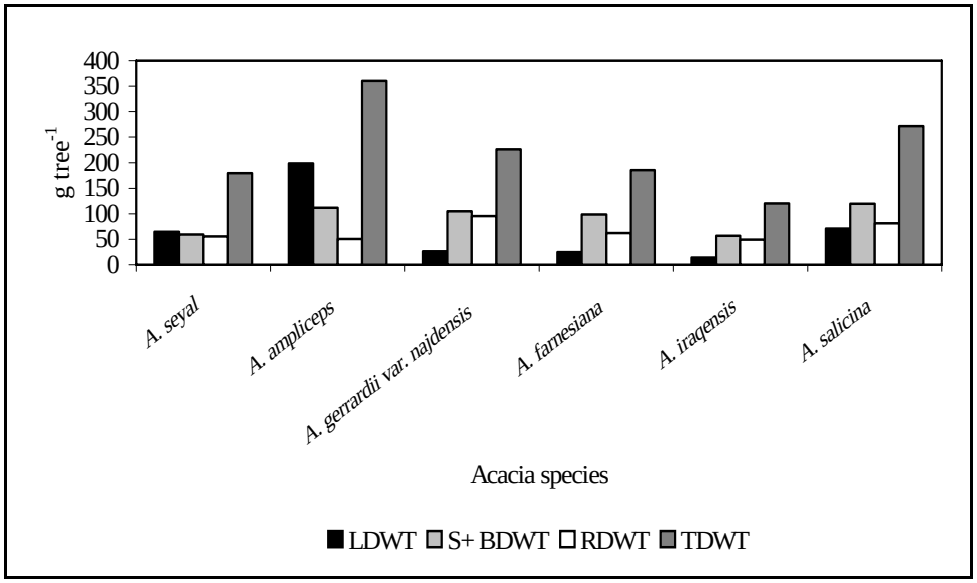

Figure 2. Leaf (LDWT), stem and branches (S+BDWT), root (RDWT) and total (TDWT) dry weight production of *Acacia seyal*, *A. ampliceps*, *A. gerrardii* var. *najdensis*, *A. iraqensis*, *A. farnesiana* and *A. salicina* averaged across adding zero, two and four DRiWATER refills to their soils. Values are means of 9 observations.

There were treatment × species interactions for stem diameter ($P<0.05$), number of branches ($P<0.001$), root length ($P<0.01$), leaf ($P=0.0005$) and total ($P<0.05$) dry weight, root/shoot ratio ($P<0.05$) and relative growth rate of stem height ($P<0.05$) indicating changing the magnitude of treatment effect on these traits from species to another.

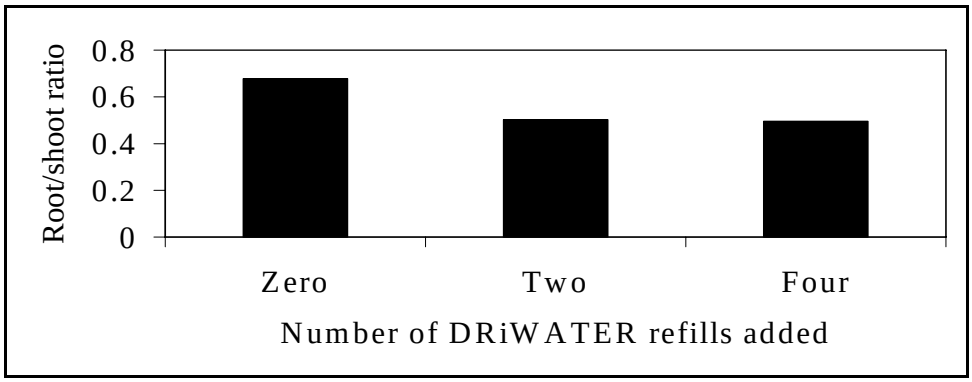

Figure 3. Effects of adding zero, two and four DRiWATER refills on root/shoot dry weight ratio averaged across *Acacia seyal*, *A. ampliceps*, *A. gerrardii* var. *najdensis*, *A. iraqensis*, *A. farnesiana* and *A. salicina*. Values are means of 18 observation.

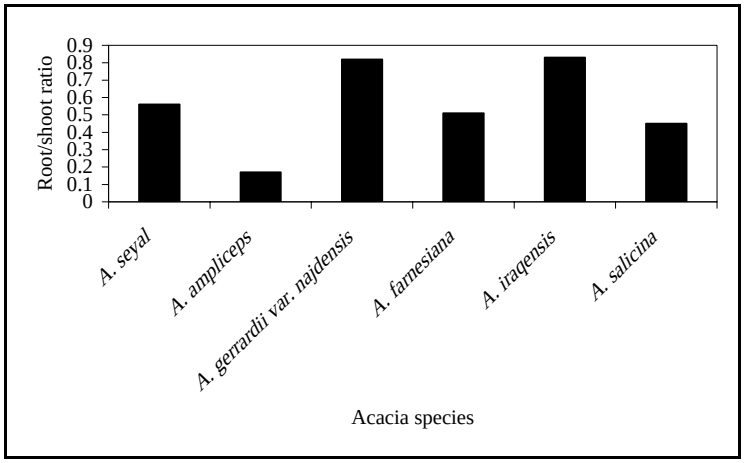

Figure 4. Root/shoot dry weight ratio of *Acacia seyal*, *A. ampliceps*, *A. gerrardii* var. *najdensis*, *A. iraqensis*, *A. farnesiana* and *A. salicina* averaged across adding zero, two and four DRiWATER refills to their soils. Values are means of 9 observations.

Discussion

The results of the present study indicated the efficacy of adding DRiWATER on the growth of acacia species in seedling stage. Dellavalle (1992) used DRiWATER material with some ornamental plants and concluded that efficacy claims for the product were substantiated. Failure of many plantations in their early stages in terms of low survival percentage and weak growth is due to lack of irrigation water. This because the main constrains face establishment of tree plantations in arid regions is the scarcity of water due to low rainfall and high evaporation. Low rainfall characterizes the arid regions while high evaporation rates resulted from high temperature and hot winds. Growth of plants is constrained primarily through photosynthetic performance either directly, as in the case of insufficient illumination, or indirectly via water stress or nutrient shortage (Körner and Menendez-Riedl 1989). Adding water to the newly established tree plantations therefore is necessary. As it is not liquid water, DRiWATER substance is considered a suitable solution to overcome the problem of high evaporation rates and meanwhile provides the new-planted trees with water. It gives water to the plant root zone only when soil start to dry out, where it works (water releases) through breaking down the cellulose Gum by enzyme cellulase which is produced by bacteria naturally found in the soil. Enhancing the growth of acacia trees in seedling stage with adding DRiWATER in the present study concurs with the results obtained by El-Juhany (2003) for *Zizyphus spina-christi* trees in seedling stage. Height, diameter and dry weight of acacia trees increased with adding two DRiWATER refills in the present study with no more increase when the number of DRiWATER refills increased to four. El-Juhany (2003) found no increase in the same growth traits of *Zizyphus spina-christi* trees when the number of DRiWATER refills increased to four. However, each plant species, age of plant and the condition under which plant is grown are the main factors determined the amount of DRiWATER that should be added. From economical point of view, achieving sensible growth, by means of low mortality percentage of the

planted trees, with adding the least possible number of DRiWATER refills is the desirable matter.

Conclusion

Adding DRiWATER to the newly planted trees under the privilege conditions in arid and semi-arid regions is of a great importance. This because lowering the mortality percentage of trees in sites of afforestation or reforestation to the level with which no re-plant for the empty pits is needed considers a great success as re-planing is a difficult and costly process. Furthermore, DRiWATER assists in lengthening irrigation intervals that may result in saving the amount of water added to the plants.

References

Aref I. M.; M. N. Shalaby; T. A. Turky; Y. M. Addol; Kh. N. Al-Mousa; A. Al-Harby and T. Al-Ghoneem. 2000. Project of Studying Afforestation of Al-Qaseem-Al-Madenah Al-Monawarah-Yunbu-Rabigh High Way. Ministry of Transportation, Riyadh, Kingdom of Saudi Arabia.

Dellavalle, N. B. 1992. Efficacy test of DRiWATER: a slow water release substrate. Communications in Soil Science and Plant Analysis, 23: 17-20. A paper presented at "the international symposium on soil testing and plant analysis in the global community", 22-27 August 1991, Orlando, Florida, USA; 3 ref.

DRiWATER INC. 1993. DRiWATER Soil Amendment, Material Safety Data- Sheet. 715 South Point Blvd., Suite P, Petaluma, CA 94954, USA.

El-Juhany L. I. 2003. Evaluation of DRiWATER effects on the growth of *Zizyphus spina-christi* seedlings under different watering regimes. *Alexandria Science Exchange* 24(2): 191-199.

Körner C. and Menendez-Riedl S P. 1989. The significance of developmental aspects in plant growth analysis. In: H Lambers, M L Cambridge, H Konings and T L Pons (editors), Causes and Consequences of Variation in Growth Rate and Productivity of Higher Plants, pp. 141-157. SPB Academic Publishing bv, The Hague.

SAS. 1987. SAS Application Guide. SAS Institute. Cary, North Carolina, USA.

زراعة أنواع الأكاسيا في المنطقة الوسطى من المملكة العربيّة السعوديّة بمساعدة DRiWATER*

إبراهيم عارف[1] و لطفي الجهني[1] و نبيل شلبي[2]

[1] *قسم الإنتاج النباتي – كلية علوم الأغذية و الزراعة – جامعة الملك سعود– السعودية*
[2] *معهد الموارد الطبيعيّة و البيئة – مدينة الملك عبد العزيز للعلوم و التقنية – السعودية*

أجريت هذه الدراسة في موقع قريب من القصيم و هي منطقة تقع في وسط المملكة العربيّة السعوديّة حيث زرعت شتلات عمرها ستة شهور من أنواع الأكاسيا A cacia seyal و A. Ampliceps و A. iraqensis و A. gerrardii var. najdensis و A. farnesiana و A. salicina . بعد الزراعة أضيف إلى تربة كل نوع من أنواع الأكاسيا عبوات DRiWATER ذات حجم لتر واحد بمعدّل صفر و اثنين و أربعة من خلال تصميم قطاعات عشوائيّة كاملة ذي خمس قطاعات. و قد صُممت هذه الدراسة لفحص فعاليّة مادة DRiWATER في نمو بعض أنواع الأكاسيا تحت ظروف الحقل في أكثر أجزاء البلاد جفافاً. أوضحت النتائج زيادة معنويّة في نمو أشجار الأكاسيا مع إضافة DRiWATER. و مع ذلك لم يكن هناك زيادات معنويّة في صفات النمو المقاسة مع زيادة عدد عبوات DRiWATER من اثنين إلى ثلاث. هذا و قد اختلفت أنواع الأكاسيا في مدى استجابتها لإضافة DRiWATER. تعتبر إضافة مادة DRiWATER مهمّة للنباتات المترعة حديثاً في المناطق الجافّة و شبه الجافّة لأنّها تزيد من نسبة بقاء الأشجار و تساعد على توفير ماء الري المضاف للنباتات.

* استخدام أسماء المواد التجارية لا يتضمن تبنيها من قبل المؤلفون و لا تفضيلها على منتجات أخرى مشابهة غير مذكورة.