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Research paper

Impact of Herbicides Glyphosate 41% S.L. and 2, 4-D 600 S.L. on Mesquite (*Prosopis juliflora* Swarz- DC) Growth and Control

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Abstract

The experiment was carried out at the Faculty of Agricultural Studies, Shambat, Sudan University of Science and Technology for two consecutive summer seasons of the years 2016 and 2017 to evaluate and compare the impacts of two post-emergence herbicides applied in Sudan: glyphosate 41% E.C. applied at 7.90, 9.20 and 10.60 l/fed (0.42 ha) and 2, 4-D 600 SL applied at 2.60, 3.90 and 5.20. l/fed., to determine the most suitable mesquite control treatment. Results showed that all herbicides treatments at their different rates significantly reduced plant height (cm), number of leaves/plant and number of leaflets/plant. The lowest Plant height (cm), number of leaves/plant and number of leaflets/plant was achieved by the highest rates of glyphosate and 2, 4-D. The highest plant height control efficiency (PHCE), number of leaves/plant control efficiency (NLCE) and number of leaflets/plant control efficiency (NLLCE) was achieved by the highest rate of glyphosate. Within the two herbicides treatments the best mesquite control was achieved with glyphosate at highest rate.

Keywords: Consecutive, control efficiency, evaluate, leaflets, post-emergence

تأثير مبيدات الحشائش جليفوسيت 41% أس أل وتو فور دي 600 أس أل على نمو ومكافحة المسكيت (*Prosopis juliflora* Swarz - DC)

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المستخلص

أجريت التجربة في كلية الدراسات الزراعية – شمبات – جامعة السودان للعلوم والتكنولوجيا لموسمين صيفيين متعاقبين للعامين 2016م و2017م لتقييم ومقارنة تأثيرات مبيدي حشائش مستعملان رشاً بعد الانبثاق في السودان: جليفوسيت 41% أس أل طبق بمعدل 7.90، 9.20 و10.60 لتر/فدان وتو فور دي 600 أس أل طبق بمعدل 2.60، 3.90 و5.20 لتر/فدان لتحديد أنسب معاملة لمكافحة المسكيت. أوضحت النتائج أن جميع معاملات مبيدات الحشائش بمعاملاتها المختلفة قللت معنوياً ارتفاع النبات بالسم، عدد الأوراق في النبات وعدد الوريقات في النبات. أقل ارتفاع للنبات بالسم، عدد الأوراق في النبات وعدد الوريقات في النبات قد أنجز بالمعدلات العالية للجليفوسيت والتو فور دي. أعلي مكافحة فعالة لارتفاع النبات، أعلي مكافحة فعالة لعدد الأوراق في النبات وأعلي مكافحة فعالة لعدد الوريقات في النبات قد أنجز بالمعدل العالي للجليفوسيت. بمقارنة المعاملات المختلفة لمبيدي الحشائش وجد أن أفضل مكافحة قد أنجزت بالمعدل العالي للجليفوسيت.

كلمات مفتاحية: متعاقب، فاعلية المكافحة، تقييم، الوريقات، بعد الانبثاق.

Introduction

Prosopis spp. (mesquite) are multi-purpose evergreen leguminous trees or shrubs. The genus comprises 44 species of which 40 are natives to the Americas, four spread globally, *P. juliflora, P. pallida, P. glandulosa, and P. relutina* (Ahmed, 2009 and Pasiecznik *et al.* 2004). Mesquite grows in arrays of environments and is not restricted by soil type, pH, and salinity or fertility (Babiker, 2006). Common mesquite (*P. juliflora* Swartz, DC.), often multi-stemmed with a spreading crown of pendulous branches hanging down to the ground, is a copious seed producer (Babiker, 2006). Tap roots reach deep water tables and extensive lateral roots spread well beyond the crown. The rapidly growing root system and un palatability of foliage increase seedling survival rate and competitiveness particularly in heavy grazed areas and/or on uncultivated fallows. The trees are believed to deplete groundwater reserves and to smother and suppress, through both allelopathic and competitive effects, growth of neighboring plants (Ahmed, 2009). *Prosopis* pollens are said to be a major cause of allergic reactions and the thorns are poisonous and/or promotive to secondary infections on prickling (Ali and Labrada, 2006).

Mesquite has role in combating desertification and supply of high-value mechanical wood products, firewood and charcoal, It provides shelters, animal feed and food for humans in areas where protein intake is very low and under adverse conditions of drought and famines (Chog and Chikamai, 2006).

However, in most of the countries where it was introduced, mesquite has spread outside where it was originally planted and has become a serious weed (El Houri, 1986). Ease of spread of mesquite is consistent with its invasive nature, ease of adaptations to novel environments, lack of natural enemies and underutilization and mismanagements (Ali and Labrada, 2006 and Babiker, 2006). Thus, common mesquite has become a formidable weed in several countries. It is noteworthy that exploitation of mesquite for wood and non-wood products in Sayun and Tarim in Yemen (Ali and labrada, 2006).

P. juliflora, was introduced into Sudan in 1917 from South Africa and Egypt and planted in Khartoum with the primary objective of curbing desertification and providing fire wood and thus preserving indigenous trees (Babiker, 2006 and Chog and Chikamai, 2006). The success attained in establishment and the ability to tolerate drought, fix sand dunes and capacity to furnish shade, fuel, timber and fodder (Babiker, 2006). In the period 1978-1981 the tree was planted as shelterbelts on premises of major cities in eastern Sudan (Babiker, 2006) and more introductions were made into various places in western and central Sudan. The tree was planted in shelter belts around farms, irrigated schemes and along the Nile (Chog and Chikamai, 2006), its deliberate distribution within the country, prevailing drought, livestock and feral animal's movement coupled with decreased land-use, land tenure, underutilization of the plant, mismanagement and over exploitation of natural vegetation have led to spread of mesquite into various locations where it has become a national pest (El Houri, 1986). The plant constitutes a threat to agriculture, biodiversity and may lead to deterioration of natural vegetation and pastures (Ali and Labrada, 2006).

In Sudan, as in other countries, where mesquite has been introduced, it is underutilized. Its use, beside sand dune fixation is limited to fuel wood and charcoal production (Babiker, 2006). Several efforts were made in Sudan, to eradicate mesquite. However, because of high cost and complexity of the problem, most of the efforts were not successful or sustainable. In 1995 the government approved a bill on mesquite management. Active eradication programmes, using both mechanical and manual methods for uprooting mesquite, were implemented in various locations in the country, at very high cost, and with variable results (Babiker, 2006). Soil disturbance resulting from uprooting brings mesquite seeds to the surface soil and aids regeneration (Ahmed, 2009). The huge seed bank and basal buds endow mesquite with a high capacity for regeneration after cutting and/or uprooting. To curtail mesquite invasion seed movement should be discouraged or the seeds should be devitalized, satellite foci should reduce establishment, over exploitation of natural vegetation and overgrazing of marginal land should be discouraged. The treated area has to be vigilantly observed and interventions by chemical and/or mechanical mean should be implemented to discourage regeneration (Chog and Chikamai, 2006).

Thus, this study was conducted to evaluate and compare the effects of two widely used post-emergence herbicides in Sudan, namely, glyphosate and 2, 4-D, 600 SL. to determine the most suitable mesquite control treatment.

Materials and methods

P. juliflora pods were collected from mesquite growing within the premises of the Faculty of Agricultural Studies at Shambat, Khartoum Bahri, Khartoum State Sudan (Latitude 15° 40` N and Longitude 32° 23` E,) (Babiker *et al*., 2013) during 2015 and 2016 winter seasons. Seeds were extracted with a home kitchen blender, cleaned and stored at room temperature till used. Plastic pots perforated at the bottom were filled with sterilized soil and sand mixture, mechanically scarified seeds of *P. juliflora* were sown on the 19 March for the two consecutive summer seasons of the years 2016 and 2017 in plastic pots (5 seeds/pot). The seedlings were later thinned to two seedlings/pot at 2 weeks after emergence and were allowed to grow for an additional 6 weeks prior to herbicides treatments. Irrigation water was applied at 10-15 days interval according to temperature and other environmental conditions. In this experiment, the design used was randomized complete block design (RCBD) with four replications. Two herbicides glyphosate and 2, 4-D were applied as aqueous as post-emergence treatments 10 weeks after sowing with a knapsack sprayer at a volume rate of 100 liters per feddan and a pressure of 4 bars with a flood jet nozzle, as follows:

(i) glyphosate 41% E C. at 7.90, 9.20 and 10.60 l/fed.

(ii) 2, 4-D 600 SL at 2.60, 3.90 and 5.20 l/fed.

Untreated pot (control) treatment was included for comparison. The seedlings were observed for chlorosis, mortality and regeneration over a period of 2 months. Growth parameters (plant height, number of leaves/plant and number of leaflets/plant) were recorded by taking 2 plants from each plot, then the mean was obtained. Also plant height control efficiency (PHCE) was calculated by using the following equation:

$$PHCE= (PHC – PHT) \div PHC \times 100$$

Where;
PHC = Plant height from control plot.
PHT = Plant height from treated plot.

Also number of leaves/plant control efficiency (NLCE) and number of leaflets/plant control efficiency (NLLCE) were calculated using the above equation putting each of them instead of plant height.

Analysis of variance (ANOVA) was carried out on data obtained as described by Gomez and Gomez (1984) using the statistical analysis system (SAS) computer package for SAS Institute Inc., 1990, to detect significant effects among the treatments and populations compared. Mean squares for treatments or populations were calculated. Simple statistics including mean, standard deviation, standard error and coefficient of variation (C.V.%) were also calculated.

Results and discussion

The results of both summer seasons indicated that, all herbicides treatments significantly reduced mesquite plant height (cm) as compared to the control. The lowest plant height was achieved by the highest rates of glyphosate and 2, 4-D (Table 1).

Combined analysis of both summer seasons indicated that, all herbicides treatments significantly increased plant height control efficiency (PHCE) as compared to the control. The highest (PHCE) was achieved by the highest rate of glyphosate followed by the highest rate of 2, 4-D, but there was no significance difference between them (Table 1). These results could be attributed to the stimulation of production of reactive oxygen species (ROS) e.g., $OH\cdot$, $O_2\cdot$, H_2O_2. by High concentrations of these herbicides which cause considerable damage per oxidation of membrane lipid components through direct interaction with various macro molecules. Similar results were found by Xiaowen *et al.* (2014) and Foyer and Nactor (2005).

Table (1): Effects of herbicides treatments on mesquite plant height (cm) and PHCE % after 4weeks from application during summer seasons (2016, 2017, combined)

Treatments	Herbicide rate (l/fed.)	Plant height (cm)	PHCE %
Glyphosate R_1	7.90	12.50 b	13.79 c
Glyphosate R_2	9.20	11.60 b	20.00 b
Glyphosate R_3	10.60	8.60 c	40.69 a
2, 4-D R_1	2.60	12.00 b	17.24 c
2, 4-D R_2	3.90	11.60 b	20.00 b
2, 4-D R_3	5.20	9.60 c	33.79 ab
Control	-	14.50 a	0.00 d
CV%	-	1.89	1.59
SE±	-	5.04	3.18

Means followed by the same letter (s) within each column do not differ significantly at 5% level of probability according to Duncan's Multiple Range Test.
PHCE = plant height control efficiency.

The mean readings of both summer seasons indicated that, all herbicides treatments significantly reduced number of leaves/plant as compared to the control. The lowest number of leaves/plant was achieved by the highest rates of glyphosate and 2, 4-D followed by the medium rates of glyphosate and 2, 4-D (Table 2).

Combined analysis of both summer seasons indicated that, all herbicides treatments significantly increased number of leaves/plant control efficiency (NLCE) as compared to the control. The highest (NLCE) was achieved by the highest rate of glyphosate followed by the medium rate of glyphosate and the medium and the highest rates of 2, 4-D (Table 2).

These results could be attributed to the stimulation of production of reactive oxygen species (ROS) by these herbicides which, promotes oxidative damage to proteins, lipids, and nucleic acids and this oxidative damage achieved low number of leaves/plant and high number of leaves/plant control efficiency (NLCE) in treated plots. These findings are in line with those obtained by Sandalio *et al.* (2012) and Yashodhara and Gupta (2010).

The combined analysis of both seasons revealed that, all herbicides treatments significantly reduced number of leaflets/plant as compared to the control. The lowest number of leaflets/plant was achieved by the highest rate of glyphosate followed by the medium rate of glyphosate and the highest rate of 2, 4-D (Table 3).

Table (2): Effects of herbicides treatments on number of leaves/plant and NLCE % after 4weeks from application during summer seasons (2016, 2017, combined)

Treatments	Herbicide rate (l/fed.)	Number of leaves/plant	NLCE %
Glyphosate R_1	7.90	7.00 b	61.11 c
Glyphosate R_2	9.20	4.00 c	77.78 b
Glyphosate R_3	10.60	2.00 d	88.89 a
2, 4-D R_1	2.60	9.00 b	50.00 d
2, 4-D R_2	3.90	5.00 c	72.22 b
2, 4-D R_3	5.20	3.00 d	83.33 b
Control	-	18.00 a	0.00 e
CV%	-	2.21	1.91
SE±	-	3.96	2.94

Means followed by the same letter (s) within each column do not differ significantly at P (0.05).
NLCE = number of leaves/pant control efficiency.

Combined analysis of both seasons showed the significant increasing of number of leaflets/plant control efficiency (NLLCE) due to herbicides treatments. However, the highest NLLCE was achieved by the highest rate of glyphosate followed by the highest rate of 2, 4-D and the medium rate of glyphosate (Table 3).

These results could be again attributed to the stimulation of production of reactive oxygen species by these herbicides which, promotes oxidative damage to nutrients which may lead to low number of leaflets/plant and high number of leaflets/plant control efficiency (NLLCE). The similar findings were reported by Sandalio *et al.* (2012) and Yashodhara and Gupta (2010).

Table (3). Effects of herbicides treatments on number of leaflets/plant and NLLCE after 4weeks from application during summer seasons (2016, 2017, combined)

Treatments	Herbicide rate (l/fed.)	Number of leaflets/plant	NLLCE
Glyphosate R_1	7.90	100.00 b	67.32 c
Glyphosate R_2	9.20	64.00 c	`79.09 b
Glyphosate R_3	10.60	32.00 d	89.54 a
2, 4-D R_1	2.60	153.00 b	50.00 d
2, 4-D R_2	3.90	110.00 b	64.05 cd
2, 4-D R_3	5.20	68.00 c	77.78 b
Control	-	306.00 a	0.00 e
CV%	-	2.83	2.01
SE±	-	4.01	3.12

Means followed by the same letter (s) within each column do not differ significantly at p (0.05).
NLLCE = number of leaflets/plant control efficiency.

Within the two herbicides the best mesquite control was achieved with glyphosate at highest rate. Similar results were reported by Ahmed (2009).

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