World Journal of Agricultural Sciences 13 (4): 150-154, 2017
ISSN 1817-3047

DOI: 10.5829/idosi.wjas.2017.150.154

Adaptation and Performance Evaluation of Prickly Pear Cactus, *Opuntia ficus- indica* (L.) for Fodder Production in Gumara-Maksegnit Watershed, North Gondar, Ethiopia

[1]*Alemu Tarekegn,* [1]*Belete Shimelash and* [2]*Aynalem Haile*

[1]Gondar Agricultural Research Center P.O. Box: 1337, Gondar, Ethiopia
[2]International Center for Agricultural Research in Dry Areas, P.O. Box: 5466, Aleppo, Syria

Abstract: Livestock feed shortage as a result of grazing land degradation and crop failure due to shortage and poorly distributed rain is critical in the Gumara-Maksegnit watershed. To assuage this problem identifying and planting feed crops with high water use efficiency that produce acceptable yield has to be considered in the watershed. An experiment was conducted to evaluate the adaptability and productivity of different Cactus cultivars under the ecological conditions of Gumara-Maksegnit watershed in the year 2012/2013 for 18 months. Six cultivars of cactus (Sulhuna, Gerao, Dilaledik, Gerwanlayele, Ameudegaado Belesa and Local cultivar) were used as experimental treatments. Cactus cladodes were planted using a Randomized Complete Block Design (RCBD) with three replications each. To assess their adaptability and productivity percent survival of cladodes, days taken to sprout, percent of plants sprouted, number of cladodes formed plant^{-1}, size of newly formed cladodes, average weight of cladodes and dry biomass yield were recorded. The results indicated that cactus cultivars evaluated showed statistically significant variation ($p < 0.05$) in days taken to sprout, number of cladodes formed plant^{-1}, width of cladodes (cm), average weight of cladodes (g) and dry biomass yield (t/ha) while there is no any statistical significant difference ($p > 0.05$) recorded in percent of plants sprouted, percent survival of cladodes, length of cladodes (cm) and dry matter percent (DM%) of cladodes. From the cultivars evaluated Sulhuna, Dilaledik and Ameudegaado Belesa were significantly at par but higher than others in number of cladodes formed plant^{-1}, average weight of cladodes and dry biomass production which are the best indicators of the superiority of cultivars as a forage source and adaptation of cultivars to the environment. Thus according to the results of this study Sulhuna, Dilaledik and Ameudegaado Belesa varieties are recommended for wider use in the watershed and other similar areas.

Key words: Cladodes · Dry biomass yield · Prickly Pear Cactus · Watershed

INTRODUCTION

The major feed sources for animals in the watershed are; natural grazing and crop residues supplemented by hay and weeds. The production and productivity of natural pasture and other feed resources of Gumara-Maksegnit watershed depends up on the rainfall distribution and intensity. The production of forage and food crops is significantly reduced due to shortage of rainfall. Other factors that contribute to feed shortages are small land holdings of the farmer that lead to encroachment of the grazing lands and the production of fewer amounts of crop residues from that limited land. Cactus pear is an introduction to Ethiopia. Now, cactus pear is widely spread throughout the Tigray region and is believed to cover more than 30, 000 hectares of land [1]. It has of course, become source of nourishment for several people during the summer months when there is shortage of cereals and other food crops. In arid and semi-arid environments, not only feed but also drinking water is a real problem for animal production. To assuage this problem farmers in drought prone areas, have developed a system of infrequent watering, by supplying water every two and three days. Although, such practice seems to benefit farmers to save water, time and labor spent in search of water, it significantly affects the productivity of animals. Cactus, in this regard, has been playing a great role in saving water problem.

Corresponding Author: Alemu Tarekegn, Gondar Agricultural Research Center P.O. Box: 1337, Gondar, Ethiopia.

Cactus pear is also found in North Gondar zone of Amhara region particularly in the Gumara-Maksegnit watershed. However, its productivity and popularity as human and animal feed is relatively low compared to that of Tigray. Feeding of Cactus for the livestock is not a common practice in the watershed but some farmers practiced cactus feeding. However, now adays the demand for prickly pear cactus pad as animal feed in the watershed is increasing through time as drought and land degradation increases. But the production and productivity of local cultivar they used is very low and there is no any recommended productive cultivar for the area to use as livestock feed. The current study was, therefore, conducted with the objective to evaluate the performance of different Cactus cultivars for fodder production in the model village of Gumara- Maksegnit watershed.

MATERIALS AND METHODS

Study Area Description: The study was conducted at Gumara-Maksegnit watershed of Gondar Zuria district; 45 km south east of the Zonal capital Gondar which is located between 12° 25' 14.8'' N latitude and 037° 36' 18.5'' E longitude, at an elevation of 2061 m.a.s.l. The soil texture of the study area is sandy, poor in water-holding capacity and fertility. The area has a moist tropical climate and has the mean monthly temperature of 13.6°C. Based on 20 years (1988-2007) data, the total annual rainfall ranges between 641 and 1678mm with a mean value of 1052mm. Farmers reported that the rainfall is small in amount, unpredictable in onset and cessation and poorly distributed. This nature of the rainfall is heavily influencing crop production and livestock husbandry and thus farmers' livelihood [2].

Planting Material Collection: One-year old cladodes of the five cultivars of Cactus pad cuttings were collected from Eastern zone of Tigray region, where Productive cultivars of cactus found and one cultivar of local cactus also collected from the watershed. From each district and site, six prickly pear cactus cultivars were selected that were clearly separated from other cultivars and had 10 to 12 cladodes connected at the base only to a previous year cladode. These selection criteria were established to ensure cladodes that were mature enough. Each cladode was cut using a disinfected knife by using alcohol and placed in a seedling tray for ease of transportation. Cladodes were collected in late April 2012 and placed in well ventilated condition.

Treatments and Experimental Design: The six cultivars of cactus they were collected and planted were Sulhuna, Gerao, Dilaledik, Gerwanlayele, Ameudegaado Belesa and Local. In the field, the 6 cultivars of cactus cuttings were distributed in a randomized complete block design (RCBD) with three replications, using 15 plants plot^{-1} as an experimental unit.

Evaluation of Under Planted Cactus Cuts: Prior to planting, the cladodes were dried for 2 weeks under partial shed to allow healing of the cutting area and then planted upright. During planting the flat edges face east and west and the thin sides face north and south. This way the sun will hit the slimmest part of the cladodes during the hottest part of the day and prevent sunburn. Mature pads of cactus (26cm long and 21cm wide) were planted at a spacing of 1.5 X 1.0m in to the holes of about 9cm deep and firmed with the soil so as to buried 1/3rd of their surface area below ground and 2/3rd above the soil surface with a density of 6, 667 plants ha^{-1}. Plot size was 5 X 4.5m to hold 15 plants in to three rows. Planting was done during the end of dry season in May 2012 to ensure maximum establishment. Establishment observation on the establishment of the Cactus pad cuttings were made after 3 and 6 weeks from planting. The total number of cuttings which had sprouted was determined. Common cultural practices related to weeding and plant protection measures were followed.

Data Collection and Analysis: After planting in the field their performance was evaluated with respect to days taken to sprout, percent of plants sprouted, percent survival of cladodes 6 months after planting, number of cladodes formed plant^{-1}, size of cladodes (cm), average weight of cladode (g), biomass yield (t/ha) and dry matter percent (DM%) of cladodes. The data collected was subjected to analysis of variance (ANOVA) by using the general linear model (GLM) procedure in Statistical Analysis System (SAS) applying version 9.1.3 software [3].

RESULTS AND DISCUSSION

Percent Survival of Cladodes after 6 Months Planting: There is non-significant statistical variation between the cactus cultivars in percent survival ($p > 0.05$) (Table 2). On an average cactus pears had higher survival rate after 6 months of planting. On an individual basis, the survival rate of cactus pears ranged from 77.78% in Sulhuna to 97.78% in Gerao cultivars with the mean value of 88.89%.

Table1: Cactus pear cultivars collected for evaluation in Gumara- Maksegnit watershed, North Gondar

S.No	Vernacular name (in Erob)	Name associated to fruit and cladode character	Meaning
1	Gerao	Taste	Sweet
2	Gerwanlayele	Location and taste	Gerwan is location in the village and layele is its watery teste
3	Sulhuna	Spiny ness	Smooth (Spineless)
4	Ameudegaado Belesa	Location and color	Ameudega is location in the village and adoBelesa means white colored fruit
5	Dilaledik	Location	Mostly found in and around apiary sites

Source: [6].

Table 2: Percent of plants sprouted, days taken to sprout and survival of cladodes after 6 months of planting

Treatments	Percent of plants sprouted till 6 months	Days taken to sprout	Percent survival of cladodes after 6 months
Sulhuna	91.11	172^{a}	77.78
Gerao	97.78	86^{d}	97.78
Dilaledik	97.78	72^{e}	95.56
Gerwanlayele	88.89	136^{b}	93.33
Ameudegaado Belesa	80.00	104^{c}	91.11
Local	77.78	169^{a}	82.22
Mean	88.89	123.13	89.63
CV (%)	24.2	2.29	17.69
LSD (0.05)	Ns	5.13	Ns

NB: a, b, c, d, e= Means followed by different superscript letters with in a treatment group are significantly different; Ns= not significant at (P>0.05); CV= coefficient of variation; LSD= list significant difference.

Table 3: Mean value of yield and yield components of different Cactus varieties evaluated at Gumara- Maksegnit watershed

Treatments	Number of cladodes formed per plant	Size of cladodes		Length to width ratio	Average weight per cladode (g)	Dry biomass yield (DMY) (t ha^{-1})	Dry matter percent (DM%) of cladodes
		Length (cm)	Width (cm)				
Sulhuna	5.0^{a}	22.61	13.92^{ab}	1.64	497.22^{a}	2.75^{a}	13.19
Gerao	3.33^{b}	23.04	12.92^{abc}	1.77	375.24^{ab}	1.18b^{c}	13.08
Dilaledik	4.22^{ab}	22.88	12.52^{abc}	1.83	386.05^{ab}	1.63^{ab}	12.90
Gerwanlayele	3.17^{b}	18.65	11.03^{c}	1.69	200.01^{bc}	0.65^{c}	12.81
Ameudegaado Belesa	3.89^{ab}	25.78	14.70^{a}	1.75	479.22^{a}	1.90^{ab}	13.34
Local	3.44^{b}	19.87	11.62^{bc}	1.71	280.56^{bc}	0.98^{bc}	13.62
Mean	3.84	22.14	12.78	1.73	369.71	1.48	13.15
CV (%)	16.45	13.25	10.44	8.49	23.28	25.23	5.35
LSD (0.05)	1.15	Ns	2.43	Ns	156.59	0.95	Ns

NB: a, b, c= Means followed by different superscript letters with in a treatment group are significantly different; Ns= not significant at (P>0.05); CV= coefficient of variation; LSD= list significant difference

Days Taken to Sprout: Data presented in Table 2 revealed that cultivar Dilaledik took the minimum period of 72 days for sprouting while significantly ($p < 0.05$) the maximum period of 169 and 172 days was taken by Local cultivar and Sulhuna, respectively. However, most of cultivars (3 cultivars) sprouted in 86 to 136 days and the local cultivar sprouted after 169 days. Earlier sprouting seems to be related to the warmer conditions during the months of May and June which is favorable to sprouting to the respective varieties.

Percent of Plants Sprouted: There is no any significant statistical variation in average percent of plants sprouted till 6 months ($p > 0.05$). The average percent of plants sprouted (Table 2) was a maximum of 97.78% and was higher than other cultivars in the case of Gerao and Dilaledik, followed by Sulhuna (91.11%). Cultivar Gerwanlayele recorded 88.89% average percent of plants sprouted, while local cultivar recoded lower average percent of plants sprouted (77.78%) till 6 months in the field.

Number of Cladodes Formed Plant^{-1}: Mean number of cladodes formed plant^{-1} of the six Cactus pear cultivars evaluated was statistically significant ($p<0.05$). Cultivar Sulhuna produced the maximum (5) cladodes plant^{-1} at 15 months of age (Table 3), closely followed by cultivar Dilaledik (4.22) and Ameudegaado Belesa (3.89). The number of cladodes was minimum in cultivar Gerwanlayele (3.17), followed by Gerao (3.33) and Local (3.44).

Both were significantly at par but lower than others. Singh and Salanki [4] reported that in arid environment most varieties grow profusely when provided with sufficient water and fertilization during early stages of growth. However, under present site condition sufficiently large damage by rats and termites in Gerao, Gerwanlayele and Local cultivars was noticed and growth was affected adversely. The fleshy nature of cladodes due to higher moisture content in these cultivars encouraged damage by these pests.

Average Weight of Cladodes: The mean value for the weight of cladodes (Table 3) was 200.01 to 497.22g, which is lower than the result obtained by Firew *et al*. [5]. Variations in the weight of cladodes could be attributed to the level of soil fertility, climatic zones, seasons and agronomic practices adopted. The average weight of cladodes was a maximum of 497.22, 479.22g, 386.09 and 375.24g and was significantly ($p<0.05$) higher than other cultivars in the case of Sulhuna, Ameudegaado Belesa, Dilaledik and Gerao, respectively. Local and Gerwanlayele varieties recorded 280.56 and 200.01g average weight and both are at par, while these cultivars recorded significantly ($p<0.05$) lower average weight than others. This may be due to the variation in genetic potential among different cultivars.

Size of Newly Formed Cladodes: There is non-statistical significant difference between cactus varieties in length of newly formed cladodes ($p> 0.05$) (Table 3). Four cultivars (Ameudegaado Belesa, Gerao, Dilaledik and Sulhuna) produced cladodes of over 22cm length and two cultivars (Local and Gerwanlayele) of less than 20cm length. The width of cladodes in different varieties varied from 11.03cm in Gerwanlayele to 14.7cm in Ameudegaado Belesa. Firew *et al*. [5] pointed out 15.05 to 19.7cm Cactus pad width and 29.3 to 36.7cm length at Eastern and Southern zone of Tigray which is by far higher than the result we obtained. Variations in the width and length of Cactus pads could be attributed to differences in the level of soil fertility, climatic zones, seasons and the varieties of cactus evaluated and agronomic practices of the different study areas.

Four cultivars (Ameudegaado Belesa, Sulhuna, Gerao and Dilaledik) had cladodes 12cm and more in width. Thus, the width of cladodes in different varieties varied significantly ($p<0.05$). Cultivar Ameudegaado Belesa, Sulhuna, Gerao and Dilaledik had very large cladodes. Such variation in size of cladodes by other cultivars has also been reported by Anonymous, Singh [6, 7]. There is no statistical significant variation among cultivars in length to width ratio ($p< 0.05$).

Dry Biomass Production: Biomass production after 18 months plantation was significantly ($p<0.05$) higher in Sulhuna (2.75t ha^{-1}) and Ameudegaado Belesa (1.90t ha^{-1}) followed by Dilaledik (1.63t ha^{-1}), while Gerwanlayele and Local varieties produced significantly ($p<0.05$) lower biomass than others. This could be due to the variation in genetic potential among different cultivars. The mean DM yield of the cultivars evaluated in this study (1.48t ha^{-1}) appeared to be relatively much lower than 13t ha^{-1}, 10t ha^{-1} and 20t ha^{-1} reported by De Kock, Gebremeskel and Santos *et al*. [8, 9, 10] in arid areas of Tigray, for un-irrigated arid areas and in Pernambuco semi-arid region, respectively. Variations in the yields could be attributed to the level of soil fertility, climatic zones, seasons, agronomic practices adopted and stage of harvest.

Percentage Dry Matter of Cladodes: The percent dry matter (DM%) in the cladodes differed not significantly ($p>0.05$) between the varieties and ranged between 12.81% (Gerwanlayele) and 13.62% (Local) (Table 3). In contrast, according to Lopez- Garcia *et al*. [11] the total amount of water stored in the cactus pear cladodes depends upon species and varieties. Clearly from this study, percent dry matter in the cladodes is also strongly influenced by environmental conditions, which can, according to Lopez- Garcia *et al*. [11], ranged between 30 and 7%.

CONCLUSION AND RECOMMENDATION

Despite its drought tolerant and ability to grow in a poor fertility status soils, Cactus will be the best alternative feed resource in the Gumara-Maksegnit watershed. According to the results of this study cultivar Sulhuna, Dilaledik and Ameudegaado Belesa gave the highest number of cladodes $plant^{-1}$, average weight of cladodes and dry biomass yield, which are the best indicators of the superiority of cultivars as a forage source and adaptation of cultivars to the environment. Thus we can conclude that these cactus cultivars are adaptive and productive for Gumara-Maksegnit watershed area. Hence these varieties can be used as an alternative feed source especially during the dry season for livestock to minimize the burden of feed shortage in the area.

ACKNOWLEDGMENTS

The authors would like to acknowledge International Fund for Agricultural Development (IFAD) project for financing the research project. The authors are also grateful to Ato Kidamemariam Shiferaw for his support and assistance in collection of planting materials from Ganta-afeshum and Erob districts, Eastern zone of Tigray region.

REFERENCES

1. SAERT (Sustainable Agricultural and Environmental rehabilitation in Tigray)., 1994. Prickly pear Cactus Production and: UNDP/ECA/TDA and the Regional Government of Tigray, 7: 45- 52.
2. Yonas, W., A. Teferi, Y. Asmamaw, A. Solomon, K. Hailu and G. Ambachew, 2010. Socio-economic survey of Gumara-Maksegnit watershed. ICARDA-ARARI-EIAR-BOKU- SG-2000 Project and Gondar Agricultural Research Center.
3. SAS, 2003. SAS User's Guide: Statistics. Version 9.1.3. Carry, North Carolina. USA. Statistical Analysis System Inc.
4. Singh, Gurbachan and K.R. Solanki, 1999. Edible cactus: a potential crop to generate export from arid lands. Paper presented in the IVth Agricultural science congress, Jaipur. February 21- 24, NAAS/RAU, Bikaner, India.
5. Firew, T., K.J. Peters and C. Kijora, 2008. Current Uses of Cactus Pear (Opuntia ficus-indica) as Forage in Northern Ethiopia and Farmer's Indigenous Knowledge on its Utilization. Ethiopian Journal of Animal Production, 8(1): 10-21. Addis Ababa, Ethiopia.
6. Anonymous, 1993. Genetic selection and improvement of Opuntia cultivars for human and animal food on semi- arid lands. Final Project report, Nimbkar agricultural research Institute, Phalton (Maharashtra), India, pp: 89.
7. Singh, R.S., 2000. Studies on propagation and growth behavior in Cactus pear (*Opuntia ficus- indica* (L.) Mill.) as affected by size and age of cladodes, season and method of planting and growth regulators. Ph.D. thesis, Dr. B R. Ambedkar University, Agra, India.
8. De Kock, G.C., 2001. The use of Opuntia as a fodder source in arid areas of South Africa. In: Mondragon C and Gonzalez S (eds), cactus (Opuntia species) as forage. FAO Plant Production and Protection Paper, Volume 169, pp: 101-106 http://jajo66.files.wordpress.com/2008/10/cactus-as-forage.pdf.
9. Gebremeskel, G., A. Getachew and T. Firew, 2013. Assessment of the potential of cactus pear (Opuntia ficus indica) as livestock feed in Northern Ethiopia. *Livestock Research for Rural Development*. Volume 25, Article #26. Retrieved July 12, 2017, from http://www.lrrd.org/lrrd25/2/moen25026.htm.
10. Santos, D.C., Md. A. Lira, F.M. Dias, I. Farias, M.V.F. Santos and V.F. Santos, 2000. Produtividade de cultivares de Palma forrageira (Opuntia e Nopalea). In: Proceedings of the 7th Northeastern Ruminant Feeding Symposium. SNPA, Teresina, PI, Brazil, pp: 121-123.
11. Lopez- Garcia, J.J., J.M. Faentes-Rodriguez and R.A. Rogriguez, 2001. Production and use of Opuntia as forage in north Mexico. In: C. mondragón- Jacobo & S. pérez- González (Eds.). pp: 29-36. Cactus (*Opuntia* spp.) as forage. FAO Plant protection and production paper 169. 164pp.