Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.5129

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **5 (3):** 454-458 (2017)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Effect of Different Water Regimes on Growth, Yield and Quality of Forage Sorghum (*Sorghum bicolor* L. Moench) Cultivars

S. M. Kumawat*, Vimal Khinchi, R. C. Sanwal and Rinku

Agricultural Research Station, S K Rajasthan Agricultural University, Bikaner- 334 006, India

*Corresponding Author E-mail: sagarskrau@gmail.com

Received: 15.06.2017 | Revised: 26.06.2017 | Accepted: 27.06.2017

ABSTRACT

A field experiment was conducted on sorghum during kharif season of 2012, 2013 and 2014 for consecutive three years at Agricultural Research Station, S.K. Rajasthan Agricultural University, Bikaner to study the effect of different water regimes on growth, yield and fodder quality of forages sorghum cultivars. The treatments consist of three levels of water regime i.e., four irrigation (in all water regimes) each of 50, 40 and 30 mm in sufficient, limited and deficit water regime, respectively and four sorghum cultivars viz. PC-23, MFSH-4, SSG & COFS-29. The experiment was laid out in split plot design with four replications. The results showed that maximum plant height (138 cm); Leaf : Stem (L:S) ratio (0.52); green fodder (231 q/ha) and dry matter (37.15 q/ha) yield; and production efficiency of green fodder (184.90 kg/ha-day) and dry matter (29.72 kg/ha-day) yield; crude protein percent (9.88%) and crude protein yield (3.67 q/ha) were recorded with sufficient water regime. The superiority of the water regime of 50 mm depth per irrigation (sufficient) was further depicted by the highest net returns of Rs. 26060/ha in fodder sorghum. However, values for all above parameters were at par with limited water regime (40 mm depth per irrigation). Highest water use efficiency (8.88 kg/ha-mm) was recorded with limited water regime, closely followed by sufficient water regime (8.87 kg/ha-mm). Further, sorghum cultivar MFSH-4 recorded highest plant height (141 cm); L:S ratio (0.53); green fodder (229.61 q/ha) and dry matter (38.71 q/ha) yield; production efficiency of green fodder (183.69 kg/ha-day) and dry matter (30.54 kg/ha-day) yield; crude protein percent (10.23 %) as well as yield (3.90 q/ha); water use efficiency (10.07 kg/ha-mm) and net returns (Rs. 30430/ha).

Key Words: *Crude protein, Dry matter yield, Green fodder yield, L:S ratio, Livestock heath, Sorghum cultivars , Water productivity, Water use efficiency.*

INTRODUCTION

Agricultural growth in state of Rajasthan is strongly backed by livestock, especially in the vast arid areas where pasture based livestock rearing is a way of life. The extreme north-west region of the state experiences frequent drought and famine. This often results in acute shortage of feed and fodder (green fodder) particularly in summer months, thus adversely affects livestock health and productivity.

Cite this article: Kumawat, S.M., Khinchi, V., Sanwal, R.C. and Rinku, Effect of Different Water Regimes on Growth, Yield and Quality of Forage Sorghum (*Sorghum bicolor* L. Moench) Cultivars, *Int. J. Pure App. Biosci.* **5(3):** 454-458 (2017). doi: http://dx.doi.org/10.18782/2320-7051.5129

Sorghum as a fodder crop, cultivated mostly by farmers in kharif as well as summer seasons. The crop is primarily grown in the warm dry climate of Africa, India, Pakistan, China and the Southern United States, and used as food, feed and fodder[2]. Sorghum grain is commonly used as poultry feed; stems for sugar extraction; the whole biomass for bio-fuels, fibre extraction and even feed for animals during periods of fodder scarcity[4]. Forage sorghum is an important biomass crop for hay and silage[14]. Sorghum as a livestock feed attains position of significant importance, particularly in the tropical zone because of its adaptation to low fertility soils and other limiting factors, such as water stress[12] etc.

The agricultural sector in general and forage in particular faces the challenge to produce more food/fodder with less water[5]. Owing to the wide scale expansion of irrigation farming water has become increasingly a scarce resource. Scarcity is further complicated when water supplies are uncertain. In literature water regimes describes a variable effect on biomass traits of different sorghum cultivars. Varieties performing better at high water availability were often surpassed by other genotypes at low water availability[1]. Keeping all these in view, the present study was therefore planned.

MATERIALS AND METHODS

A field experiment was conducted on forage sorghum cultivars and water regimes during *kharif* season of 2012, 2013 and 2014 at Agricultural Research Station, S.K. Rajasthan Agricultural University, Bikaner situated in hyper arid (zone-1c) of Rajasthan. The soil was sandy loam in nature, having field capacity 6.50%, PWP 1.52%, bulk density 1.51 g /cc, pH (1:2) 8.09, electrical conductivity (1:2) 0.09 dS/m. The soil was very low in organic carbon (0.16%), available nitrogen (126 kg/ ha) medium in available P (17.6 kg/ha) and high in available K (254.7kg/ha). The experiment was laid out in split plot design with four replications. The treatments consists of three levels of water regimes *viz*. sufficient (50 mm depth), limited (40 mm depth) and deficit (30 mm depth) in each irrigation applied through sprinkler system as 5, 4.0 and 3.0 operating hours (pressure 2.5 kg /cm^2) for the respective depth of water regime in main plot and four sudan sorghum cultivars namely PC-23, MFSH-4, SSG and COFS-29 in sub plots. Crop was sown on 10th July, 20th June and 18 July in 2012, 2013 and 2014, respectively with the onset of monsoon or pre sowing irrigation. Seed rate of 30 kg/ha was used for sowing in rows at 30 cm apart and plant to plant distance 3-5 cm. The green fodder cutting was done first at 70 DAS and second cutting at 55 days after of first cutting. Nitrogen one third dose (30 kg N/ha) and phosphorus full dose (40 kg P_2O_5/ha) and potassium (20 kg K_2O/ha) were drilled at sowing using fertilizers as Urea, Di-ammonium phosphate and Muriate of potash, respectively. Remaining 2/3rd dose of nitrogen was top dressed in two splits first at 30 DAS and the remaining dose with irrigation water on re-growth plants after first cutting. Pre sowing irrigation (60 mm) was given just before sowing to get good germination and crop establishment and thereafter four/five irrigations (as per treatment) were applied as and when water stress noticed under long dry spell condition during the growing season. Rainfall received during the crop growing period was 174.8, 186.5 and 285 mm in the year 2012, 2013 and 2014, respectively. All the cultural operations were followed as per packages of practice recommended for the zone -1c. Observations on growth parameters, yield attributing characters and yield was taken adopting standard procedure. The crude protein content was analyzed by adopting A.O.A.C., 1970 method and for crude protein per cent, nitrogen percentage was multiplied with 6.25 and further for obtaining crude protein yield crude protein percentage was multiplied by dry matter yield.

RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under following heads:

Sorghum cultivars:

The study on sorghum cultivars indicated that highest plant height (141 cm), leaf: stem ratio (0.53), green fodder yield (229q/ha), dry matter yield (38.17 q/ha) and water use efficiency (10.07 kg/ha-mm) were recorded with fodder sorghum cultivar MFSH-4, which was at par with SSG-555 cultivar (Table 1). The variation in plant height and leaf: stem ratio in different sorghum cultivars may be due to their ability to adapted to the environmental conditions in the region and difference in genetic makeup of these varieties. The overall improvement in crop growth reflected into better source-sink relationship, which in turn enhanced the yield attributes. This variability in different yield attributing characters was mainly due to their genetically behavior. These results are in close conformity with the findings of Naeem *et al*[9]. Yusuf *et al*[17]., reported significant differences in term of forage yield among different pearl millet cultivars. Zaman *et al*[18]., also reported variation in fresh forage yield of pearl millet cultivars. Muhammad *et al*., also observed significant differences among the pearl millet genotypes for green fodder yield. High forage yield is closely associated with higher values of plant height, number of leaves and leaf area. Faridullah *et al.*, also reported significant difference among pearl millet varieties regarding dry matter yield. Further, maximum crude protein content (10.23%) and yield (3.90 q/ha); green fodder (183.69 kg/ha-day) and dry matter (30.54 kg/ha-day) production efficiency; net returns (Rs. 30430/ha) and B:C ratio (1.30) were recorded with fodder sorghum cultivar MFSH-4. However, sorghum cultivars MFSH-4 and SSG-555 gave at par values for all the quality parameters, production efficiency and net returns (Table 2). This might be due to sorghum cultivar MFSH-4 had higher nitrogen uptake as it is better adapted to adverse climatic conditions and better growth of root system in low soil fertility areas. Higher nitrogen uptake leads to higher crude protein percentage in leaves and stem of fodder sorghum, which ultimately increased crude protein yield. Amodu *et al*[3]., also reported that pearl millet varieties had significant difference in crude protein content. Meena and Mann[7], opined that dry matter production efficiency of genotype determines its potential to produce economic yield.

Water regimes:

Water regimes had significant effect on plant height; the most important yield attribute *viz.* leaf : stem ratio; yield (green fodder and dry matter yield); quality parameters *viz*. crude protein percent and yield, and economics i.e., net returns and B:C ratio. Maximum plant height (138 cm); leaf stem ratio (0.52); and yield *viz*. green fodder (231 q/ha) and dry matter (37.15 q/ha) yield of fodder sorghum was recorded at sufficient water (50 mm depth) regime, however, limited water (40 mm depth) regime also gave at par values of all these parameters (Table 1) and superior to deficit irrigation regime (four irrigation each of 30 mm). Many researchers found that water deficit reduced the plant height[15], shoot growth[16] and ultimately crop yield[11]. The first effect of water deficit is reduced leaf number[6] and leaf area of every plant[10] and then yield and dry matter production. Increasing water regime increased water use by the crop and highest water use was 419 mm at sufficient water regime and lowest at deficit water regime (309 mm). Whereas, highest water use efficiency was recorded at limited water regime (8.88 kg/ha-mm). This might be attributed that lower water use efficiency with higher soil- moisture -regime was due to proportionate increase in evapotranspiration than the increase in yield[8]. Water use efficiency is either seen to increase at decreasing moisture[1]. Highest crude protein content (9.88 %) and yield (3.67 q/ha) was recorded with sufficient water (50 mm depth) regime, which was at par with limited water regime (40 mm depth). Sesani *et al*[13]., also reported that irrigation levels influenced crude protein content in fodder pearl millet. Further, highest green fodder (184.90 kg/ha-day) and dry matter (29.72 kg/ha-day) production efficiency; net returns (Rs. 26060/ha) and B:C ratio (1.04) of fodder sorghum was recorded with sufficient water (50 mm depth per irrigation) regime, which was at par with limited water (40 mm depth per irrigation) regime (Table 2).

Table 1: Effect of different water regimes on plant height, yield attribute, yield and water use efficiency of fodder sorghum cultivars (Pooled of three years)

Treatment	Plant height (cm)	L:S ratio	Green fodder yield (q/ha)	Dry matter yield (q/ha)	Water use (mm)	WUE* (kg/ha-mm)
Water regime						
Sufficient	138	0.52	231	37.15	419	8.87
Limited	129	0.48	210	33.66	379	8.88
Deficit	125	0.47	174	29.56	339	8.72
CD (P=0.05)	12	NS	30	5.24	-	-
Sorghum cultivars						
PC-23	126	0.49	207	34.09	379	8.99
MFSH - 4	141	0.53	230	38.17	379	10.07
SSG-555	136	0.52	214	34.26	379	9.04
COFS -29	119	0.43	170	27.31	379	7.21
CD (P=0.05)	11	NS	22	4.07	-	-

*Dry matter water use efficiency

Table 2: Effect of different water regimes on quality, production efficiency and economics of fodder sorghum cultivars (Pooled of three years)

Treatment	Crude protein (%)	Crude protein yield (q/ha)	Green fodder production (kg/ha-day)	Dry matter production (kg/ha-day)	Net return (Rs./ha)	B:C ratio
Water regime						
Sufficient	9.88	3.67	184.90	29.72	26060	1.04
Limited	9.67	3.25	168.06	26.93	21719	0.94
Deficit	9.46	2.79	139.26	23.65	15829	0.75
CD (P=0.05)	NS	0.73	16.90	3.23	8098	0.35
Sorghum cultivars						
PC-23	9.75	3.32	165.72	27.27	19636	0.87
MFSH - 4	10.23	3.90	183.69	30.54	30430	1.30
SSG-555	10.01	3.43	170.97	27.41	20144	0.85
COFS -29	8.70	2.38	135.93	21.85	14600	0.63
CD (P=0.05)	0.21	0.62	13.32	3.16	7013	0.31

REFERENCES

1. Aishah, S. Saberi, H.A.R., Halim, R.A. and Zaharah, A.R., Yield responses of forage sorghums to salinity and irrigation frequency. *Afr J Biotech*., **10:** 4114-4120 (2011).
2. Alagarswamy, G. and Chandra, S., Pattern analysis of international sorghum multi-environment trials for grain-yield adaptation. *Theor. Appl. Genet.,* **96:** 397-405 (1998).
3. Amodu, J.T., Adeyinka, I.A., Kallah, M.S. and Alawa, J.P., Evaluation of Pearl Millet Accession for Yield and Nutrient Composition. *Journal of Biological Sciences,* **7:** 379-383. http://dx.doi.org/10.3923/jbs.2007.379.383 (2007).
4. Dogget, H., Sorghum, 2nd edn. John Wiley & Sons, New York (1998).
5. FAO. Food and Agricultural Organization Statistical data base. Rome, Italy (2003).
6. Golombek, S. and Al-Ramamneh, E.A.D., Drought tolerance mechanisms of pearl millet. Challenges to organic farming and sustainable land use in the tropics and subtropics Proceedings. University of Kassel, Institute of Crop Science, Germany. October 9-11 (2002).
7. Meena, L.R. and Mann, J.S., *Int. J. Trop. Agric.,* **25:** 105-109 (2007).

8. Mollah, M.S.I. and Paul, N.K., Responses of Irrigation and Fertilizers on the Growth and Yield of *Hordeum vulgare* L. *Bangladesh J. Sci. Ind. Res.*, **46(3):** 369-374 (2011).
9. Naeem, M., Khan, M.A., Chohan, M.S.M., Khan, A.H. and Salah-ud-Din, S., Evaluation of different varieties of oats for green fodder yield potential. *Asian J. Plant Sci.*, **1(6):** 640-41 (2002).
10. Nagaz, K., Toum, I., Mahjoub, T., Masmoudi, M.M. and Mechlia, N.B., Yield and water use efficiency of pearl millet (*Pennisetum glaucum* L.) under deficit irrigation with saline water in arid conditions of Southern Tunisia. *Research Journal of* Agronomy, **3:** 9-17 (2009).
11. Payero, J.O., Melvin, S.R., Irmak, S. and Tarkalson, D., Yield response of corn to deficit irrigation in a semiarid climate. *Agricultural Water Management*, **84:** 101-112 (2006).
12. Pholsen, S. and Suksri. A., Effects of Phosphorus and Potassium on Growth, Yield and Fodder Quality of IS 23585 Forage *Sorghum* Cultivar (*Sorghum bicolor* L.). *Pakistan Journal of Biological Sciences*, **10:** 1604-1610 (2007).
13. Sasani, S., Jahansooz, M.R. and Ahmadi, A., The effects of deficit irrigation on Water-use efficiency, yield, and quality of forage pearl millet Proceedings of the 4th International Crop Sci Congress Brisbane, Australia, 26 Sep-1 Oct. (2004).
14. Skerman, P.J. and Rivers, F., Tropical Grasses. FAO. Plant Production and Protection, Series No. 23, FAO, Rome (1999).
15. Soler, C., Hoogenboom, G., Sentelhas, P. and Duarte, A., Impact of water stress on maize grown off-season in a subtropical environment. *Journal of Agronomy and Crop Science*, **193:** 247-261 (2007).
16. Stone, P., Wilson, D., Reid, J. and Gillespie, R., Water deficit effects on sweet corn. I. Water use, radiation use efficiency, growth, and yield. *Crop and Pasture Science*. **52:** 103-113 (2000).
17. Yusuf, M.J., Nabi, G., Basit, A., Husnain, S.K. and Akhtar, L.H., Development of High Yielding Millet Variety "Sargodha Bajra-2011" Released for General Cultivation in Punjab Province of Pakistan. *Pakistan Journal of Agricultural Sciences*, **49:** 275-282 (2012).
18. Zaman, Q., Malik, N.H. and Hayat, K., Performance of Millet Varieties for Green Fodder Production under D.I. Kshan Condition. *Sarhad Journal of Agriculture*, **20:** 47-49 (2004).