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Original article

Investigation and comparison of the forage sorghum genotypes yields under water stress conditions in the southern region of Kerman

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Extended abstract

Introduction

Most of the Produced fodder in Iran is provided by alfalfa and corn. These two forage products have a relatively high water requirement. Among cereal forage plants, sorghum is a great plant due to its high production capacity, adaptation to different climatic conditions and different uses. Iran, with an average rainfall of 240 mm per year, is classified as arid and semi-arid regions. One of the most fundamental issues of the country is water and irrigation. Food security concerns are a major threat due to climate change and water scarcity, hence replacing plants with high water use efficiency is essential. this experiment was carried out for 1(investigate the possibility of cultivating sorghum as a substitute for common forage plants in drought stress conditions in the south of Kerman province and 2) also to determine the most suitable sorghum cultivar under the different Irrigation levels in terms of forage characteristics in Jiroft region.

Materials and methods

In order to identify the most suitable cultivar resistant to drought sorghum, an experiment was carried out as strip plot design based on randomized completely block design with three replications in 2019-2020. Vertical plots were drought stress levels (irrigation after 90, 130, 180 and 220 mm evaporation from class A evaporation pan). Horizontal factors were sorghum genotypes (Speedfeed, Pegah, KFKFS18 and KFKFS2. Each experimental plot consisted of four planting lines. Plant density was 220,000 plants per hectare. The planting date was April 17th. The first irrigation was done after measuring soil moisture and calculating moisture deficiency. Irrigation was done uniformly every 5-7 days until the 4-leaf stage. The time of application of stress was after 4 to 6 leaf stage and ensuring complete establishment of plants. Early cultivars such as Speedfed were harvested based on the beginning of flowering and late cultivars were harvested based on 150 cm plant height by cutting from 10 to 15 cm above the soil surface. In each row, all plants were harvested from two middle lines of each plot and the fresh weight of leaves and stems was immediately measured. Water use efficiency in kilograms per cubic meter was calculated from the ratio of dry forage yield in kilograms per hectare per water consumption in cubic meters per hectare. Finally, combined analysis of variance of data was performed using SAS statistical software version 9. The means were compared using the LSD test at the level of 5% probability.

Results and discussion

Combined analysis of variance showed that the interaction effect of irrigation regimes and cultivars was significant on fresh forage yield, leaf and stem fresh and dry weight, plant height and leaf area. Mean

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comparison of simple effects were studied only for dry forage yield and water use efficiency. The results showed that Speedfeed cultivar had the highest fresh forage yield (298.42 tons.ha^{-1}) at the 90 mm level irrigation. Lowest forage yield (142.49 tons.ha^{-1}) resulted from the combination of KFS18 and irrigation after 220 mm evaporation. Highest dry forage yield was obtained at 90 mm irrigation level (46.22 tons.ha^{-1}). Lowest dry forage yield (39.70 tons.ha^{-1}) was related to the irrigation after 220 mm evaporation from the surface of evaporation pan. Speedfeed and KFS18 had the highest and lowest dry forage yield (41.69 and 31.17 tons.ha^{-1}), respectively. The highest and lowest water use efficiency were related to Speedfed and KFS18 (4.08 and 3.68 Kg.m^{-3}), respectively. There was no statistically significant difference between 90 mm (4.76 Kg.m^{-3}) and 220 mm (4.49 Kg.m^{-3}) levels of irrigation.

Conclusions

According to the results of the experiment, speedfeed cultivar with irrigation after 130 mm evaporation from the surface of evaporation pan can be suggested for forage production in southern Kerman province.

***Keywords*:** Irrigation, Forage yield, Speedfeed, Water use efficiency

Table 1. Meteorological information of sorghum growing seasons in two years 2018-2019

Year	Month	Mean temperature	Max temperature	Min temperature	Mean relative humidity	Precipitation	Mean wind speed
		(°c)	(°c)	(°c)	(%)	(mm)	(m.h^{-1})
2018	**April**	24.55	33.91	13.84	36.24	2.20	1.08
	May	28.94	37.24	17.87	24.76	0.20	1.19
	June	34.75	43.57	23.46	19.89	3.20	1.23
	July	36.17	44.35	25.08	35.55	0.00	1.21
	August	36.21	44.59	26.06	36.21	0.00	1.43
	October	32.75	42.22	20.79	32.75	0.20	1.12
	November	26.70	35.61	16.99	26.70	6.20	0.90
	December	21.48	13.83	28.79	21.48	10.60	0.67
2019	**April**	22.07	30.91	12.91	60.38	39.60	0.51
	May	28.98	38.33	18.46	32.18	14.60	0.80
	June	34.26	44.27	21.55	24.50	0.00	0.82
	July	35.72	45.04	24.06	21.30	0.00	1.06
	August	35.29	44.00	23.60	20.23	2.80	1.14
	October	31.21	40.77	19.29	20.91	0.00	0.94
	November	26.91	37.14	18.71	26.59	0.00	0.67
	December	20.05	30.43	10.25	41.04	18.00	0.47

Table 2- Soil characteristics of the experimental site

Characteristic	Soil texture	Organic matter	Absorbable phosphorus	Absorbable potassium	Acidity	Salinity
		(%)	(mg / kg soil)	(mg / kg soil)	Acidity	(dS / m)
value	loam	0.1	8	180	7.4	1.3

Table 3- Results of analysis of variance of the effect of experimental factors on leaf fresh weight (LFW), stem fresh weight (SFW), fresh forage yield (FFY), leaf number (LN), plant height (PH), stem diameter (SD), Leaf length (LL), leaf width (LW), leaf dry weight (LDW), stem dry weight (SDW), dry forage yield (FDY) and water use efficiency (WUE)

S.O.V	df	LFW	SFW	FFY	LN	PH	SD
Year (Y)	1	98.94	474.37	1003.86	10.97	1874.88**	2.73
R(y)	4	200.800	624.89	1178.72	36.41	58.03	4.06
I	3	811.12**	3850.29**	7347.91**	64.55**	1761.96**	3.24**
Y*I	3	18.83	42.76	26.72	0.75	32.96	0.06
Error a	12	168.83	646.84	845.68	9.17	186.35**	6.87
V	3	38079.84**	19329.00**	95487.96**	832.96**	43978.14**	39.95**
Y*V	3	38.05	164.62	293.40	3.40	493.43	0.34
Error b	12	811.97	624.07	1919.49	18.55	243.26	1.95
I*V	9	668.35**	1459.65**	1069.05**	33.95**	697.63**	1.86**
Y*I*V	9	18.77	53.35	88.74	1.49	44.29	0.18
Error c	36	238.53	491.65	723.29	14.84	143.29	1.42
C.V(%)		*18.66*	*17.61*	*12.88*	*16.07*	*9.75*	*13.84*

S.O.V	df	LA	LDW	SDW	FDY	WUE
Year (Y)	1	4852.85	1.57	2.81	60.47	0.31**
R(y)	4	2233.70	85.32	48.94	79.79	0.03
I	3	19849.21*	36.78**	66.57**	224.58**	20.68**
Y*I	3	1374.43	1.05	0.61	0.91	0.19
Error a	12	5956.75	25.75	19.16	55.30	0.07
V	3	158664.82**	1905.07**	1960.88**	7776.06**	0.80**
Y*V	3	480.12	0.12	2.62	4.67	0.04
Error b	12	2890.73	48.56	25.38	71.37	0.01
I*V	9	21314.41**	15.38**	77.30**	181.84	0.02
Y*I*V	9	829.80	1.73	1.11	81.18	0.02
Error c	36	4042.68	40.30	22.72	17.83	0.02
C.V(%)		*23.26*	*28.47*	*2.61*	*21.18*	*3.59*

*, ** significant at 5% and 1% probability level respectively

Table 4. Mean compression of simple effects of treatments (up) on dry forage yield (FDY) and water use efficiency (WUE) and interaction effects of treatments (down) on stem diameter (SD), fresh forage yield (FFY), Leaf wet weight (LFW), Stem fresh weight (SFW), Stem dry weight (SDW), Leaf dry weight (LDW), Leaf number (LN), Plant height (PH) and Leaf area (LA).

Irrigation level (mm evaporation from class A evaporation pan)					Genotypes			
	90	130	180	220	Speedfeed	Pegah	KFS2	KFS18
FDY (ton.ha^{-1})	46.27^{a}	43.86^{b}	40.36^{c}	39.7^{c}	69.41^{a}	34.35^{b}	35.21^{b}	31.17^{c}
WUE (Kg.m^{-3})	4.76^{a}	4.48^{b}	3.61^{c}	2.71^{c}	4.09^{a}	3.99^{b}	3.81^{c}	3.68^{c}

Irrigation level	Genotypes	SD	FFY	LFW	SFW	SDW	LDW	LN	PH	LA
		mm	ton.ha^{-1}	ton.ha^{-1}	ton.ha^{-1}	ton.ha^{-1}	ton.ha^{-1}	number	cm	cm^{2}
90	Speedfeed	7.43^{fg}	298.42^{a}	148.02^{ab}	156.71^{a}	36.11^{ab}	36.33^{a}	31.52^{ab}	177.26^{a}	557.08^{a}
	Pegah	8.41^{e}	243.03^{de}	60.95^{c}	166.54^{a}	17.68^{cdef}	19.53^{bcd}	32.47^{a}	157.7^{ab}	340.19^{b}
	KFS2	10.5^{a}	208.64^{g}	74.75^{c}	141.74^{ab}	12.28^{f}	14.36^{d}	19.36^{def}	128.12^{cde}	278.49^{bc}
	KFS18	9.17^{cd}	145.64^{j}	67.67^{c}	83.44^{d}	12.51^{f}	14.77^{cd}	19.36^{def}	64.36^{f}	164.45^{de}
130	Speedfeed	7.78^{f}	279.32^{b}	147.41^{ab}	166.74^{a}	31.01^{b}	35.16^{a}	60.65^{ab}	159.92^{ab}	328.12^{b}
	Pegah	9.07^{cd}	205.75^{g}	81.3^{c}	147.12^{ab}	15.09^{def}	17.13^{bcd}	29.41^{abc}	151.54^{bc}	306.29^{bc}
	KFS2	9.44^{bc}	177.44^{h}	61.69^{c}	140.91^{ab}	19.88^{cd}	2.07^{bcd}	23.45^{bcdef}	143.9^{bcd}	277.86^{bc}
	KFS18	9.35^{bc}	145.99^{ij}	50.81^{c}	92.13^{cd}	21.58^{c}	16.14^{bcd}	15.9^{f}	54.155^{f}	161.87^{de}
180	Speedfeed	7.16^{g}	249.69^{cd}	155.12^{a}	125.46^{abcd}	40.13^{a}	35.76^{a}	25.78^{abcd}	150.75^{bc}	287.58^{bc}
	Pegah	7.14^{g}	232.11^{ef}	65.91^{c}	123.3^{abcd}	18.7^{cde}	21.32^{bcd}	27.68^{abc}	134.59^{bcde}	154.33^{ef}
	KFS2	9.57^{bc}	161.4^{i}	61.58^{c}	131.91^{abcd}	79.26^{cde}	22.57^{b}	22.4^{cdef}	136.67^{bcde}	292.62^{bc}
	KFS18	8.71^{de}	165.98^{hi}	51.41^{c}	79.75^{d}	14.01^{fe}	15.98^{bcd}	17.73^{def}	59.655^{f}	148.95^{ef}
220	Speedfeed	6.93^{g}	261.48^{c}	118.16^{b}	160.51^{a}	31.21^{b}	34.78^{a}	29.56^{abc}	146.23^{bc}	274.19^{bc}
	Pegah	9.12^{cd}	208.54^{g}	60.19^{c}	106.22^{bcd}	16.72^{cdef}	14.46^{d}	24.32^{abcde}	120.16^{ed}	259.92^{c}
	KFS2	9.49^{bc}	225.91^{f}	61.6^{c}	104.57^{bcd}	15.68^{def}	18.63^{bcd}	17.55^{ef}	115.62^{e}	222.96^{d}
	KFS18	9.93^{ab}	142.5^{j}	57.99^{c}	88.11^{cd}	15.35^{def}	17.74^{bcd}	16.4^{ef}	65.928^{f}	134.26^{f}

Means containing similar letters in each column are not significantly different at 5% level of probability according to protected LSD.