

A Research on Forage Yield and Its Components In Response to Different Sowing Rate and Row Distance of Sorghum (*Sorghum bicolor* Moench.) in Turkey

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Summary

This research was carried out to determine the sowing rate and row distance in Edirne province of Thrace Region in 1993 season. According to the results of some important characteristics of sorghum and their interactions were statistically significant. In Havsa and Uzunköprü, the plant height were 70.36 and 95.28cm respectively, within each sowing rate were not significant. Number of tiller were not significant in distance and individual location. Increasing the sowing rate from 1 to 3 kg/da and the location Havsa and Uzunköprü resulted in significant stem diameter variation. Variation in fresh fodder yield has been found significant in row distance sowing rate and location 1 kg/da seed rate with 30 cm row distance together are recommended to the farmer community to obtain the optimum profit.

I . INTRODUCTION

Thrace region is the european side of Turkey. The soil and climatic conditions are congenial with Balkan countries. This region occupies about 2.8% of Turkey. A single cropping system has still carried on since the long years ago. Wheat and sunflower occupy 80% or more of the cultivated area. Because of monoculture growing system, the soil organic matters are substantially low in almost the entire region. At the same time, insect damage causes reduction in yield and quality of crops. Although Thrace region has high potential of animal production yet, but the pasture and meadows production availability are insufficient.

Comparing with our production of quality forage crops which covers merely 12% of the actual production requirements, the rest amount required for animal production is met with the yield crop residuals. Therefore, the forage crops such as alfalfa, corn and

sorghum demand attention in Thrace region of Turkey. On the other hand, culture and hybrid cow population has a huge number of percentage (92%) in cow population of the region. If culture cows are not fed with the optimum appropriate feed dose, their production are significantly decrease all of a sudden. Thus, keeping in view of these seasons, sorghum is sighted as an important forage crop, especially with respect to increase milk production.

Dry fodder yield of Sudan grass and Sorghum-sudan hybrids were affected statistically by seed rate. However maximum dry fodder yield was obtained from the heighest plant density (Gill and Singh, 1974) and maximum dry fodder yield of sorghum-sudan hybrids obtained from 1.5 kg/da seed rate. Seiglinger (1926) pointed out that tillering in sorghum genotypes was affected by sowing rate. Optimum row distance for dry matter production of sudangrass, sorghum and hybrids of these species was found to be 45~50cm

(Summer et al., 1968). In another experiment fresh and dry fodder yield of sorghum and sorghum-sudan grass hybrids increased with increasing of seed rate while number of leaves decreased (Tansi, 1989).

The effect of different row distance on fresh fodder yield, stem weight and plant height in hybrid sudan grass varieties were investigated by Tekeli and Turhan (1991) and was found that the effect of row distance on these characters was significant. İptas et al. (1997) found that fresh fodder yield was positively affected by increasing seed rate and they recommended 3 kg/da as optimum seed rate. Some investigations on sorghum showed that fodder yield for silage increased with decreasing the number of plant for unit area (Kizil et al., 1997). Yield and quality were affected by row

distance (George, F., Jr. Worker, 1976; Koller, H.R. J. M. School., 1968), and sowing rate (George, F., Jr. Worker, 1976). Number of foliage were increased by increasing of plant density (Tsukada, et al., 1977).

II. MATERIALS AND METHODS

Two field experiments were carried out in the research area that is located in Thrace Region of Turkey under farmer conditions in Edirne province (Havsa and Uzunköprü villages). The soil samples were analysed and classified as low organic matter (0.88-2.32 %). The climatic conditions during the growing season are shown Table 1.

Table 1. The climatic data of the experimental site (*Uzunköprü* and *Havsa* villages) for 1993 and long years' average.

Mon.	1993						Long Years' average					
	Temperature (°C)		Rain (mm)		Moisture (%)		Temperature (°C)		Rain (mm)		Moisture (%)	
	Havsa	Uzunk	Havsa	Uzunk	Havsa	Uzunk	Havsa	Uzunk	Havsa	Uzunk	Havsa	Uzunk
April	12.3	11.4	17.1	11.6	66	67	11.2	12.0	41.0	38.3	64	70
May	17.2	16.5	113.0	68.4	75	73	16.4	18.1	46.8	44.3	61	65
June	21.7	21.5	18.6	7.9	61	58	20.5	22.0	37.6	20.8	55	62
July	23.6	23.4	13.1	3.4	54	54	22.7	24.4	19.6	24.4	51	58
Augt.	24.2	23.8	26.0	0.5	57	61	21.9	23.8	18.7	16.0	53	58
Sept.	19.7	19.5	2.1	5.4	59	61	18.4	19.9	27.3	51.9	57	67

Two hybrid sugarleaf sorghum commercial varieties Sweet Sioux-V and Pacific were grown under different row distances (RS) and seed rate (SR). The experimental design was randomized block factorial design. Each plot consists of five rows 5m long and the seed were sown in each rows manually in the month of April. 10 N kg/da was applied for all plots prior to sowing. Three 4m long sections of a row were harvested manually and were used as sample to determine yield components (plant height, number of

tiller, stem diameter, number of foliage) and fresh fodder yield.

III. RESULT AND DISCUSSION

1. Plant height

Seed rate was also significantly different for each yield component. The plant height was not with consistent trend in seed rate of sorghum varieties. Plant

height decreased with increasing the sowing rate. At the same time the same decrease obtained by increasing

the row distance. Plant height was negative affected from increasing of sowing rate.

Table 2. Planth height (cm) of sorghum varieties.

		Location/Row distance (cm)					
SR	Var	Havsa				Uzunköprü	
		30	50	70	Av	30	50
1 kg/da	Pac.	77.17	82.30	72.87	77.44	97.53	102.70
	SS	80.56	79.93	73.80	79.00	88.80	95.10
	Av	78.86 ^{c-f}	81.12 ^{c-f}	73.33 ^{def}	77.77	93.17 ^{bcd}	98.90 ^{abc}
2 kg/da	Pac.	72.95	77.67	71.73	74.12	95.30	88.67
	SS	70.93	68.41	64.77	68.04	99.77	81.50
	Av	71.94	73.04	68.25	71.08	97.53 ^{abc}	85.08 ^{cde}
3 kg/da	Pac.	69.07	65.20	66.83	67.03	111.93	83.25
	SS	56.90	58.00	57.30	57.40	106.13	77.83
	Av	62.98 ^{ef}	61.60 ^f	62.07 ^f	62.22	109.03	80.54
	Av	71.26 ^c	71.92 ^c	67.88 ^c	70.36	99.91 ^a	88.18 ^b

		Location/Row distance (cm)					
		Uzunköprü		Average			
		70	Av	30	50	70	Av
1 kg/da	Pac.	108.83	103.02	87.35	92.50	90.85	90.23
	SS	121.50	101.80	84.68	87.52	97.65	89.95
	Av	115.17 ^a	102.41	86.02 ^{abc}	90.01 ^{ab}	94.25 ^a	90.09
2 kg/da	Pac.	102.57	95.51	84.13	83.17	87.15	84.81
	SS	88.78	90.02	85.35	74.95	76.78	79.03
	Av	95.68 ^{bc}	92.76	84.74 ^{abc}	79.06 ^{cde}	81.96 ^{bcd}	81.92
3 kg/da	Pac.	86.63	93.44	90.50	74.23	76.73	80.49
	SS	78.17	87.38	81.52	67.92	67.73	72.39
	Av	82.40	90.66	86.01 ^{abc}	71.07 ^c	72.23 ^{dc}	76.44
	Av	97.75 ^a	95.28				

	<i>Location</i>	: (t)	45.000**	<i>Sowing rate x Row distance</i>	: 3.384
Sx :	<i>Sowing rate</i>	:	1.954	<i>Location x Row Distance</i>	: 2.763
	<i>Location x Sowing rate x Row distance</i>	:			: 4.786

RS : Row distance, SR : Seed rate, Var : Variety, Pac : Pacific, SS : Sweet Sioux-V.

* Means with the same letter are not significantly different.

2. Number of tiller

The effect of location, sowing rate and row distance on number of tillers were found to be significant. Environmental factors influenced the

number of tiller. Also sowing rate geared the negative effect (Table 3). Similar effecting on the tillering have been reported in previous studies (Seiglinger, 1926; George and Worker, 1976).

Table 3. Tiller number of sorghum varieties.

		Location/Row distance (cm)					
SR	Var	Havsa				Uzunköprü	
		30	50	70	Av	30	50
1 kg/da	Pac.	7.53	7.13	7.43	7.37 ^{ef}	6.73	11.00
	SS	8.43	9.17	7.93	8.51 ^{cde}	7.50	10.87
	Av	7.98 ^{def}	8.15 ^{def}	7.68 ^{def}	7.54	7.12 ^{ef}	10.93
2 kg/da	Pac.	8.48	7.00	7.37	7.62 ^{de}	11.33	12.77
	SS	6.70	8.23	8.73	7.89 ^{de}	9.63	9.97
	Av	7.55 ^{def}	7.62 ^{def}	8.05 ^{def}	7.75	10.48 ^{bc}	11.37 ^{ab}
3 kg/da	Pac.	7.13	7.5	6.37	7.00 ^{ef}	6.87	10.03
	SS	5.30	6.43	6.43	6.04 ^f	7.10	10.50
	Av	6.20 ^f	6.97 ^{ef}	6.40 ^f	6.52	6.98 ^{ef}	10.27 ^{bc}
	Av	7.26 ^b	7.58 ^b	7.38 ^b	7.40	8.19 ^b	10.86 ^a

		Location/Row distance (cm)					
		Uzunköprü		Average			
		70	Av	30	50	70	Av
1 kg/da	Pac.	12.97	10.23 ^{ab}	7.13	9.17	10.20	8.80
	SS	12.70	10.36	7.97	10.02	10.32	9.43
	Av	12.83	10.29	7.55 ^{cd}	9.55 ^{ab}	10.26 ^a	9.12
2 kg/da	Pac.	10.40	11.50	9.991	9.88	8.88	9.56
	SS	8.79	9.46 ^{bc}	8.17	9.10	8.76	8.68
	Av	9.59 ^{bcd}	10.48	9.04 ^{ab}	9.49 ^{ab}	8.82 ^{bc}	9.12
3 kg/da	Pac.	7.77	8.22 ^{cde}	7.00	8.77	7.07	7.61
	SS	9.53	9.04 ^{bcd}	6.18	8.47	7.98	7.54
	Av	8.65 ^{cde}	8.63	6.59 ^d	8.62 ^{bc}	7.53 ^{cd}	7.58
	Av	10.36 ^a	9.80	7.73	9.22	8.67	

Sx : *Location* : (t) 31.90** *Sowing rate x Row distance* : 0.433 *Location x Sowing rate x Variety* : 0.499
Sowing rate : 0.385 *Location x Row Distance* : 0.353
Location x Sowing rate x Row distance : 0.612

3. Stem diameter

Value of stem diameter varied depending on location or seed rate. Meanwhile location × row

distance and seed rate × row distance were also significant in term of stem diameter. Stem diameter decreased with increasing the sowing rate.

Table 4. Stem diameter of sorghum varieties

		Location/Row distance					
SR	Var	Havsa				Uzunköprü	
		30	50	70	Av	30	50
1 kg/da	Pac.	8.53	8.20	8.07	8.27	9.17	9.30
	SS	8.67	8.70	7.90	8.42	9.33	9.87
	Av	8.60 ^{c-f}	8.45 ^{def}	7.99 ^{fg}	8.35 ^{bc}	9.25 ^{bc}	9.58 ^{bc}
2 kg/da	Pac.	8.03	7.07	6.97	7.36	9.00	8.13
	SS	7.27	6.97	6.07	6.77	10.33	7.73
	Av	7.65 ^{fg}	7.02 ^{ghl}	6.52 ^{hl}	7.07 ^{de}	9.67 ^b	7.93 ^{fg}
3 kg/da	Pac.	7.13	6.17	6.37	6.56	8.13	7.03
	SS	5.47	5.93	6.30	5.90	8.60	6.97
	Av	6.30 ^l	6.05 ^l	6.33 ^l	6.23 ^c	8.37 ^{ef}	7.00 ^{ghl}
	Av	7.52 ^c	7.17 ^{cd}	6.94 ^d	7.21 ^b	9.10 ^a	8.17 ^b

		Location/Row distance					
		Uzunköprü		Average			
		70	Av	30	50	70	Av
1 kg/da	Pac.	10.22	9.56	8.85	8.75	9.15	8.92
	SS	11.73	10.31	9.00	9.28	9.82	9.37
	Av	10.98 ^a	9.94 ^a	8.93 ^{ab}	9.02 ^{ab}	9.48 ^a	9.14
2 kg/da	Pac.	9.63	8.92	8.52	7.60	8.30	8.14
	SS	9.29	9.09	8.80	7.35	7.63	7.93
	Av	9.42 ^{bcd}	9.01 ^{ab}	8.66 ^b	7.48 ^{cd}	7.97 ^c	8.03 ^b
3 kg/da	Pac.	7.30	7.49	7.63	6.60	6.83	7.02
	SS	7.40	7.66	7.03	6.45	6.85	6.78
	Av	7.35 ^{gh}	7.58 ^{cd}	7.33 ^{cd}	6.53 ^c	6.84 ^{dc}	6.90 ^c
	Av	9.25 ^a	8.84 ^a	8.31	7.67	8.10	

Sx :	Location : (t)	41.889**	Sowing rate x Row distance	: 0.444
	Sowing rate :	0.256	Location x Row Distance	: 0.363
	Location x Sowing rate x Row distance			: 0.628
	Location x Sowing rate			: 0.363

4. Number of foliage

The data for number of leaves were analysed and the analysis are shown in Table 5. According to the analysis of variance, the effect of location, seed rate, row distance and location \times row distance interaction

on number of foliage were found to be significant. Similar results have been reported in previous studies in Adana (Tansi, 1989). The other investigations were not supported with our results (Tsukada, et al., 1977). The differences may be originated from location and climatic variations.

Table 5. Foliage number of sorghum varieties.

		Location/Row distance					
SR	Var	Havsa				Uzunköprü	
		30	50	70	Av	30	50
1 kg/da	Pac.	30.78	32.52	28.19	30.50	29.91	38.28
	SS	29.41	29.55	28.72	29.23	32.94	45.42
	Av	30.98	31.04	28.46	29.86	31.42	41.85
2 kg/da	Pac.	28.52	24.82	29.50	27.61	33.47	38.16
	SS	22.99	30.79	28.36	27.38	30.25	36.76
	Av	25.75	27.81	28.93	27.50	31.86	37.46
3 kg/da	Pac.	29.27	29.09	26.31	28.22	35.44	35.99
	SS	22.30	22.38	24.99	23.22	29.73	37.79
	Av	25.78	25.74	25.65	25.72	32.59	36.89
	Av	27.21 ^b	28.19 ^b	27.68 ^b	27.69 ^b	31.96 ^b	38.73 ^a

		Location/Row distance					
		Uzunköprü		Average		70	Av
		70	Av	30	50		
1 kg/da	Pac.	46.05	38.08	30.35	35.40	37.12	34.29
	SS	44.47	40.94	31.18	37.48	36.60	35.08
	Av	45.26	39.51	30.77	36.44	36.86	34.69 ^a
2 kg/da	Pac.	36.06	35.90	31.00	31.49	32.78	31.75
	SS	32.42	33.14	26.62	33.77	30.39	30.26
	Av	34.24	34.52	28.81	32.63	31.58	31.01 ^b
3 kg/da	Pac.	38.37	36.60	32.35	32.54	32.34	32.41
	SS	35.92	34.48	26.02	30.09	30.46	28.85
	Av	37.15	35.54	29.18	31.31	31.40	30.63 ^b
	Av	38.88 ^a	36.52 ^a	29.58 ^b	33.46 ^a	33.28 ^a	

Sx :	Location	: (t)	44.05**	Row distance	: 1.20
	Sowing rate	:	1.20	Location x Row distance	: 1.70

5. Fresh fodder yield

In fodder crop the most important agricultural characteristic is the yield. Location significantly affects

the fodder yield. Sowing rate and row distance have also the similar effects. On the yield the increase of sowing rate decreased the fodder yield.

Table 6. Fresh fodder yield of sorghum varieties.

		Location/Row distance					
SR	Var	Havsa				Uzunköprü	
		30	50	70	Av	30	50
1 kg/da	Pac.	1,683.33	1,866.77	988.00	1,512.70	3,900.00	3,120.67
	SS	2,358.88	1,802.67	1,510.69	1,890.75	3,608.11	3,329.67
	Av	2,021.11 ^{ef}	1,834.71 ^{efg}	1,249.35 ^{ghl}	1,701.73	3,754.05 ^{ab}	3,216.17 ^{bc}
2 kg/da	Pac.	1,752.00	1,460.48	1,210.23	1,474.24	4,173.11	2,558.00
	SS	1,650.00	1,847.33	755.05	1,417.46	3,224.00	1,994.67
	Av	1,700.10 ^{e-h}	1,653.91 ^{e-h}	982.64 ^l	1,445.85	3,698.56 ^{ab}	2,276.33 ^{dc}
3 kg/da	Pac.	1,835.76	1,235.00	1,232.94	1,434.57	3,969.23	2,741.00
	SS	1,120.20	1,269.33	885.23	1,091.59	4,693.34	2,577.66
	Av	1,477.98 ^{f-1}	1,252.17 ^{ghl}	1,059.09 ^{hl}	1,263.08	4,331.29 ^a	2,659.33 ^{cd}
	Av	1,733.26 ^c	1,580.26 ^c	1,097.03 ^d	1,470.22 ^b	3,927.97 ^a	2,717.28 ^b

		Location/Row distance					
		Uzunköprü		Average			
		70	Av	30	50	70	Av
1 kg/da	Pac.	4,034.28	3,678.98	2,791.67	2,484.72	2,511.14	2,595.84 ^{ab}
	SS	3,900.43	3,612.74	2,983.50	2,566.17	2,705.56	2,751.74 ^a
	Av	3,967.36 ^a	3,645.86	2,887.59 ^a	2,525.44 ^a	2,608.35 ^a	2,673.79 ^a
2 kg/da	Pac.	3,310.84	3,347.32	2,962.56	2,009.24	2,260.54	2,410.78 ^{abc}
	SS	2,296.90	2,505.19	2,437.00	1,921.00	1,525.98	1,961.32 ^d
	Av	2,803.87 ^{cd}	2,926.25	2,699.78 ^a	1,965.12 ^b	1,893.26 ^b	2,186.50 ^b
3 kg/da	Pac.	2,478.05	3,062.76	2,902.50	1,988.00	1,855.50	2,248.00 ^{bcd}
	SS	1,902.05	3,057.69	2,906.77	1,923.50	1,393.64	2,074.60 ^{cd}
	Av	2,190.05 ^{de}	3,060.22	2,904.63 ^a	1,955.75 ^b	1,624.57 ^b	2,161.65 ^b
	Av	2,987.09 ^b	3,210.79 ^a	2,830.66	2,148.77	2,042.06	

Sx :	Location	: (t)	21.03**	Sowing rate x Row distance	: 147.19
	Sowing rate	:	84.98	Sowing rate x Variety	: 120.18
	Row distance	:	84.98	Location x Row distance	: 120.18
	Location x Sowing rate	:		Row distance	: 208.16

Maximum fodder yield was obtained in Uzunköprü and 30 cm row distance (3,927.97 kg/da). On the other hand sowing rate \times distance interaction revealed that there was a significant difference between applications. Maximum fodder yield was obtained from 3 kg/da sowing rate and 30 cm row distance combination. Location \times sowing rate \times row distance maximum amount of fodder (4,331.29 kg/da) was harvested from Uzunköprü location \times 30 cm \times 3 kg/da combination. On the other hand maximum fodder yield 2,673.73~2,830.66 kg/da were determined from 1 kg/da sowing rate and 30 cm row distance respectively.

The results of the present research have similar trend with some researches (Koller, H.R., J.M. School, 1968; Gill and Singh, 1974, George, F., Jr. Worker, 1976; Tekeli and Turhan, 1991; Kizil et al., 1997; İptas et al., 1997) and have opposite trend with the other investigations (Summer et al., 1968; Tansi, 1989).

In the light of results obtained from this experiment the seed rate of 1 kg/da with 30 cm row distance are recommended to the farmer community to fetch the optimum profit by growing this fodder crop under Thrace Region.

IV. REFERENCES

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