JOURNAL OF AGRICULTURE & SOCIAL SCIENCES
1813–2235/2007/03–3–95–97
http://www.fspublishers.org

Yield Response of Fodder Sorghum (*Sorghum bicolor*) to Seed Rate and Row Spacing under Rain-fed Conditions

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ABSTRACT

Field studies were conducted to determine the effects of three seed rates (50, 60 & 75 kg ha^{-1}) and three rows spacing (15, 30 & 45 cm) on fodder yield of sorghum under rainfed conditions. Days to 50% flowering, was not markedly affected in seed rate x row spacing interaction, while rest of the parameters had significant effects. There were no significant differences in year x seed rate x row spacing interaction for all the characters studied indicating a small effect of the years on relative productivity. Yield was significantly decreased with decreasing seed rate and increasing row spacing. On an average, the greatest fodder yield (77.95 t ha^{-1}) was recorded 75 kg ha^{-1} (highest) seed rate and narrow (15 cm) spacing, while the lowest green fodder yield (12.39 t ha^{-1}) obtained by the lowest seed rate (50 kg ha^{-1}) and highest row spacing (45 cm).

Key Words: *Sorghum bicolor;* Row spacing; Seed rates; Fodder yield; Yield components

INTRODUCTION

Sorghum bicolor (L.) Moensh locally known as Jawar or Chari is a very important and useful summer crop. It is also one of the oldest cultivated cereals and is thought to have originated in Africa (De Wet & Huckabay, 1967), though other sorghum species appear to be native to other regions. It is raised as fodder in irrigated areas and as grain in dry tracts in Pakistan. Sorghum needs a mean daily temperature at least 7 - 10ºC to germinate. It is a short day plant and its seedling can survive several degrees of frost. Heading and flowering is induced and hastened by shortening day length and delayed by lengthening days. Sorghum stalks have the ability to revive after a period of dormancy induced by drought. It has various xerophytic characteristics that enable it to escape, avoid, tolerate and recover from drought. Economically, sorghum provides palatable green fodder over a longer period than maize and millet. Its green fodder contains 12% protein, 70% carbohydrates and remaining part consists of minerals, nitrogen and crude fats. Due to such traits, it is palatable to animals. Sorghum is successfully grown as fodder (green & dry) in rainfed (Barani) tracts.

Fodder yield in sorghum is mainly affected by row spacing and seed rate. Yield increases from narrow rows have been attributed to better light interception and more efficient water use (Scott *et al.,* 1999). Ayub *et al.* (2002) carried out experiment on sorghum and observed significant differences for yield and its components in different seed rates. Aysen *et al.* (2004) also reported that seeding rate treatments showed significant effects on dry matter, yield and most yield components. Greatest yield was obtained from highest seed rate and narrow row spacing (Orak & Kavdr, 1994) and increased row spacing reduced yield (Mokadem *et al.,* 2002). Ayub *et al.* (2003) showed that the increased seed rate significantly increased the green fodder and dry matter yield. Gonzalez and Graterol (2000) found that yield decreased with increasing row spacing in sorghum. Bishnoi and Mays (2002) indicated that sorghum yield in narrow spacing outyielded the yield in wide rows. These data were reported from irrigated regions. However, similar studies in rain-fed areas are lacking. Present studies were conducted at Barani Agricultural Research Station, Fatehjang to determine the effects of three seed rates (50, 60 & 75 kg ha^{-1}) and three rows spacing (15, 30 & 45 cm) on fodder yield of sorghum cv. JS-263 under rainfed conditions.

MATERIALS AND METHODS

Field studies were conducted under rainfed conditions during two growing seasons (2003 & 2004) at the experimental area of Barani Agricultural Research Station, Fatehjang, District Attock. Sorghum cultivar JS-263 was grown at three different seed rates (50, 60 & 75 kg ha^{-1}) and three rows spacing (15, 30 & 45 cm) in all possible combinations using split plot design with three replications. Each plot consisted of four rows of 5 m length. Seeds were sown with the help of hand drill. Hoeing and weeding was done to control the weeds. Five plants were tagged to record the data for leaf area, plant height, green fodder yield per plant and dry fodder yield per plant at the time of 50% flowering. The green fodder yield per plot was determined by harvesting central two rows of each plot and expressed in kg ha^{-1}. Means computed using MS-Excel were subjected to analysis of variance by computer program MSTATC.

RESULTS AND DISCUSSION

Estimates of variance components are presented in Table I. Highly significant results were found in seed rate for all the traits. Row spacing also showed highly significant

differences for most of the traits except green and dry fodder yield per plant. Days to 50% flowering was not markedly affected in seed rate x row spacing interaction, showing non-significant differences, while rest of the parameters had significant effects. The presence of significant RS x SR interaction indicated that the genotype responded differently to the applied treatments. There were no significant differences in year x seed rate x row spacing interaction for all the characters studied. The presence of small year x seed rate x row spacing interaction indicates a small effect of the years on relative productivity. However, significant differences were observed for green and dry fodder yield per plant (year x seed rate) and for leaf area and dry fodder yield per plant (year x row spacing). Ayub *et al.* (2002) observed significant differences for yield and its components in different seed rates.

Row-spacing and seed rate had significant effects on yield potentials (Table II). High seeding rates with narrow row spacing tended to produce higher fodder yield. The highest seed rate (75 kg ha^{-1}) and narrow row spacing (15 cm) resulted in highest fodder yield (57.36 t ha^{-1} & 49.11 t ha^{-1}, respectively). Yield significantly decreased with decreasing seed rate and increasing row spacing. Orak and Kavdr (1994) and Gonzalez and Graterol (2000) accrued highest yield was obtained from highest seed rate and narrow row spacing. Ayub *et al.* (2003) showed that the increased seed rate significantly increased the green fodder and dry matter yield.

Earlier days to 50% flowering with increased plant height were observed in increasing seed rate and decreasing rows spacing (Table III). Plant productivity is at its highest near the time the crop closes the canopy, therefore, a crop that closes its canopy earlier in the growing season should have an advantage over a crop with slower canopy development (Scott *et al.*, 1999). For the two years with average green fodder yield above 35 t ha^{-1}, sorghum in 15 cm rows with seed rate of 75 cm yielded 23 t ha^{-1} greater than in 15 cm rows with a seed rate of 60 t ha^{-1} and 37 t ha^{-1}

Table I. Mean squares and variance components for fodder yield among different row spacing and seed rate treatments in sorghum

Source	df	DHE	LA	PH	GFY per plant	GFY (t ha^{-1})	DFY per plant
R	2	21.91*	88.30ns	386.50**	2533.69*	79.55ns	7.41ns
Y	1	188.91**	47.13ns	11.48ns	2307.57*	203.39*	342.02**
SR	2	110.02**	5104.35**	1032.66**	10518.69**	2960.72**	2392.21**
Y x SR	2	3.13ns	67.25ns	34.87ns	3830.91**	49.44ns	276.39*
RS	2	35.13**	4559.89**	432.0**	774.80ns	6770.28**	78.22ns
Y x RS	2	1.46ns	1296.75**	151.92ns	32.57ns	111.65ns	206.62*
SR x RS	4	0.96ns	2078.55**	463.01**	3247.16**	198.37*	440.15**
Y x SR x RS	4	4.35ns	234.52ns	10.90ns	1238.82ns	11.50ns	60.24ns
Error	34	5.06	187.31	49.62	554.51	54.67	62.37

R= Reploication, Y= Year, SR= Seed rate, RS= Row spacing, DHE= Days to 50% flowering, LA= Leaf area, PH= Plant height, GFY= Green fodder yield, DFY= Dry fodder yield.

Table II. Means (average of 2 years) of yield and its components of different seed rates and row spacing in sorghum grown during Kharif 2004 and 2005

Determinents	DHE	LA (cm^2)	PH (cm)	GFY per plant (g)	GFY (t ha^{-1})	DFY per plant (g)
SR (50 kg ha^{-1})	64.78	252.20	225.32	169.44	23.62	41.57
SR (60 kg ha^{-1})	62.33	254.44	226.90	181.83	33.89	51.54
SR (75 kg ha^{-1})	59.83	282.42	239.16	216.11	49.11	64.56
RS (15 cm)	63.89	279.87	225.07	193.06	57.36	54.96
RS (30 cm)	61.83	260.96	234.65	192.78	28.99	51.47
RS (45cm)	61.22	248.24	231.65	181.56	20.27	51.24

SR= Seed rate, RS= Row spacing, DHE= Days to 50% flowering, LA= Leaf area, PH= Plant height, GFY= Green fodder yield, DFY= Dry fodder yield

Table III. Means (average of 2 years) of yield and its components of different seed rates x row spacing in sorghum grown during Kharif 2004 and 2005

Seed rate (kg ha^{-1})	Row spacing (cm)	DHE	LA (cm^2)	PH (cm)	GFY per plant (g)	GFY (t ha^{-1})	DFY per plant (g)
50	15	66.67	257.63	213.45	182.50	40.24	46.63
50	30	64.00	250.45	227.57	170.00	18.23	44.28
50	45	63.67	248.51	234.93	155.83	12.39	36.87
60	15	63.50	248.3	218.82	169.17	53.89	43.73
60	30	62.33	292.98	237.67	216.67	30.25	65.07
60	45	61.17	222.05	224.22	159.67	17.53	45.82
75	15	61.50	296.18	242.95	226.67	77.95	67.03
75	30	59.17	276.94	238.72	206.67	38.49	62.95
75	45	58.83	274.15	235.80	215.00	30.89	63.70

DHE= Days to 50% flowering, LA= Leaf area, PH= Plant height, GFY= Green fodder yield, DFY= Dry fodder yield.

more than the 15 cm rows with seed rate of 50 t ha^{-1} (Table III). Yields in the 15 cm rows with seed rate 60 t ha^{-1} were only 13 t ha^{-1} more than in the 15 cm rows with seed rate of 50 t ha^{-1}. This suggested that the greatest increases come from very narrow rows with increased seed rate. The mean fodder yield at different row spacing and seed rates ranged from 12.39 t ha^{-1} to 77.95 t ha^{-1}. On an average, the highest fodder yield (77.95 t ha^{-1}) was shown by highest seed rate (75 kg ha^{-1}) and narrow spacing (15 cm), while the lowest green fodder yield (12.39 t ha^{-1}) was obtained by the lowest seed rate (50 kg ha^{-1}) and highest row spacing (45 cm). Bishnoi and Mays (2002) indicated that sorghum yield in narrow spacing outyielded the yield in wide rows. Mokadem *et al.* (2002) investigated that increasing row spacing was followed by a reduction in the yield.

It was concluded that high seed rate and narrow row spacing proved to be the best combination for getting higher fodder yield of sorghum cultivar 'JS 263' under rain-fed conditions.

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(Received 09 March 2007; Accepted 27 April 2007)