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Study the effect of land configuration and integrated nutrient management on yield attributes and yield of different varieties of sorghum (*RABI*) grown on coastal salt affected soils

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Abstract
A field experiment to study the effect of land configuration and integrated nutrient management on yield attributes and yield of different varieties of sorghum (rabi) grown on coastal salt affected soils at Coastal Soil Salinity Research Station, Danti-Umbharat (Navsari Agricultural University, Navsari) in Gujarat during rabi 2011-12 to 2011-12. Significantly superior girth of earhead, number of grains per earhead, test weight, grain and stover yields were recorded when sorghum was sown on raised bed as compared to flat bed sowing. The mean grain yield advantage under raised bed sowing was 13.31 per cent over flat bed. Yield attributes and yield were significantly affected due to different varietal treatments. Variety GJ-38 recorded significantly higher length of earhead, number of grains per earhead, grain (3420 kg ha^{-1}) and stover (8481 kg ha^{-1}) yields While, stem girth was significantly superior in variety BP-53. INM levels also showed discernible influence on yield attributes and yield of sorghum. Application of 100 % recommended dose of fertilizer (80-40-00 NPK kg ha^{-1}) + FYM @ 10 t ha^{-1} was found good and remarkably improved grains per earhead, grain yield and stover yield. The magnitude of increase in grain yield was 12.13 per cent over 100 % RDF and 15.64 per cent over 75 % RDF alongwith FYM @ 10 t ha^{-1}, respectively.

Keywords: sorghum, calcareous, integrated nutrient management

Introduction

Sorghum [*Sorghum bicolor* (L.) Moench] is an important drought resistant cereal crop and fifth largest produced cereal in the world after wheat, maize, rice and barley belongs to family Poaceae, tribe Andropogoneae, subtribe Sorghinae and genus Sorghum (Clayton and Renvoize, 1986) [4]. Sorghum is termed as "Nature-care crop" as it possess strong resistance to harse environments such as dry weather and high temperature compared to other crops. It is usually grown as a low level chemical treatment crop with limited use of pesticides and it has a potential to adapt itself to the given natural environment. Poor physical soil condition is one of the major factors responsible for low productivity of crops particularly in clayey soil. Therefore, land configuration can play an important role for rapid and uniform germination as well as growth and development of plant. In spite of being such an important crop, its yield level is very low in India as compared to USA, USSR, France, Italy, Maxico, Argentina and Australia. The poor yield of sorghum is attributed to old varieties used by majority of farmers. These varieties are tall, prone to lodging and give poor response to fertilization under dry and irrigated conditions. Independent use of neither the chemical fertilizer nor an organic source can sustain the fertility of soil and productivity of crop in high input production system, whereas integrated nutrient management maintains soil and plant health. It also enhances fertilizer use efficiency and ensures higher crop production.

Materials and Methods

A field experiment was conducted for 2 years during rabi seasons of 2010-11 and 2011-12 at Coastal Soil Salinity Research Station, Danti-Umbharat (Navsari Agricultural University, Navsari) in Gujarat ($72^0 50'$ E longitude and $20^0 83'$ N latitude. The mean sea level is ranging from 0-2.5 m). The experiment comprising of 18 treatment combinations consisting of two land configuration and three varieties as main plot and three levels of integrated nutrient management in sub-plot were studied in split plot design with four replications.

The soil is classified as "Calcareous Soil" characterized by very high clay content, with good moisture holding capacity and low to very low permeability. It cracks heavily on drying and expands on wetting. The slightly alkaline soil is characterized as clayey with pH 8.58, electrical conductivity (EC) 1.42 dS m^{-1} and exchangeable sodium percentage (ESP) 12.42. The initial nutrient status of the soil revealed that it was low in available nitrogen and high in available phosphorus and potassium. Randomly selected five earhead from each net plot were used for recording observations on length of earhead, earhead girth and number of grains per earhead. The grain and stover yield obtained from net plot was converted on hectare basis and presented accordingly. The statistical analysis of the data of various observations recorded during investigation was carried through analysis of variance technique as described by Panse and Sukhatme (1967) [6].

Results and Discussion

Effect of land configuration

Yield attributes, *viz.*, earhead girth, grains per earhead and test weight as well as grain and stover yield and harvest index of sorghum were significantly influenced due to effect of land configuration. Significantly higher values of all these parameters were recorded when sorghum was sown on raised bed (Table 1 & 2).

Length of earhead at harvest did not affected significantly due to land configuration treatment during individual years and in pooled analysis. While use of raised bed treatment registered significantly superior earhead girth and test weight during first year of experimentation and in pooled analysis and was found non-significant during second year of experimentation.

Significantly superior earhead girth was recorded in raised bed treatment than flat bed during first year and in pooled analysis. Raised bed sowing recorded 5.1 and 4.0 per cent increase in earhead girth during first year and in pooled analysis, respectively. The magnitude of increase in number of grains per earhead under raised bed sown sorghum was to the tune of 9.46, 8.56 and 9.01 per cent over flat bed during both the years and in pooled analysis, respectively. Sorghum sown on raised bed recorded significantly higher test weight over flat bed sowing during the first year and in pooled analysis. The increase in values of above mentioned yield components under raised bed sowing over flat bed was supported by increased growth parameters and larger ear size *i.e.*, ear girth which might have provided sufficient space (sink) for the increased number of grains per ear and development of individual grain. The results were in agreement with those reported by Patil and Sheelavantar (2000) [10] with respect to earhead girth, number of grains per earhead and test weight in sorghum and Sepat *et al.* (2010) [12] with respect to grains per spike in wheat.

Sorghum sown on raised bed recorded significantly superior grain yield and stover yield and harvest index as compared to flat bed. The mean grain yield advantage under raised bed sowing was 14.53, 12.02 and 13.30 per cent, whereas for stover yield was 18.68, 14.17 and 16.48 per cent over flat bed during individual years as well as in pooled analysis, respectively. The grain yield was significantly and positively correlated with yield components *viz.*, earhead girth, grains per earhead and test weight. The results are in corroboration with the early findings of Patil and Sheelavantar (2000) [10], Anon. (2007) [1], Bhat and Mahal (2006) [2] and Sepat *et al.* (2010) [12].

Table 1: Earhead length (cm), earhead girth (cm) and grains per earhead of sorghum as influenced by land configuration, variety and integrated nutrient management

Treatments	**Earhead length (cm)**			**Earhead girth (cm)**			**Grains per Earhead**		
	2010-11	**2011-12**	**Pooled**	**2010-11**	**2011-12**	**Pooled**	**2010-11**	**2011-12**	**Pooled**
Land configuration									
L_1	17.85	17.79	17.82	20.69	20.80	20.75	887.61	890.32	888.96
L_2	17.63	17.66	17.64	19.63	20.19	19.91	803.64	814.14	808.89
S.Em$\pm$	0.34	0.30	0.22	0.32	0.32	0.23	19.39	21.99	14.66
C.D. (0.05)	NS	NS	NS	0.97	NS	0.66	58.44	66.30	42.34
Variety									
V_1	21.63	21.88	21.76	19.36	19.63	19.50	1067.13	1096.84	1081.99
V_2	17.67	17.53	17.60	19.24	19.86	19.55	753.12	746.23	749.67
V_3	13.92	13.78	13.85	21.89	22.00	21.94	716.62	713.62	715.12
S.Em$\pm$	0.42	0.36	0.39	0.40	0.39	0.39	23.74	26.94	25.39
C.D. (0.05)	1.25	1.09	1.12	1.19	1.19	1.14	71.57	81.20	73.33
C.V. (%)	11.5	10.0	10.8	9.6	9.4	9.5	13.8	15.5	14.7
Interactions	NS	NS	NS	NS	NS	NS	NS	NS	NS
Integrated nutrient management									
F_1	18.04	18.21	18.13	20.82	20.81	20.81	819.53	807.83	813.68
F_2	16.86	16.88	16.87	18.93	19.96	19.45	836.14	824.95	830.55
F_3	18.32	18.09	18.20	20.73	20.72	20.72	881.19	923.90	902.55
S.Em$\pm$	0.27	0.32	0.21	0.29	0.25	0.19	15.85	21.01	13.16
C.D. (0.05)	0.77	0.93	0.59	0.82	NS	0.54	45.46	60.27	37.10
C.V. (%)	7.4	9.0	8.2	7.0	6.0	6.5	9.2	12.1	10.7
Interactions	NS	NS	NS	NS	NS	NS	NS	NS	NS

L_1: Raised bed, L_2: Flat bed; V_1: GJ-38, V_2: CSV 216R, V_3: BP-53;

F_1: 100 % RDF (80: 40: 00 NPK kg ha^{-1}), F_2: 75 % RDF + FYM @ 10 t ha^{-1}, F_3: 100 % RDF + FYM @ 10 t ha^{-1}

Table 2: Test weight (g), grain yield (kg ha^{-1}), stover yield (kg ha^{-1}) and harvest index (%) of sorghum influenced by land configuration, variety and integrated nutrient management

Treatments	Test weight (g)			Grain yield (kg ha^{-1})			Stover yield (kgha^{-1})			Harvest index (%)		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
Land configuration												
L_1	30.38	29.86	30.12	3429	3332	3381	8705	8250	8478	28.31	28.73	28.52
L_2	29.10	29.04	29.07	2931	2932	2931	7079	7082	7080	29.34	29.23	29.28
S.Em$\pm$	0.36	0.32	0.24	54.7	80.5	48.7	151.5	167.7	113.0	0.18	0.35	0.20
C.D. (0.05)	1.08	NS	0.69	165	243	141	457	505	326	0.56	NS	0.57
Variety												
V_1	23.75	23.69	23.72	3391	3450	3420	8548	8415	8481	28.45	29.06	28.76
V_2	32.48	32.03	32.26	3143	3020	3081	7806	7360	7583	28.88	29.10	28.99
V_3	32.98	32.62	32.80	3007	2925	2966	7322	7223	7272	29.14	28.77	28.96
S.Em$\pm$	0.44	0.39	0.42	67.0	98.6	84.3	185.6	205.3	195.7	0.23	0.42	0.34
C.D. (0.05)	1.33	1.17	1.20	202	297	244	559	619	565	NS	NS	NS
C.V. (%)	7.3	6.5	6.9	10.3	15.4	13.1	11.5	13.1	12.3	3.9	7.2	5.8
Interactions	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Integrated nutrient management												
F_1	30.25	29.91	30.08	3128	2984	3056	7780	7407	7594	28.75	28.61	28.68
F_2	28.28	28.05	28.16	2984	2883	2934	7365	6953	7159	28.96	29.31	29.14
F_3	30.68	30.38	30.53	3428	3529	3478	8531	8638	8584	28.75	29.02	28.89
S.Em$\pm$	0.38	0.30	0.24	56.5	91.7	53.9	152.7	184.0	119.5	0.24	0.26	0.18
C.D. (0.05)	1.09	0.85	0.68	162	263	152	438	528	337	NS	NS	NS
C.V. (%)	6.2	4.9	5.6	8.7	14.4	11.8	9.5	11.8	10.6	4.1	4.4	4.3
Interactions	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

L_1: Raised bed, L_2: Flat bed; V_1: GJ-38, V_2: CSV 216R, V_3: BP-53;
F_1: 100 % RDF (80: 40: 00 NPK kg ha^{-1}), F_2: 75 % RDF + FYM @ 10 t ha^{-1}, F_3: 100 % RDF + FYM @ 10 t ha^{-1}

Effect of Variety

Varieties GJ-38, CSV 216R and BP-53 differed significantly with respect to yield attributes *viz*., earhead length, earhead girth, grains per earhead and test weight *i.e.* 1000-grain weight and yield during both the years as well as in pooled analysis. On the basis of pooled analysis, significantly superior earhead length (21.76 cm) and grains per earhead (1081.99) were recorded in variety GJ-38 (V_1) while significantly superior earhead girth was recorded in variety BP-53 (V_3). Patil (2002) [8] at Bellary (Karnataka) reported that sorghum variety M 35-1 recorded significantly higher values for panicle diameter (13.6 cm) and 1000-grain weight (30.6 g) while panicle length was significantly higher in variety SPH 1089.

Variety exerted significant effect on grain yield and stover yield during both the years as well as in pooled analysis (Table 2). Significantly superior grain and stover yield of sorghum was recorded with the variety V_1 (GJ-38) during individual years and in pooled analysis, respectively as compared to rest of the two varieties. The grain yield was significantly and positively correlated with yield components *viz.*, earhead length and grains per earhead. Similar findings were also reported by Patil and Basappa (2004) [9] at Bellary who observed that varieties M 35-1, SPV 1413, Mouli and SPV 1359 had significantly higher grain yields than other varieties due to higher panicle length, panicle diameter, panicle mass per plant and grain mass per plant. However, varieties V_2 and V_3 remained at par with each other during both the years of experimentation and in pooled analysis also.

Effect of INM

Almost all yield attributes (Table 1 & 2) *viz.*, earhead length, earhead girth, grains per earhead and test weight were favorably influenced by INM treatments. These yield attributes played vital role in determining final yield of sorghum crop.

On the basis of pooled analysis, application of 100 % RDF alongwith FYM @ 10 t ha^{-1} significantly increased earhead length and test weight of sorghum but remained at par with application of 100 % RDF alone while reverse trend was observed in case of earhead girth (Table 1 & 2). Significantly superior number of grains per earhead was recorded under INM treatment of 100 % RDF alongwith FYM @ 10 t ha^{-1} during both the years as well as in pooled analysis (Table 1).

The crop fertilized with 100 % RDF alongwith FYM @ 10 t ha^{-1} increased the values of all the yield attributes and found superior over 100 % RDF and 75 % RDF alongwith FYM @ 10 t ha^{-1}. It is might be due to vigorous growth of plants with higher levels of major nutrients in terms of plant height, LAI and dry matter production, which resulted in adequate food supply to sink and ultimately reflected into better yield attributes. Similar results have been also reported by Biradar and Gollagi (2006) [3] in sorghum crop and Pandey *et al.* (2009) [5] in wheat crop.

The results pertaining to grain yield, stover yield and harvest index have been described in earlier chapter (Table 2). The differences in grain yield and stover yield were upto the level of significance. Among integrated nutrient management, application of 100 % RDF + FYM @ 10 t ha^{-1} to sorghum gave significantly superior grain and stover yields as compared to 100 % RDF alone and 75 % RDF + FYM @ 10 t ha^{-1}. On the basis of pooled analysis, grain yield advantage under 100 % RDF + FYM @ 10 t ha^{-1} was 12.13 and 15.64 per cent, whereas for stover yield, it was 11.53 and 16.60 per cent over 100 % RDF and 75% RDF + FYM @ 10 t ha^{-1} treatments, respectively. The remarkable increase in grain and stover yield under treatment of 100 % RDF + FYM @ 10 t ha^{-1} might be due various growth attributes such as plant height, leaf area index, dry matter accumulation per plant and stem girth and yield attributes such as earhead length, earhead girth, number of grains per earhead and test weight. All these parameters showed positive and significant correlation with grain and stover yield of sorghum. These findings are in close agreement with those reported by Ponnuswamy *et al.* (2002) [11], Sonune *et al.* (2003) [13], Patidar and Mali (2004) [7] and

Biradar and Gollagi (2006) [3] in sorghum crop while Pandey *et al*. (2009) [5] in wheat crop.

Interaction effect

The interaction between land configuration, variety and integrated nutrient management to be non-significant with respect to all yield attributes and yield.

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