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Effect of intercropping and weed management practices on yield and weed parameters of Rabi sorghum (*Sorghum bicolor* L.) Under South Gujarat condition

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Abstract
A field experiment was carried out at college farm of N. M. college of Agriculture, Navsari Agricultural University, Navsari, to study the "Effect of Intercropping and Weed Management on Rabi Sorghum (*Sorghum bicolour* L.,) Under South Gujarat Condition." During Rabi season 2019. The soil of experimental unit was clayey (57.22) in texture with poor drainage and good water holding capacity. The experiment site was low in organic carbon (0.32%), low in available N (227.30 kg/ha), medium in available P_2O_5 (32.74 kg/ha) and high in available K_2O (374.65 kg/ha) with pH 7.9 and EC 0.36 ds/m. there were twelve treatment combination consisting of sole sorghum, sole Indian bean, sorghum + Indian bean (3:2), weedy check, pendimethalin 1 kg/ha and pendimethalin 1 kg/ha + HW at 30 days were evaluated with randomized block design with factorial concept with three replication. Grain yield and fodder yield of sorghum were significantly affected due to intercropping and weed management practices and the significantly the highest value were found with treatment I_1 (sole sorghum). However, it remains statistically at par with treatment I_3 (sorghum + Indian bean 2:1). Harvest index remained unaffected due to different intercropping and weed management practices as well as in interaction. Significantly lower weed count of monocot, dicot and sedges and dry weight of weeds recorded with treatment I_4 (sorghum + Indian bean 2:1) at 20 and 40 DAS for weed count. While highest weed control efficiency (WCE) and lowest weed competition index (WCI) was recorded with treatment W_3 (pendimethalin 1 kg/ha + HW at 30 DAS) and treatment I4 (sorghum + India bean 3:2).

Keywords: Intercropping, management, practices, parameters, Rabi

Introduction
Sorghum is the world's fifth most important cereal crop after rice, wheat, maize, barely and considered as king of millets and extensively grown in semi-arid tracks of Africa, China and India. Asia and Africa contributing more than 70 percent of the world's total sorghum production. Nutritionally, sorghum grain contains about 10.4 percent protein, 3.1 percent fat, 70.7 percent carbohydrate and 2.0 percent crude fiber (Kulamarva *et al.* 2009) [4]. It is relatively rich in iron, zinc, phosphorus and vitamin B-complex. Tannins found particularly in red grain type, contain antioxidants that protect against cell damage, a major cause of diseases and aging.

Materials and Methods
Experimental Details
In order to study the "Effect of intercropping and weed management on *Rabi* sorghum (*Sorghum bicolor* L.) Under south Gujarat condition" a field experiment was conducted during *Rabi* season of the year 2019. The details of the experiment are given as under data presented in Table 1 revealed that the soil of the experimental field was clayey in texture and showed low, medium and high rating for available nitrogen (227.30 kg/ha), P_2O_5 (32.74 kg/ha) and K_2O (374.65 kg/ha), respectively. The soil was slightly alkaline (pH 7.9) with normal electric conductivity (0.36 dS/m).

Table 1: Initial Physico-chemical properties of experimental soil and methods of analysis

Sr. No.	Particular	Soil depth (0-30 cm)	Method of analysis
1.Physical properties			
1.	Sand (%)	20.80	International pipette method (Piper, 1966) [9]
2.	Silt (%)	21.98	
3.	Clay (%)	57.22	
4.	Textural class (%)	Clayey	
2. Chemical properties			
1.	EC (1: 2.5) (dS/m)	0.36	Conductometric (EC meter) (Jackson, 1973) [3]
2.	pH (1: 2.5 soil: water ratio)	7.9	Potentiometric method (Jackson, 1973) [3]
3.	Organic carbon (%)	0.32	Walkley and Black method (Jackson, 1973) [3]
4.	Available nitrogen (kg/ha)	227.30	Alkaline $KMnO_4$ method (Subbaiah and Asija,1956) [12]
5.	Available P_2O_5 (kg/ha)	32.74	Spectro photometric method (Olsen *et al*., 1954) [6]
6.	Available K_2O (kg/ha)	374.65	Flame photometric method (Jackson, 1973) [3]

Treatments Details

The details of the treatments are given as below.

A. Intercropping

I_1: Sole sorghum (45 cm x 10 cm)

I_2: Sole Indian bean (30 cm x 20 cm)

I_3: Sorghum + Indian bean 2:1 (Paired row 30-60 cm)

I_4: Sorghum + Indian bean 3:2 (Paired row 30-30-75 cm)

B. Weed management practices

W_1: Weedy check

W_2: Pendimethalin 1.0 kg/ha as PE

W_3: Pendimethalin 1.0 kg/ha as PE and HW at 30 DAS

Experimental design and layout

Twelve treatments combinations were laid out in Randomized Block Design (RBD) with factorial concept. The treatments were assigned at random to different plots in each replication. The details about experiment are given as under.

Sr. No.	Crop and Variety	:	Sorghum, GNJ-1 Indian bean, GNIB-22
1.	Season and Year	:	*Rabi*- 2019
2.	Total treatment combinations	:	12
3.	Design	:	FRBD
4.	Replications	:	3
5.	Plot size	:	Gross: 5.4 m x 5.0 m Net: 2.7 m x 4.0 m
6.	Total experimental Area	:	1155 m^2
7.	Spacing	:	Sorghum- 45 cm x10 cm Indian bean- 30 cm x 20 cm
8.	Seed rate	:	Sorghum- 12 kg/ha Indian bean- 50kg/ha
9.	Month of sowing	:	November
10.	Method of sowing	:	Line sowing
11.	Fertilizer dose	:	Sorghum- 80-40-0, N-P-K kg/ha Indian bean- 20-40-0, N-P-K kg/ha

Results and Discussion

Table 2: Effect of intercropping and weed management on grain yield, fodder yield and harvest indexin sorghum

Treatment		Grain yield (kg/ha)	Fodder yield (kg/ha)	Harvest index (%)
A. Intercropping				
I_1	Sole sorghum	3294	4672	41.25
I_2	Sole Indian bean	-	-	-
I_3	Sorghum + Indian bean (2:1)	3135	4476	41.21
I_4	Sorghum + Indian bean (3:2)	2952	4330	40.56
S.Em+		90	114	0.94
CD (P= 0.05)		269	NS	NS
B. Weed management				
W_1	Weedy check	2833	4146	40.65
W_2	Pendimethalin 1.0 kg/ha	3106	4490	40.87
W_3	Pendimethalin 1.0 kg/ha + Hand weeding at 30 DAS	3441	4841	41.49
S.Em+		90	114	0.94
CD (P= 0.05)		269	341	NS
C. Interaction				
S.Em+		155	197	1.63
CD (P= 0.05)		NS	NS	NS
CV (%)		8.60	7.60	6.87

Grain yield (kg/ha)
Data on grain yield of sorghum as influenced by different treatment were presented in Table 2.

Effect of intercropping
The data presented in Table 2 reveled that intercropping system significantly increased the grain yield. Among the different intercropping system examined, significantly higher grain yield of sorghum was recorded in treatment I_1 (Sole sorghum) with 3294 kg/ha and remained at par with the treatment I_3 (Sorghum + Indian bean 2:1) with 3135 kg/ha grain yield. These superior values of yield parameters in sole crop of sorghum could be attributed to competition free environment. The similar results were observed by Pandita *et al.* (2000) [7] in maize, Guggari and Kalaghatagi (2005) [2], Rao *et al.* (2009) [10] in sorghum.

Effect of weed management
It is evident from table 2 that grain yield of sorghum was significantly affected by varying weed managementtreatments to sorghum. Among the different weed managementtreatments examined, significantly higher grain yield of sorghum was recorded with application of pendimethalin 1.0 kg/ha + HW at 30 DAS (W_3) with 3441 kg/ha and it was not found at par with ant other treatments. similar results were also reported by Rashid and Himayatullah (2003) [11], Choudhary (2009) [1], Rao *et al.* (2009) [10] in sorghum, Guggari and Kalaghatagi (2005) [2], Kumar *et al.* (2006) [5] in pearl millet.

Interaction:
The findings indicated non-significant interaction between the intercropping and weed management for grain yield.

Fodder yield (kg/ha)
Data pertaining to straw yield of sorghum as influenced by different treatment were presented in Table 2.

Effect of intercropping: The data presented in Table 2 raveled that intercropping system has non-significant effect on the straw yield of sorghum. Among the intercropping system examined, higher straw yield of sorghum was recorded with sole sorghum (I_1) and it was followed by the treatment I_3 (Sorghum + Indian bean 2:1).

Effect of weed management
It is evident from Table 2 that straw yield of sorghum was significantly affected by varying weed managementtreatments to sorghum crop. Among the different weed managementtreatments examined, significantly higher straw yield of sorghum was recorded with application of pendimethalin 1.0 kg/ha + HW at 30 DAS (W_3) and was not found at par with any other treatments.

Interaction
The findings indicated non-significant interaction between the intercropping and weed management for fodder yield.

Harvest index (%)
Data on harvest index of sorghum as influenced by intercropping and weed management treatment were given in Table 2.

Effect of intercropping
The results shows that there is no significant difference in harvest index of sorghum crop due to intercropping system.

Effect of weed management
The data in Table 2 further reveals non-significant effect of different treatments of weed management to sorghum on harvest index of the crop.

Interaction
The difference in harvest index of sorghum under interaction effect of intercropping and weed management to sorghum crop was found non-significant.

Weed population 40 DAS (No./m^2)
Data pertaining to weed population i.e., monocots, dicots and sedges at 40 DAS as influenced by intercropping and weed management practices were presented in Table 3.

Effect of intercropping
The data presented in Table 3revealed that effect on population of monocots, dicots and sedges due to intercropping at 40 DAS were found to be significant and significantly the lower number of monocots, dicots and sedges were found with the treatment I_4(Sorghum + Indian bean 3:2) but treatment I_3 (Sorghum + Indian bean 2:1) was found at par with treatment I_4 for count of dicots and sedges. But in case of monocots all treatments found significantly differed from each other. Response of intercropping on weed population of monocots was found in order ofI_4<I_3< I_2< $I_1$with their level of significance.

Table 3: Effect of intercropping and weed management on weed count at 40 DAS in sorghum

Treatment		Weed count/m^2		
		Monocot	Dicot	Sedge
A. Intercropping				
I_1	Sole sorghum	4.29 (20.66)	3.65 (14.38)	5.50 (32.19)
I_2	Sole Indian bean	4.33 (21.46)	3.67 (14.51)	5.44 (31.26)
I_3	Sorghum + Indian bean (2:1)	3.88 (17.84)	3.49 (13.33)	5.16 (28.29)
I_4	Sorghum + Indian bean (3:2)	3.43 (15.40)	3.33 (12.49)	5.03 (27.20)
S.Em +		0.13	0.07	0.12
CD (P= 0.05)		0.37	0.21	0.35
B. Weed management				
W_1	Weedy check	6.11 (37.47)	4.77 (22.77)	6.70 (44.97)
W_2	Pendimethalin 1.0 kg/ha	3.75 (14.24)	3.65 (13.42)	5.59 (31.32)
W_3	Pendimethalin 1.0 kg/ha + Hand Weeding at 30 DAS	2.09 (4.82)	2.18 (4.84)	3.57 (12.92)
S.Em +		0.11	0.06	0.10

CD (P= 0.05)	0.32	0.18	0.31
C. Interaction			
S.Em +	0.22	0.12	0.21
CD (P= 0.05)	NS	NS	NS
CV (%)	9.57	6.08	6.87

Note: Data in parentheses indicate actual value and those outside are square root transformed values.

Effect of weed management practices

An appraisal of data in Table 3 indicated that the effect of weed management on weed population (monocots, dicots, sedges) was found to be significant at 40 DAS. Significantly minimum number of monocots, dicots and sedges were recorded with treatment W_3 (Pendimethalin 1.0 kg/ha + HW at 30 DAS) and weed population was found in order ofW_1> W_2> $W_3$with their level of significance.

Interaction effect

The interaction effect of different intercropping and weed management practices on number of monocots, dicots and sedges were found to be non-significant at 40 DAS.

Table 4: Effect of intercropping and weed management on WCE and WCI in sorghum

Treatment		WCE (%)		WCI (%)
		40 DAS	At harvest	
A. Intercropping				
I_1	Sole sorghum	0.00	0.00	36.81
I_2	Sole Indian bean	2.83	3.65	24.63
I_3	Sorghum + Indian bean (2:1)	8.18	17.65	16.35
I_4	Sorghum + Indian bean (3:2)	11.81	24.14	18.09
B. Weed management				
W_1	Weedy check	0.00	0.00	35.57
W_2	Pendimethalin 1.0 kg/ha	50.84	54.98	26.29
W_3	Pendimethalin 1.0 kg/ha + Hand weeding at 30 DAS	72.99	79.77	10.48

Weed control efficiency

Weed control efficiency at 40 DAS

Effect of intercropping

A perusal of data in Table 4related to weed control efficiency at 40 DAS, revealed that the highest weed control efficiency in intercropping (11.81%) was noted under treatment I_4 (Sorghum + Indian bean (3:2) whereas, the lowest weed control efficiency was recorded with the treatment I_1 (Sole sorghum). The response of intercropping in term of weed control efficiency at 40 DAS was remained in order of I_4> I_3> I_1> I_2 with their level of significance.

Effect of weed management

A perusal of data in Table 4related to weed control efficiency at 40 DAS, revealed that the highest weed control efficiency (72.99%) was noted under W_3 (Pendimethalin 1.0 kg/ha + HW at 30 DAS) whereas, the lowest weed control efficiency (0.00%) recorded with the treatment W_1 (Weedy check). The response of weed management in term of weed control efficiency at 40 DAS was remained in order of W_3> W_2> $W_1$with their level of significance.

Weed control efficiency at harvest

Effect of intercropping

A perusal of data in Table 4related to weed control efficiency at harvest, revealed that the highest weed control efficiency in intercropping (24.14%) was noted under treatment I_4 (Sorghum + Indian bean (3:2) whereas, the lowest weed control efficiency was recorded with the treatment I_1 (Sole sorghum). The response of intercropping in term of weed control efficiency at harvest was remained in order of I_4> I_3> I_1> I_2 with their level of significance.

Similar results were also reported by Rashid and Himayatullah (2003) [11].

Effect of weed management

A perusal of data in Table 4related to weed control efficiency at harvest, revealed that the highest weed control efficiency (79.77%) was noted under W_3 (Pendimethalin 1.0 kg/ha + HW at 30 DAS) whereas, the lowest weed control efficiency (0.00%) recorded with the treatment W_1 (Weedy check). The response of weed management in term of weed control efficiency at harvest was remained in order of W_3> W_2> $W_1$with their level of significance.

Weed index (%)

Effect of intercropping

The data presented in Table 4showed markedly influence on weed index by intercropping. The treatment I_3(Sorghum + Indian bean 2:1) was recorded lowest weed index (16.35%) and found most effective in controlling the weeds followed by the treatment I_4(Sorghum + Indian bean 3:2). The response of intercropping in term of weed index was found in order of I_3>I_4>I_2>I_1.

Effect of weed management

The data presented in Table 4showed markedly influence on weed index by different weed management practices. Application of pendimethalin 1.0 kg/ha + HW at 30 DAS(W_3) was recorded the lowest weed index and found most effective in controlling the weeds followed byW_2 (Pendimethalin 1.0 kg/ha). The response of different weed management practices in term of weed index was found in order of W_3>W_2>W_1. Similar results were also reported by Kumar *et al.* (2006) [5] in pearl millet.

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