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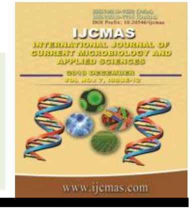

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Performance of *Rabi* Sorghum as Influenced by Preceding Legumes, Nitrogen Levels and Irrigation Schedules

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A B S T R A C T

A field experiment was conducted for two consecutive years during 2012 and 2013 at Indian Institute of Millet Research, Rajendranagar, Hyderabad. The experiment was carried out in strip split plot design with three replications. Four strips of treatments including dhaincha, greengram and cowpea raised as preceding kharif legumes along with fallow are taken as main plot treatments. During *rabi*, sorghum was grown in split plot design taking strips of *kharif* crops as main plots, four irrigation schedules assigned to sub plots and four nitrogen levels *viz.*, 0, 30, 60 and 90 kg ha^{-1} to sub sub plots. The plants attained maximum height (225.6 cm and 217.2 cm), highest dry matter production (8197 and 9151 kg ha^{-1}), grains per panicle (1160 and 1247) and ear head weight (46.3 and 47.1 g) with *in situ* incorporation of dhaincha during 2012 and 2013 followed by irrigation at panicle initiation, boot leaf stage, anthesis and milk stage at harvest, and a high dose of 90 kg ha^{-1} N significantly increased the growth and yield components. The *in situ* incorporation of dhaincha was 2511 and 3024 kg ha^{-1} was during both years. Irrigation at 4 critical phases recorded 2528 kg ha^{-1}during 2012 and 3047 kg ha^{-1} during 2013. Further, 2686 kg ha^{-1} and 3269 kg ha^{-1} during 2012 and 2013, respectively by the application of N 90 kg ha^{-1}.

Introduction

Sorghum, the fifth important cereal food crop after corn, rice, wheat and barley on the globe (Fageria *et al.,* 2014), is considered as the king of millets and extensively grown both for grain as food, animal feed and stalks as animal fodder. It is the major cereal of rainfed agriculture in the semiarid tropics. Organic manures and crop residues have been proved to be viable components of nitrogen management, which can supplement and successfully replace costly fertilizer nitrogen. The practice of residue incorporation after the harvest is feasible and economical, where a period of 30 days is available before planting of maize and the practice can contribute to about 50 to 60 kg N ha^{-1} (Kulakarni and Pandey, 1988). As the crop is raised mostly under rainfed condition with the help of stored moisture, the moisture deficit, especially during later stages of crop growth poses a serious threat to the crop consequently the yield levels of *rabi* sorghum are very low. Besides water, fertilizer is also one of the important basic inputs for realizing yield potential of fertilizer responsive high yielding varieties have further increased the demand for important crop nutrients. However, the low yield potential of *rabi* sorghum is attributed mainly due to moisture stress cycles, during the flowering and grain formation stages (Mohiuddin and Yaseen, 1973). Application of one or two supplemental irrigations during such stress cycles gives a manifold increase in the grain yield of *rabi* sorghum (Patil *et al.*, 1981, Ramshe *et al.*, 1985 and Bhoi and Jadhav, 1986). In the light of above, the present investigation was planned and carried out.

Materials and Methods

A field experiment on "performance of *rabi* sorghum as influenced by preceding legumes, nitrogen levels and irrigation schedules" was conducted for two consecutive years during the years 2012 and 2013 at the Indian Institute of Millet Research - ICAR, Rajendranagar, Hyderabad. The soil was clay loam in texture. The pH was 7.7 and EC was 0.38 dSm^{-1}. The organic carbon was 0.23% and the available N was 162 kg ha^{-1}. Their status was low. However, the soil fertility was medium in available phosphorus with 29.1 kg P_2O_5 ha^{-1} and available potassium with 282.8 kg K_2O ha^{-1}. The layout of the design was strip-split plot with 3 replications. There were four strips of legumes in *kharif viz.*, dhaincha, green gram, cowpea and fallow. Sorghum was sown in split plot layout in each strip in the following *rabi* with four main plots of irrigation and four sub-sub plots of nitrogen levels. Dhaincha was grown till the commencement of flowering and then incorporated *in situ*. The greengram pods were picked for grain and haulms were then turned down into the soil. The cowpea foliage was harvested for fodder and the stubbles turned down into the soil for decomposition. The irrigations were scheduled at critical stages *viz*., panicle initiation, boot leaf stages anthesis and milk stage of grain sorghum. The levels of nitrogen were 0, 30, 60 and 90 kg ha^{-1}. The test varieties of dhaincha as green manure, greengram for seed and cowpea for fodder were *Sesbania cannabina*, LGG-407 and EC - 4216 respectively, while the test variety of sorghum was SPV-2048 (Phule Suchitra).

Results and Discussion

Effect on growth characters

The *rabi* sorghum crop influenced by different crop residues, irrigation at critical stages and nitrogen management practices to sorghum noticeably altered the growth parameters (Table 1). The decomposing residue of dhaincha improved the vegetative growth of sorghum in the *rabi* season. There was a significant increase in the plant height, LAI and drymatter production of the crop from seedling stage to maturity. The plants attained maximum height to *in situ* incorporation of dhaincha followed by irrigation at panicle initiation, boot leaf stage, anthesis and milk stage at harvest, there was a significant increase in the plant height due to successive increase in the number of irrigations at the critical phases and a high dose of 90 kg ha^{-1} N. This response was consistent during both 2012 and 2013 years. The *in situ* incorporation of dhaincha significantly increased the dry matter 8197 kg ha^{-1} during 2012 and 9151 kg ha^{-1} at harvest, respectively. Dhaincha harvested at the beginning of flowering was succulent with high moisture content, maximum nutrient accumulation in the foliage and expected optimum C: N ratio of about 25. This was ideal for early decomposition. The haulms of greengram were less succulent and more lignified because of their incorporation late at maturity when the pods were harvested. The stubbles of cowpea added least biomass to the soil. Confirming the positive role of residual effect of legumes, Mahadkar and Saraf (1988) recorded significant improvement in the dry matter production of sorghum by the incorporation of blackgram haulms in the preceding season. Kambale (1983) reported that irrigation at grand growth stage increased the plant height, number of leaves, leaf area index and dry matter of the crop. Refay (1989) reported that the water stress reduced the ear head exertion, ear head length, plant height and dry weight. Mastronelli *et al.,* (1995) reported that the water stress at booting stage remarkably reduced the dry matter and yield of sorghum.

Effect on yield components

Sorghum preceded by dhaincha developed more number of grains per panicle and weight of the ear head while the panicle length and 1000 grain weight did not change significantly (Table 2). The number of grains per panicle was significantly influenced by the residual effect of green mass incorporation of legumes in the preceding *kharif* season. The green manure of dhaincha was most effective among others.

Maximum number of 1160 and 1247 grains were produced per panicle in 2012 and 2013 due to the beneficial carry over effects of this legume. Significantly less number of 1037 and 1164 grains per panicle were recorded in the fallow - sorghum. Sorghum grown in the fallow land was less responsive to irrigations. It produced 969 and 1132 grains per panicle by irrigating the crop only at panicle initiation stage in 2012 and 2013. Additional number of 144 and 61 grains per panicle were produced during the corresponding years by irrigating the crop at 4 critical stages. The interaction effect of sorghum grown after the incorporation of cowpea stubbles and irrigated at panicle initiation produced 983 and 1149 grains per panicle in the corresponding years. Sorghum utilized the water more efficiently than in fallow at high levels of irrigation. Hence, significantly more number of additional 171 and 118 grain per panicle were obtained during the two years by irrigating the crop at 4 critical stages preceding cowpea. The ear head weight of sorghum grown in fallow and irrigated at the panicle initiation stage increased from 42.4 g in 2012 and 43.2 g in 2013 to 47.2 and 44.0 g by irrigating the crop at 4 critical stages. The gain in weight due to increase in irrigation was thus 4.8 g in the first year and 0.8 g in the second year. Henadez *et al.,* (1992) reported that the ear head weight decreased due to moisture stress at all the critical stages, except when stressed at physiological maturity. Nitrogen improved the yield components remarkably. A low dose of 30 kg ha^{-1} N increased the panicle length, grains per panicle, 1000 grain weight and the ear head weight both in 2012 and 2013. These components showed further improvement to high level of nitrogen and the maximum response was at 90 kg ha^{-1} N.

Effect on grain and stover yield

Maximum grain yield of 2528 and 3047 kg ha^{-1} was obtained by irrigating the crop at panicle initiation, boot leaf, anthesis and milking stage of grain during the two years (Table 3). Sorghum irrigated at the panicle initiation stage produced 2338 and 2870 kg grain ha^{-1} during 2012 and 2013 respectively. Irrigation at panicle initiation and boot leaf stage yielded significantly more quantity of 2413 and 2929 kg grain ha^{-1}. The production increased further to 2477 and 2997 kg ha^{-1} during the corresponding years by giving 3 irrigations at panicle initiation, boot leaf and anthesis stage. Mishra *et al.*, (2011) also reported that green manure of dhaincha increased the production of sorghum compared to the yield from fallow-sorghum.

Table.1 Sorghum growth parameters as influenced by irrigation schedules and levels of nitrogen preceded by *kharif* legumes at harvest

Treatment	Plant height (cm)		LAI		Dry matter production (kg ha^{-1})	
	2012	2013	2012	2013	2012	2013
Preceding legumes in *kharif*						
C_1: Sorghum preceded by Dhaincha	225.6	217.2	2.1	2.3	8197	9151
C_2: Sorghum preceded by Greengram for seed	221.5	217.3	2.0	2.1	7933	9005
C_3: Sorghum preceded by Cowpea for fodder	220.6	213.3	1.3	1.6	7830	8946
C_4: Sorghum preceded by Fallow	218.5	208.3	1.3	1.4	7776	8949
S Em ±	1.34	1.98	0.21	0.14	76.9	68.2
CD at 5 %	4.6	6.8	NS	0.5	266	236
Irrigation schedules						
I_1: Panicle initiation	210.4	201.1	1.5	1.9	7649	8700
I_2: PI and booting	218.1	209.9	1.6	1.9	7832	8882
I_3: PI, booting and anthesis	225.3	217.5	1.8	1.8	8047	9138
I_4: PI, booting, anthesis and milk stage	232.5	227.6	1.7	1.7	8209	9333
S Em ±	1.27	1.70	0.07	0.07	31.8	13.5
CD at 5 %	4.5	5.8	NS	NS	110	47
Nitrogen (kg ha^{-1})						
N_1: No Nitrogen	199.6	190.1	1.5	1.7	6902	7777
N_2: 30	220.6	210.6	1.6	1.8	7685	8719
N_3: 60	230.1	222.5	1.8	1.9	8358	9560
N_4: 90	235.9	232.8	1.8	2.0	8790	9995
S Em ±	4.95	4.60	0.28	0.07	223.0	220.9
CD at 5 %	13.8	13.0	NS	NS	625	619
Interaction						
***Kharif* legumes × Irrigation**						
S Em ±	3.32	5.16	0.42	0.35	298.7	239.0
CD at 5 %	NS	NS	NS	NS	NS	NS
***Kharif* legumes × Nitrogen**						
S Em ±	17.26	16.48	0.14	0.14	787.5	777.4
CD at 5 %	NS	NS	NS	NS	NS	NS
Irrigation × Nitrogen						
S Em ±	17.26	16.41	0.14	0.14	775.0	765.9
CD at 5 %	NS	NS	NS	NS	NS	NS
***Kharif* legumes × Irrigation × Nitrogen**						
S Em ±	4.95	4.60	0.28	0.42	223.0	220.9
CD at 5 %	NS	NS	NS	NS	NS	NS

Table.2 Sorghum yield components as influenced by irrigation schedules and levels of nitrogen preceded by *kharif* legumes

Treatment	Panicle Length (cm)		Grains panicle^{-1}		1000 grain weight (g)		Earhead Weight (g)	
	2012	2013	2012	2013	2012	2013	2012	2013
Preceding legumes in *kharif*								
C_1: Sorghum preceded by Dhaincha	16.1	18.2	1160	1247	26.0	25.9	46.3	47.1
C_2: Sorghum preceded by Greengram for seed	16.0	17.8	1126	1206	25.9	25.8	44.2	45.9
C_3: Sorghum preceded by Cowpea for fodder	15.6	18.5	1073	1201	26.0	26.1	43.6	46.4
C_4: Sorghum preceded by Fallow	16.1	17.9	1037	1164	26.3	25.6	44.6	44.7
S Em ±	0.07	0.07	4.24	4.24	0.21	0.71	0.07	0.14
CD at 5 %	0.2	0.2	14	15	NS	NS	0.2	0.6
Irrigation schedules								
I_1: Panicle initiation	14.6	16.6	1030	1152	24.5	24.4	41.6	44.1
I_2: PI and booting	15.5	17.6	1078	1189	25.6	25.3	44.0	45.4
I_3: PI, booting and anthesis	16.6	18.7	1123	1217	26.5	26.5	44.9	46.7
I_4: PI, boot, anthesis and milk stage	17.2	19.5	1165	1259	27.6	27.2	48.2	47.9
S Em ±	0.07	0.07	3.54	4.24	0.21	0.71	0.07	0.14
CD at 5 %	0.2	0.2	13	13	0.7	2.4	0.2	0.5
Nitrogen (kg ha^{-1})								
N_1: No Nitrogen	13.7	15.9	906	1055	22.9	22.8	39.4	39.3
N_2: 30	15.2	17.5	1059	1156	25.0	25.1	43.3	44.3
N_3: 60	16.7	18.7	1171	1259	27.2	27.0	45.7	48.4
N_4: 90	18.2	20.3	1261	1348	29.1	28.5	50.4	52.1
S Em ±	0.35	0.42	26.17	26.87	0.64	1.49	0.99	0.99
CD at 5 %	1.3	1.4	91	93	1.8	4.1	3.4	3.5
Interaction								
***Kharif* legumes × Irrigation**								
S Em ±	0.14	0.21	12.02	12.02	0.21	0.28	0.14	0.78
CD at 5 %	NS	NS	41	42	NS	NS	0.4	2.7
***Kharif* legumes × Nitrogen**								
S Em ±	1.34	1.41	91.94	93.35	2.62	2.76	3.39	3.54
CD at 5 %	NS	NS	NS	NS	NS	NS	NS	NS
Irrigation × Nitrogen								
S Em ±	1.34	1.41	91.23	93.35	2.62	2.90	3.39	3.54
CD at 5 %	NS	NS	NS	NS	NS	NS	NS	NS
***Kharif* legumes × Irrigation × Nitrogen**								
S Em ±	0.35	0.42	26.17	26.87	0.78	0.78	0.99	0.99
CD at 5 %	NS	NS	NS	NS	NS	NS	NS	NS

Table.3 Grain and Stover yield (kg ha^{-1}) of sorghum as influenced by irrigation schedules and levels of nitrogen preceded by *kharif* legumes

Treatment	Grain yield (kg ha^{-1})		Stover yield (kg ha^{-1})	
	2012	2013	2012	2013
Preceding legumes in *kharif*				
C_1: Sorghum preceded by Dhaincha	2511	3024	5686	6127
C_2: Sorghum preceded by Greengram for seed	2446	2942	5487	6063
C_3: Sorghum preceded by Cowpea for fodder	2389	2947	5441	5999
C_4: Sorghum preceded by Fallow	2409	2930	5367	6019
S Em ±	17.0	24.8	7.8	8.5
CD at 5 %	59	85	27	29
Irrigation schedules				
I_1: Panicle initiation	2338	2870	5311	5830
I_2: PI and booting	2413	2929	5419	5953
I_3: PI, booting and anthesis	2477	2997	5570	6141
I_4: PI, booting, anthesis and milk stage	2528	3047	5681	6286
S Em±	13.4	6.4	36.1	37.5
CD at 5 %	46	22	124	131
Nitrogen (kg ha^{-1})				
N_1: No Nitrogen	2039	2466	4863	5311
N_2: 30	2380	2886	5305	5833
N_3: 60	2650	3222	5708	6338
N_4: 90	2686	3269	6104	6726
S Em ±	54.5	57.3	131.5	140.0
CD at 5 %	188	199	457	484
Interaction				
***Kharif* legumes × Irrigation**				
S Em ±	46.0	64.4	49.5	54.5
CD at 5 %	NS	NS	NS	NS
***Kharif* legumes × Nitrogen**				
S Em ±	190.9	204.4	456.9	484.4
CD at 5 %	NS	NS	NS	NS
Irrigation × Nitrogen				
S Em ±	189.5	199.4	461.8	485.1
CD at 5 %	NS	NS	NS	NS
***Kharif* legumes × Irrigation × Nitrogen**				
S Em ±	54.5	57.3	131.5	140.0
CD at 5 %	NS	NS	NS	NS

In an earlier investigation, Pawar and Bhogi (2009) reported that the legumes differed in their influence on the relative performance of sorghum. Additional mean grain yield of 67, 133 and 184 kg ha^{-1} was obtained due to 2, 3 and 4 irrigations over 1. Similarly, the stover yield increased from 5311 kg ha^{-1} due to irrigation at panicle initiation to 5419 kg ha^{-1} by irrigating the crop at panicle initiation and boot leaf stage in the first year and from 5830 to 6286 kg ha^{-1} in the second year. More quantity of 5570 and 6141 kg ha^{-1} stover was obtained by irrigation at panicle initiation, boot leaf and anthesis stage during the two years. Maximum stover yield of 5681 and 6286 kg ha^{-1} was obtained when the soil was not deprived of moisture stress at panicle initiation, boot leaf, anthesis and milk stage of grains.

It is inferred that the beneficial effects of growing dhaincha and its *in situ* incorporation at flowering in *kharif* as a preceding crop increased the production of sorghum grain and fodder vis-a-vis their nutrient value as food for man and fodder for cattle. The crop should be irrigated at the critical stages viz; panicle initiation, boot leaf, anthesis and milking stage of the grains to improve the vegetative growth, yield components and ultimately increasing their production.

References

Bhoi, P.G. and Jadhav, S.B. 1986. Studies on the effect of minimal irrigation and organic mulch on the yield and water use of *rabi* sorghum hybrids. J of Maharashtra Agril Univ. 11(3): 377-378.

Fageria, N.K., Virupax, C., Baligar and Jones C.A., 2014. Growth and mineral nutrition of field crops. CRC Press, Boca Raton London, Newyork, Taylor and Francis Group, Sorghum. 11: 343-361.

Henadez, V.A.G., Manjarrez, S.P. and Mendoza, C.L.E. 1992. Drought-stress effect on dry matter production and distribution in sorghum plants. Sorghum News letter. 33:56.

Kamble, G.K. 1983. Studies on minimal irrigation and mulch on *rabi* sorghum [*Sorghum bicolor* (L.) Moench] CSH-8R. M.Sc. thesis submitted to Mahatma Phule Krishi Vidyapeeth, Rahuri, India.

Kulakarni, K.R and Pandey, P.K. 1988. Annual legumes for food as green manure in rice based cropping systems. In: Sustainable agriculture-green manure in rice farming. Intl. Rice Res. Ins., Los Bonas, Leguna, Philippines. 289-299

Mahadkar, U.V and Saraf, C.S. 1988. Effect of various inputs on yield of urd bean and its residual effects on succeeding fodder sorghum. J of Maharashtra Agril Univ. 13(3): 293-295.

Mastronilli, M., Katerji, N and Rana, G. 1995. Water-efficiency and stress on grain sorghum at different reproductive stages. J of Agril Water Manage. 28(1): 19-22.

Mishra, J.S., Raut, M.S., Pushpendra Singh, R., Kalpana, Khubsad, V.S., Lokhande, O.G., Patel, Z.N., Thakur, N.S., Nemade, S.M., Spandana Bhat, Pramod Kumar, Kewalanand, 2011. Sorghum Agronomy: *Kharif* Report agm12: 1-16.

Mohiuddin, S.H and Mohammad Yaseen. 1973. A note on the effect of moisture-stress on the yield components of sorghum 'CSH-1'. Indian J. of Agr. 18(1): 96-97.

Patil, N.D., Umrani, N.K., Shende, S.A., Manke, B.S., Kale, S.P and Shingte, A.K. 1981. Improved crop production technology for drought-prone areas of Maharashtra. Technical bulletin of Dry Farming Research Station, Solapur, India. Pp: 55-58, 96.

Pawar, A.D and Bhogi, R.S. 2009. Effect of green manure and its incorporation methods in *rabi* sorghum cropping system. Annals of Plant Physiology. 23(2): 162-164.

Ramshe, D.G., Mane, S.S and Pol, P.S. 1985. Irrigation studies on *rabi* (winter) sorghum. Current Res. Rep. 1(1): 52-55.

Refay, Y.A. 1989. The influence of variable amounts of irrigation water and nitrogen fertilizer and their interaction on the development, growth and nitrogen uptake of grain sorghum. Dissertation Abstract in International B. Sciences and Engineering. 50(5):1701B.

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