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Research Article

Effect of foliar application of plant nutrients on crop growth, flowering parameters and seed yield on sorghum hybrid cv. SHD-9704 (*Sorghum bicolor*)

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ABSTRACT : The present investigation was undertaken during 2007 and 2008 at the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, during *Rabi* season in 2007-08 and *Kharif* season in 2008 and their pooled data on effect of planting ratios on crop growth. flowering parameters and seed yield on sorghum hybrid cv. SHD-9704 (*Sorghum bicolor*).The foliar application of urea @ 2 per cent (N_3) recorded numerically more plant height (115.42 cm) at harvest, leaf number (9.87), leaf area (3244 cm^2) and leaf area index (4.81) at 75 DAS compared to water spray (N_0) (105.08 cm, 9.40, 3007 cm^2 and 4.45) except for crop maturity where water spray control (N_0) treatment recorded relatively more number of days (91.31 days) for days to crop maturity and less (88.55 days) in urea spray @ 2 per cent (N_3).Number of days for flower primordial initiation and 50 per cent flowering were relatively less (34.86 and 64.18 days, respectively) in 2 per cent urea spray (N_3) than control (N_0) (36.74 and 66.63 days, respectively).The higher harvest index, ear length, ear width, ear weight, number of seeds per ear, seed setting percentage, seed weight per ear and hybrid seed yield per hectare were significantly higher (0.163, 28.60 cm, 4.36 cm, 33.26 g, 394.50, 34.23 per cent, 13.41 g and 5.27 q/ha, respectively) in foliar spray of urea @ 2 per cent (N_3) and least in foliar spray of water (N_0) (0.119, 23.09 cm, 3.75 cm, 26.95 g, 287.71, 24.92 per cent, 9.83 g and 4.28 q/ha, respectively).

KEY WORDS : Sorghum, Plant nutrients, Growth, Flowering parameter, Seed yield

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INTRODUCTION

Sorghum [*Sorghum bicolor* (L.)Moench] commonly known as 'jowar', is the fifth most important cereal crop in the world next to wheat, rice, maize and barley. It is a staple food crop for more than 300 million people of Asia and Africa continents. India has the largest share (32.50%) of world sorghum area and ranks second in production after USA. In India, it is cultivated on about 7.93 million hectare area with annual production of 7.78 million tonnes and productivity of 981 kg per ha (Anonymous, 2008). The major sorghum growing states in India are Maharashtra, Karnataka, Andhra Pradesh, Madhya Pradesh, Rajasthan and Tamil Nadu. In India, Karnataka state is one of the important sorghum growing states and stands second in area and production after Maharashtra. In Karnataka, it accounts for 1.38 million hectare area and production of 1.62 million tonnes with average productivity of 1192 kg per ha (Anonymous, 2009). About 50 per cent of people in Karnataka depend on sorghum as a staple food crop particularly in Northern Karnataka *viz*., Bijapur, Dharwad, Belgaum, Raichur, Gulbarga, Bellary and Mysore.The plant nutrients like urea and GA_3 are known to be potential chemical to enhance seed crop productivity of sorghum hybrid by modifying morphological and physiological characteristics in enhancing source to sink relationship ultimately realizing higher yield of quality hybrid seeds. Since sorghum is a nitro positive

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crop, increased dose of nitrogen application is being practiced to enhance the flowering as well as yielding ability (Kudasomannavar, 1974; Malali *et al*., 1981 and Shivappa, 1988). The foliar spray of urea at primordial initiation to late flowering parent will help in bridging the gap of 3-4 days in flowering period of the parents (Joshi, 1976). Flowering behavior can also be enhanced by the application of gibberillic acid, a growth promoter at flower primordial initiation stage (Joshi, 1976 and Biradar, 1999). Hence, systematic research works are to be initiated to findout the effect of foliar application of nitrogen and gibberillic acidon the female parental line (AKMS-14A) of new pre-released hybrid sorghum cv. SHD-9704 to achieve better synchronization of flowering for higher seed setting and yield of hybrid seed.

EXPERIMENTAL METHODS

The field experiment was conducted to study the effect of foliar application of plant nutrients on growth, flowering parameters and seed yield in pre-released sorghum hybrid SHD-9704 at the Main Agricultural Research Station, Dharwad Farm,University of Agricultural Sciences, Dharwad during *Rabi* season in 2007-08 and *Kharif* season in 2008-09.The field experiment consisted of five foliar sprays *viz.*, N_0 (Control - Water spray), N_1 (GA3 @ 150 ppm), N_2 (GA3 @ 250 ppm), N_3 (Urea @ 2%) and N_4 (Urea @ 3%).The foundation seeds of female parent cv. AKMS-14A and male parent cv. SVD-9607 of pre-released sorghum hybrid SHD-9704 were obtained from the Sorghum Breeder, All India Coordinated Sorghum Improvement Project, Main Agricultural Research Station, Dharwad. The observations were made on plant height at harvest, number of leaves, leaf area,leaf area index at 75 DAS (days after sowing), days to crop maturity, days to flower primordial initiation and 50 per cent flowering, harvest index,ear length, ear width, ear weight, number of seeds per ear, seed setting percentage, seed weight per ear and hybrid seed yield per hectare. The data obtained from various periodical observations were subjected to statistical analysis. The analysis of variance and interpretation of data were done as per procedure given by Gomez and Gomez (1984). The experimental data of 2007 (*Rabi*) and 2008 (*Kharif*) were used for combined analysis to arrive best treatment combination effect.

EXPERIMENTAL RESULTS AND ANALYSIS

The results obtained from the present study have been discussed in detail under following heads :

Growth parameters :

The foliar application of plant nutrients did not exhibit marked variations on various growth parameters in both the years of experiment and pooled analysis as mentioned Table 1

Table 1 : Effect of foliar application of plant nutrients on plant height (cm) at harvest, number of leaves at 75 DAS, leaf area (cm^2) at 75 DAS and leaf area index at 75 DAS on female parent of sorghum hybrid cv. SHD-9704

Treatments	Plant height at harvest (cm)			Number of leaves at 75 DAS			Leaf area (cm^2) at 75 DAS			Leaf area index at 75 DAS		
	Rabi 2007-08	*Kharif* 2008-09	Pooled data	*Rabi* 2007-08	*Kharif* 2008-09	Pooled data	*Rabi* 2007-08	*Kharif* 2008-09	Pooled data	*Rabi* 2007-08	*Kharif* 2008-09	Pooled data
N_0	103.92	106.25	105.08	9.36	9.44	9.40	2947	3067	3007	4.36	4.54	4.45
N_1	110.90	113.25	112.08	9.57	9.68	9.62	3099	3215	3157	4.59	4.76	4.67
N_2	109.37	111.67	110.52	9.41	9.58	9.50	3042	3158	3100	4.50	4.67	4.59
N_3	114.25	116.58	115.42	9.80	9.94	9.87	3186	3303	3244	4.72	4.89	4.81
N_4	110.33	112.75	111.54	9.49	9.63	9.56	3085	3201	3143	4.57	4.74	4.65
Mean	109.75	112.10	110.93	9.53	9.65	9.59	3072	3189	3130	4.55	4.72	4.63
	S.E.± *	S.E.± *	S.E.± *	S.E.± *	S.E.± *	S.E.± *	S.E.± *	S.E.± *	S.E.± *	S.E.± *	S.E.± *	S.E.± *
N	3.30 NS	3.30 NS	3.30 NS	0.28 NS	0.29 NS	0.28 NS	92 NS	97 NS	94 NS	0.13 NS	0.14 NS	0.10 NS

NS – Non significant * = C.D. P=0.05 DAS – Days after sowing

Foliar applications of plant nutrient (N)

N_0 – Control (Water spray) N_1 – GA_3 @ 150 ppm N_2 – GA_3 @ 250 ppm N_3 – Urea @ 2% N_4 – Urea @ 3%

Table 2 : Effect of foliar application of plant nutrients on days to crop maturity, days to flower primordial initiation, days to 50% flowering and harvest indexon female parent of sorghum hybrid cv. SHD-9704

Treatments	Days to crop maturity			Daystoflower primordial initiation			Days to 50% flowering			Harvest Index		
	Rabi 2007-08	*Kharif* 2008-09	Pooled data	*Rabi* 2007-08	*Kharif* 2008-09	Pooled data	*Rabi* 2007-08	*Kharif* 2008-09	Pooled data	*Rabi* 2007-08	*Kharif* 2008-09	Pooled data
N_0	92.48	90.15	91.31	37.25	36.23	36.74	67.59	65.67	66.63	0.113	0.126	0.119
N_1	90.78	88.52	89.65	36.32	34.23	35.28	66.40	64.23	65.32	0.138	0.153	0.145
N_2	91.36	88.83	90.10	36.70	35.03	35.87	66.90	64.98	65.94	0.131	0.144	0.137
N_3	89.51	87.59	88.55	35.69	34.03	34.86	65.18	63.18	64.18	0.158	0.169	0.163
N_4	91.00	88.51	89.76	36.33	34.83	35.58	66.56	64.81	65.68	0.135	0.147	0.141
Mean	91.03	88.72	89.87	36.46	34.87	35.67	66.53	64.57	65.55	0.135	0.148	0.141
	S.E.± *	S.E.± *	S.E.± *	S.E.± *	S.E.± *	S.E.± *	S.E.± *	S.E.± *	S.E.± *	S.E.± *	S.E.± *	S.E.± *
N	2.77 NS	2.99 NS	2.87 NS	1.69 NS	1.63 NS	1.65 NS	2.20 NS	2.04 NS	2.10 NS	0.005 0.014	0.005 0.015	0.003 0.010

NS – Non significant * C.D. (P=0.05)

Foliar applications of plant nutrient (N)

N_0 – Control (Water spray) N_1 – GA_3 @ 150 ppm N_2 – GA_3 @ 250 ppm N_3 – Urea @ 2% N_4 – Urea @ 3%

and 2. The foliar application of urea @ 2 per cent (N_3) recorded numerically more plant height (115.42 cm) at harvest, leaf number (9.87), leaf area (3244 cm^2) and leaf area index (4.81) at 75 DAS compared to control water spray (N_0) (105.08 cm, 9.40, 3007 cm^2 and 4.45) except for crop maturity, water spray (N_0) treatment recorded relatively more number of days (91.31 days) and less (88.55 days) in urea spray @ 2 per cent (N_3).In this study, foliar spray of urea @ 2 per cent recorded numerically higher growth parameters and it may be attributed to readily available N nutrient in the source and it might have modified morpho-physiological characteristics and has enhanced the source availability to the developing sinks (seeds). Hence, urea @ 2 per cent resulted in more number of leaves, leaf area and leaf area index. Similar beneficial effect of plant nutrients on growth parameters was also reported by research workers like Shivappa (1988), Lakkappan (1999) and Patil (2001) in sorghum.

Flowering parameters:

The foliar spray of plant nutrients revealed non-significant variation on flowering parameters in both the years of experiment and pooled analysisas mentioned Table 2. However, number of days for flower primordial initiation and 50 per cent flowering were relatively less (34.86 and 64.18 days, respectively) in 2 per cent urea spray (N_3) than in control water spray (N_0) (36.74 and 66.63 days, respectively) The earliness in flower primordial initiation and 50 per cent flowering noticed in foliar spray of urea @ 2 per cent may be related to higher plant height, number of leaves, leaf area and leaf area index leading to faster growth of reproductive parameters. Further, it was also related to greater availability and translocation of photosynthates at the metabolizing zone and it hastened flowering behaviour of the plants sprayed with 2 per cent urea over water sprayed plants. Similar findings were also reported by Pandusastry (1981), Vadivelu *et al*. (1984), Shivappa (1988), Lakkappan (1999), Shivashekhar Patil (2001) and Kannababu *et al*. (2002) in sorghum. Jarugula (2002) in rice, Dhedhi *et al*. (2006) in bajra, Varshney *et al*. (2006), Tanwir Alam *et al.* (2007) and Hipparagi (2011) in maize.

Hybrid seed yield and yield components:

Hybrid seed yield and yield components differed significantly due to foliar application of plant nutrients in both the years of experiments as well as combined analysisas mentioned Table 2, 3 and 4. In general, foliar spray of urea @ 2 per cent (N_3) recorded significantly more harvest index (0.163), ear length (28.60 cm), ear width (4.36 cm), ear weight (33.26 g) (Fig .1), number of seeds per ear (394), seed setting percentage (34.23%), seed weight per ear (13.41 g) and higher hybrid seed yield per hectare (5.27 q/ha) followed by GA3 spray @ 150 ppm (N_1) (0.145, 27.15 cm, 4.24 cm, 31.31 g, 351, 30.29 per cent, 11.96 and 4.90 q/ha) compared to control (N_0) (0.119, 23.09 cm, 3.75 cm, 26.95 g, 287, 24.92 per cent, 9.83 g and 4.28 q/ha,

Table 3 : Effect of foliar application of plant nutrients on ear length (cm), ear width (cm) and ear weight(g)on female parent of sorghum hybrid cv. SHD-9704

Treatments	Ear length (cm)			Ear width (cm)			Ear weight (g)		
	Rabi 2007-08	*Kharif* 2008-09	Pooled data	*Rabi* 2007-08	*Kharif* 2008-09	Pooled data	*Rabi* 2007-08	*Kharif* 2008-09	Pooled data
N_0	22.32	23.86	23.09	3.64	3.86	3.75	25.57	28.23	26.95
N_1	26.20	28.11	27.15	4.11	4.37	4.24	29.95	32.68	31.31
N_2	25.31	26.87	26.09	4.02	4.25	4.13	28.96	31.21	30.08
N_3	27.75	29.46	28.60	4.22	4.50	4.36	31.83	34.68	33.26
N_4	25.52	27.20	26.36	4.04	4.27	4.15	29.49	31.88	30.68
Mean	25.42	27.10	26.26	4.01	4.25	4.13	29.18	31.74	30.46

	S.E.±	C.D. (P=0.05)	S.E.±	C.D. (P=0.05)	S.E.±	C.D. (P=0.05)	S.E.±	C.D. (P=0.05)	S.E.±	C.D. (P=0.05)	S.E.±	C.D. (P=0.05)	S.E.±	C.D. (P=0.05)	S.E.±	C.D. (P=0.05)	S.E.±	C.D (P=0.05)
N	0.80	2.28	0.79	2.26	0.73	2.09	0.12	0.34	0.12	0.35	0.12	0.34	1.01	2.88	1.01	2.90	0.92	2.64

NS – Non sigrificant

Foliar applications of plant nutrient (N)

N_0 – Control (Water spray) N_1 – GA_3 @ 150 ppm N_2 – GA_3 @ 250 ppm N_3 – Urea @ 2% N_4 – Urea @ 3%

Table 4 : Effect of foliar application of plant nutrients on ear weight (g), number of seeds per ear, seed setting percentage, seed weight per ear (g)and hybrid seed yield per hectare (q/ha) on female parent of sorghum hybrid cv. SHD-9704

Treatments	Number of seeds per ear			Seed setting percentage			Seed weight per ear (g)			Hybrid seed yield per hectare (q/ha)		
	Rabi 2007-08	*Kharif* 2008-09	Pooled data	*Rabi* 2007-08	*Kharif* 2008-09	Pooled data	*Rabi* 2007-08	*Kharif* 2008-09	Pooled data	*Rabi* 2007-08	*Kharif* 2008-09	Pooled data
N_0	255	320	288	23.25	26.60	24.92	8.94	10.73	9.83	3.87	4.70	4.28
N_1	316	386	351	28.62	31.96	30.29	10.95	12.97	11.96	4.46	5.34	4.90
N_2	302	363	332	26.94	30.04	28.49	10.32	12.17	11.24	4.37	5.18	4.77
N_3	360	429	395	32.74	35.72	34.23	12.53	14.29	13.41	4.79	5.76	5.27
N_4	307	371	339	28.01	30.48	29.24	10.72	12.32	11.52	4.38	5.28	4.83
Mean	308	374	341	27.91	30.96	29.44	10.69	12.49	11.59	4.37	5.25	4.81

	S.E.±	*	S.E.±	*	S.E.±	*	S.E.±	*	S.E.±	*	S.E.±	*	S.E.±	*	S.E.±	*	S.E.±	*	S.E.±	*	S.E.±	*	S.E.±	*
N	12	34	13	37	9	25	0.92	2.64	1.04	2.99	0.73	2.08	0.37	1.05	0.38	1.09	0.36	1.02	0.13	0.38	0.16	0.45	0.10	0.29

NS – Non sigrificant * = (P=0.05)

Foliar applications of plant nutrient (N)

N_0 – Control (Water spray) N_1 – GA_3 @ 150 ppm N_2 – GA_3 @ 250 ppm N_3 – Urea @ 2% N_4 – Urea @ 3%

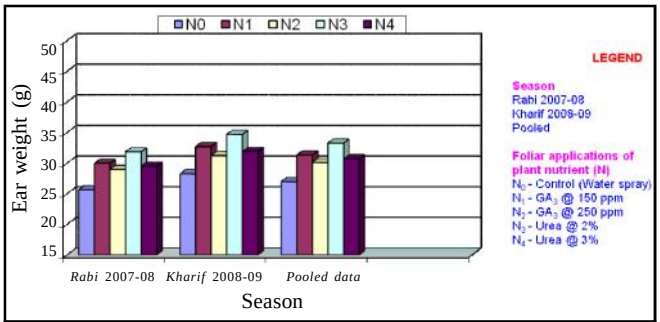

Fig. 1 : Effect of foliar application of plant nutrients on ear

respectively).

The foliar urea spray @ 2 per cent solution was out yielded by showing 23.1 percentage increase in hybrid seed yield per ha over control water sprayed plants and other treatment. This increase in yield may be probably attributed to higher number of leaves, leaf area, leaf area index, earliness in flower primordial initiation and 50 per cent flowering, apart from greater availability of nutrients at metabolizing zone and it hastened flowering period between the two parents. Further, smaller differences in flowering between female and male parent may be also due to good flowering synchronization between parents an account of more availability of viable pollens from male parent to female parent at flowering period. Hence, it resulted in the higher seed setting (34.23%) and increased hybrid seed yield components as evident from the results of this study. Similar positive results of plant nutrients on hybrid seed yield components was also reported by workers Joshi (1976), Patil (1978), Korikanthimath and Palaniappan (1984), Lakkappan (1999) and Kannababu*et al*. (2002) in sorghum, Dhedhi *et al*. (2006) in bajra, Varshney *et al*. (2006), Alam *et al*. (2007) and Hipparagi (2011) in maize.

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