The Andhra Agric. J 56(4):478-481, 2009

Physiological Assessment of Sweet Sorghum [*Sorghum bicolor* (L.) Moench] Cultivars in Coastal Andhra

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ABSTRACT

A filed experiment was carried out at the Agricultural College Farm, Bapatla during *Maghi* season of 2004-05. Physiological growth parameters such as LAI, CGR, RGR, NAR and dry matter production were higher with the cultivars SSV84, SSV74, NTJ_2 and S-35. The cultivars like ICSR 37, Seredo and SSV74 recorded less number of days to 50% growing and maturity than that taken by the other cultivars.

Key words : Crop Growth Rate (CGR), Dry matter production, Leaf Area Index (LAI), Net Assimilation Rate (NAR), Days to 50% Flowering, Relitive Growth Rate (RGR)

India accounts for about 40 per cent of the worlds millet output. Sorghum is one of the five major cultivated species of the cereals and millets in the world in both area and production. It can out produce other cereals under marginal environmental conditions particularly under hot and dry conditions. Eighty percent of sorghum cultivated area in the world is located in Africa and Asia.

Sorghum is cultivated both in Kharif (rainy), *Maghi*, and Rabi (post-rainy) seasons in India. Sweet sorghum as a cash crop is new for coastal Andhra Pradesh.Therefore, it is imperative to go for physiological assessment of sweet sorghum cultivars and to find out their suitability in coastal Andhra.

MATERIAL AND METHODS

The field experiment was conducted at the Agricultural College Farm, Bapatla during *maghi* season of 2004–05 to assess the physiological characters of sweet sorghum [*Sorghum bicolor* (L.) Moench] cultivars. Fifteen sweet sorghum cultivars viz., SSV84, SSV,74 Seredo, NTJ_2, ICSV 574, Ent64, DTN, ICSV 700, ICSV 93046, ICSR 37, ICSV 56, ICRR108, ICSR 196, ICSV 96117, S 35 and ICSR 93034 were tried as treatments, replicated thrice in a randomized block design. The soil texture was clay loam. It had 7.2 P^H and EC was 0.38 $d.sm^{-1}$. It was low in organic carbon, the available nitrogen was low and with medium availability of phosphorus (P_2O_5) and the available potassium is high with 674 Kg ha^{-1}. The average maximum and minimum temperatures during the crop period were 32.4^{0}C and 21.7^{0}C respectively.

Leaf area index was calculated at 15 day interval by specific leaf area method

$$LAI = \frac{A}{P}$$ Where ,

A = Leaf Area, LAI = Leaf area index, P = Unit land area.

CGR (Crop growth rate) is the rate of dry matter production per plant per unit ground area per unit time and expressed in gm^{-2} day^{-1} (Watson, 1952).

$$CGR = \frac{(W_2 - W_1)}{(t_2 - t_1)} \times \frac{1}{P} \quad gm^{-2} d^{-1})$$

Where,

W_1 = Weight of dry matter per m^2 at time t_1
W_2 = Weight of dry matter per m^2 at time t_2
P = Total ground area (m^2)

Blackman (1969) considered the increase in dry matter of plants as a process of continuous compound interest, where in the increment in any interval adds to the capital for subsequent growth. The rate of increment is known as "Relative Growth Rate" and was calculated according to the following formula.

$$RGR = \frac{\log_e W_2 - \log_e W_1}{t_2 - t_1} \quad (mg\ g^{-1} d^{-1})$$

Where,

W_1 = Dry weight of the plant at time t_1
W_2 = Dry weight of the plant at time t_2
Log_e = Natural logarithm

The RGR was worked out at 15 days interval from sowing to harvesting and the average values were assessed.

NAR may be defined as the increase in dry weight of a plant per unit leaf area per unit time.

$$NAR = \frac{W_2 - W_1}{t_2 - t_1} X \frac{\log_e A_2 - \log_e A_1}{A_2 - A_1} (mg\ cm^{-2}\ d^{-1})$$

Where W_1 and W_2 are representative dry matter at beginning and end of the time interval t_1 and t_2 respectively. A_1 and A_2 represent the average leaf area at time t_1 and t_2 respectively. The NAR values were worked out at 15 days interval from sowing to harvesting and the average values were assessed.

Distructive growth analysis was carried out at every 15 days interval from the demarked sampling area of each plot. Five plants were selected and separated into leaves, stem, root and reproductive parts. Later these plant parts were either sun dred on oven dried at 85^0C for three days till they attain constant dry weight.

The number of days taken from the date of sowing to 50 percent flowering was counted as number of days to 50 percent flowering.

RESULTS AND DISCUSSIONS

The genetic variation in productivity of a crop is related parameters to such as LAI, CGR, RGR, NAR and partitioning of total photosynthates into economic organs. At early stage *i.e.,* 15 and 45 DAS, non-significant difference in LAI among cultivars were observed, at 30 DAS, SSV84, SSV74 recorded significantly more LAI at flowering, SSV84, ICSR 37, SSV74 recording more LAI, from flowering stage onwards. SSV84, ICSR 37, SSV74, ICSV 700, ICSV 93046, NTJ_2, S35 in general maintained higher LAI. The LAI increased up to 60 DAS and afterwards it declined. High LAI during 60 DAS might have interrupted more light and enhanced their photosynthetic rate (NAR) which ultimately resulted in higher dry matter production, stalk yield, 1000 seed weight, grain weight per panicle and grain yield. These are in conformity with Chandrasekhar *et.al* (2001) in rice and Patil *et.al* (2003) in sweet sorghum.

Crop growth rate (CGR), which is a measure of rate of biomass production per unit of ground area per unit time was initially low in the sweet sorghum cultivars and increased with advancement of crop age.Variation in CGR leeds to differential dry matter accumulation in different plant parts of cultivars with different crop duration.

In general SSV84, SSV74, S35, NTJ_2 maintained higher CGR throughout the crop period, while ICSV 700, ICSV 93046 recorded higher CGR from 30 to 45 DAS onwards till maturity due to slow growth vigour at initial stages i.e., at 15 and 30 DAS in these cultivars. As these two are long duration cultivars slow increase in CGR during early vegetative phases was associated with poor growth of stem and leaves. As season advanced, CGR progressively increased in the cultivars with the receipt of good rainfall.

Rapid increase in CGR after ear head (panicle) formation resulted in increased accumulation of drymatter in the reproductive organs and economic sinks. These finding are in conformity with Chandrasekhar *et.al.* (2001) in rice and Veerbadhram and Kennedy (2001) in sorghum.

Relative growth rate (RGR) is a measure of rate of drymatter increase per unit drymatter per unit time. It is evident from the data, which differed from cultiver to cultivar,that show higher at 15-30 DAS which gave a push to the transition to flowering (reproductive phase) with slight reduction at 60 DAS and again slightly increased at 60-75 DAS and 75-90 DAS and there after reduced at maturity. Similar decrease in RGR with crop age in rice was observed by Chandrasekhar *et.al*., (2001). SSV84, SSV74, NTJ_2, S35 and ICSR 93034 maintained more RGR through out the crop growth period, like ICSV 700, ICSV 93046 recorded more RGR only at late stages i.e., from flowering stage onwards until maturity since these are long duration cultivars, Veerabadhram and Kennedy (2001) also reported higher values of NAR, RGR and CGR with increasing yield in sorghum. The production of a crop is dependent on its capacity of net assimilation rate (NAR) and photosynthetic area (LAI). NAR is in general was maximum between 30-45 DAS and there after reduced gradually to reach a minimum level at maturity which may be due to mutual shading and senescence of older leaves. SSV84, SSV74, and S35 recorded higher NAR from 30-45 DAS (vegetative) to 60-75 DAS (post-flowering) stage. The cultivars did not differ significantly from 75-90 DAS onwards. The increased demand for assimilates is due to rapid growth of the stem and grain or grain filling. In general, the dry mater accumulation increased two folds from vegetative stage to flowering stage in all cultivars and only a marginal increase in most of the cultivars was observed at maturity. An increasing trend was observed in total drymatter production of different sweet sorghum cultivars across different growth stages. However total drymatter production was almost doubled at flowering. At vegetative stage,

Table Physiological assessment of sweet sorghum cultivars

	LAI (DAS)						CGR (gm-2 md-1)					
Cultivar	15	30	45	60	75	Maturity	15-30	30-45	45-60	60-75	75-90	Maturity
SSV84	1.46	3.13	4.07	3.88	3.38	3.20	0.46	4.53	3.70	8.50	12.00	5.06
SSV74	1.34	3.11	4.00	3.76	3.28	3.10	0.39	4.34	3.67	8.23	11.30	4.23
SEREDO	0.97	2.01	3.07	2.89	2.15	2.06	0.32	3.90	3.10	4.03	6.60	1.76
NTJ2	1.11	2.86	3.69	3.06	3.05	3.01	0.42	4.27	3.60	5.20	10.00	4.30
ICSV574	0.01	2.66	3.38	3.01	2.98	2.92	0.27	4.13	3.30	4.50	8.26	2.86
Ent 64DIN	1.08	2.83	3.43	3.06	2.99	2.90	0.43	4.37	3.40	4.60	8.33	3.26
ICSV700	0.88	2.85	3.80	3.69	3.15	3.06	0.32	4.10	3.50	7.76	12.00	5.03
ICSV93046	0.86	2.62	3.76	3.44	3.11	3.05	0.26	3.90	3.43	5.23	9.90	4.80
ICSV37	1.01	3.05	4.03	3.72	3.22	3.04	0.30	4.10	3.45	5.20	7.86	1.56
ICSV56	0.80	2.66	3.04	2.99	2.94	2.56	0.35	3.56	2.80	2.60	6.16	2.83
ICRR108	0.77	2.56	3.02	2.96	2.80	2.45	0.32	3.46	3.10	1.96	5.30	1.70
ICSR196	0.80	2.65	3.03	3.03	2.87	2.53	0.32	3.50	2.77	2.20	5.33	1.96
ICSV96117	0.75	2.54	3.00	3.00	2.93	2.65	0.36	3.90	3.13	4.16	6.76	2.83
S35	1.08	2.95	3.62	3.40	2.97	2.96	0.39	4.17	3.63	7.40	11.00	4.10
ICSR 93034	1.05	2.88	3.48	3.21	3.08	2.94	0.38	4.15	3.57	5.30	9.66	3.33
S Em +-	0.89	0.56	0.35	0.29	0.30	0.26	0.04	0.17	0.18	0.15	0.70	0.32
CP (p=0.05)	0.27	NS	0.87	0.75	0.76	0.69	0.10	0.40	0.45	0.46	2.10	1.15
CV (%)	5.60	3.50	5.17	3.39	5.18	5.19	4.99	9.87	4.66	5.54	14.81	10.12

RGR (mg g-1 d-1)						NAR (mg cm-2 d-1)						Days to 50% flowering	Total Dry matter	
15	30	45	60	75	Maturity	15	30	45	60	75	Maturity		Flowering	Maturity
61.00	28.60	22.00	39.00	40.80	18.00	0.49	1.98	1.69	0.38	0.36	0.14	51.70	11.45	22.07	24.23
60.30	28.31	21.50	38.50	39.00	16.00	0.47	1.92	1.64	0.36	0.34	0.13	51.00	10.72	21.30	21.93
57.30	25.01	19.00	21.60	18.00	12.30	0.46	1.26	1.40	0.33	0.30	0.11	49.70	8.69	16.90	17.25
60.00	27.60	21.30	26.30	31.00	16.00	0.49	1.64	1.46	0.34	0.32	0.12	51.70	10.13	19.16	18.87
55.50	26.60	20.00	22.30	24.00	7.50	0.43	1.60	1.50	0.35	0.30	0.10	56.70	9.11	18.71	19.45
60.60	28.00	20.30	22.60	29.00	10.00	0.45	1.65	1.52	0.36	0.31	0.12	52.30	9.37	19.25	19.94
58.00	26.00	20.60	38.30	39.50	20.00	0.46	1.59	1.65	0.38	0.47	0.15	60.00	9.59	21.40	24.06
56.00	25.30	20.50	24.30	38.00	21.30	0.46	1.56	1.60	0.36	0.46	0.16	67.70	9.47	19.87	21.43
55.00	24.00	20.50	24.00	19.00	8.00	0.45	1.63	1.64	0.38	0.30	0.10	49.00	7.23	15.90	18.21
56.50	28.30	18.67	21.00	16.50	9.00	0.42	1.43	1.26	0.33	0.30	0.12	51.00	8.42	17.65	18.77
56.20	22.00	18.30	20.00	15.00	10.00	0.41	1.40	1.25	0.31	0.28	0.11	57.00	7.42	14.31	15.30
57.00	23.00	18.53	20.60	15.60	11.00	0.41	1.42	1.30	0.32	0.29	0.12	58.00	7.56	15.36	17.51
57.20	24.33	19.60	21.80	17.60	9.50	0.43	1.47	1.45	0.34	0.24	0.13	58.00	8.85	17.40	17.04
60.00	27.70	21.30	29.60	32.00	14.00	0.49	1.90	1.59	0.36	0.34	0.14	51.00	10.30	19.73	20.56
60.00	27.30	21.00	26.60	30.00	13.00	0.44	1.87	1.55	0.35	0.30	0.13	56.30	10.18	19.03	20.12
1.44	1.89	0.76	1.41	4.01	1.71	0.04	0.15	0.15	0.02	0.08	0.10	0.50	0.61	0.70	0.61
2.68	4.70	1.98	3.80	10.93	3.05	NS	0.41	NS	0.05	NS	NS	1.40	1.76	2.01	1.59
12.50	12.60	4.80	9.37	8.50	13.08	2.52	6.14	3.80	4.12	3.28	7.10	0.10	11.58	10.92	10.00

SSV84, SSV74, S35, ICSR93034 and NTJ_2 recorded significantly higher total dry matter production. At flowering stage SSV84, ICSV700, SSV74, ICSV 93046 and S35 recorded significantly more total dry matter. Differences in days to 50 percent flowering was an imperfect factor for determining grain yield. As ICSR196, ICRR 108, ICSV574 and ICSR93034 having optimum duration of reproductive period might have resulted in proper dry matter partitioning and moderate grain yield. There was a positive relation for days to 50 percent flowering with other parameters like LAI, CGR, RGR and NAR which determine factors for dry matter production and its partitioning into economic sinks *viz* stalk and grain, conformity with Patel *et.al*., (1994)

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(Received on 07.12.2008 and revised on 15.05.2009)