Annals of Plant and Soil Research 17(3): 257-261 (2015)

EFFECT OF CANOPY TEMPERATURE ON GROWTH ATTRIBUTES AND YIELD COMPONANTS OF RABI SORGHUM GENOTYPES UNDER DRY LAND CONDITION

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Received: March, 2015; Revised accepted; July, 2015

ABSTRACT

A field experiment was conducted during *rabi* season of 2010-11 to evaluate canopy temperature of different rabi sorghum genotypes under dry land condition at Parbhani (Maharashtra). Amongst all the genotypes, Parbhani Moti produced significantly highest grain and fodder yield. The canopy temperature and temperature differential. The genotype K-677 showed significantly more canopy temperature and lower soil moisture throughout the growth period of the crop and it was reflected into lower yield. The canopy temperature differential was more in K-677 and lowest in Parbhani Moti genotype. The genotypes K-219, K-369, K-217, K-252, K-606 and E-36-1 matured moderately early, showed moderate canopy temperature, moderate temperature differential (Tc-Ta) and moderate grain and fodder yield, indicating that these genotypes possess characters attributing drought tolerance. Parbhani Moti posses maximum drought resistance characters.

Key words: Rabi sorghum, canopy temperature, water stress, temperature differential

INTRODUCTION

Sorghum (*Sorghum bicolor* (L.) Moench) one of the most major food grains of the world, is cultivated in tropical and subtropical climates, especially in semi-arid tropics. In addition, the fodder and straw is feed to millions of animal providing milk and meat for man. It is widely grown under dry-land for food grain in India. Moisture stress at any stage of the crop growth reduces yield considerably. There exist genotypic differences with regard to their response to moisture stress resulting in yield reduction. Hence, it is important to isolate genotypes which are affected to a lesser degree by moisture stress. Such genotypes could be directly recommended for cultivation under rainfed condition. Canopy temperature have been recognized as indicator of overall plant water status (Blum *et al.*1982 and Idso *et al.* 1982), irrigation scheduling, cultivar comparison for water use (Chantereau *et al.* 2001; Morgan *et al.* 2002 and Kumar *et al.* 2009). Considering these aspects, the present experiment was carried out using sorghum genotypes at Parbhani.

MATERIALS AND METHODS

The experiment was carried out during the *rabi* season (October - February) of 2010–2011 at the research farm of Department of Agricultural Meteorology, Marathwada Krishi Vidyapeeth (Latitude 19^0 08' N, Longitude 76^0 50' E and altitude 409 m amsl), Parbhani, India. The study site is situated in the subtropical climate zone with average annual rainfall is 957.6 mm. The experiment was laid out in randomized block design with twenty genotypes with three replications. The genotypes details were cv; K-219, K-369, K-217, K-252, K-225, K-352, K-241, K-279, K-648, K-282, K-606, K-677, RSG-04005, Phule Mauli, Akola Kranti, Parbhani Jyoti, Parbhani Moti, B-15, R-16, and E-36-1. Weather observations recorded at meteorological observatory during *rabi* season were used to study the effect of weather on crop growth. The canopy temperature was recorded at each phenophases of the crop growth between 13.30 and 14.30 hr by using Telatemp thermometer (Teletemp model (AG-42)).

RESULTS AND DISCUSSION

Canopy temperature and temperature differential (CT-AT): The result revealed that canopy temperature had influenced significantly the different genotypes (Table1). The range of canopy temperature throughout the growth period of crop was observed from 25.8 to 34.1°C. The mean canopy temperature throughout all growth stages in all genotypes was observed in between 30.2 °C (Physiological maturity and flowering stage) and 31.8 °C (dough stage). The lowest canopy temperature was recorded in B-35 (25.8 °C) at panicle initiation and highest in K-677 (34.1 °C) at boot stage. The variation in canopy temperature is influenced by the genotypes as well as growth stage of *rabi* sorghum crop. The data revealed that the growth stage wise lowest canopy temperature was observed in B-35 (25.8 °C), K-219 (31.8 °C), K-369 (31.4 °C) and (30.9 °C) and K-225 (27.3 °C) and the highest canopy temperature in K-225 (32.5 °C),

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K-677 (34.1 °C), K-677 (33.8 °C), K-677 (32.6 °C) and RSG-04005 (31.5 °C) at panicle initiation, boot stage, flowering stage, dough stage and physiological maturity, respectively. While, it was observed highest at panicle initiation (32.5 °C) in K-225 and at physical maturity (31.5 °C) in RSG-04005. K-677 showed higher canopy temperature at boot stage (34.1 °C), flowering stage (33.8) and dough stage (32.6 °C).Amongst the varieties at panicle initiation stage B-35 showed less temperature which may be due to medium size of leaves and good aeration of roots having a genetical character. Whereas at boot stage, K-219 showed lowest canopy temperature because of the varietal character good water absorptive by root.However, at flowering and dough stage, K-369 variety showed less canopy temperature. It may be due to more transpiration rate which helps to regulate the body temperature and cool the leaf tissues. Whereas, at physiological maturity it was found lowest in Parbhani Moti, It may be due to the more absorption of water from the lower layer of soil during moisture stress.

Table 1: Growth stag wise canopy temperature (^{0}C) and temperature differential (CT-AT) under different sorghum genotypes

Genotype	Panicle initiation		Boot stage		Flowering		Dough stage		Physiological maturity	
	CT	CT-AT	CT	CT-AT	CT	CT-AT	CT	CT-AT	CT	CT-AT
K-219	31.2	-1.0	31.8	-0.7	31.6	0.1	31.6	4.0	31.2	3.4
K-369	29.4	-1.9	32.0	-1.3	31.4	0.5	30.9	2.7	31.0	3.3
K-217	31.0	-1.8	33.6	-0.03	33.1	1.2	32.2	3.9	29.4	1.7
K-252	31.7	-1.0	32.2	0.3	31.9	0.5	31.7	2.5	29.4	2.6
K-225	32.5	-0.7	32.4	-0.6	32.3	0.4	32.0	2.9	27.3	3.2
K-352	31.4	-0.7	32.0	-0.1	31.7	0.8	31.2	3.0	30.7	2.1
K-241	29.9	-3.2	33.1	-0.5	32.7	1.5	32.2	3.2	29.3	1.3
K-279	31.7	-3.6	33.0	-0.4	32.7	0.9	32.2	3.5	29.3	1.7
K-648	30.3	-2.5	32.1	-1.5	32.1	0.9	31.2	2.7	30.5	2.3
K-282	30.0	-2.4	33.1	-0.5	32.6	1.3	31.9	3.5	31.1	2.1
K-606	30.9	-1.8	31.9	-1.8	31.8	1.0	31.5	3.5	30.0	1.9
K-677	31.8	-0.4	34.1	0.1	33.8	2.8	32.6	4.5	31.0	3.7
RSG-04005	31.5	-1.5	32.9	0.2	33.0	1.4	32.3	4.4	31.5	2.4
E-36-1	31.0	-1.9	32.1	0.6	33.1	1.6	32.1	3.4	31.0	2.6
Akola Kranti	30.5	-2.0	33.4	-1.4	32.7	1.3	31.7	3.2	30.5	2.4
Parbhani Moti	30.3	-2.4	33.1	0.6	31.7	1.6	32.1	3.4	29.1	1.8
Parbhani Jyoti	30.0	-2.5	32.5	-1.5	32.2	0.9	31.5	3.6	29.5	1.3
Phule Mauli	28.9	-3.9	32.8	-2.0	32.5	1.7	31.8	4.2	29.8	1.1
B-35	25.8	-3.4	32.4	-1.6	33.3	1.7	31.8	4.1	31.4	3.2
R-16	29.9	-3.0	32.9	-1.0	32.2	0.7	31.6	3.0	31.0	3.0
Mean	30.5	-1.9	30.2	-0.7	30.5	1.1	31.8	3.4	30.2	2.3
CD = 0.05	2.3	-3	0.2	1.1	2.3	1.1	0.7	0.7	0.2	0.6

CT - Canopy temperature, AT - Air temperature, CT-AT - temperature differential between CT and AT

The average canopy temperature throughout the growth period was found in the range between 30.2 and 31.8 ^{0}C. At panicle initiation and boot stage, average canopy temperature was less than air temperate because of availability of more soil moisture due to occurrence of rainfall in 38, 39, 42 and 43 MW. While, at boot stage average canopy temperature was more than panicle initiation, flowering stage and dough stage. However, the canopy temperature was more at this stage than air temperature, because of depletion of soil moisture and increase in demand of water by plant. The genotype K-677 produced significantly lowest grain yield over the other genotypes and also showed the higher canopy temperature over the all genotype at most of the growth stages of sorghum crop. Similar results were reported by Olufayo *et al.* (1993) and Zhang *et al.* (2007). The similar results were obtained for canopy temperature - air temperature i.e. temperature differential (CT- AT) (Table 1) and its positive values showed water stress and negative values indicates availability of soil moisture to the plant or crop. The trend of mean temperature differential was found increasing from panicle initiation to physiological maturity continuously. It is because of increasing leaf area and demand of soil moisture but soil moisture

showing inverse trend (i.e. it was decreased soil moisture availability from panicle initiation to physical maturity). It is seen from the data (Table 1) that there was no moisture stress in all the genotypes at panicle initiation. It also revealed that there was slight moisture stress at boot stage in K-252, K-677, E-36-1 and Parbhani Moti. While, amongst stressed genotypes, more stress was observed in E-36-1 and Parbhani Moti, whereas lowest stress in Phule Mauli variety as compared to all genotypes. It may due to the impact of soil moisture and it is clearly correlated with soil moisture availability (Table 2).

Table 2: Soil moisture content (%) under different sorghum genotypes

Genotype	Days after sowing						
	15	**30**	**45**	**60**	**75**	**90**	**105**
K-219	30.6	30.3	32.9	31.3	28.6	26.3	26.4
K-369	32.4	31.7	33.4	31.3	31.2	28.4	26.6
K-217	35.4	33.0	33.5	32.7	32.1	28.6	26.9
K-252	33.3	32.6	33.0	32.3	29.4	29.0	25.8
K-225	31.2	30.5	33.5	31.2	28.0	27.4	27.8
K-352	31.6	30.3	33.4	31.2	28.1	27.0	26.2
K-241	31.8	27.8	32.4	28.5	27.3	26.5	25.9
K-279	32.8	28.4	31.6	28.6	26.3	27.8	26.3
K-648	31.8	27.7	31.0	28.3	26.9	28.6	27.1
K-282	32.7	27.3	29.0	28.0	25.5	27.2	28.0
K-606	31.8	28.4	31.3	28.2	26.3	27.8	26.7
K-677	30.0	27.0	28.0	27.2	26.4	26.0	25.0
RSG-04005	32.5	30.8	31.8	30.3	29.6	28.1	25.8
E-36-1	31.3	31.0	30.6	31.3	29.8	27.5	26.9
Akola Kranti	31.3	27.2	27.2	27.9	27.7	26.8	26.0
Parbhani Moti	31.3	27.2	28.6	28.2	26.6	27.8	27.8
Parbhani Jyoti	32.6	27.0	28.6	28.0	25.5	28.2	27.3
Phule Mauli	33.1	27.6	28.4	27.7	27.0	27.4	26.5
B-35	31.3	29.0	31.4	27.6	26.5	26.5	26.5
R-16	30.1	29.0	31.4	28.4	28.1	26.7	26.0
Mean	32.0	29.9	30.9	28.9	27.6	26.3	26.6
CD = 0.05	1.1	1.2	0.1	0.1	0.1	0.1	0.7

Soil Moisture: The inverse trend with temperature differential was found in soil moisture in all the genotypes (Table 2). While a decreased trend in the soil moisture content was seen from 15 DAS to 105 DAS. The differences in soil moisture of the genotype were significant at all crop growth stages. The mean soil moisture was decreased initially from 15 DAS upto 30 and it was increased up to 45 DAS (vegetative growth stage) and therefore decreased continuously up to 105 DAS (physiological maturity) in all the genotypes. While, at 15 DAS the soil moisture level was higher due to good quantum of rainfall (69.5 mm in 38 MW and 41.4 mm in 39 MW) and lower at 30 DAS, due to a dry spell experienced during 40 and 41 MW. The genotype K-677 showed significantly lowest soil moisture content throughout growth period except at 45 DAS in Akola Kranti and at 175 DAS in K-282. The genotype K-217 showed significantly highest soil moisture content throughout the growth period except K-252 at 90 DAS and K-282 at 105 DAS. The soil moisture stress experienced in all genotype at flowering stage and it was highest in K-677 and lowest in K-219. At dough stage it was significantly highest in K-677 and significantly lowest in K-252. However, soil moister stress at physiological maturity in all genotypes was significantly highest in K-677 and lowest in Phule Mauli. It may be due the genotypic differences, variation in soil moisture content was observed and the varietal character of reacting to soil moisture stress and weather condiation.

Phenological study: Significant differences were observed in attaining the 50% flowering, physiological maturity, grain and fodder yields within the genotype of *rabi* sorghum (Table 3). Mean number of days required for 50 % flowering showed significant differences among the genotypes. The mean days required to attain 50 % flowering was observed 64.9 days and genotypes K-219, K-352, K-241, and K-606 flowered significantly earlier (57 days) and late flowered than other genotypes Phule Mauli (72.3 days). It may be due genetical character or moisture stress or combine effect. The similar result were reported by Norem *et al.* (1985) who reported genotypic difference in days required for 50 % flowering in *rabi* sorghum genotypes.

The days required for attaining the physiological maturity were 110.7 days with significant difference amongst the genotypes. The genotype K-352 and K-606 matured significantly earlier (105 days) and attained late physical maturity by Parbhani Moti (122.3) than all other genotypes. It may be due to genotypic character and variety behaviour during moisture stress and other weather parameter. The *rabi* sorghum grown on residual soil moisture stored by soil as well as terminal monsoon rainfall and early maturity of the genotypes helped to escape the crop from terminal moisture stress during physiological maturity stage. Similar results were reported by Kadam *et al.* (2002).

Table 3: Phenological stages and yield of sorghum genotypes

Genotype	Days to 50% flowering	Days to physiological maturity	Grain yield (q ha^{-1})	Fodder yield (q ha^{-1})
K-219	57.0	105.6	20.2	74.7
K-369	60.0	108.0	21.1	75.5
K-217	57.1	105.3	21.7	76.1
K-252	58.3	107.0	21.4	72.0
K-225	59.3	107.3	18.6	76.3
K-352	57.0	105.0	18.6	72.8
K-241	57.0	105.3	19.7	74.3
K-279	58.0	107.0	18.8	76.5
K-648	60.0	108.0	19.8	74.8
K-282	60.0	108.0	18.9	76.6
K-606	57.0	105.0	20.4	73.5
K-677	60.0	124.0	17.7	77.3
RSG-04005	58.0	107.0	19.4	78.3
E-36-1	57.3	106.0	20.0	72.1
Akola Kranti	70.0	119.3	20.6	73.3
Parbhani Moti	60.0	122.3	22.1	79.0
Parbhani Jyoti	72.0	122.0	20.0	78.8
Phule Ma	72.3	110.0	20.6	68.9
B-35	71.6	119.3	17.9	75.0
R-16	67.6	116.0	19.1	74.9
Mean	64.9	110.7	21.4	73.9
CD = 0.05	2.4	0.6	2.1	2.6

Grain and fodder yield: The data (Table 3) indicated that significant differences were observed amongst genotypes in respect of mean grain and fodder yield. The highest grain yield was observed in genotype Parbhani Moti (22.1 qha^{-1}) and lowest in K-677 (17.7 qha^{-1}). The genotype Parbhani Moti produced significantly highest yield over all the genotypes and it was superior over all other genotypes except K-219, K-369, K-217, K-252, K-606, E-36-1 and Akola Kranti, which were at par. Similar results were reported by Kadam *et al.* (2002). The genotype Parbhani Moti produced significantly highest fodder (79.0 qh^{-1}), and proved superior over all the other genotypes except K-369, K-217 and Parbhani Jyoti, it was at par. The similar results are reported by (Kusalkar *et al.*, 2003).

It is because of the genetical performance in different weather conditions and soil moisture content. Genotype K-677 produced lowest yield because of more canopy temperature and more (i.e. positive) canopy temperature deferential indicating lower drought tolerance characters. While, inverse trend was observed in genotypes Parbhani Moti (i.e. which was more drought tolerance characters) and reflected into highest grain yield and fodder yield.

REFERANCECS

Blum, A., Mayer, J., Gozlan, G. (1982) Infrared thermal sensing of plant canopies as screening technique for dehydration avoidance in wheat. *Field Crops Research* **5**:137- 146.

Chantereau, J., Trouche, G., Rami, J.F., Deu, M., Barro, C., Grivet, L., (2001) RFLP mapping of QTLs for photoperiod response in tropical sorghum. *Euphytica* **120**: 183–194.

Idso, S.B. (1982) Non water stressed baseline. A key to measuring and interpreting plant water stress. *Agricultural and Forest Meteorology* **27**:59-70.

Kadam, G.N., Gadakh, S.R. and Awari, V.R. (2002) Physiological analysis of rabi sorghum genotypes for shallow soil. *Journal of Maharashtra Agricultural Universities* **27**(3): 274-276.

Kumar, S.R., Graeme L., Hammer, G.L., Ian Broad, L., Harland, P., McLean, G. (2009) Modelling environmental effects on phenology and canopy development of diverse sorghum genotypes. *Field Crops Research* **111**: 157–165.

Kusalkar, D.V., Awari, V.R., Pawar, V.V. and Shinde, M.S. (2003) Physiological parameters in relation to grain yield in rabi sorghum on medium soil *Advances in Plant Sciences.* **16**(1): 119-122.

Morgan, P.W., Finlayson, S.A., Childs, K.L., Mullet, J.E., Rooney, W.L. (2002) Opportunities to improve adaptability and yield in grasses: lessons from sorghum. *Crop Science* **42**: 1791–1799.

Norem, M.A., Doberenge, A.K., and Voight, R.L. (1985) Protein and other quality components of drought mutant sorghum grain with an irrigation gradient system. *Sorghum Newsletter* **28**:126.

Olufayo, A., C. Balday, P. Ruelle and Konate J. (1993) Diurnal course of canopy temperature and leaf water potential of sorghum (*Sorghum bicolour* (L) Moench) under a Mediterranean climate. *Agril. and Forest Meteorology* **64**: 223-236.

Patil, R.P. (1987) Physiological factors influencing growth and yield of rabi sorghum genotypes under rainfed conditions. *M.Sc. (Agri.) thesis, MKV, Parbhani.*