E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; 7(3): 480-482
Received: 01-12-2023
Accepted: 05-01-2024

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Evaluation of growth and yield attributes and yield analysis components in summer sorghum genotypes grown under different sowing dates in Marathwada region of Maharashtra

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DOI: https://doi.org/10.33545/2618060X.2024.v7.i3g.456

Abstract
Field experiment was conducted during 2017-18 at AICRP on Sorghum, VNMKV., Parbhani, with split plot design and replicated thrice. The Main plot consists of three different dates of sowing *viz.* D_1: 01 MW (01 January 2018), D_2: 03 MW (15 January 2018), D_3: 05 MW (30 January 2018) and subplots four genotypes of sorghum *viz.* G_1: PVK-801, G_2: SPH 1641, G_3: Parbhani Moti and G_4: Parbhani Jyoti, sown at spacing 45cm×15cm. The plot size was 4.5m×5m. The result indicated that the sowing of sorghum during summer season on first date of sowing D_1 (01 MW) recorded significantly highest plant height plant^{-1}, higher number of functional leaves plant^{-1}, maximum leaf area plant^{-1} (cm^2), maximum dry matter plant $^{-1}$(g), long length of earhead, highest weight of earhead, test weight (g), grain yield (kg ha^{-1}), fodder yield (kg ha^{-1}) and harvest index (%) which was found significantly superior over sowing date D_3 (05 MW) and at par with D_2 (03 MW) at all periodical days and at harvest except 30 DAS plant height. Among different sorghum genotypes G_1 PVK-801 recorded significantly highest maximum plant height plant^{-1},, maximum leaf area plant^{-1} (cm^2), highest dry matter plant $^{-1}$(g), long length of earhead, highest weight of earhead, test weight (g), grain yield, fodder yield and harvest index over sorghum genotypes G_2 (SPH 1641), G_3 Parbhani Moti and G_4 Parbhani Jyoti during summer season at all periodical days and at harvest except 30 DAS plant height.

Keywords: growth, yield attributes, sorghum genotypes

Introduction
Sorghum is an important food grain crop in India. Area under this crop in India is about 5.79 million ha. With an annual production of 5.54 million t. with a productivity of 957 kgha^{-1}. Abiotic factors play an important role in deciding the failure or success of the crop, because these factors strongly influence the physiological expression of genetic potential of the crops. Yield from any given crop or variety depends on the availability of optimum condition of relative humidity, solar radiation, heat units, temperature, soil moisture, etc. during growth stages of crop. Temperature is an important meteorological variable that affect plant growth and development. Required temperature for germination is at least 8.0 to 10.0 °C, tolerated by crop having optimum temperature range for growth as 24.0-30.0 °C. The base temperature is 10 °C and below which its growth and development stunted.

Sowing time is the most important non-monetary input. Sowing at proper time improves the yield by offering suitable environment to crop at all growth stages. Until know effect of sowing date summer season on performance of these improved varieties and hybrids in marathwada region work has not evaluated. Sowing time directly affects the duration of crops during growing season; genotypes of different maturity groups will correspondingly be affected. Considering different views in mind, the thought is given for the determine summer cultivation of sorghum in the Marathwada region "Studies on Crop Weather Relationship in Summer Sorghum (*Sorghum bicolor* (L.) Moench)"

Materials and Methods

Time of sowing for sorghum during summer is important non-monetary input for proper growth and development of plants for gaining maximum grain yield. But until now very few literatures is available on cultivation of summer sorghum and keeping this in view, the present investigation was conducted during *summer* seasons of 2017-18 to "Studies on Crop Weather Relationship in Summer Sorghum (*Sorghum bicolor* (L.) Moench)" at Sorghum Research Station, vnmkv., Parbhani. Experimental field Soil was heavy black which represents the typical black cotton. The experiment comprised with total twelve treatment combination. The experiment was laid out with split plot design and replicated thrice. The Main plot consists of three different dates of sowing *viz.* D_1: 01 MW (01 January 2018), D_2: 03 MW (015 January 2018), D_3: 05 MW (30 January 2018) and subplots four genotypes of sorghum *viz.* G_1: PVK-801, G_2: SPH 1641, G_3: Parbhani Moti and G_4: Parbhani Jyoti, sown at spacing 45cm×15cm. Plot size of experimental each plot was 4.5m×5m. Seasonal mean of maximum and minimum temperatures (T mean) was recorded 36.4 °C and 17.5 °C, respectively.

Results and Discussion

Effect of sowing dates

Plant height, was found to be increased at every stage of crop growth till maturity. The rate of increase in plant height was found to be faster from 30 to 90 DAS and thereafter relatively slow during subsequent stages up to maturity. The mean number of functional leaves, leaf area increased rapidly up to 60 days and thereafter decreased towards maturity to drying of leaf.

The effect of sowing dates on plant height plant^{-1}, number of functional leaves plant^{-1}, leaf area plant^{-1} (cm^2), total dry matter accumulation plant$^{-1,}$ days to 50% flowering, physiological maturity, was found significant during all periodical days and at harvest except at 30 DAS plant height Table 1. At all periodical days, Sowing of sorghum on first date of sowing D_1 (01 MW) recorded significantly the highest plant height plant^{-1}, higher number of functional leaves plant^{-1}, maximum leaf area plant^{-1} (cm^2), maximum dry matter plant $^{-1}$(g) was found at par with D_2 (03 MW) and significantly superior over sowing date D_3 (05 MW).

Sowing of sorghum in D_1 (01 MW) recorded significantly more Days to 50% flowering, Days to physiological maturity, Length of earhead (cm), Weight of earhead (g), Test weight (g), highest grain yield (1631 kg ha^{-1}) fodder yield kgha^{-1} and harvest index over sowing dates D_2 (03 MW) and D_3 (05 MW) Table 2. The first date of sowing was more suitable for grain yield production as compared to late sown sorghum.

Date of sowing D_1 i.e. recorded maximum leaf area per plant which may be larger size leaves due to exposure of crop to optimum weather conditions. Also, delay in sowing decreased height of plant which resulted into decrease in number of functional leaves plant^{-1} as well as leaf area plant^{-1} which result into lower dy matter production and grain yield. The variation in leaf area due to different times of sowing was also observed by Mishra *et al.* (2017) [4].

Sowing of sorghum at D_1 (01 MW) recorded significantly the highest fodder yield over rest of sowing dates. This was due to prevalence of maximum temperatures within favorable limits, ranging between 28 °C to 34 °C during the major duration of the crop which became instrumental in boosting up the growth and yield parameters. As sowing dates intervals increased flowering of that period comes under high tempter which affect on decrease in viability of pollen results into decrease in seed seating which results into low yield. Similar results were reported by Reddy and Rao (1978) [6], Andhale *et al.* (2005) [1] and Deshmukh *et al.* (2009) [2]. Patel *et al.* (2017) [5] and Singh *et al.* (2000) [9].

Effect of genotypes

At periodical days, the highest plant height plant^{-1}, leaf area plant^{-1}, maximum dry matter plant^{-1}, was recorded by genotypes G_4 (Parbhani Jyoti) which was found significantly superior over all genotypes during all periodical days and at harvest except 30 Days plant height. These results were in conformity with findings of Satpal *et al*. (2015) [8], Mishra *et al.* (2017) [4] and Sai Maheswari *et al.* (2019) [7].

The effect of genotypes on number of functional leaves was found to be non-significant at all the growth stages.

The response of genotypes on long length of earhead, weight of earhead, test weight (g), grain yield (kg ha^{-1}), fodder yield (kg ha^{-1}) and harvest index was found to be significant. Among different genotypes, G_1 PVK-801 recorded significantly long length of earhead, weight of earhead, highest, test weight (g), grain yield, fodder yield and harvest index over G_2 SPH 1641, G_3 Parbhani Moti and G_4 Parbhani Jyoti. This may be due to performance of these genotypes to climatic conditions in summer season and difference in genetic potential.

Interaction effect

The interaction between sowing date and genotypes did not influence the growth attributes, yield attributes and yield. Similar results were found by Deshmukh *et al.* (2013) [2] and Sai Maheswari *et al.* (2019) [7]

Table 1: Plant height plant^{-1} (cm), number of leaves plant^{-1}, leaf area plant^{-1} (cm^{-2}) and dry matter plant^{-1}(g) as influenced by sowing date and genotypes

Treatment	plant height				number of leaves				leaf area				dry matter			
Date of sowing	30	60	90	At harvest	30	60	90	At harvest	30	60	90	At harvest	30	60	90	At harvest
D_1: (01 MW)	25.71	81.62	119.83	140.33	7.25	8.10	6.96	1.55	643.06	2022.90	1198.92	359.97	15.46	83.78	121.84	131.58
D_2: (03 MW)	22.85	71.98	117.00	132.42	5.96	7.30	6.24	1.40	610.57	1983.20	1194.80	339.01	13.76	76.54	110.74	122.68
D_3: (05 MW)	20.78	58.47	106.88	118.17	5.64	7.08	6.14	1.25	573.58	1791.60	1094.64	337.71	11.80	71.87	106.13	121.28
S.Em±	1.21	9.42	6.98	6.13	0.06	0.17	0.15	0.03	10.32	45.39	19.17	4.65	0.45	1.34	1.60	0.50
C.D. at 5%	NS	27.13	21.5	17.9	0.25	0.66	0.62	0.10	40.52	178.25	75.29	18.28	1.78	5.28	6.30	1.97
Genotypes																
G_1: PVK-801	21.96	54.80	100.56	118.00	6.46	7.83	6.66	1.53	946.89	2169.50	1221.50	433.66	8.22	75.97	114.18	120.71
G_2: SPH 1641	22.71	67.60	106.17	123.00	6.32	7.57	6.45	1.45	852.33	1957.10	1164.14	353.63	5.29	68.02	104.08	109.52
G_3: Parbhani Moti	23.87	68.51	124.56	140.22	6.15	7.26	6.32	1.38	305.74	1763.50	1106.10	296.89	19.36	81.84	111.58	133.83
G_4: Parbhani Jyoti	23.91	91.84	127.00	142.67	6.21	7.32	6.42	1.24	331.33	1840.20	1153.31	298.06	21.81	83.77	121.78	136.68
S.Em±	1.47	6.10	5.98	6.62	0.35	0.36	0.26	0.06	15.31	77.71	24.42	11.31	1.29	1.35	2.07	1.41

C.D. at 5%	NS	19.3	18.2	22.14	NS	NS	NS	NS	45.43	230.55	72.47	33.61	3.83	4.01	6.15	4.19
D X G Interaction																
S.Em±	2.54	10.57	10.36	11.47	0.20	0.20	0.15	0.11	26.52	134.60	42.31	19.59	2.23	2.34	3.59	2.45
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
General mean	23.11	70.69	114.57	130.31	6.29	7.50	6.45	1.4	609.07	1932.60	1162.80	345.56	13.67	77.40	112.90	125.18

Table 2: Days to 50% flowering, Days to physiological maturity, Length of earhead (cm), Weight of earhead (g), Test weight (g), Grain yield (kg ha^{-1}), Grain yield (kg ha^{-1}) and Harvest index (%) as influenced by sowing date and genotypes

Treatment	Days to 50% flowering	Days to physiological maturity	Length of earhead (cm)	Weight of earhead	Test weight	Grain yield (kg ha^{-1})	Fodder yield (kg ha^{-1})	Harvest index (%)
Date of sowing								
D_1: (01 MW)	73	119.17	16.45	41.96	26	1631	7782	17
D_2: (03 MW)	79	117.75	15.90	38.76	25	1098	6941	14
D_3: (05 MW)	77	115.50	14.42	31.88	12	585	5995	09
S.Em±	1.0	0.40	0.31	1.21	1.0	105	222	1.0
C.D. at 5%	NS	1.58	1.23	4.76	2.0	313	659	3.0
Genotypes								
G_1: PVK-801	77	117.44	17.40	48.31	22	1456	6590	17
G_2: SPH 1641	73	116.22	17.80	34.60	21	1150	6450	13
G_3: Parbhani Moti	76	117.33	12.91	33.64	20	889	6871	11
G_4: Parbhani Jyoti	79	118.22	14.25	33.60	21	923	7712	13
S.Em±	1.0	0.50	0.52	4.03	1.0	101	356	1.0
C.D. at 5%	NS	NS	1.56	12.0	2.0	300	659	3.0
D X G Interaction								
S.Em±	1.0	0.87	0.91	6.99	2.0	175	617	2.0
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS
General mean	76	117.31	15.59	37.53	21.0	1105	6906	14

Conclusion

Sowing of sorghum in summer that D_1 sowing i.e. 01 MW (01 to 07 Jan) showed higher biometric and yield contributing characters and production of the highest grain yield (kg ha^{-1}) and fodder yield (kg ha^{-1}). Genotype G_1 (PVK-801) recommended for sowing in summer season on the basis of the highest grain yield

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