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Influence of solid and liquid organic manures on growth, yield and economics of *parching* sorghum (*Sorghum bicolor*)

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Abstract
Crop production is influenced by the fertility of soil has significant impact on physiological and biochemical processes in favour of higher crop production. So, addition of organic manures to soil in optimum and proper proportion is necessary for sustainable production. A field experiment was conducted to study the influence of solid and liquid organic manures on *parching* sorghum during *Rabi*, 2020 at Instructional farm, College of Agriculture, Vijayapur. The experiment was laid out under randomized complete block design with 9 treatments replicated thrice. Application of ghanajeevamrutha based on 100% RDN as basal dose coupled with foliar application of 25 per cent jeevamrutha at 20 and 45 DAS recorded significantly higher plant height (176.5 cm) and leaf area (2358.2 cm^2 $plant^{-1}$) at harvest, yield attributes such as roasted panicle weight per plant (60.99g) and roasted grain yield (1505 kg ha^{-1}), higher gross returns (1,59,480 Rs. ha^{-1}), net returns (1,22,208 Rs. ha^{-1}) and benefit cost ratio (4.28) over other treatments.

Keywords: Ghanajeevamrutha, Jeevamrutha, Vermiwash, *Parching* sorghum, foliar application

Introduction
Sorghum [*Sorghum bicolor* (L.) Moench] is an ancient cereal grain belonging to the grass family Poaceae (Graminaceae). It is the king of millets and third significant crop in the nation next to rice and wheat. Jowar is one of the vital food crops in dry land of tropical Africa, India and China. In India, sorghum is one of the principal food crops of many states like Maharashtra, Karnataka, Madhya Pradesh, Tamil Nadu, and Gujarat and is consumed by a huge segment of people predominantly in the dry land areas with low rainfall.

The tender sorghum grains in English is termed as *parching* Sorghum, also known by different names such as *sheetani* (Kannada), *hurda* (Marathi) and *ponk* (Gujarati). Basically, the period during late winter when sorghum grain is juicy and very tender, panicle is roasted over cakes of dry cow dung. It is the main principal grain of rural Maharashtra and Northern Karnataka. According to American chefs say sweet grain sorghum is the subsequent "wonder grain". They extoll its health profits, its flexibility in cooking (amongst other things, it pops like corn) and its eco-friendliness due to being remarkably drought tolerant (Bagchi, 2013) [1].

Growing of high yielding varieties with undiscriminating usage of fertilizers, poor

Water management practices and unproductive plant protection trials in current chemical rigorous agriculture has caused into deprivation of lands owed to low crop yields with poor quality of produce (Pradhan and Mondal, 1997) [8]. Therefore, use of locally obtainable agro-inputs in agriculture by avoiding or lessening the use of synthetically compounded agro-chemicals seems to be one of the profitable decisions to sustain the agricultural productivity by maintaining the soil fertility without affecting its physical property. When organic fertilizers are applied, soil microorganisms themselves degrade them till they become water-soluble compounds that plants take benefit from. Thus, the goal of the current study is to determine the effect of organic manures on growth, yield and economics of *parching* sorghum.

Material and Methods

The experiment was carried out at College of Agriculture, Vijayapur, situated in the Northern Dry Zone of Karnataka (Zone 3), at 16^0 49' North latitude, 75^0 43' East longitude and at an altitude of 593.8 m above the mean sea level. The soil was low in organic carbon (0.37%), low in available nitrogen (188 kg ha^{-1}), high in both available phosphorus (29.5 kg ha^{-1}) and available potassium (390 kg ha^{-1} high).

During the cropping period of 2020-21, an over-all rainfall of 865.5 mm was obtained in 51 rainy days from April 2020 to March 2021 as against the normal rain of 594.4 mm which was obtained in 38 rainy days. The maximum monthly temperature over the years (1981-2019) was the highest in the month of May (39.6 °C), while it was the lowest in the month of December (29.1°C). The normal monthly mean minimum temperature was the lowest in the month of January (14.6 °C) as given in Fig.1.

The field experiment was laid out in Randomized Complete Block Design with 9 treatments (T_1-Ghanajeevamrutha based on 100% RDN as basal dose, T_2-Vermicompost based on 100% RDN as basal dose, T_3- T_1 + foliar application of 10% vermiwash at 20 & 45 DAS, T_4- T_1 + foliar application of 10% cow urine at 20 & 45 DAS, T_5- T_1 + foliar application of 25% jeevamrutha at 20 & 45 DAS, T_6- T_2 + foliar application of 10% vermiwash at 20 & 45 DAS, T_7- T_2 + foliar application of 10% cow urine at 20 & 45 DAS, T_8- T_2 + foliar application of 25% jeevamrutha at 20 & 45 DAS and T_9- Organic RPP of *parching* sorghum) and 3 replications. After the preceding crop was harvested, the ground was ploughed once more and planking was done in both the direction to prepare a levelled and fine seed bed. The total quantity of ghanajeevamrutha and vermicompost were calculated based on their respective nitrogen content in order to meet the recommended dose of Nitrogen (40 kg ha^{-1}).

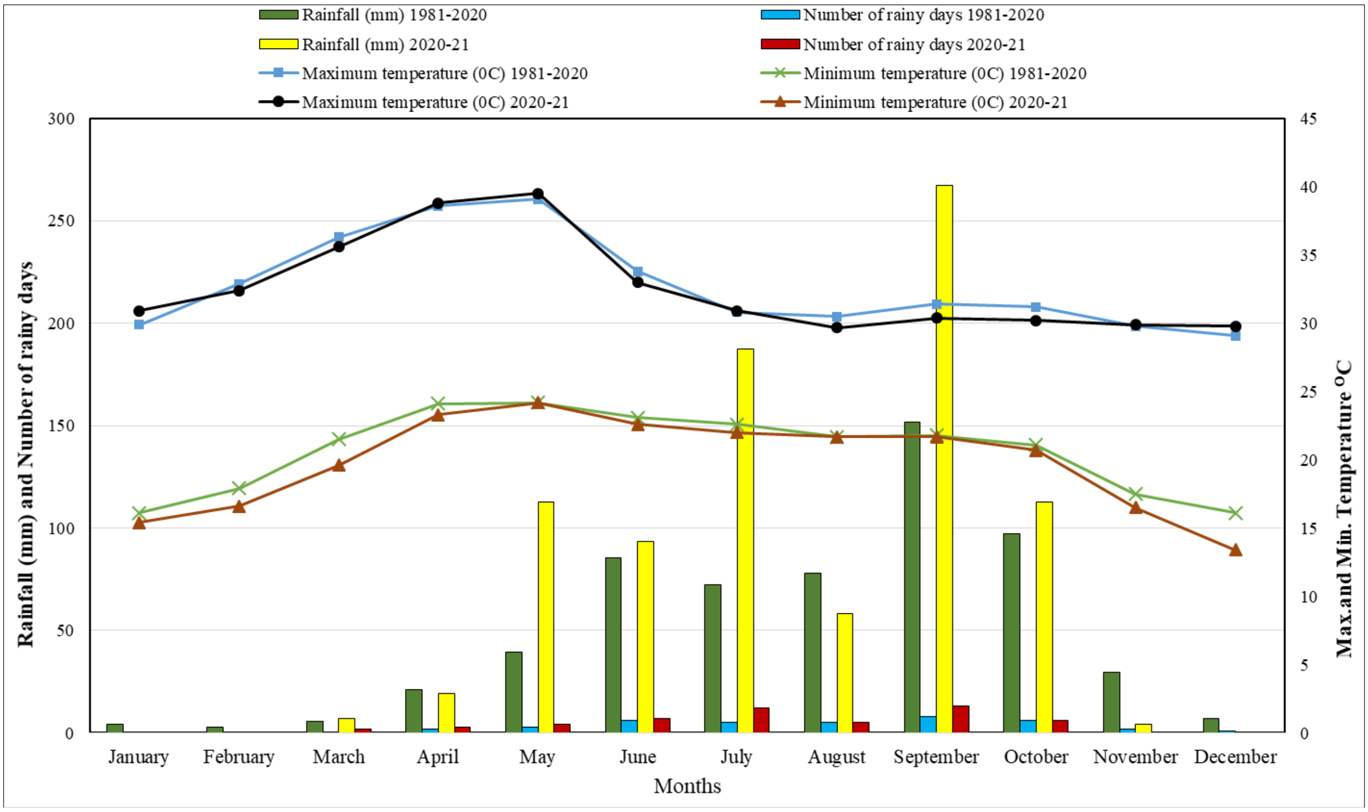

Fig 1: Monthly meteorological data for experimental year (2020-21) against mean monthly meteorological data for 39 years (1981-2020) at RARS, Vijayapura (Karnataka)

The variety SMJ-1 was used after treatment with biofertilizers and dried under the shade. Sowing was done on 20th October with the spacing of 45×15 cm. Inter cultivation was done to remove all weeds from the field in order to check crop weed competition. Observation on growth attributes were taken on 30, 60 DAS and at harvest. Harvesting was done when crop had attained milky dough stage. The sorghum heads from net plot were cut, panicles were exposed for baking in cow dung fire for 5 min. Then the roasted sorghum grains were detached by hand by holding the panicle in both the hands and then rubbing it with palm. The raw and roasted grains were weighed. The stalks were separately weighed after drying which is useful green fodder for cattle. Using the formula recommended by Donald (1962) [5], the economic to biological yield ratio was calculated.

The yield characteristics and yield observations were observed from the net plots and grain yield was reformed to hectare basis in kilograms. The economics of individual treatment was calculated with usual market prices of the corresponding year. The yield was further calculated for gross and net returns as well B: C to calculate the cost-effectiveness. The benefit cost ratio was worked out by dividing the gross returns by the total cost of cultivation of particular treatments. The data collected from the experiment at various growth periods and at harvest were exposed to statistical analysis as suggested by Gomez and Gomez (1984) [6]. The level of significance used for 'F' and't' tests was P=0.05. Critical Difference (CD) values were computed at 5 per cent probability level if the F test was found to be significant.

Results and Discussion

Growth attributes

Plant height and leaf area of *parching* sorghum didn't vary significantly at 30 DAS under different treatments. At 60 DAS and at harvest significantly higher plant height was detected with the application of ghanajeevamrutha based on 100 per cent RDN as basal dose coupled with foliar application of 25 per cent jeevamrutha at 20 & 45 DAS (154.5 cm and 176.5 cm respectively). At 60 DAS and at harvest significantly higher leaf area was observed through the application of ghanajeevamrutha based on 100 per cent RDN as basal dose plus foliar application of 25 per cent jeevamrutha at 20 & 45 DAS (2504.0 cm^2 $plant^{-1}$ and 2358.2 cm^2 $plant^{-1}$ respectively) (Table 1).

This increment might be due to the infusion of ghanajeevamrutha and jeevamrutha which are being rich source of plant growth promoting hormones, which might have supported for better cell elongation and cell division, resulting in enhancement of plant height and leaf area. Also, better growth and development in *parching* sorghum may be because of favorable effects of IAA, GA_3, macro and micronutrients present in them. The results are in accordance with Divya and Mahapatra (2015) [4], in which they stated that better plant growth and yield parameters in aerobic rice are observed when supplied with foliar application of jeevamrutha @ 500 l ha^{-1} at planting, 30 and 60 DAS.

Yield attributes

Raw panicle weight and roasted panicle weight of *parching* sorghum differed significantly with incorporation of ghanajeevamrutha based on 100 per cent RDN as basal dose coupled with foliar application of 25 per cent jeevamrutha at 20 & 45 DAS (88.74 g and 77.79 g respectively). Increase in raw grain yield and roasted grain weight was noticed with infusion of ghanajeevamrutha based on 100 per cent RDN as basal dose plus foliar application of 25 per cent jeevamrutha at 20 & 45 DAS (1063 kg ha^{-1}, 1505 kg ha^{-1}, 5932 kg ha^{-1} and 3318 kg ha^{-1} respectively) over other treatments (Table 2).

This increment in panicle weight and grain yield was mainly due to inclusion of organic manures as well as jeevamrutha as a foliar spray which improved the soil health, so that plants.

Table 1: Plant height and leaf area of *parching* sorghum as influenced by different organic sources

Treatments	Plant height (cm)			Leaf area (cm^2 $plant^{-1}$)		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
T_1: Ghanajeevamrutha based on 100% RDN as basal dose	52.0	129.0	144.7	268.8	1861.9	1497.7
T_2: Vermicompost based on 100% RDN as basal dose	51.7	128.0	143.4	263.3	1846.1	1422.1
T_3: T_1 + foliar application of 10% vermiwash at 20 & 45 DAS	53.8	133.4	153.6	276.2	2138.7	1766.7
T_4: T_1 + foliar application 10% Cow urine at 20 & 45 DAS	54.8	138.4	161.6	312.6	2211.6	1974.5
T_5: T_1 + foliar application 25% jeevamrutha at 20 & 45 DAS	55.8	154.5	176.5	369.0	2504.0	2358.2
T_6: T_2 + foliar application 10% vermiwash at 20 & 45 DAS	53.2	131.5	150.6	274.3	2121.3	1655.5
T_7: T_2 + foliar application 10% Cow urine at 20 & 45 DAS	54.3	136.0	160.6	285.4	2183.9	1887.0
T_8: T_2 + foliar application 25% jeevamrutha at 20 & 45 DAS	55.3	152.4	174.5	342.9	2487.8	2296.4
T_9: Organic RPP of *parching* sorghum	52.9	129.3	144.7	272.0	1991.8	1565.6
SEm±	2.1	4.8	5.1	25.1	83.4	60.9
CD (P=0.05)	NS	14.4	15.2	NS	249.9	182.6

Note: RDN- Recommended dose of Nitrogen, DAS- days after sowing, RPP- Recommended package of practices, NS- Non significant

Table 2: Panicle weight and grain yield of *parching* sorghum as influenced by different organic sources

Treatments	Panicle weight per plant (g)		Grain yield (kg ha^{-1})	
	Raw	Roasted	Raw	Roasted
T_1: Ghanajeevamrutha based on 100% RDN as basal dose	70.34	60.06	819	1220
T_2: Vermicompost based on 100% RDN as basal dose	69.60	58.18	804	1209
T_3: T_1 + foliar application of 10% vermiwash at 20 & 45 DAS	77.27	63.80	907	1314
T_4: T_1 + foliar application 10% cow urine at 20 & 45 DAS	80.53	67.72	936	1359
T_5: T_1 + foliar application 25% jeevamrutha at 20 & 45 DAS	88.74	77.79	1063	1505
T_6: T_2 + foliar application 10% vermiwash at 20 & 45 DAS	75.03	60.99	884	1299
T_7: T_2 + foliar application 10% cow urine at 20 & 45 DAS	79.00	66.89	924	1344
T_8: T_2 + foliar application 25% jeevamrutha at 20 & 45 DAS	87.67	76.30	1045	1485
T_9: Organic RPP of *parching* sorghum	72.40	58.42	853	1266
SEm±	3.45	3.79	42	63
CD (P=0.05)	10.35	11.35	127	188

Note: RDN- Recommended dose of Nitrogen, DAS- days after sowing, RPP- Recommended package of practices

Got benefited with the balanced level of nutrition which led to higher yield. Significant enhancement in the growth and yield parameters of foxtail millet can be seen on application of jeevamrutha + mulching + compost + vermicompost + panchagavya treatment over control as reported by Upendranaik *et al*. (2018) [9] which is in conformity to the similar findings of Kumbar and Devakumar (2014) [10].

Economics

Economic gain is one of the main factors in any technology's success and will not be embraced by the farming community unless it is economically viable. Significantly higher gross returns (1,59,480 Rs. ha^{-1}), net returns (1,22,208 Rs. ha^{-1}) and B:C (4.28) were observed with the incorporation of ghanajeevamrutha based on 100 per cent RDN as basal dose plus foliar application of 25 per cent jeevamrutha at 20 & 45 DAS (Figure 2).

Considerably higher net returns and BC ratio was mainly due to higher gross returns, lower cost and higher nutrient content of ghanajeevamrutha and jeevamrutha which in turn decreased cost of cultivation of *parching* sorghum. The outcomes of current study are in line with the records of Manjunatha *et al.* (2009) [7] and this can also be supported by the studies of Channagouda *et al.* (2015) [2].

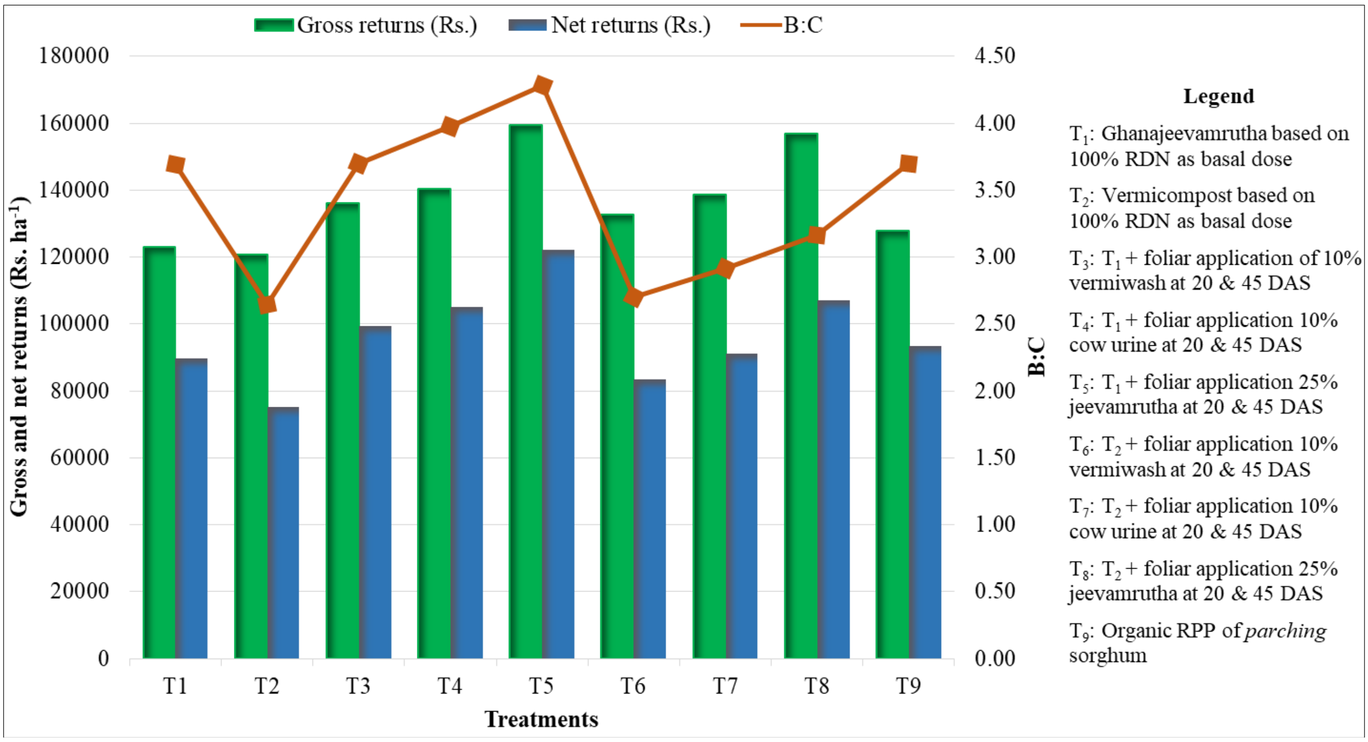

Fig 2: Gross returns, net returns and B: C of parching sorghum as influenced by various organic sources

Conclusion

The incorporation of ghanajeevamrutha (2963 kg ha^{-1}) based on 100 per cent RDN as basal dose coupled with foliar application of 25 per cent jeevamrutha at 20 and 45 DAS recorded significantly higher plant height, leaf area, panicle weight, grain yield of *parching* sorghum (*hurda*), net profit and B:C as compared to other treatments.

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