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Influence of organic and inorganic fertilizer levels on growth and yield of dual purpose K12 sorghum (*Sorghum bicolor*) under irrigated condition

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Abstract
Field experiment was conducted at Agricultural College and Research Institute, Killikulam during *rabi* season (October 2019 - January 2020) to find out the suitable organic manures and level of fertilizers on the growth and yield of dual purpose K12 sorghum (*Sorghum bicolor*) under irrigated condition. The experiment was laid out in split plot design and replicated thrice. The main plot consists of four different organic manures namely FYM @12.5 t ha^{-1}, poultry manure @ 5.0 t ha^{-1}, vermicompost @5.0 t ha^{-1} and composted pressmud @ 3.0 t ha^{-1}. In sub plots 75%, 100%, 125% recommended dose of fertilizers was applied along with absolute control (without fertilizer). Observation on plant growth parameters like plant height and dry matter production was recorded at 30, 60 DAS and at harvest. The grain yield and stover yield was also recorded. The experimental result shows that application of poultry manure @ 5 t ha^{-1} with 125% recommended dose of NPK recorded significantly higher plant height (307.3cm), dry matter production (19635 kg ha^{-1}), grain (4589 kg ha^{-1}) and stover yield (15711 kg ha^{-1}).

Keywords: Dual sorghum, integrated nutrient management, growth and yield

Introduction
Sorghum (*Sorghum bicolor* (L.) Moench) popularly known as "Cholam" in Tamil Nadu which was an important staple food crop in the world. Sorghum stands in fifth rank as important cereal crop next to wheat, rice, maize and barley. Sorghum have higher adaptability and greater biomass production potential (Nirmal *et al.*, 2016) [9] at different climatic conditions and withstand heat so that it is known as the "Camel of crops" and also tolerate water logging better than any other forage crops. Now a day's sorghum is gaining importance and said as "healthy food" due to its high dietary fibre which ranges from 7.6 to 9.2%, 72.6% carbohydrates, 10 to 12% proteins, 1.6% per cent mineral and 1.9 per cent fat. In India, sorghum is grown in an area of about 5.02 million hectares with 4.80 million tonnes of production and 956 kg ha^{-1}of productivity. In Tamil Nadu, total area under sorghum is 3.85 lakh hectares with a production of 4.30 lakh tonnes and productivity of 1117 kg ha^{-1} during 2017-18 (INDIASTAT, 2018). K12 sorghum is newly developed dual purpose variety released from Tamil Nadu Agricultural University to meet out the demand of both grain and fodder with higher quality. Application of organic manures will improved the quality of grain and fodder when it combined with appropriate dose of inorganic fertilizer level. Hence this study was initiated to find out the influence of organic and inorganic fertilizer levels on growth and yield of dual purpose K12 sorghum (*Sorghum bicolor*) under irrigated condition.

Materials and Methods
The field experiment was conducted at Agricultural College and Research Institute, Killikulam, during *rabi* season (2019-2020). The soil was sandy clay loam with pH 7.3, EC 0.27 dSm^{-1} and organic carbon content 5.60 g kg^{-1}. The soil was low in available nitrogen (249.7 kg ha^{-1}), medium in available phosphorus (18.9 kg ha^{-1}) and available potassium (239 kg ha^{-1}). The experiment was laid out in split plot design and replicated thrice. The main plot consist of 4 different organic manures namely FYM @12.5 t ha^{-1}, poultry manure @ 5.0 t ha^{-1}, vermicompost @ 5.0 t ha^{-1}, composted pressmud @ 3.0 t ha^{-1}. In sub plots three levels of RDF *viz*., 75%, 100%, 125% and absolute control (without fertilizer).

The sorghum variety K12 (dual purpose) was chosen for this study. Observation like plant height and dry matter production was recorded at 30, 60 DAS and at harvest. The grain and stover yield were recorded and illustrated.

Result and Discussion

Effect of organic manures and inorganic fertilizer levels on growth parameters

Plant height (cm)

The plant height was greatly influenced by application of organic manures such as FYM, poultry manure, vermicompost and composted pressmud. Among the different organic manures, poultry manure @ 5t ha^{-1} showed the maximum plant height of 136.1, 248.2, and 276.4 cm at 30, 60 DAS and at harvest, respectively. However, it was on par with vermicompost @ 5.0 t ha^{-1}with a height of 128.2, 238.3 and 260.5 cm. The lowest plant height was observed in FYM @12.5 t ha^{-1} *viz*., 106.0, 213.3 and 223.8 cm at 30, 60 DAS and at harvest, respectively.

With regard to inorganic fertilizer levels, application of 125% RDF recorded maximum plant height of 140.4, 258.7 and 279.7 cm at 30, 60 DAS and at harvest, respectively. However, it was on par with 100% RDF and recorded 131.0, 241.9 and 263.0 cm of plant height. Increasing rate of fertility levels could be ascribed to modifying the soil and plant environment which is conducive for better development of both morphological and biochemical components of the growth (Gebreslassie *et al.*, 2016) [4]. Lowest plant height of 90.7, 196.4 and 211.2 cm was recorded in absolute control at 30, 60 DAS and at harvest respectively.

Drymatter production (kg/ha)

Maximum drymatter production was recorded in poultry manure @ 5.0 t ha^{-1} with 2279, 11635 and 17931 kg ha^{-1} at 30, 60 DAS and at harvest, respectively. However, it was on par with vermicompost @ 5.0 t ha^{-1} recorded 2135, 11314 and 17287 kg ha^{-1} of drymatter in the respective stages. Lower influence of organic manure in terms of dry matter production is observed in 12.5 t ha^{-1} FYM. As increase in plant height and drymatter production in poultry manure treated plot is due to the adequate supply of beneficial nutrients at right time of crop need (Nagavani and Subbian 2014) [8] and results in rapid cell division, cell elongation and nodal length of the plant.

Similarly maximum drymatter production of 2345, 12068 and 18666 kg ha^{-1} was observed in 125% RDF at 30, 60 DAS and at harvest, respectively. However, it was on par with 100% RDF and recorded 2216, 11500 and 17775 kg ha^{-1}of drymatter production. The lower dry matter production of 1777, 9021 and 13379 kg ha^{-1} recorded in absolute control at 30, 60 DAS and at harvest, respectively. Increased fertilizer might increase the growth parameters like plant height, LAI and which resulted in increased drymatter production. P and K application could enhance the enzymatic activities and might improve nutrient absorption by extensive root system development and photosynthetic efficiency by the plant. This resulted in higher dry matter production. The result was in accordance with (Kondumahanthi *et al*., 2013) [5].

Different organic manures and fertilizer level practices had substantial interaction effect on growth characters and maximum 307.3 cm plant height and 19635 kg ha^{-1} drymatter production was obtained in poultry manure5.0 t ha^{-1} + 125% of RDF at 30, 60 DAS and at harvest, respectively. The combined application of poultry manure with inorganic nutrients facilitate in more availability of the essential macro and micro nutrients to the plant and overall increase in plant height and drymatter accumulation of the plant.

Effect of organic manures and inorganic fertilizer levels on yield

Grain yield (kg/ha)

Among the organic manures poultry manure @ 5.0 t ha^{-1} recorded the maximum grain yield of 4034 kg ha^{-1} and it was on par with vermicompost application at 5.0 t ha^{-1} recorded 3769 kg ha^{-1} of grain yield. This might be due to increased availability of N, P, K, Ca, and Mg in (Akanbi *et al.*, 2010) [1] poultry manure treated soil and hence the overall yield increased. Lower grain yield of 2971 kg ha^{-1} was recorded in FYM application at 12.5 tha^{-1}. This might be due to nutrient releasing pattern of FYM is slow and further the nutrient content also low when compare to other manures.

With regard to inorganic fertilizer levels, 125% RDF recorded the higher grain yield of 4205 kg ha^{-1} and it was on par with 100% RDF accounting 3790 kg ha^{-1}. This might be due to the grain yield depends on the synthesis and accumulation of photosynthates and their distribution among various plant parts as well as the extent of translocation into sink (grains) and also on plant growth and development during early stages of crop growth which in turn depends on the availability of nutrients. (Bharathi *et al.*, 2020) [1].

Stover yield (kg/ha)

Similarly, maximum stover yield was recorded in poultry manure @ 5.0 t ha^{-1} applied plots recorded 13844 kg ha^{-1} and it was on par with application of vermicompost at 5.0 t ha^{-1} recorded the stover yield of 12990 kg ha^{-1}. This could be due to supply of higher concentration of macro and micro nutrients and it can supply the nutrients in soluble form for a longer period (Sangeetha *et al.*, 2010) [10]. This was in accordance with Lazcano (2011) [6]. Lower stover yield of 11397 kg ha^{-1} was obtained in FYM application @ 12.5 t ha^{-1}.

Application of 125% RDF showed maximum stover yield of 14434 kg ha^{-1} due to high accounting of yield attributes and higher availability of nutrients (Singh *et al.*, 2016) [11] and it was on par with 100% RDF producing stover yield of 13713 kg ha^{-1}. This may be owing to build up of soil fertility that led to increased nutrient availability that induces higher grain as well as fodder yield (Choudhary and Govindasamy 2014) [3]. Lower stover yield of 9136 kg ha^{-1} was recorded at absolute control due to the low availability of nutrients.

Adaptation of different organic manures and fertilizer levels practices had greater combined effect on yield of K12 sorghum. Maximum grain and stover yield (4589 and 15711 kg ha^{-1}) was obtained in poultry manure applied plots @ 5.0 t ha^{-1} along with 125% RDF. The increased grain and stover yield in the above said treatment combination is might be due to reducing the negative effect of solely use of inorganic fertilizer as sources of nutrient and balanced proportion of nutrient availability in appropriate amount cause higher yield. This statement was also in conformity with (Muhammad *et al.*, 2018) [7]. Lowest yield was evidenced in 12.5 tha^{-1} FYM with absolute control recorded 2165 and 8547 kg ha^{-1} grain and stover yield.

Table 1: Effect of organic manures and inorganic fertilizer levels on plant height (cm)

30 DAS						60 DAS						HARVEST					
	S_1	S_2	S_3	S_4	Mean		S_1	S_2	S_3	S_4	Mean		S_1	S_2	S_3	S_4	Mean
M_1	99.8	115.9	124.3	83.9	106.0	M_1	209.3	229.3	239.8	174.6	213.3	M_1	220.1	237.2	251.4	186.3	223.8
M_2	141.5	147.9	156.3	98.7	136.1	M_2	243.6	256.8	275.8	216.5	248.2	M_2	274.6	285.3	307.3	238.2	276.4
M_3	131.2	138.2	149.2	94.2	128.2	M_3	235.9	245.6	264.7	206.8	238.3	M_3	252.9	274.1	293.2	221.6	260.5
M_4	112.9	121.8	131.8	86.1	113.2	M_4	222.9	235.8	254.6	187.6	225.2	M_4	238.8	255.3	266.9	198.5	239.9
Mean	121.4	131.0	140.4	90.7		Mean	227.9	241.9	258.7	196.4		Mean	246.6	263.0	279.7	211.2	
	M	S	M at S	S at M			M	S	M at S	S at M			M	S	M at S	S at M	
SEd	3.8	1.9	5.1	3.9		SEd	7.9	3.7	10.2	7.5		SEd	10.5	4.6	13.1	9.2	
CD (p=0 .05)	9.4	4.1	11.8	8.2		CD (p=0 .05)	19.5	7.7	23.6	15.5		CD (p=0 .05)	25.7	9.4	30.4	18.9	

Table 2: Effect of organic manures and inorganic fertilizer levels on dry matter production (Kg ha^{-1})

30 DAS						60 DAS						HARVEST					
	S_1	S_2	S_3	S_4	Mean		S_1	S_2	S_3	S_4	Mean		S_1	S_2	S_3	S_4	Mean
M_1	1956	2009	2135	1625	1931	M_1	10128	10987	11397	8032	10136	M_1	16056	16682	17687	12158	15646
M_2	2263	2395	2517	1940	2279	M_2	11756	12031	12818	9935	11635	M_2	18097	18987	19635	15005	17931
M_3	2103	2262	2377	1799	2135	M_3	11508	11948	12219	9579	11314	M_3	17789	18397	18981	13980	17287
M_4	2020	2198	2351	1745	2078	M_4	10410	11035	11837	8536	10455	M_4	16284	17035	18361	12687	16092
Mean	2086	2216	2345	1777		Mean	10951	11500	12068	9021		Mean	17006	17775	18666	13379	
	M	S	M at S	S at M			M	S	M at S	S at M			M	S	M at S	S at M	
SEd	68.5	61.9	63.1	56.4		SEd	355.8	344.9	337.8	325.8		SEd	550.2	522.8	517.6	492.9	
CD (p=0 .05)	147.3	133.9	134.6	119.6		CD (p=0 .05)	761.5	738.1	729.7	703.8		CD (p=0 .05)	1182.9	1124.2	1112.7	1059.8	

Table 3: Effect of organic manures and inorganic fertilizer levels on yield (kg ha^{-1})

Grain yield						Stover yield					
	S_1	S_2	S_3	S_4	Mean		S_1	S_2	S_3	S_4	Mean
M_1	3012	3209	3498	2165	2971	M_1	11598	12352	13089	8547	11397
M_2	4159	4328	4589	3058	4034	M_2	14529	15150	15711	9987	13844
M_3	3878	4047	4315	2837	3769	M_3	13454	14441	14778	9287	12990
M_4	3159	3577	3698	2327	3190	M_4	12523	12910	14158	8723	12079
Mean	3552	3790	4025	2597		Mean	13026	13713	14434	9136	
	M	S	M at S	S at M			M	S	M at S	S at M	
SEd	110.5	63.7	156.2	127.4		SEd	399.9	422.1	507.7	479.6	
CD (p=0 .05)	270.6	131.5	352.4	263		CD (p=0 .05)	978.4	907.5	1091.6	989.8	

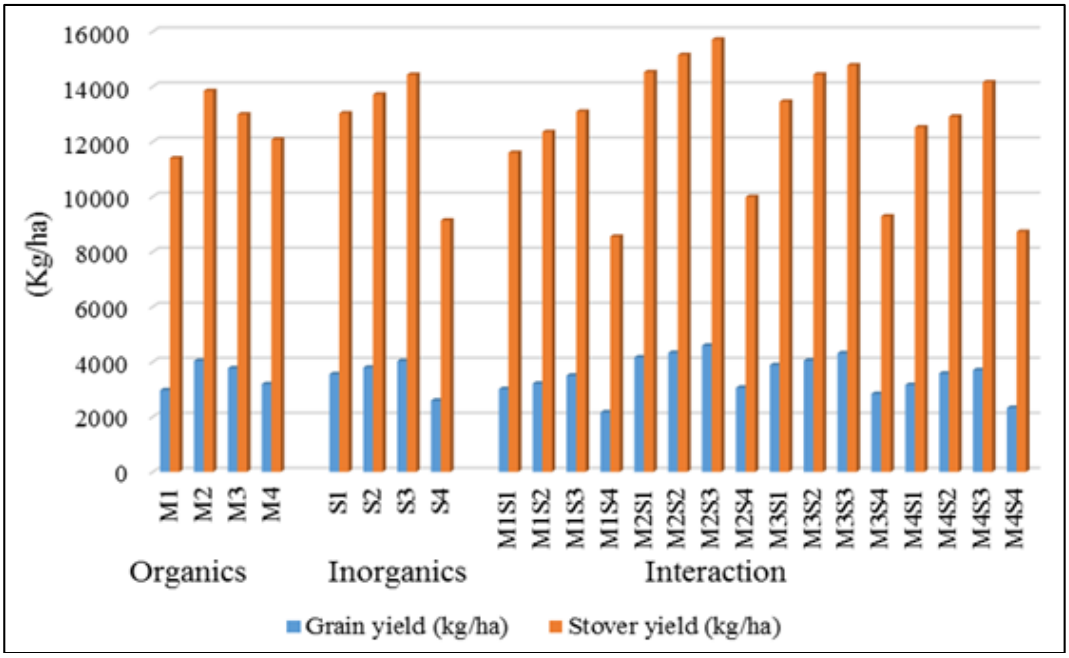

Fig 1: Effect of organic manures and inorganic fertilizer levels on yield of grain and stover yield of K12 Sorghum

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