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# Effect of tillage, seed bed preparation and FYM on yield, physico-chemical properties and economics of sorghum (*Sorghum bicolour* L.)

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**Abstract**
A field experiment was conducted during the *Kharif* season of the year 2017-2018 and 2018- 2019 at College Farm, College of Agriculture, Navsari Agriculture University, Bharuch, Gujarat, to study the effect of tillage, seed bed preparation and FYM on yield and physico-chemical properties of sorghum. Two levels of tillage (Deep tillage with mould board plough and planking with cultivator and shallow tillage with cultivator), three levels of seed bed preparation (raised bed with three rows, raised bed with six rows and flat bed sowing) and two levels of FYM (No FYM, FYM 10 t/ha) were evaluated in split plot design and replicated four times. Deep tillage with mould board plough and planking with cultivator recorded significantly the highest girth of ear head, weight of ear head/plant, grain yield, straw yield, water stable aggregate, infiltration rate available N, $P_2O_5$, $K_2O$, gross returns, net returns and BCR. Raised bed with three rows were recorded significantly higher yield attributes and yield but remained at par with raised bed with six rows. Application of FYM 10 t/ha recorded significantly higher girth of ear head, weight of ear head/plant, grain yield, straw yield, water stable aggregate, infiltration rate, available N, $P_2O_5$, $K_2O$, gross returns, net returns and BCR.

**Keywords:** Sorghum, tillage, seed bed preparation, FYM, yields

## Introduction
Sorghum (*Sorghum bicolor* L. Moench) is an annual self- pollinated crop which belongs to family gramineae. It ranks the fifth most important cereal crops in the world. In India, Sorghum occupies about 5.02 million hectares of area with an annual production of 4.8 million tonnes and productivity of 956 kg/ha during the year 2017-18 (Anon., 2018) [1]. Sorghum is staple food for millions of people in Africa and India. It is widely used for human consumption as well as animal feed. The dry stalks are commonly used as fuel for cooking and fencing or roofing huts. The sorghum grain also used in manufacturing starch, alcohol and glucose. Tillage practices can greatly affect soil water content both at planting and during the growing season. For maximum sorghum production and profit, planned crop rotations and tillage practices are critical for enhancing soil water contents and ensuring successful sorghum production. Tillage techniques are used in order to provide a good seedbed, root development, weed control and manage crop residues, leveling the surface for uniform irrigation and incorporation of fertilizers. Rainfed agriculture (crop and animal husbandry) is now emerging as a major opportunity in raising overall agricultural growth. Rainfed systems are characterised by undulating topography, soil types ranging from shallow red soils to deep black clays, common lands, crop varieties, livestock and rainfall conditions varying from 400 to 1600 mm. Rainfed areas have been facing historical neglect and discrimination in terms of public investments. Rainfed agriculture relies on local knowledge and experience and facilitates extensive systems of production which are mutually dependent. Farm yard manure is the source of primary, secondary and micronutrient to the plant growth. It is a constant source of energy for hetrotropic microorganisms, help in increasing the availability of nutrient and quality of crop produce. Farm yard manure improves the crop production as well as improves soil physical properties and can be used to reduce heavy metal hazards in plants.

## Materials and Methods
A field experiment was conducted at College of Agriculture, Navsari Agricultural University, Bharuch, Gujarat, India during *kharif* season of 2017-18 and 2018-19 to study the effect of tillage, seed bed preparation and FYM on yield, physico-chemical properties and economics of sorghum (*Sorghum bicolour* L.). The experiment was laid out in split plot design with 4 replications. The field is situated about one kilometre away from the narmada river towards East and geographically at 21° 7'' N latitude and 72° 97'' E longitude with altitude of 2.5 metres above mean sea level.

The field experiment consisted of twelve treatments, comprising combinations of two main plot treatment *viz.*, tillage ($A_1$: Shallow tillage with cultivator and $A_2$: Deep tillage with mould board plough and planking with cultivator) and three seed bed preparation [$B_1$: Flat bed sowing, $B_2$: Raised bed with three rows (furrow after three rows) and $B_3$: Raised bed with six rows (furrow after six rows)] and two sub plot treatment *viz.*, application of FYM ($C_1$: No FYM, $C_2$: FYM 10 t/ha). The soil of the experimental field was clayey in texture, low in organic carbon (0.30%), medium in available nitrogen (194 kg/ha) and low in available phosphorus (24.50 kg/ha), while high in available potassium (638 kg/ha).

## Results and discussion

### Effect of Yield and yield attributes

It is evident from the data that girth of ear head, weight of ear head/plant, grain and straw yields of sorghum was significantly influenced by tillage treatments. Use of deep tillage with mould board plough and planking with cultivator ($A_2$) recorded significantly highest girth of ear head (22.69, 23.18 and 22.94 cm, respectively), weight of ear head/plant (74.70, 79.40 and 77.05 g, respectively), grain yield (4907, 4967 and 4937 kg/ha, respectively) and straw yield (12879, 13315 and 13097 kg/ha, respectively) during both the years of experimentation and in pooled analysis. This may be due to the plants got maximum exposure to sunlight which enhanced the photosynthetic activity. It also improved the plant vigour, resulted in producing the wider and bigger ear head Shahid *et al.* (2018) [8] and Bikshu *et al.* (2019) [3].

Girth of ear head, weight of ear head/plant, grain and straw yields of sorghum was affected significantly due to different seed bed preparation practices. Raised bed with three rows ($B_2$) recorded significantly superior values of girth of ear head (22.52, 22.97 and 22.74 cm, respectively), weight of ear head/plant (74.33, 78.97 and 76.65 g, respectively), grain yield (4877, 4938 and 4908 kg/ha, respectively) and straw yield (12860, 13239 and 13050 kg/ha, respectively) remained at par with raised bed with six rows ($B_3$). Moreover, significantly lowest girth of ear head, weight of ear head/plant, grain and straw yields of sorghum was recorded with flat bed sowing ($B_1$) during both the years of study as well as in pooled analysis. The healthy sorghum grains in the deep tillage treatment might be due to more deep rooting system that may uptake more nutrients, mineral and water from the soil and hence improved the grains physical properties. Moreover, the deep plough may be broke down the hardpan of soil which ensured the availability of more nutrients especially nitrogen for the better growth and development of sorghum plant canopy that may store more photosynthates in the form of longer grains, more grains breadth and higher area of the sorghum grains Khan *et al.* (2017) [5].

An appraisal of data in Table 1 revealed that various treatments differed significantly for girth of ear head, weight of ear head/plant, grain and straw yields of sorghum. Application of FYM 10 t/ha ($C_2$) produced significantly highest girth of ear head (22.04, 22.54 and 22.29 cm, respectively) and significantly lowest girth of ear head (20.55, 21.44 and 20.99 cm, respectively) was recorded under no FYM application ($C_1$) during both the years of experimentation and in pooled analysis. The advantage of FYM is quite obvious, as this provide a steady supply of nutrients leading better growth of plants Goyal *et al.* (2018) [4].

### Effect of Physico-chemical properties

The perusal of data on water stable aggregate, infiltration rate, Available N, $P_2O_5$ and $K_2O$ of sorghum exerted significant difference due to tillage treatments. Deep tillage with mould board plough and planking with cultivator ($A_2$) recorded significantly the highest water stable aggregate, infiltration rate, Available N, $P_2O_5$ and $K_2O$. This might be due to loosening of the dense layer by deep tillage would provide a larger soil volume with increase pore space Basir *et al.* (2017) [2].

It is evident from data that the differences observed in water stable aggregate, infiltration rate and Available $P_2O_5$ was found significant, while, seed bed preparation did not show any significant impact on available N and $K_2O$. Raised bed with three rows ($B_2$) recorded significantly higher values of water stable aggregate, infiltration rate and Available $P_2O_5$ as compared to flat bed sowing ($B_1$). Raised bed with three rows ($B_2$) was remained statistically at par with raised bed with six rows ($B_3$) during both the years of study and in pooled analysis. This might be due to better aeration resulted into more microbial activity caused high mineralization of nutrients Salahin *et al.* (2013) [7].

The data presented in Table 2 showed that different FYM treatment significantly influenced the water stable aggregate, infiltration rate, Available N, $P_2O_5$ and $K_2O$. Application of FYM 10 t/ha recorded significantly higher water stable aggregate, infiltration rate, Available N, $P_2O_5$ and $K_2O$ as compared to no FYM application during 2017-18, 2018-19 and in pooled analysis. This might be due to release of organic acid during decomposition of FYM enhance the process of mineralization which in turn increases the availability of nutrients. It is an established fact that organic manures improves the physical, chemical and biological properties of soil and supplies almost all the essential nutrients for growth and development of plants and Meena *et al.* (2017) [6].

### Effect of economics

On the basis of pooled results, the data revealed that the maximum gross realization of Rs. 124934/ha, net realization of Rs. 86096/ha and B:C ratio 3.19 were recorded under deep tillage with mould board plough and planking with cultivator ($A_2$). The magnitude of increase in net realization deep tillage with mould board plough and planking with cultivator ($A_2$) sown sorghum over shallow tillage with cultivator was ($A_1$) Rs. 9046/ha.

Among the seed bed preparation, the highest value of Rs. 124260/ha gross realization, Rs. 96656/ha net realization and B:C ratio of 3.50 were recorded under raised bed with three rows ($B_2$) which was followed by treatment raised bed with three rows ($B_3$) *i.e.*, Rs. 121502/ha gross realization, Rs. 94254/ha net realization. The increase in net realization under raised bed with three rows ($B_2$) over raised bed with six rows ($B_1$) and flat bed sowing ($B_1$) was Rs. 2402/ha and Rs. 11076/ha, respectively.

With respect to FYM treatments, application of FYM 10 t/ha ($C_2$) secured maximum gross realization Rs. 122166/ha, while maximum net realization 89762/ha and B:C ratio 3.34 were observed under no FYM ($C_2$) application.

**Table 1:** Girth of ear head (cm), weight of ear head/plant (g), grain yield (kg/ha) and straw yield (kg/ha) of sorghum as influenced by tillage, seed bed preparation and FYM

| Treatment | | Girth of ear head (cm) | | | Weight of ear head/plant (g) | | | Grain yield (kg/ha) | | | Straw yield (kg/ha) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2017-18 | 2018-19 | Pooled | 2017-18 | 2018-19 | Pooled | 2017-18 | 2018-19 | Pooled | 2017-18 | 2018-19 | Pooled |
| **Main Plot** | | | | | | | | | | | | | |
| ***Tillage*** | | | | | | | | | | | | | |
| $A_1$: | Shallow tillage with cultivator | 19.89 | 20.79 | 20.34 | 69.55 | 74.03 | 71.79 | 4502 | 4533 | 4517 | 11592 | 11955 | 11774 |
| $A_2$: | Deep tillage with mould board plough and planking with cultivator | 22.69 | 23.18 | 22.94 | 74.70 | 79.40 | 77.05 | 4907 | 4967 | 4937 | 12879 | 13315 | 13097 |
| SEm± | | 0.43 | 0.45 | 0.31 | 1.21 | 1.29 | 0.88 | 95 | 97 | 68 | 265 | 284 | 194 |
| CD (P=0.05) | | 1.29 | 1.36 | 0.90 | 3.63 | 3.90 | 2.55 | 285 | 293 | 196 | 799 | 857 | 561 |
| **Seed bed Preparation** | | | | | | | | | | | | | |
| $B_1$: | Flat bed sowing (45 cm) | 19.44 | 20.61 | 20.03 | 68.89 | 73.15 | 71.02 | 4453 | 4482 | 4467 | 11323 | 11808 | 11566 |
| $B_2$: | Raised bed with three rows (furrow after three rows) | 22.52 | 22.97 | 22.74 | 74.33 | 78.97 | 76.65 | 4877 | 4938 | 4908 | 12860 | 13239 | 13050 |
| $B_3$: | Raised bed with six rows (furrow after six rows) | 21.92 | 22.38 | 22.15 | 73.14 | 78.02 | 75.58 | 4782 | 4829 | 4806 | 12523 | 12858 | 12691 |
| SEm± | | 0.52 | 0.55 | 0.38 | 1.48 | 1.59 | 1.08 | 116 | 119 | 83 | 325 | 348 | 238 |
| CD (P=0.05) | | 1.58 | 1.66 | 1.10 | 4.45 | 4.78 | 3.13 | 349 | 358 | 240 | 979 | 1049 | 688 |
| CV (%) | | 9.86 | 10.04 | 9.95 | 8.19 | 8.27 | 8.23 | 9.85 | 10.01 | 9.93 | 10.62 | 11.02 | 10.83 |
| **Sub Plot** | | | | | | | | | | | | | |
| **FYM** | | | | | | | | | | | | | |
| $C_1$: | No FYM | 20.55 | 21.44 | 20.99 | 70.87 | 75.20 | 73.03 | 4603 | 4642 | 4622 | 11886 | 12328 | 12107 |
| $C_2$: | FYM 10 t/ha | 22.04 | 22.54 | 22.29 | 73.37 | 78.23 | 75.80 | 4806 | 4858 | 4832 | 12585 | 12942 | 12763 |
| SEm± | | 0.27 | 0.31 | 0.21 | 0.83 | 0.90 | 0.61 | 63 | 68 | 47 | 178 | 188 | 129 |
| CD (P=0.05) | | 0.80 | 0.93 | 0.59 | 2.47 | 2.67 | 1.76 | 188 | 203 | 134 | 528 | 558 | 371 |
| CV (%) | | 6.21 | 6.99 | 6.63 | 5.66 | 5.73 | 5.70 | 6.60 | 7.05 | 6.83 | 7.11 | 7.29 | 7.20 |
| Interactions | | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

**Table 2:** Available nutrient (N, $P_2O_5$ and $K_2O$) of sorghum as influenced by tillage, seed bed preparation and FYM

| Treatment | | Water stable aggregates (%) | | | Infiltration rate (mm/hr) | | | Available N (kg/ha) | | | Available $P_2O_5$ (kg/ha) | | | Available $K_2O$ (kg/ha) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2017-18 | 2018-19 | Pooled | 2017-18 | 2018-19 | Pooled | 2017-18 | 2018-19 | Pooled | 2017-18 | 2018-19 | Pooled | 2017-18 | 2018-19 | Pooled |
| **Main Plot** | | | | | | | | | | | | | | | | |
| ***Tillage*** | | | | | | | | | | | | | | | | |
| $A_1$: | Shallow tillage with cultivator | 61.37 | 64.15 | 64.15 | 3.96 | 4.11 | 4.03 | 189.31 | 172.59 | 180.95 | 22.21 | 23.98 | 23.09 | 606.53 | 596.55 | 601.54 |
| $A_2$: | Deep tillage with mould board plough and planking with cultivator | 68.09 | 69.71 | 69.71 | 4.49 | 4.78 | 4.64 | 206.52 | 190.59 | 198.55 | 24.19 | 26.05 | 25.12 | 658.26 | 648.19 | 653.23 |
| SEm± | | 1.34 | 1.41 | 0.97 | 0.10 | 0.10 | 0.07 | 4.80 | 4.26 | 3.21 | 0.44 | 0.48 | 0.93 | 13.01 | 12.73 | 9.10 |
| CD (P=0.05) | | 4.03 | 4.24 | 2.80 | 0.29 | 0.32 | 0.20 | 14.48 | 12.84 | 9.27 | 1.32 | 1.44 | 0.32 | 39.21 | 38.36 | 26.28 |
| **Seed bed Preparation** | | | | | | | | | | | | | | | | |
| $B_1$: | Flat bed sowing (45 cm) | 60.66 | 63.13 | 63.13 | 3.88 | 3.99 | 3.94 | 193.17 | 170.34 | 181.76 | 22.02 | 23.77 | 22.90 | 618.23 | 608.14 | 613.19 |
| $B_2$: | Raised bed with three rows (furrow after three rows) | 67.45 | 69.34 | 69.34 | 4.46 | 4.74 | 4.60 | 201.95 | 189.12 | 195.54 | 24.10 | 25.94 | 25.02 | 644.22 | 634.49 | 639.35 |
| $B_3$: | Raised bed with six rows (furrow after six rows) | 66.08 | 68.32 | 68.32 | 4.32 | 4.61 | 4.47 | 198.62 | 185.30 | 191.96 | 23.47 | 25.34 | 24.40 | 634.73 | 624.48 | 629.61 |
| SEm± | | 1.64 | 1.72 | 1.19 | 0.12 | 0.13 | 0.09 | 5.88 | 5.22 | 3.93 | 0.53 | 0.58 | 0.40 | 15.93 | 15.59 | 11.14 |
| CD (P=0.05) | | 4.94 | 5.19 | 3.43 | 0.35 | 0.39 | 0.25 | NS | NS | NS | 1.61 | 1.76 | 1.14 | NS | NS | NS |
| CV (%) | | 10.12 | 10.29 | 10.21 | 11.14 | 11.52 | 11.34 | 11.89 | 11.49 | 11.72 | 9.22 | 9.35 | 9.30 | 10.08 | 10.02 | 10.05 |
| **Sub Plot** | | | | | | | | | | | | | | | | |
| **FYM** | | | | | | | | | | | | | | | | |
| $C_1$: | No FYM | 63.08 | 65.54 | 64.31 | 4.08 | 4.26 | 4.17 | 192.44 | 176.72 | 184.58 | 22.63 | 24.41 | 23.52 | 616.02 | 605.95 | 610.98 |
| $C_2$: | FYM 10 t/ha | 66.38 | 68.32 | 67.35 | 4.36 | 4.63 | 4.50 | 203.39 | 186.46 | 194.92 | 23.76 | 25.62 | 24.69 | 648.77 | 638.79 | 643.78 |
| SEm± | | 0.89 | 0.92 | 0.64 | 0.07 | 0.07 | 0.05 | 3.09 | 2.76 | 2.07 | 0.30 | 0.34 | 0.23 | 9.28 | 8.94 | 6.44 |
| CD (P=0.05) | | 2.65 | 2.73 | 1.84 | 0.19 | 0.22 | 0.14 | 9.18 | 8.19 | 5.94 | 0.89 | 1.01 | 0.65 | 27.58 | 26.55 | 18.48 |
| CV (%) | | 6.76 | 6.71 | 6.74 | 7.59 | 8.18 | 7.91 | 7.65 | 7.43 | 7.56 | 6.33 | 6.67 | 6.52 | 7.19 | 7.03 | 7.11 |
| Interactions | | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

**Table 3:** Economics of sorghum as influenced by tillage, seed bed preparation and FYM

| Treatment | | Gross realization (Rs./ha) | Net realization (Rs./ha) | BCR |
|---|---|---|---|---|
| **Main Plot** | | | | |
| ***Tillage*** | | | | |
| $A_1$: | Shallow tillage with cultivator | 113888 | 86096 | 3.10 |
| $A_2$: | Deep tillage with mould board plough and planking with cultivator | 124934 | 95142 | 3.19 |

| | | | | |
|---|---|---|---|---|
| **Seed bed Preparation** | | | | |
| $B_1$: | Flat bed sowing (45 cm) | 112472 | 85580 | 3.18 |
| $B_2$: | Raised bed with three rows (furrow after three rows) | 124260 | 96656 | 3.50 |
| $B_3$: | Raised bed with six rows (furrow after six rows) | 121502 | 94254 | 3.46 |
| **Sub Plot** | | | | |
| **FYM** | | | | |
| $C_1$: | No FYM | 116654 | 89762 | 3.34 |
| $C_2$: | FYM 10 t/ha | 122166 | 85274 | 2.31 |

## Conclusion

Based on the findings of two years experimental results, it can be concluded that for achieving higher yield and net return of sorghum crop, land should be prepared by deep tillage with mould board plough followed by planking with cultivator. Further, sowing should be done on raised bed with six rows (furrow after six rows) and be nourished with FYM 10 t/ha (considering common application of RDF 80+40+00 kg $N+P_2O_5+K_2O$/ha).

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