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# GROWTH, YIELD AND ECONOMICS OF SORGHUM [*SORGHUM BICOLOR* (L.) MOENCH] AFFECTED BY TILLAGE AND INTEGRATED NUTRIENT MANAGEMENT

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## SUMMARY

A field experiment was conducted at Instructional Farm, Rajasthan College of Agriculture, Udaipur (Rajasthan) to study the effect of tillage and integrated nutrient management on sorghum productivity during *kharif* season of 2009. Results, showed that conventional tillage recorded significantly higher plant height, dry matter accumulation, yield attributing character, yield, gross, net return and B.C. ratio over minimum tillage. Among the INM treatments RDF recorded significantly higher plant height at 25 DAS, dry matter accumulation at all stage of crop growth, yield attributing character, yield, gross, net return and BC ratio of crop over rest of the treatment. When RDF was applied with conventional tillage, it was found significantly superior over reduced tillage and minimum tillage in terms of grain yield.

**Keywords :** Sorghum, INM, tillage, yield and dry matter accumulation

Sorghum is the fourth most important cereal crops of India, next to rice, wheat and maize. Sorghum is important food and fodder crop in *kharif* season in the states of Maharashtra, Karnataka, Rajasthan and Andhra Pradesh. Because of its relative drought tolerance, it is the crop par excellence for dry regions and areas with uncertain and scanty rainfall. 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 (Srivastava *et al*., 2006). Different tillage practices may influence the growth and yield of grain sorghum. Tillage practices are critical components of soil management systems (Mosaddeghi *et al*., 2009). Inappropriate tillage practices could inhibit crop growth and yield. The selection of an appropriate tillage practice for the production of crops is very important for optimum growth and yield. Chemical fertilizer, herbicide and pesticide used in agriculture for increasing yield and controlling weeds and pests can contaminate the water, air and food, decrease soil fertility, inhibit growth of soil microorganisms and hazard human health (Erisman *et al.*, 2001). In addition, chemicals may destroy many species of plants, insects, fishes and soil microorganisms. The integrated nutrient management, helps to restore and sustain fertility and crop productivity. It may also help to check the emerging deficiency of nutrients other than N, P and K. Further, it brings economy and efficiency in fertilizers. The integrated nutrient management favorably affects the physical, chemical and biological environment of soils. Thus integrated use of chemical fertilizers along with other organic sources of nutrients (Roy, 1992) and biofertilizers can help in maintaining yield levels in most of the crops under different agro-ecological regions.

## MATERIALS AND METHODS

A field investigation was carried out during the **kharif** 2009 at the Instructional Farm, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur. The soil of experimental site was clay loam in texture, slightly alkaline (pH 7.9) in reaction, organic carbon (0.32%), medium with respect

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to available nitrogen (276.00 kg/ha), available phosphorus (32.00 kgha) and high in available potassium (459.00 kg/ha). The experiment consisted of three tillage practices (Conventional tillage, Reduced tillage and Minimum tillage) assigned in main plot and four INM practices RDF (80 kg N+40 kg $P_20_5$+40 kg $K_20$/ha) through inorganic fertilizer, 75% RDF through inorganic fertilizer+5 t FYM/ha, 50% RDF through inorganic fertilizer+2.5 t FYM/ha+*Azotobacter*+PSB, control (Native fertility) in subplot treatments were tested in a split plot design having four replications. Sorghum genotype CSH-16 was sown on 4$^{th}$ July 2009 keeping row to row distance 45 cm with recommended seed rate (10 kg/ha). The numbers of rows were 8 in gross plot of 3.6 m x 5 m size. FYM was applied as per treatment about a week before sowing. Fertilizer were applied at the time of sowing through urea, DAP and MOP as a basal application. Biofertilizer was applied as a seed treatment at the sowing time. Crop was harvested at 102 DAS on 12$^{th}$ October 2009.

## RESULTS AND DISCUSSION

### Tillage Practices

Conventional tillage recorded significantly higher plant height at 25 and 50 DAS (Table 1). The dry matter accumulation at 25, 50, 75 DAS and at harvest, earhead length, weight of earhead, grain weight/earhead, 1000-grain weight, grain fodder and biological yield, gross, net return and BC ratio were significantly higher under conventional tillage (Table 1&2). While this treatment was found statistically at par with reduced tillage in 1000 grain weight, grain, fodder, biological yields, gross, net returns and B:C ratio. The percent increases in grain, straw and biological yield with conventional tillage to the tune of 18.46, 6.11 and 18.20 per cent, respectively was observed over minimum tillage. Treatment conventional tillage recorded maximum gross return (Rs.37564/ha), net return (Rs. 21271 ha$^{-1}$) and B:C ratio (1.30). The probable reason could be the favorable integrated effect of soil physical environment that enhanced root growth for greater uptake of water and nutrients, thereby, maintaining high plant water status. Adequate availability of water to plants resulted in cell turgidity and eventually higher meristematic activity, leading more foliage development, greater photosynthetic rate and consequently better plant growth (Singh *et al*., 1997). Besides water and nutrient uptake, roots can markedly influence the activities of shoot and yield attributes in crop (Sharma and Acharya, 1994). The beneficial effects of tillage have also been obtained by Painuli *et al*. (2000) who reported that soil tillage significantly increased the yield in high textured soil by decreasing the percolation losses of nutrient and improving moisture storage in the soil.

### Integrated Nutrient Management

Recommended dose of fertilizer significantly

TABLE 1

Effect of tillage and integrated nutrient management on plant height and dry matter accumulation by sorghum at 25, 50, 75 DAS and harvest (g/plant)

| Treatment | Plant height (cm) | | Dry matter accumulation (g/plant) | | | |
|---|---|---|---|---|---|---|
| | 25 DAS | At harvest | 25 DAS | 50 DAS | 75 DAS | At harvest |
| **Tillage practices** | | | | | | |
| Conventional | 27.70 | 212.61 | 3.71 | 36.32 | 183.98 | 193.12 |
| Reduced | 26.05 | 201.17 | 3.46 | 33.41 | 173.01 | 183.17 |
| Minimum | 25.45 | 196.08 | 3.37 | 32.60 | 167.69 | 175.57 |
| S. Em± | 0.497 | 3.247 | 0.075 | 0.611 | 2.789 | 2.889 |
| C. D. (P=0.05) | 1.721 | 11.236 | 0.261 | 2.116 | 9.652 | 9.998 |
| **Nutrient management** | | | | | | |
| RDF | 28.35 | 213.67 | 3.81 | 36.95 | 185.21 | 206.45 |
| 75% RDF+5 t FYM/ha | 26.32 | 208.49 | 3.50 | 34.10 | 175.90 | 189.28 |
| 50% RDF+2.5 t FYM/ha+*Azotobacter*+PSB | 26.22 | 207.74 | 3.48 | 33.47 | 172.71 | 188.39 |
| Control | 24.71 | 183.24 | 3.26 | 31.91 | 165.89 | 151.67 |
| S. Em± | 0.561 | 1.952 | 0.085 | 0.811 | 2.725 | 2.445 |
| C. D. (P=0.05) | 1.628 | 5.663 | 0.248 | 2.352 | 7.907 | 7.096 |

RDF = 80 kg N+40 kg $P_2O_5$+40 kg $K_2O$/ha.

TABLE 2

Effect of tillage and integrated nutrient management on yield attributes, yield, gross, net return and B : C ratio of sorghum

| Treatment | Ear head length (cm) | Weight/ earhead (g) | Grain weight/ earhead (g) | 1000-grain weight (g) | Yield (kg/ha) | | | Gross returns (Rs/ha) | Net returns (Rs/ha) | B : C ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Grain | Fodder | Biological | | | |
| **Tillage practices** | | | | | | | | | | |
| Conventional | 28.61 | 126.56 | 104.44 | 30.30 | 3650 | 9545 | 13195 | 37564 | 21271 | 1.30 |
| Reduced | 26.09 | 121.81 | 98.63 | 29.76 | 3464 | 8994 | 12458 | 35556 | 19762 | 1.24 |
| Minimum | 25.46 | 116.75 | 89.89 | 28.51 | 3081 | 8085 | 11167 | 31752 | 16454 | 1.07 |
| S. Em± | 0.538 | 1.291 | 2.009 | 0.201 | 76.90 | 206.90 | 251.90 | 691.00 | 691.72 | 0.043 |
| C. D. (P=0.05) | 1.860 | 4.469 | 6.953 | 0.697 | 266.10 | 715.96 | 871.50 | 2393.00 | 2393.00 | 0.150 |
| **Nutrient management** | | | | | | | | | | |
| RDF | 29.03 | 137.83 | 113.33 | 31.61 | 3910 | 9778 | 13688 | 39593 | 23358 | 1.44 |
| 75% RDF+5 t FYM/ha | 26.68 | 127.00 | 102.70 | 30.27 | 3663 | 9129 | 12793 | 37051 | 20364 | 1.22 |
| 50% RDF+2.5 t FYM/ha+ *Azotobacter*+PSB | 26.19 | 127.58 | 99.40 | 29.84 | 3462 | 9160 | 12622 | 35785 | 19913 | 1.25 |
| Control | 24.98 | 94.42 | 75.17 | 26.38 | 2558 | 7431 | 9988 | 27398 | 13022 | 0.90 |
| S. Em± | 0.610 | 1.941 | 1.657 | 0.366 | 71.09 | 173.17 | 199.90 | 568.00 | 568.00 | 0.036 |
| C. D. (P=0.05) | 1.770 | 5.632 | 4.808 | 1.061 | 206.29 | 502.51 | 580.10 | 1649.00 | 1649.00 | 0.104 |

RDF = 80 kg N + 40 kg $P_2O_5$+40 kg $K_2O$/ha

influenced all the parameters except plant height and dry matter accumulation at harvest over rest of the treatment. Application of 75% RDF + 5 t FYM $ha^{-1}$ and 50% RDF+2.5 t FYM/ha+*Azotobacter*+PSB were statistically at par in all characters but all the nutrient management treatments were significantly superior over control. RDF significantly recorded 52.91, 31.60, 37.04 and 79.37 percent higher grain, straw, biological yield and net returns over control respectively. Application of RDF recorded significantly higher benefit / cost ratio (1.44) over rest of the treatments. It is well emphasized that increasing rates of fertilizer, markedly improved over all growth of the crop in terms of dry matter production per plant by virtue of its impact on morphological and photosynthetic components along with accumulation of nutrients. This suggests greater availability of nutrients and metabolites for growth and development of reproductive structure, which ultimately led to realization of higher productivity of individual plants. One of the other probable reasons could be ascribed to earlier flowering, which might have provided greater duration for reproductive growth. The increased availability of nutrients and photosynthates might have enhanced number of flowers and their fertilization resulting in higher number of grains per panicle. Further, in most of cereals, greater assimilating surface at reproductive development results in better grain formation because of adequate production of metabolites and their translocation towards grain as evident from improvement in nutrient concentration and their uptake. This might have resulted in increased weight of individual grain expressed in terms of test weight. Since the grain weight per panicle depends on number of grains per panicle and weight of individual grain, the significant improvement in grain weight per panicle under fertility levels could be ascribed to improvement in both these parameters. Observed improvement in various yield attributing characters, yield and monetary returns due to N and P fertilization is in close conformity with the findings of Das *et al.* (2000), Dixit *et al.* (2005), Singh and Sumeriya (2006) and Sumeriya *et al.* (2007).

### Interaction Effect

Data further showed that when RDF was applied, conventional tillage was found significantly superior over reduced tillage and minimum tillage in terms of grain yield, while under 50% RDF + 2.5 t FYM + *Azotobacter* + PSB, conventional tillage was found at par with reduced tillage but both these were superior over minimum tillage (Table 3). When 75% RDF + 5 t FYM was applied or no fertilizer was applied, all these three tillage practices were found at par within treatment. A critical examination of data shows that combination of RDF and conventional tillage remained significantly superior over all other combinations, when judged in

TABLE 3
Interaction effect of tillage and INM on grain yield (kg/ha)

| Treatments | CT | RT | M T |
|---|---|---|---|
| RDF | 4398 | 3781 | 3551 |
| 75% RDF+5 t FYM/ha | 3857 | 3703 | 3430 |
| 50% RDF+2.5 t FYM/ha+*Azotobacter*+PSB | 3710 | 3716 | 2960 |
| Control | 2634 | 2655 | 2384 |
| | S. Em± | C. D. (P=0.05) | |
| For INM at same level of tillage | 174 | 357 | |
| For tillage at same or different level of INM | 197 | 451 | |

terms of grain yield. The results of present investigation are in close conformity with the findings of Reddy *et al*. (1999) and Sarma *et al*. (2007).

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