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RESEARCH ARTICLE

# Influence of integrated nutrient management and split application of nitrogen on productivity, uptake of *Kharif* sorghum and soil fertility status

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## SUMMARY

A field experiment was conducted during *Kharif* season of 2002-2007 at the farm of Sorghum Research Unit Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to find out the effect of integrated fertilizer management and number of splits on productivity, nutrient uptake of sorghum and soil fertility status under rainfed condition. The significantly highest grain yield (31.25 q $ha^{-1}$)and fodder yield(79.12q/ha) of sorghum(Pooled mean) was obtained with application of 75%RDF (60:30:30 kg NPK $ha^{-1}$) FYM @ 5 t $ha^{-1}$and use of *Azospirllum* and PSB and the 60 kg nitrogen through urea($T_4$) was applied in three split doses *viz.*, 20 N at 10 DAS, 20 kg N at 30 DAS and 20 kg N at 45 DAS. This treatment also increased total uptake of N (92.11 kg/ha), P (22.85 kg/ha) and K (106.50 kg/ha). This treatment also improved soil fertility status with the increased OC (6.33g/kg), available N(283/ha), available $P_2O_5$ (25.00kg/ha) and $K_2O$ (424 kg/ha), sustained soil ph (7.56) and EC (0.23 $dSm^{-1}$) and bulk density (1.28$cm^3$) over all other treatments. Continues use of organic manure along with 75 per cent dose of fertilizer in combination with seed inoculants and application of N in three splits was beneficial in enhancing crop productivity and soil fertility. The, INM with organic manure, inoculants and chemical fertilizer and use of N fertilizer in the splits not only improved the productivity but also sustained the soil fertility.

**Key Words :** Integrated nutrient management, Number of splits,Yield, Uptake, Soil properties

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Sorghum (*Sorghum bicolor* L.) is the third most important cereal crop after rice and wheat in India. Sorghum is staple diet and nutritious source of vitamins,minerals and protein,while sorghum store is a valuable livestock feed. It is well known that hybrid varieties of sorghum are heavy feeders and respond to application of fertilizers. In modern agriculture biofertilizers have attained considerable significance due to their positive role in maintaining productivity and fertility. *Rhizobium, Azotobacter* and *Azospirllum* substitutes 19,22 and 20 kg N respectively (Tandon,1992). Application of only chemical fertilizers for sorghum in two splits is common practice of farmers. But if the nutrient requirement of the crop is not managed properly, then we may face the problem of decline in productivity and soil fertility status. In intensified cropping system, which has high turnover of nutrients, poor recycling of organic sources and application of high analysis fertilizers caused deficiency of several micronutrients in soil and also leads to environmental pollution(Kumar, 2008).

Hence, judicious nutrient management planning is the need of hour. The information on effect of nutrients with integrated nutrient management including application of nitrogen fertilizer in three splits is scanty. Thus, ensuring of

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**Table A : Treatment details**

| Treatments | Nutrient applied kg $ha^{-1}$ $N:P_2O_5:K_2O$ | Method of fertilizer application | | | |
|---|---|---|---|---|---|
| | | Basal | Split application of N | | |
| | | | 10 DAS | 30 DAS | 45 DAS |
| $T_1$ | Control | 40 kg N,40 kg $P_2O_5$ and 40 kg $K_2O$ | - | 40 kg N | - |
| $T_2$ | | FYM, 30 kg $P_2O_5$ and 30 kg $K_2O$ | 20 kg N | 40 kg N | - |
| $T_3$ | 75% RDF +FYM 5 t $ha^{-1}$+ *Azospirillum*+PSB@ 250g each per 10 kg seed | FYM, 30 kg $P_2O_5$ and 30 kg $K_2O$ | 20 kg N | - | 40 kg N |
| $T_4$ | 75%RDF +FYM 5 t $ha^{-1}$+ *Azospirillum*+PSB @ 250 g each per 10 kg seed | FYM, 30 kg $P_2O_5$ and 30 kg $K_2O$ | 20 kg N | 20 kg N | 20 kg N |
| $T_5$ | 50%RDF +FYM 5 t $ha^{-1}$+ *Azospirillum*+PSB @ 250 g each per 10 kg seed | FYM, 20kg $P_2O_5$ and 20 kg $K_2O$ | 13 kg N | 27 kg N | - |
| $T_6$ | 50%RDF +FYM 5 t $ha^{-1}$+ *Azospirillum*+PSB @ 250 g each per 10 kg seed | FYM, 20 kg $P_2O_5$ and 20 kg $K_2O$ | 13 kg N | - | 27 kg N |
| $T_7$ | 50% RDF +FYM 5 t $ha^{-1}$+*Azospirillum*+PSB @ 250 g each per 10 kg seed | FYM, 20 kg $P_2O_5$ and 20 kg $K_2O$ | 13 kg N | 13 Kg N | 14 kg N |

adequate availability of N, P and K through fertilizers at critical stages of crop growth is prerequisite for increasing the crop yield. Utilization of nutrients by sorghum crop at various growth stages may commensurate with the plant need and prove efficient in increasing the crop productivity (Solankey *et al.*,1990).

Hence, an attempt was made to study the best time of application for N, P and K in integration with FYM and biofertilizer for increase in the yield and changes in soil property.

## MATERIAL AND METHODS

The present field experiment was conducted at Sorghum Research Unit Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Kharif* season of 2002-2007.The experiment was laid out with Randomized Block Design having three replications comprising of seven treatments (Table A) under rainfed condition in vertisol. Net plot size was 2.7 x 4 m. The recommended dose of fertilizer of sorghum was 80:40:40 kg $N:P_2O_5:K_2O$.The requisite quantities of N though urea, phosphors through super phosphate and potassium through muriate of potash were applied. As per treatment details FYM @ 5 t $ha^{-1}$ was applied uniformly before 15 days of sowing. Basal application was done by placing the fertilizers in furrow before sowing the seed, while in standing crop it was placed in the side inter row space. Before sowing seed were treated with *Azospirillum* and PSB @ 250 g per 10 kg seed. The seed sorghum CSH- 14(12 kg ha-1) were sown at 45 x 10 cm spacing. The soil of the experimental field was clay texture (47.4% clay), pH 7.61, EC 0.30 $dSm^{-1}$, high in $CaCo_3$ 87.3% low in available nitrogen 188 kg $ha^{-1}$ , phosphorus 17.9 kg $ha^{-1}$ and high in available potassium 371.2 kg $ha^{-1}$, low in organic carbon 4.2 g $kg^{-1}$. Bulk density 1.32 g/$cm^3$ moisture at field capacity was 38.00 per cent.

## RESULTS AND DISCUSSION

The results of the present study as well as relevant discussions have been presented under following sub heads:

**Grain and fodder yield :**

The data pertaining to grain and fodder yield of sorghum have been presented in Table 1 (pooled of five years)showed that the highest grain yield (31.25 q/ha) and fodder yield (79.12 q/ha) was recorded in treatment $T_4$ and it was at par with treatment $T_2$ . The effect of studied yield attributing characters are ultimately manifested in the increased yield of sorghum grain and fodder. This might be happened as the uptake and utilization of nutrients by sorghum crop at various growth stages commensurate with the plant need and prove efficient in increasing the crop productivity (Solankey *et al.*,1990). Similar trend of results have reported earlier (Patil *et al.*,1978 and Pawar *et al.*,1996).

**Nutrient uptake :**

The uptake of all the nutrient obtained highest in treatment $T_4$ and found significantly superior over all the treatment (Table 2). Similar trend was reported earlier (Solankey *et al.*, 1990).

**Fertility status of soil :**

The Soil pH, EC ($dSm^{-1}$) and bulk density was lowest with $T_4$, however organic carbon (g/kg), available nitrogen (kg/ha), phosphorus (kg/ha) and potassium (kg/ha) were highest with $T_4$. Decrease in pH may be attributed to balance use of fertilizers with FYM and seed inoculants, which released organic acids during decomposition of manures resulting in decline in soil pH. There was slight increase in soil pH, EC ($dSm^{-1}$) and bulk density with application of recommended dose of fertilizers only. This may be attributed to continuous use of inorganic fertilizers alone.

**Organic carbon :**

The treatment $T_4$ recorded highest organic matter than other treatments. There was slight decline in organic matter in control treatment only. The increase in organic matter can be attributed to higher contribution of biomass to soil in the form of better root growth, crop stubbles biomass and residues (Ghathala *et al.*, 2007).

The treatment $T_4$ showed higher increased amount of

**Table 1 : Grain and fodder yield(q/ha), uptake of NPK in grain and fodder and total N, P and K uptake(kg/ha)of *Kharif* sorghum as influenced by different treatment (Pooled means)**

| Treatments | Grain yield (q/ha) | Fodder yield (q/ha) | Uptake grain | | | Uptake by fodder | | | Total uptake | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | N | P | K | N | P | K | N | P | K |
| $T_1$ | 26.76 | 71.39 | 39.35 | 9.29 | 10.80 | 37.49 | 10.65 | 83.99 | 76.84 | 19.94 | 94.81 |
| $T_2$ | 29.89 | 76.73 | 44.04 | 10.43 | 12.02 | 38.62 | 11.24 | 89.41 | 82.66 | 21.67 | 101.44 |
| $T_3$ | 27.50 | 72.71 | 38.99 | 9.61 | 10.97 | 37.01 | 10.42 | 85.10 | 76.01 | 20.03 | 96.07 |
| $T_4$ | 31.25 | 79.12 | 48.00 | 11.37 | 13.10 | 44.11 | 11.48 | 93.39 | 92.11 | 22.85 | 106.50 |
| $T_5$ | 24.15 | 64.22 | 32.32 | 7.62 | 8.89 | 28.91 | 8.46 | 73.62 | 61.24 | 16.09 | 82.52 |
| $T_6$ | 22.48 | 63.09 | 29.12 | 6.87 | 8.09 | 26.29 | 7.96 | 69.21 | 55.41 | 14.83 | 77.30 |
| $T_7$ | 21.92 | 60.01 | 28.22 | 6.27 | 7.51 | 25.62 | 7.32 | 66.67 | 53.84 | 13.59 | 74.18 |
| S.E.± | 0.59 | 1.17 | 1.812 | 0.175 | 0.282 | 0.944 | 0.337 | 2.448 | 2.35 | 0.42 | 3.05 |
| C.D. | 1.81 | 3.61 | 5.577 | 0.539 | 0.868 | 2.908 | 1.038 | 7.543 | 7.25 | 1.31 | 9.40 |

**Table 2: Fertility status of soil as influenced by various treatments after five years**

| Treatments | pH | EC ($dSm^{-1}$) | Org.C (g/kg) | B:D ($cm^{-3}$) | Avail. (N kg/ha) | Avail. ($P_2O_5$ kg/ha) | Avail. ($K_2O$ kg/ha) |
|---|---|---|---|---|---|---|---|
| $T_1$ | 7.63 | 0.33 | 4.13 | 1.35 | 185 | 18.33 | 373 |
| $T_2$ | 7.57 | 0.26 | 6.00 | 1.29 | 268 | 24.10 | 416 |
| $T_3$ | 7.58 | 0.27 | 5.90 | 1.30 | 264 | 23.00 | 408 |
| $T_4$ | 7.56 | 0.23 | 6.33 | 1.28 | 283 | 25.00 | 424 |
| $T_5$ | 7.60 | 0.29 | 5.73 | 1.30 | 256 | 20.80 | 422 |
| $T_6$ | 7.60 | 0.28 | 5.80 | 1.30 | 259 | 20.90 | 420 |
| $T_7$ | 7.59 | 0.28 | 5.70 | 1.31 | 255 | 21.20 | 421 |
| Initial value | 7.61 | 0.30 | 4.2 | 1.32 | 188 | 17.9 | 371.2 |

available N (283kg\ha) than other treatments and as compared to initial (188 kg\ha). Such increase in available nitrogen is due to mineralization of FYM and continuous supply of N in 3 splits. Singh *et al*.(2009) observed that available nitrogen content in soil increased with the use of recommended dose of fertilizer(RDF) in combination with organic manure.

**Available phosphorus :**

The higher built up of phosphorus was observed under the treatment $T_4$ (25.00kg) in comparison to control (18.33kg). Microbiological means acts on insoluble P compounds through production of organic and inorganic acids, accompanied by acidification of the medium which enhanced the availability of P to the plant (Mahdi *et al*., 2010).

**Available potassium :**

The treatment $T_4$ (424 kg ha)recorded highest available potassium. Application of OM may have caused reduction reaction in the potassium fixation and consequently increased potassium content due to interaction of organic manure with clay besides the direct addition to the available K pools of soils (Prasad and Mathur, 1997)

Thus, from the five years (2002-2007) of experimentation it can be concluded, that highest grain and fodder yield with additional benefit of improvement in soil fertility status in respect of organic carbon (%) and available NPK (kg/ha) was obtained with the application of FYM @ 5 t/ha + seed treatment of *Azospirillum* and PSB @ 250 g per 10 kg seed + 60:30:30 kg NPK/ha with 3 split of N doses (20 kg N/ha each) at 10, 30, 45 DAS for *Kharif* hybrid sorghum.

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