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# EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON YIELD, PROTEIN CONTENT, NUTRIENT CONTENT AND UPTAKE OF SORGHUM [*SORGHUM BICOLOR* (L.) MOENCH]

Research Article

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**ABSTRACT**

**A field experiment was conducted at Instructional Farm, Rajasthan College of Agriculture, Udaipur (Rajasthan) to study the effect of integrated nutrient management on sorghum productivity during *kharif* season of 2009. Results showed that recommended dose of fertilizer recorded higher NPK uptake and content in grain and stover of sorghum. Significantly higher protein content, protein yield, grain, stover, biological yield and harvest index was 11.06%, 431.86,kg ha$^{-1}$, 3910 kg ha$^{-1}$, 9778 kg ha$^{-1}$, 13688 kg ha$^{-1}$ and 28.56 % respectively under recommended dose fertilizer than other treatment combination.**

## Introduction

Sorghum is the fourth most important cereal crops of India, next to rice, wheat and maize. Sorghum grown on 5 m ha is important food and fodder crop in post rainy 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. Integrated use of all potential sources of plant nutrients seems to be the only option to maintain soil fertility and crop productivity. Long-term studies on various crops indicated that the balanced use of NPK fertilizer could not maintain the higher yields over years because of emergence of secondary and micronutrient deficiencies and deterioration of soil physical properties. The integrated use of organic materials and inorganic nitrogenous fertilizers has received considerable attention in the past with a hope of meeting the farmer's economic need as well as maintaining favourable ecological conditions on long-term basis (Kumar *et al.*, 2007). 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, having slightly alkaline (pH 7.9) in reaction, organic carbon (0.32 %), medium with respect to available nitrogen (276.00 kg $ha^{-1}$), available phosphorus (32.00 kg $ha^{-1}$) and high in available potassium (459.00 kg $ha^{-1}$). The experiment consisted of three tillage practices (Conventional tillage, Reduced tillage, Minimum tillage) assigned in main plot and four INM practices RDF (80 kg N+ 40 kg $P_20_5$+ 40 kg $K_20$ $ha^{-1}$) through inorganic fertilizer, 75% RDF through inorganic fertilizer + 5 t FYM $ha^{-1}$, 50% RDF through inorganic fertilizer + 2.5 tones FYM $ha^{-1}$ + *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 4th July 2009 keeping row to row distance 45 cm with recommended seed rate (10 kg $ha^{-1}$). 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 application was made as per the treatment. Fertilizer were applied at the time of sowing through urea, DAP and MOP as a basal application. The quantity of nitrogen supplied through DAP was adjusted with urea. Biofertilizer was applied as a seed treatment at the sowing time. Crop was harvested at 102 DAS on 12th October 2009.

**Table 1. Plant nutrients analyzed and their respective methods**

| Plant nutrients | Method used |
|---|---|
| Nitrogen concentration | Modified micro-kjeldahl method |
| Phosphorus concentration | Wet digestion molybdo phosphoric acid method |
| Potassium concentration | Flame emission spectro photometery method |

**Nutrient analysis of plant:** The plant sample (seed and straw) of sorghum were collected from each plot and were dried for 48 hrs in hot air oven at 65 ± 5°C.These dried samples were partitioned into grain and straw. Finally ground samples were passed through 0.5 mm mesh sieve and were used for chemical determination of nitrogen, phosphorus and potassium concentration as described by Humphries (1956) for nitrogen and Jackson (1973) for phosphorus and potassium).

**Uptake of NPK:** The total respective nutrient uptake by sorghum from each treatment was calculated as follows:

**i) Nitrogen uptake (kg $ha^{-1}$)**

N content in seed (%) X seed yield (kg $ha^{-1}$) + N content in straw (%) X straw yield (kg $ha^{-1}$)/100

**ii) Phosphorus uptake (Kg $ha^{-1}$)**

P content in seed (%) X seed yield (kg $ha^{-1}$) + P content in straw (%) X straw yield (kg $ha^{-1}$)/100

**iii) Potassium uptake (kg $ha^{-1}$)**

K content in seed (%) X seed yield (kg $ha^{-1}$) + K content in straw(%) X straw yield (kg $ha^{-1}$)/100

**Quality characteristics of grain (Protein):** The protein content in grain was obtained by multiplying the nitrogen content of seed by 6.25 as described by AOAC (1975). Protein yield was calculated by using the following formula:

Protein yield (kg $ha^{-1}$) = Protein content (%) X Seed yield Kg $ha^{-1}$/100

**Results and discussions**

**Nutrient uptake**

Application of nutrients to crop noted significantly higher uptake of NPK by grain and fodder of sorghum over no fertility (control) whereas, application of RDF resulted significantly higher NPK accumulation by grain, dry fodder and over all at harvest over rest of the nutrient management practices (Table 2). While, both the lower doses i.e. 75% RDF + 5 t FYM $ha^{-1}$ and 50% RDF + 2.5 t FYM $ha^{-1}$ + *Azotobacter* + PSB were at par with each other in all the nutrients uptake by grain and fodder as well as

total uptake, On the basis of total uptake the increases with RDF were by 8.58, 11.51, 54.65 per cent in N, 8.41, 11.15,51.09 per cent in P and 8.95, 8.91, 44.89 per cent in K uptake by the crop over 75% RDF + 5 t FYM $ha^{-1}$ and 50% RDF + 2.5 t FYM $ha^{-1}$ + *Azotobacter* + PSB and control. It is an established fact that accumulation of nutrient is dependent on their concentrate at cellular level and dry matter accumulation. Thus, impact of N, P and K fertilizers ultimately led to higher accumulation of nutrient by plant along with uptake by the crop. An increase in the N, P and K contents and their uptake as a consequence of N, P and K fertilization is in agreement with the findings of Kaushik and Shaktawat, 2005; Sumeriya *et al*., 2005; Sareen, 2007 and Singh, 2007.

**Table 2. Effect of integrated nutrient management on N, P and K uptake by grain and fodder of sorghum**

| Treatment | Nutrient uptake (kg $ha^{-1}$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Nitrogen | | | Phosphorus | | | Potassium | | |
| | Grain | Fodder | Total | Grain | Fodder | Total | Grain | Fodder | Total |
| RDF | 69.10 | 54.40 | 123.49 | 13.47 | 19.50 | 32.97 | 19.86 | 163.90 | 183.76 |
| 75% RDF + 5 t FYM $ha^{-1}$ | 63.74 | 49.99 | 113.73 | 12.45 | 17.96 | 30.41 | 18.31 | 150.34 | 168.61 |
| 50% RDF + 2.5 t FYM $ha^{-1}$ + *Azotobacter* + PSB | 60.45 | 50.30 | 110.74 | 11.71 | 17.95 | 29.66 | 17.35 | 151.37 | 168.70 |
| Control | 41.68 | 38.16 | 79.85 | 8.13 | 13.69 | 21.82 | 11.97 | 114.86 | 126.80 |
| SEm± | 1.176 | 1.020 | 1.767 | 0.265 | 0.373 | 0.520 | 0.365 | 3.157 | 3.29 |
| CD (P = 0.05) | 3.412 | 2.960 | 5.129 | 0.768 | 1.082 | 1.509 | 1.060 | 9.162 | 9.56 |

RDF = 80 kg N + 40 kg $P_2O_5$ + 40 kg $K_2O$ $ha^{-1}$

**Nutrient content**

It is clear from the Table 3. that application of INM to sorghum crop significantly increased NPK content in sorghum grain and dry fodder over their controls while, among the nutrients level non was found effective with one another in all the nutrient content in grain as well as dry fodder.

**Protein content and yield**

The crop fertilized with RDF attained maximum protein content in grain but it was statistically at par with all the nutrient management practices while, all the nutrient levels were obtained significantly higher protein content over control. It can be inferred from the data (Table 4.) that RDF recorded maximum protein yield (431.86 kg $ha^{-1}$) which was significantly superior over all other treatment. Nitrogen alone or in combination with organic nutrients increased protein content due to nitrogen. Because nitrogen is a basic constituent of protein and with increase in the rate of nitrogen application, nitrogen availability increased which resulted in increased protein content in seed. The results are in conformity with Nagre, 1991.The supplementary application of organic manure and biofertilizer increased nitrogen availability and nitrogen use efficiency thereby increasing protein synthesis. Similar findings were of Jasrotics, 1999 and Kumawat, 1994. Since the protein yield are mainly the function of seed yield and their respective content in the seed.

**Table 3. Effect of integrated nutrient management on N, P and K content in grain and fodder of sorghum**

| Treatment | Nutrient content (%) | | | | | |
|---|---|---|---|---|---|---|
| | Grain | | | Fodder | | |
| | N | P | K | N | P | K |
| RDF | 1.77 | 0.3447 | 0.51 | 0.557 | 0.20 | 1.68 |
| 75% RDF + 5 t FYM $ha^{-1}$ | 1.74 | 0.3397 | 0.50 | 0.547 | 0.20 | 1.65 |
| 50% RDF + 2.5 t FYM $ha^{-1}$ + *Azotobacter* + PSB | 1.74 | 0.3385 | 0.50 | 0.548 | 0.20 | 1.65 |
| Control | 1.63 | 0.3170 | 0.47 | 0.511 | 0.18 | 1.54 |
| SEm± | 0.017 | 0.00238 | 0.005 | 0.0053 | 0.001 | 0.017 |
| CD (P = 0.05) | 0.048 | 0.00691 | 0.013 | 0.0155 | 0.004 | 0.050 |

RDF = 80 kg N + 40 kg $P_2O_5$ + 40 kg $K_2O$ $ha^{-1}$

**Table 4. Effect of integrated nutrient management on protein content and protein yield**

| Treatment | Protein content (%) | Protein yield (kg $ha^{-1}$) |
|---|---|---|
| RDF | 11.06 | 431.86 |
| 75% RDF + 5 t FYM $ha^{-1}$ | 10.87 | 398.37 |
| 50% RDF + 2.5 t FYM $ha^{-1}$ + *Azotobacter* + PSB | 10.89 | 377.79 |
| Control | 10.16 | 260.51 |
| SEm± | 0.104 | 7.349 |
| CD (P = 0.05) | 0.302 | 21.325 |

RDF = 80 kg N + 40 kg $P_2O_5$ + 40 kg $K_2O$ $ha^{-1}$

**Table 5. Effect of integrated nutrient management on grain, fodder and biological yield and harvest index of sorghum**

| Treatment | Yield (kg $ha^{-1}$) | | | Harvest index (%) |
|---|---|---|---|---|
| | Grain | Fodder | Biological | |
| RDF | 3910 | 9778 | 13688 | 28.56 |
| 75% RDF + 5 t FYM $ha^{-1}$ | 3663 | 9129 | 12793 | 28.68 |
| 50% RDF + 2.5 t FYM $ha^{-1}$ + *Azotobacter* + PSB | 3462 | 9160 | 12622 | 27.44 |
| Control | 2558 | 7431 | 9988 | 25.65 |
| SEm± | 71.09 | 173.17 | 199.90 | 0.487 |
| CD (P = 0.05) | 206.29 | 502.51 | 580.10 | 1.412 |

RDF = 80 kg N + 40 kg $P_2O_5$ $ha^{-1}$+ 40 kg $K_2O$ $ha^{-1}$

**Yield**

RDF significantly recorded 52.91, 31.60 and 37.04 percent higher grain, straw and biological yield over control respectively. Application of 75% RDF + 5 t FYM $ha^{-1}$ and 50% RDF + 2.5 t FYM $ha^{-1}$ + *Azotobacter* + PSB were statistically at par with each other in in respect to grain, straw and biological yield. The higher availability of nutrients together with congenial environment led to higher uptake of nutrients by plants. The higher uptake of nutrients, more synthesis of carbohydrates and their translocation to different plants parts including the reproductive structures which are ultimate sinks, brought substantial improvement in both grain and stover yield of sorghum. These results are in close conformity

with those of Singh *et al*., 2003. It may be seen that application of INM treatment 75% RDF + 5 t FYM $ha^{-1}$ significantly increased the harvest index over control but all treatment were at par with one another.

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