

Performance of Rice-fallow Sorghum as Influenced by Nutrient Management

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ABSTRACT

A field experiment was conducted during 2012 at Agricultural College Farm, Bapatla to study the influence of nutrient management involving inorganics, bio-fertilizers and FYM on growth parameter, yield and quality of rice-fallow sorghum. The plant height was significantly increased with each increment in nitrogen level from 90 to 150 kg N ha⁻¹ alone and in combination with bio-fertilizers at 30 and 60 DAS. While it was significant up to 120 kg N ha⁻¹ in FYM treated plots and in all plots at harvest. The number of days to 50 % flowering and maturity were lowest in no nitrogen treatment and increased with increase in applied nitrogen. Highest length of ear, 1000 grain weight and yield were recorded by the integrated treatment that received 150 kg N ha⁻¹ + FYM + Bio-fertilizers. An increase of 23, 19 and 4 per cent in grain sorghum yield was recorded by the treatments that received maximum inorganic nitrogen (150 kg N ha⁻¹) along with FYM and bio-fertilizers, with FYM and with bio-fertilizers, respectively over only inorganic treatment. The protein content of the grain was significantly influenced by imposed treatments while no such effect was noticed with carbohydrates.

Key words : Bio-fertilizers, Inorganics, Quality of grain, Organic manure.

Sorghum (*Sorghum bicolor* L. Moench) an important staple cereal crop popularly known as jowar is grown in rainy and post rainy seasons. In spite of its multiple uses as food, feed, fodder and bio-fuel, the area under grain sorghum in India has declined from 18.61 million ha in 1969-70 to 7.53 million ha in 2008-09 (ASG, 2010).

In India, the crop is grown in an area of 7.5 million hectares with a productivity of 963 kg ha⁻¹ and a total production of 7.25 million tones. In Andhra Pradesh, it is grown in an area of 2.79 lakh hectares with a productivity of 1563 kg ha⁻¹ and a total production of 4.36 lakh tones (Ministry of Agriculture, 2009).

New avenues have been opening for sorghum in rice fallows as an alternate crop to pulses particularly in Krishna and Godavari zones of A.P with a high productivity of 5.7 t ha⁻¹ Guntur district (Rao *et al.* 2006). However the rice sorghum sequence is a highly exhaustive cropping system which may deprive the soil quality if followed continuously. Nutrient management for rice fallow crop help in maximizing production while sustaining soil health. Keeping this in view a study was conducted to evaluate the influence of different

components of nutrient management on performance of rice fallow sorghum.

MATERIAL AND METHODS

A field experiment was conducted at the Agricultural College Farm, Bapatla of Acharya N.G. Ranga Agricultural University in rice fallow situation during 2012. The experiment was laid out in a randomized block design with three replications and thirteen treatments viz., T₁ - 90 kg N ha⁻¹; T₂ - 120 kg N ha⁻¹; T₃ - 150 kg N ha⁻¹; T₄ - 90 kg N ha⁻¹ + Bio-fertilizers; T₅ - 120 kg N ha⁻¹ + Bio-fertilizers; T₆ - 150 kg N ha⁻¹ + Bio-fertilizers; T₇ - 90 kg N ha⁻¹ + FYM; T₈ - 120 kg N ha⁻¹ + FYM; T₉ - 150 kg N ha⁻¹ + FYM; T₁₀ - 90 kg N ha⁻¹ + FYM + Bio-fertilizers; T₁₁ - 120 kg N ha⁻¹ + FYM + Bio-fertilizer; T₁₂ - 150 kg N ha⁻¹ + FYM + Bio-fertilizers; T₁₃ - No nitrogen. The soil of the experimental field was sandy clay loam in texture, neutral in reaction (pH 7.4), medium in organic carbon (0.55 %), low in available nitrogen (122 kg ha⁻¹), medium in available phosphorus (27.9 kg ha⁻¹) and high in available potassium (729 kg ha⁻¹). Sorghum hybrid MLSH-151 was dibbled at 45 cm x 15 cm spacing on 2nd February, 2012. Well decomposed (C: N of

25:1) FYM was applied 7 days before sowing. Bio-fertilizer consortium consisting of *Azospirillum*, phosphorus solubilizing bacteria (PSB) and plant growth promoting rhizobacteria (PGPR) @ 5 kg ha⁻¹ each was applied one day before sowing. Nitrogen was applied in 2 splits, while P₂O₅ and K₂O (30 kg ha⁻¹) were applied to all treatments as per recommendation.

RESULTS AND DISCUSSION

Growth parameters

The growth parameters recorded are presented in (Table 1). At 30 and 60 DAS, the plant height increased significantly with each increment in nitrogen from 90 to 150 kg N ha⁻¹ (T₁ to T₃) alone and in combination with bio-fertilizers (T₄ to T₆). However, a significant increase in plant height was observed up to 120 kg N ha⁻¹, when combined with FYM or FYM + Bio-fertilizer. At harvest, significant increase in plant height was observed up to 120 kg N ha⁻¹ in all treatments. At all stages the highest plant heights were recorded by the treatment T₁₂ (150 kg N ha⁻¹ + FYM + Bio-

fertilizers), which was on par with treatment T₉ (150 kg N ha⁻¹ + FYM) and T₁₁ (120 kg N ha⁻¹ + FYM + Bio-fertilizer). While the lowest plant heights were recorded by T₁₃ (no nitrogen). The higher plant height under FYM application may probably be due to the regular supply of the essential nutrients by continuous mineralization of organic manures, besides enhanced nutrient supplying capacity of soil and its favourable effect on growth parameters (Hati *et al.*, 2001). The number of days taken to 50 % flowering and maturity of plants were maximum (72 and 112, respectively) in the treatment that received 150 kg N ha⁻¹ + FYM + Bio-fertilizers (T₁₂), while control (T₁₃) recorded the lowest no of days (46 and 85, respectively). The increase in number of days for 50 % flowering and maturity with increase in nitrogen, could be due to more contribution towards vegetative growth delaying the flowering. Addition of FYM and bio-fertilizers might have stimulated the vegetative organs even at lower doses of nitrogen making the influence of high levels non significant. Marchetti *et al.* (2006) reported similar results.

Table 1. Effect of nitrogen levels, bio-fertilizers and FYM on growth parameters of sorghum.

Treatments	Plant height (cm)			Days to 50% flowering	Days to 50% maturity
	30 DAS	60 DAS	Harvest		
T ₁ - 90 kg N ha ⁻¹	52	110	137	54	94
T ₂ - 120 kg N ha ⁻¹	56	124	151	62	103
T ₃ - 150 kg N ha ⁻¹	60	140	161	70	112
T ₄ - 90 kg N ha ⁻¹ + Bio - fertilizers	52	111	137	59	99
T ₅ - 120 kg N ha ⁻¹ + Bio- fertilizers	57	125	152	64	104
T ₆ - 150 kg N ha ⁻¹ + Bio- fertilizers	61	142	162	70	110
T ₇ - 90 kg N ha ⁻¹ + FYM	56	126	152	60	100
T ₈ - 120 kg N ha ⁻¹ + FYM	61	155	167	65	106
T ₉ - 150 kg N ha ⁻¹ + FYM	63	157	176	71	111
T ₁₀ - 90 kg N ha ⁻¹ + FYM + Bio - fertilizers	56	127	154	63	103
T ₁₁ - 120 kg N ha ⁻¹ + FYM + Bio - fertilizers	62	156	169	68	108
T ₁₂ - 150 kg N ha ⁻¹ + FYM + Bio - fertilizers	64	158	177	72	112
T ₁₃ - No nitrogen	48	98	121	46	85
SEm±	1	3	4	2	2
CD @ 0.05	3	11	13	7	8
CV (%)	6	7	8	9	7

FYM @ 10 t ha⁻¹; Bio-fertilizer consortium consists of *Azospirillum*, PSB and PGPR @ 5 kg ha⁻¹ each.

Table 2. Effect of nitrogen levels, bio fertilizers and FYM on yield attributes of sorghum.

Treatments	Length of ear (cm)	No. of grains per ear	1000 grain weight (gm)
T ₁ - 90 kg N ha ⁻¹	22.1	992	24.48
T ₂ - 120 kg N ha ⁻¹	21.4	1094	24.18
T ₃ - 150 kg N ha ⁻¹	22.8	1125	28.43
T ₄ - 90 kg N ha ⁻¹ + Bio - fertilizers	21.3	904	24.49
T ₅ - 120 kg N ha ⁻¹ + Bio- fertilizers	21.7	1008	25.14
T ₆ - 150 kg N ha ⁻¹ + Bio- fertilizers	23.1	1108	28.86
T ₇ - 90 kg N ha ⁻¹ + FYM	22.0	1023	27.59
T ₈ - 120 kg N ha ⁻¹ + FYM	23.4	1194	31.09
T ₉ - 150 kg N ha ⁻¹ + FYM	23.8	1244	31.15
T ₁₀ - 90 kg N ha ⁻¹ + FYM + Bio - fertilizers	22.2	1022	28.00
T ₁₁ - 120 kg N ha ⁻¹ + FYM + Bio - fertilizers	23.6	1244	31.10
T ₁₂ - 150 kg N ha ⁻¹ + FYM + Bio - fertilizers	24.0	1271	31.29
T ₁₃ - No nitrogen	20.9	784	23.23
SEm±	1.3	35	2.12
CD @ 0.05	NS	101	NS
CV (%)	10.3	8	13.2

FYM @ 10 t ha⁻¹; Bio-fertilizer consortium consists of *Azospirillum*, PSB and PGPR @ 5 kg ha⁻¹ each.

Table 3. Effect of nitrogen levels, bio- fertilizers and FYM on quality parameters.

Treatments	Protein (%)	Carbohydrates (%)
T ₁ - 90 kg N ha ⁻¹	10.81	45.0
T ₂ - 120 kg N ha ⁻¹	11.44	42.8
T ₃ - 150 kg N ha ⁻¹	12.06	41.8
T ₄ - 90 kg N ha ⁻¹ + Bio - fertilizers	10.94	45.2
T ₅ - 120 kg N ha ⁻¹ + Bio- fertilizers	11.31	44.3
T ₆ - 150 kg N ha ⁻¹ + Bio- fertilizers	11.81	43.2
T ₇ - 90 kg N ha ⁻¹ + FYM	11.56	42.8
T ₈ - 120 kg N ha ⁻¹ + FYM	12.06	41.6
T ₉ - 150 kg N ha ⁻¹ + FYM	12.12	44.0
T ₁₀ - 90 kg N ha ⁻¹ + FYM + Bio - fertilizers	11.69	45.0
T ₁₁ - 120 kg N ha ⁻¹ + FYM + Bio - fertilizers	12.19	44.7
T ₁₂ - 150 kg N ha ⁻¹ + FYM + Bio - fertilizers	12.25	43.6
T ₁₃ - No nitrogen	10.18	40.7
SEm±	0.23	0.90
CD @ 0.05	0.61	NS
CV (%)	5.58	6.9

FYM @ 10 t ha⁻¹; Bio-fertilizer consortium consists of *Azospirillum*, PSB and PGPR @ 5 kg ha⁻¹ each.

Yield attributing characters

The data pertaining to yield components viz. length of ear, no of grains per ear and thousand grain weight are presented in (Table 2). The data indicated no significant effect of imposed treatments on length of ear. The highest length (24.0 cm) of ear was recorded by the treatment that received 150 kg N ha⁻¹ + FYM + Bio-fertilizer (T₁₂), while the lowest (20.9 cm) was recorded by no nitrogen treatment (T₁₃). The present findings support the results of Patil and Sheelavantar (2000). The number of grains per ear was significantly influenced by nitrogen levels, bio-fertilizers and FYM. However a significant increase in grain number was observed only up to 120 kg N ha⁻¹. The highest no of grains per ear (1271) was recorded by the treatment T₁₂ (150 kg N ha⁻¹ + FYM + Bio-fertilizers), which was on par with treatment T₁₁ (120 kg N ha⁻¹ + FYM + Bio-fertilizers), and T₉ (150 kg N ha⁻¹ + FYM). The lowest number of grains per ear (784) was recorded by T₁₃ (no nitrogen). The more numbers of grains per ear in integrated treatments indicate the positive response of crop to higher level of nitrogen and beneficial effects of organic manures in transportation of growth stimulating materials through phloem tissues thereby resulting in enhanced grain number. The data indicated that 1000-grain weight was not significantly influenced by levels of inorganic nitrogen or its combination with FYM and bio fertilizers. The highest 1000 grain weight (31.29 g) was recorded by T₁₂ (150 kg N ha⁻¹ + FYM + Bio-fertilizers) and the lowest 1000 grain weight (23.23 g) was recorded by T₁₃ (no nitrogen). Turi *et al.* (2007) reported that difference of ear length and 1000 grain weight are genetic characteristics, which would not be affected by the environment and inputs.

Sorghum Grain and Stover yields (q ha⁻¹)

The data presented in figure 1 revealed a significant effect of levels of nitrogen and its integration with bio-fertilizers and FYM on grain and stover yields of sorghum.

Even though grain yield increased with increase in nitrogen up to 150 kg N ha⁻¹, a significant increase was observed only up to 120 kg N ha⁻¹. However, at a given dose, addition of FYM alone

and in combination with bio-fertilizer resulted in a significant increase in yield.

The highest grain yield (35.8 q ha⁻¹) was recorded by the treatment T₁₂ (150 kg N ha⁻¹ + FYM + Bio-fertilizers), which was on par with treatments T₉, T₁₁ and T₈. Treatments receiving FYM with 150 or 120 kg N ha⁻¹ were on par with each other showing no significant effect of high dose of N or addition of bio fertilizers. The lowest grain yield (17.2 q ha⁻¹) was recorded in no nitrogen treatment (T₁₃).

Stover yield followed the same pattern as grain yield showing significant influence of nitrogen up to 120 kg N ha⁻¹ alone or in combination with bio fertilizers and/or FYM.

The highest stover yield (69.4 q ha⁻¹) was recorded in treatment supplied with 150 kg N ha⁻¹ + FYM + Bio-fertilizers (T₁₂), which was on par with treatments T₉ (150 kg N ha⁻¹ + FYM ha⁻¹) and T₁₁ (120 kg N ha⁻¹ + FYM + Bio-fertilizers) and significantly superior over others. The treatment T₈ (120 kg N ha⁻¹ + FYM) was on par with the treatment T₆ (150 kg N ha⁻¹ + Bio-fertilizers) and significantly superior over T₃ (150 kg N ha⁻¹). The lowest stover yield (47.9 q ha⁻¹) was found in the treatment T₁₃ (no nitrogen).

Persual of the data revealed a positive influence of levels of nitrogen and application of FYM and/or bio fertilizers on yield. The favourable response to higher level of nitrogen on yield could be ascribed to overall improvement in crop growth that enabled the plant to absorb more nutrients and moisture which empowered the plant to manufacture more quantities of photosynthates and accumulate them in sink. Similar findings of response of sorghum to higher nitrogen levels were reported by Patil (1998).

The production of organic acids and growth promoting substances during decomposition of organic manures might have facilitated easy availability of macro as well as micronutrients. Adequate supply of nutrients to the crop helps in the synthesis of carbohydrates, and their subsequent translocation to sink. An increase in yield might also be on account of increased symbiotic activity of nitrogen fixers and solubilization of nutrients and production of growth regulators due to addition of bio-fertilizer consortium which consists of *Azospirillum*, PSB and PGPR.

Quality parameters

The data presented in table 3 revealed that application of organic and inorganic source of nutrient combinations significantly influenced the protein content of sorghum grain. Among inorganic treatments increase in nitrogen level from 90 to 150 kg N ha⁻¹ significantly increased the protein content in grain while, in combination with bio-fertilizers the effect was non- significant. At a given dose up to 120 kg N ha⁻¹, FYM treated plots reported a significant increase over other treatments. Maximum protein content was observed in T₁₂ (150 kg N ha⁻¹ + FYM + Bio-fertilizers) and the lowest protein content was recorded in T₁₃ (no nitrogen). The increase in protein content at higher doses of nitrogen might be due to increased availability of nitrogen and its uptake and storage in grain. Nitrogen, an essential constituent making up to 16 per cent by weight of protein is found to influence the protein content, if it is available in abundance. These results are in accordance with the findings of Raza *et al.* (2005). Similar reports were made by Mishra *et al.* (1994) and Koteva *et al.* (1995). The perusal of data presented in (Table 1) indicated that carbohydrate content in grain was not significantly influenced by different treatments. Maximum carbohydrate content was observed in T₄ (90 kg N ha⁻¹ + Bio- fertilizers) and the lowest was recorded in T₁₃ (no nitrogen).

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