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Effect on Yield and Rhizosphere Biota by use of Recommended Dose of Fertilizers in Combination with Biofertilizer Consortium on Rice Fallow Sorghum (*Sorghum bicolor L. moench*)

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Authors' contributions

This work was carried out in collaboration among all authors. Author KSR designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author CHPR and Author MML managed the analyses of the study. Author MML managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To evaluate the effect of manures in combination with biofertilizers consortium on yield and rhizosphere biota in rice fallow sorghum

Study Design: The experiment was laid in a Randomized Block Design (RBD) with seven treatments and replicated thrice.

Place and Duration of Study: At Agricultural college farm, Agricultural college, Bapatla during *Rabi*, 2018-19.

Methodology: After the preliminary layout, Bio-fertilizer consortium contains 500ml each of Azospirillum, PSB and KRB in liquid form had been applied per acre along with Vermicompost @ 1 t ha^{-1} is used as carrier. A high yielding hybrid CSH-16 with a yield potential of 5 to 8 t ha^{-1} and

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matures in 110-120 days. Sowing was done manually by using a seed rate of 12 kg ha^{-1} and adopting a spacing of 45 cm x 15 cm raised well in advance in their respective treatments.
Results: Yield attributes, Grain yield and stover yields were obtained maximum with 125% RDF+ Biofertilizers consortium which was on par with 100% RDF+ Biofertilizers consortium. In case of Bacterial, fungal and actinomycetes population were also influenced significantly at harvest compared to initial population of the observed soil and recorded the highest population with 125% RDF+ Biofertilizers consortium treatment.
Conclusion: The fertilizer requirement with application of 125% RDF+ Biofertilizer can be recommended for coastal region of A.P under rice fallow rabi sorghum in no till conditions. As it resulted in high yield attributes, yields and significant improvement in rhizosphere biota for soil health enhancement.

Keywords: Yield; RDF & Biofertilizer consortium; colony forming units per gram of soil (CFU g-1 soil).

1. INTRODUCTION

Sorghum (*Sorghum bicolor* L. Moench), popularly called as jowar, is an important staple food crop in the world. One of the most important cereal crops after wheat, rice, maize and barley. Sorghum is the staple food crops grown for millions of the people in semiarid tropics. occupies an area of 5.97 M ha with total production of 5.01 M t and a productivity of 1013 kg ha^{-1} [1]. Of late, rabi sorghum has also been introduced in the rice fallows of Krishna zone of coastal Andhra Pradesh. Sorghum cultivation is an emerging scenario in rice fallows under zero tillage. However, there is a prospective situation especially in areas having frugal water resources in rice-fallows of this zone for taking up sorghum as an alternate crop. Practically, the sorghum growing farmers in this area are mostly inclined towards obtaining maximum monetary benefits from sorghum yields. As they are getting higher potential yields and thereby marginal profit could be increased by introducing potential cost-effective and the resource use efficiency technologies. It is now grown in more than 14,000 ha area in rice-fallows of Guntur district alone in state of Andhra Pradesh. It had the highest productivity of 6.9 t ha^{-1} in 2014-15 in the country [2]. Therefore, necessary to judiciously manage the inflow of inorganic fertilizers and the integration with organic manures and biofertilizer besides adopting general package of practices. The yield and grain quality of sorghum as in rice fallows may be improved by rational application of manures and bio-fertilizers consortium.

2. MATERIAL AND METHODS/ EXPERIMENTAL DETAILS/ METHODOLOGY

This experiment was conducted at agricultural college farm, bapatla. It is located in coastal region of krishna agro-climatic zone, Andhra pradesh situated at 15º 54’ N latitude and 80º 25’ E longitude, an altitude of 5.49 metres above the mean sea level (MSL). The treatments consisted of T_1: control, T_2: 100% recommended dose of fertilizers, T_3: 50% RDF+ Biofertilizer consortium, T_4: 75% RDF+ Biofertilizer consortium, T_5: 100% RDF+ Biofertilizer consortium, T_6: 125% RDF+ Biofertilizer consortium, T_7: Biofertilizer consortium. The experiment was laid in a randomized block design (RBD) and replicated thrice with seven treatments. Weather data being recorded during crop period and the weekly mean maximum temperatures with an average of 31.6°C The temperature was higher than optimum for crop as the experimental period is from january to april. The soil property was sandy clay loam in texture, near neutral (pH 6.94), E.C (0.98 ds m^{-1}), organic carbon (0.4 %) was low, available nitrogen was low (224.6 kg ha^{-1}) and high in available phosphorus (38 kg ha^{-1}) and in potassium (482 kg ha^{-1}). Sorghum cultivar, CSH-16 was developed by Indian Institute of Millets Research, Hyderabad. A high yielding hybrid with a yield potential of 5 to 8 t ha^{-1} and matures in 110-120 days. Sowing was done manually by using a seed rate of 12 kg $ha^{-1}$and adopting a spacing of 45 cm x 15 cm. Nitrogen (100 kg ha^{-1}) was applied in the form of urea (46% N) in 2 equal splits i.e., ½ at 30 DAS and remaining ½ at 30 days after first application. Entire dose of phosphorus (60 P_2O_5 kg ha^{-1}) was applied in form of SSP (16% P_2O_5) and 40 kg K_2O ha^{-1} was applied in the form of MOP (60% K_2O), along with 1st split application of urea. The sun dried ears from net plot area for yield were threshed, cleaned and weight of the grain was recorded grain yield ha^{-1} was worked out and later expressed in kg ha^{-1}. The stover weight from each net plot area was recorded after leaving the stalks in the field for sun drying until a constant weight was recorded. The grain and stover yield

ha^{-1} was calculated and expressed in kg ha^{-1}. Note: bio-fertilizer consortium contains 500ml each of azospirillum, phosphate solubilizing bacteria (PSB) and potassium releasing bacteria (KRB) in liquid form to be applied per acre along with vermicompost @ 1 t ha^{-1} used as carrier.

2.1 Method for Enumeration of Bacteria, Fungi and Actinomycetes

The enumeration of total bacteria in fresh soil samples was carried out by following serial dilution plate count technique [3] using nutrient agar medium (agar agar-20 g; beef extract-3 g; peptone-5 g; water-1 litre) in laminar air flow chamber. Exactly, 1g of soil was added to 10 ml of sterile water to dilute the population by 10 times, from which 0.1 ml was transferred to another 9.9 ml of sterile water to make it 10^3 times dilution and it was continued till 106 dilutions and 0.1 ml of the final diluted solution was transferred on to a petri plate with nutrient agar medium and spread with 'l' shaped glass rod and allowed it to grow for one and half days after which colony counts were recorded. The enumeration of total fungi in the fresh soil samples of all treatments was carried out by following the standard serial dilution plate technique using martins rose bengal agar for fungi. Actinomycetes soil samples of all treatments was carried out by following the standard serial dilution plate technique and was enumerated using ken- knight and munaier's medium. The population expressed in terms of colony forming units per gram of soil (cfu g^{-1} soil).

2.2 Statistical Analysis

Statistical analysis for the data recorded was done by following the analysis of variance technique for randomized block design with factorial concept as suggested by [4]. Statistical significance was tested by applying f-test at 0.05 level of probability and critical differences were calculated for those parameters which turned to the significant ($p<0.05$) in order to compare the effects of different treatments.

3. RESULTS AND DISCUSSION

3.1 Grain Yield, Stover Yield and H.I

The data on grain yield, stover yield and h.i are presented in Table 1 which revealed that grain and stover yields of sorghum under rice fallows was significantly differed with increased levels of inorganic fertilizers along with biofertilizer consortium upto 125% RDF+ biofertilizer consortium. The maximum grain yield (4135 kg ha^{-1}) was recorded with the same treatment which proved its superiority i.e. T_6 treatment (125% RDF +biofertilizer consortium) but it remained on par with 100% RDF +Biofertilizer consortium (T_5) treatment (3918 kg ha^{-1}) and 100% RDF (T_2) treatment (3854 kg ha^{-1}). The lowest grain yield (2880 kg ha^{-1}) was recorded with the control. The treatments T_6, T_5 and T_2 had recorded 43.5, 36, 33.8 percent increase respectively over control. This has promoted better root growth and resulting in higher extraction of nutrients from soil environment to aerial plant parts. The improvement in yield attributes with inorganic fertilizers and biofertilizer consortium consequently resulted in higher grain yield. The enhanced yield could be a result of good drymatter production for grain filling as a result of greater number of leaves and increased photosynthetic activity.

The stover yield of sorghum under rice fallows followed the same trend as that was noticed in respect of grain yield of sorghum crop. Highest stover yield (7524 kg ha^{-1}) was recorded with the treatment (T_6) supplied with 125% RDF+ Bio-fertilizer consortium. Lowest stover yield (5529 kg ha^{-1}) was recorded with control (T_1). The magnitude of increase in stover yield with T_6, T_5 and T_2 was 36.0, 30.3 and 28.9 percent increase respectively over control (T_1). Further, this could be ascribed to its positive influence on both vegetative and reproductive phases of the crop which lead to increase in stover yield. Increased photosynthetic rate might have also resulted in higher accumulation of drymatter and ultimately enhanced stover yield. The highest H.I value of (35.5%) was recorded with (T_6) treatment during the study followed by T_5 (35.3%). However, the control treatment (T_1) recorded the lowest H.I (34.2%).Similar results have been reported earlier by scientists viz., Nemade et al.[5], Jat et al. [6], Kishor et al.[7], Yadav et al.[8].

3.2 Microbial Population (cfu g^{-1} soil) of Rice Fallow-Sorghum

The results of microbial populations were presented in Table 2 and Table 3, which was depicted in Fig.1 and Fig.2 had significantly influenced the increase in bacteria population at harvest compared to initial population of the experimental soil. The bacteria, fungal and actinomycets colonies were observed during two stages of crop growth i.e at 15 days after application of biofertilizer consortium and later at harvest stage.

Table 1. Grain yield (kg ha^{-1}), straw yield (kg ha^{-1}) and H.I (%) of rice fallow-sorghum as influenced by inorganic fertilizers with Biofertilizer consortium

Treatments	Grain yield	Straw yield	Harvest index
T_1 - Control	2880	5529	34.2
T_2 - 100% Recommended dose of fertilizers	3854	7129	35.1
T_3 - 50% Recommended dose of fertilizers + Biofertilizer consortium	3184	6049	34.5
T_4 - 75% Recommended dose of fertilizers + Biofertilizer consortium	3460	6505	34.7
T_5 - 100% Recommended dose of fertilizers + Biofertilizer consortium	3918	7209	35.3
T_6 - 125% Recommended dose of fertilizers + Biofertilizer consortium	4135	7524	35.5
T_7 - Biofertilizer consortium only	3016	5706	34.6
S.Em ±	198.4	419.3	1.1
CD (P=0.05)	612	1292	NS
CV (%)	9.8	11.1	5.8

Table 2. Microbial population (cfu g^{-1} soil) of rice fallow-sorghum after 15 days as influenced by inorganic fertilizers with biofertilizer consortium

Treatments	Microbial population		
	Bacteria (10^6)	Fungi (10^4)	Actinomycetes (10^4)
T_1 - Control	15.7	2.2	9.3
T_2 - 100% Recommended dose of fertilizers	22.3	3.1	16.3
T_3 - 50% Recommended dose of fertilizers + Biofertilizer consortium	25.7	4.4	20.7
T_4 - 75% Recommended dose of fertilizers + Biofertilizer consortium	30.3	4.7	24.3
T_5 - 100% Recommended dose of fertilizers + Biofertilizer consortium	32.7	5.2	27.7
T_6 - 125% Recommended dose of fertilizers + Biofertilizer consortium	37.3	6.4	30.3
T_7 - Biofertilizer consortium only	23.6	4.5	15.9
S.Em ±	1.7	0.2	1.3
CD (P=0.05)	5.1	0.7	4.1
CV (%)	10.6	9.5	10.8

Table 3. Microbial population (CFU G-1 soil) of rice fallow-sorghum harvest as influenced by inorganic fertilizers with Biofertilizer Consortium

Treatments	Microbial population		
	Bacteria (10^6)	Fungi (10^4)	Actinomycetes (10^4)
T_1 - Control	43.3	3.5	28.9
T_2 - 100% Recommended dose of fertilizers	68.7	4.5	47.6
T_3 - 50% Recommended dose of fertilizers + Biofertilizer consortium	63.3	5.4	44.3
T_4 - 75% Recommended dose of fertilizers + Biofertilizer consortium	72.3	6.6	49.3
T_5 - 100% Recommended dose of fertilizers + Biofertilizer consortium	79.7	7.1	52.7
T_6 - 125% Recommended dose of fertilizers + Biofertilizer consortium	88.3	8.2	57.3
T_7 - Biofertilizer consortium only	59.3	5.2	33.8
S.Em ±	4.3	0.4	3.2
CD (P=0.05)	13.5	1.3	9.7
CV (%)	10.6	9.5	10.8
	11.1	12.2	12.1

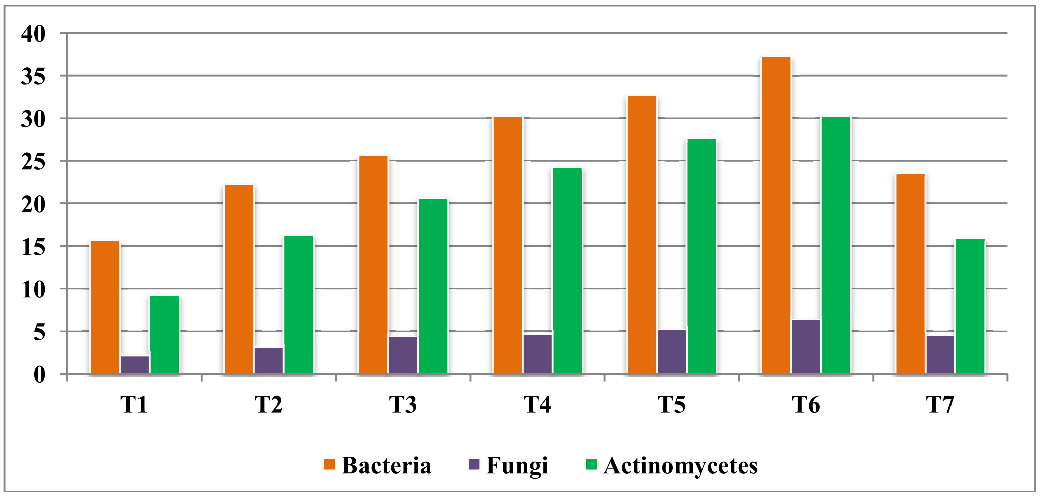

Fig. 1. Microbial population (CFU g -1 soil) of rice fallow -sorghum at 15 days after application as influenced by inorganic fertilizers with Biofertilizer consortium

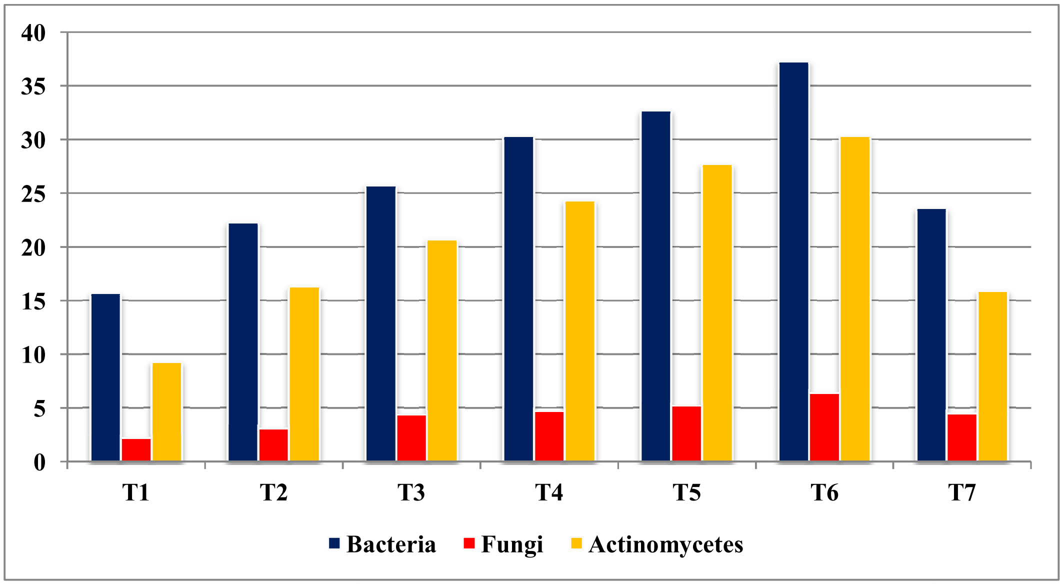

Fig. 2. Microbial population (CFU g -1 soil) of rice fallow -sorghum at harvest after application as influenced by inorganic fertilizers with Biofertilizer consortium

Maximum bacterial population (37.3×10^6 cfu g^{-1} soil) at 15 days after application was noticed in treatment (T_6) which was significantly superior to rest of treatments. The treatment (T_5) recorded (32.7) followed by (T_4) treatment. Minimum population obtained in control treatment (15.7×10^6 cfu g^{-1} soil). At harvest, similar trend was noticed as that was observed at 15 days after application of biofertilizer consortium, the maximum population (88.3) was observed with (T_6) treatment followed by (T_5) treatment (79.7×10^6 cfu g^{-1} soil). High bacteria population was observed, when compared with fungal population due to the short generation time and high multiplication rate. The increase in bacterial population may be due to application of bio-fertilizers consortium. Interaction of roots of a plant with its neighboring plant might have increased bacterial population with closer density. This result is in agreement with [10]. An increase in fungal population was observed at harvest compared to initial population of the experimental soil. Fungal population (6.4×10^4 cfu g^{-1} soil) was observed at T_5 days of in the treatment (T_6) on par with treatment (T_5) recorded (5.2) followed by (T_4) treatment (4.7×10^4 cfu g^{-1} soil). At harvest, population (8.2) noticed in the treatment (T_6) remained on par with (T_5) treatment (7.1). The results of actinomycetes population was significantly influenced with application of inorganic and biofertilizer consortium, at 15 days after application, maximum population (30.3) was noticed in the treatment (T_6) followed by the treatment T_5 (27.7). Minimum population obtained in control treatment (9.3×10^4 cfu g^{-1} soil). Population of actinomycetes at harvest in (T_6) treatment (57.3) and was on par with T_5 (52.7) and T_4 treatment (49.3×10^4 cfu g^{-1} soil).

The results suggested that combined application of inorganic fertilizers and biofertilizers favored the augmentation of microbial population and the activities such as biological nitrogen fixation, phosphorus solubilization and availability of plant nutrients. These results are in accordance with findings of Gautami et al. [9] Padmaja et al.[10].

4. CONCLUSION

Grain and stover yields were recorded maximum in 125% RDF+ biofertilizers consortium treatment. In the Rhizosphere biota such as Bacterial, fungal and actinomycetes populations were influenced significantly at harvest with 125% RDF+ biofertilizers consortium and reported in almost all parameters compared with other treatments. Thus, can be recommended for coastal region of a.p under rice fallow rabi sorghum in no-till conditions.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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