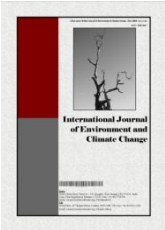

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# Effect of Production Factors on Growth and Yield of *Rabi* Sorghum (*Sorghum bicolor* L.)

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***Authors' contributions***

*This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.*

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## ABSTRACT

An experiment was carried out at Agricultural Research Station, Tandur, Professor Jayashankar Telangana State Agricultural University (PJTSAU) for three consecutive years *viz.* 2014-16, 2015-16 and 2016-17 to study the Effect of production factors on growth and yield of *rabi* sorghum (*Sorghum bicolor* L.) during the winter seasons. The experiment was laid out in randomized block design with nine treatments comprised of T1: Control only improved hybrid CSH-15-R T2: Full package of practices (FPP) T3: FPP without Irrigation T4: FPP without Fertilizer T5:FPP without Weed Control T6: FPP without -Plant protection T7: FPP without seed treatment with PSB and azospirillum T8 : FPP without Thinning T9 : FPP without Improved variety (only local variety) with three replications. The pooled results of the trial indicated that there was 32% yield reduction when the improved sorghum hybrid was grown without using all the full package of practices. (i.e., over FPP). The gross returns of rupees 115615 $ha^{-1}$, net returns of rupees 91655 $ha^{-1}$ and benefit cost ratio of 3.83 were recorded highest with all the full package of practices.
The control is recommended to be the local variety). This is the All India Coordinated research network project conducted across India without any changes in the hybrid and is predominantly successful production factor over the variety which is released for its performance over the existing suitable varieties for testing.

*Keywords: Production factors; Rabi sorghum and yield.*

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## 1. INTRODUCTION

Grain in the form of wheat, rice, millet, sorghum, or maize/corn provides daily nutrition to millions of people in most developing countries. Cereals are commonly thought of as breakfast products such as cornflakes, oats, or rye, as well as baking ingredients in Western culture. Despite the fact that there are over 350,000 plant species on the planet, only 20 species provide over 90% of human sustenance. Corn/maize, wheat, rice, barley, and sorghum are the top five grains consumed around the world (Food and Agriculture Organization [1]. A cereal - wheat, rice, millet, maize, or sorghum – is always present in an average Indian meal, accounting for 70% of per capita calorie intake [2]. Though India attained high growth per capita incomes in the last decade, it is paradox that the country‘s per capita food consumption (in kcal/person in day) did not improve [3].

In Telangana agriculture is only 40% of the total geographical area is utilized and a sizeable part, around 23% of total geographical area, is fallow ground. The presence of large fallow land in the region indicates the neglect of agriculture and absence of investments or underutilization of land for development. Soils and climate are critical for agriculture development. The need to feed increasing population in the country requires regular assessment of its natural and climate resources for proper land use.

Due to the development and distribution of high-yielding cultivars, sorghum and pearl millet output has expanded since the 1970s. Disease-resistant and productive varieties have increased yields and benefited 6 million millet-growing households and 3 million sorghum-growing households over the years. In India's semi-arid areas, effective partnership between public research and private enterprise has led to the adoption of improved cultivars by poor and small farmers [4].

In India, *Rabi* Sorghum is cultivated in an area of 30.69 L ha with a production of 30.75 L t and productivity of 1002 kg $ha^{-1}$. In Telangana, it occupies an area of 0.31 L ha with a production 0.56 L t and an average yield of 1818 kg $ha^{-1}$ [5]. It is an important winter season crop grown in Telangana, Andhra Pradesh, Maharashtra and Karnataka. In Telangana it is confined to Ranga Reddy, Mahabubnagar, Adilabad, Nizamabad and Khammam districts.

Sorghum adapts well to tropical and subtropical environments, but a significant portion of the crop is grown in drought-prone, semi-arid tropical regions around the world. With limited inputs and rain, as well as low soil fertility, its growth and yields are constrained. However, under favourable conditions, sorghum has enormous potential. Unfortunately, a large proportion of subsistence farmers are not maximising their potential due to a lack of better management practises. Improve the rationale for research.

There are about several environmental factors which governs the successful crop production among these few factors which implicates the techniques to be adopted by several scientists based evidence in many common experiments which are rarely intervened and interacted. few among them to consider for experimentation includes the utilization of the order of critical inputs for maximizing the production under limited supply of the need based range of locally available resources.

For increasing the production of crop, the use of different components such as application of fertilizers, thinning, plant protection measures and weed control are the major components. Several production technologies have been recommended by the research stations but in most of the circumstances farmers have either not adopted or only partially adopted them. Hence, it seems clear that technologies have to be evaluated by taking the view of the farmers' environment, and with farmers' active participation. Priority inputs for crop production depends on farmers economic conditions, crop / environment conditions.

Keeping these insights, the present investigation was planned to find out the contribution of different production factors (Priority inputs) in Rabi sorghum production. during rabi seasons of 2014-15, 2015-16 and 2016-17.

## 2. MATERIALS AND METHODS

An experiment on Priority inputs in Rabi grain sorghum was conducted during Rabi seasons of 2014-15, 2015-16 and 2016-17 at Agricultural Research Station. Tandur, Vikarabad. The experimental design consists of Randomized Block Design replicated thrice with nine treatments. Treatments comprises are T1 : Control (only improved variety without any input CSH 15-R) T2 : Full package of practices (FPP (Protective irrigation+ fertilizer (RDF) + Weed

control (Herbicides and Hand Weeding) +Plant protection (application of insecticide and fungicides seed treatments with fungicides)+ seed treatment with PSB and Azospirillum + Thinning + Improved variety)) T3 : FPP minus irrigation, T4 : FPP minus fertilizer, T5 :- FPP minus weed control, T6: FPP minus plant protection, T7 : FPP minus seed treatment with PSB and Azospirillum, T8: FPP minus thinning, and T9: FPP minus improved hybrid (local cultivar). The gross and net plot sizes were 4.5 m x 5.0 m and 3.6 m x 4.40 m, respectively. The sowing was done by dibbling two seeds per hill at each plot with a spacing of 45 x 15 $cm^2$ apart and seeds were covered with soil. CSV 29 R variety of Rabi sorghum selected. The soil of the experimental field was clay in texture, low in organic carbon (0.22%), low in available nitrogen (148 kg $ha^{-1}$), high in available phosphorus (34 kg $ha^{-1}$), high in available potassium (418 kg $ha^{-1}$) and slightly alkaline in reaction (pH 7.35). The recommended plant protection schedule was followed. The fertilizer application was done as per recommended dose of 60 kg N and 40 kg $P_2O_5$ $ha^{-1}$ by placement method. Nitrogen was applied through urea (46% N), phosphorus in the form of single super phosphate (16% $P_2O_5$) and which was applied along the marked lines (i.e. line placement) 5 cm below the soil. Net plot yields were used for calculating yield per hectare. The available nitrogen in soil was analyzed by alkaline permanganate method Subbiah and Asija [6]. The available phosphorus status in soil was estimated by Olsen's method [7] and potassium content in soil was determined by Flame Photometry Jackson [8]. The results were analyzed using standard statistical procedure given by Panse and Sukhatme [9].

## 3. RESULTS AND DISCUSSION

### 3.1 Growth and Yield

The results clearly indicated that the plant height (161cm) produced with the treatment Full package of practices (FPP) was significantly higher than the rest of the treatments. While the days to 50% flowering did not exhibit any significant variation among the different treatments of priority inputs. Grain yield, fodder yield kg $ha^{-1}$, harvest index (%), indicated that Full package of practices (FPP) were significantly influenced by application of all priority inputs (Table 1). This implicated that all the inputs or production factors are essential to Rabi sorghum. This might be due to the cumulative effect of all production factors. There was 32% yield reduction when the improved sorghum hybrid was grown without using all the full package of practices. (i.e., over FPP). Among different Rabi sorghum priority input factors adaptation of only improved variety without any input treatments (T1) recorded significantly lowest plant height (cm), grain yield 2.04 t/ha, dry fodder yield 5.30 t/ha, (Clarify: fresh or dry?) harvest index (27.79%), gross returns of rupees 79350 $ha^{-1}$, net returns of rupees 58350 $ha^{-1}$ and benefit cost ratio of 2.78 over all priority inputs treatments. The tune of decrease was upto 32% as compared to T2 (FPP). While the cost of production is rupees 23960 $ha^{-1}$ under full package of practices is relatively higher than any other production factors treatments except seed treatment with PSB and Azospirillum. (make a benefit/cost analysis that justifies the financial investment).

The grain yield reduction ranges from 12 to 24% was observed when the priority inputs such as irrigation, seed treatment, weed control, or thinning or plant protection or fertilizer or using local variety as priority input. Full package of practices resulted in the significantly superior grain yield of 3.15 t/ha (a) and fodder yield of 6.61 t/ha (a) and harvest index was 31.36 (a) over the other treatments. Increase in yield may be due to adoption of all the full package of practices such as high yielding varieties, optimum plant population, sufficient fertilizer availability, weed free crop for crop production. Which may leads into well plant stand, competition free nutrient and moisture availability result into vigorous growth leads to increases in yield contributing characters result into higher yield. Similar findings were reported by Bangar [10]; Sumeriya and Singh [11]; Mishra et al. [12].

### 3.2 Economics

The gross returns of rupees 115615 $ha^{-1}$, net returns of rupees 91655 $ha^{-1}$, while the cost of production is rupees 23960 $ha^{-1}$ is relatively higher than any other production factors treatments except seed treatment with PSB and Azospirillum. and benefit cost ratio of 3.83 were recorded highest with all the full package of practices was adopted. Similar findings were reported by Ahmed et al. [13] and Sagarka et al. [14].

**Table 1. Plant height, yield and economics of *Rabi* sorghum as influenced by priority inputs (Pooled means for three years)**

| Treatment | Plant height (cm) | Days to 50% flowering | Grain Yield (t/ha) | Fodder Yield (t/ha) | Harvest Index (%) | Gross returns (Rs/ha) | Cost of production (Rs/ha) | Net returns (Rs/ha) | BCR | Decrease in grain yield as compared to FPP |
|---|---|---|---|---|---|---|---|---|---|---|
| T1 : Control (only improved hybrid without any input) | 137[d] | 71 | 2.04 [b] | 5.30 | 27.79 | 79350 | 21100 | 58350 | 2.78 | 32 |
| T2 : Full package of practice (FPP): Protective irrigation +Fertilizer (RDF)+Weed control (herbicide and hand weeding)+ | 161[a] | 70 | 3.15[a] | 6.61[a] | 31.36[b] | 115615 | 23960 | 91655 | 3.83 | 0 |
| T3 : FPP minus Irrigation | 140[c] | 68. | 2.77[c] | 5.60 | 33.09[a] | 105350 | 22990 | 82360 | 3.58 | 12 |
| T4 : FPP minus Fertilizer | 137[d] | 67 | 2.40[b] | 6.30 | 27.59 | 93450 | 21500 | 71950 | 3.35 | 23 |
| T5 : FPP minus Weed control | 124[b] | 67 | 2.68[c] | 5.71 | 31.94 | 102365 | 22550 | 79815 | 3.54 | 14 |
| T6 : FPP minus Plant protection | 128[b] | 71 | 2.38[b] | 5.83 | 28.99 | 92045 | 22900 | 69145 | 3.02 | 24 |
| T7 : FPP minus Seed treatment with PSB and Azospirillum | 143[c] | 71 | 2.73[c] | 5.93 | 31.52 | 104445 | 23400 | 81045 | 3.46 | 13 |
| T8 : FPP minus Thinning | 128[b] | 71 | 2.42[c] | 6.00 | 28.74 | 93700 | 21900 | 71800 | 3.28 | 23 |
| T9 : FPP minus Improved variety (use local variety of the region) | 148 | 72 | 2.72[c] | 6.01 | 31.16 | 104215 | 23540 | 80675 | 3.43 | 13 |
| SE m | 5.7 | 0.30 | 0.12 | 0.0021 | 0.022 | | | | | |
| C.D. (5%) | 12.4 | NS | 0.36 | 0.0044 | 0.057 | | | | | |
| C.V. (%) | 5.00 | 3.91 | 8.04 | 5.20 | 6.77 | | | | | |

*Place the level of statistical difference in the resulting mean values of the measured variables: a, b, c, d, etc.*
*The similar variables a,b,c and d represent of each individual parameters represent statistically significant.*

**Table 2. Pooled (three years) analysis of grain yield (t/ha) of *Rabi* sorghum as influenced by priority inputs**

| Treatment | 2014-15 | 2015-16 | 2016-17 | Pooled mean (t/ha) |
|---|---|---|---|---|
| T1 : Control (only improved hybrid without any input) | 2.14 | 1.95 | 2.02 | 2.04 |
| T2 : Full package of practice (FPP): Protective irrigation +Fertilizer (RDF)+Weed control (herbicide and hand weeding)+ | 3.39 | 3.10 | 2.96 | 3.15 |
| T3 : FPP minus Irrigation | 3.05 | 2.62 | 2.63 | 2.77 |
| T4 : FPP minus Fertilizer | 2.53 | 2.36 | 2.30 | 2.40 |
| T5 : FPP minus Weed control | 2.81 | 2.61 | 2.60 | 2.68 |
| T6 : FPP minus Plant protection | 2.37 | 2.37 | 2.41 | 2.38 |
| T7 : FPP minus Seed treatment with PSB and Azospirillum | 2.91 | 2.60 | 2.69 | 2.73 |
| T8 : FPP minus Thinning | 2.48 | 2.39 | 2.39 | 2.42 |
| T9 : FPP minus Improved variety (use local variety of the region) | 2.81 | 2.68 | 2.69 | 2.72 |
| SE m | 0.16 | 0.14 | 0.02 | 0.12 |
| C.D. (5%) | 0.48 | 0.36 | 0.05 | 0.36 |
| C.V. (%) | 10.3 | 8.32 | 8.39 | 8.04 |

## 4. CONCLUSION

For better Rabi sorghum productions one should go with all Priority inputs FPP i.e. Protective irrigation+ fertilizer (RDF)+Weed control (Herbicides and Hand Weeding) + Plant protection (application of insecticide and fungicides seed treatments with fungicides)+ seed treatment with PSB and Azospirillum + Thinning.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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