ORIGINAL RESEARCH ARTICLE

EFFECT OF PRODUCTION FACTORS ON GROWTH AND YIELD OF *RABI* SORGHUM (*Sorghum bicolor* L.)

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

Key words: Production factors, *Rabi* Sorghum and Yield

INTRODUCTION.

In most of the developing countries, grain in the form of wheat, rice, millet, sorghum or maize/corn supports daily sustenance of millions of population. In Western parlance, cereals are viewed as breakfast items such as cornflakes, oats or rye and as baking components. Though there are over 350,000 plant species on earth, no fewer than 20 plant species supply over 90% of human food requirements. The top five grains that are consumed in the world: corn/maize, wheat, rice, barley, and sorghum are indeed cereals (Food and Agriculture Organization (FAO, 2015) [1]. An average Indian meal always revolves around a cereal – wheat, rice, millet, maize, or sorghum which replenishes 70% of per capita calorie intake (Sen, 2009) [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 (Alexandratos & Bruinsma, 2012) [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

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development. The need to feed increasing population in the country requires regular assessment of its natural and climate resources for proper land use.

The production of sorghum and pearl millet has increased from the 1970s due to the development and distribution of high-yielding varieties. Over the years disease-resistant and productive varieties have raised yields and positively impacted 6 million millet producing households and 3 million sorghum-producing households. Effective collaboration between public research and private industry has been the reason for the poor and small farmers' adoption of improved varieties in the India's semi-arid lands (Pray & Nagarajan, 2009) [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} (www.Indiastat.com, 2019-20)[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 substantial part of crop comes under drought-prone, semi-arid tropical regions on earth. With limited inputs and rain and low soil fertility, its growth is limited, so also the yields. However, there is a tremendous potential for sorghum under favorable conditions. Unfortunately a large percentage of subsistence farmers are failing to maximize its potential due to absence of better management practices.

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

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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

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, fodder yield 5.30 t/ha, 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).

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 and fodder yield of 6.61 t/ha and harvest index was 31.36 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

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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 (1991)[10]; Sumeriya and Singh (2008) [11]; Mishra et al. (2009) [12]

ECONOMICS

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 was adopted. Similar findings were reported by Ahmed et al. (2010) [13] and Sagarka et al. (2013) [14]

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.

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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)	Net returns (Rs/ha)	BCR	Decrease in grain yield as compared to FPP
T1 : Control (only improved hybrid without any input)	137	71	2.04	5.30	27.79	79350	58350	2.78	32
T2 : Full package of practice (FPP): Protective irrigation +Fertilizer (RDF)+Weed control (herbicide and hand weeding)+	161	70	3.15	6.61	31.36	115615	91655	3.83	0
T3 : FPP minus Irrigation	140	68.	2.77	5.60	33.09	105350	82360	3.58	12
T4 : FPP minus Fertilizer	137	67	2.40	6.30	27.59	93450	71950	3.35	23
T5 : FPP minus Weed control	124	67	2.68	5.71	31.94	102365	79815	3.54	14
T6 : FPP minus Plant protection	128	71	2.38	5.83	28.99	92045	69145	3.02	24
T7 : FPP minus Seed treatment with PSB and Azospirillum	143	71	2.73	5.93	31.52	104445	81045	3.46	13
T8 : FPP minus Thinning	128	71	2.42	6.00	28.74	93700	71800	3.28	23
T9 : FPP minus Improved variety (use local variety of the region)	148	72	2.72	6.01	31.16	104215	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				

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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

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