INFLUENCE OF SEED PRIMING AND FOLIAR SPRAY OF NUTRIENTS 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.* 2015-16, 2016-17 and 2017-18 to study the Influence of seed priming and foliar spray of nutrients on growth and yield of *Rabi* Sorghum during the winter seasons. The experiment was laid out in split plot design with two factors. The treatments comprised were Factor 1: Seed priming (5) 1.Priming for 12 Hours in Water 2.Priming with $ZnSo_4$ (2% solution) 3.Priming with K_2HPO_4 (2% solution). 4. Priming with KNO_3 (2% solution) and 5.Control (No Priming). Factor 2: Foliar Spray (4) 1.KNO_3 @ 2g in 100 ml of water, 2. Diammonium phosphate @ 2g in 100 ml of water, 3.Urea @ 2g in 100 ml of water and 5.Control (Simple water spray) with three replications. The pooled results of the trial indicated that seed treatment with KNO_3 @ 0.5% and seed priming with KH_2PO_4 @ 0.5% recorded significantly on par and highest among all other seed priming treatment. The 100 seed weight (g) and grain yield t/ha recorded significantly on par by foliar spraying of KNO_3 @ 2 % and di ammonium phosphate @ 2g in 100 ml of water over the control. The combination of seed priming with KNO_3 and foliar spray of KNO_3 or di ammonium phosphate @ 2g in 100 ml of water or Urea @ 2g in 100 ml of water resulted in highest and on par grain yield of rabi sorghum.

Key words: seed priming, foliar spray, *Rabi* Sorghum and Yield

INTRODUCTION

Sorghum is an important cereal crop of poor, small and marginal farmers in semi-arid regions of the world. Yield and quality of the sorghum crop often suffers due to presence of insufficient soil moisture during its growth period. The productivity of rabi sorghum is dependent on quantity of rains during pre-season monsoon and water holding capacity of soil, use of moisture conservation practices, use of high yielding cultivars on basis of soil types and available production technologies. Rabi sorghum is valued mainly for direct human food consumption and fodder for livestock.

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). 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. Among different dryland crops, the crops like Rabi Sorghum which are grown in post rainy season under receding soil moisture conditions frequently suffer due terminal drought conditions. Among various drought mitigation options, seed priming and foliar nutrition known to impart tolerance to drought in several other crops.

Drought is the most widespread hydro-meteorological syndrome of 'prolonged period of water scarcity affecting natural resources, environment and, thereby, the people'. Environmental changes, viz. climate change, land-use changes and natural resource degradation have aggravated drought occurrences and vulnerability, thus disrupting the normal socio-economic settings. All the regions of India suffer with drought incidences of varying periodicity, with 13 states repeatedly declared as drought-prone. Among different dryland crops, the crops like Rabi Sorghum which are grown in post rainy season under receding soil moisture conditions frequently suffer due to terminal drought conditions. Among various drought mitigation options, seed priming and foliar nutrition known to impart tolerance to drought in several other crops.

Seed priming has been used to improve germination, reduce seedling emergence time, improve stand establishment and yield. Foliar application is widely used to mitigate the nutrient stress in many crops. Uniformity and increased seedling emergence of direct seeded crops have major impact on final yield and quality (Gupta et al., 2008). Soluble salts are generally effective in foliar sprays. Dudhade and Gadakh (2020) reported that foliar spray increase in seed yield was due to more absorption of micronutrients through leaves and flowers. The foliar spraying can reduce the cost incurred by farmers on soil applied fertilizers but also the applied nutrients are taken-up directly by their target organs, providing a specific and rapid response. Than often the soil with its chemical, physical and biological complexity acts as a barrier and a buffering medium.

Keeping this in view, the present investigation was under taken to study the influence of seed priming and foliar spray on yield of rabi sorghum during rabi seasons of 2015-16, 2016-17 and 2017-18.

MATERIAL AND METHODS

A field experiment was conducted at Agriculture Research Station, Tandur, Professor Jayashankar Telangana State Agricultural University for three consecutive years 2015-16, 2016-17 and 2017-18. 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 treatment combinations were laid out Split Plot design with two factors Factor 1: Seed priming (5)

1.Priming for 12 Hours in Water 2.Priming with $ZnSO_4$ (2% solution) 3.Priming with K_2HPO_4 (2% solution). 4. Priming with KNO_3 (2% solution) and 5.Control (No Priming). Factor 2: Foliar Spray (4) 1.KNO_3 @ 2%, 2.di ammonium phosphate @ 2g in 100 ml of water, 3.Urea @ 2% and 5.Control (Simple water spray) with three replications. After priming seeds were dried in shade for about one hour and then used for sowing. The foliar spraying was done at 55 days after emergence (at boot leaf stage). The crop was sown with the spacing of 45×20 cm. 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 (1956). The available phosphorus status in soil was estimated by Olsen's method (Olsen et al., 1954) and potassium content in soil was determined by Flame Photometry (Jackson, 1967). The results were analyzed using standard statistical procedure given by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

SEED PRIMING

The pooled analysis of results revealed that (Table.1), there is a significant difference between the growth and yield parameters of *Rabi* Sorghum. Among the treatments of seed priming with KNO_3 @ 0.5% for 12 hours produced significantly higher plant height (172 cm), while seed priming with KNO_3 @ 0.5% and seed priming with KH_2PO_4 @ 0.5% recorded significantly on par and highest among all other seed priming treatments with respective to the parameters of days to 50% flowering (71 & 72 days), 100 seed weight (3.6 and 3.57 g), grain yield 2.73 & 2.70 t/ha, dry fodder yield (5.68 & 5.70 t/ha) respectively. Harvest index did not exhibit any significant variation among the different seed priming treatment. This might be due to the seeds priming resulted in earlier emergence of seedlings by 1-3 days and significantly increased plant stand and initial growth vigour. Nitrate is utilised as food by plants for growth and production. The level of nitrate in soil varies widely, depending upon the type of soil, climate conditions, rainfall and fertilizing practices. Similar results were obtained by Musa et al. (1999). Srivastava and Bose (2012) reported the beneficial effect of priming treatments [(Mg $(NO_3)_2$] and KNO_3) which was clearly exhibited in plant height, leaf area and number of leaf and yield attribute characteristics in rice. Ahmadvand et al., (2012) reported that seed priming with

KNO_3 caused a significant increase in germination and emergence percentage, radicle and plumule length, seedling dry weight, plant height, plant leaf area and plant dry weight in soybean.

FOLIAR SPRAY

The plant height (cm) did not exhibit any significant difference by the foliar spray treatment. The days to 50 % percent flowering was significantly higher and on par with the foliar spray of KNO_3 @ 2 %, di ammonium phosphate @ 2g in 100 ml of water and urea @ 2% spray over the control. It recorded 70.93, 70.47 and 70.47 respectively. While the 100 seed weight and grain yield recorded significantly on par by foliar spraying of KNO_3 @ 2 % and di ammonium phosphate @ 2g in 100 ml of water (3.60 & 3.62 g) and (2.70 & 2.75 t/ha) respectively over the control. While, the dry fodder yield recorded higher yield of 5.69 t/ha with urea @ 2% spray over the other foliar sprayings. Harvest index did not have any significant change by the foliar spray of the nutrients. This might be due to prolonged vegetative growth which increased the plant height (Sivamurugan *et al*, 2018). This result is in conformity with the Poornima and Koti (2019) indicated that higher grain yield was recorded in 500 ppm Nano ZnO Foliar Spray as compared to 1000 ppm Bulk $ZnSO_4$ Foliar Spray. The grain yield of ragi was increased by 31.49 % due to the application of urea spray followed by 19:19:19 spray which has recorded 30.37 % increase in yields (Gokul and Senthilkumar 2019). The findings of Dudhade and Gadakh (2020) reported that foliar spray of KNO_3 increased the grain yield of sorghum to 13.08 per cent over the control. KNO_3 and di ammonium phosphate @ 2g in 100 ml of water foliar spray mitigates the water stress during critical stages of flowering and grain formation.

The combination of seed priming and foliar spray of the nutrients (Table.2) resulted in significant yield increase over the control. The combination of seed priming with $ZnSO_4$ @ 0.5% and foliar spraying of KNO_3 and di ammonium phosphate @ 2g in 100 ml of water spray resulted in higher grain yield of 2.98 and 2.91 t/ha respectively, while the combination of seed priming with KNO_3 and foliar spray of KNO_3 and di ammonium phosphate @ 2g in 100 ml of water and Urea @ 2% resulted in highest and on par grain yield of rabi sorghum (3.09, 2.99 and 2.77 t/ha) respectively. This might be due to the fact that nitrate-N levels in soils are governed by soil clay content, bulk density, organic matter content, pH, temperature, and rainfall. Maximal rates of N mineralization require an optimal level of air-filled pore space and Nitrogen also leaches out of soil naturally. Nitrate ions and ammonium ions can be taken up by plants (some prefer one to the other). In very high nitrogen soils, the added extra nitrate will stimulate plant growth. While that of the combination of seed priming with KH_2PO_4 and KNO_3 and di ammonium phosphate @ 2g in 100 ml of water spray resulted in highest and on par grain yield of 2.87 and 2.98 t/ha respectively over the control. Rishi Prasad and Debolina chakraborty (2019) reported that the concentration of phosphorus available to plants at any time is very low and ranges from 0.001 mg L^{-1} to 1 mg L^{-1}. The forms of phosphorus most readily accessed by plants are orthophosphate ions ($H_2PO_4^-$, HPO_4^{2-}) Application of chemical fertilizer temporarily increases the concentration of the plant-available phosphorus pool in soil and supports the plant phosphorus needs during their vegetative and reproductive stages Nitrate mobility within the soil environment is governed to a significant extent by electrostatic interactions between negatively charged NO_3^- ions and charged soil particle sur-faces (either mineral or organic). Anion adsorption occurs when NO_3^- ions become attached to positively charged exchange sites on a soil surface. Barry et al., 2007 reported that anion exclusion processes dominate, NO_3^- ions are repelled from soil particle surfaces and move at a rate faster than the overall average pore-water velocity. Bhadane et al., (2020) reported that seed priming with 2% $CaCl_2$ followed by 1% foliar spraying at 30 DAS significantly improved most of morpho-physiological parameters and yield contributing traits in Green gram. Seed treatment with bulk $ZnSO_4$ has produced higher total dry matter and grain yield but grain zinc content was highest in nano ZnO. (Poornima and Koti, 2019). While Dudhade and Gadakh (2020) reported by combined effect of seed priming KNO_3 @ 0.5% and foliar spray of KNO_3 @ 2 % produced higher grain yield of 3.0 t/ha and fodder yield 7.6 t/ha respectively.

ECONOMICS

Gross returns of Rupees 98280 ha^{-1}, Net returns of rupees 75780 ha^{-1} and benefit cost ratio were recorded highest with the seed priming of KNO_3 @ 0.5% for 12 hours. While Gross returns of Rupees 99000 ha^{-1}, Net returns of rupees 76500 ha^{-1} and benefit cost ratio of 3.40 accrued with the foliar spray of di ammonium phosphate @ 2g in 100 ml of water were recorded highest. This might be due to higher yield of crop with these treatments. Similar results were earlier reported by (Poornima and Koti, 2019) Dudhade and Gadakh (2020) in Rabi Sorghum.

CONCLUSION

On the basis of results obtained from the experiment, it can be concluded that seed priming with KNO_3 @ 0.5% or $ZnSO_4$ for 10-12 hrs and foliar spray of KNO_3 and di ammonium phosphate @ 2g in 100 ml of water at 55 DAS is equally effective as compared to other seed priming and foliar sprays. The combined effect of seed priming and foliar spray priming with KNO_3 and foliar spray of KNO_3 and di ammonium phosphate @ 2g in 100 ml of water and Urea @ 2% resulted in highest and on par grain yield of rabi sorghum.

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Table 1. Effect of seed priming and foliar spray on plant height, yield attributes, yield and economics of rabi sorghum. (Pooled means 2014-15, 2015-16 and 2016-17)

Treatment	Plant height (cm)	Days to 50% flowering	100 Seed weight (g)	Grain yield (t/ha)	Dry fodder yield (t/ha)	Harvest index (%)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C Ratio
Seed priming for 12 hours									
1 Control (No priming)	153	67	3.18	2.11	4.23	33.28	75960	53585	2.39
2 Seed priming with water	159	69	3.31	2.40	5.44	30.61	86400	64025	2.86
3 Seed priming with $ZnSO_4$ (0.5%)	161	69	3.51	2.58	5.36	32.49	92880	70380	3.13
4 Seed priming with KNO_3 (0.5%)	172	72	3.60	2.73	5.68	32.46	98280	75780	3.37
5 Seed priming with KH_2PO_4 (0.5%)	159	71	3.57	2.70	5.70	32.14	97200	74700	3.32
SE m	4.52	0.64	0.09	0.05	0.20	0.96			
C.D. (5%)	9.21	1.32	0.18	0.13	0.56	NS			
Foliar spray									
Control (water spray)	156	66.33	3.31	2.17	4.84	30.96	78120	55820	2.50
KNO_3 @ 2g in 100 ml of water	163	70.93	3.60	2.70	5.20	34.01	97200	74700	3.32
Di Ammonium Phosphate @ 2g in 100 ml of water	159	70.47	3.62	2.75	5.40	33.74	99000	76500	3.40
Urea @2 g in 100 ml of water	160	70.27	3.27	2.40	5.69	29.67	86400	63900	2.84
SE m	3.56	1.17	0.07	0.04	0.17	0.90			
C.D. (5%)	NS	2.29	0.15	0.12	0.50	1.70			
C.V. (%)	7.00	6.81	5.94	6.77	7.48	7.15			
Interaction PXF									
SE m	7.2	0.7	0.12	0.13	0.31	1.58			
C.D. (5%)	NS	NS	NS	0.27	NS	NS			

Table 2. Pooled means of Interaction effect of seed priming and foliar spray on grain yield t/ha (2014-15, 2015-16 and 2016-17).

Seed priming with foliar spray	(water spray)	KNO_3 @ 2g in 100 ml of water	DI ammonium phosphate @ 2g in 100 ml of water	Urea @ 2g in 100 ml of water	Mean
(No priming)	1.99	2.15	2.11	2.21	2.11
Seed priming with water	2.11	2.41	2.78	2.29	2.40
Seed priming with $ZnSo_4$ (0.5%)	2.33	2.98	2.91	2.08	2.58
Seed priming with KNO_3	2.08	3.09	2.99	2.77	2.73
Seed priming with KH_2PO_4 (0.5%)	2.34	2.87	2.98	2.63	2.70
Mean	2.17	2.70	2.75	2.40	

Seed priming	SE (m) 0.05	CD 0.13
Foliar spray	SE (m) 0.04	CD 0.12
Seed priming with foliar spray	SE (m) 0.09	CD 0.27