International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2020; 8(1): 2176-2179

Received: 04-11-2019
Accepted: 06-12-2019

Siddanagouda
Department Crop Physiology, College of Agriculture, UAS, Raichur, Karnataka, India

MM Dhanoji
Department Crop Physiology, College of Agriculture, UAS, Raichur, Karnataka, India

MK Meena
Department Crop Physiology, College of Agriculture, UAS, Raichur, Karnataka, India

TC Suma
Department Crop Physiology, College of Agriculture, UAS, Raichur, Karnataka, India

Hasan Khan
Department of Genetics and Plant Breeding, College of Agriculture, UAS, Raichur, Karnataka, India

Corresponding Author:
Siddanagouda
Department Crop Physiology, College of Agriculture, UAS, Raichur, Karnataka, India

Physiological approaches to improve productivity of *Rabi* sorghum (*Sorghum bicolor* L. Moench) through foliar nutrition

Siddanagouda, MM Dhanoji, MK Meena, TC Suma and Hasan Khan

DOI: https://doi.org/10.22271/chemi.2020.v8.i1ag.8589

Abstract
A field experiment was conducted at Agricultural Research Station (ARS) Bheemarayanagudi, UAS, Raichur, Karnataka during *Rabi* -2018, to study the influence of foliar spray of nutrients and PGRs on growth and yield of *Rabi* sorghum (*Sorghum bicolor* L. Moench) variety M 35-1. The experiment was laid out in RCBD and was replicated thrice. There were twenty treatments consisting of primary (2%), secondary (0.5%), micronutrients (0.1%), salicylic acid (200 ppm) and cycocel (4000 ppm) alone or in combination. Foliar spray treatments *viz.*, CCC and SA were imposed at 40 and 50 DAS, respectively. The foliar spray of essential nutrients were imposed twice at 60 and 80 DAS.

Foliar spray treatment T_{19} (Primary nutrients@ 2%+ Secondary nutrients @ 0.5%+ Micronutrients @0.1%+ SA @200ppm + CCC@400ppm) recorded the significant improvement grain yield (1996.5 kg ha^{-1})over control (1,376 kg ha^{-1}). The significant increase in the seed yield with combination of nutrients and PGRs (T_{19}) may be due to the improvement in the yield traits namely ear length, ear weight, seeds per ear and test weight, which were largely depends on the growth parameters like plant height, leaf area and total dry matter accumulation and its partition into leaf, stem, and ear. Thus, improvement in the yield seems to be due to timely supply of essential nutrients and PGRs

Keywords: SA CCC**,** Grain yield, rabi sorghum, foliar spray

Introduction

Sorghum (*Sorghum bicolor* L. Moench) locally known as jowar is the fifth most important cereal crop, after rice, wheat, maize and barley. It is a short-day C_4 plant, and it is easily adaptable to hot and dry agro-ecologies India is the second largest producer of sorghum and also a major consumer after rice and wheat particularly in northern Karnataka and parts of Maharashtra. The national (812 kg ha^{-1}) and Karnataka state (892 kg ha^{-1}) level productivity of sorghum is much lower than the world average. (1440 kg ha^{-1}. Anon., 2017) [2].

One of the reasons for the poor productivity is its cultivation season is *Rabi* which is characterised as residual moisture situation and more so as a rain fed crop. Because of the terminal drought which coincides with yield formation phase of the crop, plants are may not be able to absorb required nutrients. Further, enhanced early ageing of leaves due to low or under supply of nutrients and imbalanced plant growth regulators level due to drought, certainly results in source limitation. As a matter of fact, the expected level of physiological processes will not be taking place mostly production and translocation of assimilates. The nutritional imbalance in plants can be addressed rapidly and effectively through foliar spray to realize productivity potential. (Dixon, 2003) [4].

Plant growth regulators play a vital role in improving important growth and yield attributing characters by optimising sources and sink relationship. The growth retardant cycocel (CCC) check the excess vegetative growth and reduces plant stature with more branching and keeps leaves green for long period and consequently improves grain quality and yield. On other hand, salicylic acid (SA) plays an important role in tolerance of abiotic stress. Salicylic acid significantly alleviated the growth inhibition induced by drought and manifested by less decreased fresh and dry mass, plant height, root length, chlorophyll and many physiological roles. Hence the present investigation was under taken to improve the grain yield through foliar spray nutrients, CCC and SA.

Materials and Method

A field experiment was conducted at Agricultural Research Station (ARS) Bheemarayanagudi, University of Agricultural Sciences, Raichur, Karnataka to study effect of foliar spray of essential nutrients and plant growth regulators on morphological and yield parameters of *RABI* sorghum (var. M 35-1). The experiment was laid out in randomized complete block design with 3 replications during 2018. The experiment consisting of 20 different treatment *i.e.*, T_1 = (Primary nutrients ie NPK @ 2%, source is water soluble 19 all commercial grade.) T_2 = (Secondary nutrients, source is MgSO4 and CaSO4 @ 0.5 %-water soluble commercially available grades) T_3 = Micronutrients @0.1 % (water soluble mixture of Iron Zinc and Boron source is commercialy available Librel TMX 2) $T_4 = T_1+T_2+T_3$, T_5= Salicylic acid,@ 200ppm (laboratory grade) T_6 = Cycocel 4000 ppm (Lihosin commercial grade was used,) $T_7 = T_5+T_6$, $T_8 = T_1+T_5$, $T_9 = T_1+T_6$, $T_{10} = T_1+T_7$, $T_{11} = T_2+T_5$, $T_{12} = T_2+T_6$, $T_{13} = T_2+T_7$, $T_{14} = T_3+T_5$, $T_{15} = T_3+T_6$, $T_{16} = T_3+ T_7$, $T_{17} = T_4+T_5$, $T_{18} = T_4+T_6$, $T_{19} = T_4+T_7$ and T_{20} = control (without spray). At physiological maturity of crop stage, five plants were randomly selected and tagged from each net plot for the purpose of recording various observations. Plant height was measured from the ground level up to the tip of plant and expressed in centimeters. The leaf area per plant was worked out by disc method on dry weight basis as per Vivekanandan *et al.* (1972) [10]. Total dry matter production and its partition into leaf, stem and reproductive parts were recorded at harvest. Seed yield per hectare was computed from seed yield per plot. The ear head of the net plot were threshed, cleaned and the weight of seeds was recorded as seed yield per plot and expressed as yield per hectare.

Results & Discussion

Significantly higher plant height was recorded in foliar spray treatment T_{17} (248.1) cm) and was on par with T 19. The increase in plant height might be due to the fact that, in time availability of the essential nutrients to the plant at the important growth stages might have resulted in proper ratio of growth promoting growth regulators. These nutrients might have helped in keeping more photosynthetic apparatus as a consequence more assimilates were produced and increased the plant height (Jasim Iqbal *et al.*, 2016) [5]. It is evident from the reports of Manasa and Devaranavadagi, 2015 who recorded increased IAA with Zn supply Further significantly least plant height by T_6 (CCC spray, 177.4) as compare control and all other treatments might due to the fact that CCC is a growth retardant which checks linear growth of the plants. similar effect of CCC was observed in wheat (Mahmoud, 2001) [6] and in maize (Parasuraman, 2008) [7].

Leaf area provides a fair idea of the photosynthetic capacity of the crop. However, T_{19} recorded statistically higher leaf area over Control (23.8 dm^2 $plant^{-1}$). Increased leaf area might be due to increased plant height and more number of leaves per plant in addition to e improved photosynthetic capacity by the foliar fertilization of major nutrients *viz.,* nitrogen, phosphorus and potassium including the micronutrients (Prajwal *et al*. (2018) [8].

The T_{19} (recorded the higher dry matter (165.3 g $plant^{-1)}$, over Control (102.1 g $plant^{-1}$). The improvement in the dry matter production may be due to greater absorption, assimilation, translocation and metabolization of nutrients resulting in increased physiological process viz photosynthesis and translocation, particularly at flowering period indirectly helping in maintaining higher leaf area, leaf area index ultimately, higher dry matter production per plant. (Zayed *et al*. 2011) [11]. Interestingly, in the present study. Increased production of dry matter and its efficient translocation to the economic parts ultimately reflected on significant improvement in yield and yield attributes (Table 2) like ear weight (100.79), test weight (3.12), grain yield (1996.5 kg ha^{-1}) and straw yield (5526.9 kg ha^{-1}) and more so with $T_{19.}$

The treatment T_{19} showed the increased test weight (1.35 folds) compared to control. The in time supply of macro and micro nutrients in combination with CCC and SA, at critical stage of the crop, certainly stimulated cell division and expansion or elongation, consequently increasing number and weight of grains resulying in enhanced accumulation of assimilate in the grains and thus heavier grains. This might be due to improved dry matter production, higher photosynthesis and sugar accumulation as influenced by foliar spray. (Arif *et al*. (2006) [3] and Shekoofa *et al*. (2008) [9].

The foliar application of essential nutriants in combination with PGRs ieT_{19} (Primary @ 2% + Secondary @ 0.5% + Micronutrients @ 0.1% + SA @ 200 ppm + CCC @ 4000 ppm) increased the grain yield by 46% as compared to unspray. This increase in yield might be due to the additional availability of macro and micro nutrients which might have improved source and vegetative sink and was evident from higher leaf area, leaf weight per plant, stem weight. plant height and total dry matter. Further, it is was observed that, not only the source, but sink size and sink capacity were also improved and was clear from more number of seeds per head and more seed weight per ear head test weight of the seeds. This might be attributed to the improved translocation and assimilation of nutrients leading to increased grain yield. Obviously significantly increased straw yield was associated with T 19 as compare control. Similar observations reported by Arif *et al*. (2006) [3] in wheat and Anees *et al*. (2016) [1] in maize.

Table 1: Morphological parameters of *Rabi* sorghum as influenced by foliar spray of essential nutrients and plant growth regulators

Treatment	Plant height (cm)	Leaf area (dm^2 $plant^{-1}$)	Total dry matter (g $plant^{-1}$)	Leaf dry matter (g $plant^{-1}$)	Stem dry matter (g $plant^{-1}$)	Total dry matter (g $plant^{-1}$)
T_{1}-Primary nutrients @ 2%	222.8	26.0	121.6	9.51	45.19	121.6
T_{2}-Secondary nutrients @ 0.5%	221.4	24.5	115.0	9.25	41.81	115.0
T_{3}-Micronutrients @ 0.1%	217.8	25.7	114.4	8.13	40.78	114.4
T_{4} - Primary @ 2% + Secondary @ 0.5% + Micronutrients @ 0.1%	243.1	26.5	129.9	9.25	48.58	129.9
T_{5}-SA @ 200 ppm	214.9	27.1	113.8	8.06	39.19	113.8
T_{6}-CCC @ 4000 ppm	177.4	25.8	124.0	9.60	46.27	124.0
T_{7} -SA @ 200 ppm + CCC @ 4000 ppm	189.6	27.2	129.5	9.69	51.49	129.5
T_{8}- Primary nutrients @ 2% + SA @ 200 ppm	235.1	25.9	122.2	7.72	46.59	122.2
T_{9}- Primary nutrients @ 2% + CCC @ 4000 ppm	195.3	27.8	129.8	8.24	50.81	129.8
T_{10}-Primary nutrients @ 2% + SA @ 200 ppm + CCC @ 4000 ppm	197.8	25.9	134.4	9.64	56.46	134.4
T_{11}-Secondary nutrients @ 0.5% + SA @ 200 ppm	230.8	26.9	116.7	7.89	42.29	116.7
T_{12}-Secondary nutrients @ 0.5% + CCC@ 4000 ppm	193.2	28.1	129.3	8.62	46.64	129.3
T_{13}-Secondary nutrients @ 0.5% + SA @ 200 ppm + CCC @ 4000 ppm	197.5	27.3	133.6	9.52	54.35	133.6
T_{14}-Micronutrients @ 0.1% + SA @ 200 ppm	220.9	26.5	118.3	8.00	41.43	118.3
T_{15}-Micronutrients @ 0.1% + CCC @ 4000 ppm	189.7	25.2	125.9	8.96	48.07	125.9
T_{16}-Micronutrients @ 0.1% + SA @ 200 ppm + CCC @ 4000 ppm	219.2	26.0	133.0	8.03	53.49	133.0
T_{17}-Primary @ 2% + Secondary @ 0.5% + Micronutrients @ 0.1% + SA @ 200 ppm	248.1	29.5	147.2	10.76	61.03	147.2
T_{18}- Primary @ 2% + Secondary @ 0.5% + Micronutrients @ 0.1% + CCC @ 4000 ppm	196.9	31.2	154.7	12.55	66.64	154.7
T_{19}-Primary @ 2% + Secondary @ 0.5% + Micronutrients @ 0.1% + SA @ 200 ppm + CCC @ 4000 ppm	201.8	32.1	165.3	14.98	69.71	165.3
T_{20}-Control	203.4	23.8	102.1	6.13	37.62 49.47	102.1
Mean	211.8	27.0	128.0	9.132	2.01	128.0
Se.M. (±)	8.7	1.0	5.1	0.37	++5.75	5.1
CD @ 5%	24.9	2.2	14.7	s1.05		14.7

Table 2: Yield and yield attributes of *Rabi* sorghum as influenced by foliar spray of essential nutrients and plant growth regulators

Treatment	Grains per ear head	Ear weight (g)	Test weight (1000seed g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T_{1}-Primary nutrients @ 2%	1574	86.15	2.70	1591.8 (16)	4176.5
T_{2}-Secondary nutrients @ 0.5%	1478	83.59	2.61	1548.2 (12)	3754.5
T_{3}-Micronutrients @ 0.1%	1423	81.51	2.52	1510.8 (10)	3584.2
T_{4} - Primary @ 2% + Secondary @ 0.5% + Micronutrients @ 0.1%	1943	88.63	2.8	1701.7 (24)	5214.8
T_{5}-SA @ 200 ppm	1278	80.11	2.44	1462.5 (6)	3598.2
T_{6}-CCC @ 4000 ppm	1539	87.62	2.67	1497.1 (9)	4166.4
T_{7} -SA @ 200 ppm + CCC @ 4000 ppm	1766	89.73	2.76	1586.6 (15)	4731.8
T_{8}- Primary nutrients @ 2% + SA @ 200 ppm	1623	81.95	2.78	1569.3 (14)	4396.1
T_{9}- Primary nutrients @ 2% + CCC @ 4000 ppm	1731	90.15	2.75	1538.1 (12)	4960.0
T_{10}-Primary nutrients @ 2% + SA @ 200 ppm + CCC @ 4000 ppm	1892	85.68	2.84	1627.9 (18)	5283.0
T_{11}-Secondary nutrients @ 0.5% + SA @ 200 ppm	1502	86.19	2.68	1498.3 (9)	3768.4
T_{12}-Secondary nutrients @ 0.5% + CCC@ 4000 ppm	1699	89.50	2.74	1520.4 (10)	4863.5
T_{13}-Secondary nutrients @ 0.5% + SA @ 200 ppm + CCC @ 4000 ppm	1853	87.82	2.78	1626.9 (18)	4970.6
T_{14}-Micronutrients @ 0.1% + SA @ 200 ppm	1358	82.06	2.58	1492.4 (8)	4231.5
T_{15}-Micronutrients @ 0.1% + CCC @ 4000 ppm	1661	89.13	2.73	1478.7 (7)	4934.6
T_{16}-Micronutrients @ 0.1% + SA @ 200 ppm + CCC @ 4000 ppm	1810	85.01	2.77	1559.5 (13)	5113.2
T_{17}-Primary @ 2% + Secondary @ 0.5% + Micronutrients @ 0.1% + SA @ 200 ppm	1992	96.39	2.89	1757.3 (28)	5249.5
T_{18}- Primary @ 2% + Secondary @ 0.5% + Micronutrients @ 0.1% + CCC @ 4000 ppm	2040	98.27	2.96	1872.4 (36)	5104.3
T_{19}-Primary @ 2% + Secondary @ 0.5% + Micronutrients @ 0.1% + SA @ 200 ppm + CCC @ 4000 ppm	2112	100.79	3.12	1996.5 (46)	5526.9
T_{20}-Control	1187	72.24	2.30	1376.4	3359.4
Mean	1673	86.98	2.72	1589.7	4454.4
Se.M. (±)	68	3.50	0.11	60	171.5
CD @ 5%	194	10.04	0.31	171.7	491.2

() Figures in parenthesis indicates per cent increase in yield over control.

Reference

1. Anees MA, Ali A, Shakoor U, Ahmed F, Hasnain Z, Hussain A. Foliar applied potassium and zinc enhances growth and yield performance of maize under rainfed conditions. Int. J Agri. Biol. 2016; 18(5):1025-1032.
2. Anonymous. Ministry of Agriculture, Govt. of India, 2017. www.indiastat.com.
3. Arif M, Chohan MA, Ali S, Khan S. Response of wheat to foliar application of nutrients. J Agri. Bio. Sci. 2006; 1:30-34.
4. Dixon RC. Foliar fertilization improves nutrient use efficiency. Fertilizer Tech. 2003; 40:22-23.
5. Jasim I, Khan R, Wahid A, Sardar K, Ahmad R. Effect of nitrogen and zinc on maize (*Zea mays* L.) yield components and plant concentration. Adv. Environ. Bio. 2016; 10(10):203-208.
6. Mahmoud MS. Effect of trace nutrient foliar fertilizer on nutrient balance, growth, yield and yield components of two cereal crops. Pakistan J Biol. Sci. 2001; 4(7):770-774. (Wheat and maize).
7. Parasuraman P. Studies on integrated nutrient requirement of hybrid maize (*Zea mays* L.) under irrigated conditions. Madras Agric. J. 2008; 92(1):89-94.
8. Prajwal GK, Lalitha BS, Kalyana Murthy KN, Bhavya V. Foliar Nutrition: A novel technology to increase growth and yield in baby corn (*Zea mays* L.). Int. J Curr. Microbiol. App. Sci. 2018; 7(4):1136-1148.
9. Shekoofa A, Emam Y. Effect of nitrogen fertilization and plant growth regulators (PGRs) on yield of wheat. Shiraz. J. Agric. Sci. Tech. 2008; 10:101-08.
10. Vivekanandan AS, Gunasena HPM, Sivananyagam T. Statistical evaluation of accuracy of three techniques used in estimation of leaf area of crop plants. Indian J. Agri. Sci. 1972; 42:857-860.
11. Zayed BA, Salem AKM, El-Sharkawy HM. Effect of different micronutrient treatments on rice (*Oryza sativa* L.) growth and yield under saline soil conditions. World J. Agric. Sci. 2011; 7(2):179-184.