International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(2): 1077-1080

Received: 15-01-2019
Accepted: 19-02-2019

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Effect of water soluble fertilizers on growth parameter and economics of sweet corn (*Zea mays* L. *var. saccharata*)

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Abstract
A field experiment was conducted during rabi season of 2016-17 on clayey soil at Instructional Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh to study the effect of recommended dose of fertilizer 120:60:60 NPK kg ha^{-1}along with foliar spray of water soluble fertilizers *viz.*, 19:19:19, 13:40:13, 12:61:00, 00:52:34, 28:28:00, 00:00:50:17.5 S, Urea and KNO_3 on growth and yield of sweet corn var. Madhula in randomized block design with three replications. Foliar spray of water soluble fertilizers, urea and KNO_3 will be done @ 2 % (20 g $liter^{-1}$ water) with soil application of RDF (120:60:60 NPK kg ha^{-1}) at 30, 45 and 60 DAS, the entire dose of phosphorus, potassium and $1/3^{rd}$ dose of nitrogen was applied as basal. Remaining dose of nitrogen was applied in two splits 30 & 60 DAS. The results of experiment indicated that growth parameters *viz*., plant height and dry matter accumulation at 30, 45, 60 DAS and at harvest increased significantly with the application of RDF 120:60:60 kg ha^{-1} NPK along with foliar spray of WSF (19:19:19) @ 2 per cent at 30, 45 and 60 days after sowing and also gave significantly higher green cob and green fodder yields of 7040 kg ha^{-1} and 38737 kg ha^{-1}, respectively. The highest net return (₹ 65714 ha^{-1}) and B: C ratio (2.51) was accrued under the same treatment. In contrast, the control (T_1) recorded minimum net profit as well as BCR.

Keywords: Sweet corn, *Zea mays L. var. saccharata*, Water soluble fertilizers, recommended dose of fertilizer.

Introduction
The cereals are crop plants belonging to the grass family (Poaceae) that are grown for their edible starchy seeds having global importance. About half the ploughed land of the world is given to growing the principal cereals. Wheat, rice, corn, barley, oat, rye, sorghum, and millets provide 56% of the food energy and 50% of the protein consumed on the earth. In general wheat, rice and corn together make-up three-fourth of the world's grain production. Among the cereals, maize (*Zea mays* L.) ranks third in total world production after wheat and rice and it is principal staple food in many countries, particularly in the tropics and subtropics. It has high yield potential than any other cereal crop any it is also referred as "miracle crop" or the "queen of cereals". It is grown as both food for man and fodder for animals and several industrial uses also.

Foliar application of water soluble fertilizers is already a known method of supplementation of plant nutrition. Nutrient uptake by leaves is considerably faster than the roots, foliar nutrition is extremely effective. Application of balanced fertilizer in critical stages of growth will greatly benefit level and quality of agricultural production (Dobrinoiu and Dumbrava, 2003) [3]. Foliar application of nutrients along with soil application has several advantages in supplementing the nutritional requirements of crops such as rapid and efficient response by the plants, less product needed and independence of soil conditions. Foliar nutrition designed to eliminate the problems like fixation and immobilization of nutrients. Hence, foliar nutrition is recognized as an important method of fertilization in modern agriculture. This method provides utilization of nutrients more efficiently and for correcting deficiencies rapidly especially for short duration crops. Recently, new generation specialty fertilizers have been introduced exclusively for foliar feeding and fertilization. Speciality fertilizers are a better source for foliar application (Vibhute, 1998) [13].

Materials and Methods

An experiment was conducted at instructional farm, Junagadh Agricultural University, during *rabi* seasons of 2016-17. The experiment site is situated in South Saurashtra Agro-climatic region of Gujarat. The experimental soil was calcareous clayey and slightly alkaline in reaction with pH 7.9 and EC 0.33 ds/m, The soil (0-15 cm depth) medium in available nitrogen was carried out with Alkaline $KMnO_4$ method by Subbaiah and Asija, 1956 (254-269 kg ha^{-1}), available phosphorus (28.4-30.7 kg ha^{-1}) and available potassium (183-185 kg ha^{-1}). The available P and K were carried out with Olsen's method and Flame Photometric method by Olsen *et al.*, 1954 and Jackson, 1967. The experiment comprise of total 10 treatments comprising of different water soluble fertilizers *viz*., (T_1) Control, (T_2) RDF + Water spray, (T_3) RDF + WSF (19:19:19), (T_4) RDF + WSF (13:40:13), (T_5) RDF + WSF (12:61:00), (T_6) RDF + WSF (00:52:34), (T_7) RDF + WSF (28:28:00), (T_8) RDF + WSF (00:00:50:17.5 S), (T_9) RDF + Urea and (T_{10}) RDF + KNO_3 were evaluated in randomized block design with three replications. Foliar spray of water soluble fertilizers (WSF), urea and KNO_3 will be done @ 2 % (20 g $liter^{-1}$ water) at 30, 45 and 60 DAS. RDF (120:60:60) kg ha^{-1} the entire dose of phosphorus, potassium and 1/3rd dose of nitrogen was applied as basal. Remaining dose of nitrogen was applied in two splits 30 & 60 DAS. The sweet corn variety 'Madhula' was sown on November 24, 2016 at row spacing of 45 cm using seed rate of 15-20 kg ha^{-1}. The area of experiment was 37.0 m ×15.3 m, while gross and net 5.0 m × 2.7 m and 4.0 × 1.8 m, respectively.

Results and Discussion

Effect on growth parameters

Significantly the highest plant height (cm), (Table 1, Fig.1) were observed with the foliar spray of WSF 19:19:19 @ 2 per cent along with 120:60:60 kg NPK ha^{-1} which remained statistically at par with the foliar spray of T_9 (RDF + Urea), T_{10} (RDF + KNO_3) and (T_4) RDF + WSF (13:40:13) at 2% 45 & 60 DAS) in most of the cases. This might be due to positive effect of N, P, K which enhances the higher plant growth and canopy due to augment cell division and cell expansion. Highest dry matter production was recorded in the treatment (T_3) that received (Table 1, Fig. 2) three sprays of WSF 19:19:19 (2%) at 45 and 60 DAS and the lowest dry matter yield was found in control. This might be due to the beneficial effect of nutrients particularly NPK present in readily available form in this fertilizer which were supplied through foliar spray. This increased growth attributes may be the result of additional and adequate supply of N, P and K through foliar application which might have increased nutrient uptake and better translocation of nutrients. These results are in accordance with the findings of Parasuraman (2001) [8]. Significantly increased growth attributes like plant height, number of secondary branches and total dry matter accumulation at flowering as well as pod development stages over control Mudalagiriyappa *et al.* (2016) [6]. The results are in conformity with Abd EL-Fattah *et al.* (2012) [1] in maize.

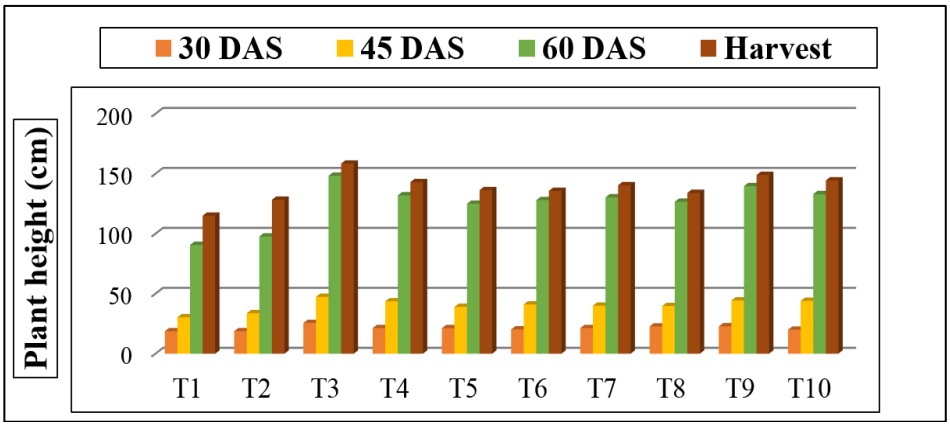

Fig 1: Plant height of sweet corn as influenced by different water soluble fertilizers at different stages

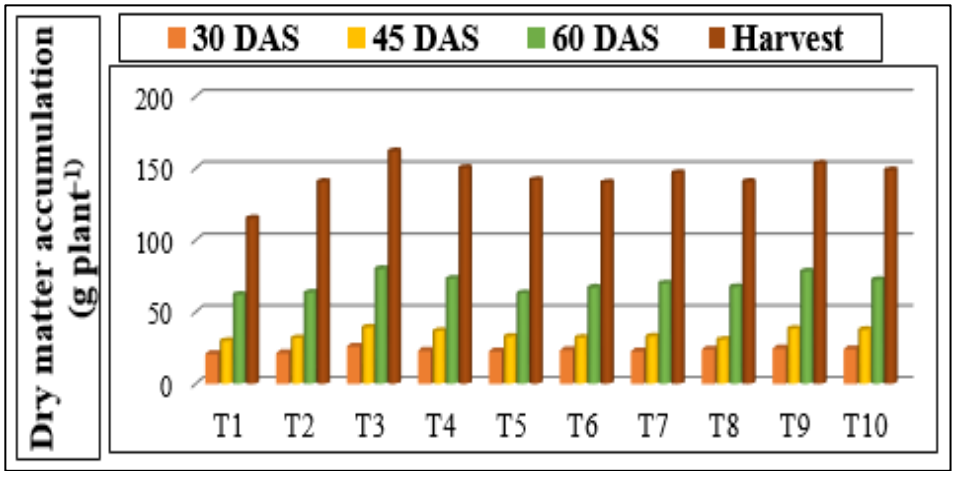

Fig 2: Dry matter accumulation as influenced by different water soluble fertilizers at different stages

Effect on yield

Foliar application of water soluble fertilizers treatments influenced the cob, fodder yield and biological yield of sweet corn. Among the different treatment significantly highest and lowest were recorded with T_3 (RDF 120:60:60 NPK kg ha^{-1} + foliar spray of WSF 19:19:19) @ 2% at 30, 45 and 60 DAS and T_{10} (control), respectively, given in Table 1, Fig 3. Foliar feeding of major nutrients especially N resulted in development and maintenance of more chlorophyll and photosynthetic area in terms of higher leaf area and leaf area index which resulted in higher photosynthesis. In addition, foliar feeding of K helps in higher translocation of photosynthates from leaves to the developing seed and resulted in more seed yield (Sarkar and Mukhopadhyay 1990) [11]. These two factors combined together increased the photosynthates translocated to developing seeds and resulted in development of sound and mature seed and hence the foliar spray of 2.0 % WSF having 19:19:19 combination recorded significantly higher cob and fodder yield compared to control. The biological yield is a function of green cob and green fodder yields. Thus, significant increase in biological yield with the application of WSF (19:19:19) could be ascribed to the improvement in yields might have resulted from favourable influence of N,P,K through water soluble fertilizer on growth and efficient partitioning of metabolites to reproductive structure. Further, higher nutrient uptake and better use of radiant energy led to higher vegetative and reproductive growth, thus enhancing biological yield. The results are also fall in the line of Afifi *et al*. (2012) [2], who noticed the higher grain yield of maize (3186.40 kg ha^{-1}) by the foliar fertilization of urea with micronutrients.

Table 1: Effect of different water soluble fertilizers on plant height, Dry matter accumulation and yield

Treatments	Plant height (cm)				Dry matter accumulation (g plant^{-1}) at				Yield (kg ha^{-1})		
	30 DAS	45 DAS	60 DAS	At harvest	30 DAS	45 DAS	60 DAS	At harvest	Green cob	Green fodder	Biological yield
T_1- Control	18.7	30.3	90.7	115.0	20.67	29.73	61.97	115.13	3990	25394	29384
T_2- RDF + water spray	18.7	33.7	97.7	128.3	21.33	31.72	63.40	140.67	4932	28518	33450
T_3- RDF + WSF (19:19:19)	25.6	47.4	148.3	158.4	25.95	39.13	79.93	161.93	7040	38737	45777
T_4- RDF + WSF (13:40:13)	21.3	43.6	132.0	143.0	23.00	36.67	73.30	150.33	5914	34576	40489
T_5- RDF + WSF (12:61:00)	21.3	39.0	125.0	136.3	22.55	32.74	62.97	141.83	5730	29844	35574
T_6- RDF + WSF (00:52:34)	20.2	41.0	128.0	135.7	23.33	32.00	67.01	140.00	5784	30886	36670
T_7- RDF + WSF (28:28:00)	21.3	40.0	130.3	140.4	22.50	32.92	69.83	146.67	5774	31954	37728
T_8- RDF + WSF (00:00:50:17.5 S)	22.7	39.7	126.7	134.0	23.83	30.67	67.33	140.67	5673	32308	37981
T_9- RDF + Urea	22.8	44.3	139.7	149.0	24.55	38.23	78.18	153.33	6370	36000	42370
T_{10}- RDF + KNO_3	20.0	44.0	133.0	144.4	24.03	37.55	72.13	148.67	6080	35458	41538
SEm ±	1.39	2.09	5.97	6.13	1.16	1.78	3.79	5.78	356.5	1893.2	2231.8
CD (P = 0.05)	NS	6.23	17.74	18.23	NS	5.31	11.29	17.18	1059.2	5625.0	6631.0
CV (%)	11.32	9.01	8.26	7.67	8.58	9.06	9.45	7.02	10.80	10.13	10.21

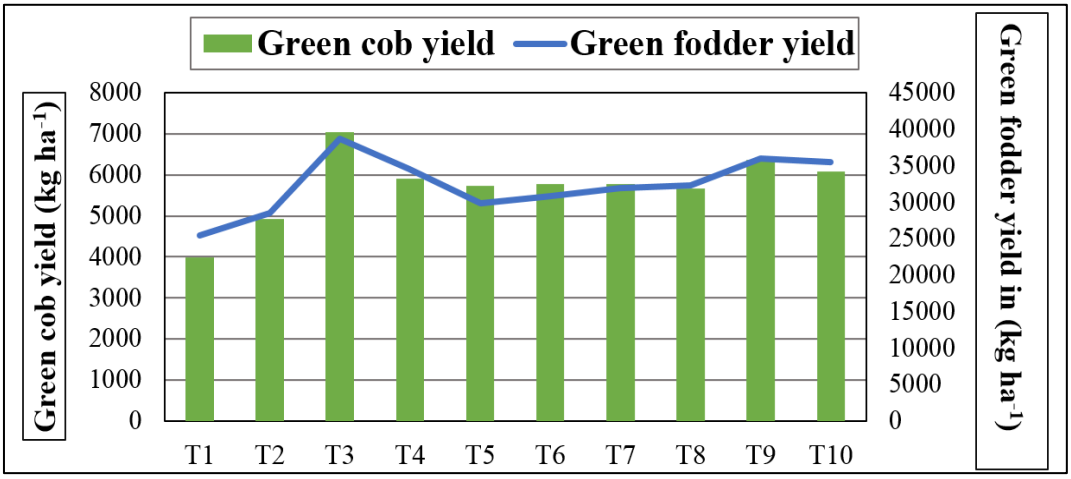

Fig 3: Green cob yield, green fodder yield as influenced by different water soluble fertilizers

Effect on economics of treatments

The acceptance of any generated technology is ultimately depends on the economics involved in the crop production. Among the different indicators of monetary efficiency in any production system, the economics in terms of net returns and the benefit cost ratio have a greater impact on the practical utility and acceptance of the technology. In the present investigation, the significantly maximum gross returns, net returns and B: C ratio was obtained with the application of 120:60:60 kg NPK ha^{-1} + foliar WSF 19:19:19 @ 2 per cent applied at 30, 45 and 60 DAS, ₹ 109137 ha $^{-1}$, ₹ 65714 ha^{-1} and 2.51 respectively, (T_1) over control (Table 2, Fig. 4).

This might be due to effect of water soluble fertilizers and the higher B: C was attributed to the more gross returns with lower cost of cultivation involved with it. The highest benefit obtained under these treatments were also due to comparatively less cost of fertilizers then other as well as higher cob and fodder yield of sweet corn.

The above results are concomitant with the findings of Parasuraman (2008) [9], Premasekar and Rajashree (2009) [10] and also Manjanaik (2012) [3] in maize.

Table 2: Effect of different water soluble fertilizers on economics of sweet corn

Treatments	Gross return (₹/ha)	Cost of cultivation (₹/ha)	Net return (₹/ha)	B : C ratio
T_1- Control	65294	35069	30221	1.86
T_2- RDF + water spray	77838	40873	36965	1.90
T_3- RDF + WSF (19:19:19)	109137	43423	65714	2.51
T_4- RDF + WSF (13:40:13)	93716	43423	50293	2.16
T_5- RDF + WSF (12:61:00)	87144	44035	43109	1.98
T_6- RDF + WSF (00:52:34)	88726	44953	43773	1.97
T_7- RDF + WSF (28:28:00)	89694	44273	45421	2.03
T_8- RDF + WSF (00:00:50:17.5 S)	89038	43389	45649	2.05
T_9- RDF + Urea	99700	41094	58606	2.43
T_{10}- RDF + KNO_3	96258	44137	52121	2.18

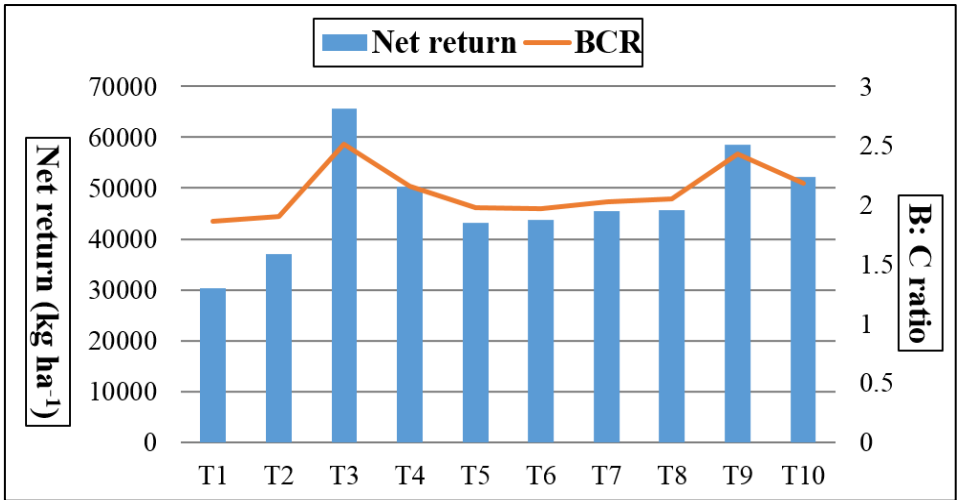

Fig 4: Net return and B:C ratio of sweet corn as influenced by different water soluble fertilizers

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