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Influence of foliar nutrition at different vegetative stages on growth and yield performance of maize (*Zea mays* L.)

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Abstract
Maize being a C_4 crop is a high nutrient demanding crop. Application of nutrients through foliar along with recommended dose of fertilizers at the optimum growth stage could be a viable option to fulfill the crop nutrient requirement and increase the yield. Hence, field experiment was conducted to evaluate the influence of foliar nutrition at different vegetative stages on growth and productivity of maize during *kharif* 2017 at Agricultural college farm, Raichur. Foliar nutrition of NPK (19:19:19) at 1 per cent, H_3BO_3 at 0.1 per cent and $ZnSO_4$ at 0.5 per cent along with recommended dose of fertilizer sprayed at different growth stages (V5, V6, V11 and V12) were evaluated in randomized complete block design. Results showed that foliar application of $ZnSO_4$ (0.5 %) at early vegetative stages (V5 and V6) significantly enhanced all plant growth, physiological, yield and phenological traits of maize compared to foliar nutrition at late vegetative stages (V11 and V12) and control. Statistically maximum grain yield was obtained with foliar spray of $ZnSO_4$ at V6 stage. These results suggested that foliar application of $ZnSO_4$ (0.5 %) at early vegetative stages can improve the performance of maize.

Keywords: Foliar application, maize, physiological parameters, phenology and grain yield

Introduction
Maize (*Zea mays* L.) is an important cereal in the agricultural economy after rice and wheat, in the world as well as in India. Among all the cereals, maize in general and hybrids in particular are responsive to nutrients, as the productivity is mainly dependent on it. Maize is an exhaustive crop which consumes large quantity of nutrients at different growth stages for growth and development. Under the present trend of exploitive agriculture in India, inherent soil fertility can no longer be maintained on the sustainable basis. It is said that nutrient supplying capacity of soil declines steadily under continuous and intensive cropping system. Foliar application of the major nutrients appeared to increase yield and quality of different crops. Nitrogen application stimulates protein synthesis and enhances the remobilization from stored carbohydrates in vegetative organs to grain. Phosphorus mainly controls the reproductive growth of plant. It is needed for the growth, utilization of sugar and starch, photosynthesis, cell division, nucleus formation, fat and albumen formation. Potassium plays an important role in the phloem translocation and also helps in the starch sugar synthesis. A primary function of boron (B) is related to cell wall formation. Hence boron deficient plants may be stunted. Sugar transport in plants, flower retention and pollen formation and germination also are affected by boron. Zinc exerts a great influence on basic plant life processes, such as nitrogen metabolism - uptake on nitrogen and protein quality, photosynthesis - chlorophyll synthesis, carbon anhydrase activity, development and function of floral tissues and resistance to abiotic and biotic stresses – protection against oxidative damage. Nutrient application timing is very important to maximize the potential response from foliar applied nutrients. The timing should occur around yield determining growth stages which in turn will benefit ear set and grain fill (Ritchie *et al.*, 1996) [23]. Higher yield and profits can be obtained by supplying the nutrients to the plant at critical stages of development. The yield of maize is based on the number of kernels per ear and kernel weight. These factors are predetermined at the particular leaf stage and are influenced by the availability of nutrients and environmental conditions. At present, the nutrients are applied only at the time of sowing and in addition nitrogen is top dressed at 45 days after sowing. This may not be as much helpful for grain formation and development since the grain numbers in cob will be determined at 5^{th} to 6^{th} leaf stage and grain development takes place at 12^{th} leaf stage. Timing of nutrient demand and acquisition by maize is nutrient specific and associated with key vegetative or reproductive growth stages. Thus, the knowledge of dynamics of nutrient accumulation to sink organs and the fate of foliar-applied nutrients at specific growth stages would provide useful

information to deliver nutrients more efficiently to meet requirement, thus improving nutrient management and sustainable intensification and obtaining greater yield.

Materials and methods

A field experiment was conducted to evaluate the influence of foliar nutrition at different vegetative stages on growth and yield performance of maize (*Zea mays* L.) during *kharif* season of 2017. The experiment was conducted at Agricultural College Farm, University of Agricultural Sciences, Raichur situated in North Eastern Dry Zone of Karnataka at latitude of 16º15′ North, longitude of 77º21′ East with an altitude of 389 meters above mean sea level. The experiment was laid out in randomized complete block design with five replications consisting of thirteen treatments including control. Maize hybrid RCRMH2 was selected as test crop. The details of the treatments were T_1 - NPK (19:19:19) (1%) at V5 stage, T_2 - NPK (19:19:19) (1%) at V6 stage, T_3 - NPK (19:19:19) (1%) at V11 stage, T_4 - NPK (19:19:19) (1%) at V12 stage, T_5 - H_3BO_3 (0.1%) at V5 stage, T_6 - H_3BO_3 (0.1%) at V6 stage, T_7 - H_3BO_3 (0.1%) at V11 stage, T_8 - H_3BO_3 (0.1%) at V12 stage, T_9 - $ZnSO_4$ (0.5%) at V5 stage, T_{10} - $ZnSO_4$ (0.5%) at V6 stage, T_{11} - $ZnSO_4$ (0.5%) at V11 stage, T_{12} - $ZnSO_4$ (0.5%) at V12 stage and T_{13} - Control (RDF).

To find out the effect of treatments application, three plants were selected plants from each plot to obtain the data regarding all growth, physiological, quality and yield related parameters. Plant height was measured from the base of the plant to the fully opened top leaf up to the stage of tassel. After tasseling, plant height was measured from the base of the plant to collar of the flag leaf. Total dry matter of various plant parts was arrived by taking the sum of all the plant parts after keeping the sample in oven at 70° C for 48 hours. For days to 50 per cent silking and physiological maturity, dates were noted at 50% completion of silking and appearance of black spot on the hilum of the seed of each experimental plot and calculated the total number of days taken from sowing, respectively. Leaf area index (LAI) was worked out by dividing the leaf area per plant by land area occupied by the plant as per Sestak *et al.*, (1971) [29].

$$\text{Leaf area index} = \frac{\text{Leaf area (dm}^2\text{)}}{\text{Land area (dm}^2\text{)}}$$

The specific leaf weight which indicates the leaf thickness was determined by the method of Pearce *et al.* (1968) [22] and expressed as g cm^{-2}.

$$\text{Specific Leaf Weight} = \frac{\text{Leaf dry weight (g)}}{\text{Leaf area (dm}^2\text{)}}$$

Starch content of the grains was determined by following anthrone method as devised by Hodge and Hofreiter (1962) [14]. Yield attributing parameters were recorded from three plants at randomly selected from each experimental plot at maturity and then average was worked out. For grain yield, after harvesting the maize plants of each experimental plot was sun dried and threshed manually, then grain yield per plot was calculated. The collected research data was subjected to the analysis of variance by following the method of Sukhatme and Panse (1967) [31] with the level of significance used as P = 0.05.

Results and discussion

Foliar application of $ZnSO_4$ @ 0.5 per cent at early vegetative stages (V5 and V6) increased the plant height as compared to other treatments and the lower plant height was recorded with control where recommended dose of fertilizer is applied (Table 1). Significant variation in the plant height might be due to in time availability of the needed nutrients to the plant at the important growth stages and foliar application of zinc has led to production of IAA resulting in increased plant height (Cakmak *et al.* 1989) [5] in maize plant. Similar results regarding plant height due to foliar zinc at early stage in maize was reported by Ghazvineh and Yousefi (2012) [11]. Leaf area index is one of the most important and commonly used indices to analyze the growth of crop plant. It depends on the per cent of expansion of crop canopy to utilize the sunlight for photosynthesis. Similalarly, Manasa and Devaranavadagi (2015) [16] recorded significantly higher plant height (205.20 cm) to the foliar spray of $ZnSO_4$ @ 1.0 per cent along with the recommended dose of N, P_2O_5, K_2O during grand growth stage. Verma *et al.* (2004) [32], Singh and Bhatt (2013) [26] and Amanullah *et al.* (2016) [2] also reported that foliar application of zinc increased the plant height. The leaf area index was also greatly influenced by the foliar application. Maximum leaf area index was recorded with foliar application of $ZnSO_4$ @ 0.5 per cent at early vegetative stages (V5 and V6) and lower leaf area index was recorded with control (RDF only) (Table 1). Early application of foliar nutrition improved the vegetative growth and increased leaf area index. Increased in leaf area index by zinc application might be due to increase in tryptophan amino acid and indole acetic acid hormone which are two main factors in leaf area expansion. Safyan *et al*. (2012) [25] reported increased leaf area index (LAI) of maize crop due to foliar applied zinc.

Specific leaf weight is the integral structure of leaf and is known to have correlation with photosynthetic rate. Significantly higher specific leaf weight (Table 1) was recorded in foliar application of $ZnSO_4$ @ 0.5 per cent at early vegetative stages (V5 and V6). Higher specific leaf weight noticed at early stage in the present study might have helped in enhancing the photosynthetic rate resulting in better growth. The results are in conformity with Roul *et al.* (2017) [24], who reported that foliar application of most of the micronutrients alone or in combination significantly increased specific leaf weight. Starch content is an important factor that contributes towards the yield and quality of maize grain. In the present investigation, application of different foliar nutrients at various vegetative stages resulted in significant marked variation in the content of starch. However the highest content of starch were recorded in the foliar application of $ZnSO_4$ at early vegetative stages (V5 and V6 stage) compared to the control. Formation of NADPH or NADH depending on the zinc foliar nutrition might have involved in tapping and converting the radiation energy for photosynthetic activities and increased formation of sugars and starch. This results are in line with the findings of Debnath *et al.* (2016) [6] in maize.

The differences were observed in dry matter partitioning (stem, leaves and cob). It was increased at different time of intervals (30, 60, 90 DAS and at harvest). It was found that maximum dry matter accumulation in leaves, stem and cob were recorded in the treatment foliar spray of $ZnSO_4$ @ 0.5 per cent during early vegetative stages (V5 and V6) at 60, 90 DAS and at harvest as compared to control (Table 2 and Figure 1). The maximum dry matter accumulation in leaves, stem and cob were recorded at different growth stages in this treatment. Similarly, total dry matter was recorded in an increasing manner from 30 DAS to harvest. Significant response of maize to foliar zinc might be due to activation of various enzymes such as carbonic anhydrase, alcohol dehydrogenase, superoxide dismutase and RNA polymerase. It also favors increased synthesis of enzymes and hormones along with the metabolisation of major nutrients, which in turn promoted the growth components. The foliar nutrition at early vegetative stage increased the leaf area index and accumulation of photosynthates which contributed the increase in dry matter production. The results are in agreement with the findings of Grezebisz *et al.* (2008) [13], Parasuraman (2008) [20] and Kumar *et al.* (2016) [15]. Nalini *et al.* (2013) [19] reported similar findings in greengram where foliar application of zinc at pre flowering stage improved total dry matter and its partitioning. Roul *et al.* (2017) [24] reported that foliar application of all the micronutrients and their combination significantly increased leaf dry matter, stem dry matter, pod dry matter and total dry matter of the plant at 45, 60 and 90 DAS over control where RDF alone is applied in sesame. Deswal and Pandurangam (2018) [7] also reported highest increment in dry matter of about 91.67 per cent and 87.38 per cent during 40 and 50 DAS when foliar spray of zinc @ 1.0 percent was applied at two growth stages 30 and 40 DAS in maize.

Results revealed that foliar spray of $ZnSO_4$ @ 0.5 per cent at early vegetative stages (V5 and V6) taken less days to silking compared to control (Table, 3). Similar finding were recorded by Ewa and Pawel (2012) [10] indicating that zinc ions present in the growth medium promote early flowering in *A. arenosa* and this effect may depend on zinc concentration used. Zinc-induced early flowering in *A. arenosa* seemed to be a universal plant response present within the species and is not an effect of stress or physiological adaptation to high Zn content in the environment. Anees *et al*. (2016) [3] also noticed minimum number of days to 50 per cent silking in maize on combined foliar spray of potassium (1.0 %) and zinc (0.1 %) at 20 and 50 days after sowing compared to control. Sangolli *et al.* (2018) [27] also reported that soil application of $ZnSO_4$ @ 10 kg per ha and foliar application of $ZnSO_4$ @ 0.5 per cent recorded minimum days to flowering in chick pea. Significant effect on early maturity was observed with the application of foliar zinc @ 0.5 percent at early vegetative stages (V5 and V6) and late maturity was noted in control. The application of the zinc significantly reduced the days to maturity in their individual application but significant variation could be noticed due to other treatment. The early maturity may be due to proper water uptake and better water relations in the plant in the presence of zinc which resulted in better auxin metabolism and activities of dehydrogenase enzymes. The similar findings were reported by Amanullah *et al*. (2016) [2] who noticed maize crop with foliar application of potassium and zinc at vegetative stage attained early maturation than foliar application of nutrients at reproductive stage.

Starch content is an important factor that contributes towards the yield and quality of maize grain. Application of different foliar nutrients at various vegetative stages resulted in significant marked variation in the content of starch. However the highest content of starch were recorded in the foliar application of $ZnSO_4$ at early vegetative stages (V5 and V6 stage) compared to the control (Table 3). Similar results were found with Stalin *et al.* (2014) [28] in rice, Ali *et al.* (2016) [1] in maize, Debnath *et al.* (2016) [6] in maize and Ghasal *et al.* (2017) [12] in wheat.

Cob characteristics *viz.*, cob length, cob girth and cob weight are indicator of yield performance. Among the different foliar nutrition at different vegetative stages, foliar spray of $ZnSO_4$ at early stages (V5 and V6) improved the cob characteristics compared to other treatments (Table 4). This significant effect of foliar nutrition on cob length, cob girth and cob weight might be due to the improved leaf dry matter production, leaf area index, specific leaf weight which cud have improved photosynthetic rate, chlorophyll content with the application of foliar nutrition of zinc at early stages. This may resulted in improvement of the grain size of the plants. The foliar application of $ZnSO_4$ at early vegetative stages (V5 and V6) also improved the number of kernel rows per cob and number of kernels per row compared to the control where only recommended dose of fertilizer was applied. This might be due to the fact that number of rows per cob and number of kernels per row are predetermined factor at early vegetative stage between V5 to V6. The foliar nutrition at these critical stages helped in the increased nutrient supply for cob development. The findings are in agreement with Ehsanullah *et al.* (2015) [8] in maize. Similar results also obtained by Anjum *et al.* (2017) [4] who reported that increment in carbohydrates partitioning to grains might exert positive influence on cob length and girth. These results are in accordance with Mohsin *et al.* (2014) [17], Manasa and Devaranavadagi (2015) [16], Prajwal *et al.* (2018) [21].

The yield potential of any variety is always determined by the test weight and in the present study $ZnSO_4$ foliar spray at early stages (V5 and V6) showed the increased test weight (Table 4 and Figure 2). Improved dry matter production, higher photosynthesis and sugar accumulation at early vegetative stages of foliar spray might be attributed for the increased 100 grain weight.It is clear that foliar application of nutrients increased the grain yield compared to control where only recommended dose of fertilizers was applied (Table 5). Among the different treatments, foliar spray of $ZnSO_4$ at early vegetative stages (V5 and V6) increased grain yield by 21.5 and 22.7 per cent, respectively as compared to control (RDF only). Foliar nutrition at the early vegetative stage improved the cob development and grain yield pertaining to the significant variation in early silking, increased chlorophyll contents, photosynthesis rate which in turn increased the sugar contents and dry matter production. In addition, the foliar nutrients improved translocation and assimilation of nutrients by maize plants leading to significant increase in grain yield. Similar results were obtained by El-Azab (2015) [9], who reported that foliar application of $ZnSO_4$ at 5^{th} leaf stage significantly increased the grain yield of maize hybrid.

Stover yield was increased with the foliar application of different nutrients during various vegetative stages as compared to control where only recommended dose of fertilizer was applied (Table 5). Foliar $ZnSO_4$ at early vegetative stages (V5 and V6) showed higher stover yield. The vigorous vegetative growth and improved plant height and leaf area index lead to higher total dry matter production per plant which attributed to higher stover yield over other treatments. Subhanullah *et al.* (2017) [30] also reported the higher stover yield of maize by foliar nutrition of zinc. Shelling percentage and harvest index were also significant due to foliar nutrition at different vegetative stages compared to control (Table 5). This might be due to the effective translocation of photosynthates and partitioning in different parts of the plant attributing to the increased grain yield. This result is in accordance with Anjum *et al.* (2017) [4].

Table 1: Influence of foliar nutrition on plant height, Leaf area index and specific leaf weight in maize

Treatment	Plant height			Leaf area index			Specific leaf weight		
	Days after sowing								
	60	90	Harvest	60	90	Harvest	60	90	Harvest
T_1 - NPK (19:19:19) (1%) at V5 stage	173.9	190.6	192.2	4.35	4.65	3.01	0.532	0.567	0.657
T_2 - NPK (19:19:19) (1%) at V6 stage	175.2	192.5	194.1	4.45	4.75	3.08	0.536	0.570	0.671
T_3 - NPK (19:19:19) (1%) at V11 stage	180.1	198.8	200.9	5.01	5.33	3.42	0.545	0.589	0.684
T_4 - NPK (19:19:19) (1%) at V12stage	184.4	200.2	202.5	5.15	5.49	3.61	0.551	0.596	0.703
T_5 - H_3BO_3 (0.1%) at V5 stage	188.6	206.5	208.6	5.42	5.77	3.91	0.560	0.598	0.705
T_6 - H_3BO_3 (0.1%) at V6 stage	190.5	207.7	209.8	5.48	5.89	4.06	0.569	0.603	0.710
T_7 - H_3BO_3 (0.1%) at V11 stage	177.7	194.4	196.7	4.70	5.04	3.10	0.538	0.570	0.677
T_8 - H_3BO_3 (0.1%) at V12 stage	179.2	196.1	198.4	4.77	5.13	3.24	0.545	0.574	0.681
T_9 - $ZnSO_4$ (0.5%) at V5 stage	191.6	210.8	213.1	5.59	6.06	4.23	0.577	0.606	0.715
T_{10} - $ZnSO_4$ (0.5%) at V6 stage	193.5	212.1	214.2	5.81	6.21	4.36	0.578	0.609	0.738
T_{11} - $ZnSO_4$ (0.5%) at V11 stage	182.8	202.3	203.8	5.08	5.39	3.50	0.549	0.592	0.688
T_{12} - $ZnSO_4$ (0.5%) at V12 stage	185.3	203.4	205.9	5.18	5.51	3.73	0.555	0.596	0.704
T_{13} – Control (RDF only)	168.8	187.9	190.3	4.01	4.40	2.92	0.525	0.544	0.617
Mean	182.4	200.3	202.3	5.00	5.35	3.55	0.551	0.586	0.688
S.Em (±)	2.90	3.38	3.33	0.04	0.04	0.05	0.013	0.012	0.014
C.D at 5%	8.24	9.60	9.47	0.12	0.13	0.13	0.036	0.034	0.039

Table 2: Influence of foliar nutrition on dry matter partitioning at different growth stages in maize

Treatment	Leaf dry matter			Stem dry matter			Cob dry matter	
	Days after sowing							
	60	90	Harvest	60	90	Harvest	90	Harvest
T_1 - NPK (19:19:19) (1%) at V5 stage	28.08	31.79	30.27	46.42	65.27	67.10	77.20	122.26
T_2 - NPK (19:19:19) (1%) at V6 stage	29.04	32.68	31.46	46.69	66.00	68.86	79.02	123.42
T_3 - NPK (19:19:19) (1%) at V11 stage	33.01	38.53	37.62	49.99	69.63	73.31	86.28	129.32
T_4 - NPK (19:19:19) (1%) at V12stage	34.03	39.24	37.79	50.77	70.62	74.69	91.11	131.20
T_5 - H_3BO_3 (0.1%) at V5 stage	36.07	40.76	38.77	53.62	72.76	76.77	93.24	131.08
T_6 - H_3BO_3 (0.1%) at V6 stage	37.41	41.78	39.69	54.91	74.60	77.84	93.41	132.64
T_7 - H_3BO_3 (0.1%) at V11 stage	30.17	34.32	33.20	47.64	68.13	71.38	79.56	126.81
T_8 - H_3BO_3 (0.1%) at V12 stage	30.43	35.17	33.61	48.17	69.15	72.36	80.40	129.06
T_9 - $ZnSO_4$ (0.5%) at V5 stage	38.74	43.33	41.63	57.53	76.29	79.21	97.33	135.42
T_{10} - $ZnSO_4$ (0.5%) at V6 stage	40.31	45.15	43.82	58.91	78.98	80.26	99.25	136.58
T_{11} - $ZnSO_4$ (0.5%) at V11 stage	33.19	38.69	37.22	50.22	71.84	73.92	90.17	130.72
T_{12} - $ZnSO_4$ (0.5%) at V12 stage	34.75	40.22	38.61	51.44	72.56	75.27	91.35	131.32
T_{13} – Control (RDF only)	24.27	28.68	27.72	43.43	62.48	64.25	75.87	118.98
Mean	33.04	37.72	36.26	50.75	70.64	73.48	87.24	129.14
S.Em (±)	0.75	0.66	0.79	0.42	0.68	0.67	2.47	3.46
C.D at 5%	2.14	1.88	2.25	1.18	1.93	1.91	7.12	9.84

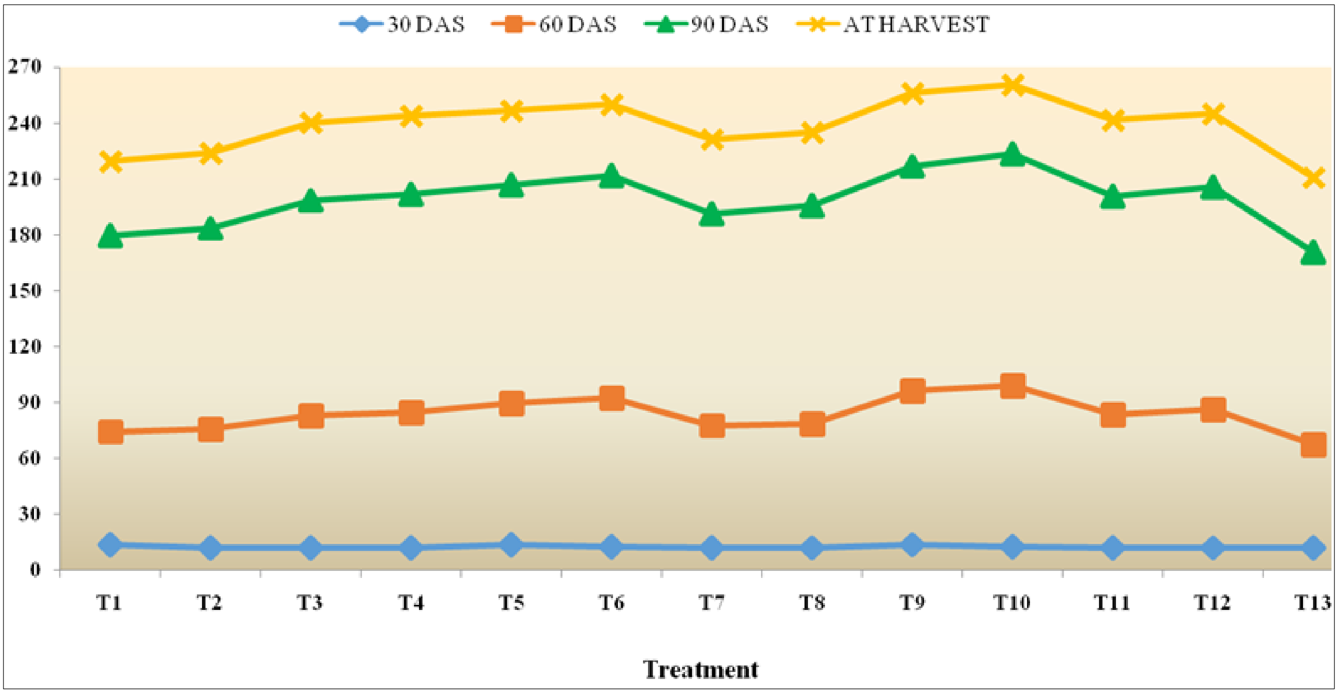

Fig 1: Influence of foliar nutrition on total dry matter (g/plant) at different growth stages in maize

Table 3: Influence of foliar nutrition on total dry matter, days to 50 per cent silking, days to physiological maturity and starch content in maize

Treatment	Total dry matter (g plant^{-1}) Days after sowing			Days to 50 per cent silking	Days to physiological maturity	Starch content (%)
	60	90	Harvest			
T_1 - NPK (19:19:19) (1%) at V5 stage	74.50	174.26	219.63	67	106	65.03
T_2 - NPK (19:19:19) (1%) at V6 stage	75.73	177.71	223.74	67	106	65.41
T_3 - NPK (19:19:19) (1%) at V11 stage	82.99	194.44	240.25	66	104	66.22
T_4 - NPK (19:19:19) (1%) at V12stage	84.80	200.97	243.68	66	103	66.43
T_5 - H_3BO_3 (0.1%) at V5 stage	89.69	206.76	246.62	65	101	67.41
T_6 - H_3BO_3 (0.1%) at V6 stage	92.32	209.79	250.17	65	101	67.74
T_7 - H_3BO_3 (0.1%) at V11 stage	77.81	182.01	231.39	67	106	65.52
T_8 - H_3BO_3 (0.1%) at V12 stage	78.60	184.72	235.02	66	105	65.90
T_9 - $ZnSO_4$ (0.5%) at V5 stage	96.27	216.95	256.24	64	101	68.12
T_{10} - $ZnSO_4$ (0.5%) at V6 stage	99.22	223.38	260.65	63	100	68.35
T_{11} - $ZnSO_4$ (0.5%) at V11 stage	83.41	200.70	241.86	66	104	66.48
T_{12} - $ZnSO_4$ (0.5%) at V12 stage	86.19	204.13	245.20	66	102	66.81
T_{13} – Control (RDF only)	67.70	167.05	210.95	68	107	64.62
Mean	83.79	195.61	238.88	66	103	66.47
S.Em (±)	0.90	3.07	3.60	0.37	0.41	0.77
C.D at 5%	2.55	8.73	10.23	1.05	1.18	2.19

Table 4: Influence of foliar nutrition on yield and yield components in maize

Treatments	Cob length (cm)	Cob girth (cm)	Cob weight (g)	Number of rows per cob	Number of kernels per row	Test weight (g)
T_1 - NPK (19:19:19)(1%) at V5 stage	15.80	12.30	122.26	12.40	31.20	26.10
T_2 - NPK (19:19:19)(1%) at V6 stage	16.20	12.36	123.42	12.60	31.40	26.44
T_3 - NPK (19:19:19)(1%) at V11 stage	17.60	12.86	129.32	13.20	33.00	28.16
T_4 - NPK (19:19:19)(1%) at V12stage	18.16	13.12	131.20	13.60	33.40	28.96
T_5 - H_3BO_3 (0.1%) at V5 stage	18.64	13.40	131.08	13.80	34.20	29.28
T_6 - H_3BO_3 (0.1%) at V6 stage	19.10	13.46	132.64	14.00	34.80	29.80
T_7 - H_3BO_3 (0.1%) at V11 stage	16.42	12.42	126.81	12.80	32.00	27.18
T_8 - H_3BO_3 (0.1%) at V12 stage	17.06	12.72	129.06	13.00	32.20	27.62
T_9 - $ZnSO_4$ (0.5%) at V5 stage	20.70	13.94	135.42	14.00	36.00	31.10
T_{10} - $ZnSO_4$ (0.5%) at V6 stage	21.50	14.40	136.58	14.20	36.20	31.94
T_{11} - $ZnSO_4$ (0.5%) at V11 stage	17.86	13.06	130.72	13.40	32.80	28.34
T_{12} - $ZnSO_4$ (0.5%) at V12 stage	18.20	13.32	131.32	13.60	33.20	29.16
T_{13} – Control	15.04	12.16	118.98	12.00	29.20	25.66
Mean	17.87	13.04	129.14	13.28	33.05	28.44
S.Em (±)	0.51	0.20	3.46	0.45	0.69	0.73
C.D at 5%	1.45	0.56	9.84	1.28	1.96	2.07

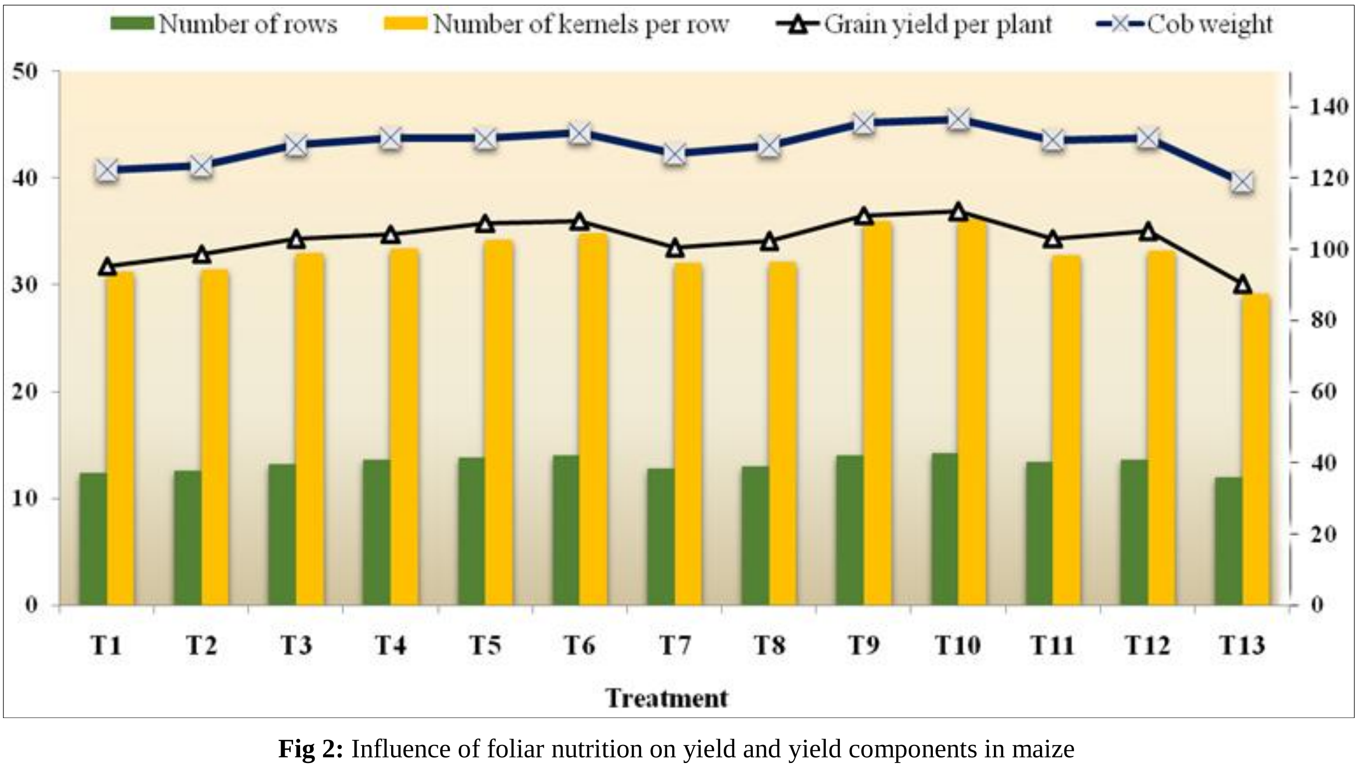

Fig 2: Influence of foliar nutrition on yield and yield components in maize

Table 5: Influence of foliar nutrition grain yield, stover yield, shelling percentage and harvest index in maize

Treatments	Grain yield (g plant^{-1})	Grain yield (kg ha^{-1})	% increase over control	Stover yield (kg ha^{-1})	% increase over control	Shelling percentage (%)	Harvest index (%)
T_1 - NPK (19:19:19)(1%) at V5 stage	95.31	7157.58	5.7	8398.07	2.8	78.50	46.01
T_2 - NPK (19:19:19)(1%) at V6 stage	98.71	7412.93	9.5	8666.21	6.0	78.68	46.10
T_3 - NPK (19:19:19)(1%) at V11 stage	102.79	7719.90	14.1	8775.02	7.4	79.37	46.81
T_4 - NPK (19:19:19)(1%) at V12stage	104.22	7827.26	15.6	8862.35	8.4	79.28	46.90
T_5 - H_3BO_3 (0.1%) at V5 stage	107.41	8066.20	19.2	8986.68	10.0	80.60	47.30
T_6 - H_3BO_3 (0.1%) at V6 stage	108.00	8111.06	19.8	9038.82	10.6	80.76	47.30
T_7 - H_3BO_3 (0.1%) at V11 stage	100.35	7536.55	11.3	8671.23	6.1	78.92	46.50
T_8 - H_3BO_3 (0.1%) at V12 stage	102.19	7674.70	13.4	8794.48	6.9	79.15	46.60
T_9 - $ZnSO_4$ (0.5%) at V5 stage	109.52	8224.66	21.5	9090.03	11.2	80.88	47.50
T_{10} - $ZnSO_4$ (0.5%) at V6 stage	110.58	8304.51	22.7	9142.05	11.9	80.95	47.60
T_{11} - $ZnSO_4$ (0.5%) at V11 stage	102.97	7733.34	14.2	8721.65	6.7	78.77	47.00
T_{12} - $ZnSO_4$ (0.5%) at V12 stage	105.03	7887.66	16.5	8894.27	8.8	79.82	47.00
T_{13} – Control	90.13	6768.79	0.0	8173.23	0.0	77.27	45.32
Mean	102.86	7716.94		8781.08		79.46	46.77
S.Em (±)	1.16	80.22		127.83		0.79	0.32
C.D at 5%	3.30	228.11		363.48		2.24	0.91

Conclusion

From the results of this study, it can be concluded that foliar applications of $ZnSO_4$ (0.5 %) at early vegetative stages (V5 and V6) gave 22% more grain yield than control where no foliar sprays were applied. So, keeping in view the above stated results, it can be concluded that, higher yield and Phenology, physiological parameters can be obtained by applying the foliar spray of 0.5% $ZnSO_4$ at early vegetative stages (V5 and V6).

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