Int.J.Curr.Microbiol.App.Sci (2019) *8*(4): 3056-3066

EXCELLENT PUBLISHERS

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 8 Number 04 (2019)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2019.804.352

Study of Multinutrient Effect on Growth, Plant Pigment Concentration and Yield of Maize (*Zea mays*)

T.R. Zagade, S.R. Adat*, Sunil Chowdhary Vajja and D. Bhuvneshwari

Division of Soil Science and Agricultural Chemistry,
Ratnai College of Agriculture, Akluj.Dist.-Solapur (MS, India)

**Corresponding author*

Keywords

Maize, Chlorophyll, Plant pigment, Yield

Article Info

Accepted:
28 March 2019
Available Online:
10 April 2019

A B S T R A C T

In the present study, chlorophyll ‘a’, chlorophyll ‘b’ and total chlorophyll was found to be influenced by the application of essential nutrients particularly, N, S and Fe. Lower chlorophyll concentration was found in early immature and later at senescence leaves. Total chlorophyll in canopy increased during the vegetative growth period, reaching a maximum close to tasseling stage and then decreased during reproductive and senescence period. Among the various treatments (F_5) i.e. application of 100kgN,50kgP,30kgS and 20kgZn through soil and foliar spray of Fe@2% showed maximum concentration of chlorophyll ‘a’, ‘b’, total chlorophyll and carotenoids followed F_4, F_3, F_2, F_1 and F_0.

Introduction

Crop growth and development is influenced by various stress conditions (Patil and Kolte, 2003). Application of nitrogen upto 120 Kg per ha significantly increased plant height, dry matter, LAI, chlorophyll content, cobs per plant, grains per row per cob, weight per cob, shelling percentage, test weight and biological yield of the maize.

The significant improvement in growth character might be attributed to the fact that nitrogen helps in maintaining higher N contain level which might have resulted in better plant height, LAI and chlorophyll content of the leaves of maize (Vyas and Singh, 2000).

Taalab *et al.,* (2008) reported that grain and straw yield of maize responded strongly P application. Significant differences in the grain yield of maize were observed between No P (control) versus SSP as well as TSP and RP. The treatments receiving P sources with sulfur had higher grain and straw yield than those without it. The results of this study showed that the application of SSP gave higher effects on maize yield than the use of phosphate rock. Maize yield improved remarkably through the solubilizing effect of sulfur and citric acid N and K uptake increased.

Biljana and Stojanovic (2005) indicated that chlorophyll a, b, and total chlorophyll (chl a+b) and carotenoid (carotenes and xanthophylls) content depended on the presence and ratio of mineral elements in the substrate. The variant of fertilization with N and P turned out to be most favorable. The next most favorable variant was the one with nitrogen alone, and it was followed by the variant with N and K. The greatest chlorophyll content in plants occurs at the outset of the flowering phase. Thus, the content of chlorophyll content and levels of other leaf biochemical constituents can be used as indicators of crop stress under conditions of nutritional deficiencies. Application of mineral fertilizers also promotes better utilization of assimilates in metabolic and growth processes.

Materials and Methods

It was aimed to study the relationship between plant pigments and spectral reflectance and leaf nutrient concentration. In order to meet the objectives of the project, a field experiment was laid out (Fig. 3) in Randomized Block Design using maize as a test crop. There were six fertility treatments as detailed below replicated in to four.

Fertility levels (six)

F_0 No fertilizer application
F_1 Only N (100 kg N ha^{-1})
F_2 N + P (100 kg N ha^{-1} + 50 kg P_2O_5 ha^{-1})
F_3 N + P + S (100 kg N ha^{-1} + 50 kg P_2O_5 ha^{-1} + 30 kg S ha^{-1})
F_4 N + P +S + Zn (100 kg N ha^{-1} + 50 kg P_2O_5 ha^{-1} + 30 kg S ha^{-1} + 20 kg $ZnSO_4$ ha^{-1}
F_5 N + P + S + Zn + Fe (100 kg N ha^{-1} + 50 kg P_2O_5 ha^{-1} + 30 kg S ha^{-1} + 20 kg $ZnSO_4$ ha^{-1} + 2 % Fe foliar spray at 2 crop growth stages i.e. Silking and cob development)

The recommended dose of fertilizer for irrigated maize under Marathwada condition is 10:50:50 kg N, P_2O_5 and K_2O ha^{-1}. Potassium @ 50 kg K_2O ha^{-1} for all six treatments and full quantity of phosphorus as per treatments was applied at the time of sowing. Nitrogen was applied in two splits. Two iron sprays @ 2% Fe were given one at silking stage and another at cob development stage.

Results and Discussion

Effect of fertility levels on growth parameters and grain yield of maize

In the present investigation, observations were recorded on height, leaf area index, total biomass and economic yield.

Effect of fertility levels on plant height

The height of maize was monitored throughout growth period of the crop. Periodical observations recorded on various dates under various fertility level treatments are presented in Table 1. It was evidenced that in first phase of crop, growth rate was rather slow and results were non significant due to application of various treatments. However after 51 DAS, the treatments showed significant differences. Treatment F_3, F_4 and F_5 showed significant increase in height over F_2, F_1 and F_0. Further, it was also observed that there was continuous increase in plant height throughout growth period of crop due to each additional nutrient (93.78 cm in F0 to 123.5 95 cm in F5). Each incremental level of nutrient recorded increase in the height of maize. Application of N100+P50+S30+Zn20 and foliar spray of 2% Fe at 2 stages (F_5 treatment) significantly increased plant height to the extent of 232.5 cm (109 DAS) and this was the maximum height attained by maize crop. Results showed that F_5 (N+P+S+Zn +Fe@ 2% foliar spray) treatment was superior over rest, followed by F_4 (N+P+S+Zn, F_3(N+P+S), F_2(N+P) and F_1 (only N).

In depth scrutiny of data effect of multinutrient application on height of maize showed that was increased at higher rate up to 70 DAS.

Effect of fertility levels on leaf area index

Leaf area is one of the important attributes that influences the growth and development of crop. Therefore, the measurement on leaf area was carried out in all possible observations during the growth cycle of maize crop. On an average increase in leaf area index was from 0.014 to 3.50 from 18 to 109days old crop. Similarly, the application of each additional nutrient had influence on leaf area index of maize. Maize receiving all deficient nutrients through F_5 (NPSZnFe) treatment had profound influence on leaf area which was increased nearly by 50% or more over rest of the treatments. Addition of nitrogen, phosphorus, sulphur and zinc to soil and foliar sprays of iron increased the leaf area index. There was boost in leaf area index after 51 DAS. This period coincides with top dressing of maize with remaining dose of nitrogen and increase in bright sunshine hours.

It was very clear from the data that F_5 treatment had significantly higher leaf area over rest of the treatments particularly from 32 DAS to last observation. Treatment F_2 to F_4 had significantly higher leaf area over control. Similar findings were reported by Jawale (2009).

From Fig. 2 and 3, it was observed that biomass per plant (g plant^{-1}), total biomass per hectare(q ha^{-1}) and Grain yield per hectare (q ha^{-1}) responded strongly to F_5 (N+P+S+Zn+Fe@ 2% foliar spray) followed by F_4 (N+P+S+Zn), F_3 (N+P+S), F_2 (N+P) and F_1(Only N). It was also noticed that biomass (g plant^{-1}) and total biomass (q ha^{-1}) increased with the advancement of crop growth and it was maximum in F_5 treatment (complete nutrient package). From both figures 2 and 3, it was noticed that the amount of biomass accumulation of maize significantly increased with increasing plant age in every treatment .However F_5 treatment was superior over rest of the treatments. Results indicated that, application of N, P, S, Zn through soil and Fe through foliar spray at silking and cob development stage gives higher yield. Kayoed *et al.*, (2005) ascribed that other nutrient besides N, P and K affect the yield of maize. Therefore, the inclusion of other nutrients besides N, P and K in the fertilizer recommendation for maize should be encouraged.

Effect of fertility levels on total biomass and economic yield

The total biomass and economic yield of maize (grain yield) under various fertility levels are presented in Table 3 and showed in Figure 2 and Figure 3. The data indicated the periodical increase in total biomass of maize.

The average increase in biomass recovery was from 1.09 g plant^{-1} to 176.83 g plant^{-1} within 91 days. Influence of fertility levels was recognizable and seen in the data presented in the Table 3 and Fig. 2. On an average lowest biomass of 0.79 g plant^{-1} was recorded in control treatment at 18 DAS which was increased upto 221.0 g plant^{-1} at 109 DAS in the treatment received additional nutrient application (F_5). The accumulation of biomass was relatively more at 109 DAS, this may be attributed to the productive phase of the maize. At all growth observations, application of each additional nutrient produced higher biomass. The biomass production under treatment F_5 (100:50:30:20 N, P_2O_5, S, $ZnSO_4$ kg ha^{-1} respectively), with two iron sprays (at 51 and 73 DAS) produced maximum biomass. It was also evidenced that when sulphur was added to soils, there was marked increase in biomass accumulation (139 g $plant^{-1}$ to 193 g $plant^{-1}$) at 109days of maize. This response of maize to sulphur application indicates that sulphur is becoming deficient in growing media and warns that due care must be taken in further fertilizer application programmes. Among the two micronutrients, foliar spray of iron contributed more to the growth of maize as compared to zinc application. There was 8 g per plant increase in biomass due to application of $ZnSO_4$ (F_4) whereas foliar spray of Fe has 20 g per plant biomass increase. This might be because of highly calcareous nature of soil, which reduced the soil iron availability and hence crop responded to foliar application of iron.

Further scrutiny of data of Table 3 revealed that the total biomass and grain yield was lowest (224.42 and 70.4 q ha^{-1}, respectively) in unfertilized plot while yield was improved in nutrient added plots. The total biomass and grain yield increased in N applied treatment was 10.90 q ha^{-1} and 0.28 q ha^{-1}. In addition to N when P was applied the biomass and grain yield was increased to the level of 265.10 q ha and 84.8 q ha^{-1}, respectively. It was noted in the present investigation that in addition to N and P when sulfur was added there was sharp elevation in total biomass and grain yield. The additional application of zinc and iron further increased the total biomass and grain yield. Among the two micronutrients applied, spraying of iron contributed more in respect of total biomass and grain yield, which was to the tune of 300.64 and 96.08 q ha^{-1}. These results showed that foliar sprays of iron satisfied the iron hunger of plant.

From Fig. 2 and 3, it was observed that biomass per plant (g $plant^{-1}$), total biomass per hectare(q ha^{-1}) and Grain yield per hectare (q ha^{-1}) responded strongly to F_5 (N+P+S+Zn+Fe@ 2% foliar spray) followed by F_4 (N+P+S+Zn), F_3 (N+P+S), F_2 (N+P) and F_1(Only N). It was also noticed that biomass (g $plant^{-1}$) and total biomass (q ha^{-1}) increased with the advancement of crop growth and it was maximum in F_5 treatment (complete nutrient package). From both figures 2 and 3, it was noticed that the amount of biomass accumulation of maize significantly increased with increasing plant age in every treatment .However F_5 treatment was superior over rest of the treatments. Results indicated that, application of N, P, S, Zn through soil and Fe through foliar spray at silking and cob development stage gives higher yield. Kayoed *et al.*, (2005) ascribed that other nutrient besides N,P and K affect the yield of maize. Therefore, the inclusion of other nutrients besides N, P and K in the fertilizer recommendation for maize should be encouraged.

The results interpreted in above paragraphs on various growth parameters viz., height of plant, number of leaves, leaf area index (LAI), total biomass per plant, total biomass per hectare at harvest and grain yield of maize revealed that all the listed growth parameters and yield were found to be improved due to each additional nutrient viz., N, P, S, Zn and Fe. The height of plant significantly improved after 32 DAS in all the treatments. This may be because of top dressing of remaining dose of nitrogen which was applied to maize at 21 DAS. Further, it was also noticed that application of N, N + P, N + P + S, N + P + S + Zn, N + P + S + Zn + Fe significantly increased height of maize over control. Petkar (2004), Bodkhe (2008), Jawale (2009) and Zagade and Patil (2011) recorded increase in height and growth parameters of maize due to application of nitrogen. Even though the rate of increase of height of fertilized crop was always higher than the control plot at all observations. The increase of height was at its lower magnitude till 18 DAS. The treatment differences were broadened with advancement of age of crop at 70 and 109

DAS. This low initial growth rate might be because of initial time taken by crop for its acclimatization with soil and climate. Among P, S, Zn and Fe application, application of sulfur and iron showed higher increase in height, number of leaves, leaf area and total biomass and grain yield. These results showed the response of sulfur and iron in the experimental soil. Thus, it can be inferred that with time soils are becoming increasingly deficient in sulfur. Patil and Mali (2000) reported nearly 34 % soils of Parbhani and Latur districts of Marathwada are deficient in sulfur. They also documented the response of sulfur application to sunflower, soybean, safflower and groundnut. Similarly, Jaggi *et al.,* (2008) and Rasheed *et al.,* (2004) attributed improvement in growth and yield of maize crop to the sulfur application along with nitrogen application. Visual observations confirmed the deficiency of N, S and Fe. The maize leaves in F_0 treatment were very small, yellowish and internodes were shortened. The poor growth of maize in control plot was attributed to the low supply of nitrogen, sulphur and iron. Such effects due to low nutrient supply were noticed by Petkar (2004). Leaf area index is one of the important parameters that affect the growth of plant. Application of nitrogen had profound influence on leaf area index. There was about 50% increase in leaf area over no nitrogen application. Further, addition of phosphorus, sulphur and zinc to soil and foliar sprays of iron increased the leaf area index. Relatively more increase was observed from 18 DAS to 70 DAS. This period coincides with grand growth period of maize and top dressing of nitrogen. The balanced fertilization with increasing treatment number improved the growth parameters and biomass production. The increase was from 0.79 g plant^{-1} to 221.0 g plant^{-1} within 91 days. Similarly, with the addition of nitrogen, phosphorus, sulphur, zinc to soil and iron spray to plant increased the total biomass. It is proven fact that the application of fertilizer nutrient improves the growth parameters Heege(2001), Kayode *et al.*, (2005) and Vyas and Singh(2000).Results showed that F_5 (treatment receiving complete nutrient package) was superior over rest of the treatments followed by F4, F3, F2 and F1. These results found in confirmation with the findings of Bodkhe (2008).

Effect of fertility levels on chlorophyll ‘a’

On an average chlorophyll ‘a’ concentration of maize was found to be increased with growth of maize crop upto 82 DAS (Table 4 and Fig. 4). Thereafter there was decrease in chlorophyll ‘a’ concentration. The average increase was from 0.0807 (18DAS) to 0.467 mg g^{-1} (82DAS). Application of nitrogen over no nitrogen (Treatment F_1) enhanced the chlorophyll content at all growth stages. Further, treatments i.e. F_2, F_3 and F_4 shown significant influence in chlorophyll ‘a’, synthesis over control and F1. The highest chlorophyll ‘a’content was recorded in control treatment receiving complete nutrient package (N + P + S + Zn + Fe). Further, it was also noticed that application of S + Zn + Fe in addition to N, P synthesized more chlorophyll than control and only N received treatment. These findings confirm that though nitrogen play vital role in chlorophyll synthesis other nutrients are also essential in the process of chlorophyll synthesis. Similar pattern of increase in chlorophyll concentration was observed at all growth stages of maize with each additional nutrient. Similar results were reported by Thomas and Gausman (1977).

Effect of fertility levels on chlorophyll b

The data on chlorophyll ‘b’ concentration in maize leaves are presented in Table 5 and depicted in Fig. 5. Chlorophyll ‘b’ concentration under various treatments showed a similar pattern as that of chlorophyll ‘a’ at various growth stages. However, chlorophyll ‘b’ concentration was relatively more than chlorophyll ‘a’ and it was highest in Treatment F_5 (N+P+S+Zn+Fe) between 51 and 82 DAS.

Effect of fertility levels on total chlorophyll

The data on total chlorophyll concentration of fresh maize leaves are presented in Table 6 and shown in Figure 6. The data indicated that chlorophyll concentration in maize leaves was ranged from 0.311 to 1.428 mg g^{-1}. With the advancement of growth of maize, the total chlorophyll concentration was found to be increased upto 82 DAS. At 109 DAS the total chlorophyll concentration was reduced from 1.428 (82 DAS) to 1.130 mg g^{-1} (109 DAS).

Table.1 Effect of fertility levels on plant height (cm $plant^{-1}$)

Treatments	18 DAS	32 DAS	51 DAS	70 DAS	82 DAS	93 DAS	109 DAS	Mean
F_0	11.85	26.68	51.25	113.0	123.75	146.87	183.12	**93.78**
F_1 (N)	11.53	27.53	51.25	114.37	133.12	162.50	189.25	**99.07**
F_2 (NP)	11.31	28.42	52.87	115.5	143.12	180.00	196.87	**104.01**
F_3 (NPS)	12.60	28.95	53.87	129.25	154.87	180.37	196.87	**107.68**
F_4 (NPSZn)	12.08	29.00	55.62	130.62	176.25	218.12	224.37	**120.86**
F_5 (NPSZnFe)	12.05	30.03	55.62	136.62	180.87	220	232.5	**123.95**
Mean	11.80	28.40	53.40	123.15	151.50	184.98	204.50	**108.24**
SEm±	0.82	1.20	3.15	5.00	4.00	6.36	1.99	**-**
CD at 5%	**NS**	**NS**	**NS**	**18.05**	**11.02**	**19.14**	**6.00**	**-**

Table.2 Effect of fertility levels on leaf area index (LAI) of maize

Treatments	18 DAS	32 DAS	51 DAS	70 DAS	82 DAS	93 DAS	109 DAS	Mean
F_0	0.0051	0.226	0.630	1.730	2.011	2.028	2.293	**1.274**
F_1 (N)	0.0052	0.232	0.798	2.061	2.412	2.450	2.743	**1.528**
F_2 (NP)	0.0054	0.250	0.812	2.604	2.801	2.912	2.992	**1.768**
F_3 (NPS)	0.0056	0.251	0.979	2.707	2.892	3.011	3.092	**1.84**
F_4 (NPSZn)	0.0060	0.307	1.105	3.430	2.899	3.175	3.411	**2.047**
F_5 (NPSZnFe)	0.0070	0.415	1.587	3.438	3.791	3.876	3.791	**2.414**
Mean	0.0057	0.280	0.985	2.600	2.800	2.900	3.050	**-**
SEm±	0.00015	0.046	0.120	0.110	0.210	0.170	0.090	**-**
CD at 5%	**0.00045**	**0.139**	**0.390**	**0.330**	**0.640**	**0.520**	**0.290**	**-**

Table.3 Effect of fertility levels on biomass and economic yield (grain yield)

Treatments	Biomass (g plant^{-1})								Total biomass at harvest (q ha^{-1})	Grain yield (q ha^{-1})
	18 DAS	**32 DAS**	**51 DAS**	**70 DAS**	**82 DAS**	**93 DAS**	**109 DAS**	**Mean**		
F_0	0.79	5.02	29.07	73.49	82.08	123.45	139	67.70	244.42	**70.40**
F_1 (N)	1.07	5.08	30.02	110.62	113.75	126.72	146	176.18	255.32	**70.68**
F_2 (NP)	1.07	5.71	30.02	113.67	125.30	132.00	162	81.25	265.10	**84.80**
F_3 (NPS)	1.06	6.74	37.78	136.09	141.15	146.66	193	94.63	286.40	**92.92**
F_4 (NPSZn)	1.14	6.86	38.52	147.59	158.33	173.12	201	103.79	292.66	**93.10**
F_5 (NPSZnFe)	1.46	7.07	39.92	159.96	162.91	190.87	221	111.88	300.64	**96.08**
Mean	1.09	6.08	34.22	123.56	130.57	148.80	176.83	--	274.09	**84.66**
SEm$\pm$	0.32	1.81	15.29	71.89	60.47	32.50	32.80	--	27.65	**6.12**
CD at 5%	**NS**	**NS**	**46.03**	**NS**	**NS**	**NS**	**NS**	**--**	**NS**	**18.43**

Table.4 Effect of fertility levels chlorophyll 'a' content (mg g^{-1})

Treatment	18DAS	32 DAS	51 DAS	70 DAS	82 DAS	93 DAS	109 DAS	Mean
F_0	0.443	0.049	0.250	0.312	0.369	0.211	0.200	**0.205**
F_1 (N)	0.062	0.073	0.261	0.33	0.400	0.261	0.243	**0.233**
F_2 (NP)	0.064	0.088	0.286	0.341	0.406	0.311	0.275	**0.253**
F_3 (NPS)	0.077	0.108	0.301	0.349	0.499	0.382	0.312	**0.289**
F_4 (NPSZn)	0.110	0.137	0.343	0.403	0.517	0.487	0.414	**0.345**
F_5 (NPSZnFe)	0.120	0.141	0.398	0.410	0.611	0.525	0.500	**0.386**
Mean	0.080	0.099	0.306	0.357	0.467	0.362	0.324	**0.285**
SEm$\pm$	0.013	0.021	0.011	0.022	0.013	0.017	0.015	**--**
CD at 5%	**0.040**	**0.065**	**0.035**	**0.066**	**0.041**	**0.051**	**0.045**	**--**

Table.5 Effect of fertility levels chlorophyll b content (mg g^{-1})

Treatment	18 DAS	32 DAS	51 DAS	70 DAS	82 DAS	93 DAS	109 DAS	Mean
F_0	0.731	0.078	0.314	0.388	0.403	0.228	0.202	**0.335**
F_1 (N)	0.085	0.115	0.322	0.410	0.482	0.275	0.212	**0.272**
F_2 (NP)	0.098	0.227	0.368	0.420	0.485	0.358	0.244	**0.314**
F_3 (NPS)	0.107	0.253	0.400	0.454	0.524	0.406	0.395	**0.363**
F_4 (NPSZn)	0.132	0.303	0.412	0.510	0.587	0.576	0.506	**0.432**
F_5 (NPSZnFe)	0.161	0.459	0.497	0.626	0.702	0.660	0.573	**0.525**
Mean	0.109	0.239	0.385	0.468	0.530	0.417	0.355	**0.358**
SEm±	0.46	0.081	0.026	0.0304	0.0309	0.0250	0.0196	--
CD at 5%	**0.140**	**0.245**	**0.0792**	**0.0917**	**0.0931**	**0.0754**	**0.0389**	--

Table.6 Effect of fertility levels total chlorophyll content (mg g^{-1})

Treatment	18 DAS	32 DAS	51 DAS	70 DAS	82 DAS	93 DAS	109 DAS	Mean
F_0	0.212	0.311	0.439	0.797	1.140	1.017	0.940	**0.693**
F_1 (N)	0.275	0.358	0.584	0.870	1.260	1.170	0.950	**0.781**
F_2 (NP)	0.291	0.382	0.712	1.125	1.460	1.340	1.120	**0.918**
F_3 (NPS)	0.335	0.429	0.827	1.270	1.530	1.380	1.210	**0.997**
F_4 (NPSZn)	0.356	0.432	0.907	1.320	1.570	1.400	1.2400	**1.032**
F_5 (NPSZnFe)	0.400	0.450	1.011	1.360	1.615	1.420	1.327	**1.083**
Mean	0.311	0.393	0.746	0.957	1.428	1.280	1.130	**0.917**
SEm±	0.0805	0.0783	0.0514	0.0728	0.0685	0.0449	0.0571	--
CD at 5%	**NS**	**NS**	**0.154**	**0.219**	**0.206**	**0.135**	**0.171**	--

Fig.1

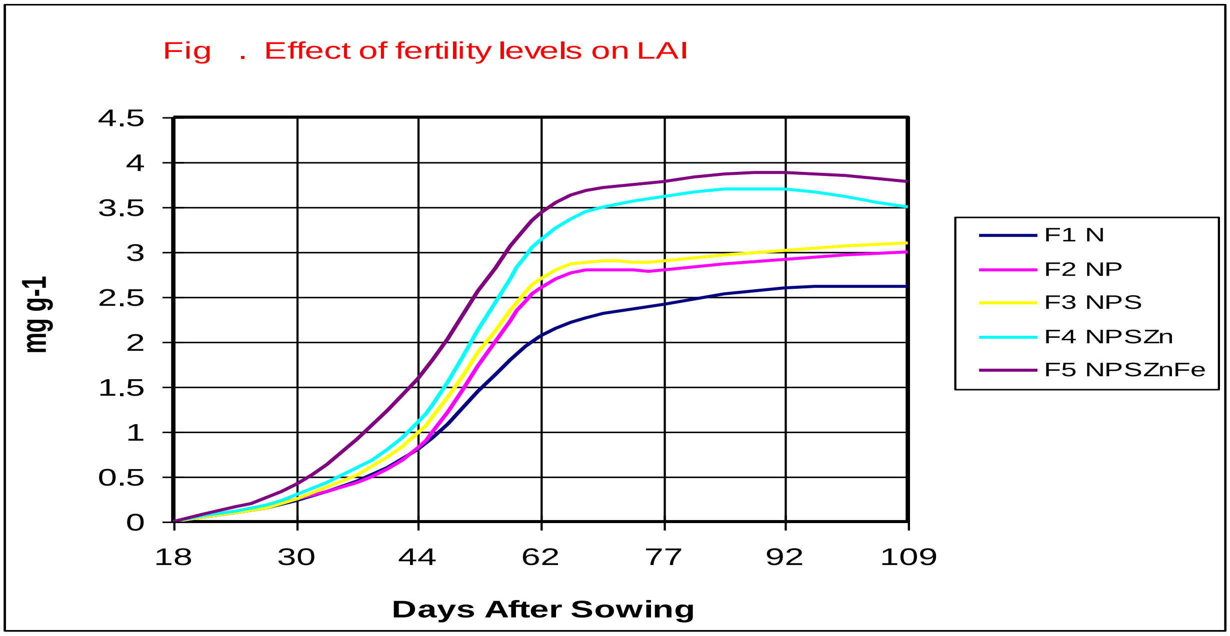

Fig.2

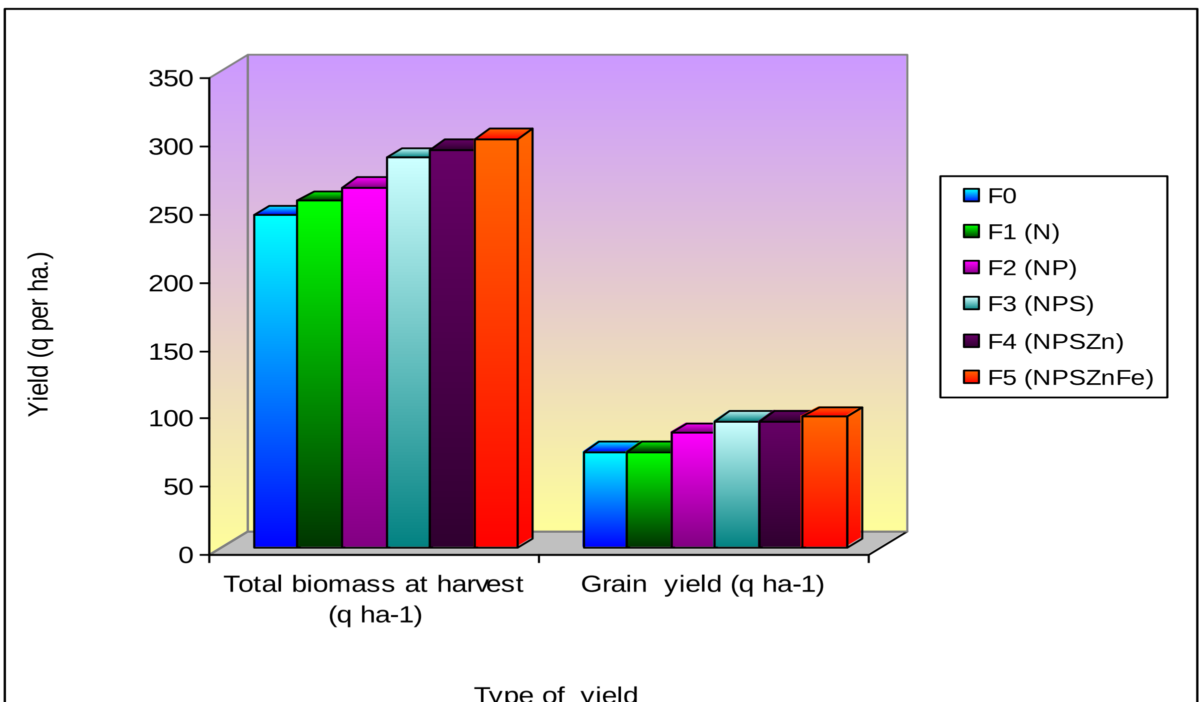

Fig. 4.3. Total biomass and cob yield as influenced by fertility levels

Fig.3

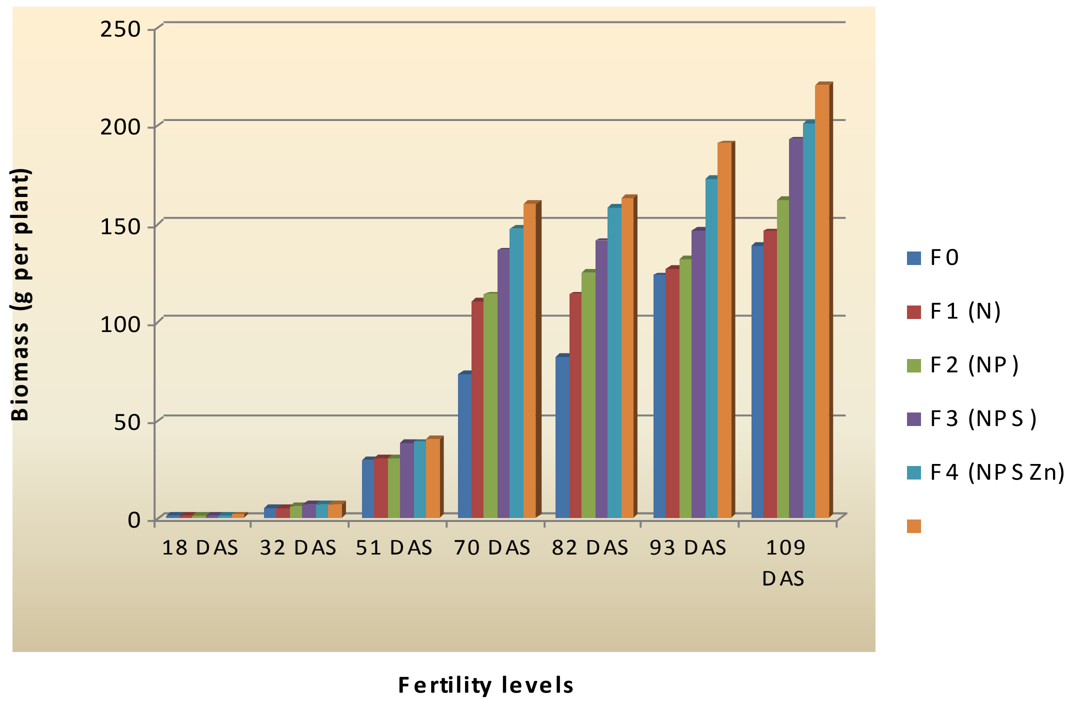

Fig. 4.2. Biomass per plant as influenced by fertility levels

The maximum total chlorophyll concentration was observed at 82 DAS. There was increase in total chlorophyll concentration with each additional nutrient. Irrespective of growth, the average chlorophyll content observed in treatment F_1 to F_5 was 0.781, 0.918, 0.997, 1.032 and 1.083 mg g^{-1} which found to be significantly higher than F_0 (0.693 mg g^{-1}). The behaviour of various treatments in respect of total chlorophyll synthesis adopted a similar pattern as that of chlorophyll 'a'. The graph clearly depicts the higher chlorophyll synthesis in treatment F_2 to F_5 over F_0 and F_1 (Fig. 6).Costa (1991) reported that leaf chlorophyll content was improved due to nutrient application.

Conclusion of the study is as follows:

Each additional nutrient in the treatment increased the nitrogen and phosphorus availability at all growth stages over control. Sulfur, Zinc and Iron availability was low in all the treatments upto 51 DAS and increased thereafter.

The growth parameters viz. height of plant, no. of leaves, LAI, total biomass and grain yield of maize found to be improved due to each additional nutrient and maximum in treatment received N (150 kg ha^{-1}) + P (50 kg ha^{-1}) + S (30 kg ha^{-1}) + Zn (20Kgha^{-1}) + Fe (@ 2% foliar spray at two crop growth stages) application.

Among P, S, Zn and Fe application of S and Fe showed higher impact on growth parameters and grain yield of maize.

Chlorophyll concentration was more in the maize fertilized with N, S and Fe. It was increased upto tasseling stage and decreased during reproductive and senescence stage. Chlorophyll concentration was more in F_5 (N + P + S + Zn + Fe @ 2% foliar spray) followed by F_4 (N + P + S + Zn), F_3 (N + P + S), F_2 (N+P) and F_1 (only N).

References

Biljana, B. and J. Stojanovic (2005). Chlorophyll and carotensoid content in wheat cultivars as a functions of mineral nutrition. *Arch. Boil. Sci. Belgrade*, 57(4): 283-290.

Blackburn and George A. (1998). Quantifying chlorophylls and carotenoids at leaf and canopy scales: An evaluation of some hyperspectral approaches. *Remote sensing of ENV*, 66(5): 273-285.

Ciganda, V. and Gitelson, A. (2009). Non destructive determination of maize leaf and canopy chlorophyll content. *J. of Plant Physio*., 166(2): 157-167 Hatfield J.L., A.A. Gitelson, J.S. Schepers and C.L. Walthall (2006). Application of Spectral *Remote sensing* for Agronomic *Decisions. Agron, Journ*. 100:117-131.

Kumar S.N. and Singh, C.P. (1996). Chlorophyll content in maize (*Zea mays* L.) leaves: physiological and seasonal variation. *Indian J. Plant Physiol.* 1(3): 189-194

Patil V.D. and Kolte, S.B. (2003). Relationship between spectral parameters and physiological parameters in soybean crop. *Paper presented in 2nd International Congress of plant physiology on sustainable plant productivity under changing environment held at IARI, New Delhi, Jan* 8-12.

Patil V.D. and Mali C.V. (2000). Report on soil survey and field trials on sulfur

Petkar, M.K. (2004). Diagnosis of nitrogen deficiency and growth assessment of maize (*Zea mays* L.) under varying levels of nitrogen by remote sensing. *M.Sc. (Agri.) Thesis Department of Soil Science and Agril. Chem. MAU, Parbhani.*

Rasheed, M.A.; Hakoomat Ali and Tariq M. (2004). Impact of nitrogen and sulfur application on growth and yield of maize (*Zea mays* L.) crop. *J. of Res. Sci., Bahauddin Zakariya University, Multan Pakistan,* 15(2): 153-157

Rathore, D.N.; Singh, B.P. and Kirpal Singh (1972). Effect of phosphorus and zinc on yield and attributes of maize. *Indian J. Agri. Res*., 6(2): 111-114.

Reddy, G.S., Narashimha Rao C.L., Venkataratham L. and Krishna Rao P.V. (2001). Influence of plant pigments on spectral reflectance of maize, groundnut and soybean grown in semi-arid environments. *International J. remote sensing*, 22(17): 33-3380.

Taalab, A.S.; Hellal, F.A. and Abou-Seffa, M.A. (2005). Influence of phosphate fertilizers enriched with sulfur on phosphorus availability and com yield in calcareous soils in arid region. *Ozean J. of App. Sci.*, 1(1): 2008.

How to cite this article:

Zagade, T.R., S.R. Adat, Sunil Chowdhary Vajja and D. Bhuvneshwari, D. 2019. Study of Multinutrient Effect on Growth, Plant Pigment Concentration and Yield of Maize (Zea mays). *Int.J.Curr.Microbiol.App.Sci.* 8(04): 3056-3066. doi: https://doi.org/10.20546/ijcmas.2019.804.352