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Effect of IPNS and Foliar nutrition on growth and yield of maize

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Abstract

A field experiment was carried out in rabi 2022 at a farmer's field in Ahilandapuram village to investigate the effects of IPNS and foliar nutrition on the growth and yield of maize. The experiment was set up using a random block design with thirteen treatments and three replications, using maize as a test crop. The treatments include the control, 100% & 75% STCR-IPNS alone, 100% STCR-IPNS the treatment (T₁₂) that received 100% STCR-IPNS along with the foliar application of TNAU maize maxim, TNAU PPFM, Aloe vera leaf extract, and the Amino acid has recorded the highest plant height and dry matter production. Significantly, the same treatment (T₁₂) recorded the maximum cob length, grith, grain yield and stover yield. Based on the above outcome, the integrated application of STCR-IPNS along with a foliar spray of TNAU Maize maxim + TNAU PPFM+ Aloe vera leaf extract+ Amino acid (T₁₂) can be considered as the most effective technique to enhance the growth and yield properties of maize.

Keywords: Maize, STCR-IPNS, Foliar nutrition, Growth, Yield

Abbreviations: STCR-IPNS- Soil Test Crop Response- Integrated plant Nutrition System FS- Foliar spray, PPFM- Pink Pigmented Facultative Methylootrophs, AA- Amino acid ALE- Aloe vera Leaf Extract, MM- Maize maxim

1. Introduction

Maize (*Zea mays* L.) is a major cereal crop in a majority of developing and developed countries all over the world. Because of its higher productivity, it was known as the "Queen of Cereals" as well as a "Miracle Crop". Apart from grain, stalks provide excellent livestock feed and are known as the "King of fodder." Maize is mainly grown for grain, but it is also used for forage and raw materials in industrial processes.

Unbalanced fertilizers application by farmers without knowledge of soil fertility conditions and crop nutritional needs is one of the reasons for decreased productivity. This has negative impact on soil and crops, both in response to nutrient toxicity and deficiencies (Singh *et al.*, 2015) ^[10]. It is necessary to provide sufficient balanced nutrition to the crop in order to achieve maximum yield and maintain soil fertility.

The most efficient method for finding optimum fertilizers doses is to apply fertilizers quantities depending on the Soil Test Crop Response under Integrated Plant Nutrition System (STCR-IPNS) studies (Raghuramakrishnan *et al.*, 2021) ^[9].

The fundamental concept of the Integrated Plant Nutrient System (IPNS) is to maintain and improve soil fertility in order to maintain crop yield through the use of organic manure, inorganic fertilizers, and bio-fertilisers in combinations (Hemalatha *et al.*, 2018) ^[4]. Fertilizer application to the soil results in nutrient losses in the form of leaching loss, volatilization, and fixation reducing nutrient utilization efficiency. As a result, an effort is being made to boost crop productivity through foliar fertilization of nutrients in addition to the recommended dose of fertilizer.

Foliar feeding is commonly the most significant and cost-effective method of correcting plant nutrient deficiency or bridging the nutrient gap in crop requirements. Foliar nutrient feeding has always been standard practise in crop production in recent decades, with both the objective of enhancing yield and improving crop quality (Shwetha *et al.*, 2018) ^[12]. Plant hormones influence every stage of growth and development of plants; hence, they can be used to boost yield per unit area.

Maize maxim is a crop booster and a plant growth regulator that helps to improve crop

productivity and drought tolerance in plants. Plant growth is enhanced by aloe vera leaf peeling extract and powder because it contains nutrients and phytohormones (Hemalatha *et al.*, 2018) [5]. In addition, amino acids are a well-known bio stimulant for their beneficial effects on plant growth, yields, and helps to mitigate the effects of abiotic stresses on plants (Shehata *et al.*, 2011) [13]. Pink-pigmented facultative methylotrophs (PPFM) are used to maximize the germination, plant growth, development and yield, while somehow minimising the negative impacts of drought stress (Ajaykumar *et al.*, 2022) [2]. As a result, the current study examined the effects of foliar spraying of nutrients and plant growth regulators on maize growth and yield properties.

2. Materials and Methods

2.1 Experimental site

A field experiment was carried out in a Farmer's field in Ahilandapuram Village of Kayathar Block, Tuticorin district of Tamil Nādu, during the Purattasipattam season of 2021 to 2022 to study the effect of IPNS and foliar nutrition on growth and yield of maize. The initial soil sample was taken and analysed for its properties. The soil physical properties of the experimental soil consist of sandy clay texture, with a bulk density of 1.11Mg/m³, Particle density of 2.46 Mg/m³ and a pore space of 39%. The soil chemical properties of the experimental soil consist of pH and Electrical conductivity values of 8.25 and 0.23 dS/m respectively. Based on the soil fertility status, the soil available N range is 163 kg ha⁻¹(low), soil available P is 18 kg ha⁻¹(medium), soil available K is 300 kg ha⁻¹(High), soil organic carbon is 2.43 g/kg and DTPA micronutrients are sufficient in soil. A Randomized Block Design was used to carry out this experiment, which included thirteen treatments and three replications.

Treatment details

Treatment No	Treatments
T ₁	Control
T ₂	STCR-IPNS
T ₃	75% STCR-IPNS
T ₄	T ₂ + Foliar spray (fs) of 0.2% Amino acid (AA)
T ₅	T ₃ + Foliar spray of 0.2% Amino acid
T ₆	T ₂ + Foliar spray of 1.5% Maize maxim (Mm)
T ₇	T ₃ + Foliar spray of 1.5% Maize maxim
T ₈	T ₂ + Foliar spray of 50 ppm Aloe vera leaf extract (ALE)
T ₉	T ₃ + Foliar spray of 50 ppm Aloe vera leaf extract
T ₁₀	T ₂ + Foliar spray of 1% Pink Pigmented Facultative Methylotrophs (PPFM)
T ₁₁	T ₃ + Foliar spray of 1% PPFM
T ₁₂	T ₂ + Foliar spray of 0.2% Amino acid+1.5% Maize maxim + 50 ppm Aloe vera leaf extract+1% PPFM
T ₁₃	T ₃ + Foliar spray of 0.2% Amino acid+1.5% Maize maxim+50 ppm Aloe vera leaf extract+1% PPFM

2.2 Experimental design and data collection

Foliar application used in the treatments are TNAU Maize maxim @ 1.5%, PPFM @ 1%, Amino acid @ 0.2% and Aloe vera leaf extract @ 50 ppm. On 30, 40, and 50 DAS, foliar spraying of TNAU Maize maxim, Aloe vera leaf extract, PPFM, and Amino acids was done early in the morning. The maize cultivar (Ankur Aditya hybrid) was utilised as a test crop, with a row spacing and a plant spacing of 60 X 25 cm with a Plot size of 6 X 4 cm. Fertilizers are applied to the plots based on the recommendations (155:90:56 kg N, P₂O₅,

K₂O ha⁻¹) provided under STCR, which is based on the initial soil test values with a target yield of 6-8 t ha⁻¹. The crop production guide was followed for recommended plant protection measures and other management methods. The data was taken from the plot's five samples, averaged, and also the mean data was taken.

2.3 Statistical analysis

According to Gomez and Gomez (1984) [3], the data acquired throughout the experiment were statistically analysed.

3. Results and Discussion

3.1 Growth parameters

3.1.1 Plant height

The foliar application of nutrients has a significant and positive impact on the growth of the maize crop. Among the several treatments, the treatment T₁₂ (T₂ + Fs of 0.2% AA+1.5% Maize maxim + 50 ppm Aloe vera leaf extract+1% PPFM) recorded the highest plant height of 124.85, 215.96 and 237.38 cm at 30, 60 DAS and at harvest stages respectively.

It was observed that this was on par with treatment T₁₃ (T₃ + Fs of 0.2% AA+1.5% Maize maxim + 50 ppm Aloe vera leaf extract+1% PPFM). The minimum plant height of 81.38, 134.44, 155.90 cm was observed in the control (T₁) (Table 1). From the result, it can be concluded that the performance in plant growth is probably due to the combined application of nutrients that increases cell division, cell enlargement and growth as well as photosynthesis and protein synthesis (Tomar *et al.*, 2017) [14].

3.1.2 Dry Matter Production

In terms of dry matter production, significant differences were observed among the treatments. Among the treatments, T₁₂ (T₂ + Fs of 0.2% AA+1.5% Maize maxim + 50 ppm Aloe vera leaf extract+1% PPFM) has recorded the highest dry matter production of 3323 kg ha⁻¹, 9940 kg ha⁻¹ and 17484 kg ha⁻¹ at 30, 60 DAS and at harvest stages respectively which was on par with treatment T₁₃ (T₃ + Fs of 0.2% AA+1.5% Maize maxim + 50 ppm Aloe vera leaf extract+1% PPFM). The lowest dry matter production of 1503 kg ha⁻¹, 6344 kg ha⁻¹, 9749 kg ha⁻¹ was observed in the control plot (T₁) (Table 2). Similar findings was reported by (Arthy *et al.*, 2020) [1].

3.2 Yield parameters

3.2.1 Cob length

In case of cob's length, the maximum cob length was observed in the treatment T₁₂ (T₂ + Fs of 0.2% AA+1.5% Maize maxim + 50 ppm Aloe vera leaf extract+1% PPFM) with the length of 24.46 cm which was on par with treatment T₁₃ (T₃ + Fs of 0.2% AA+1.5% Maize maxim + 50 ppm Aloe vera leaf extract+1% PPFM), recording 20.47 cm and the least was observed in the control (T₁) of 9.69 cm (Table 3). A similar report was reported by (Mahapatra *et al.*, 2018) [7].

3.2.2 Cob girth

The treatment T₁₂ (T₂ + Fs of 0.2% AA+1.5% Maize maxim + 50 ppm Aloe vera leaf extract+1% PPFM) recorded the maximum cob girth of 23.08 cm which was on par with treatment T₁₃ (T₃ + Fs of 0.2% AA+1.5% Maize maxim + 50 ppm Aloe vera leaf extract+1% PPFM) recording 19.24 cm (Table 3). The control (T₁) registered the least of 8.44 cm.

3.2.3 Grain yield

Foliar application of Amino acid, TNAU PPFM, Maize maxim and Aloe vera leaf extract along with 100% STCR-IPNS (T₁₂) produced significantly maximum grain yield of 7559.67 kg ha⁻¹, which was followed by the treatment T₁₃ (T₃ + Fs of 0.2% AA+1.5% Maize maxim + 50 ppm Aloe vera leaf extract+1% PPFM) registering grain yield of 7044.67 kg ha⁻¹. The lowest grain yield of 3624.33 kg ha⁻¹ was observed in the control plot (T₁) (Table 3). This yield advantage observed when using inorganic fertilizers in combination with biofertilizers, crop boosters, and amino acid might be attributed to maize increased growth and yield attributing characteristics (Kalhapure *et al.*, 2013) [6]. Shanwad *et al.* (2010) [11] has stated that applying nutrients from both organic and inorganic sources together increases maize productivity.

3.2.4 Stover yield

The treatment T₁₂ (T₂ + Fs of 0.2% AA+1.5% Maize maxim + 50 ppm Aloe vera leaf extract+1% PPFM) registered the maximum stover yields of 9609.67 kg ha⁻¹. This was followed by the treatment T₁₃ (T₃ + Fs of 0.2% AA+1.5% Maize maxim + 50 ppm Aloe vera leaf extract+1% PPFM) recording 9227.00 kg ha⁻¹. The control plot (T₁) produced 6164.67 kg ha⁻¹, which was the yield with the lowest production (Table 3). The improved soil structure accompanied by the greater usage of organic nutrients, which influenced the yield. Stover yield might have increased because nutrient balance during the crop period led to increased root growth, leading to an increase in stem and stalk weight. Similar outcomes have also been reported by (R. Prathibha *et al.*, 2018)

Table 1: Effect of STCR-IPNS and foliar nutrition on maize Plant height (cm)

SI No.	Treatments	30 DAS	60 DAS	90 DAS
T ₁	Control	81.38	134.44	155.90
T ₂	STCR-IPNS	97.17	154.96	175.06
T ₃	75% STCR-IPNS	91.74	148.95	166.11
T ₄	T ₂ + foliar spray (Fs) of 0.2% Amino acid (AA)	102.47	167.03	185.35
T ₅	T ₃ + Fs of 0.2% AA	94.77	162.81	177.17
T ₆	T ₂ + Fs of 1.5% Maize maxim	115.45	184.11	203.71
T ₇	T ₃ + Fs of 1.5% Maize maxim	112.26	184.05	192.73
T ₈	T ₂ + Fs of 50 ppm Aloe vera leaf extract	95.40	157.04	194.48
T ₉	T ₃ + Fs of 50 ppm Aloe vera leaf extract	92.84	147.47	183.51
T ₁₀	T ₂ + Fs of 1% PPFM (Pink pigmented Facultative methylotrophs)	113.76	183.69	202.44
T ₁₁	T ₃ + Fs of 1% PPFM	101.99	173.40	193.45
T ₁₂	T ₂ + Fs of 0.2% AA+1.5% Maize maxim + 50 ppm Aloe vera leaf extract+1% PPFM	124.85	215.96	237.38
T ₁₃	T ₃ + Fs of 0.2% AA+1.5% Maize maxim+50 ppm Aloe vera leaf extract+1% PPFM.	119.30	203.47	212.25
	S.Ed	2.02	3.12	3.27
	CD (p= 0.05)	4.18	6.54	6.72

Table 2: Effect of STCR-IPNS and foliar nutrition on maize dry matter production (kg ha⁻¹)

SI No.	TREATMENTS	30 DAS	60 DAS	90 DAS
T ₁	Control	1503	6344	9749
T ₂	STCR-IPNS	2297	8304	12387
T ₃	75% STCR-IPNS	2038	8024	11829
T ₄	T ₂ + foliar spray (Fs) of 0.2% Amino acid (AA)	2409	8389	15495
T ₅	T ₃ + Fs of 0.2% AA	1998	8029	14616
T ₆	T ₂ + Fs of 1.5% Maize maxim	2941	7753	15825
T ₇	T ₃ + Fs of 1.5% Maize maxim	2772	9040	14808
T ₈	T ₂ + Fs of 50 ppm Aloe vera leaf extract	2428	8747	13302
T ₉	T ₃ + Fs of 50 ppm Aloe vera leaf extract	2241	8351	12898
T ₁₀	T ₂ + Fs of 1% Pink pigmented Facultative methylotrophs (PPFM)	2989	7546	16128
T ₁₁	T ₃ + Fs of 1% PPFM	2833	7370	16034
T ₁₂	T ₂ + Fs of 0.2% AA+1.5% Maize maxim + 50 ppm Aloe vera leaf extract+1% PPFM	3323	9940	17484
T ₁₃	T ₃ + Fs of 0.2% AA+1.5% Maize maxim+50 ppm Aloe vera leaf extract+1% PPFM.	3118	9415	16862
	S.Ed	45.05	162.43	165.10
	CD (p= 0.05)	92.97	335.25	340.76

Table 3: Effect of STCR-IPNS and foliar nutrition on maize yield and yield attributes

SI No.	Treatments	Cob length (cm)	Cob girth (cm)	Grain yield (kg ha ⁻¹)	Stover yield (kg ha ⁻¹)
T ₁	Control	9.69	8.44	4291	6164
T ₂	STCR-IPNS	17.69	16.61	6288	8670
T ₃	75% STCR-IPNS	16.30	15.60	5869	8018
T ₄	T ₂ + foliar spray (Fs) of 0.2% Amino acid (AA)	11.20	10.30	6372	8229
T ₅	T ₃ + Fs of 0.2% AA	10.49	9.30	6043	8072
T ₆	T ₂ + Fs of 1.5% Maize maxim	12.74	11.43	5939	8004
T ₇	T ₃ + Fs of 1.5% Maize maxim	11.52	10.47	5598	7928
T ₈	T ₂ + Fs of 50 ppm Aloe vera leaf extract	15.45	14.68	6411	8112
T ₉	T ₃ + Fs of 50 ppm Aloe vera leaf extract	14.71	13.83	6030	8005

T ₁₀	T ₂ + Fs of 1% PPFM (Pink pigmented Facultative methylotrophs)	19.05	18.43	6999	8588
T ₁₁	T ₃ + Fs of 1% PPFM	18.17	17.47	6932	8410
T ₁₂	T ₂ + Fs of 0.2% AA+1.5% Maize maxim + 50 ppm Aloe vera leaf extract+1% PPFM	24.46	23.08	7559	9609
T ₁₃	T ₃ + Fs of 0.2% AA+1.5% Maize maxim+50 ppm Aloe vera leaf extract+1% PPFM.	20.47	19.24	7078	9227
S.Ed		0.39	0.26	202.57	226.77
CD (p= 0.05)		0.81	0.54	418.09	468.03

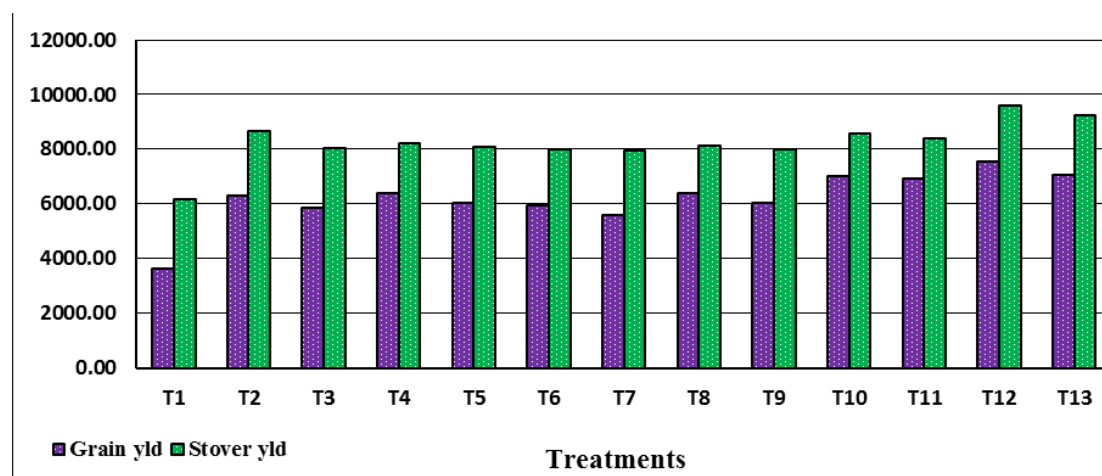


Fig 1: Effect of various treatments on yield of maize

4. Conclusion

In conclusion, based on the results of the experiments that the application of STCR-IPNS along with a foliar spray of TNAU Maize maxim, TNAU PPFM, Amino acid and Aloe vera leaf extract was found to be better performance in terms of growth and yield of maize

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