Original Research Article

Effect of Nitrogen Levels and Seaweed extract (*Kappaphycus alvarezii*) on Growth and Yield of summer Maize (*Zea mays* L.)

Abstract

The trail was conducted in Crop Research Farm, Department of Agronomy of Naini Agricultural Institute, SHUATS, Prayagraj (U.P), during *Zaid* 2022. The experiment consists of three Nitrogen Levels i.e., 50%, 75% and 100% N along with Seaweed extract (*Kappaphycus alvarezii*) applied at different concentration i.e., 5%,10% and 15%. The experiment was laid out in Randomized Block Design with ten treatments each replicated thrice. The results showed that plant height (165.73 cm) and dry weight (88.13 g/plant), were recorded significantly highest in the treatment 7 which is with the application of 100% Nitrogen + 15% K-sap as compared to all other treatments. The significantly highest number of cobs/plant (3), number of Rows/cob (14.47), Grains/row (28.27), Grain Yield (4.05 t/ha), stover yield (15.37 t/ha), and seed Index (26.2) were recorded with application of 100% Nitrogen + 15% K-sap as compared to all other treatments.

Keywords: Maize, Nitrogen, Seaweed extract (K-sap), Growth and Yield.

1. Introduction

Maize (*Zea mays* L.), a monocotyledonous plant and belongs to the family *Poaceae.* It is an important cereal crop grown across the world. [7] According to FAO 1992, Maize is ranked the 3 most important cereal crop after rice and wheat. [9] Among the maize growing countries India rank 4th in area and 7th in production. In India during 2021 the production of maize is 32.4 m/t from an area of 9.86 m/ha with the productivity 2.43 t/ha. Among Indian states area of maize of U.P state is 8% with 6.1% production. It serves as a source of nutrients for human and animal and as raw materials for various Industries. In developed world it is used as a animal feed while it is used majorly as food in the developing world. [27] According to Varheye 2010, maize is presently grown in more than 100 countries and it has served as a diversification from the traditional root crops in the local Diets.

Nitrogen is considered one of the most important nutrients affecting yield and quality of Maize (*Zea mays* L.).[1] Maize usually requires a considerable amount of nitrogen (N) for its better growth and development because of its exhaustive nature.[26] It is a major component of numerous plant biological compounds that play a crucial role in photosynthetic 11 activities

and consequently influence crop yield capacity. Adequate N levels result in dark green leaves, whilst, deficiencies cause leaf chlorosis. Deficiencies may also result in slow stunted growth and weak plants; such plants normally mature early which may significantly reduce grain quality and quantity. Maize grain quality and quantity are improved with adequate nitrogen levels in the soil.

Nitrogen management in maize production system is one of the main concerns since it is the most important and primary nutrient for growth and development of the crop [3]. [16] Nitrogen is the essential constituent of chlorophyll, protoplasm and enzymes. Inappropriate soil and asymmetric nutrients management are the major causes for poor yield output. Precision of nitrogen management is efficient for maize crops in terms of economy and the environment. Adoption of optimum amount of N increases the N use Efficiency as well as reduces the N loss, and ensure optimal use of N with help of certification system. Nitrogen also mediates the utilization of phosphorous, potassium and other element in the plant.

[4] Higher nitrogen levels are reported to increase plant height, stem thickness, leaf area, leaf area index, dry matter accumulation; net assimilates ratio and yield per hectares. In maize the amount of maize grain produced per unit of nitrogen applied depends upon the uptake from fertilizer and soil N and its utilization in producing grains. [24] As such nitrogen being the most limiting nutrient its supply along with other nutrients becomes a matter of paramount concern to maintain fertility of the soil for the sustain high crop production.

Seaweeds and various seaweed extracts have been utilized in agricultural practices since long. Sea weed extracts contain different phytohormones like Auxins, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Betaine and Polyamines and other growth promoters along with trace elements, vitamins, amino acids, antibiotics and micronutrients which enhance the yield and yield attributes of crops, when applied exogenously. Unlike chemical fertilizers, extract derived from seaweeds are biodegradable, non-toxic, non-polluting and non-hazardous to humans, animal and birds [5].

Seaweed aids in the production of beneficial soil microorganisms, [28] develops tolerance against environment stress. seaweed extract has been found to increase the yield of several crops as well as impart drought tolerance., increases nutrient uptake from soil. [18] Liquid seaweed fertilizer is a unique combination of micronutrients, especially K and trace elements, polysaccharides and sugar that are in dissolve, [6] the foliar spray of liquid extract from seaweed causes cereals, vegetables, fruit plants, and horticultural crops to grow faster and

produce more. In many commercial crops, foliar spraying with seaweed extract is a popular practice to increase yield.

Kapppahycus alvarezii (Rhodophyta, Gigartinales) is a Red algae. *Kapppahycus alvarezii* a native of the Phillippines, has been introduced and domesticated in many countries including Indonesia, Mexico, Fiji, Vietnam, Brazil, China and India for commercial cultivation. In India *Kappaphucus alvarezii* was first introduced by the Central Salt and Marine Chemicals Research Institute (CSMCRI) and therefore its cultivation technology was perfected. Currently *K. alvarezii* is acclimatized and also is being extensively farmed on the east coast of Mandapam in Tamilnadu and along the west coast in Diu and more recently along the Gujarat coast. There are results showed that single application of K sap even a late crop stage can be beneficial under normal irrigates conditions. [17] India's share is about >2% in global *K. alvarezii* production. [11] The protein content of *K. alvarezii* varied from 12.69 ± 0-6 to 23.61 ± 0.02 g/100 g DW, and the fiber content varied between 9.68 ± 0.08 to 18.57 ± 0.15 g/100 g DW

MATERIALS AND METHODS

The experiment was carried out during *Zaid* season of 2022 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (Allahabad) which is located at 25˚ 24' 42" N latitude, 81° 50' 56" E longitude, and 98 m altitude above the mean sea level. This area is situated on the right side of the river Yamuna by the side of Allahabad Rewa Road about 5 km away from Prayagraj (Allahabad) city. The facilities required for crop cultivation were available. The meteorological data including the weekly average of maximum and minimum temperature, relative humidity, and rainfall recorded at the Agro Meteorological Observatory Unit, School of Forestry and Environment Sciences, Sam Higginbottom University of Agriculture Technology & Sciences, Prayagraj (Allahabad) during the cropping period are presented in Fig 1

1.1 soil of the Experimental Field

The soil of the experimental field constituting a part of central Gangetic alluvium is neutral and deep. With the use of an auger, pre-sowing soil samples were gathered from a depth of 15 cm. Chemical and mechanical analyses were performed on the composite samples. The texture of the soil was sandy loam, with low organic carbon, medium available nitrogen, phosphorus, and low potassium. Tables 1 and 2 show the mechanical, chemical, and physico-chemical properties of the soil in the experimental field, as well as the methods employed to determine them.

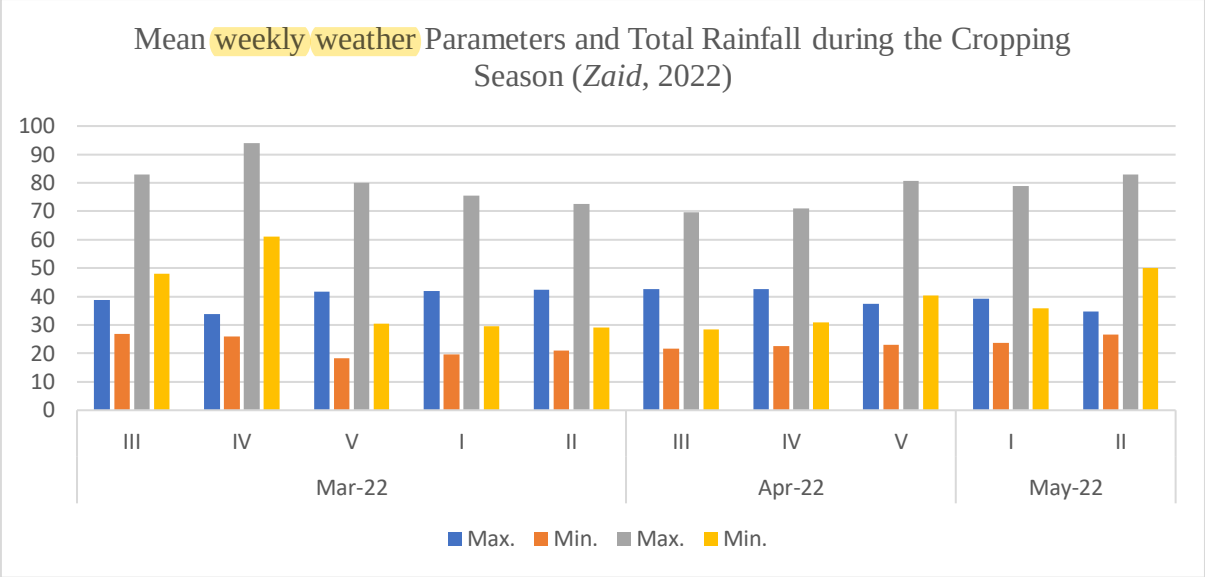

Fig.1. Meteorological data on means weekly weather parameters during the cropping season (*Zaid*, 2022)

1.1.1 Mechanical analysis of soil during *Zaid* 2022

Table 1. the mechanical analysis of soil (0-15 cm depth) is represented below

Particulars	Result (%)
Sand (%)	63.00 (%)
silt (%)	22.60 (%)
Clay (%)	14.40 (%)
Textural class	Sandy Loam

1.2 Chemical analysis of soil during *Zaid* 2022

Table 2. Mechanical analysis of soil

Parameter	Result (Unit)	Method
Organic carbon	0.69%	Walkely and Black Method
Available Nitrogen	271.81 kg/ha	Alkaline Permanganate Method
Available Phosphorous	30.19 kg/ha	Olsen's Colorimetric Method
Available Potassium	331 kg/ha	Flame photometer method
Ph	7.1	Lass electrode pH meter
EC	0.21 (d/Sm)	Method No.4, USDA Handbook No.60

1.3 Experimental Details

Randomized Block Design was used to set up the experimental. It is a bifactoral experiment with two factors 1. Nitrogen Levels (which has 100,75 and 50% Nitrogen) and the 2. Foliar application of Seaweed extract (*Kappaphycus alvarexii*) (which includes concentration of 5,10 and 15% K-sap). The treatment comprised and 3 different Nitrogen Levels and 3 different concentrations of Seaweed extract. Each of the ten treatments was divided into thirty (30) plots with treatments distributed at random. With different treatment combinations as follow, 1. 100% Nitrogen + 5% K.sap 2. 75% Nitrogen + 5% K.sap 3. 50% Nitrogen + 5% K.sap 4. 100% Nitrogen + 10% K.sap 5. 75% Nitrogen + 10% K.sap 6. 50% Nitrogen + 10% K.sap 7. 100% Nitrogen + 15% K.sap 8. 75% Nitrogen + 15% K.sap 9. 50% Nitrogen + 15% K.sap 10. RDF + water spray.

1.4 Statistical Analysis

Randomized block design was used in the experiment. The analysis of variance technique was applied for drawing conclusion from the data. The calculated value was compared with tabulated value at 5% level of significant for appropriate degree of variable table.

2. RESULTS AND DISCUSSION

Results and Discussions include all the growth and yield attributing characters of the crop that have been observed. Showed that the values of the growth contributing characters viz, plant height (cm), plant dry weight (g/m^2), Crop Growth Rate (g/m^2/day), Relative Growth Rate (g/g/day) and yield attributes like number of cobs/plant, number of rows/cob, number of grains/row, seed Index, grains (t/ha), Stover yield (t/ha), and Harvest Index.

PRE-HARVEST READIGS

Effects on Growth of Maize

2.1 Plant Height

At 80 DAS, significantly highest plant height (172.63 cm) was recorded with Treatment 7 (100% Nitrogen + 15% K.sap). However, Treatment 4 (100% Nitrogen+ 10% K sap) *i.e.*, (171.03 cm) was statistically at par with Treatment 7. Whereas lowest plant height was seen in Treatment 10 (RDF + water spray) *i.e.*, (141.43 cm). it is a vitally associated with the activity of every living cell. Thus, [12] greater availability of nitrogen at higher fertilizer doses might have improved protein synthesis and photosynthesis leading thereby to rapid cell division and enlargement, which ultimately resulted in to vigorous plant growth and similar findings

[21] Seaweed extract stimulate various aspects of plant development plant height (59.13 cm). [15] Observed higher plant height (196.73 cm) under 100% recommended nitrogen dose.

3.2 Plant Dry weight (g/plant)

At 80 DAS, significantly highest plant dry weight (88.18 g) was recorded with Treatment 7 (100% Nitrogen + 15% K.sap). However, Treatment 4 (100% Nitrogen+ 10% K sap) *i.e.*, (86.54 g) was statistically at par with Treatment 7. Whereas lowest plant dry weight was seen in Treatment 10 (RDF + water spray) *i.e.*, (68.92 g). Latha and prasad (2008) reported higher dry matter accumulation in Maize with more trogen dose in intercropping system with mung bean. [2] Reported that application of 100% RDN (120 kg N/ha) increase significantly highest dry matter production (1150.03 g/m^2).

3.3 Crop Growth Rate (g/m^2/day)

During 60-80 DAS, o significant difference is recorded among the treatments. The maximum value for CGR (24.55 g/m^2/day) is recorded with application of 50% Nitrogen + 15% K.sap. Crop growth rate of maize uncreased progressively with time reaching maximum at 80 DAS. Application of higher amount of N developed larger canopy and showed greater CGR of maize. It is not unlikely to have negative CGR values in the later crop growth stages. [8] The fertilizer treatment had significant effect on the crop growth rate at different growth stages, with increasing nitrogen levels, crop growth rate (CGR) was increased. Significantly highest CGR (52.7 g/m^2/day) were obtained from 180 kg N/ha and was at par with 120 kg N/ha (50.7 g/$m^{2/}$day).

3.4 Relative Growth Rate

During 60-80, no significant difference is recorded among the treatment. The maximum reading of RGR (0.017 g/g/day) with T_3 (50% Nitrogen + 5% K.sap).

POST-HARVEST READINGS

Effects of Yield attributes of Maize

3.4 Number of cobs/plant

At the time harvest, significantly highest no.of cobs/plant (3 cob/plant) recorded in Treatment 7. However, Treatment 4 (3 cob/plant) which was statistically at par with Treatment 7. Whereas lowest No.of cobs/plant (2) is recorded in Treatment 10 ~~(2)~~. [23] reported significant highest in cobs/plant (3 cob/plant) and weight of cob of maize were noted with application of increasing levels of nitrogen fertilizers.

3.5 Number of rows/cob

The significantly highest no.of row/cob (14.47) was recorded in Treatment 7. However, Treatment 4 (14.46) which was statistically at par with Treatment 7. Whereas lowest no.of rows/cob is recorded in Treatment 10 (10.1). [20] showed an extraordinary effect of seaweed extract on corn growth and performance.

3.6 Number of Grains/row

The significantly highest no.of grains/row (28.27) was recorded in Treatment 7. However, Treatment 4 (27.7) which was statistically at par with7. Whereas lowest no.of grains/row is recorded in Treatment 10 (23.23).

3.7 Seed Index (g)

The significantly highest Seed Index (26.2) was recorded in Treatment 7. However, Treatment 4 (25.7) which was statistically at par with 7. Whereas lowest Seed Index is recorded in Treatment 10 (20.97).

3.8 Grain Yield (t/ha)

An appraisal review of the table shows that the grain yield differed significant. The significantly highest grain yield was observed in Treatment 7 (4.05 t/ha). However, Treatment 4 (3.87 t/ha) is statistically at par with Treatment 7. Whereas lowest grain yield is seen in treatment 10 (2.16 t/ha). [19] stated that the increased growth and yield attributes may be due to the presence of some growth promoting substances such as IAA and IBA, gibberellins, cytokinins, micronutrients, vitamins and amino acids. [25] stated that the adequate fertilization are key factors to exploit the full potential of the genotype. Baby corn with N 150-200 kg/ha to harvest maximum yield. This may be due to supplying of adequate percent of fertilizers through different available sources which leads to the improvement in the yield and yield parameters in corn.

3.9 Stover Yield (t/ha)

An appraisal review of the table shows that the stover yield differed significant. The significantly highest stover yield (15.37 t/ha) was observed in Treatment 7. However, treatment 4 (14.93 t/ha) is statistically at par with treatment 7. Whereas lowest stover yield is seen in treatment 10 (10.77 t/ha). [22] in a field experiment was conducted University of Agricultural Sciences, Dharwad. similarly, significantly higher stover yield (16.37 t/ha).

3.10 Harvest Index.

Effects of Nitrogen Levels and Seaweed Extract on harvest index was found to be significant among different combination. However, significantly highest harvest index (23.47) was recorded in the treatment 4 followed by the Treatment 1 (22.5), and lowest harvest index was observed in Treatment 6 (15.25). [10] Seaweed extracts stimulate various aspects of plant development

Conclusion

From the experiment it is concluded that the treatment 7 application of 100% Nitrogen and 15% K.sap was considered as the best treatment combination with maximum grain yield and straw yield. However, this experiment results were based on one season trail. Further trails are needed for conformity and recommendation.

REFERENCES

1. Asibi, A.E., Qiang Chai, Q. and Coulter, J.A. (2020). Mechanisms of nitrogen use in maize, *Agronomy* **9:** 775.
2. Bindhani, A., Barik, K.C., Garnayak, L.M. and Mahapatra, P.K. (2007). Nitrogen management in baby corn (Zea mays L.). *Indian Journal of Agronomy* **52**: 135-138.
3. Blumenthal, J.M., Baltensperger, D.D., Cassman, K.G., Mason, S.C. and Pavlista, A.D. (2008). Importance and Effect of Nitrogen on Crop Quality and Health *Nitrogen in the Environment: Source, Problems, and Management, Second edition* CHAPTER **3.**
4. Cheem, M.A., Farhad. M.F., Saleem, H.Z., Khan, A., Munir, M.A., Wahid, F. and Rahul, H.M. (2010). Nitrogen management strategies for sustainable maize production. *Crop Environment* **1**: 49-52.
5. Dhargalkar, V.K., Pereira, N. (2005). Seaweed promising plant of the millennium science and culture **71**, pp. 60-66.
6. Elansary, H.O., Skalicka, W.K. and King, I.W. (2016). Enhancing stress growth traits as well as phytochemical and antioxidant contents of Spiraea and Pittosporum under seaweed extract treatments. *Plant Physiology and Biochemistry* **105**: 310–320.

7. FAO (1992). Maize in human nutrition, Food and Agriculture Organization Of The United Nations Rome. *FAO Food and Nutrition Series* **25.**
8. Hokmalipour, S. and Darbandi, M.H. (2012) Physiological Growth Indices in Corn (*Zea mays* l.) Cultivars as Affected by Nitrogen Fertilizer Levels. *World Applied Sciences Journal* **16**(6).
9. ICAR- Indian Institute of Maize Research. (2015). Nuturing Diversity, Resilience, Livelihood and Industrial Inputs, ISO 9001:2015 certified.
10. Ismail, M.M. and El-Shafay, S.M. (2015) Variation in taxoomical position and biofertilizing efficiency of some seaweed on germination of *Vigna unguiculata* (L). *International Journal of Emerging Sciences and Engineering* **6**: 47-57.
11. Kumar, S.K., Ganesan, K. and Rao, S.P.V. (2015). Seasonal variation in Nutritional composition of *Kappaphycus alvarezii* were an edible seaweed. *Journal of Food Science and Technology* **52**(5): 2751-2760.
12. Kumar, R., Kumawal, N., Kumar, S., Singh, A. K. and Bohra.J.S. (2017). Effects of NPKS and ZN Fertilization on Growth, Yield and Quality of Baby Corn. *International Journal of Current Microbiology and Applied Sciences* **6**(3): 1392-1428.
13. Kaur, P., Singh, S.K., Kaur, R. and Sidhu, M.K. (2020). Response of Different Levels of Nitrogen and Spacing on Growth and yield of Cauliflower Growth under Central Region of Punjab. *International Journal of Bio-resource and Stress Management* **11**(4): 320-326.
14. Latha, P.M. and Prasad, P.V.N. (2008). Productivity and economics of maize + greengram intercropping at different NPK levels. *Agricultural Science Digest* **28**(1): 30-32.
15. Layek, J., Shivakumar, B.G., Rana, D.S., Munda, S. and Lakshman, K. (2012). Growth pattern, physiological indices and productivity of different soybean (Glycine max) based intercrops as influenced by nitrogen nutrition. *Indian Journal of Agronomy* **57**(4): 349-356.
16. Maitra, S., Zaman, A., Mandal, T.K. and Palai, J.B. (2018). Green manures in agriculture. *Journal of Pharma.Phytochemistry* **7**(5): 1319-1327.
17. Mandal, S.K., Veeragurunatha, V. and Ganesh, M. (2017). Present status of the *Kappaphycus alvareziii* in India Scenario, *CSIR-Cetral Salt and Marine Chemicals Research Institute* (CSMCRI) *Journal of Applied Phycology* **26**(2): 775-781.
18. Mondal, D., Ghosh A., Prasad K., Singh, S., Bhatt, N., Zodape, S.T., Chaudhary, J.P., Chaudhari, J., Chatterjee, P.B., Seth, A. and Ghosh, P.K. (2015). Elimination of gibberellin from *Kappaphycus alvarezii* seaweed sap foliar spray enhances corn stover production without compromising the grain yield advantage. *Plant Growth Regulation* **75**: 657-66.

19. Mohamed, S.B., Dalia, A.H.S., Rania, M.A.N. and Azza, M. S. (2016). Influence of foliar spray with seaweed extract on growth, yield and its quality, profile of protein pattern and anatomical structure of chickpea plant (*Cicer arietinum* L.). *Middle East Journal of Applied Sciences* vol **6**: 01.
20. Partani, T. (2013). Determination of the effect rates of seaweed extract on growth and performance of corn (Sc704) in Gorgan. *International Journal of Agricultural Crop Sciences* **6**: 219–224.
21. Pramanick, B., Brahmachari, K. and Ghosh, A. (2013). Effect of seaweed saps on growth and yield improvement of green gram. *African Journal of Agricultural Research* **8**(13): 1,180–1,186.
22. Rajeshwari, R. S., Hebsur, N. S., Pradeep, H. M. and Bharamagoudar, T. D. (2007). Effect of integrated nitrogen management on growth and yield of maize. Karnataka J. Agric. Sci. 20(2): 399-400.
23. Sahoo, S.C. and Mahapatra, P.K. (2007). Yield and economics of sweet corn (*Zea mays* L.) as affected by Plant population and fertility levels. *Indian Journal of Agronomy* **52**(3): 239-242.
24. Scharf, P., Wiebold, W.J. and Lory, J.A. (2002). Corn Yield Response to Nitrogen Fertilizer Timing and Deficiency Level. *Agronomy Journal* **94**(3).
25. Thakur, D.R., Prakash, O., Kharwara, P.C., Bhall, S.K. and Prakash, O. (2000). Effect of nitrogen and plant spacing on yield, nitrogen uptake and economics in baby corn. *Indian Journal of Agronomy* **43**(4): 668-671.
26. Tajul, M.I., Alam, M.M., Hossain, S.M.M., Naher, K., Rafii, M.Y. and Ltif, M.A. (2013). Influence of Plant population and Nitrogen-Fertilizer at various Levels on Growth and Growth Efficiency of Maize. *The Scientific world* **1**:9.
27. Varheye, W. (2010). Growth and Production of Maize: Traditional Low-Input Cultivation. Soil, Plant Growth and Crop Production. Encyclopedia of Life Support Systems (EOLSS).
28. Zhang X., Ervin E.H., Schmidt E.R. (2003). Plant growth regulator can enhance the recovery of Kentucky bluegrass sod from heat injury. *Crop Science society of America* **43:** 3.