**Timing of nitrogen treatment in maize (*Zea Mays L*.) produced in Punjab’s coarse loamy typic haplustept soil being evaluated**

**ABSTRACT**

Field experiments were performed at the Soil Science research farm of Lovely Professional University, Phagwara, Punjab, during the *kharif* season of 2022 and 2023. This experiment primary goal was to understand, biomass and nitrogen uptake pattern of maize (*Zea mays L*.) grown in coarse loamy Typic Haplustept soil. The experiment farm is located at latitude at 31°14’30.5’’N and longitude 75°41'52.1” E. The field trial was conducted in randomized block design with three replications in non-saline alkaline soil. Their wore two treatments: the recommended dose of fertilizer N @ 125 kg ha-1, P2O5 @ 60 kg ha-1, K2O @ 30 kg ha-1 was tested against the no fertilizer control. The PAU maize variety PMH-13 was sowing in kharif season of 2022 and 2023.The plant attribute data was collected at 3 days of interval starting after 23 days of sowing till maturity. Data on plant height, dry matter weight and total nitrogen was recorded for the plant sample after the plant achieved 3 leaves stage. The perusal of plant height data indicated for clear cut stages of maize growth at 42, 56, 65 and 89 days of sowing. However, the differences in growth stages are not clearly decipherable in dry weight in total nitrogen data. So, plant growth stage at 42 days is almost near to the knee-high stage and 65 days stage is near to the tasseling stage of the maize. These two stages match with the already recommended dose of nitrogen fertilizer. Plant height data indicate two more growth stages of maize at 56 and 89 days. So, for improving maize productivity and increasing fertilizer urea efficiency it is suggested that nitrogen fertilizer dose should be further splits to four top dressing application. However further field trials in different agro-climatic reigns are necessary for any final recommendation to the farmer.

**Keywords**: Variety, Maize growth, RDF, Nitrogen

**INTRODUCTION**

The yield of maize is influenced by soil, climate, cultivar, and cultural practices. Since maize was first cultivated, researchers have sought to link these processes in order to maximize harvests. The competition from other cereals and marketable crops limits the potential to expand the area planted to maize. So, enhancement of productivity by various management interventions is the only alternative. Insufficient irrigation and low plant population are the yield limiting issues of maize in many areas (Reddy and Devi, 2017). The area used for maize cultivation worldwide almost doubled starting in 1961, rising from 106 M ha-1 to the current 197 M ha-1. Around the world, maize is expected to surpass wheat by 2030, when the former remains essentially stationary (Erenstein *et al.,* 2021). Different nitrogen fertilizers affect maize production in different ways. When nitrogen was applied in splits as opposed to basal application, grain output was higher (Abdelsalam et al., 2019). By lengthening the real grain-filling period, the proper nitrogen fertilizer rate and timing could raise grain weight (Hammad *et al.,* 2022). The only nano fertilizer available is nano-urea from Indian Farmers Fertilizer Cooperative Limited (IFFCO). It is incorporated into the Fertilizer Control Order and approved by the Government of India (GOI). IFFCO is the one who created and patented it. The farmers have recommended applying IFFCO sagarika and nano-urea fertilizers via foliar spray as an alternative to soil application of fertilizers. It is highly recommended for improving plant growth characteristics and productivity. In maize, it recorded the highest benefit to cost ratio. 100 kg of urea are replaced by one liter of IFFCO nano-urea,(Ajithkumar *et al.,*2021).

**MATERIALS AND METHODS**

During the *kharif* season of the years 2022 and 2023, a field experiments was conducted at the Lovely Professional University's soil science research farm in Phagwara, Punjab, to meet the objectives of investigation entitled, ‘Timing of nitrogen treatment in maize (*Zea Mays L*.) produced in Punjab’s coarse loamy typic haplustept soil being evaluated’ Soil of the experimental site was alkaline in reaction, sandy loam in texture. Sand 45.22(%), silt 35.65(%), clay 19.13(%), soil pH 7.9, soil EC 0.31(dSm- 1), organic carbon 3.57(g/kg), cation exchange capacity 4.19(meq100g-1), available nitrogen 172 (kg ha-1), available phosphorus 7.82 (kg ha-1) and available potassium 113.1 (kg ha-1). It is classified as coarse loamy mixed hyper- thermic family of Typic Haplustept as per Soil Taxonomy, these deep soils have a high base saturation throughout the layers below the surface layer but do not have a calcic horizon. The soils are dry for moderate periods in normal years. Soils that have expanding clays and deep cracks are excluded. Most of the soils are gently sloping .The native vegetation consists mostly of grass, shrubs, and trees. Most of the less sloping soils are intensively used for cereal crops. Typic Haplustepts occur extensively in the piedmont and alluvial plain eco-subregion of the state of Punjab occupying about 28.39% area of state (Raj Kumar *et al.,* 2008). Total sixteen treatments we have used our experimental. Maize seeds of variety PMH 13 were treated with chloropyriphos fungicide @ 3 g/kg. Details of 16 different treatments in experiment-1: T1 : Absolute control,T2 : 75% RDF (recommended dose of fertilizer), T3 : 75% RDF + FYM @5t ha-1 (farm yard manure), T4 : 75% RDF + vermi-compost @2.5t ha-1,T5:75% RDF + nano urea T6:75% RDF (3 application timings),T7:75% RDF (2 application timings) T8:75% RDF (4 application timings) T9:75% RDF (basal application timings) T10:100% RDF (3 applications), T11:100% RDF + FYM @5t ha-1,T12:100% RDF + vermi-compost @2.5t ha-1, T13:100% RDF + nano urea, T14:100% RDF (4 application timings), T15: 100% RDF (2 application timings),T16 :100% RDF (basal application timings). Recommended dose of fertilizer (RDF) = N @ 125 kg ha-1(neem coated urea 46% N, neem oil coating@ 3-4%), P2O5 @ 60 kg ha-1(Single superphosphate 16% P2O5), K2O @ 30 kg ha-1 (Muriate of potash 60% K2O) and details of two treatments in experiment-2: T1 : Absolute control, T2 100%RDF (3applications).

**RESULTS AND DISCUSSION**

Plant height data were collected at every 3 days from 23 days of sowing onwards, up to harvest. During *kharif* growing season 2022, the treatment wise details of data are presented in table no 1 and figure 1. In 2022 highest plant height was recorded in treatment T1 (171.33 cm) i.e. 95 days after plant height and lowest plant height was recorded in treatment T1 (25.67 cm) i.e. 23 days after plant height. In 2022 highest plant height was recorded in treatment T2 (184.00) i.e. 98 days after plant height and lowest plant height was recorded in treatment T2 (24.00) i.e. 23 days after plant height. In experimental site observed that plant height gradually increases in both treatments. The findings indicated that the height of the plants rose when more nitrogen fertilizer was applied. Whereas maize grown without fertilizer exhibited the lowest plant height, maize grown with a complete dose of nitrogen showed the largest plant height. The early sowing dates of the plants' rapid growth were mostly caused by the high maximum and minimum temperatures that prevailed at that time. Crop development, both physiologically and morphologically, is greatly influenced by temperature. Comparable outcomes had been reported by Panahi *et al.,* (2010) and Azadbakht *et al.,* (2012)

**Table-1 Plant height at every three days from 23 days of sowing to harvesting during 2022**

|  |  |
| --- | --- |
| **Days after sowing**  | **Height (cm)** |
| **T1**  | **T2** | **Mean** |
| 23 | 25.67 | 24.00 | 24.84 |
| 26 | 29.67 | 34.67 | 32.17 |
| 29 | 30.33 | 34.00 | 32.19 |
| 32 | 41.33 | 40.33 | 40.83 |
| 35 | 45.67 | 44.00 | 44.84 |
| 38 | 51.00 | 52.67 | 51.84 |
| 41 | 64.33 | 54.67 | 59.50 |
| 44 | 70.33 | 62.67 | 66.50 |
| 47 | 82.33 | 77.00 | 79.67 |
| 50 | 77.67 | 74.33 | 76.00 |
| 53 | 86.33 | 85.00 | 85.67 |
| 56 | 104.67 | 99.67 | 102.17 |
| 59 | 108.33 | 102.33 | 105.33 |
| 62 | 125.67 | 131.67 | 128.67 |
| 65 | 142.33 | 137.67 | 140.00 |
| 68 | 136.00 | 144.33 | 140.17 |
| 71 | 137.00 | 142.67 | 139.84 |
| 74 | 153.00 | 160.67 | 156.84 |
| 77 | 140.67 | 149.67 | 145.17 |
| 80 | 140.00 | 154.67 | 147.34 |
| 83 | 143.00 | 161.33 | 152.17 |
| 85 | 143.67 | 159.67 | 151.67 |
| 89 | 154.00 | 151.33 | 152.67 |
| 92 | 170.00 | 168.00 | 169.00 |
| 95 | 171.33 | 173.00 | 172.17 |
| 98 | 170.67 | 184.00 | 177.34 |
| 101 | 171.21 | 180.36 | 175.79 |
| 104 | 170.19 | 176.43 | 173.31 |
| 107 | 169.08 | 174.56 | 171.82 |
| C.D.(P=0.05) | 6.85 | 7.36 | 7.09 |
| S.E.m. (±) | 3.26 | 3.50 | 3.38 |

**Figure-1 Plant height 2022**

Data on plant height was recorded every three days starting on day 23 of seeding and continuing until harvest. Table No. 2 and Figure 2 exhibit the statistics by treatment during the 2023 *Kharif* growing season, treatment T1 recorded the highest plant height (171.45 cm), which was 101 days after the plant height, and treatment T2 recorded the greatest plant height (173.27 cm), which was 101 days after the plant height. It was found that the lowest plant height in 2023 occurred in treatment T1 (25) 23 days following the plant height. As the nitrogen content rose, so did the height of the maize plants. Variations in maize height morphological characteristics between regions are brought about by a variety of factors, including planting density and genotype.

**Table-2 Plant height at every three days from 23 days of sowing to harvesting during 2023**

|  |  |
| --- | --- |
| **Days after sowing**  | **Height(cm)** |
| **T1** | **T2** | **Mean** |
| 23 | 25 | 27 | 26.00 |
| 26 | 32 | 33 | 32.50 |
| 29 | 32 | 34 | 33.00 |
| 32 | 42 | 40 | 41.00 |
| 35 | 47 | 49 | 48.00 |
| 38 | 51 | 54 | 52.50 |
| 41 | 63 | 62 | 62.50 |
| 44 | 67 | 72 | 69.50 |
| 47 | 80 | 78 | 79.00 |
| 50 | 77 | 82 | 79.50 |
| 53 | 86 | 89 | 87.50 |
| 56 | 98 | 99 | 98.50 |
| 59 | 110 | 117 | 113.50 |
| 62 | 125 | 125 | 125.00 |
| 65 | 138 | 134 | 136.00 |
| 68 | 146 | 148 | 147.00 |
| 71 | 143 | 144 | 143.50 |
| 74 | 141 | 145 | 143.00 |
| 77 | 139 | 151 | 145.00 |
| 80 | 145 | 149 | 147.00 |
| 83 | 153 | 153 | 153.00 |
| 85 | 153 | 154 | 153.50 |
| 89 | 157 | 154 | 155.50 |
| 92 | 160 | 159 | 159.50 |
| 95 | 170 | 171 | 170.50 |
| 98 | 168 | 172 | 170.00 |
| 101 | 171.45 | 173.27 | 172.36 |
| 104 | 169.22 | 170.33 | 169.78 |
| C.D.(P=0.05) | 6.86 | 6.93 | 6.89 |
| S.E.m. (±) | 3.27 | 3.30 | 3.28 |

**Figure-2 Plant height 2023**

Dry weight of plantdata was collected at every 3 days from 23 days of sowing onwards, up to harvest. During *kharif* growing season 2022, the treatment wise details of data are presented in table no 3 and figure 3. In 2022 highest dry weight of plantdata was recorded in treatment T1 (133 gm) i.e. 107 days after plant and highest dry weight of plantdata was recorded in treatment T2 (139 gm) i.e. 101 days after plant. In 2022 lowest dry weight of plantwas recorded in treatment T1 (6 gm) i.e. 23 days after plant and lowest plant height was recorded in treatment T2 (5 gm) i.e. 23 days after plant in 2022. Weight measurements of entire plants and ears alone were made throughout the maize harvest in order to calculate the yield structure and total dry matter yield. To compute the dry matter yield of straw, ears, and entire plants, the percentage of dry matter in the maize aerial parts was also ascertained (Szulc P *et al*., 2021).

**Table-3 Dry weight of plants at every three days from 23 days of sowing to harvesting**

|  |  |
| --- | --- |
| **Days after sowing**  | **Weight (gm) 2022** |
| T1 | T2 | Mean |
| 23 | 6 | 5 | 5.50 |
| 26 | 8 | 10 | 9.00 |
| 29 | 8 | 7 | 7.50 |
| 32 | 11 | 14 | 12.50 |
| 35 | 10 | 12 | 11.00 |
| 38 | 10 | 13 | 11.50 |
| 41 | 19 | 19 | 19.00 |
| 44 | 21 | 21 | 21.00 |
| 47 | 20 | 18 | 19.00 |
| 50 | 22 | 23 | 22.50 |
| 53 | 27 | 22 | 24.50 |
| 56 | 18 | 27 | 22.50 |
| 59 | 29 | 32 | 30.50 |
| 62 | 36 | 38 | 37.00 |
| 65 | 39 | 43 | 41.00 |
| 68 | 42 | 39 | 40.50 |
| 71 | 43 | 45 | 44.00 |
| 74 | 49 | 49 | 49.00 |
| 77 | 48 | 53 | 50.50 |
| 80 | 55 | 60 | 57.50 |
| 83 | 57 | 63 | 60.00 |
| 85 | 96 | 79 | 87.50 |
| 89 | 91 | 92 | 91.50 |
| 92 | 95 | 95 | 95.00 |
| 95 | 94 | 92 | 93.00 |
| 98 | 112 | 117 | 114.50 |
| 101 | 123 | 129 | 126.00 |
| 104 | 127 | 132 | 129.50 |
| 107 | 133 | 139 | 272.00 |
| C.D.(P=0.05) | 5.32 | 5.56 | 5.44 |
| S.E.m. (±) | 2.53 | 2.65 | 2.59 |

**Figure-3 Dry weight of plant**

Dry weight of plant data was collected at every 3 days from 23 days of sowing onwards, up to harvest. During *kharif* growing season 2023, the treatment wise details of data are presented in table no 4 and figure 4. In 2023 highest dry weight of plant data was recorded in treatment T1 (135 gm) i.e. 104 days after plant and highest dry weight of plant data was recorded in treatment T2 (137 gm) i.e. 104 days after plant. In 2023 lowest dry weight of plant was recorded in treatment T1 (4 gm) i.e. 23 days after plant and lowest plant height was recorded in treatment T1 (5 gm) i.e. 23 days after plant. The depth of fertilizer treatment has a substantial impact on the production of dry matter of entire plants and ears (Kruczek, 2005).

**Table-4 Dry weight of plants at every three days from 23 days of sowing to harvesting**

|  |  |
| --- | --- |
| **Days after sowing**  | **Weight (gm) 2023** |
| **T1** | **T2** | **Mean** |
| 23 | 4 | 5 | 4.50 |
| 26 | 6 | 8 | 7.00 |
| 29 | 10 | 7 | 8.50 |
| 32 | 9 | 14 | 11.50 |
| 35 | 12 | 17 | 14.50 |
| 38 | 10 | 15 | 12.50 |
| 41 | 20 | 19 | 19.50 |
| 44 | 17 | 17 | 17.00 |
| 47 | 18 | 18 | 18.00 |
| 50 | 21 | 23 | 22.00 |
| 53 | 27 | 29 | 28.00 |
| 56 | 24 | 24 | 24.00 |
| 59 | 22 | 27 | 24.50 |
| 62 | 37 | 39 | 38.00 |
| 65 | 36 | 37 | 36.50 |
| 68 | 40 | 43 | 41.50 |
| 71 | 43 | 43 | 43.00 |
| 74 | 50 | 54 | 52.00 |
| 77 | 48 | 49 | 48.50 |
| 80 | 58 | 54 | 56.00 |
| 83 | 60 | 63 | 61.50 |
| 85 | 95 | 79 | 87.00 |
| 89 | 90 | 85 | 87.50 |
| 92 | 98 | 96 | 97.00 |
| 95 | 95 | 101 | 98.00 |
| 98 | 106 | 96 | 101.00 |
| 101 | 119 | 125 | 122.00 |
| 104 | 135 | 137 | 136.00 |
| C.D.(P=0.05) | 5.40 | 5.48 | 5.44 |
| S.E.m. (±) | 2.57 | 2.61 | 2.59 |

**Figure-4 Dry weight of plant**

**CONCLUSION**

Plant height data indicated two more growth stages of maize at 56 and 89 days. Therefore, for improving maize productivity and increasing fertilizer urea efficiency it is suggested that nitrogen fertilizer dose should be further split to four top dressing applications. However, further field trials in different agro-climatic reigns are necessary for any final recommendation to the farmers.

**REFERENCES**

Abdelsalam N R, Kandil E E and Al-Msari M A F (2019) Effect of foliar application of NPK nanoparticle fertilization on yield and genotoxicity in crop, Te Science of the Total Environment **653**: pp.1128–1139.

Ajithkumar K, Kumar Y, Savitha AS, Ajayakumar MY, Narayanaswamy C, Raliya R, Krupashankar MR and Bhat SN (2021) Effect of IFFCO nano fertilizer on growth, grain yield and managing turcicum leaf blight disease in maize. International Journal of Plant and Soil Science.2021; v**33:** pp16-19.

Azadbakht A, Azadbakht G, Nasrollahi H and Bitarafan Z (2012) Evaluation of different planting dates effect on three maize hybrids in Koohdasht region of Iran. Int. J. Sci. Adv. Technol, **2**: pp34-38.

Erenstein O, Chamberlin J and Sonder K (2021) Estimating the global number and distribution of maize and wheat farms. Global Food Security **30**: pp100-108.

Erenstein O, Jaleta M and Sonder K (2022) Global maize production, consumption and trade: trends and R&D implications. Food Sec*.* **14**: pp1295–1319.

Hammad H M, Ahmad A, Azhar F, Khaliq T, Wajid A, Nasim W and Farhad W (2011) Optimizing water and nitrogen requirement in maize (Zea mays L.) under semiarid conditions of Pakistan. Pak. J.Bot.,43(6): pp2919-2923.

Hammad H M, Chawla M S and Jawad R (2022) Evaluating the impact of nitrogen application on growth and productivity of maize under control conditions, Frontiers of Plant Science, vol.**13**: pp 13-18.

Kruczek A (2005) The effect of method fertilization on the maize yield and Energy value of raw material, in dependence on varieties and term of sowing. Rocz. Akad. Rol. Pozn. **64**: pp 87–96.

Panahi M, Nsaeri R, Soleimani R (2010) Efficiency of some sweet corn hybrids at two sowing dates in central Iran. Middle- East J. Scientific Res, **6:** pp 51-55.

Raj K, Singh B, Kaur P and Beri V (2008). Planning for precision farming in different agro- ecological sub-regions of Punjab - role of natural resources in agricultural research, planning, development, & transfer of technology. Department of Soils, Punjab Agricultural University, Ludhiana -141001, India, p 72 + 13 maps

Reddy V R and Devi MJ (2017) Stomatal closure response to soil drying at different vapor pressure deficit conditions in maize. Plant Physiol. Biochem*.*v**154**: pp714–722.

Szulc P, Ambroży-Deręgowska K, Waligóra H, Mejza I, Grześ S, Zielewicz W, Wróbel B. Dry Matter Yield of Maize (Zea mays L.) as an Indicator of Mineral Fertilizer Efficiency. Plants. 2021; 10(3):535.