第 50 卷第 01 期
2023 年 1 月

湖南大学学报（自然科学版）
Journal of Hunan University（Natural Sciences）

Vol. 50. No. 01.
January 2023

Open Access Article

EVALUATION OF TIMING OF NITROGEN APPLICATION IN MAIZE (*ZEA MAYS L.*) GROWN ON COARSE LOAMY TYPIC HAPLUSTEPTS SOIL OF PUNJAB

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ABSTRACT

The study was a field experiment conducted in the Experimental Farm of the School of Agriculture on the campus of Lovely Professional University in Punjab, at latitudes of 31°24' N and 75°69' E. Analyzing the effects of adding nitrogen to both organic and inorganic fertilizer solutions on maize growth, yield, nutrient absorption, and economics in India during the kharif season of 2022. At the experimental site, the soil texture is coarse loamy Typic Haplustept soil. The trial had sixteen treatments, a randomized block design, and was triple repeated. Following the recommended fertilizer schedule of 50:24:12 N, P_2O_5, and K_2O kg ha^{-1}. To supply the nutrients N, P, and K, respectively, fertilizers containing urea (46% N), single super phosphate (16% P_2O_5), and muriate of potash (60% K_2O) were used. The hybrid PAU variety of maize known as PMH-13, which was utilized in the tests, was the subject of this study and analysis. Both potassium and phosphorus are supplied completely by basal application. Nitrogen was administered at the appropriate amount in a basic manner. Net plot area was used to compute crop yields. Crop observations were conducted at the 20 DAS, 40 DAS, 60 DAS, 80 DAS, and harvest stages. For the purpose of recording biometric observations, samples from each plot were randomly selected. After spraying Nanourea to plant leaves, the plants grow 40, 60, 80 DAS taller and produce yield. After harvest, maizecobs with ears measured 22.9 cm, with 100% RDF+Nanourea treatments having the highest measurement and 75%RDF (3 Application Timings) treatments having the lowest measurement. After 10 days of sowing, the treatments with 100% RDF+ FYM 5t ha^{-1} had 81 plants the most. Fresh weight of seven maize plants is 3215 gm greatest in 100% RDF+FYM 5t ha^{-1} treatments and 2167 gm lowest in 100% RDF+Nano urea treatments. Maizecobs length without ear is 16.4 cm lowest in Absolute control treatments and 18.9 cm highest in 100% RDF (2 Application timings) treatments, Seven maize plants treated with 100% RDF (2 application timings) had the maximum dry weight of 804 gm, whereas seven plants treated with 75% RDF had the lowest dry weight of 518 gm among all the treatments.

Keywords: Maize yield, Maize cob, Maize height, Nanourea.

Introduction

In the family Poaceae, which also includes wheat and rice, maize (Zea mays L.) is the third-most significant cereal crop in the world. Its oldest known ear, dating back to roughly 7000 years ago, was discovered in Mexico, where it first appeared. Maize (Zea mays L.) is the third important cereal crop in India after rice and wheat. It is sensitive to water logging those results in reduced yields of those

Received: December 18, 2022 / Revised: December 30, 2022 / Accepted: January 06, 2023 / Published: January 21, 2023

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grown in tropical and subtropical region. There are many applications for the crop. Human food, commercially processed food, starch manufacturing, and usage as pasture for livestock are a few of them. With its numerous cultivars and varied maturation times, maize has a greater range of tolerance for various environmental circumstances. Due to its photo-thermo-insensitive nature and among the cereals' best genetic output, maize is known as the "queen of cereals" and is produced all year long. It converts solar energy into dry matter very well since it is a C_4 plant. In the nation, human food accounts for more than 85% of the maize production. In addition to being used as human food and animal feed, maize has a wide range of industrial uses. People are really interested in eating green cobs that have been cooked. 10% protein, 4% oil, and 2-3% crude fiber may be found in maize seeds. A crucial source of several phyto-chemicals that are vital to human health is maize. This technique combines both organic and inorganic nutrient sources to achieve higher crop productivity, prevent soil degradation, and improve soil-water infiltration, contributing to the world's food supply in the process. It involves the prudent use of the right kinds of chemical fertilizers and organic resources. Wintertime maize yields are greater than rainy season yields. Wintertime conditions for maize include low temperatures, a clear sky, and more solar radiation absorption. Less insect pest infestation also results in improved yields. An exhaustible crop, maize needs a lot of nourishment to grow and flourish. The crop's production is influenced by the fertilizer management systems. The most common type of fertilizer used worldwide is inorganic since it produces a larger yield and more pleasing results. Utilizing nitrogen effectively is crucial for maize production because it boosts productivity, maximizes return on investment, and reduces NO_3 leaching to the ground. In particular, due to its function in photosynthesis and other biological activities including the absorption of water and minerals, vacuole storage, and xylem movement, nitrogen is a crucial nutrient for maize and a major regulator of grain output. In sub-Saharan Africa, maize now occupies 25 million hectares and is predominantly grown by smallholder systems, producing 38 million metric tons principally for food. In addition to providing N, P, and K, organic sources can also convert previously inaccessible sources of elemental nitrogen, bound phosphates, micronutrients, and decomposing plant residues into forms that the plant can use to absorb the nutrients.

Material and Methods

The field experiment was carried out at the Experimental Farm of the School of Agriculture on the campus of Lovely Professional University, Punjab, at 31° 24' N latitude & 75° 69' E longitude during kharif season of 2022. The soil texture is coarse loamy Typic Haplustept soil. with a pH of 7.4 at the experimental site. The experiment was laid out in a randomized block design, having sixteen treatments and replicated thrice. The following treatments were examined during an experiment: T_1Absolute control,$T_2$75% RDF,$T_3$75% RDF+FYM 5t $ha^{-1}$$T_4$75% RDF+Vermi-compost 2.5t ha^{-1}, $T_5$75% RDF+Nanourea,$T_6$75% RDF (3Application timings), $T_7$75%RDF(2Application timings), $T_8$75% RDF (4Application timings), T_9 75%RDF (Basal application timings), T_{10}100%RDF (3Applications), T_{11}100% RDF+FYM 5t ha^{-1}, T_{12}100% RDF+Vermi-compost 2.5t ha^{-1}, T_{13}100% RDF+Nanourea, T_{14}100%RDF (4Application timings), T_{15}100% RDF (2 Application timings), T_{16} 100% RDF (Basal Application Timings). The suggested fertilisers schedule of 50:24:12 N, P_2O_5, and

K_2O kg ha^{-1} was followed. Fertilizers including urea (46% N), single super phosphate (16% P_2O_5), and Muriate of potash (60% K_2O) were employed to deliver the nutrients N, P, and K, respectively. The hybrid PMH-13 variety of maize, which is a PAU variety, was used for this experiment. Net Plot size is 2.9m x 4.8m and Total Requirement area is $670M^2$. Potassium and phosphorus both are given in fully via basal application. And recommended dose of nitrogen was applied basally. Crop yields were calculated using the net plot area. At the 20 DAS, 40 DAS, 60DAS, 80DAS and harvest stage, observations of the crop were made. Samples in each plot were marked randomly for recording biometric observations

Table-1 Treatment Details

Sl no	Treatment
1	T_1 = Absolute control
2	T_2 = 75% RDF (Recommended dose in fertilizer)
3	T_3 = 75% RDF + FYM 5 t ha^{-1} (Farm yard manure)
4	T_4 = 75% RDF+ Vermi-compost 2.5 t ha^{-1}
5	T_5 = 75% RDF + Nano urea
6	T_6 = 75% RDF (3 Application timings)
7	T_7 = 75% RDF (2 Application timings)
8	T_8 = 75% RDF (4 Application timings)
9	T_9 = 75% RDF (Basal application timings)
10	T_{10} = 100% RDF (3 Applications)
11	T_{11} = 100% RDF + FYM 5 t ha^{-1}
12	T_{12} = 100% RDF+ Vermi-compost 2.5 t ha^{-1}
13	T_{13} = 100 % RDF + Nano urea
14	T_{14} = 100% RDF (4 Application timings)
15	T_{15} = 100% RDF (2 Application timings)
16	T_{16} = 100% RDF (Basal application timings)

Fig-1 (field excursion)

Fig-2 (Field Layout)

Fig-3 (crop sowing)

Figure 1 illustrates a proper field find out before an experiment, before sowing, the field's configuration is shown in Figure 2 and Figure 3 shows the sowing of the maize crop in the experiment field on May 25, 2022.

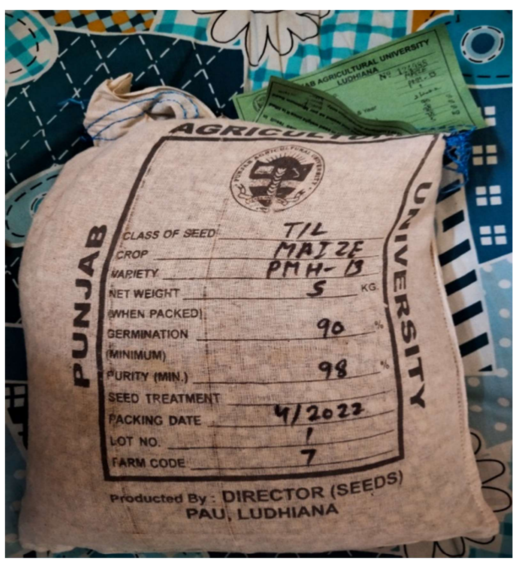

Fig -4 (PMH-13 Seed Packet)

Fig-5 (Sowing after Experimental field)

Fig-6 (experiment's water irrigation canal)

The PMH13 seed packet is shown in Fig. 4, and it is only available at the Punjab Agriculture University's Seed Store. Showing Fig. 5 Designing experiments and conducting them, Figure 6 illustrates the water irrigation channel via that water can easily flow and enter all treatment-wise plots.

Fig-7 (5 Days after sowing crop)

Fig-8 (Gap filing)

Fig-9 (15 days after Experimental site)

Fig. 7 shows that the plant height is measured at 1 to 2 cm 5 days after seeding; Figure 8 displays the gape filling all of the experiment's treatment plots and After 20 days of plant development, fig. 9 shows

Result and Discussion

Different fertilizer treatments using organic and inorganic materials were used in an experimental field. On 30, 40, 50, 60, 70, 80 days, as well as during harvest, data showed the maximum plant height. Following the peak plant height of 34cm, 50cm, 65cm, 93cm, 142cm, 160cm, and 173cm on 30, 40, 50, 60, 70, and 80 DAS and harvest stage, foliar spray of Nanourea is applied. The lowest plant height was recorded in 30, 40, 50, 60, 70, 80 days and a harvest that is 25cm, 41cm, 49cm, 87 cm, 129cm, 150cm, and 169 cm. foliar application of nanourea increased the plant height among all treatments. This might be due to positive effect of N, P, K which enhances the higher plant growth and canopy due to augment cell division and cell expansion (Mudalagiriyappa et al., 2016). After 10 days of seeding, 3356 plants across all treatments were counted. Data was collected on the experiment plant's height.

Sl. no	T	Treatment	Plant height at 30 day(cm)			
			R1	R2	R3	Mean
1	T_1	Absolute control	35	29	30	31.33
2	T_2	75% RDF	31	38	34	34.33
3	T_3	75% RDF+FYM 5t ha^{-1}	31	36	37	34.67
4	T_4	75% RDF+Vermi-compost 2.5t ha^{-1}	30	31	30	30.33
5	T_5	75% RDF+Nanourea	34	29	33	32.00
6	T_6	75%RDF(3Application timings)	29	28	32	29.67
7	T_7	75%RDF(2Application timings)	27	34	39	33.33
8	T_8	75%RDF(4Application timings)	31	37	31	33.00
9	T_9	75%RDF(Basal application timings)	32	31	34	32.33
10	T_{10}	100%RDF (3Applications)	36	33	32	33.67
11	T_{11}	100% RDF+FYM 5t ha^{-1}	33	30	30	31.00
12	T_{12}	100%RDF+Vermi-compost 2.5t ha^{-1}	29	33	27	29.67
13	T_{13}	100 % RDF+Nano urea	31	25	34	30.00
14	T_{14}	100%RDF(4Application timings)	34	31	37	34.00
15	T_{15}	100%RDF(2Application timings)	32	29	33	31.33
16	T_{16}	100%RDF(Basal application timings)	31	27	30	29.33

Table-2 (30 Days after Plant height)

The maximum plant height was seen in T_7-75%RDF (2Application timings) x R_3 (39cm) treatments, while the lowest was observed in T_{13}-100% RDF + Nanourea x R_2 (25cm) treatments 30 days after planting.

Fig-10 (30 Days After plant)

Sl. no	**T**	**Treatment**	**Plant height at 40 day(cm)**			
			R1	**R2**	**R3**	**Mean**
1	T_1	Absolute control	51	42	42	45.00
2	T_2	75% RDF	46	51	44	47.00
3	T_3	75% RDF+FYM 5t ha^{-1}	53	47	40	46.67
4	T_4	75% RDF+Vermi-compost 2.5t ha^{-1}	46	43	44	44.33
5	T_5	75% RDF+Nanourea	50	50	39	46.33
6	T_6	75%RDF (3Application timings)	41	41	41	41.00
7	T_7	75%RDF (2Application timings)	47	42	43	44.00
8	T_8	75%RDF (4Application timings)	42	38	51	43.67
9	T_9	75%RDF(Basal application timings)	45	40	49	44.67
10	T_{10}	100%RDF (3Applications)	50	43	38	43.67
11	T_{11}	100% RDF+FYM 5t ha^{-1}	42	41	36	39.67
12	T_{12}	100% RDF+Vermi-compost 2.5t ha^{-1}	47	50	42	46.33
13	T_{13}	100 % RDF+Nano urea	49	41	49	46.33
14	T_{14}	100%RDF(4Application timings)	39	50	47	45.33
15	T_{15}	100%RDF(2Application timings)	41	43	51	45.00

16	T_{16}	100%RDF(Basal application timings)	40	51	48	46.33

Table-3 (40 Days after Plant height)

40 days after planting, T_3-75% RDF+FYM 5t ha^{-1} x R_1 (53cm) RDF treatments produced the tallest plants, whereas T_{11} 100% RDF+FYM 5t ha^{-1} x R_3 (36cm) treatments produced the shortest.

Fig-11 (40 Days after Plant)

Sl. no	T	Treatment	Plant height at 50 day(cm)			
			R1	R2	R3	Mean
1	T_1	Absolute control	59	58	61	59.33
2	T_2	75% RDF	61	67	52	60.00
3	T_3	75% RDF+FYM 5t ha^{-1}	64	58	63	61.67
4	T_4	75% RDF+Vermi-compost 2.5t ha^{-1}	59	57	62	59.33
5	T_5	75% RDF+Nanourea	63	49	60	57.33
6	T_6	75% RDF (3Application timings)	59	57	57	57.67
7	T_7	75%RDF (2Application timings)	61	62	54	59.00
8	T_8	75% RDF (4Application timings)	59	67	59	61.67
9	T_9	75%RDF (Basal application timings)	54	52	63	56.33
10	T_{10}	100%RDF (3Applications)	51	55	55	53.67

11	T_{11}	100% RDF+FYM 5t ha^{-1}	59	53	59	57.00
12	T_{12}	100% RDF+Vermi-compost2.5tha^{-1}	62	60	54	58.67
13	T_{13}	100 % RDF+Nano urea	61	59	65	61.67
14	T_{14}	100% RDF (4Application timings)	57	57	61	58.33
15	T_{15}	100% RDF (2 Application timings)	55	55	68	59.33
16	T_{16}	100%RDF (Basal application timings)	63	59	59	60.33

Table-4 (50 Days after plant height)

The tallest plants were generated by T_{15}-100% RDF (2 Application timings) x R_3 (68 cm) treatments, while the shortest plants were produced by T_5-75% RDF+Nanourea x R_2 (49 cm) treatments, 50 days after planting.

Fig-12 (50 Days after Plant)

Sl. no	**T**	**Treatment**	**Plant height at 60 day(cm)**			
			R1	**R2**	**R3**	**Mean**
1	T_1	Absolute control	81	89	101	90.33
2	T_2	75% RDF	73	91	89	84.33
3	T_3	75% RDF+FYM 5t ha^{-1}	79	84	91	84.67
4	T_4	75% RDF+Vermi-compost 2.5t ha^{-1}	89	92	97	92.67
5	T_5	75% RDF+Nanourea	93	89	89	90.33
6	T_6	75% RDF (3Application timings)	100	91	100	97.00
7	T_7	75%RDF (2Application timings)	94	93	89	92.00
8	T_8	75% RDF (4Application timings)	89	88	93	90.00
9	T_9	75%RDF (Basal application timings)	85	89	91	88.33
10	T_{10}	100%RDF (3Applications)	109	91	93	97.67

11	T_{11}	100% RDF+FYM 5t ha^{-1}	71	96	89	85.33
12	T_{12}	100% RDF+Vermi-compost 2.5t ha^{-1}	101	89	100	96.67
13	T_{13}	100 % RDF+Nano urea	93	87	89	89.67
14	T_{14}	100% RDF (4Application timings)	85	89	98	90.67
15	T_{15}	100% RDF (2 Application timings)	87	92	91	90.00
16	T_{16}	100%RDF (Basal application timings)	102	90	102	98.00

Table-5 (60 Days after plant height)

The tallest plants were generated by T_{10}- 100%RDF (3Applications) x R_1 (109 cm) treatments, while the shortest plants were produced by T_{11}-100% RDF+FYM 5t ha^{-1} x R_1 (71 cm) treatments, 60 days after planting.

Fig-13 (60 Days after Plant)

Sl. no	**T**	**Treatment**	**Plant height at 70 day(cm)**			
			R1	**R2**	**R3**	**Mean**
1	T_1	Absolute control	119	136	139	131.33
2	T_2	75% RDF	103	141	137	127.00
3	T_3	75% RDF+FYM 5t ha^{-1}	115	129	141	128.33
4	T_4	75% RDF+Vermi-compost 2.5t ha^{-1}	110	143	139	130.67
5	T_5	75% RDF+Nanourea	134	129	142	135.00
6	T_6	75% RDF (3Application timings)	143	137	147	142.33
7	T_7	75%RDF (2Application timings)	121	140	151	137.33
8	T_8	75% RDF (4Application timings)	132	139	127	132.67
9	T_9	75%RDF (Basal application timings)	134	137	149	140.00
10	T_{10}	100%RDF (3Applications)	129	141	140	136.67

11	T_{11}	100% RDF+FYM 5t ha^{-1}	120	137	138	131.67
12	T_{12}	100% RDF+Vermi-compost 2.5t ha^{-1}	119	135	136	130.00
13	T_{13}	100 % RDF+Nano urea	139	140	139	139.33
14	T_{14}	100% RDF (4Application timings)	144	144	153	147.00
15	T_{15}	100% RDF (2 Application timings)	149	131	139	139.67
16	T_{16}	100%RDF (Basal application timings)	138	130	151	139.67

Table-6 (70 Days after plant height)

The tallest plants were generated by T_{14}-100% RDF (4Application timings) x R_3 (153 cm) treatments, while the shortest plants were produced by T_2-75% RDF x R_1 (103 cm) treatments, 70 days after planting.

Fig-14 (70 Days after Plant)

Sl. no	T	Treatment	Plant height at 80 day(cm)			
			R1	**R2**	**R3**	**Mean**
1	T_1	Absolute control	142	157	155	151.33
2	T_2	75% RDF	139	150	154	147.67
3	T_3	75% RDF+FYM 5t ha^{-1}	142	161	163	155.33
4	T_4	75% RDF+Vermi-compost 2.5t ha^{-1}	159	163	161	161.00
5	T_5	75% RDF+Nanourea	151	150	156	152.33
6	T_6	75% RDF (3Application timings)	163	152	152	155.67
7	T_7	75%RDF (2Application timings)	155	154	161	156.67
8	T_8	75% RDF (4Application timings)	161	161	167	163.00
9	T_9	75%RDF (Basal application timings)	152	164	159	158.33
10	T_{10}	100%RDF (3Applications)	150	159	168	159.00
11	T_{11}	100% RDF+FYM 5t ha^{-1}	153	162	159	158.00

12	T_{12}	100% RDF+Vermi-compost 2.5t ha^{-1}	151	154	167	157.33
13	T_{13}	100 % RDF+Nano urea	156	160	159	158.33
14	T_{14}	100% RDF (4Application timings)	159	153	157	156.33
15	T_{15}	100% RDF (2 Application timings)	161	162	160	161.00
16	T_{16}	100%RDF (Basal application timings)	158	157	172	162.33

Table-7 (80 Days after plant height)

80 days after planting, T_{16}-100% RDF (Basal Application timings) x R_3 (172cm) treatments resulted in the tallest plants, whereas T_2-75% RDF x R_1 (139cm) treatments resulted in the shortest plants.

Fig-15 (80 Days after Plant)

Sl. no	**T**	**Treatment**	**Plant height at Harvest(cm)**			
			R1	**R2**	**R3**	**Mean**
1	T_1	Absolute control	169	174	174	172.33
2	T_2	75% RDF	167	176	179	174.00
3	T_3	75% RDF+FYM 5t ha^{-1}	163	167	177	169.00
4	T_4	75% RDF+Vermi-compost 2.5t ha^{-1}	171	170	169	170.00
5	T_5	75% RDF+Nanourea	173	173	174	173.33
6	T_6	75% RDF (3Application timings)	170	171	177	172.67
7	T_7	75%RDF (2Application timings)	169	169	168	168.67
8	T_8	75% RDF (4Application timings)	177	177	171	175.00
9	T_9	75%RDF (Basal application timings)	173	173	178	174.67
10	T_{10}	100%RDF (3Applications)	175	170	170	171.67
11	T_{11}	100% RDF+FYM 5t ha^{-1}	169	174	179	174.00

12	T_{12}	100% RDF+Vermi-compost 2.5t ha^{-1}	178	168	178	174.67
13	T_{13}	100 % RDF+Nano urea	173	173	169	171.67
14	T_{14}	100% RDF (4Application timings)	169	177	171	172.33
15	T_{15}	100% RDF (2 Application timings)	172	170	176	172.67
16	T_{16}	100%RDF (Basal application timings)	170	168	183	173.67

Table-8 (Plant height at Harvest)

The maximum plant height was seen in T_{16}- 100%RDF (Basal application timings) x R_3 (183cm) treatments, while the lowest was observed in T_3-75% RDF+FYM 5t ha^{-1} x R_1 (163cm) treatments at harvest time of plants.

Fig-16 (plant's harvest phase)

CONCLUSION

According to the results of the current experiment, soil compaction has a negative impact on crop phenology, which lowers yields and reduces heat use efficiency The current study demonstrated the need of considering characteristics related to soil strength, soil temperature, and soil nutrition for better maize yield prediction utilizing multiple thermal indices.

ACKNOWLEDGEMENT

We thank the Department of Soil Science and Agricultural Chemistry, School of Agriculture, Lovely Professional University, Punjab, India for providing field and lab facilities to conduct this experiment. I would especially want to thank Dr. Raj Kumar for guiding me through each and every tricky experimental condition.

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