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Strategic Replacement of Chemical Fertilizer by Organic Manure for Eco-Friendly Maize Production

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Abstract

The present research was carried out at the Agronomy Field Laboratory, Department of Agronomy and Agricultural Extension, University of Rajshahi, Rajshahi, during the period from December 2021 to April 2022 to study the "Strategic Replacement of Chemical Fertilizer by Organic Manure for Eco-friendly Maize Production". There are four types of fertilizer treatment, namely T_1 (all chemical fertilizer), T_2 (Vermicompost), T_3 (Cow dung), and T_4 (½ Vermicompost + ½ Cow dung + ½ Chemical fertilizer), as well as two maize varieties, namely V_1 (KOHINOOR 1820 Hybrid Maize) and V_2 (PAC 559 Hybrid Maize). The study was carried out by Randomized Completely Block Design (RCBD) with three replications. The highest plant height, leaf area, Chlorophyll content (ChN_{SPAD}), total dry matter (TDM) and crop growth rate (CGR) were observed in V_1T_4. Maximum tassel length (25.44 cm), maximum cob length (19.56 cm), the maximum number of grains row cob^{-1} (15.89), the maximum number of grains cob^{-1} (462.55), maximum 1000 grains weight (246.03 g), maximum grain yield (12.03 t ha^{-1}), highest stover yield (16.06 t ha^{-1}), and highest biological yield (28.09 t ha^{-1}) was observed in the association of V_1 with T_4 which was equivalent in the association of V_1 with T_1. The V_1 variety had (ISPAHANI KOHINOOR 1820), which would better performances. As the T_4 treatment had ½ cowdung, ½ vermicompost, and ½ chemical fertilizers, using this combination in maize production might save money and make the land healthier. Organic manures encourage sustainable and ecologically friendly agricultural practices and are affordable and straightforward. Therefore, organic manures were advised for producing maize to maintain environmentally responsible and sustainable farming operations..

Keywords: Environmental sustainability, Chemical fertilizer replacement ,Vermicompost, Cow dung and maize.

Introduction

Maize (*Zea mays* L.), a prominent cereal grain, originated in Mexico and Central America approximately 8700 years ago (Schnable *et al.,* 2009). Maize belongs to the Gramineae family, which is widely cultivated (Kaul *et al.,* 2011). It is often called the "Queen of Cereals" since it has the highest genetic yield potential and nutritional value (Singh, 2002). In Bengali, it is also referred to as "Bhutta" (corn) (Alam *et al.,* 2018). The world's highest-yielding grain crop is vital for Bangladesh, where a fast-growing population has exhausted the food availability. Maize is the third most frequently grown cereal crop globally, followed by rice and wheat (Bukhsh *et al.,* 2011). Since rice is Bangladesh's most significant cereal crop and yields the most, maize may be used as food for people to eat directly (Alam *et al.,* 2020a, b). Approximately 1181699 acres and 4261845 metric tons of maize were produced in 2021–2022 (BBS, 2022). It is raised for meals for livestock and as a raw material for manufacturing goods, including starch, glucose, dextrose, corn sugar, oil, protein, corn crackers, soup, salad, and corn syrup, among others. However, it is currently the introductory food source and feed for raising fish and fowl (Alam *et al.,* 2020b). It may be nutritionally beneficial. Specifically, 100 grams of mature maize seeds have a 9.42 g protein content, 74.26 g of carbs, 0.64 g of sugar, 7.3 g of dietary fibre, and 365 kcal of energy. (Wikifarmer, 2022). Maize growing in Bangladesh began in the late 19th century, but it has recently picked up steam as demand for maize grain has risen significantly due to the country's expanding poultry sector. Chemical fertilizers perform a critical role in boosting agricultural output. Still, an over-reliance on them can result in long-term declines in crop yields and other soil properties as well as land-related severe issues such as soil degradation (Hepperly *et al.,* 2009). To ensure the availability of food, a lot of chemical fertilizers have recently been imported into farms, leading to various environmental issues and an imbalance in the nutrients in the soil (Yang *et al.,* 2019). Chemical fertilizers are practical, easy to use, and reliably produce abundant crop yields. However, their excessive and careless usage has resulted in irreversible

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environmental degradation and has contaminated groundwater, land, and the ecosystem in general (Nadarajan and Sukumaran*,* 2021). Overusing chemical fertilizers without adequate soil testing has polluted many ecosystem components, harming human health and the natural world. (Savari and Gharechaee, 2020)Farmers apply organic and inorganic fertilizers to improve crop yields and maintain soil productivity (Chukwu *et al.,* 2012). The activities of microbes in the soil, enzymatic agents, and nutrients that are readily available can all be increased by using organic and inorganic fertilizers correctly (Saha *et al.,* 2008). An environmentally friendly approach for effective nutrient utilization is the integrated use of inorganic fertilizers and organic manures, which improves the effectiveness of chemical-based fertilizers while minimizing the loss of nutrients (Schoebitz and Vidal, 2016). He and Li (2004) suggested that the use of organic and inorganic fertilizers together may enhance soil microbial activity and nutrient availability. Additionally, using organic manure along with chemical fertilizer might be a highly effective method for preserving and enhancing soil fertility and enhancing fertilizer usage efficiency. In contrast, integrated nutrient management (INM) uses natural and artificial nutrients to build a lucrative and ecologically beneficial cropping model (Selim, 2020). Over the last few decades, substantial farming has had a detrimental impact on the soil environment (such as soil erosion, water contamination, and loss of organic matter) (Zhao *et al.,* 2009). A sustainable and environmentally beneficial choice for crop production is organic fertilizer. They outperform artificial fertilizers in terms of their high levels of organic matter and nutrient content, which boost the physical characteristics of the soil and the composition of the microbial population. (Oluwaseyi *et al.,* 2023). Additionally, new research suggests that incorporated soil fertility management, which makes innovative service of relations of organic and inorganic materials, is a workable explanation for soil fertility crises (Abedi *et al.,* 2010). Bangladesh consumes almost two million tons of maize yearly, while only 4,700 thousand tons are produced (BBS, 2021). This is an enormous difference between two quantities. Much money is spent importing maize seeds and goods to meet the demand. There has yet to be a lot of research done in our country about the impacts of compost and vermin compost on maize yield, quality, and nutrient absorption. Using organic fertilizers to produce sustainable crops is a cheap and ecologically responsible option. Given this information, a few objectives for the study were determined: (i) To find out the varietal differences on the growth and yield of maize, (ii) To evaluate the proper combinations of cow dung, vermin compost, and chemical fertilizers with the aim to reduce the use of chemical fertilizers without minimizing the growth and yield of maize, and (iii) To assess the interaction effects between cultivars and different sources of chemical fertilizers on the growth and yield of maize.

Materials and Methods

The present research was carried out at the Agronomy Field Laboratory, Department of Agronomy and Agricultural Extension, University of Rajshahi, Rajshahi during the period from December 2021 to April 2022. The chapter concludes with a brief overview of the experimental site, climate, soil, land preparation, experimental design layout, intercultural operation, data recording, and data analysis.

Detailed Description of the Experimental Site

Location and site

The experimental plot was located 21.5 meters (71 feet) above sea level at latitude 24°22′26″ N and longitude 88°38′27″ E. The Appendix I contains a map of this area's location. The experiment's site is located in the "High Ganges River Floodplain" Agro-Ecological Zone (AEZ-11) (BBS, 2022). Deep troughs have been dug into the underlying Madhupur clay in this area, which has been raised. In Appendix II's AEZ of Bangladesh map, the experimental site is indicated.

Land and climate

Environment Tropical wet and dry climate prevails throughout the region. This region's climate is typically characterized by the monsoon, high temperatures, high levels of humidity, and moderate rainfall. In the Kharif season (April to September), there are sporadic gusty gusts; in the Rabi season, there is modest rainfall and low temperatures (October- March).

Soil

In the experimental location, there was medium-high land with sandy loam soil texture and a pH value of 8.1. Nitrogen, phosphorus, and cation exchange capability were in a moderate state. The soil was brown to dark gray in tone. The level of organic matter was low to medium. The general level of soil fertility was low to medium.

Treatments

Two factors are included in this experiment (Factor A and Factor B),Factor A= Maize varieties (2)V_1= KOHINOOR 1820 Hybrid Maize (Marketed by Ispahani Agro Limited) V_2= PAC 559 Hybrid Maize (Marketed by Lal Teer Seed Limited),Factor B = Treatments (4): T_1: All chemical fertilizer (recommended dose), T_2: Vermicompost (Recommended dose), T_3: Cow dung (Recommended dose), T_4: ½ Vermicompost + ½ Cow dung + ½ Chemical fertilizer, Recommended dose:Cowdung and Vermicompost - 6.0 t ha^{-1} and 4.0 t ha^{-1}, Urea, TSP, MP, Gypsum, ZnSO4, Boric acid -540-300-220-160-10-5 kg ha^{-1}, respectively.

Description of the variety

KOHINOOR 1820 Hybrid Maize (Marketed by Ispahani Agro Limited) and PAC 559 Hybrid Maize (Marketed by Lal Teer Seed Limited) were selected for the study. KOHINOOR 1820 Hybrid Maize life cycle is about 150 days (Rabi season). The height of the maize plant is about 260 cm. The grain is large size and orange coloured. This variety is resistance to leaf blight. Yield of this variety is 14.50-15.00 t ha^{-1}. PAC 559 Hybrid Maize life cycle is about 155 days (Rabi season). The height of the maize plant is about 250 cm. The grain is flint type and orange yellow coloured. Yield of this variety is 14.00-14.50 t ha^{-1}.

Experimental design

A Randomized Complete Block Design (RCBD) with three replications was used to set up the experiment. The total number of unit plot was 24. The size of each unit plot was 4m × 2.5m = 10 m^2. Row to row and plot to plot distances was 40 cm and 20 cm, respectively. Distance was maintained between replication and plots was 1.0 m and 0.75m, respectively. The treatments was assigned in the plot randomly.

Cultivation techniques

In this experiment, a plot was prepared in early December 2021 using a power tiller and was left exposed to the sun for a week. The land was then harrowed, ploughed, and cross-ploughed multiple times, followed by laddering to achieve a fine tilth. All weeds and crop residues were removed, and well-decomposed cowdung and vermicompost were applied at rates of 6.0 t ha^{-1} and 4.0 t ha^{-1}, respectively. A recommended dose of chemical fertilizers was also applied. Maize seeds of two varieties were sown on December 21, 2021, with specific spacing. Fertilization was done in installments, and irrigations were scheduled at various intervals. Thinning and weeding were performed, and earthing up was done to protect plants and enhance nutrient uptake. Throughout the growing period, the crop faced threats from jackals, squirrels, and parakeets, which were mitigated by employing guards. Insecticides were applied to control pests. The maize was harvested on April

Table 1. Varietal differences, impacts of different chemical fertilizers and organic manures and their combinations and interactions impact on plant height (cm), leaf Area (LA), chlorophyll content (ChN_{SPAD}) of maize at different day's after sowing (DAS)

Variety	Plant Height (cm)	Leaf area (cm^2)			Chlorophyll content (ChN_{SPAD})		
	105DAS	30DAS	60DAS	90DAS	30DAS	60DAS	90DAS
V_1	246.82 ± 4.24	269.88 ± 4.04	3191.91 ± 54.64	4868.27 ± 70.12	26.41 ± 1.06	54.57 ± 1.05	62.31 ± 1.94
V_2	244.53 ± 4.49	261.60 ± 4.09	3140.32 ± 48.53	4745.26 ± 80.17	24.55 ± 0.89	53.10 ± 0.91	60.41 ± 1.60
LS	NS	NS	NS	NS	NS	NS	NS
Treatments							
T_1	251.90 ± 5.47ab	267.72 ± 3.23ab	3191.92 ± 57.36ab	4857.18 ± 116.86ab	26.38 ± 1.20ab	54.62 ± 1.44ab	64.20 ± 1.80ab
T_2	239.10 ± 4.01ab	260.83 ± 5.86ab	3113.78 ± 78.06ab	4731.88 ± 75.51ab	24.21 ± 0.85ab	53.20 ± 0.83ab	58.56 ± 1.96ab
T_3	233.15 ± 4.70b	257.31 ± 4.54b	3036.87 ± 50.35b	4613.52 ± 115.92b	22.97 ± 1.16b	51.14 ± 1.67b	56.08 ± 1.28b
T_4	258.54 ± 4.44a	277.09 ± 6.94a	3321.90 ± 56.60a	5024.46 ± 39.57a	28.36 ± 1.49a	56.39 ± 0.68a	66.58 ± 2.37a
LS	0.01	0.05	0.05	0.05	0.01	0.05	0.01
Interactions							
V_1T_1	252.11 ± 7.33ab	272.41 ± 4.70	3210.83 ± 101.43ab	4911.99 ± 155.67ab	26.63 ± 2.07ab	50.84 ± 1.98ab	65.21 ± 1.27ab
V_1T_2	240.30 ± 5.10ab	265.99 ± 2.77	3140.57 ± 133.85ab	4806.00 ± 103.93ab	25.12 ± 1.29ab	53.79 ± 1.15ab	58.60 ± 2.82ab
V_1T_3	234.42 ± 7.89b	261.11 ± 7.92	3062.58 ± 68.88ab	4684.90 ± 172.96ab	23.52 ± 1.48b	51.79 ± 3.34ab	56.27 ± 2.55ab
V_1T_4	260.45 ± 6.21a	279.94 ± 12.93	3353.68 ± 98.02a	5070.14 ± 55.99a	30.37 ± 1.95a	56.89 ± 0.72a	69.15 ± 3.84ab
V_2T_1	251.70 ± 9.81ab	262.98 ± 2.76	3173.02 ± 76.20ab	4802.36 ± 202.59ab	26.14 ± 1.68ab	53.40 ± 2.23ab	63.19 ± 3.69ab
V_2T_2	237.90 ± 6.59ab	255.66 ± 11.72	3086.99 ± 108.77ab	4657.75 ± 110.51ab	23.30 ± 1.06b	52.62 ± 1.34ab	58.53 ± 3.37ab
V_2T_3	231.90 ± 6.81b	253.50 ± 5.07	3011.17 ± 85.29b	4542.15 ± 179.39ab	22.42 ± 2.05b	50.50 ± 1.54b	55.89 ± 1.30b
V_2T_4	256.63 ± 7.50ab	274.24 ± 8.12	3290.12 ± 73.48ab	4978.78 ± 51.06ab	26.36 ± 1.82ab	50.89 ± 1.26ab	64.02 ± 20.60ab
LS	0.05	NS	0.05	0.05	0.05	0.05	0.01
CV(%)	5.18	5.14	5.22	5.03	11.65	5.99	8.01

In each column lower case lettering is used to show the significant difference between different types of interaction at $P<0.01$ level. Values show means ± standard errors (SE) of three replicates. LS= Level of significance, CV= Co-efficient of variance, V_1 = KOHINOOR 1820 Hybrid Maize, V_2 = PAC 559 Hybrid Maize, T_1 = All chemical fertilizer (recommended dose), T_2 = Vermicompost (Recommended dose), T_3 = Cow dung (Recommended dose) and T_4 = ½ Vermicompost + ½ Cow dung + ½ Chemical fertilizer

26, 2022, after the husks dried and black coloration appeared at the grain base. Yield attributes were recorded from randomly selected plants, and the harvested produce was dried for 3-4 days.

Collection of Experimental Data

A short description on data collection procedure is given below: At different stages of crop growth (21, 42, 63, 84, and 105 DAS), the height of five randomly selected plants from the inner rows per plot, avoiding the edge of plot was measured from ground level to the tip of the plant portion and the mean value of plant height was recorded in cm. Leaf area index were estimated manually by counting the total number of leaves per plant and measuring the length and average width of leaf and multiplying by a factor of 0.70 (Kluen and Wolf, 1986). It was done at 30, 60, and 90 days after sowing (DAS)

$$\text{Leaf area} = \frac{\text{Surface area of leaf sample}(\text{m}^2)\times\text{correction factor}}{\text{Ground area from where the leaves were collected}}$$

The Soil-Plant Analyses Development (SPAD-502) meter (Konica-Minolta, Japan) was used for the measurement of relative leaf chlorophyll levels. It is an inexpensive, hand-held device based on two light-emitting diodes and a silicon photodiode receptor, that measures leaf transmittance in the red (650 nm; the measuring wavelength) and infrared (940 nm; a reference wavelength used to adjust for non-specific differences between samples) regions of the electromagnetic spectrum. These transmittance values are used by the device to derive a relative SPAD meter value that is proportional to amount of chlorophyll in the sample (Uddling *et al*., 2007). Five randomly plant was selected and data was collected from them. The average value of the collected data was taken for analysis.From each plot 3 plants were uprooted randomly. The whole plant was sliced into very thin pieces and put into envelop and placed in oven maintaining 70^0 C for 72 hours. Then the sample was transferred into desiccators and allowed to cool down at room temperature. The final weight of the sample was taken. It was performed at 21, 42, 63, 84, and 105 DAS. The crop growth rate values at different growth stages were calculated using the following formula (Beadle, 1987).

$$CGR = \frac{1}{GA} \times \frac{W_2 - W_1}{T_2 - T_1}\ gm^{-2}day^{-1}$$

Where,

W_1= Total dry matter production at previous sampling date ,
W_2= Total dry matter production at current sampling date ,
T_1= Date of previous sampling
T_2= Date of current sampling
GA= Ground area (m^2) .

Table 2. Varietal differences, impacts of different chemical fertilizers and organic manures and their combinations and interaction impacts in total dry matter (TDM) and crop growth rate (CGR) of maize at different day's after sowing (DAS)

Variety	**Total Dry Matter (m^{-2})**					**Crop Growth Rate ($gm^{-2}day^{-1}$)**			
	21DAS	**42DAS**	**63DAS**	**84DAS**	**105DAS**	**21-42DAS**	**42-63DAS**	**63-84DAS**	**84-105DAS**
V_1	6.97 ± 0.31	12.58 ± 0.79	130.10 ± 5.13	550.83 ± 16.24	889.20 ± 23.70	0.27 ± 0.03	5.60 ± 0.22	20.03 ± 0.62	16.11 ± 0.86
V_2	6.47 ± 0.30	12.12 ± 0.84	126.01 ± 5.27	543.58 ± 17.95	827.73 ± 29.97	0.27 ± 0.03	5.42 ± 0.22	19.90 ± 0.66	13.53 ± 0.90
LS	NS	NS	NS	NS	0.05	NS	NS	NS	NS
Treatments									
T_1	7.27 ± 0.28a	14.06 ± 0.52a	137.73 ± 3.69a	591.27 ± 13.83a	927.69 ± 23.70a	0.32 ± 0.03ab	5.89 ± 0.17a	21.58 ± 0.60 a	16.02 ± 1.40
T_2	6.44 ± 0.30ab	10.79 ± 0.55b	123.91 ± 4.30ab	521.77 ± 9.725b	806.78 ± 34.13b	0.21 ± 0.04bc	5.39 ± 0.21ab	18.95 ± 0.55ab	13.60 ± 1.50
T_3	5.54 ± 0.31b	9.09 ± 0.30b	106.61 ± 3.95b	478.43 ± 13.64b	765.64 ± 24.54b	0.17 ± 0.01c	4.64 ± 0.18b	17.70 ± 0.61b	13.70 ± 1.32
T_4	7.63 ± 0.29a	15.45 ± 0.38a	143.98 ± 5.32a	597.34 ± 12.31a	933.75 ± 22.43a	0.37 ± 0.03a	6.12 ± 0.25a	21.60 ± 0.60a	16.02 ± 0.98
LS	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	NS
Interactions									
V_1T_1	7.52 ± 0.38a	14.23 ± 0.93a	137.74 ± 5.19a	591.46 ± 26.85a	931.56 ± 27.19ab	0.32 ± 0.03abc	5.89 ± 0.28ab	21.60 ± 1.21a	16.19 ± 2.57ab
V_1T_2	6.50 ± 0.59ab	11.16 ± 0.92bc	129.01 ± 5.13ab	527.99 ± 11.50ab	861.43 ± 29.59abc	0.22 ± 0.07abc	5.61 ± 0.24ab	18.89 ± 0.68ab	15.88 ± 0.98ab
V_1T_3	6.00 ± 0.45ab	9.38 ± 0.36c	107.10 ± 5.79c	485.25 ± 14.48b	798.63 ± 43.02bc	0.16 ± 0.01c	4.65 ± 0.30b	18.00 ± 0.10b	14.92 ± 2.13ab
V_1T_4	7.86 ± 0.55a	15.55 ± 0.46a	146.56 ± 7.87a	598.61 ± 19.15a	965.18 ± 25.09a	0.37 ± 0.05ab	6.24 ± 0.40a	21.52 ± 0.95a	17.45 ± 1.59a
V_2T_1	7.03 ± 0.44a	13.90 ± 0.70ab	137.71 ± 6.41a	591.09 ± 15.34a	923.82 ± 45.33ab	0.33 ± 0.05abc	5.88 ± 0.27ab	21.58 ± 0.60a	15.84 ± 1.70ab
V_2T_2	6.37 ± 0.31ab	10.42 ± 0.74c	118.80 ± 6.36ab	515.55 ± 17.35ab	752.14 ± 44.31c	0.19 ± 0.04bc	5.16 ± 0.33ab	19.00 ± 1.02ab	11.26 ± 2.23b
V_2T_3	5.08 ± 0.27b	8.80 ± 0.48c	106.12 ± 6.64c	471.62 ± 25.98b	732.65 ± 8.57c	0.18 ± 0.01bc	4.63 ± 0.29b	17.40 ± 0.92b	12.43 ± 1.64ab
V_2T_4	7.40 ± 0.25a	15.35 ± 0.71a	141.41 ± 8.56a	596.07 ± 19.74a	902.33 ± 29.97ab	0.38 ± 0.04a	6.00 ± 0.40ab	21.65 ± 0.92a	14.58 ± 0.50ab
LS	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.05
CV(%)	10.96	9.78	8.92	6.16	6.8	26.38	9.96	8	20.85

In each column lower case lettering is used to show the significant difference between different types of interaction at $P<0.01$ level. Values show means ± standard errors (SE) of three replicates. LS= Level of significance, CV= Co-efficient of variance, V_1 = KOHINOOR 1820 Hybrid Maize, V_2 = PAC 559 Hybrid Maize, T_1 = All chemical fertilizer (recommended dose), T_2 = Vermicompost (Recommended dose), T_3 = Cow dung (Recommended dose) and T_4 = ½ Vermicompost + ½ Cow dung + ½ Chemical fertilizer

Statistical Analysis

Statistical analysis was performed using a windows software package (IBM SPSS Statistics 23). Means of different treatments were compared using the least significant difference at a 0.05 or 0.01 level of probability. Correlation analysis was performed using Pearson correlation function of SPSS. All the data are presented as means ± standard errors (SE) of three replicates. The collected data were analyzed statistically using the analysis of variance technique and the mean differences were adjudged by Duncan's New Multiple Range Test with the help of STATVIEW software.

Results and Discussions

Plant Height (cm)

The plant height of two distinct varieties of maize was determined at 105 days after sowing (DAS) and is displayed in (**Table 1**). The plant height was non-significant at 105 DAS. At 105 DAS, maximum plant height (246.82 cm) was estimated in V_1 and minimum (244.53 cm) was found in V_2. At 105 DAS, the fluctuations in plant height of maize under various chemical fertilizers and organic manures and their combinations was noticeably different (**Table 1**). Plant height of maize eventually declined with the T_4, T_1, T_2, and T_3 at all growth stages and the largest value was recorded in T_4. At 105 DAS, the highest plant height (258.54 cm) was identified in T_4, which lessened slightly by 2.57% in T_1 but significantly by 7.52% and 9.82% in T_2 and T_3, sequentially. Similar findings were further supported by Asfaw (2022), who stated that considerable variations were recorded in plant height in different organic manures. Identical findings were further supported by Adhikari *et al.* (2022), who noted that substantial interpretation was documented in plant height of maize when under different organic and inorganic and their combination sources. The variation in maize plant height was numerically appreciable due to the collaborations between varieties and various chemical fertilizers and organic manures and their combinations (At 105 DAS) (**Table 1**). At 105 DAS, the tallest plant (260.45 cm) was estimated in V_1 with T_4 and the shortest plant (231.90) was noted in V_2 with T_3. The interpretation of plant height due to different fertilizer applications was also noted by Adhikari *et al.* (2022) and Walia *et al.* (2021), who followed that the applications of fertilizers had a substantial consequence on plant height and the plant height increase slowly with combinations of fertilizer for sustainable maize productions.

Leaf Area (LA)

Total leaf area of maize varieties was not fluctuated significantly at 30, 60, and 90 DAS (**Table 1**). At 30 DAS, the longest leaf area (269.88 cm^2) was obtained in V_1 and the shortest (261.60 cm^2) was in V_2. At 60 DAS, the largest leaf area (3191.91 cm^2) was obtained in V_1 and the smallest (3140.32 cm2) was in V_2. At 90 DAS, the highest leaf area (4868.27 cm^2) was estimated in V_1 and the lowest (4745.26 cm^2) was in V_2.

The impact of different chemical fertilizers and organic manures and their combinations in leaf area of maize was statistically meaningful at 30, 60, and 90 DAS (**Table 1**). At 30 DAS, the largest leaf area (277.09 cm^2) was observed in T_4, which was reduced lightly (3.38%) in T_1 but significantly by 5.87 and 7.14% for T_2 and T_3, respectively. At 60 DAS, the longest leaf area (3321.90 cm^2) was recorded in T_4, which lessened slightly (3.91%) in T_1 but significantly 6.27 and 8.58% for T_2 and T_3, accordingly. At 90 DAS, the longest leaf area (5024.46 cm^2) was determined in T_4, which was decreased slightly (3.33%) in T_1 but significantly 5.82 and 8.18% in T_2 and T_3, respectively. Identical findings were further presented by Idham *et al.* (2021) and Prayogo *et al.* (2021), who stated that meaningful variations were recorded in leaf area in organic manure and inorganic fertilizers.

There was no substantial relationship between varieties and chemical fertilizers and organic manures mixtures on total leaf area (cm^2) (**Table 1**). At 30 DAS, the largest leaf area (279.94 cm^2) was recorded in the interaction of V_1 with T_4 and the lowest (253.50 cm^2) was in V_2 with T_3. At 60 DAS, the highest leaf area (3353.68 cm^2) was estimated in the combination of V_1 with T_4 and the lowest (3011.17 cm^2) was in V_2 with T_3. At 90 DAS, the highest leaf area (5070.14 cm^2) was found in the collaboration of V_1 with T_4 and the lowest (4542.15 cm^2) was in V_2 with T_3. The variation of LA due to dissimilar fertilizer applications was also noted by Idham *et al.* (2021) and Prayogo *et al.* (2021).

Chlorophyll Content (ChN_{SPAD})

Leaf chlorophyll contents of maize varieties was not fluctuated substantially at 30, 60, and 90 DAS and displayed in (**Table 1)**. At 30 DAS, the highest chlorophyll content (26.41) was found in V_1 and the lowest (24.55) was in V_2. At 60 DAS, maximum chlorophyll content (54.57) was found in V_1 and minimum (53.10) was observed in V_2. At 90 DAS, largest chlorophyll content (62.31) was found in V_1 and smallest (60.41) was observed in V_2.

Chlorophyll content of maize showed statistically remarkable assessments due to different chemical fertilizers and organic manures and their combinations (**Table 1**). At 30 DAS, the highest chlorophyll content (28.36) was observed in T_4 which reduced slightly by 6.98% in T_1 but significantly 14.63 and 19.00% for T_2 and T_3, respectively. At 60 DAS, maximum chlorophyll content (56.39) was estimated in T_4 which decreased slightly by 3.14% in T_1 but significantly 5.66 and 9.31 % for T_2 and T_3, consequently. At 90 DAS, the largest chlorophyll content (66.58) was estimated in T_4 which lessened slightly (3.74%) in T_1 but significantly 12.05 and 15.77% for T_3 and T_4 respectively. Identical assessments were further reinforced by Idham *et al.* (2021) and Prayogo *et al.* (2021), who stated that meaningful deviations were recorded in chlorophyll content in different organic manure and inorganic fertilizers.

Chlorophyll content of maize showed statistically significant result due to interaction between variety and different chemical fertilizers and organic manures and their combinations (**Table 1**). At 30 DAS, the highest chlorophyll content (30.37) was found in the combination of V_1 with T_4 and the lowest (22.42) was in V_2 with T_3. At 60 DAS, maximum chlorophyll content (56.89) was estimated in the combination V_1 with T_4 and minimum (50.50) was recorded in V_2 with T_3. At 90 DAS, the largest chlorophyll content (69.15) was noted in the interaction of V_1 and T_4 and the lowest chlorophyll content (55.89) was in V_2 with T_3. The variation in chlorophyll content of maize due to different fertilizer applications was also registered by Idham *et al.* (2021) and Prayogo *et al.* (2021).

Total Dry Matter (TDM)

The total dry matter production was not fluctuated noticeably at 21, 42, 63, 84 DAS but it differed considerably at 105 DAS (**Table 2**). At 21 DAS, the highest TDM (6.97 g m^{-2}) was recorded in V_1 and the lowest (6.47 g m^{-2}) was obtained at V_2. At 42 DAS, maximum TDM (12.58 g m^{-2}) was estimated in V_1 and minimum (12.12 g m^{-2}) was recorded at V_2. At 63 DAS, the TDM (130.10 g m^{-2}) was determined in V_1 and the lowest (126.01 g m^{-2}) was found in V_2. At 84 DAS, the highest TDM (550.83 g m^{-2}) was noted in V_1 and the lowest (543.58 g m^{-2}) was conducted at V_2. At 105 DAS, the highest TDM (889.20 g m^{-2}) was estimated in V_1 which was significantly decreased 6.91 % in V_2. Remarkable fluctuation was noted in TDM production of maize due to different chemical fertilizers and organic manures and their combinations (**Table 2**). At 21 DAS, the highest TDM (7.63 g m^{-2}) was measured in T_4 which marginally reduced 4.72% in T_1 but significantly 15.60 and 27.39% for T_2 and T_3, respectively. At 42 DAS, the highest TDM (15.45 g m^{-2}) was observed in T_4 which reduced 8.99% in T_1 but significantly 30.16 and 41.17% for T_2 and T_3, respectively. At 63 DAS, the highest TDM (143.98 g m^{-2}) was estimated in T_4 which marginally lessened by 4.34% in T_1 and significantly 13.94 and 25.95% in T_2 and T_3, respectively. At 84 DAS, the highest TDM (597.34 g m^{-2}) was recorded in T_4 which marginally reduced only 1.02% in T_1 but significantly 12.65 and 19.91% in T_2 and T_3, respectively. At 105 DAS, the highest TDM (933 g m^{-2}) was determined in T_4 which marginally reduced 0.65% in T_2 but significantly 13.59 and 18.00% for T_2 and T_3, respectively. The variation in TDM was also observed by Kabira *et al.* (2020), who noted that considerable variations were recorded in TDM in different organic manure and inorganic fertilizers and their assortments. In case of total dry matter, there were meaningful variations in the interaction between variety and different chemical fertilizers and organic manures and their combinations of maize **(Table 2**). At 21 DAS, the highest TDM (7.86 g m^{-2}) was recorded in V_1T_4 and the smallest (5.08 g m^{-2}) was in V_2T_3. At 42 DAS, the largest TDM (15.55 g m^{-2}) was recorded in V_1T_4 and the lowest (8.80 g m^{-2}) was in V_2T_3. At 63 DAS, the highest TDM (146.56 g m^{-2}) was estimated in V_1T_4 and the lowest (106.12 g m^{-2}) was in V_2T_3. At 84 DAS, the highest TDM (598.61 g m^{-2}) was determined in V_1T_4 and the lowest (471.62 g m^{-2}) was in V_2T_3. At 105 DAS, the highest TDM (965.189 g m^{-2}) was noted in V_1T_4 and the lowest (732.65 g m^{-2}) was in V_2T_3. Equivalent conclusions was further supported by Kabira *et al.* (2020), who noted that considerable variations were recorded in TDM in varieties and different organic manure and inorganic fertilizers and their assortments.

Crop Growth Rate (CGR)

Result showed that, the two maize varieties not fluctuated significantly in crop growth rate (**Table 2**). At 21-42 DAS, the highest CGR (0.28 g m^{-2} day^{-1}) was found in V_1 and the smallest (0.27 g $m^{-2}day^{-1}$) was in V_2. At 43-63 DAS, the biggest CGR (5.60 g m^{-2} day^{-1}) was observed in V_1 and the lowest (5.42 g $m^{-2}day^{-1}$) was in V_2. At 64-84 DAS, the maximum CGR (20.03 g m^{-2} day^{-1}) was estimated in V_1 and the minimum (19.90 g $m^{-2}day^{-1}$) was in V_2. At 85-105 DAS, the largest CGR (16.11 g m^{-2} day^{-1}) was examined in V_1 and the smallest (13.53 g $m^{-2}day^{-1}$) was in V_2.Difference chemical fertilizers and organic manures and their combination revealed remarkable impacts on crop growth at 21-42, 43-63, and 64-84 DAS but non-significant in 85-105 DAS (**Table 2**). At 21-42 DAS, maximum CGR (0.37 g m^{-2} day^{-1}) was estimated in T_4 which reduced by 13.51% in T_1 but significantly 43.24 and 54.05% for T_2 and T_3, respectively. At 43-63 DAS, the highest CGR (6.12 $gm^{-2}day^{-1}$) was obtained in T_4 which lessened marginally by 3.76% in T_1 but significantly 11.93 and 24.18% for T_2 and T_3, accordingly. At 64-84 DAS, the highest CGR (21.60 $gm^{-2}day^{-1}$) was estimated in T_4 which reduced marginally by 0.09% in T_1 but significantly 12.27 and 18.06% for T_2 and T_3, consequently. At 85-105 DAS, the

Table 3. Varietal differences, impacts of different chemical fertilizers and organic manures and their combinations and interaction impacts on yield components and yield of maize

Variety	Cob length (cm)	Number of grain row cob^{-1}	Number of grain cob^{-1}	1000 grain weight (g)	Grain Yield (t ha^{-1})	Stover Yield(t ha^{-1})	Biological Yield (t ha^{-1})	Harvest Index %
V_1	18.11 ± 0.42	14.83 ± 0.39	445.04 ± 6.53	237.37 ± 3.53	10.50 ± 0.52	14.16 ± 0.63	24.65 ± 1.15	42.52 ± 0.16
V_2	17.61 ± 0.43	14.53 ± 0.31	426.34 ± 7.36	231.89 ± 4.50	9.52 ± 0.53	12.77 ± 0.70	22.28 ± 1.23	42.69 ± 0.15
LS	NS	NS	NS	NS	0.05	0.05	0.05	NS
Treatments								
T_1	18.33 ± 0.64ab	15.00 ± 0.40ab	445.60 ± 8.20a	239.66 ± 5.04ab	11.22 ± 0.52a	15.02 ± 0.71a	26.24 ± 1.22a	42.76 ± 0.16
T_2	17.33 ± 0.42ab	14.28 ± 0.31ab	428.90 ± 8.72ab	232.66 ± 4.57ab	9.08 ± 0.39b	12.20 ± 0.52b	21.28 ± 0.90b	42.65 ± 0.28
T_3	16.50 ± 0.36b	13.66 ± 0.42b	415.70 ± 8.28b	223.30 ± 3.90b	7.99 ± 0.38b	10.96 ± 0.53b	18.96 ± 0.91b	42.19 ± 0.086
T_4	19.27 ± 0.29a	15.80 ± 0.50a	452.56 ± 10.88a	246.10 ± 6.34a	11.73 ± 0.44a	15.66 ± 0.49a	27.39 ± 0.93a	42.81 ± 0.24
LS	0.01	0.01	0.05	0.05	0.01	0.01	0.01	NS
Interactions								
V_1T_1	18.90 ± 0.41ab	15.22 ± 0.80ab	455.89 ± 8.20ab	240.47 ± 3.90ab	11.96 ± 0.48a	15.93 ± 0.60a	27.88 ± 1.07a	42.88 ± 0..16
V_1T_2	17.56 ± 0.49abc	14.44 ± 0.51ab	438.80 ± 10.23abc	237.47 ± 2.05ab	9.48 ± 0.56abc	12.92 ± 0.79abc	22.40 ± 1.35abc	42.33 ± 0.19
V_1T_3	16.45 ± 0.68c	13.78 ± 0.71ab	422.92 ± 12.45abc	227.93 ± 4.00ab	8.51 ± 0.46bc	11.72 ± 0.57bc	20.23 ± 1.10bc	42.08 ± 0.04
V_1T_4	19.56 ± 0.48a	15.89± 0.90a	462.55 ± 11.60a	246.03 ± 12.37a	12.03 ± 0.67a	16.06 ± 0.57a	28.09 ± 1.23a	42.79 ± 0.53
V_2T_1	17.77 ± 1.24abc	14.78 ± 0.31ab	435.25 ± 12.78abc	238.86 ± 10.58ab	10.48 ± 0.75ab	14.12 ± 1.15ab	24.60 ± 1.89ab	42.65 ± 0.29
V_2T_2	17.11 ± 0.77bc	14.11 ± 0.43ab	419.03 ± 13.35bc	227.86 ± 8.80ab	8.67 ± 0.53bc	11.49 ± 0.47bc	20.16 ± 0.99bc	42.97 ± 0.52
V_2T_3	16.55 ± 0.45c	13.56 ± 0.60b	408.50 ± 11.63c	218.66 ± 6.23b	7.48 ± 0.51c	10.20 ± 0.64c	17.68 ± 1.15c	42.31 ± 0.15
V_2T_4	18.99 ± 0.33ab	15.67 ± 0.58ab	442.58 ± 18.90abc	242.16 ± 6.66ab	11.43 ± 0.66a	15.25 ± 0.86a	26.68 ± 1.52a	42.82 ± 0.07
LS	0.05	0.05	0.05	0.05	0.01	0.01	0.01	NS
CV(%)	6.49	7.39	5.06	5.59	10.11	9.54	9.73	1.22

In each column lower case lettering is used to show the significant difference between different types of interaction at P<0.01 level. Values show means ± standard errors (SE) of three replicates. LS= Level of significance, CV= Co-efficient of variance, V_1 = KOHINOOR 1820 Hybrid Maize, V_2 = PAC 559 Hybrid Maize, T_1 = All chemical fertilizer (recommended dose), T_2 = Vermicompost (Recommended dose), T_3 = Cow dung (Recommended dose) and T_4 = ½ Vermicompost + ½ Cow dung + ½ Chemical fertilizer

highest CGR (16.02 gm^{-2} day^{-1}) was found in T_1 and the lowest (13.60 gm^{-2} day^{-1}) was obtained from T_2. It may be happened due to increase in N level rises CGR. Identical outcomes was further analyzed by Ghosh *et al.,* (2020) who stated that significant variations were recorded in CGR in different organic manure and inorganic fertilizers and their combinations. Crop growth rate was meaningful fluctuations due to interaction between varieties and different chemical fertilizers and organic manures and their combinations (**Table 2**). At 21-42 DAS, the highest CGR (0.38 gm^{-2} day^{-1}) was observed in combination of V_2T_4, and the lowest value (0.16 g m^{-2} day^{-1}) was in V_1T_3. At 43-63 DAS, maximum CGR (6.24 g m^{-2} day^{-1}) was found in interaction of V_1T_4, and minimum (4.63 gm^{-2} day^{-1}) was in V_2T_3. At 64-84 DAS, the largest CGR (21.65 g m^{-2} day^{-1}) was estimated in collaboration of V_2T_4, and the lowest (17.40g m^{-2} day^{-1}) was from V_2T_3. At 85-105 DAS, the highest CGR (17.45 g m^{-2}day^{-1}) was estimated in combination of V_1T_4, and the lowest (11.26 g m^{-2} day^{-1}) was from V_2T_2. Enrich N level rises CGR. Equivalent outcomes were also noted by Ghosh *et al.* (2020) and Ponmozhi *et al.* (2019).

Cob Length (cm)

There was no substantial variation in cob length among different maize cultivars. Maximum cob length (18.11 cm) was estimated in V_1 and minimum (17.61 cm) was noted in V_2. (**Table 3**)Maize cob length was notable fluctuation due to impacts of chemical fertilizers and organic manures and their combinations (**Table 3**). The highest cob length (19.27 cm) was recorded in T_4 which reduced slightly (4.88%) in T_1, but significantly by 10.07 and 14.27% in T_2 and T_3, respectively. Application of ½ cowdung, ½ vermicompost, and ½ chemical fertilizers required quantities recorded the longest cob and optimal vegetative and reproductive development of maize, subsequently entire chemical fertilizers as recommended.In case of cob length, a considerable fluctuation was observed between interaction of varieties and chemical fertilizers and organic manures and their combined effects (**Table 3**). The highest cob length (19.56 cm) was estimated in the combination of V_1 with T_4 and minimum (16.55 cm) was estimated in V_2T_3. The identical statement was also noted by Singh and Sukul (2019) Kaur *et al.* (2020) that combined application increased cob length.

Number of Grains Row Cob^{-1}

The number of grains row cob-1 was similar for two maize cultivars. The highest number of grains row cob^{-1} (14.83) was observed in V_1 and minimum (14.53 cm) was estimated in V_2. (**Table 3**).Remarkable fluctuations in the number of grains row cob^{-1} were observed for different chemical fertilizers and organic manures and their combinations (**Table 3**). The highest number of grains row cob^{-1} (15.80) was recorded in T_4 which reduced slightly (5.05%) in T_1, but significantly by 9.62 and 13.54% in T_2 and T_3, respectively. Significant interaction in number of grains row cob^{-1} was examined between maize varieties and different chemical fertilizers and organic manures and their combinations (**Table 3**). Maximum number of grains row cob^{-1} (15.89) was reported in the combination of V_1 with T_4 and minimum (13.56) was obtained in V_2 with T_3.

Number of Grains Cob^{-1}

The number of grains cob^{-1} was non-significant variation between two maize varieties. The largest number of grains cob^{-1} (445.04) was noted in V_1 and minimum (426.34) was estimated in V_2. (**Table 3**). The number of grains cob^{-1} was substantially impacted by maize varieties, chemical fertilizers and organic manures, and their combined application (**Table 3**). The maximum number of grains cob^{-1} (452.56) was recorded in T_4 which reduced slightly (1.54%) in T_1, but significantly by 5.22 and 8.14 % in T_2 and T_3, respectively. This conclusion was approved by Singh and Sukul (2019) and Dalei *et al.* (2023), who indicated that grain cob^{-1} improved by application green manure, FYM and biofertilizers. The number of grains cob^{-1} was drastically impacted by maize varieties and chemical fertilizers and organic manures and combination (**Table 3**). Maximum number of grains cob^{-1} (462.55) was determined in the combination of V_1 with T_4 and minimum (408.50) was noted in the V_2 with T_3. These outcomes were in identical with Singh and Sukul (2019) and Dalei *et al.* (2023) who recorded that combinations effect enhanced number of grains cob^{-1}.

Thousand (1000) Grains Weight (g)

There was no considerably variations was noted in 1000 grains weight of maize. The largest 1000 grains weight (237.37 g) was estimated from V_1 and the lowest 1000 grains weight (231.89 g) was observed from V_2 (**Table 3**). Meaningful fluctuations in 1000 grains weight were observed for different chemical fertilizers and organic manures and their combinations (**Table 3**). The maximum 1000 grains weight (246.10 g) was recorded in T_4 which reduced slightly (2.62%) in T_1 but significantly by 5.46 and 9.26% in T_2 and T_3 respectively. Significant variations was observed in the interaction between varieties and different chemical fertilizers and organic manures and their combinations in 1000 grains weight (**Table 3**). Maximum 1000 grains weight (246.03 g) was estimated in the combination of V_1 with T_4 and minimum (218.66 g) was determined in V_2 with T_3. Identical observation were examined by Ghosh *et al.* (2020), Ponmozhi *et al.* (2019), and Singh and Sukul (2019) where performed considerably with fertilizer combinations.

Grain Yield (t ha^{-1})

There were no noticeable difference in grain yield between the two varieties of maize. The highest grain yield (10.50 t ha^{-1}) was noted in V_1 which was reduced slightly (10.29%) in V_2 (**Table 3**). Grain yield revealed noticeable variations due to application of different chemical fertilizers and organic manures and their combinations (**Table 3**). The maximum grain yield (11.73 t ha^{-1}) was estimated in T_4 which reduced slightly (0.35%) in T_1 but significantly 22.59 and 33.88% in T_2 and T_3, respectively. There was a notable relationship in grain yield between maize types and the use of various chemical fertilizers and organic manures and their combined application (**Table 3**). The maximum grain yield (12.03 t ha^{-1}) was estimated in the combination of V_1 with T_4 and minimum (7.48 t ha^{-1}) was estimated in V_2 with T_3. Similar determinations were noted by Adhikari *et al.* (2022), Walia *et al.* (2021), and Bezboruah *et al.* (2021) that grain yield notably increased with combined fertilizers application.

Stover Yield (t ha^{-1})

The meaningful differences was noted between two varieties in stover yield. Maximum stover yield (14.16 t ha^{-1}) was noted in V_1 which was reduced significantly (10.88%) in V_2 (**Table 3**). Stover yield provided relevant distinction due to different chemical fertilizers and organic manures and their combinations (**Table 3**). The maximum stover yield (15.66 t ha^{-1}) was estimated in T_4 which decreased (4.09%) in T_1 but significantly 22.09 and 30.01% in T_2 and T_3, sequentially. Significant interaction was found between varieties and different chemical fertilizers and organic manures and their combinations on stover yield of maize (**Table 3**). The highest stover yield (16.06 t ha^{-1}) was estimated in the combination of V_1 with T_4 and the lowest (10.20 t ha^{-1}) was in V_2 with T_3. Identical observation were conducted by Hammad *et al.* (2022), Varma *et al.* (2022), and Kumar *et al.* (2019), where stover yield raised with organic and inorganic and their combinations.

Biological Yield (t ha^{-1})

Relevant distinctions were found between two maize varieties in biological yield. The most prominent biological yield (24.65 t ha^{-1}) was noted in V_1 which was reduced extensively (10.64%) in V_2 (**Table 3**), and this difference was statistically significant. A meaningful fluctuations were observed in biological yield for different chemical fertilizers and organic manures and their combinations (**Table 3**). The most prominent biological yield (27.39 t ha^{-1}) was estimated in T_4, which reduced marginally (4.20%) in T_1 but substantially 22.31 and 30.78% in T_2 and T_3, consequently. Considerable interaction between varieties and different chemical fertilizers and organic manures and their combinations were observed in biological yield of maize (**Table 3**). The most prominent biological yield (28.09 t ha^{-1}) was observed in the combination of V_1 with T_4 and the lowest (17.68 t ha^{-1}) in V_2 with T_3. Identical conclusions were decided by Adhikari *et al.* (2022), Kaur *et al.* (2020), and Aslam *et al.* (2020), where biological yield increased with combined application of organic and inorganic fertilizers.

Harvest Index (%)

There was not remarkable fluctuation between two maize varieties in harvest index (HI). The highest HI (42.69%) was observed in V_2, and the lowest (42.52%) was found in V_1, (**Table 3**). Harvest index was not numerically noticeable at different chemical and organic fertilizers and their combinations. The maximum HI (42.81%) was recorded in T_4 and minimum (42.19%) was estimated in T_3 (**Table 3**). Harvest index had no significant interaction between varieties and different chemical fertilizers and organic manures and their combinations (**Table 3**). The maximum HI (42.97%) was estimated in the combination of V_2 with T_2 and minimum (42.08%) in V_1 with T_3. Identical outcomes were recorded by Humtsoe *et al.* (2018), and Aslam *et al.* (2020).

Summary and Conclusions

The study examined the effects of four fertilizer treatments (chemical, vermicompost, cow dung, and a combination of vermicompost, cow dung, and chemical fertilizers) on two varieties of hybrid maize (KOHINOOR 1820 and PAC 559) using a Randomized Complete Block Design with three replications. The results demonstrated that the combination treatment (½ vermicompost + ½ cow dung + ½ chemical fertilizer) produced the best growth and yield outcomes, particularly for the KOHINOOR 1820 variety. This treatment significantly improved parameters such as plant height, leaf area, chlorophyll content, total dry matter, crop growth rate, tassel length, cob length, grain number, grain weight, grain yield, stover yield, and biological yield. Conversely, cow dung alone resulted in the lowest performance across most attributes. These results suggest that replacing half the chemical fertilizer with a combination of vermicompost and cow dung (T_4) can be a viable strategy for maize cultivation in Bangladesh. This approach has the potential to reduce production costs while maintaining or even improving yields. Additionally, it promotes sustainable and environmentally friendly agricultural practices by minimizing dependence on chemical fertilizers.

Conflict of interest

The authos declare there is no conflict of interest.

References

Abedi, T., Alemzadeh, A. and Kazemelni, S.A. (2010). Effect of organic and inorganic fertilizers on grain yield and protein bonding pattern of wheat. *Australian J. Crop Sci*. 4: 384-389.

Adhikari, P., Sharma, R., and Pokharel, B. B. (2022). Effect of Organic Manures and Chemical Fertilizers on Maize Productivity and Soil Properties in the Winter Season. *J. Nepal Agric. Res. Counc.*, 8: 53–63.

Alam, M. J., Ahemd, K. S., Nahar, M. K., Akter, S. and Uddin, M. A. (2020a). Effect of different sowing dates on the performance of maize. *J. Krishi. Vigyan*. 8(2): 75-81

Alam, M. J., Ahmed, K. S., Sultana, A., Firoj, S. M. and Hasan, I. M. (2018). Ensure food security of Bangladesh: Analysis of post-harvest losses of maize and its pest management in stored condition. *J. Agric. Eng. Food Technol.,* 5(1): 26-32.

Alam, M. J., Mukta, L. N., Nahar, N., Haque, M. S. and Razib, S. M. H. (2020b). Management practices of aphid (*Rhopalosiphum maidis*) in infested maize field. *Bangladesh J. Environ. Sci*. 38: 23-28

Asfaw, M. D. (2022). Effects of animal manures on growth and yield of maize (*Zea mays* L.). *J. Plant Sci. Phytopathol*, *6*: 033-039.

Aslam, Z., and Ahmad, A. (2020). Effects of vermicompost, vermi-tea and chemical fertilizer on morpho-physiological characteristics of maize (*Zea mays* L.) In Suleymanpasa District, Tekirdag of Turkey. *J. Innov. Sci.*, *6*(1): 41-46.

BBS (Bangladesh Bureau of Statistics). (2021). Statistical Year Book of Bangladesh, Ministry of Agriculture: Crops, Livestock, Forestry and Fishery.

BBS (Bangladesh Bureau of Statistics). (2022). Statistical Year Book of Bangladesh, Ministry of Agriculture: Crops, Livestock, Forestry and Fishery.

Beadle, C.L. (1987). Plant Growth Analysis. In: Coomlos, J.D.O., Long, S.P. and Scurlock, J.M.O. (Eds.). Techniques in Bio-productivity and Photosynthesis, 2nd Ed., pp: 21-23. Pergamon press, Oxford, New York.

Bezboruah, M., and Dutta, R. (2021). Effect of integrated nutrient management on growth and yield of summer maize (*Zea mays*). *Int. J. Chem. Stud.*, *9*(2): 677-680.

Bukhsh, M., Ahmad, R., Iqbal, J., Hussain. S., Rehman. A. and Ishaque, M. (2011). Potassium application reduces bareness in different maize hybrids under crowding stress conditions. *Pakistan J. Agric. Sci.,* 48(1): 41-48.

Chukwu, L.I., Ano, A.O. and Asawalam, D.O. (2012). Effects of Poultry Manure and NPK fertilizer on soil properties and Nutrient uptake of maize (*Zea mays* L.) Plants growth in an ultisol. Proceedings of the 36th Annual Conference of the Soil Science Society of Nigeria (SSSN) on 7th – 11th March, 2012 University of Nigeria Nsukka

Dalei, B. B., Rath, B. S., Mohapatra, A. K., Patnaik, G. P., Phonglosa, A., Sahoo, S., and Senapati, N. (2023). Yield and Economics of Hybrid Maize (Zea mays L.) under Integrated Nutrient Management Practices in Odisha, *India. Int. J. Plant Soil Sci.,* 35(1): 149-157.

Donald, C.M. (1963).Competition among crop and pasture plants. *Adv. Agron*. 15: 1-18.

Ghosh, D., Brahmachari, K., Skalicky, M., Hossain, A., Sarkar, S., Dinda, N. K., and El Sabagh, A. (2020). Nutrients supplementation through organic manures influence the growth of weeds and maize productivity. *Molecules,* 25(21): 4924.

Hammad, H. M., Chawla, M. S., Jawad, R., Alhuqail, A., Bakhat, H. F., Farhad, W. and Fahad, S. (2022). Evaluating the impact of nitrogen application on growth and productivity of maize under control conditions. *Front. Plant Sci.*, 13: 1402.

He Y. and Li, R. (2004). Effect of the organo–inorgano-mixed fertilizer application on sugarcane yield and soil enzymatic activity. Sugar Crops China, 4: 36-38.

Hepperly, Y.P., Lotter, D., Ulsh, C.Z., Siedel, R., and Reider, C. (2009). Compost, manure and synthetic fertilizer influences crop yields, soil properties, nitrate leaching and crop nutrient content. *Compost Sci. Util*., 17: 117-126.

Humtsoe, B. M., Dawson, J., and Rajana, P. (2018). Effect of nitrogen, boron and zinc as basal and foliar application on growth and yield of maize (*Zea mays* L.). *J. pharmacogn. phytochem.*, *7*(6): 01-04.

Idham, I., Pagiu, S., Lasmini, S. A., and Nasir, B. H. (2021). Effect of doses of green manure from different sources on growth and yield of maize in dryland. *Int. J. Des. Nat. Ecodynamics.,* 16(1): 61-67.

Kabira, M. H., Hossaina, M. D., Rashida, M. H. O., Kobirb, M. S., and Hasana, M. K. (2020). Growth performances and their impact on corn yield of baby corn as affected by varieties and different sources of nitrogen fertilizer. *Acta Scientifica Malaysia (ASM)*, 5(1): 10-14.

Kaul, J., Kumar, R.S. and Das, S. (2011). Varietal improvement in maize development of single cross hybrids in India. National press. (http://krishisewa.com/articles/2011/vimaize.html).

Kaur, H., Vaidya, P., and Parmar, N. (2020). Effect of organic and inorganic fertilizers on growth, yield and economics of Hybrid Maize (*Zea mays* L.). *Indian J. Agron.*, *65*(4): 497-500.

Kluen, H. and Wolf, J. (1986). Modeling of Agricultural production: Weathering, Soils & Crops Prod. Wageningen. p.23

Kumar, M., Singh, S., Singh, V., Singh, K., and Khanna, R. (2019). Effect of zinc and boron on growth and yield of maize (*Zea mays* L.). *Progressive res. int. j.*, *14*(3): 215-221.

Nadarajan, S., and Sukumaran, S. (2021). Chemistry and toxicology behind chemical fertilizers. In Controlled Release fertilizers for sustainable agriculture (pp. 195-229). Academic Press.

Oluwaseyi, M., Abioye., D., A., Olasehinde., T., and Abadunmi. (2023). The Role of Biofertilizers in Sustainable Agriculture: An Eco-Friendly Alternative to Conventional Chemical Fertilizers. *Appl. Sci. Eng. Prog.,* doi: 10.14416/j.asep.2023.07.001

Ponmozhi, C. I., Kumar, R., Baba, Y. A., and Rao, G. M. (2019). Effect of integrated nutrient management on growth and yield of maize (*Zea mays* L.). *Int. J. Curr. Microbiol. Appl. Sci.*, *8*(11): 2675-2681.

Prayogo, C., Prasetya, B., and Arfarita, N. (2021). Comparative effects of the combination of biofertilizer, NPK, and mycorrhizal application on maize production system. In *IOP* Conference Series: Earth and Environmental Science (Vol. 905, No. 1, p. 012003). IOP Publishing.

Saha, S., Parkas, V., Kudu, S., Kumar, N. and Mina, B. L. (2008). Soil enzymatic activity as affected by long-term application of farmyard manure and mineral fertilizer under a rained soybean-wheat system in N-W Himalaya. *European J. Soil Biol*. 44: 309-315.

Savari, M., and Gharechaee, H. (2020). Application of the extended theory of planned behavior to predict Iranian farmers' intention for safe use of chemical fertilizers. *J. Clean. Prod.*, 263:121512.

Schnable, P. S., Ware, D., Fulton, R. S., Stein, J. C., Wei, F., Pasternak, S., and Presting, P. G. (2009). The b73 maize genome: complexity, diversity, and dynamics. *Science*, *326*(5956): 1112-1115.

Schoebitz, M., and Vidal G. (2016). Microbial consortium and pig slurry to improve chemical properties of degraded soil and nutrient plant uptake. *J. Soil Sci. Plant Nutr*. 16 (1): 226-236.

Selim, MM. (2020). Introduction to the integrated nutrient management strategies and their contribution to yield and soil properties. *Int. J. Agron.,* 2020

Singh, C. (2002). Modern Techniques of Raising Field Crops, Oxford and IBH Publishing Co. Pvt. Ltd. New Dehli, India.

Singh, L., and Sukul, P. (2019). Impact of vermicompost, farm yard manure, fly ash and inorganic fertilizers on growth and yield attributing characters of maize (*Zea mays* L.). *Plant Archives (09725210)*: *19*(2).

Uddling, J., Gelang-Alfredsson, J., Piikki, K., and Pleijel, H. (2007). Evaluating the relationship between leaf chlorophyll concentration and SPAD-502 chlorophyll meter readings. *Photosynthesis res.*, 91: 37-46.

Varma, D. J., Adhikary, R., Reddy, M. D., and Maitra, S. (2022). Influence of nitrogen and phosphorus on growth and yield of summer maize (*Zea mays* L.). *Crop Res.*, *57*(3): 141-144.

Walia, S. S., and Patidar, A. (2021). Effect of organic, integrated and chemical sources of nutrient on growth and productivity of maize (*Zea mays*). *Indian J. Agron.*, *66*(4): 419-424.

Wikifarmer, (2022). Online: https://wikifarmer.com/maize-health-benefits-nutritional-value/ [Accessed 21 April 2013].

Yang, Y., Wang, P., and Zeng, Z. (2019). Dynamics of bacterial communities in a 30-year fertilized paddy field under different organic–inorganic fertilization strategies. Agronomy, 9(1): 14.

Zhao, Y., Wang, P., Li, J., Chen, Y., Ying, X. and Liu, S. (2009). The effect of two organic manures on soil properties and crop yields on a temperate calcareous soil under a wheat-maize cropping system. *European J. Agron*. 31: 36-42.

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