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Growth and profitability of Maize (*Zea mays* L. Under Sole and Combined Applications of Different Organic and Inorganic Nutrient Management at Rampur, Chitwan, Nepal

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ABSTRACT

A field experiment was carried out during the spring season of 2017 at research field of National Maize Research Programme (NARC), Rampur, Chitwan to evaluate the effect of sole and combined applications of different organic and inorganic fertilizers on growth parameters and profitability maize cultivation practices. The recommended dose of nitrogen (120 kg ha^{-1}) was supplied through Urea, Farm Yard Manure (FYM) and Poultry Manures (PM) in different ratios. The experiment was laid out in Randomized Complete Block Design (RCBD) having four replications and eight treatments; i.e., T_1 (120 kg N ha^{-1} as Urea), T_2 (60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as FYM), T_3 (60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as PM), T_4 (60 kg N ha^{-1} as FYM+60 kg N ha^{-1} as PM), T_5 (60 kg N ha^{-1} as FYM+30kg N ha^{-1} as Urea+30 kg N ha^{-1} as PM), T_6 (60 kg N ha^{-1} as Urea+30 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM), T_7 (60 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM+30 kg N ha^{-1} as Urea) and T_8 (Control /no nitrogen application). The research result showed that, the growth parameters such as plant height, leaf area index and biomass accumulation were found higher at the plot fertilized with combined application of organic and inorganic fertilizers as compared to control. Likewise, days to tasseling (62.5 days), days to silking (68.0 days) and anthesis silking interval (3.5 days) were also found earlier with the same treatments. Similarly, biological yield (10.12 t ha^{-1}), net return (NRs 42.57) and B: C ratio (1.58) were comparatively superior at T_3 (60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as PM). Therefore, based on the research treatments, application of 120 kg nitrogen through combinations of 60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as PM were found best combinations of fertilizers in inner terai conditions Nepal.

Keywords: Maize, Farm yard manure, Poultry manure, Urea, Yield.

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important emerging versatile crops having wider adaptability and is grown in diverse agro-climatic regions for various purposes. It is the second most important crop after rice in terms of area and production in Nepal. It is grown in 8, 91,583 hectares of land and is produced 2,231,517 tons of maize grain with the productivity of 2.5 t ha^{-1} [1]. It is produced in three distinct agro-climatic regions within Nepal, the terai and inner terai (below 900 m), the mid-hills (900-1800 m) and the high-hills (above 1800 m). The proportion of maize area consists of about 73.78 % in mid-hills, 16.42 % in terai and 9.80 % in high-hills in Nepal [1]. It is one of the major food crops in the hilly regions of Nepal and accounts for 71% maize production of the country [1].

It is a traditional crop grown for food, feed and fodder. It is not only the source of food and feed but also the major ingredient of animal feed and industrial product. Manures and fertilizers are not applied in adequate amounts due to lack of sufficient manure and fertilizer and poverty [2]. Limited and irregular access of improved seeds and fertilizers specifically to the small farmers in the remote areas is the main constraint for maize production. Most of the farmers are not aware about information on crop management aspects particularly balanced use of fertilizers.

Intensive agriculture is one of the major causes of using relatively high doses of fertilizers and pesticides. In many parts of country, intensive cultivation practices from many years, along with inappropriate production techniques such as continuous soil removal without use of organic matter and the widespread use of mineral fertilizers, has created the problems of soil degradation. Thus, the need to minimize environmental impact without reducing yields is the best way to achieve the sustainable production of the crop. Application of organic fertilizers is a management strategy that would help in improving crop production by counteracting the progressive loss in organic matter both in the short and long-term.

Integrated use of organic manures and chemical fertilizers is beneficial in improving yield of crop, soil pH, organic carbon and available nitrogen, phosphorus and potash in sandy loam soil [3]. Use of organic manures improves the micronutrient deficiencies in the crop plants. Organic manure and cattle dung increased root growth of maize and enhanced the extracted soil water more efficiently which ultimately increased grain and biomass yield [4]. Currently poultry manure (PM) is an excellent organic fertilizer, as it contains high nitrogen, phosphorus, potassium and other essential plant nutrients. Bocchi and Tano reported that, there is also positive interaction between the combined application of organic manures and urea nitrogen [5].

Organic fertilizers such as compost and poultry manure have been used in agriculture for thousands of years; ancient farmers did not understand the chemistry involved, but they did recognize the benefit of organic material in increasing crop yield. Organic manure also has limitation like need of huge amounts or bulkiness to provide sufficient amount of nutrients, slow release of nutrients in the soil and low nutrients content in the manure. Study showed that sole use of either inorganic or organic fertilizer in appropriate amount to provide needed essential nutrients is sufficient for soil nutrient management in improving crop yield. However, recent interest in the use of organic manure has been re-emerged because of high fertilizer cost, importance of farm yard manure and poultry manure in maintaining long term soil productivity and in meeting timely requirement of nutrient by creating living soil. Therefore, organic fertilizers are used as a supplement with chemical fertilizers.

Considering the above facts, it was thought to conduct the research on the performance of spring maize affected by the use of sole and combined ratio of different proportion of urea, Farm yard manure (FYM) and poultry manure in Rampur Chitwan.

MATERIALS AND METHODS

A field experiment was conducted to study sole and combined application of organic manure and inorganic N on the growth attributing traits and profitability of maize at National Maize Research Program (NMRP), Rampur Chitwan in spring season. The physical and chemical analysis of soil was carried out before planting of crop using standard procedures **(Table 1)**. To know the nutritional status of the FYM and Poultry manure, the samples of 500 gram of FYM and Poultry manure sample was taken and tested in soil test laboratory **(Table 2).**

Table 1: Physio-chemical properties of soil at experimental plot in 2017.

S. No	Properties	Average content	Rating
1	Physical properties (%)		
	Sand	61	
	Silt	29	
	Clay	10	
	Textural class/Rating		Sandy loam
2	Chemical properties		
	Soil pH	5.37	Acidic
	Soil organic matter (%)	2.18	Low
	Total nitrogen (%)	0.07	Low
	Available phosphorus (kg ha^{-1})	163.5	High
	Available potassium (kg ha^{-1})		Medium

Table 2: Chemical analysis of FYM and Poultry manure.

Characteristics	Unit	Value	
		FYM	Poultry manure
Nitrogen	%	0.95	3.51
Phosphorus	%	1	4.19
Potassium	%	0.62	4.35
pH	-	7.4	8.8
Moisture	%	43	31.3

The experiment was laid out in simple Randomized Completely Block Design (RCBD) with four replications and eight treatments as follows:

T_1=(120 kg N ha^{-1} as Urea)

T_2=(60 kg N ha^{-1} as Urea+60kg N ha^{-1} as FYM)

T_3=(60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as PM)

T_4=(60 kg N ha^{-1} as FYM+60 kg N ha^{-1} as PM)

T_5=(60 kg N ha^{-1} as FYM+30kg N ha^{-1} as Urea+30 kg N ha^{-1} as PM)

T_6=(60 kg N ha^{-1} as Urea+30 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM)

T_7=(60 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM+30 kg N ha^{-1} as Urea)

T_8=Control (No nitrogen application)

The Rampur Composite cultivar was sown on a well-prepared seed bed on 12^{th} of March 2017 at 60 cm spaced ridges, using a seed rate of 25 kg ha^{-1}, maintaining plant to plant distance of 25 cm. Plant to plant distance was achieved through crop thinning at 30 days after planting (DAP) followed by earthing up at 45 DAP. The manure and fertilizer were applied and mixed thoroughly each plot in accordance with treatment assigned. Nitrogen (N), Phosphorus (P_2O_5) and K_2O were supplied thorough organic fertilizers such as FYM and Poultry manure and inorganic fertilizers as Urea, single super phosphate (SSP) and Muriate of potash (MOP). The recommended dose of fertilizers for improved maize is 120:60:40 kg NPK ha^{-1}.

The nitrogen (N) was applied through different sources of organic and inorganic fertilizers in different ratios. The full dose of phosphorus and potash and half dose of nitrogen were applied at the time of final land preparation. The remaining half dose of fertilizer was applied in two equal splits at knee height stage and tasseling stage of crops. After harvesting, the cobs were separated out and remaining biomass was weighed. The sum of total biomass i.e., grain yield and stover yield at harvest was calculated as biological yield of crop. Economic analysis was done on the basis of fixed and variable cost of cultivations and market prices of the products and by-products of the crop as **Tables 3 and 4**. During the course of study, different parameters regarding growth attributing traits of maize were recorded and data was analysed through analysis of variance (ANOVA) technique using Gen Stat and LSD test was applied to test the difference among the treatments.

Table 3: Price of different products and by-products of maize at Rampur, Chitwan Nepal in 2017.

S.No	Products and by-products	Price rate (NRs)
1.	Maize grain	25
2.	Maize stover	1.5

Table 4: Cost of cultivation of maize under the study of sole and combined application of organic and inorganic fertilizers (Urea, FYM and PM) at NMRP, Rampur Chitwan in 2017.

S.No	Particulars	Total (NRs ha^{-1})
	Fixed cost	
1.	Land preparation	6000
2.	Fertilizer cost	-
	a. SSP	13333.33
	b. MOP	3333.33

3.	Fertilizer application	2400
4.	Seed requirement	1500
5.	Planting	3300
6.	Weeding	20000
7.	Earthing up and top dressing of fertilizers	7500
8.	Irrigation	4000
9.	Plant protection	800
10.	Harvesting	6000
11.	Dehusking, shelling, drying and storage	9000
	Total	64766.66
	Variable cost	
	T_1	5217.39
	T_2	8924.47
	T_3	7751.27
	T_4	11458.63
	T_5	10257.2
	T_6	8338
	T_7	9604.94
	T_8	0

RESULT AND DISCUSSION

Growth parameters

Plant height: The data on plant height as influenced by application of fertilizers but not by the different combination of organic and chemical fertilizers in improved maize crop is presented in **Table 5**. Plant height is one of the most important characters of crop, which determines the yield potential of crop and eventually helps to shape the economic return. Plant height of the maize crop was observed at different growth stages of maize crop such as 30,45,60,75 and 90 days after planting (DAP).

Table 5: Plant height of maize as influenced by sole and combined application of organic and inorganic fertilizers (Urea, FYM and PM) at NMRP, Rampur Chitwan in 2017.

Treatments	Plant height (cm)				
	Days After Planting (DAP)				
	30	45	60	75	90
T_1=(120 kg N ha^{-1} as Urea)	70.15	128.5^a	205.2^a	220.5^a	209.5
T_2=(60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as FYM)	77.1	143.1^a	203.9^a	217.4^a	202.9
T_3=(60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as PM)	61.38	136.5^a	205.1^a	223.7^a	212.9
T_4=(60 kg N ha^{-1} as FYM+60 kg N ha^{-1} as PM)	79.99	141.4^a	205.6^a	215.6^a	199.3
T_5=(60 kg N ha^{-1} as FYM+30 kg N ha^{-1} as Urea+30 kg N ha^{-1} as PM)	67.99	135.1^a	200.0^a	224.4^a	212.2
T_6=(60 kg N ha^{-1} as Urea+30 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM)	76.72	144.1^a	216.0^a	217.5^a	211.9
T_7=(60 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM+30 kg N ha^{-1} as Urea)	74.4	144.6^a	202.5^a	225.0^a	199
T_8=Control (No nitrogen application)	59.35	109.4^b	164.6^b	185.0^b	181.3
SEm (±)	5.97	6.12	6.64	7.37	7.82
LSD (=0.05)	NS	17.99	19.53	21.67	NS
CV, %	16.8	9	6.6	6.8	7.7
Grand Mean	70.9	135.3	200.4	216.1	203.6

The plant heights at 30 and 90 DAP was found statistically similar. Plant heights were found significantly higher at 45,60 and 75 DAP in the fertilized plots however control plot produced shorter plant height. The data over the different treatments designates that the plant height of maize was in increasing order from initial stage to the maturity stage of the crop and almost constant at maturity. At 45 and 75 DAP, maximum plant heights of 144.6 cm and 225.0 cm was obtained by T_7 (60 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM+30 kg N ha^{-1} as Urea) treatment however, other treatments were at par with each other except control that produced the plant height of 109.4 cm and 185 cm respectively. At 60 DAP, the highest plant height of 216 cm was obtained by T_6 (60 kg N ha^{-1} as Urea+30 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM) which was also at par with all the other treatments except T_8 or control (164.6 cm).

Nasim et al. found statistically similar result of plant height as influenced by application of different combination of organic and mineral nitrogenous fertilizers but found significantly taller height as compared to unfertilized maize crop [6]. Plants that received poultry manure grew taller than other plants possibly because of more concentrated nutrients or minerals were made readily available and easily absorbable by the receiving plants leading to faster growth and development [7].

Note: Means followed by common letter (s) within each column are not significantly different at 5% level of significance based on DMRT

Leaf area index: Leaf area index is the measure of leaf area per unit ground area and denotes the extent of photosynthetic machinery. Leaf area influences interception and utilization of solar radiation of maize crop canopies and consequently affects the maize dry matter accumulation and grain yield [6]. LAI is the product of maximum length and breadth of fully open leaves. At 30 DAP all the treatments regarding LAI measurements showed statistically similar results. The combined application of organic and inorganic sources of fertilizers did not influence the LAI at 60,45 and 75 DAP but it was significantly different with no fertilizer application i.e., control. The data on leaf area index at 90 DAP as influenced by different combination of organic and inorganic fertilizer levels on maize cultivar are presented in **Table 6**.

Table 6: Leaf area index of maize as influenced by sole and combined application of organic and inorganic fertilizers (Urea, FYM and PM) at NMRP, Rampur Chitwan in 2017.

Treatments	Leaf area index (cm)				
	Days after planting (DAP)				
	30	45	60	75	90
T_1=(120 kg N ha^{-1} as Urea)	0.29	1.79^{ab}	3.11^a	1.73^a	1.29^{ab}
T_2=(60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as FYM)	0.36	1.40^{ab}	3.28^a	2.1^a	0.90^{bc}
T_3=(60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as PM)	0.43	1.64^{ab}	2.68^{ab}	1.41^b	1.14^{bc}
T_4=(60 kg N ha^{-1} as FYM+60 kg N ha^{-1} as PM)	0.24	1.33^{ab}	1.89^b	2.19^a	0.83^{bc}
T_5=(60 kg N ha^{-1} as FYM+30 kg N ha^{-1} as Urea+30 kg N ha^{-1} as PM)	0.35	2.53^a	3.59^a	1.94^a	2.03^a
T_6=(60 kg N ha^{-1} as Urea+30 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM)	0.35	2.46^a	2.70^{ab}	1.84^a	1.96^a
T_7=(60 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM+30 kg N ha^{-1} as Urea)	0.24	1.80^{ab}	3.17^a	2.08^a	1.30^{ab}
T_8=Control (No nitrogen application)	0.23	0.90^b	1.77^b	0.84^b	0.40^c
SEm (±)	0.06	0.25	0.35	0.28	0.25
LSD (=0.05)	NS	0.73	1.04	0.82	0.73
CV, %	41.7	28.6	25.6	31.6	40.3
Grand Mean	0.32	1.73	2.77	1.76	1.23

There was zero significantly differences between LAI produced by different treatments at 30 days of planting, but maximum LAI of 2.53 was produced by T_5 (60 kg N ha^{-1} as FYM+30kg N ha^{-1} as Urea+30 kg N ha^{-1} as PM) at 45 DAP, which was at par with all other treatments except control (1.77). The control was observed to be statistically similar with T_4 (60 kg N ha^{-1} as FYM+60 kg N ha^{-1} as PM), T_3 (60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as PM). Similarly at 75 DAP maximum LAI (2.19) was observed in T_4 (60 kg N ha^{-1} as FYM+60 kg N ha^{-1} as PM) that was statistically similar to all the treatments except control (0.84). The LAI found in control was also statistically similar with T_3 (60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as PM). At maturity (90 DAP), combined application of different sources of fertilizers influenced on the LAI. Significantly higher LAI (1.956) was recorded at T_6 (60 kg N ha^{-1} as Urea+30 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM) that was statistically similar to T_5 (60 kg N ha^{-1} as FYM+30kg N ha^{-1} as Urea+30 kg N ha^{-1} as PM), T_7 (60 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM+30 kg N ha^{-1} as Urea) and T_3 (60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as PM). While minimum LAI (0.40) recorded was at T_8 (control).

Observation shows that lower numbers of leaves were developed at early growth stages, because of which lower photosynthesis was occurred and lower dry matter was produced resulting in which lower LAI development. As the number of leaves increased in the crop plant LAI, was also influenced to be higher as a result photosynthesis and dry matter accumulation in the plant increased in the similar way. It was suggested that split application of fertilizer on later stage of maize increased leaf size that helped to maximize light interception, dry matter accumulation and maximize plant economy for acquisition of resources needed for growth and development of plants [8]. The increased LAI with increased fertilizer levels was possibly due to increased number of leaves, improved leaf expansion in plants with the application of optimum dose of fertilizers.

The leaf area index was increased up to the silking stage of plant and then it was decreased in the decreasing order due to drying and senescence of lower leaves. Nasim et al. were also in accordance with our results, that they found higher LAI in the maize crop at fertilized plots in comparison to the plants at control plots [6].

Note: Means followed by common letter (s) within each column are not significantly different at 5% level of significance based on DMRT.

Days to 75% tasseling and silking: The days to 75% tasseling was significantly affected by sole and combined application of different organic and inorganic fertilizers presented in **Table 7.** The data showed that, earlier tasseling (62.50 days) was observed in T_2 (60 kg N ha^{-1} as Urea+60kg N ha^{-1} as FYM) which was statistically at par with T_7 (60 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM+30 kg N ha^{-1} as Urea) and T_6 (60 kg N ha^{-1} as Urea+30 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM). The control (T_8) took more days of 75.0 days for tasseling. These results were closely related with the findings of Nasim et al. who observed that, application of nitrogenous fertilizer through organic and inorganic source helps in earlier development of reproductive parts in maize due to continuous supply of all the essential plant nutrients throughout the growth period of crop [6].

Table 7: Days to tasseling, silking and anthesis silking interval of maize as influenced by sole and combined application of organic and inorganic fertilizers (Urea, FYM and PM) at NMRP, Rampur Chitwan in 2017.

Treatments	Days to 75% tasseling	Days to 75% Silking	ASI (Days)
T_1=(120 kg N ha^{-1} as Urea)	65.75^{bc}	75.00^{b}	9.25^{ab}
T_2=(60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as FYM)	62.50^{c}	72.25^{b}	9.75^{ab}
T_3=(60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as PM)	64.50^{bc}	68.00^{b}	3.50^{b}
T_4=(60 kg N ha^{-1} as FYM+60 kg N ha^{-1} as PM)	66.25^{bc}	75.70^{b}	9.25^{ab}
T_5=(60 kg N ha^{-1} as FYM+30 kg N ha^{-1} as Urea+30 kg N ha^{-1} as PM)	68.75^{b}	75.50^{b}	6.75^{b}
T_6=(60 kg N ha^{-1} as Urea+30 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM)	63.25^{c}	71.25^{b}	8.00^{b}
T_7=(60 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM+30 kg N ha^{-1} as Urea)	63.75^{c}	71.75^{b}	8.00^{b}
T_8=Control (No nitrogen application)	75.00^{a}	90.00^{a}	15.0^{a}
SEm (±)	1.66	2.52	2.04
LSD (=0.05)	4.89	7.4	6
CV, %	5	6.7	47
Grand Mean	66.22	74.91	8.69

The earlier silking was found (68.00 days) in the T_3 (60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as PM) which was statistically at par with all other treatments except control. The late silking was found in the control plot (90.00 days). Silking formation is the indicator of maize reproductive stage. It might be attributed to the fact that nitrogen promoted vegetative growth more to affected to delaying maturity. Early silking in FYM treated plots could be attributed to slow and timely release of essential nutrients from FYM throughout the growing season that encouraged to the vegetative growth of the plant [9].

Anthesis Silking Interval (ASI): Anthesis silking interval is greatly influenced by sole and combined application of different organic and inorganic fertilizer application. The day's interval between tasseling and silking on maize is presented in Table 7. The short Anthesis silking interval was found (3.5 days) in the combining supply of nitrogen through 60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as PM which was at par with all the treatments except control that took anthesis silking interval of 15.00 days. In drought condition, there is the delay in silking and the period between male and female flowering increases giving rise to Anthesis Silking Interval (ASI). Therefore, application of organic fertilizers along with inorganic fertilizers helps in moisture conservation and escapes the crop from drought which facilitates earlier silking of maize in spring season. The shorter the ASI, better spikelet fertility and higher the partitioning of assimilates in to the reproductive parts [10].

Note: Means followed by common letter (s) within each column are not significantly different at 5% level of significance based on DMRT.

Biological yield: The biomass yield of maize as influenced by sole and combined application of different sources of organic and inorganic fertilizers are presented in **Table 8**. The significantly higher biological yield (10.12 t ha^{-1}) was produced by T_3 (60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as PM) which was at par with the T_6 (60 kg N ha^{-1} as Urea+30 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM) followed by T_1 (120 kg N ha^{-1} as Urea) and least (2.5 t ha^{-1}) was produced by T_8 (Control or no nitrogen application). The lower N level in the soil results in lower yield due to less available N for the optimum plant growth [11]. The incorporation of organic manure in the soil have thought to reduce the evaporation demand, thus have adequate water for plant root growth, or perhaps due to the softness of soil caused by manure in which the roots may expand rapidly and properly into wet soil to meet plant water requirements [12].

Table 8: Biological yield of crop as influenced by sole and combined application of organic and inorganic fertilizers (Urea, FYM and PM) at NMRP, Rampur Chitwan in 2017.

Treatments	Biological yield (Grain+Stover) t ha^{-1}
T_1=(120 kg N ha^{-1} as Urea)	7.65^{bc}
T_2=(60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as FYM)	5.50^{d}
T_3=(60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as PM)	10.12^{a}
T_4=(60 kg N ha^{-1} as FYM+60 kg N ha^{-1} as PM)	4.99^{d}
T_5=(60 kg N ha^{-1} as FYM+30 kg N ha^{-1} as Urea+30 kg N ha^{-1} as PM)	6.37^{cd}
T_6=(60 kg N ha^{-1} as Urea+30 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM)	8.5^{ab}
T_7=(60 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM+30 kg N ha^{-1} as Urea)	6.67^{bcd}
T_8=Control (No nitrogen application)	2.5^{e}
SEm (±)	0.6
LSD (=0.05)	1.77
CV %	18.6
Grand Mean	6.46

Stover yield was significantly influenced by application of nitrogenous fertilizers but not by its supplied sources such as combined use of urea, FYM and poultry manure. These results were also in accordance with the findings of Boateng et al. who reported that, poultry manure along with urea significantly increased the grain yield [13]. Also, similar findings were reported by Ali et al. who indicated that, higher biomass production produced by maize crop was due to greater LAI, plant height, major and micronutrients availability due to supply of nutrients through both the organic and inorganic fertilizers in suitable proportions [9].

Note: Means followed by common letter (s) within each column are not significantly different at 5% level of significance based on DMRT.

Economic analysis

Gross return: The gross return as influenced by sole and combined application of different sources of organic and inorganic fertilizers are presented in **Table 9**. The data on gross return was influenced by combined application of different sources of organic and inorganic fertilizers. Significantly higher gross return (NRs 115.09 thousand ha^{-1}) was recorded from T_3 (60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as PM) which was statistically at par with T_6 (60 kg N ha^{-1} as Urea+30 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM) which gave (NRs.101.53 thousand ha^{-1}) as a gross return followed by T_7 (60 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM+30 kg N ha^{-1} as Urea. The T_7 (60 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM+30 kg N ha^{-1} as Urea) and T_1 (120 kg N ha^{-1} as Urea) also showed statistically similar gross returns. The lowest gross return (NRs. 45.86 thousand ha^{-1}) was observed from T_8 (control).

Table 9: Gross return, net return and B: C ratio of maize cultivation as influenced by sole and combined application of organic and inorganic fertilizers (Urea, FYM and PM) at NMRP, Rampur Chitwan in 2017.

Treatments	Gross return (x000 NRs ha^{-1})	Net Return (x000 NRs ha^{-1})	B:C
T_1=(120 kg N ha^{-1} as Urea)	97.37^{b}	27.39^{ab}	1.39^{ab}
T_2=(60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as FYM)	77.78^{c}	3.79^{c}	1.05^{c}
T_3=(60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as PM)	115.09^{a}	42.57^{a}	1.59^{a}
T_4=(60 kg N ha^{-1} as FYM+60 kg N ha^{-1} as PM)	64.27^{c}	-11.95^{d}	0.84^{d}
T_5=(60 kg N ha^{-1} as FYM+30 kg N ha^{-1} as Urea+30 kg N ha^{-1} as PM)	78.73^{c}	3.70^{c}	1.05^{c}
T_6=(60 kg N ha^{-1} as Urea+30 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM)	101.53^{ab}	28.43^{ab}	1.39^{ab}
T_7=(60 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM+30 kg N ha^{-1} as Urea)	97.46^{b}	23.09^{b}	1.31^{b}
T_8=Control (No nitrogen application)	45.86^{d}	-18.9^{d}	0.71^{d}
SEm(±)	5.04	5.04	0.07
LSD (=0.05)	14.81	14.81	0.2
CV, %	11.9	82.1	12.1
Grand Mean	84.7	12.3	1.17

Net return: The net return as influenced by sole and combined application of different sources of organic and inorganic fertilizers are presented in **Table 9.** The data on net return was influenced by combined application of different sources of organic and inorganic fertilizers. Significantly higher net return of NRs 42.57 thousand ha^{-1} was recorded from T_3 (60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as PM) which was statistically at par with T_6 (60 kg N ha^{-1} as Urea+30 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM) and T_1 (120 kg N ha^{-1} as Urea) which gave net return of NRs 28.43 thousand ha^{-1} and NRs 27.39 respectively. The lowest net return of NRs-18.9 thousand ha^{-1} was observed from T_8 (control) which was statistically at par with T_4 (60 kg N ha^{-1} as FYM+60 kg N ha^{-1} as PM) that produced net return of NRs 1.95 thousand ha^{-1}. Grater the net return by T_3 could be attributed by, higher grain and stover yield and lowers the cost of fertilizers as compared to other treatments.

Benefit cost ratio (B:C): Benefit cost ratio is the ratio of gross return to the cost of cultivation and that reflects return per rupees investment. The benefit cost ratio was influenced by sole and combined application of different sources of organic and inorganic fertilizers. Significantly higher benefit cost ratio (1.59) was recorded from T_3 (60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as PM) which was statistically at par with T_1 (120 kg N ha^{-1} as Urea) and T_6 (60 kg N ha^{-1} as Urea+30 kg N ha^{-1} as PM+30 kg N ha^{-1} as FYM) which gave benefit cost ratio of 1.39 and 1.38 respectively. The lowest benefit cost ratio of 0.71 was observed from T_8 (control). The gross returns, net returns and B:C ratio has direct correlation with economical yield of crop under different nutrient management practices. Therefore, higher the grain and stover yield of maize will increase the gross income, net return and B:C ratio.

Note: Means followed by common letter (s) within each column are not significantly different at 5% level of significance based on DMRT.

CONCLUSION

The productivity of spring maize is highly influenced by sole and combined application of different sources of organic and inorganic sources of fertilizers. The combination of different organic and inorganic sources of fertilizers produced highest biological yield and economic benefit of maize at Chitwan during spring season. The application of 120 kg nitrogen per hectare through combination of 60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as PM produced the highest biological yield. The net return and B:C ratio was also highest in same treatment. Therefore, application of 120 kg nitrogen through the combinations of 60 kg N ha^{-1} as Urea+60 kg N ha^{-1} as PM can be recommended to the farmers during spring season under sub-tropical inner terai condition of Nepal.

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