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RESEARCH ARTICLE

INTEGRATED NUTRIENT MANAGEMENT ON HYBRID MAIZE (ZEA MAYS L.) PRODUCTION IN LAMAHI DANG, NEPAL

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ABSTRACT

The key to sustainable agricultural production and environmental protection is the prudent use of both organic and inorganic fertilizers. With these goals in mind, an experiment was carried out in the spring of 2021 in Lamahi municipality Dang district of Lumbini province to ascertain the impact of Integrated Nutrient Management (INM) on hybrid maize yield and yield-attributing characteristics. With nine treatments and three replications, the experiment was set up in a randomized complete block design. Poultry manure, farm-yard manure (FYM), vermi-compost, and inorganic fertilizers are all included in INM. 10v10 was the variety used in the experiment. Grain yield, cob circumference, number of rows per cob, harvest index, and economic parameter (i.e., cost of cultivation, gross income, net income and benefit cost ratio) were all significantly impacted by the various Integrated Nutrient Management approaches. In comparison to 100% N through chemical fertilizers, the INM practices of 50% N through chemical fertilizers and 50% N through vermin-compost demonstrated the maximum grain output (6.84 t ha-1), cob circumference (16.67 cm), number of rows per cob (16.9), and harvest index (42.7). In terms of B: C ratio and net income, treatment with 100% N via Recommended Dose of Fertilizer (RDF) also showed the top ratings. However, the treatment that received 50% N from chemical fertilizers and 50% N from vermi-compost had the highest gross income.

KEYWORDS

Maize, Integrated Pest Management, Yield and yield attributing characters

1. INTRODUCTION

An important agronomic crop grown all over the world is maize (Zea mays L.), a member of the Poaceae family. It is said to have originated in America and was first cultivated in Mexico some 7,000 years ago. After rice and wheat, maize is the third most important cereal crop produced worldwide. The nation's agriculture contributes 60% of its GDP, with cereal crops accounting for the majority of this contribution (Gautam et al., 2018). In contrast, farmers who grow maize in areas with adequate irrigation facilities generate income equivalent to that of cash crops like cotton, onions, sugarcane, etc. in a short period of 120–130 days. This has caused farmers' interest in intensive maize cultivation to supplant some cash crops (Kalhapure et al., 2013).

According to a study, authors integrated nutrient management can assist in reducing the use of synthetic fertilizers while simultaneously enhancing the efficiency of farmers' profits (Dahal et al., 2017). According to a group researchers, the key to use the best available organic resource as fertilizer is to determine how best to combine it with a corresponding amount of synthetic fertilizers (Kalhapure et al., 2013). The nutrients have a major impact on cereal output. Modern chemical fertilizers are expensive, therefore marginal and impoverished farmers cannot afford them. As a result, they do not apply enough nutrients to their crops. Locally accessible organic nutrient sources also somewhat lessen the need for chemical fertilizers, which have been shown to increase efficiency. Synthetic fertilizers increase crop growth and development and yield, but they also significantly contribute to the decomposition of soil organic matter, the loss of beneficial insects that habituate the soil, the loss of crop vitamins and protein, and the spread of weeds. In addition to providing N, P, and K, the organic source makes the previously unavailable source of elemental nitrogen, micronutrients, bound phosphate, and decomposing plant residues available to the plant for absorption. Despite all of this, it isn't possible to ignore the organic manure's poor nutritional content because it is unable to generate the ideal amount of maize on its own (Kalhapure et al., 2013). Maintaining soil health and production, as well as partially satisfying the crop's need for synthetic fertilizer, has been demonstrated to be possible with the appropriate management and integration of organic sources and chemicals (Kumar, 2019). The study aims to investigate the impact of integrated nutrient management on maize yield, the optimal combination of organic and inorganic fertilizers, and the production economics of maize under various INM treatments.

2. MATERIALS AND METHODOLOGY

The experiment was conducted in research plot of the agronomy farm of IAAS, Prithu Technical College, Lamahi Municipality, Bangaun ward no.3 of Dang district from 2nd Feb to 28th June 2021.The experimental field used mustard-fallow sequence, with good working conditions and uniform fertility. Soil sampling was done from the experimental site with the help of soil sampling auger before first ploughing. Samples were taken randomly from nine spots (three from each replication) at the depth of 0-20 cm representing whole replication. These sub-samples were mixed, air dried, grounded and sieved and stored for analysis. The final composited soil samples were sent and analyzed in Soil Science Division (SSD) of Nepal Agriculture Research Council (NARC), Khumaltar.

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Table 1: Physico-chemical properties of the soil of the experimental site (2021)			
S.N	**Properties**	**Content**	**Category**
1	Physical properties		
	sand (%)	21.6	
	Slit(%)	58.8	
	Clay(%)	19.6	
	soil texture		slit loam
2	Chemical properties		
	PH(1:2)	6.3	Slightly acidic
	Total Nitrogen(%)	0.1	Medium
	Available phosphorus(P205 kg/ha)	45	Medium
	Available potassium(k20 kg/ha)	190.8	Medium
	Organic matter(%)	2.1	Low

The experiment was conducted in Randomized Complete Block Design with three replications and 9 treatments (Table 2). The treatments consist of 100%N (i.e. recommended dose of nitrogen through different combination i.e. inorganic and organic (FYM, Poultry, Vermi-compost).

Table 2: Different treatment			
Treatment	**Treatment details**	**Mineral fertilizer/plot**	**Organic manure/plot**
T1	100% N through RDF	57.6gm MOP, 113gm DAP, 295gm Urea	Nil
T2	75% N through RDF + 25% N from FYM.	57.6gm MOP, 113gm DAP, 210gm Urea	1.36 kg FYM
T3	75% N through RDF + 25% N from PM	57.6gm MOP, 113gm DAP, 210gm Urea	1.78 kg PM
T4	75% N through RDF + 25% N from VM.	57.6gm MOP, 113gm DAP, 210gm Urea	1.86 kg VC
T5	75% N through RDF + 25% N from (FYM+PM+VC)	57.6gm MOP, 113gm DAP, 210gm Urea	0.62 kg VC ,0.46 kg FYM,0.59 PM
T6	50% N through RDF + 50% N from FYM	57.6gm MOP, 113gm DAP, 125gm Urea	2.73 kg FYM
T7	50% N through RDF + 50% N from PM	57.6gm MOP, 113gm DAP, 125gm Urea	3.55 kg PM
T8	50% N through RDF + 50% N from VM	57.6gm MOP, 113gm DAP, 125gm Urea	3.72 kg VC
T9	50% N through RDF + 50% N from (FYM+PM+VC).	57.6gm MOP, 113gm DAP, 125gm Urea	1.24 kg VC , 0.91 kg FYM, 1.18 kg PM

The experimental plot was ploughed twice, removing crop residue and weeds one week before sowing. Fertilizer was applied just one week before sowing. Field preparation exposed stubbles, weed rhizomes, and insect pest eggs. The experiment was divided into plots with 3.6m*2.4m dimensions, 1m space between blocks, and 0.75m space between treatments. Two boarder rows were treated as non-sampling rows. Fertilizers are organic and inorganic substances used to add nutrients to plants for growth and development. The RDF for maize is 180:60:40 NPK Kg/ha (NARC), with treatments designed with different chemical and organic fertilizer compositions. Organic manure is applied one week before sowing, and DAP, MOP and Urea were applied in different stage of maize.

The study recorded biometrical observations of five maize plants during physiological maturity. The number of kernel rows, test weight, grain yield, and Stover yield were calculated using various methods. The cost of cultivation was calculated based on the prevailing market price at Dang district, including labor, fertilizer, compost, seed, and land rent. The gross return was converted into Rs ha-1 based on the prevailing market price, and the net return was calculated by deducting the cost of cultivation from the gross return. The economic analysis was conducted to determine the profitability of the treatments used in the experiment.

All the data of experimental plots were analyzed by using ANOVA procedure. When the F-test indicated statistical significance at p=0.05 level, Duncan's Multiple Range Test (DMRT) was used to compare the difference of the means (Gomez and Gomez, 2002). In addition, simple correlation analysis was run between selected parameters. Microsoft word 2010 was used for word processing; MS excels for tables, S-graphs and Simple Statistical Analysis, R-package was used for statistical analysis and SPSS was used for the correlation analysis.

3. Result and Discussion

3.1 Effect of INM on plant height and ear height (cm)

Treatment T3 (75% N through RDF + 25% N from PM) had the highest plant height (188.9 cm) followed by treatment T8 (50% N from RDF + 50% N from VC) and T9 (50% N from RDF + 50% N from (FYM + PM + VC)) with a plant height of 184.9cm and 183.1 cm respectively.Lowest plant height was recorded with treatment T6 (50% N from RDF + 50% N from FYM) i.e. 175.4 cm.Similar result was obtained from experiments performed by (Wailare and Kesarwani, 2017).Treatment T3 (75% N through RDF + 25% N from PM) had the highest ear height (85.3 cm) followed by treatment T2 (75% N through RDF + 25% N from FYM) and T5 (75% N through RDF + 25% N from (FYM + PM + VC)) with a plant height of 84.7cm and 84 cm respectively

Table 3: Effect of INM on plant height and ear height		
Treatment	**Plant height (cm)**	**Ear height (cm)**
T1 (100% N through RDF)	180.9	78
T2 (75% N through RDF + 25% N from FYM)	178.1	84.7
T3 (75% N through RDF + 25% N from PM)	188.9	85.3
T4 (75% N through RDF + 25% N from VC)	182.9	81.7
T5 (75% N through RDF + 25% N from (FYM + PM + VC))	178.9	84
T6 (50% N from RDF + 50% N from FYM)	175.4	74.7
T7 (50% N from RDF + 50% N from PM)	178.7	78

Table 3 (cont): Effect of INM on plant height and ear height		
T8 (50% N from RDF + 50% N from VC)	184.9	83
T9 (50% N from RDF + 50% N from (FYM + PM + VC))	183.1	80
CV (%)	5.1	9.1
LSD(0.05)	NS	NS
Mean	181.31	81.04

3.2 Effect of INM on Cob length and Cob diameter

Table no 4 shows no significant difference. However, treatmentT8 (50% N from RDF + 50% N from VC) had the maximum cob length (20.9 cm) followed by treatment T4 (75% N through RDF + 25% N from VC) and T1 (100% N through RDF) with a cob length of 20.1 cm and 20 cm respectively. Lowest cob length was recorded with treatment T6 (50% N from RDF + 50% N from FYM) i.e. 18.9cm. Treatment T8 (50% N from RDF + 50% N from VC) had the maximum cob diameter (16.7 cm) followed by treatment T4 (75% N through RDF + 25% N from VC) with a cob diameter of 15.9 cm.Lowest cob diameter was recorded with treatment T2 (75% N through RDF + 25% N from FYM) i.e. 15.1 cm. Similar result was obtained (Biswasi et al., 2020).

Table 4: Effect of INM on Cob length and Cob diameter		
Treatment	**Cob length (cm)**	**Cob diameter (cm)**
T1 (100% N through RDF)	20	16.2[ab]
T2 (75% N through RDF + 25% N from FYM)	19.2	15.1[d]
T3 (75% N through RDF + 25% N from PM)	19.6	15.5[bcd]
T4 (75% N through RDF + 25% N from VC)	20.1	15.9[abc]
T5 (75% N through RDF + 25% N from (FYM + PM + VC))	19.8	15.4[bcd]
T6 (50% N from RDF + 50% N from FYM)	18.9	15.2[cd]
T7 (50% N from RDF + 50% N from PM)	19.4	15.4[bcd]
T8 (50% N from RDF + 50% N from VC)	20.9	16.7[a]
T9 (50% N from RDF + 50% N from (FYM + PM + VC))	19.4	15.5[bcd]
CV (%)	5.6	3.1
LSD(0.05)	NS	0.84
Mean	19.7	15.7

3.3 Effect of INM on No. of row per cob, no. of grain per row and Thousand grain weight

Treatment T8 (50% N from RDF + 50% N from VC) had the maximum no. of row per cob (i.e. 16.9) followed by the treatment T1 (100% N through RDF) with 16.5 rows per cob. Treatment T4 (75% N through RDF + 25% N from VC) had the highest no. of grain per row (40.8) followed by treatment T5 (75% N through RDF + 25% N from (FYM + PM + VC)) with (40.4).Lowest no. of grains per row was recorded with treatmentT6 (50% N from RDF + 50% N from FYM) i.e. 37.8.Similar results were obtained (Biswasi et al., 2020). Treatment T5 (75% N through RDF + 25% N from (FYM + PM + VC)) had the maximum thousand grain weight (193.7) followed by treatments T6 (50% N from RDF + 50% N from FYM) and T1 (100% N through RDF) with the thousand grain weight of 189.3 and 188.3 respectively.Similar results were obtained from experiment performed by some researcher, reported 5 t/ha PM + 50% RDF recorded the highest thousand grain weight (35.9 g/ 100 grains) (Wailare and Kesarwani, 2017).

Table 5: Effect of INM on No. of row per cob, no. of grain per row and Thousand grain weight			
Treatment	**No. of row per cob**	**No. of grain per row**	**Thousand grain w.t.**
T1 (100% N through RDF)	16.5[ab]	39.4	188.3
T2 (75% N through RDF + 25% N from FYM)	14.7[d]	39.7	172
T3 (75% N through RDF + 25% N from PM)	15.7[bcd]	38.2	167.7
T4 (75% N through RDF + 25% N from VC)	15.9[abc]	40.8	176
T5 (75% N through RDF + 25% N from (FYM + PM + VC))	14.9[cd]	40.4	193.7
T6 (50% N from RDF + 50% N from FYM)	14.8[cd]	37.8	189.3
T7 (50% N from RDF + 50% N from PM)	15.6[bcd]	38.8	174.3
T8 (50% N from RDF + 50% N from VC)	16.9[a]	39.8	168
T9 (50% N from RDF + 50% N from (FYM + PM + VC))	15.9[abc]	39.8	184.7
CV (%)	4.4	2.8	7.5
LSD(0.05)	1.2	NS	NS
Mean	15.7	39.4	179.3

3.4 Effect of INM on Grain yield, Stover Yield and Harvest Index

Treatment T8 (50% N through RDF + 50% N through VM) had the highest grain yield (6.8 ton/ha) which was statistically at par with treatment T1 (100% N through RDF), T4 (75% N through RDF + 25% N through VC).Similar result was obtained from experiment performed by who recorded significantly higher yield with the integrated application of 50 % RDF + 50 % VC (Baharvand et al., 2014). Treatment T1 (100% N through RDF) had the highest Stover yield (10.7 ton /ha) followed by treatment T2 (75% N through RDF + 25% N through FYM) and T3 (75% N through RDF + 25% N through PM) with a Stover yield of 9.8 ton/ha and 9.3 ton/ha respectively. Similar result was obtained by who reported that the Stover yield increased with the increase in N level (Singh et al., 2000).

The observation presented in table 6 regarding Harvest index indicated a significant difference between different treatments combination.

Treatment T8 (50% N through RDF + 50% N through VM) had the highest Harvest index i.e. (42.7) which was statistically at par with treatment T4 (75% N through RDF + 25% N through VC) with a harvest index of (41.3). The lowest Harvest index was recorded with Treatment T9 (50 % N through RDF + 50 % N through (FYM+VM+ PM) i.e.35.5. Similar result was obtained from experiment performed by who showed that significantly higher biological yield, harvest index were obtained under 5 ton vermincompost+ 75% RDF (Yadav et al., 2016).

Table 6: Effect of INM on Grain yield, Stover Yield and Harvest Index

Treatment	Grain yield (ton/ha)	Stover yield	Harvest index
T1 (100% N through RDF)	6.2[ab]	10.7	36.4[c]
T2 (75% N through RDF + 25% N from FYM)	5.7[abcd]	9.8	36.8[c]
T3 (75% N through RDF + 25% N from PM)	5.7[bcd]	9.3	37.9[bc]
T4 (75% N through RDF + 25% N from VC)	6.1[abc]	8.7	41.3[ab]
T5 (75% N through RDF + 25% N from (FYM + PM + VC))	5[cd]	8.1	38.2[bc]
T6 (50% N from RDF + 50% N from FYM)	5.3[bcd]	9	37[bc]
T7 (50% N from RDF + 50% N from PM)	4.9[d]	8	37.9[bc]
T8 (50% N from RDF + 50% N from VC)	6.8[a]	9.2	42.7[a]
T9 (50% N from RDF + 50% N from (FYM + PM + VC))	5.2[bcd]	9.2	35.9[c]
CV (%)	11.8	10.2	6.6
LSD(0.05)	1.2	NS	4.3
Mean	5.7	9.1	38.2

3.5 Effect of INM on net-income and benefit cost ratio

The highest Net income was recorded on treatment 100 % N through RDF followed by treatment 75% N from RDF + 25 % N from FYM (48.8) and lowest Net income was recorded on treatment (50% N from RDF + 50% N from PM).Similar result was observed by Nagavani et al.,(2014) who reported that the net income was highest with 100 per cent RDF through inorganics during 2008.The treatment combination of 100% N through RDF show maximum benefit:Cost Ratio (1.8) followed by treatment 75% N through RDF + 25% N from FYM (1.5). Similar result was observed by who recorded highest B: C ratio with 100 per cent RDF through inorganics during 2008 and 2009 (Nagavani et al., 2014).

Table 7: Effect of INM on net-income and benefit cost ratio

Economic Parameter Rs/ha (,000)		
Treatment	**Net income**	**Benefit Cost ratio (B:C)**
T1 (100% N through RDF)	75.3[a]	1.8[a]
T2 (75% N through RDF + 25% N from FYM)	48.8[ab]	1.5[b]
T3 (75% N through RDF + 25% N from PM)	33.4[bc]	1.3[bc]
T4 (75% N through RDF + 25% N from VC)	32.2[bc]	1.2[bcd]
T5 (75% N through RDF + 25% N from (FYM + PM + VC))	16.3[c]	1.1[cde]
T6 (50% N from RDF + 50% N from FYM)	25[bc]	1.2[bcd]
T7 (50% N from RDF + 50% N from PM)		0.9[e]
T8 (50% N from RDF + 50% N from VC)	11.6[cd]	1.1[cde]
T9 (50% N from RDF + 50% N from (FYM + PM + VC))	2.6[cd]	1[de]
CV (%)	70.6	12
LSD(0.05)	31.1	0.3
Mean	25.4	1.2

4. Conclusion

The experiment on integrated nitrogen management in hybrid maize production in Lamahi Dang, Nepal, found that organic manures and inorganic fertilizers had productive effects on maize growth and yield parameters. The integrated application of 50% nitrogen from RDF and 50% nitrogen from VC resulted in better results. Vermicompost with chemical fertilizer led to the highest gross income, but the B:C ratio was maximum under 100% N through RDF due to low cultivation costs.

Conflict of Interest

The authors declare that they have no conflict of interests.

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