INFLUENCE OF NUTRIENT AND WEED MANAGEMENT ON GROWTH, YIELD AND ENERGETICS OF MAIZE

ABSTRACT

A field experiment entitled "Influence of nutrient and weed management on growth, yield and bioenergetics of maize (*Zea mays* L.)" was conducted in agricultural research farm of Lovely Professional University, Punjab. The investigation was laid out in factorial randomized block design with three replications, aimed to study the impact of nutrient and weed management on growth attributes, yield attributes and bioenergetics of maize. The treatment consisted of three nutrient management treatments *viz.*, T_1 (100% N through RDF), T_2 (75% N through RDF and 25% N through vermicompost (P&K recommended doses)), T_3 (75% N through RDF and 25% N through FYM (recommended doses of P&K)); three weed management treatments, viz, W_1 (control), W_2 (Atrazine @1 kg a.i/ha + Tembotrione @110 g a.i/ha), W_3 (Live mulching with cowpea). The results of the experiment revealed that among the nutrient management treatments, significantly higher growth attributes, yield attributes, energy output, energy efficiency index was observed with treatment T_2 (75% N through RDF and 25% N through vermicompost) and the lowest was observed in treatment T_1 (100% N through RDF), the pooled data suggested that yield was significantly highest in treatment combination T_2W_2 (75% N through RDF and 25% N through vermicompost along with Atrazine @1 kg a.i/ha + Tembotrione @110 g a.i/ha).

Key words: Nutrient management, Weed management, growth attributes, yield attributes, bioenergetics

INTRODUCTION

Maize (*Zea mays* L.) is considered as one of the most significant cereal crops in the global agricultural economy since it is used as food humans, feed for animals and raw material for the industrial purposes. It ranks fifth in terms of world's area and production as it is cultivated in an area of 193.7 million ha with a production of 1147.7 million tonnes with an average productivity of 5750 kg/ha. It is regarded as the "Queen of Cereals" because of its capability to generate higher yields when compared to the other cereal crops. It is cultivated in an area of 9.2 million ha which contributes around 4% of the world's maize area and has the production of 27.23 million tonnes with an average yield of 3 t/ha which represents 2% of the global production. It is the fourth largest cereal crop grown in India after rice, wheat and bajra and is widely grown in the states of Haryana, Uttar Pradesh, Punjab, Karnataka, Andhra Pradesh, Rajasthan and Tamil Nadu. Nutrient management is one of the most prominent factors that impacts the growth and yield of the maize crop. In recent years, decline in productivity of maize has been observed mainly due to the deterioration of soil fertility status as a result of indiscriminate use of inorganic fertilizers over the years. These inorganic fertilizers severely impact the soil properties by altering the soil pH, reducing the microbial population and organic matter in the soil and causing disturbance to the soil ecosystem while leaving residues in the soil (Kumar *et al.*, 2019). In this scenario, integrated nutrient management is one of the suitable options for ensuring long-term crop yields while maintaining soil fertility, especially in cereal-based cropping systems. So, in order to attain optimal crop productivity and sustainable ecosystem, balanced use of nutrients in the form of organic inputs becomes essential. Organic manures such as vermicompost and farmyard manure help in sustaining the soil productivity by enhancing the physico-chemical properties of the soil, they also aid to maximize the efficiency of the chemical fertilizers that are applied (Ponmozhi *et al.*, 2019). Organic manures mitigate the adverse effects of chemical fertilizers in the soil by lowering the chemical toxicity and promoting the growth of the microorganisms. They also help in providing trace amounts of micronutrients which are usually not supplied through inorganic fertilizers. Additionally, organic manures enhance the cation exchange capacity and water holding capacity of the soil, resulting in a consistent supply of nutrients to the crop plants (Brar *et al*., 2015). Hence, cheap alternative organic sources to optimize the use of chemical fertilizers and improve the soil health are of utmost importance in modern agriculture.

Amongst the biotic stresses, weeds are considered as one the most important limiting factors in cultivation of maize. During its early stages of development, maize is extremely susceptible to weed competition. Around 40- 60% yield losses occur in maize due to the uncontrolled growth of weeds and improper management practices Kumawat *et al.*, (2019). Thus, a proper weed management is essential for minimizing the losses of crop yield due to the same. Integrated weed management comprises of various methods to control the weeds; hence it is considered to be an effective way along with the chemical fertilizers, cultural methods such as mulching, cover crops etc. can be used.

Keeping the above prospects in mind, the experiment has been laid out with the mentioned objectives:

1. To study the effect of nutrient and weed management on growth attributes of maize.
2. To study the effect of nutrient and weed management on yield and yield attributes of maize.
3. To study the energetics of maize.

MATERIALS AND METHODS:

The experiment was conducted at agricultural research farm of Lovely Professional University, in the district of Kapurthala, state of Punjab during the *kharif* season of the year 2021.This experimental site is located at 31°14'43.8"N and 75°41'44.1"E with an average elevation of 252 m from mean sea level. The experimental site has subtropical weather, which is often favorable for the cultivation of maize. The average annual rainfall of the area is 816 mm. Average value of temperature (maximum and minimum) and relative humidity during the field experimental period of June-October in 2021 have been 45^0C & 20^0C and 82 %& 38 %, respectively. The investigation was laid out in factorial randomized block design with three replications. The treatment consisted of three nutrient management treatments *viz.*, T_1 (100% N through

RDF), T_2 (75% N through RDF and 25% through vermicompost (P&K recommended doses)), T_3 (75% N through RDF and 25% through FYM (recommended doses of P&K)); three weed management treatments, *viz*, W_1 (control), W_2 (Atrazine @1 kg a.i/ha + Tembotrione @110 g a.i/ha), W_3 (Live mulching with cowpea). The field was ploughed and given pre-sowing irritation. After the preparatory tillage, field was divided into 27 different plots of 5m x 4m size. Application of required amount of vermicompost and FYM as per doses was done as per the treatment requirements. The pre-treated seed of variety Laxmi CP-333 were sown by dibbling method in between the rows by using maize seed at the rate of 25kg/ha with a spacing of 60 x 20 cm on 30 June, 2021. Plant protection measures and irrigations, whenever required were provided in same manner for all the treatments. Regular biometric observations were recorded at periodic intervals of 30DAS, 60DAS and 90 DAS, whereas yield attributes were recorded just before harvesting of crop. The crop was harvested on 3 October, 2021 when about 80 per cent of the cobs turned yellowish and grains became hard and then tied in the labelled bundles. The cobs were removed from the plants, dried and threshed with hand operated maize sheller. Thus grain yield of each plot was recorded. The observations were recorded on three randomly chosen plants from each treatment, and replication data was acquired by averaging the values. The collected data were statistically analysed by the method described by Gomez and Gomez (1981). The data was, however, interpreted using 0.05 probability levels, when the F test found significance, critical difference values were calculated.

RESULTS AND DISCUSSION:

Growth parameters

The results of the present investigation revealed that growth parameters of plant such as plant height, leaf area were significantly influenced by the nutrient and weed management treatments and their combinations. Plant height and leaf area of maize at 30, 60 and 90 DAS has been presented in the Table 1.1. At 30 DAS, there was no significant influence of nutrient and weed management on the plant height and leaf area. However, at 30 DAS among nutrient management treatments T_1 had the maximum plant height and leaf area that was followed by the treatment T_2. The reason behind this might be due to the readily available fertilizers and their higher utilization by the crop plants. Similar findings were reported by (Singh *et al.*, 2017). Among the weed management treatments W_2 had the maximum plant height and leaf area which might be due to the increase in the proliferation of roots and shoots and better absorbance of nutrients as result of less crop-weed competition by the application of herbicides. The results are in conformity with the findings reported by (Verma *et al*., 2009), (Kolekar *et al.*, 2022). At 60 and 90 DAS, among the nutrient management treatments, T_2 had significantly higher plant height and leaf area when compared to other treatments, while T_1 had the lowest plant height and leaf area, whereas among the weed management treatments, W_2 had significantly higher plant height and leaf area in comparison to other treatments, while W_1 had lowest value of plant height and leaf area due to no weed management. Similar findings were reported by (Nanjappa *et al.*, 2000), (Kannan *et al.*, 2013).

Table 1.1 Influence of nutrient and weed management on growth parameters of maize

	Plant height (cm)			**Leaf area (cm^2)**		
	30 DAS	**60 DAS**	**90 DAS**	**30 DAS**	**60 DAS**	**90 DAS**
Nutrient management						
T_1- 100% RDF	39.72	137.01	141.96	74.14	395.89	406.19
T_2- 75% RDF + 25% VC	38.21	151.54	157.62	64.04	447.11	465.64
T_3-75% RDF + 25% FYM	35.00	143.63	148.62	56.80	418.87	440.60
CD $_{(p=0.05)}$	1.45	1.18	1.02	1.73	2.70	3.08
S.Ed (±)	0.71	0.56	0.48	0.87	1.27	1.45
Weed management						
W_1 - Control	33.74	132.37	137.54	58.89	380.04	394.69
W_2- Atrazine + Tembotrione	39.56	151.77	158.66	70.23	447.27	465.64
W_3- Live mulching with cowpea	36.40	148.06	152.00	65.87	434.56	451.22
CD $_{(p=0.05)}$	1.45	1.18	1.02	1.73	2.70	3.08
S.Ed (±)	0.71	0.56	0.48	0.7	1.27	1.45

Yield attributes

Data pertaining to the yield attributes revealed that yield attributes *viz.*, Number of grains per cob, grain yield, stover yield, seed index were significantly influenced by the nutrient and weed management. The yield attributes of maize have been presented in Table 1.2. Among the nutrient management treatments, T_2 recorded the highest yield and yield attributes and the lowest yield was observed in T_1 which might be due to the increase in the photosynthates and biomass production with the combined application of vermicompost and inorganic fertilizer than sole application of inorganic fertilizers. Similar findings were reported by (Baharvand *et al.*, 2014) and (Zaremanesh *et al.*, 2016). Among the weed management treatments W_2 recorded the highest yield and yield attributes, while the lowest values of yield and yield attributes were found in W_1. The reason behind this might be due to the better efficiency of herbicides in reducing the crop weed competition, and ensuring them better growth of plants, whereas W_1 had recorded the lowest yield and yield attributes due to no weed management. The results are in conformity with the findings reported by (Gupta *et al.*, 2020).

Table 1.2. Influence of nutrient and weed management on yield attributes of maize

	Number of grains/ cob	Grain yield (q/ha)	Stover yield (q/ha)	Seed index (g)	Harvest index (%)
Nutrient management					
T1- 100% RDF	470.27	24.81	51.37	34.66	32.55
T2- 75% RDF + 25% VC	567.19	34.45	64.96	39.79	34.71
T3-75% RDF + 25% FYM	540.53	31.81	61.71	36.40	34.03
CD (P=0.05)	2.73	0.31	0.34	0.44	0.26
S.Ed (±)	1.29	0.15	0.16	0.21	0.12
Weed mangament					
W1 - Control	423.62	22.77	46.31	33.13	32.96
W2- Atrazine + Tembotrione	544.86	34.34	64.30	39.68	34.42
W3- Live mulching with cowpea	516.22	29.65	57.31	38.03	33.90
CD (P=0.05)	2.73	0.31	0.34	0.44	0.26
S.Ed (±)	1.29	0.15	0.16	0.21	0.12

Bioenergetics

Amounts of energy equivalencies and energy inputs in maize production as influenced by nutrient and weed management are furnished in Table 1.3 and 1.4 respectively. Energy output, energy efficiency index and energy intensiveness have been presented in Table 1.5.

Energy input

Maximum energy input was incurred under the treatment combinations T_1W_2 (10407.15 MJ/ha) that was followed by T_1W_3 (10325.57 MJ/ha). Variations in the energy input values might be due to the differences in variable energy inputs viz., fertilizer doses, manures, chemical herbicides and their respective energy equivalents as per the treatments. T_2W_1 (7455.64 MJ/ha) had the lowest energy input among all the treatment combinations, which might be due to lowest dosing of the variable inputs. Similar findings were reported by (Saikia *et al.*, 2007), who observed that the variable energy inputs differ due to distinct intercultural operations.

Table 1.3. Energy equivalencies of the inputs used in maize production

S.No	Particulars	Units	Equivalent Energy
1	Maize Seeds	kg	15.1
2	Diesel	lit	56.31
3	DAP	Kg	11.1
4	MOP	kg	6.7
5	Emamectin Benzoate	kg	120
6	Manures	per kg	0.3
7	Harvest Labour	per hr	1.96
8	Atrazine	kg	120
9	Tembotrione	ml	0.102

Table 1.4. Energy inputs in maize as influenced by nutrient and weed management

Treatment combination	Energy Input
T_1W_1	10227.82
T_1W_2	10407.15
T_1W_3	10325.57
T_2W_1	7455.64
T_2W_2	8964.15
T_2W_3	8882.57
T_3W_1	9609.82
T_3W_2	9789.15
T_3W_3	8378.39

Energy output

Maximum energy output was observed in T_2W_2 (153728.53 MJ/ha) that was followed by T_2W_3 (142337.23 MJ/ha) . Higher output of the economic product and by-product in these treatment combinations of might be the reason for high energy output. The findings are in conformity with (Prasanta Neog *et al.*, 2015).

Treatment combination T_1W_1 (82942.63 MJ/ha) had the lowest energy output when compared to the rest of the treatments, this might be due to the lowest economic and by-product obtained.

Table 1.5. Influence of nutrient and weed management on energy output, energy efficiency index and energy intensiveness

Treatment combination	Energy output		Total energy output (MJ/ha)	Energy efficiency index	Energy intensiveness (MJ/Rs)
	Economic Product	By-product			
T_1W_1	30471.80	52470.83	82942.63	8.10	0.27
T_1W_2	42003.17	72125.00	114128.17	10.96	0.20
T_1W_3	39919.37	68050.00	107969.37	10.45	0.21
T_2W_1	37679.53	63445.83	101125.37	13.56	0.16
T_2W_2	62066.03	91662.50	153728.53	17.14	0.12
T_2W_3	56333.07	86004.17	142337.23	16.02	0.13
T_3W_1	34996.77	57762.50	92759.27	9.65	0.22
T_3W_2	51511.13	79812.50	131323.63	13.41	0.15
T_3W_3	47826.73	77341.67	125168.40	14.93	0.14

Energy efficiency index

Energy efficiency index is the rate at which input generates the output, maximum efficiency revealed that T_2W_2 (17.15) had the maximum energy efficiency index that was followed by T_2W_3 (16.02). This may be due to the increase in the grain yield of the respective treatment combinations. The minimum energy efficiency index was observed in T_1W_1 (8.11) which might be due to the higher energy input and lowest grain yield obtained from the respective treatment.

Energy intensiveness

Energy intensiveness is computed as

$$I = \frac{Ei}{Pi \times Yi}$$

Where, Ei = energy input for crop

Pi = price of the crop (Rs. /kg)

Yi = grain yield of crop (kg/ha)

Minimum energy intensiveness was observed in the treatment combination T_2W_2 (0.12 MJ/Rs), followed by T_2W_3 (0.13 MJ/Rs). The reason behind this is due to the lower energy input and higher grain yield obtained in the respective treatment combinations. The maximum energy intensiveness was observed in T_1W_1 (0.27 MJ/Rs) which might be due to the maximum energy input and lowest grain yield obtained.

Conclusion

On the basis of results summarized above, it can be concluded that maximum growth parameters, yield attributes and energetics were observed with the application of 75% N through RDF and 25% N through vermicompost (T_2) among the nutrient management treatments and application Atrazine @1 kg a.i/ha + Tembotrione @110 g a.i/ha (W_2) among weed management treatments. Also treatment combination 75% N through RDF and 25% N through vermicompost along with Atrazine @1 kg a.i/ha + Tembotrione @110 g a.i/ha (T_2W_2) performed best under the studied parameters. However, it must be tested in multiple locations in order to get better knowledge and viability before being suggested to the farmers.

REFERENCES

Amanolahi-Baharvand, Z., Zahedi, H., Sharghi, Y., & Seifolahi-Nik, S. (2014). Comparative assessment of conventional and organic nutrient management on yield and yield components of three corn cultivars. *Int. J. Biosci*, *4*(12), 281-287.

Nanjappa, H. V., Ramachandrappa, B. K., & Mallikarjuna, B. O. (2001). Effect of integrated nutrient management on yield and nutrient balance in maize (*Zea mays*). *Indian Journal of Agronomy*, *46*(4), 698-701**.**

Brar, B. S., Singh, J., Singh, G., & Kaur, G. (2015). Effects of long-term application of inorganic and organic fertilizers on soil organic carbon and physical properties in maize–wheat rotation. *Agronomy, 5*(2), 220-238.

Kannan, R. L., Dhivya, M., Abinaya, D., Krishna, R. L., & Krishnakumar, S. (2013). Effect of integrated nutrient management on soil fertility and productivity in maize. *Bulletin of Environment, Pharmacology and Life Sciences, 2*(8), 61-67.

Kolekar, V. B., Bade, A. N., & Solanke, B. N. (2022). Weed dynamics in kharif sweet corn (*Zea mays* L. var. Saccharata sturt.) under different weed management practices. *The Pharma Innovation Journal*; 11(2): 1011-1013.

Kumar, R., Kumar, R., & Prakash, O. (2019). Chapter-5 the Impact of Chemical Fertilizers on Our Environment and Ecosystem. *Chief Ed, 35*, 69.

Kumawat, N., Yadav, R. K., Bangar, K. S., Tiwari, S. C., Morya, J., & Kumar, R. (2019). Studies on integrated weed management practices in maize-A review. *Agricultural Reviews*, *40*(1).

Neog, P., Sarma, P. K., Saikia, D., Borah, P., Hazarika, G. N., Sarma, M. K., ... & Rao, C. (2020). Management of drought in sali rice under increasing rainfall variability in the North Bank Plains Zone of Assam, North East India. *Climatic Change*, 158(3), 473-484.

Ponmozhi, C. I., Kumar, R., Baba, Y. A., & Rao, G. M. (2019). Effect of Integrated Nutrient Management on Growth and Yield of Maize (Zea mays L.). *Int. J. Curr. Microbiol. App. Sci*, *8*(11), 2675-2681.

Saikia, H., Halim, R. A., Bhowmick, B. C., & Barua, D. (2007). Energy use in sali rice cultivation-An economic analysis in Golaghat district of Assam. Indian Journal of Agricultural Research, 41(1), 39.

Singh, L., Kumar, S., Singh, K., & Singh, D. (2017). Effect of integrated nutrient management on growth and yield attributes of maize under winter season (*Zea mays* L.). *Journal of Pharmacognosy and Phytochemistry*, *6*(5), 1625-1628.

Verma, V. K., Tewari, A. N., & Dhemri, S. (2009). Effect of atrazine on weed management in winter maize-greengram cropping system in central plain zone of Uttar Pradesh. *Indian Journal of Weed Science*, *41* (1&2), 41-45.

Zaremanesh, H.; Naisiri, B. and Amiri, A. (2017). The effect of vermicompost biological fertilizer on crop yield. *J. Mater. Env. Sci.* 8(1): 154-159.