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Effects of combining organic and inorganic nitrogen and planting technique on the growth of maize (*Zea mays*)

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Abstract
The research was performed in triplicate using a split plot design with two lead treatments (i.e. flatbed and raised bed) and five nitrogen treatments from organic and inorganic combined (e.g. 100% Inorganic source, 100% Farm yard manure, 50% Inorganic source + 50% by Farm yard manure, 75% Inorganic source + 25% by Farm yard manure, 100% Inorganic source + 25% by Farm yard manure and analyzed at 25, 50 and 75 days after sowing. Results showed that the application of treatment T_3 (50% IO + 50% FYM) reported the tallest number of plants, number of leaves/plant, number of leaves, weight/plant, dry weight/plant While 50% tasseling was observed on the shortest day, it was observed with T_1 (100% IO) application. Therefore, the combination of organic nitrogen sources with inorganic nitrogen sources in T_3 (50% Inorganic + 50% Farm yard manure) with litter improved the performance of maize. It is recommended to use beds with 50% Inorganic + 50% Farm yard manure for crop growth.

Keywords: Chemical fertilizers, combined management of nutrients, growth criteria, natural and artificial & planting methods

Introduction
Corn (*Zea mays* L.) also reffered as the "queen of cereals" as it has high yielding capacity and widespread use in hot and humid regions of the world. The United States of America is the largest maize producer, followed by China and Brazil, while India is the world's sixth largest maize producer. In terms of consumption, corn ranks third after wheat and rice. Corn has many uses such as starch, silage, gasoline and biofuel, as well as human consumption and animal feed. It also contains vitamins, carbohydrates, fiber and minerals.

With an area of 294.3 million hectares and an output of 644.4 million tons of maize in 2017–18, Himachal Pradesh is in second place on the list of maize-growing states in India, behind Karnataka, Telangana, and Bihar (NCoMM report, 2017) [4]. The Sirmaur region in the Himachal Pradesh's central mountains has special climatic and agro-ecological characteristics that have a direct impact on crop productivity. The soil in this region consists of sand and the response is slightly acidic to neutral. The area also receives a lot of rain during the summer, which, combined with poor drainage, results in a massive loss of plant nutrients that would not be available to crops.

Corn has the potential to increase yields as a C4 crop, but the lack of agronomic technologies and poor technological equipment among farmers in the state are some of the barriers to achieve high yields for this crop. In today's agricultural management system, the cultivation of paddy fields has an advantage over bed cultivation because it is easy to change and replace as-Ham in nutrients for growing crops while allowing for effective rainfall management. Additionally, planting in raised beds shields crops from soil crusts and conserves 25–30% of field applied water for more productive crops. Water in the bed travels horizontally from the furrow to the bed surface through the capillaries, preventing an excessive amount of moisture. Corn planted in raised beds captures more solar radiation from the border effect than the crop shade and has the benefit of crop protection.

Corn is a very nutritious crop (160-200 Kg N ha^{-1}) and requires a lot of inorganic fertilizer to meet the crop's requirement. Farmers do not want to use a combination of nutrients (natural + artificial) to reduce the cost of cultivation by reducing the use of expensive inorganic fertilizers, depending on the cultivation. Natural fertility according to the practice and soil law to use organic and inorganic materials in the village as nutrients will help as nutrient of low cost harvested crop. The process of combining natural and inorganic fertilizers can maintain

production stability for a long time and increase soil fertility through additional benefits (Ponnusamy *et al*., 2017) [5]. Therefore, organic fertilizer (farm manure) and inorganic fertilizers should be used proportionally to improve the hardness and density of the soil in the area. The use of agricultural fertilizers can not only improve the physically visible and chemical properties of the soil, but also follow the development of fragility, which will replace the excess use of chemical fertilizers

Material & Methods

The experiment was conducted at Dr. K.S.G. Akal College of Agriculture, Chhpang Research Farm in Buru Sahib, in summer 2019. The variety used was Shakti 1001, which was lysine and methionine-rich, QPM variety planted in fine clay loamy and slightly acidic (pH 6.34) soil. The research consists of two main applications and five sub-plot applications and was carried out with 3 replications, and the processes are designed according to the split plot design. Processing data includes raised and flat beds of the following combination: - T_1 = 100% N from urea, T_2 = 100% Nitrogen from Farm yard manure, T_3 = 50% Nirogen from Urea + 50% Nitrogen from Farm yard manure, T_4 = 75% Nitrogen from Urea + 25% Nitrogen from Farm yard manure, T_5 = 100% Nitrogen from Urea + 25% Nitrogen from Farm yard manure. Data were collected on five plants selected from each plot at 25, 50 and 75 DAS (day after sowing) and the mean value of each parameter, i.e. plant height, leaf per plant, was recorded at different stages with leaf index, fresh weight, dry weight, % 50 tassel details.

Result & Discussion

The use of combining natural and artificial nitrogen sources has been found to have a fruitful impact on plant growth, specifically the height of maize plants. Among the treatments tested, treatment T_3, which involved applying 50% nitrogen through integrated organic sources and 50% nitrogen through farm yard manure on raised beds, showed significantly superior results in terms of taller height of plant at all three stages of 25, 50, and 75 days after sowing (56.84 cm, 78.88 cm, 104.84 cm). Similar findings have been registered by Kesarwani *et al*., (2017) [3] and Raman and Suganya (2018) [6], where the use of combined different inorganic nutrients with poultry manure or farm yard manure resulted in higher plant height. This can be assumed as positive impact of organic matter on nutrient accumulation and promoting plant growth. However, the treatment T5, which involved 100% nitrogen through integrated organic sources and 25% nitrogen through farm yard manure, resulted in the lowest plant height recorded at 25, 50, and 75 days from sowing (43.24 cm, 64.71 cm, 94.34 cm).

Number of leaves per plant showed positive results for T_3 treatment (50% N of Inorganic + 50% N of Farm yard manure) with raised bed applications at 25, 50 and 75 Days after sowing (11.03, 11.71, 12.84) respectively. The increased number of leaves per plant was a result of combining organic and inorganic fertilizers, which provided the necessary nutrients for plant growth. Similarly, Amanullah *et al*., (2016) [9] found that using different ecofriendly carbon sources (manures and plant residues) along with beneficial microbes led to the maximum number of leaves. Singh *et al*. (2017) [7] also resulted that their research included 8 health coordinating systems, showing T_2 - 100% Recommended dose of fertilizer + vermicompost (5t ha^{-1}) and T_4-75% Recommended dose of fertilizer + vermicompost (5t ha^{-1}) best result of growth.

The highest observed leaf area was found in treatment T_3, where 50% of the nitrogen was applied through recommended dose of fertilizer (RDF) and 50% of the nitrogen was applied through farmyard manure (FYM) on raised beds. This was followed by treatment T_1, where all the nutrient supply was from inorganic sources. The reason for this is that balanced nutrient absorption promotes better plant growth and productivity. Similar results were reported by Kannan *et al*. (2013) [2] in their experiment, where the integration of inorganic fertilizer with FYM resulted in better leaf area. There does not appear to be much difference in the performance between raised beds and flat beds, but raised beds perform comparatively better than flat beds.

Fresh and dry weight was found to be most effective in the T_3 treatment, where 50% of the nitrogen in the bed was from RDF and the other 50% from FYM. This can be attributed to the good growth and slow release of nutrients associated with Farm yard manure, resulting in greater release of nutrients in the plant and consequent loss of both fresh and dry weight. Verma *et al*. (2018) [8] also found that the combination of RDF and FYM increased fresh and dry viability in T_4 application, where 25% of the nitrogen comes from FYM and 75% from fertilizers.

According to the results of the study, it was found that the application of inorganic fertilizers (100% Nitrogen via. Inorganic) alone in the T_1 application or the application of organic fertilizers (100% Nitrogen via. Farm yard manure) in the T_2 application gave fast results. Tassel Process and INM process. Pilar *et al*. (2017) [10] found in their study that the use of 100% inorganic fertilizers caused the shortest time (50 days) for male and male development, while the increase in nitrogen content caused sunset in men and women.

Thus, the study concluded that the treatment T_3, which consisted of 50% Nitrogen via. Inorganic and 50% Nitrogen via. Farm yard manure, yielded significantly superior results in terms of maize growth attributes when combined with the raised bed treatment. Additionally, the use of INM improved soil structure and created a more favourable environment for plant growth compared to using solely inorganic or organic treatments. Implementing a balanced INM approach resulted in increased nutrient uptake, while the raised bed planting technique effectively managed resources. Therefore, the integration of the raised bed treatment and T_3 (50% Nitrogen via. Inorganic + 50% Nitrogen via. Farm yard manure) was reported to be the most effective amidst the other applied combinations for achieving optimal growth.

Table 1: The effect of combination of nitrogen on height of plant and corn leaf number

T. No.	Treatment	Plant Height (cm)			No. of leaves/plant			Leaf Area (cm^2)		
		25 DAS	50 DAS	75 DAS	25 DAS	50 DAS	75 DAS	25 DAS	50 DAS	75 DAS
	Main Plot Treatment									
P_1	Flat Bed	51.54	65.21	95	6.50	7.92	9.79	84.6	429.7	466.8
P_2	Raised Bed	51.52	77.10	103.28	11.02	12.25	13.29	86.2	432.5	475.3
Sem±		0.53	1.13	0.35	0.08	0.18	0.15	1.26	3.02	3.24
CD (0.05)		2.15	4.7	1.29	0.34	0.77	0.64	2.12	6.02	6.75
	Sub Plot Treatment									
T_1	100% IO	57	76.66	101.84	7.36	8.41	12.54	83.0	475.7	646.4
T_2	100% FYM	51	70.40	98	6.87	8.92	10.38	56.5	383.0	457.4
T_3	50% IO + 50% FYM	56.84	78.88	104.84	11.03	12.84	11.71	80.7	494.3	656.7
T_4	75% IO + 25% FYM	49.57	66.18	96.66	6.21	7.31	8.93	51.6	454.0	463.3
T_5	100% IO + 25% FYM	43.24	64.71	94.34	7.36	7.96	7.16	80.7	494.3	656.7
Sem±		1.44	0.98	0.56	0.34	0.45	0.38	1.22	3.17	7.70
CD (0.05)		2.94	1.89	1.05	0.71	0.94	0.79	2.72	7.07	17.17

Table 2: Effect of combination of nitrogen on Dry weight, Days of 50% tasseling of maize and Fresh weight.

T. No.	Treatment	Fresh Weight (gm)			Dry Weight (gm)			Days of 50% tassel
		25 DAS	50 DAS	75 DAS	25 DAS	50 DAS	75 DAS	
	Main Plot Treatment							
P_1	Flat Bed	15.75	92.25	146.25	2.12	16	28.42	61.01
P_2	Raised Bed	18.67	104.13	160.41	4.53	23.08	34.54	59.62
Sem±		2.13	4.1	4.05	1.28	4.33	3.44	1.34
CD (0.05)		3.74	5.73	11.8	2.25	NS	NS	NS
	Sub Plot Treatment							
T_1	100% IO	21.13	93.18	165.10	4.24	24.16	23.68	60.05
T_2	100% FYM	15.21	94	155.34	2.52	13.18	34.66	58.34
T_3	50% IO + 50% FYM	22.05	113.66	168.32	7.55	25.68	42.51	61.87
T_4	75% IO + 25% FYM	13.64	97.51	147.51	2.79	18.84	25.34	63.05
T_5	100% IO + 25% FYM	15.04	87.12	134.50	3.50	12.82	31.16	62.32
Sem±		3.71	5.4	5.7	1.41	4.64	7.14	1.62
CD (0.05)		6.7	8.3	12.7	1.86	NS	NS	2.28

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