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EFFECT OF NUTRIENT MANAGEMENT ON GERMINATION AND PLANT HEIGHT OF MAIZE (VAR. SHIATS MAKKA 2) UNDER POPLAR BASED AGROFORESTRY SYSTEM

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Abstract

Lower maize productivity was primarily caused by declining soil fertility, which was addressed by the use of commercial fertilisers. The rising costs of inorganic fertilisers, on the other hand, may discourage smallholder farmers. As a result, while looking for a way to cut production costs while enhancing productivity, integrated nutrition management has been advocated. Several studies have been conducted to maximise the combined use of organic and inorganic fertilisers in various areas. The current study took place in the Nursery of the College of Forestry, SHUATS, Prayagraj, from July 2019 to October 2020. The study used a Randomized Block Design (RBD) with twelve treatments that were reproduced three times. The treatments were T1 (control), T2 (100% RDF), T3 (75% RDF), T4 (50% RDF), T5 (75%RDF+ FYM 25%), T6 (50%RDF+ FYM 50%), T7 (75%RDF+ Mustard Oil Cake 25%), T8 (50%RDF+ Mustard Oil Cake 50%), T9 (75% RDF+ Vermicompost 25%), T10 (50% RDF+ Vermicompost 50 %), T11 (75% RDF+ Poultry manure 25 %) and T12 (50% RDF+ Poultry Manure 25 %). From the present experiment it is found that treatment Combination T9 (75% RDF+ Vermicompost 25%) was found to be the best treatment in terms of germination and plant height as compared to others and minimum was recorded in treatment T1 (control) under Maize-poplar agroforestry system.

Keywords: Agroforestry, Germination, INM, Plant height, Poplar

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Introduction

Maize (*Zea mays* L.) is a member of the Gramineae family. It originated in America and was initially farmed more than 7,000 years ago in the Mexican region (Hilaire, 2000). Maize is the third most important cereal crop in the world, behind wheat and rice (Zamir et al., 2013). Due to its photo-thermo-insensitive characteristics, it is widely grown all year in tropical, subtropical, and temperate climates around the world (Kumar Verma, 2013). It is a main food crop in many developing countries (Kandil, 2013). Maize is grown on around 118 million hectares around the world, yielding around 6 million metric tonnes each year. The United States topped the list of ten maize-producing countries in 2014, with 351 million metric tonnes produced, and followed by China, Brazil, the EU-27, Ukraine, Argentina, India, Mexico, South Africa, and Canada (Mitiku & Asnakech, 2016). Maize (*Zea mays* L.) is an important cereal crop in India, ranking third in terms of production after rice and wheat. The United States leads in terms of output, followed by China. Maize production and productivity in India are 9.43 million hectares, 24.35 million tonnes, and 2557 kg per hectare (Anonymous, 2015).

Agro-forestry systems based on poplar (*Populus deltoides*) will play an important role in meeting people's economic, social, and environmental concerns if they are widely embraced by farmers on a commercial basis. Poplar can be used to cultivate a variety of agricultural products (wheat, mustard, turmeric, ginger, colocasia, cabbage, potato, spinach, garlic, and so on), as well as fruit crops (citrus, guava, mango, and so on) (Sharma, 1996). Poplar intercropping is an exceptionally worthwhile and productive venture since there is a prepared market for its goods because of the area's set up handling enterprises (around 1,200 units of all class in Punjab, Haryana, Delhi, Uttarakhand, Uttar Pradesh, and so forth) (GIEWS, 2016) The normal yearly production is 26.14 million tons, with a usefulness of 2.43 t ha^{-1}. Maize is burned-through as human food (23%), poultry feed (51%), creature feed (12%), modern (starch) goods (12%), beverages, and seed in India (1% each). Cultivation of cereal crops like maize under poplar trees could be a sustainable solution for enhancing soil fertility, increasing cereal crop and poplar tree productivity, and giving economic security to farmers that adopt the system. However, successful cereal crop development in an agri-silviculture system necessitates knowledge of species compatibility, component arrangement, and nutrient management strategies. Maize is a highly exhausting crop due to its rapid growth tendencies, and it is critical that vital nutrient components are given in appropriate proportions to preserve soil fertility and to get higher yield.

In this perspective, the best choice for maintaining soil fertility while boosting crop output in maize and other cereal-based cropping systems is to adopt integrated nutrient management. Crop yields are improved as a result of this. The options that are available animal excreta and crop wastes are insufficient to meet the country's crop production needs. As a result, the optimum option appears to be optimising the use of organic waste and combining it with chemical fertilisers in the form of integrated manure. Concurrent application of organic and inorganic nutrients to the field boosts yield and production while also helping to maintain soil fertility (Hedge, 1998). Organic manure and bio-fertilizers, as well as chemical fertilisers, are required for improved production and soil health. The use of inorganic fertilisers in conjunction with organic manures will not only help to maintain crop yield, but will also improve soil quality and increase nutrient output (Katyal et al., 2002). The INM approach focuses on preserving plant nutrition supplies in order to maintain a particular level of crop production by combining the profits of all available plant nutrition sources, as appropriate for each crop trend and farming circumstance (Kaushik et al., 2012). Incorporating organic manure into the soil regulates nutrient absorption, promotes development, improves soil quality (physical, chemical, and biological), and has synergistic effects on crops (Singh et al., 2007). Any crop's ability to absorb nutrients is mostly determined by the amount of biomass produced by the plant. The accumulation of various nutrients inside the plant system, on the other hand, frequently determines their overall intake. (Bajpai et al., 2006).

The crop's low yield can be ascribed to various issues. Low maize yields are for the most part brought about by inadequate crop nutrition management and deficient soil fertility (Shah et al., 2009). The fundamental idea hidden integrated nutrient management (INM) in crop production is the reconciliation of old and new supplement the board strategies into an environmentally strong and financially ideal cultivating framework that exploits all accessible natural, inorganic, and organic segments in a prudent, proficient, and incorporated way (Janssen, 1993). Its goal likely improves the physical, compound, and natural characteristics of the dirt to build farm productivity and lessen land degradation (Esilaba et al., 2004). As per Gundlur et al., (2015), consolidating inorganic composts with different wellsprings of natural fertilizers in different amounts significantly affects crop yield, improve supplement take-up by plants and keep up soil supplement status in maize based cropping frameworks.

Material and methods

The Experimental research was led at Forest Nursery, College of Forestry, Sam Higgin bottom University of Agriculture, Technology and Sciences, Prayagraj, India. Prayagraj is arranged at 25.26° N longitude and elevation, 81.54° E longitude and height, and 98 m over the mean sea level. It is situated in the south-eastern piece of Uttar Pradesh and has tropical to subtropical environment with limits of summer and winter. During kharif, the experiment will be set up in RBD with 12 treatments and 3 replications on levelled land. Maize var. SHIATS Makka 2 (MS-2) will be planted under poplar plantation during the kharif season. Manual hoeing was used to keep the field weed-free. Plant protection measures and irrigations were applied in the same way for all of the treatments. Under the poplar agroforestry system, plant height was assessed at 30 days, 60 days, and at harvest stage after sowing, while germination was measured at 7 and 10 days after sowing.

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Results and discussion: Germination %

The data on germination% after 7 and 10days are depicted in Table 1.The observation of germination was taken after 7 days and 10 days of sowing. Prior to sowing all the integrated nutrient treatments were applied along all the replications. The germination % of maize was recorded after 7 and 10 days of sowing (DAS). Maximum germination was seen in T9 (75% RDN + 25% N by vermicompost) followed by T11 in 2019 and T6 in 2020 followed by T12 after 7 DAS, whereas in pooled data analysis, T9 and T11 gained maximum. Similarly, after 10 DAS, maximum germination was noted in T1and T7 followed by T9 in 2019 and T11 followed by (T3=T4=T5) in 2020, whereas in pooled data analysis T4 got highest germination followed by T5, T7, T9 and T11 after 10 DAS.

Early sprouting could be owing to the use of fertilisers combined with organic manures, which supplied plants with a more balanced diet and allowed seeds to absorb more organic and inorganic nutrients, enhancing the physiological process and improving germination, this encourages sprouting by increased cell division and expansion, resulting in optimal germination. The findings are consistent with those of Kumar et al. (2014), Chaudhari et al. (2014), and Sharma et al. (2008).

Table 1: Effect of INM on Germination (%) of maize crop in maize-poplar based agroforestry system

Treatments	Germination %					
	7 DAS			10 DAS		
	2019	2020	Pooled	2019	2020	Pooled
T_1 Control (No fertilizer and organic manure)	87.00	93.00	90.00	96.00	96.00	96.00
T_2 100% Recommended dose of nitrogen (RDF)	90.00	92.00	91.00	92.00	95.00	93.50
T_3 (75%) RDF	88.00	95.00	91.50	93.00	97.00	95.00
T_4 (50%) RDF	88.00	94.00	91.00	95.00	97.00	96.00
T_5 (75%) RDF + (25%) RDF FYM	91.00	95.00	93.00	94.00	97.00	95.50
T_6 (50%) RDF + (50%) RDF FYM	88.00	98.00	93.00	94.00	95.00	94.50
T_7 (75%) RDF + (25%) RDF Mustard Oilcake	92.00	95.00	93.50	96.00	95.00	95.50
T_8 (50%) RDF + (50%) RDF Mustard Oilcake	89.00	95.00	92.00	94.00	95.00	94.50
T_9 (75%) RDF + (25%) RDF Vermicompost	95.00	94.00	94.50	95.00	96.00	95.50
T_{10} (50%) RDF + (50%) RDF Vermicompost	90.00	93.00	91.50	92.00	96.00	94.00
T_{11} (75%) RDF + (25%) RDF Poultry Manure	93.00	95.00	94.00	93.00	98.00	95.50
T_{12} (50%) RDF + (50%) RDF Poultry Manure	89.00	97.00	93.00	94.00	95.00	94.50
SEm (±)	**1.91**	**1.65**	**1.29**	**1.01**	**1.50**	**0.86**
CD @ 5%	**5.59**	**4.83**	**3.78**	**2.95**	**4.40**	**2.52**

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3.2 Plant height

Plant height is an important biometric indicator of a crop's growth and development. Table 2 shows that fertiliser management had a significant impact on maize crop plant height in both years. Plant height was found to be significantly higher with 75 percent RDF + 25 percent N by vermicompost (T9) as compared to all other treatments at the initial stages of crop growth at 30 DAS during both years of experimentation and in pooled data at 39.33 cm and 41.2 cm with 75 percent RDF + 25 percent N by vermicompost (T9) as compared to all other treatments at the initial stages of crop growth at 30 DAS during both years of experimentation and in pooled data. But in subsequent stages of growth, the data presented in Table 2 depicted that the plant significantly influenced by the nutrient management treatments in 2019 and 2020 and in pooled data *i.e.* it was highest in T9 (167.00 cm and 174.63 cm) followed by T11 (165.13 cm and 166.83 cm) and lowest in T1 (153.27 cm and 120.60 cm) with control after 60 DAS. It was observed that plant height exhibited significantly superiority (207.2 cm and 220.40) with 75% RDF + 25% N by vermicompost (T9) over other treatments at harvest. On the other hand, plant height was registered to be the lowest (185.23 cm and 173.03 cm) with control at harvest where neither manure nor chemical nitrogen was applied.

The considerable effect of fertiliser treatments and year on maize crop plant height was also observed in the pooled data. Maximum plant height (213.80 cm) was recorded in T9, which was statistically equivalent to T11, while minimal plant height (179.13 cm) was observed in T1. There was a considerable change in maize crop plant height between years. Light is one of the most essential variables impacting corn (*Zea mays* L.) production because it is a C4 plant.

During the growing season, however, maize frequently encountered low light intensities that restrict growth capacity under poplar based agroforestry system, therefore limiting the plant height. Chao-hai et al. (2005) also reported that plants of maize were taller in the area where full light was available as compared to places with shade. Consequently, the limitation of maize can be attributed to the tree's (dense crown) shadowing effect on the crops. Sinclair and Muchow (1999), Liu et al. (2012), and Ekhuya et al. (2013) all observed reduced maize plant growth owing to intercepted photo synthetically active radiation (IPAR) (2015). Ponmozhi et al. (2019) also reported that application of Inorganic fertilizer and organic manure would affect he height of the plant gradually. He suggested the effect of Vermicompost, FYM and chemical fertilizer in combination was more pronounced with the advancement of crop growth indicating better effect on plant height of maize.

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Table 2. Effect of INM on plant height (cm) of maize crop in maize-poplar based agroforestry system

Treatments	Plant Height (cm)								
	30 DAS			60 DAS			At harvest		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
T_1 Control (No fertilizer and organic manure)	25.97	28.70	27.33	153.27	120.60	136.93	185.23	173.03	179.13
T_2 100% Recommended dose of nitrogen (RDF)	31.50	37.30	34.40	159.73	158.03	158.88	200.23	215.73	207.98
T_3 (75%) RDFs	28.67	32.70	30.68	156.50	151.83	154.17	194.83	206.53	200.68
T_4 (50%) RDF	27.83	29.30	28.57	154.40	147.50	150.95	188.67	203.17	195.92
T_5 (75%) RDF + (25%) RDF FYM	33.77	38.00	35.88	161.67	159.27	160.47	201.13	215.80	208.47
T_6 (50%) RDF + (50%) RDF FYM	28.43	30.80	29.62	154.63	148.77	151.70	189.70	205.77	197.73
T_7 (75%) RDF + (25%) RDF Mustard Oilcake	34.73	38.80	36.77	163.43	166.60	165.02	202.07	216.03	209.05
T_8 (50%) RDF + (50%) RDF Mustard Oilcake	28.93	33.60	31.27	157.07	153.47	155.27	195.43	209.37	202.40
T_9 (75%) RDF + (25%) RDF Vermicompost	39.33	41.20	40.27	167.00	174.63	170.82	207.20	220.40	213.80
T_{10} (50%) RDF + (50%) RDF Vermicompost	30.43	36.70	33.57	157.90	155.97	156.93	197.77	212.50	205.13
T_{11} (75%) RDF + (25%) RDF Poultry Manure	35.17	39.00	37.08	165.13	166.83	165.98	204.07	216.80	210.43
T_{12} (50%) RDF + (50%) RDF Poultry Manure	29.03	36.60	32.82	157.50	155.30	156.40	197.00	210.37	203.68
SEm (±)	**1.98**	**1.92**	**1.52**	**2.96**	**6.66**	**3.40**	**3.77**	**7.50**	**4.08**
CD @ 5%	**5.81**	**5.63**	**4.45**	**8.68**	**19.54**	**9.98**	**11.06**	**21.99**	**11.97**

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On the other hand, among fertilizer treatments, plant height was reported maximum where, integration of organic manures was done with inorganic fertilizers (T9). This could be attributed to fertiliser sources that met nutritional requirements at early growth phases, while manures aided crop development at later stages by providing a constant and consistent intake of nutrients. Has him et al. (2015) also found that applying 50 percent of the required fertiliser dose (RDF) with chemical fertilisers and 50 percent of the recommended nitrogen dose (RDN) through crop residue mixed farmyard manure resulted in maize with the best growth characteristics. Kumar et al. (2014), Thakur and Verma (2014), and Sharma and Dhadwal (2014) all found similar results. Furthermore, due to favourable meteorological circumstances and reduced biotic interference during the second year of the experiment, maize crop growth parameters were better than the first year.

The use of organic and inorganic fertilisers has a substantial impact on the average height of maize plants. The highest plant height (232 cm) was obtained from a 10 t ha^{-1} application of composted domestic waste and stale cow dung with 70 kg N and 13 kg P2O5 ha1, while the lowest plant heights (225 and 226 cm, respectively) were obtained from an unfertilized plot and sole composted domestic waste and stale cow dung at 5 t ha^{-1} (Makinde & Ayoola, 2010). Ravi et al. (2012) observed a substantially higher (187.8 cm) plant height with an application of FYM at 10 t ha^{-1} with 100 percent RDF (150 N + 75 P2O5 + 37.5 K2O kg ha^{-1}) than the above findings. Even many applications of decomposed and dried FYM had a substantial impact on plant height.

Quality Parameters

The results of the statistical analysis demonstrated that the combination of different organic manures and inorganic fertilisers had a substantial impact on maize height growth. Treatment T9 [RDF (75%) + Vermicompost (25%)] had the highest overall plant height, followed by T11 [RDF (75%) + Poultry manure (25%)], as shown in (Table 2). Ponmozhi et al. (2019) and Garima and Pant (2018) observed similar findings in maize.

Conclusion

The application of 75 %t RDF + 25 % vermicompost in maize under promptly seeded conditions offered the highest outcomes in terms of plant height, as shown by the findings given above. T11 (75 % RDF with 25 % poultry manure) is the second best treatment, whereas T1 (control) treatment is the poorest where no fertilizer and manure was applied.

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