Effect of Humic Plus and Green Magic on Growth and Yield of Rice

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ABSTRACT

Background: Rice is a crucial food source for almost half of the world's population and is one of the most significant food crops worldwide. Humic acids, which are naturally occurring compounds formed from decomposed organic matter, can enhance rice growth, yield and nutrient absorption when applied.

Methods: A field experiment conducted from July to September 2022 in Kadavacheri village, Chidambaram, Cuddalore district, examined the impact of foliar applications of Humic Plus and soil applications of Green Magic on the growth of the rice variety ASD16. The soil was a clay loam (*Typic Haplusterts*) with a pH of 7.50, electrical conductivity of 0.40 dSm^{-1} and medium organic carbon content (6.02 g kg^{-1}). Nutrient analysis indicated low N availability (238.3 kg ha^{-1}), medium P (12.40 kg ha^{-1}) and high K levels (302.5 kg ha^{-1}). Treatments included NPK fertilizer application alongside varying combinations of foliar sprays of Humic Plus at rates of 5, 7.5 and 10 ml ha^{-1} and soil application of Green Magic at 15 kg ha^{-1}. The trial, which included an absolute control and the 100% recommended dose of fertilizer (150:50:50 kg ha^{-1}), was arranged in a randomized block design and replicated three times.

Result: The best treatment was much pronounced with foliar application of Humic plus @ 10 ml ha^{-1} at 30 DAT and soil application of Greenmagic@15 kg/ha was recorded plant height (107.7 cm), productive tillers/hill (19.09), no. of panicle m^{-2} (335.4), no. of grains/ panicle (138.5), panicle length (26.6 cm), grain and straw yield (7276 and 8648kg ha^{-1}).

Key words: Grain yield, Green magic, Humic plus, Rice, Straw yield.

INTRODUCTION

Rice (*Oryza sativa* L.) is a crucial global crop that feeds nearly half of the world's population with essential nutrients. In India, it is grown on 43.90 million hectares, producing 114.45 million tonnes with a productivity of 2,607 kg ha^{-1}. In Tamil Nadu, rice is cultivated on 1.905 million hectares, yielding 7.58 lakh metric tonnes and boasting a higher productivity of 4,220 kg ha^{-1}.

Humic acid, formed from organic decomposition and microbial activity, significantly influences plant growth by improving soil properties based on its source, concentration and molecular weight (Anonymous, 2010). It enhances root development and overall plant health. Studies show that both soil applications of humic and fulvic acids stimulate root growth, while foliar applications of humic acid boost plant growth and nutrient absorption Pettit (2004) and Helaly (2021).

Fulvic acid (FA) is a complex mixture of soluble organic acids found in humic substances, effective across all pH levels. Its chelating properties enhance the absorption of micro and macronutrients through plant cell membranes, supporting protein synthesis and enzyme activity, as noted by Mahmoud *et al*. (2019). Applying FA as a foliar spray at different stages of plant growth can strategically maximize plant productivity and health.

Green magic represents the forefront of natural soil nutrients, embodying an optimal blend of macro and micronutrients indispensable for promoting robust root growth, fostering plant development and ultimately maximizing yield potential.

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Gibberellic acid (GA) is an important plant hormone that facilitates cell elongation, playing a vital role in promoting plant growth. Its application is particularly crucial for cultivating hybrid rice seeds with high seed yields, as highlighted by Gavino *et al*. (2008). The use of growth regulators, such as GA, represents an innovative approach to enhancing the productivity of crop plants. These chemical substances are instrumental in regulating various growth processes within plants, ultimately contributing to improved agricultural output (Atteya *et al*., 2018).

Humic plus is a product that contains 12% humic acid. This water-soluble liquid formulation is derived from the humus resulting from the bio-degradation of plants and animals in the soil. Functioning as a plant stimulant, humic plus is versatile, suitable for both soil application and foliar use. When employed alongside nutrients, it serves as a

chelating agent, enhancing the activity of micronutrients. Furthermore, humic plus plays a role in activating auxins, amino acids and organic phosphorous, facilitating their easy uptake by plant roots.

The study focused on evaluating the effects of two commercial products, Humic Plus and Green Magic, on rice growth and yield. The main objectives were to assess the impact of foliar spraying with Humic Plus and soil application of Green Magic on the development and productivity of rice plants.

MATERIALS AND METHODS

The field experiment was conducted on a farmer's Holding in Kadavacheri Village, Chidambaram taluk, during the *kharif* season, spanning 110 to 115 days (June 2022 to September 2022). The study focused on the rice variety ASD 16 and aimed to examine the effects of Humic Plus and Green Magic on rice growth and yield in clay loam soil. Utilizing a RBD with three replications, the study ensured robust statistical analysis. Geographically, the site is located at 11°36′55.61″N latitude and 79°69′654″E longitude. The soil, classified as Typic Haplusterts, had a pH of 7.50 and an EC of 0.40 dS/m, indicating a medium status of organic carbon at 6.02 g/kg. Nutrient analysis revealed low available N (238.3 kg/ha), medium P (12.40 kg/ha) and high K levels (302.5 kg/ha). Comprehensive details regarding the soil characteristics at the experimental site are provided in Table 1 to 3.

Treatment details

The experiment featured a total of nine treatments, designed to evaluate the effects of different combinations of fertilizers and additives on rice growth and yield. The treatments were as follows:

T1 - Absolute control.
T2 - RDF at 150:50:50 kg/ha.
T3 - RDF + Humic Plus Foliar Spray at 5 ml/ha.
T4 - RDF + Humic Plus Foliar Spray at 7.5 ml/ha.
T5 - RDF + Humic Plus Foliar Spray at 10 ml/ha.
T6 - RDF + Soil Application of Green Magic at 15 kg/ha.
T7 - RDF + Humic Plus Foliar Spray at 5 ml/ha + Soil Application of Green Magic at 15 kg/ha.
T8 - RDF + Humic Plus Foliar Spray at 7.5 ml/ha + Soil Application of Green Magic at 15 kg/ha.
T9 - RDF + Humic Plus Foliar Spray at 10 ml/ha + Soil Application of Green Magic at 15 kg/ha.

The study used a RBD with three replications to improve the reliability of results on the effects of Humic Plus and Green Magic on rice growth and yield, allowing for more accurate statistical analysis of variations.

Several parameters related to plant growth were measured, including:

- Plant height
- Number of tillers/hill

Parameters were recorded at harvest, while others were assessed during the tillering and panicle initiation stages.

- Leaf area index
- Chlorophyll content

Yield parameters such as the following were recorded at the harvest stage:

- No. of panicles per square meter
- No. of grains per panicle
- Panicle length
- 1000 grain weight
- Grain and straw yield

Both humic plus and Green Magic were sourced from ASL, located in Vadalur, Cuddalore district, Tamil Nadu. This comprehensive approach allowed for a detailed analysis of the impact of these treatments on rice cultivation.

RESULTS AND DISCUSSION

Growth yield and yield attributes

Theres ultsgenerally showed that effect of humic plus and green magicofrice significantly increased growth andyield parameters over control.

Plant height (cm)

Table 4 and Fig 1 show that applying foliar spray with Humic Plus and soil application of Green Magic significantly

Table 1: Physico-chemical properties of the field experimental soil.

Parameters	Value
I. Physical properties	
Sand (%)	33.27
Silt (%)	25.20
Clay (%)	41.01
Textural class	Clay loam
Taxonomical class	*Typic haplusterts*
Soil series	Kondal series
II. Chemical properties	
pH (1:2.5 soil:water)	7.50
EC (1.:2.5 soil:water) dSm^{-1}	0.40
Soil organic carbon (g kg^{-1})	6.02
CEC [cmol(p+) kg^{-1}]	30.5
$KMnO_4$ (kg ha^{-1})	238.32
Olsen P (kg ha^{-1})	12.40
Available K (kg ha^{-1})	302.51

Table 2: Composition of humic plus.

Nutrient	Content
Humic acid	15%
Fulvic acid	6%
Gibberellic acid	500 ppm

Table 3: Composition of green magic.

Nutrient	Content (%)
Nitrogen	1.2
Phosphorus	0.84
Potassium	38
Humic acid	7
Fulvic acid	2.1
Organic carbon	4.54

increased plant height. Among the treatments, T9, which consisted of RDF combined with Humic Plus foliar spray at 10 ml ha^{-1} applied at 30 days after transplanting (DAT) and soil application of Green Magic at 15 kg ha^{-1}, recorded the highest plant height of 107.72 cm at the harvest stage. Plant height is a crucial morphological trait that reflects a crop's vigor and potential for higher yields. Taller plants are generally associated with a greater capacity for photosynthesis and nutrient uptake, leading to improved yields. The increase in vegetative growth observed in rice is attributed to the soil application of the organic fertilizer Green Magic, which contains humic and fulvic acids, as well as the foliar application of Humic Plus, which comprises humic, fulvic and gibberellic acids. This aligns with findings by El-Bassiony *et al*. (2010), which also reported improvements in plant height due to similar treatments.

Gabr *et al*. (2022) emphasized the positive impact of fulvic acid in Humic Plus on plant height. Additionally, foliar spraying of Humic Plus, which includes Gibberellic acid at a concentration of 500 ppm, has been shown to promote various growth characteristics, supporting the results reported by Gunalarasi *et al*. (2022). Overall, these findings underscore the positive impact of these nutrient management strategies on the growth of rice.

Number of tillers $hill^{-1}$

Tiller production in rice was significantly superior by the application of foliar spray with Humic Plus and the soil application of Green Magic, as detailed in Table 4 and Fig 1. Among the tested treatments, T_9 comprising RDF (recommended dosage of fertilizers) along with a foliar spray of Humic Plus at 10 ml ha^{-1} applied at 30 days after transplanting (DAT) and soil application of Green Magic at 15 kg ha^{-1} -achieved the highest recorded tiller production, with an average of 19.09 productive tillers per hill at the harvest stage.

Tillering is a complex characteristic influenced by various factors, including the genotype of the rice variety, environmental conditions, management practices and their interactions. As a significant determinant of grain production, tiller formation is crucial for overall plant growth. The study found that the use of Humic Plus as a foliar spray contributed to the highest number of tillers per hill, supporting previous research by Kazemi (2014) that reported similar outcomes.

The raise in tiller manufacture can be largely ascribed to the 6% fulvic acid content in Humic Plus, which may have enhanced nutrient uptake, thus promoting greater tiller formation compared to other treatments. This reasoning is consistent with findings by Ahmad *et al*. (2018), who noted improved tillering as a result of enhanced nutrient availability. Furthermore, the significant presence of gibberellic acid in Humic Plus was likely beneficial for plant development, contributing to the observed improvements in tiller production, as noted by Soomro *et al*. (2020). Overall, these findings highlight the importance of employing specific nutrient management strategies to optimize tiller production and improve the yield potential of rice crops.

Leaf area index

The application of Humic Plus foliar spray and soil application of Green Magic significantly improved the leaf area index (LAI) in rice, as indicated in Table 4. The highest LAI values observed were 3.76 at the tillering stage and 4.65 at panicle instigation in treatment T9, which included RDF combined with Humic Plus foliar spray at 10 ml ha^{-1} applied at 30 DAT and Green Magic at 15 kg ha^{-1}.

The leaf area index is a critical ecological parameter that reflects leaf foliage volume, photosynthetic surface area and the effects of management practices on crop growth, as highlighted by Sang-Il *et al*. (2013). Maximizing leaf area is essential for high productivity, as noted by Singh and Agarwal (2001). The increase in leaf area and LAI can be attributed to higher chlorophyll content both from the organic fertilizers in Green Magic and the humic and fulvic acids it contains, as indicated by Chatterjee and Choudhuri (2012). Furthermore, the presence of gibberellic acid (GA3) in

Table 4: Effect of humic plus and green magic on plant height (cm) and productive tillers $hill^{-1}$ LAI and chlorophyll content of rice.

Treatments	Plant height (cm)	Productive tillers $hill^{-1}$	Leaf area index		Chlorophyll content (SPAD reading)	
	Harvest stage	Harvest stage	Tillering stage	Panicleinitiation stage	Tillering stage	Panicleinitiation stage
T_1	74.33	8.14	2.29	2.89	32.83	33.29
T_2	85.54	12.85	2.74	3.42	34.77	35.90
T_3	88.70	13.87	2.89	3.60	35.83	37.15
T_4	91.88	14.85	3.03	3.72	36.89	38.41
T_5	95.05	15.64	3.18	3.91	37.96	39.99
T_6	98.21	16.56	3.34	4.10	39.02	40.92
T_7	101.39	17.39	3.49	4.28	40.10	42.19
T_8	104.56	18.28	3.63	4.46	41.17	43.47
T_9	107.72	19.09	3.76	4.65	42.25	44.74
S.Ed.	1.47	0.28	0.05	0.07	0.52	0.67
CD (p=0.05)	3.15	0.59	0.12	0.16	1.05	1.25

Humic Plus is acknowledged for enhancing leaf area and LAI in various crops, including rice, as demonstrated in studies by Khan *et al*. (2006) and Liu *et al*. (2012). Overall, these findings emphasize the role of specific nutrient management and growth regulators in promoting vegetative growth in rice.

Chlorophyll content (SPAD Value)

The addition of foliar spray of Humic plus and soil application of Green magic caused significant increases in chlorophyll content (Table 4). Among the treatments (T_9) - application of RDF+ Humic plus foliar spray @ 10 ml ha^{-1} at 30 DAT +Soil application of Green magic @15 kg ha^{-1} was registered maximum chlorophyll content (42.25 and 44.74) attillerin gand panicle initiation. Chlorophyll coloration is linked to nutrient uptake in plants. Seadh *et al*. (2017) found that foliar application of humic acid in Humic Plus significantly enhances chlorophyll content. Additionally, Suh *et al*. (2014) reported that Humic Plus, containing humic and fulvic acids along with Gibberellic acid, also improves chlorophyll levels in plants.

Number of panicle m^{-2}

The application of Humic Plus foliar spray and soil application of Green Magic significantly increased the number of panicles per square meter, as shown in Table 5. Notably, the treatment T_9 comprising RDF along with a Humic Plus foliar spray at 10 ml/ha applied at 30 DAT and Green Magic

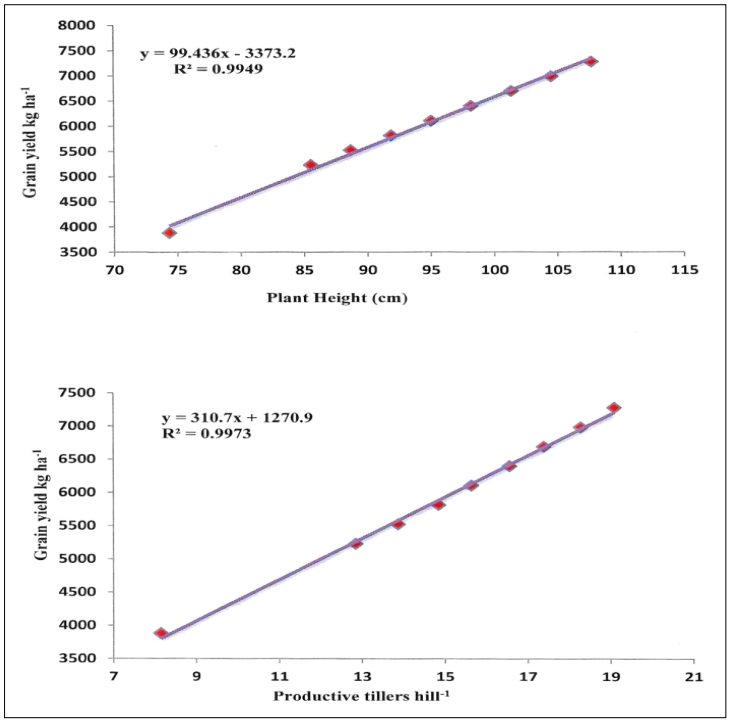


Fig 1: Linear regression relationship between grain yield with plant height, productive tillers of rice.

Table 5: Effect of humic plus and green magic on yield and yield attributes of rice.

Treatments	Number of panicles m^2	Number of grains $panicle^{-1}$	Panicle length (cm)	1000 grain weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T_1	189.5	71.5	16.3	18.88	3880	4887
T_2	221.3	90.8	18.5	20.19	5230	6200
T_3	235.4	96.2	19.0	20.39	5524	6550
T_4	252.5	103.1	20.0	20.67	5814	6896
T_5	269.2	110.2	21.2	2.76	6106	7246
T_6	285.6	117.2	22.1	21.07	6398	7595
T_7	302.1	124.7	23.4	21.24	6691	7946
T_8	319.2	131.2	25.1	22.00	6982	8299
T_9	335.4	138.5	26.6	22.11	7276	8648
S.Ed.	5.7	2.3	0.4	0.2	118	136
CD (p=0.05)	11.8	4.9	0.9	NS	237	274

at 15 kg/ha recorded the highest number of panicles at 335.4 per square meter.

The analysis of the components provides insight into the physiological basis of the crop and the source-sink relationships influenced by various nutrient treatments. The substantial increase in the number of panicles can be attributed to the application of Green Magic, which contains humic acids. These acids may help mitigate panicle abortion by improving the availability of metabolites at critical growth stages, thereby reducing competition for these resources among panicles. Al-Ubori *et al*. (2023) provide additional support for this observation.

The increase in panicles is attributed to the fulvic acid in the Humic Plus spray, known to enhance plant growth (El-Said *et al*., 2022). Productive tillers, which generate panicles, are vital for yield, as the no. of tillers per plant indirectly affects yield and positively influences panicle production.

The use of Humic Plus, which includes gibberellic acid, led to an increased number of effective tillers per plant. This aligns with Kumaravel *et al*. (2022), who noted the positive impact of gibberellic acid on tiller development.

Overall, the integration of humic plus and green magic not only enhances the physiological aspects of the plants but also contributes to increased panicle production. This relationship underscores the importance of nutrient management and growth regulators in maximizing rice yield potential.

Number of grains panicle^{-1}

The analysis indicated that using Humic Plus foliar spray and Green Magic soil application significantly increased the number of grains per panicle. Treatment T_9, which combined the recommended fertilizers with a Humic Plus spray at 10 ml/ha and Green Magic at 15 kg/ha, achieved the highest count of 138.5 grains per panicle.

The increase in the number of grains per panicle can be attributed to the beneficial effects of Green Magic, particularly its humic acid content. This component enhances photosynthetic efficiency and creates favorable conditions for flower formation by alleviating competition among flowers for resources. This finding is supported by Al-Fatlawi and Alrubaiee (2020).

Additionally, the concentration of fulvic acid in the Humic Plus foliar spray likely played a significant role in improving

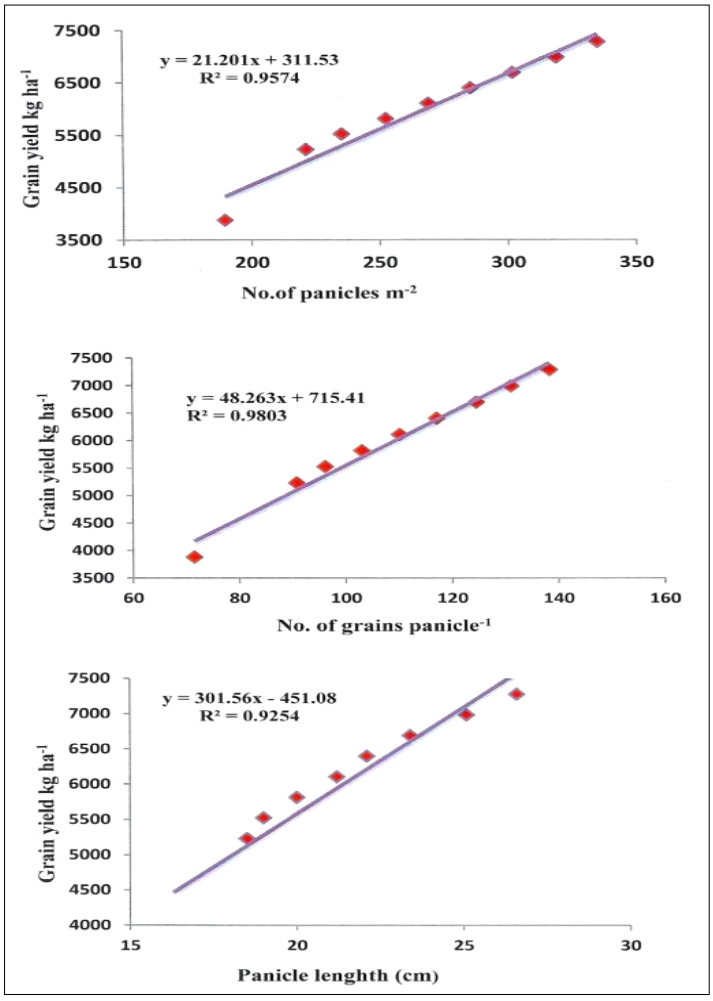


Fig 2: Linear regression relationship between grain yield with yield attributes of rice.

the number of grains per panicle, as noted by Kanabar and Nandwani (2023). Understanding the increase in grains per panicle can be complex due to the intricate relationships and processes that influence grain development and physiology. Factors such as nutrient availability, hormonal regulation and environmental conditions interact in ways that may be challenging to dissect fully.

Furthermore, the potential influence of gibberellic acid present in the Humic Plus formulation may also contribute to these positive outcomes. The findings align with those of Singh *et al*. (2018), who reported similar improvements in grain development due to treatments involving growth regulators.

In summary, the application of Humic Plus and Green Magic not only enhances the number of grains/ panicle but also highlights the intricate interplay of growth factors that facilitate improved crop performance. This underscores the importance of comprehensive nutrient management strategies in optimizing rice yields.

Panicle length (cm)

Examination of the data on the panicle length showed in Table 5 and Fig 2 the addition of foliar spray of Humic plus and soil application of Green magic caused significant increases inpanicle length (cm). Among the treatments (T_9) - application of RDF+Humic plus foliar spray @ 10 ml ha^{-1} at 30 DAT + Soil application of Green magic @ 15 kg ha^{-1} was obtained highest panicle length (26.6 cm) was superior to all the treatments. The panicle length is augmented because of soil application of Green magic consists of humic and fulvic acid. The findings of Saha *et al*. (2013) indicate that reduced nitrogen loss in the presence of humic acid promotes vegetative growth, including increased panicle length in rice plants.

Thousand grain weight (g)

The data on thousand grain weight showed no significant differences due to the foliar application of Humic Plus or the soil application of Green Magic, with all treatments having a similar effect. While other growth parameters, like panicle numbers and grains per panicle, benefited from these treatments, grain weight remained consistent across the board. This suggests that factors affecting grain weight may be more complex or unrelated to the nutrient applications studied. Further research is necessary to explore the reasons behind this finding and to identify other variables that could influence thousand grain weight.

Grain yield

The data in Table 5 and Fig 2 indicate that the foliar spray of Humic Plus and the soil application of green magic significantly enhanced grain yield. The combination of RDF, Humic Plus foliar spray at 10 ml ha^{-1} applied at 30 DAT and soil application of Green Magic at 15 kg ha^{-1} resulted in the highest grain yield of 7276 kg ha^{-1}. Green Magic, which contains humic and fulvic acids, improves soil nutrient

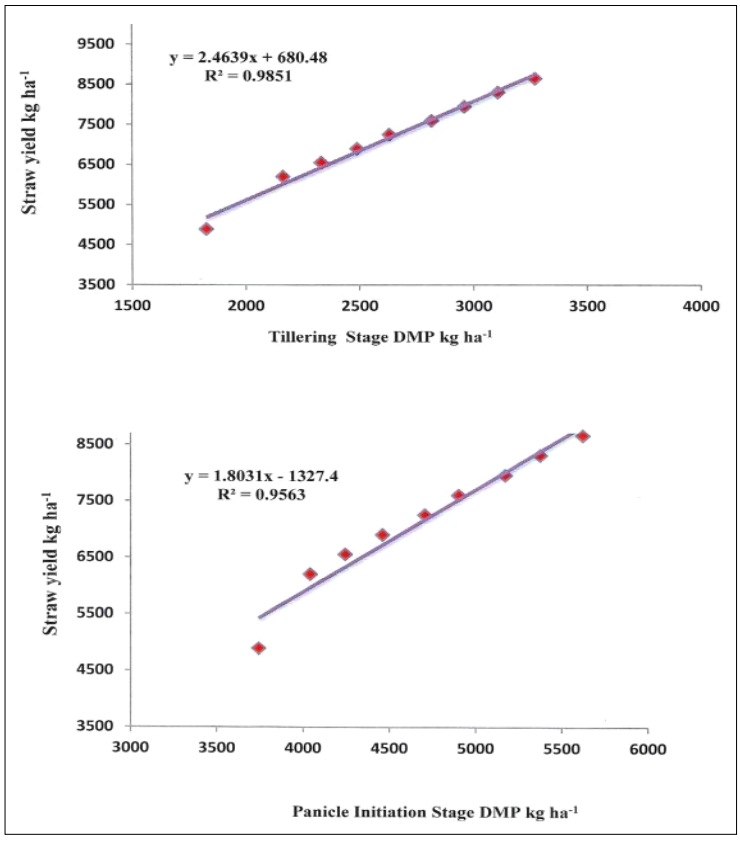


Fig 3: Linear regression relationship between straw yield with DMP at tillering and panicle initiation stage of rice.

levels, increases microbial populations, enhances CEC and improves soil structure. The biochemical effects also influence growth at the cellular level, as discussed by Wali *et al*. (2018). The increase in grain yield from foliar application of Humic Plus is attributed to its components humic, fulvic and gibberellic acidswhich enhance grain weight, aligning with findings from Hamed (2021) and Mahmoud *et al*. (2019). The higher yield in plants treated with Humic Plus is primarily due to an increased number of spikelets per panicle. To boost rice production, applying Humic Plus, particularly with gibberellic acid, is recommended, as noted by Haifaa and Moses (2022).

Straw yield

The data on straw yield, as shown in Table 5 and Fig 3, indicate that the application of foliar spray of Humic Plus and soil application of Green Magic positively affected straw yield. The highest straw yield of 8748 kg ha^{-1} was achieved with the treatment combining RDF, Humic Plus foliar spray at 10 ml ha^{-1} applied at 30 days after transplanting (DAT) and soil application of Green Magic at 15 kg ha^{-1}. This increase is attributed to the soil application of Green Magic, which provides a continuous supply of nutrients, leading to enhanced leaf area and dry matter production, consistent with findings by Kumar *et al*. (2019). The enhancement in straw yield is also associated with the application of Humic Plus, which contains humic, fulvic and gibberellic acids that further increase leaf area and dry matter. This effect has been supported by Balaji *et al*. (2019). Additionally, research by Rahman *et al*. (2018) and Alam *et al*. (2015) indicates that foliar application of gibberellic acid can also lead to higher straw yields.

CONCLUSION

The study found that the combination of recommended fertilizer dose (RDF), Humic Plus foliar spray at 10 ml/ha and Green Magic at 15 kg/ha (T_9) significantly improved rice growth, yield and various growth parameters. This treatment effectively increased both grain and straw yields, demonstrating its efficacy as a nutrient management strategy for rice production.

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Conflict of interest

The author declare that there is no conflict of interest related to this article.

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