

Studies on the efficacy of AGMA-Foliar (Kazuki Gold/Yoshi Gold) for Growth Development and yield of Paddy (*Oryza sativa*)

ABSTRACT

Rice (*Oryza sativa* L.) is a principal staple food, with significant production worldwide. In 2021, rice covered 161.77 million hectares globally, with India as the second-largest producer. For sustained output, rice (*Oryza sativa* L.), a major crop around the world, needs balanced fertilization. Overuse of fertilizers degrades the soil, requiring the use of bio stimulants as an alternative. This study evaluates AGMA Foliar (Kazuki Gold/Yoshi Gold) and AGMA Energy on rice cultivar IET 4786 during the kharif season of 2021-22 at C-block farm, Bidhan Chandra Krishi Vishwavidyalaya, Kalyani, Nadia, and West Bengal. A randomized block design with seven treatments and three replications was used. Treatments included AGMA Kazuki Gold and Kazuki Energy applied at various stages. AGMA treatments significantly enhanced plant height, dry matter, grain count, and yield. Results indicated that T3 treatment (Kazuki Gold applied twice at 25-30 and 40-45 DAT) achieved the highest plant height (93.00 cm), dry matter (983.66 g/m²), grain count (180.05 grains/panicle), and grain yield (5.26 t/ha), with statistical significance confirmed by F-tests at 5% level. T6 treatment showed comparable results. Chlorophyll content was also highest in T3. Control plots consistently showed the lowest values. The study emphasizes the effectiveness of AGMA Foliar biostimulant applications, which significantly improve rice growth, yield, and nutrient efficiency. It highlights their potential as sustainable agricultural inputs and suggests optimal application stages for maximizing benefits.

Keywords: Rice, Physio-activator, biostimulant, Chlorophyll Content.

Introduction :

Rice (*Oryza sativa* L.) is the principal staple food grain, accounting for over half of the world's production and extensively cultivated worldwide (Muthayya *et al.*, 2014). In 2021, it was grown on 161.77 million hectares globally, producing 749.19 million metric tons. India ranks second in rice production (122.3 MMT), following China (209.61 MMT). In India, rice cultivation covers 45.07 million hectares, yielding 122.27 million tons with an average

productivity of 2713 kg ha⁻¹ (by Our World in Data) and <https://www.fao.org/markets-and-trade/commodities/rice/en>. However, the indiscriminate use of fertilizers has led to imbalanced soil nutrient use, gradually decreasing soil productivity. Balanced fertilizer use is essential for sustaining rice production (Chettriet.al. 2005. Singh, V.K., 2017 and Ramteke *et.al.*, 2023).

To achieve adequate yields and high-quality products, growers use various fertilizers and pesticides, which constitute up to 38% and 43% of total production costs, respectively. However, heavy use of these chemicals can adversely affect non-target species and lead to soil, water, and produce contamination (Hossain *et.al.*,2022 and Baweja *et al.*,2020). Therefore, maximizing soil nutrient availability and nutrient use efficiency is crucial for a sustainable rice production system. Plant biostimulants, such as AGMA Foliar (Brand Names: Kazuki Gold/Yoshi Gold, Kazuki Energy), can be beneficial. These liquid formulations of protein hydrolysate and amino acids, which include peptide and amino acids, can be used as foliar sprays and are available as liquid extracts (Begum and Martín *et. al.*, 2022).

AGMA Biostimulant Foliar products modulate the physiological and molecular processes of plants, promoting growth, increasing production, and reducing abiotic stress impacts such as salinity, heavy metals, heat, nutritional stress, and water stress (Chatterjee *et.al.*, 2023 and Rahaman *et.al.*:2024). They stimulate carbon and nitrogen metabolism, regulate N uptake through enzymes involved in the N assimilation process, and modulate the activity of enzymes in the tricarboxylic acid cycle (Van Oostenet *al.*, 2017). The bioactive peptides in these products may also affect hormonal functions, with studies showing that PHs derived commercial products induce hormone-like activities (auxin and gibberellins), enhancing shoot growth and crop productivity (Colla *et.al.*, 2017 and Martín *et. al.*,2022). Additionally, PHs have indirect effects on plant nutrition and growth by increasing the efficiency of macro and micronutrient absorption and utilization through foliar treatments(Colla *et.al.*, 2017 Martín*et. al.*,2022 and Kundu *et.al.*2023).

To address these challenges, an experiment was conducted to standardize the efficacy of Kazuki Gold and Kazuki Energy. The objectives were to standardize AGMA-Foliar's effectiveness for rice growth and yield and to determine the optimal application stage of AGMA-Foliar in rice cultivation

MATERIALS AND METHODS

The field experiment was conducted at C-block farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, and West Bengal. The experiment was done during the kharifseason of 2021–22. The laboratory work was carried out at the "Department of Vegetable Science" and the "Quality Control Laboratory", Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia. The experimental site is located at 22.89° N latitudes and 88.45° E longitudes at 9.75m AMSL. The "C" block farm is situated in a warm sub-tropical humid climate within the torrid regions but in proximity to the Bay of Bengal with a network of rivers, which protects the place from extreme conditions. The average temperature ranges from 25°-36.5°C during the summer months and between 12°C and 25°C during the winter months. The experimental field is located in the New Alluvial Plains of West Bengal. The soil was sandy loam with a slightly acidic nature. The experimental site had assured irrigation facilities. The trial was laid out in a randomized block design with seven treatments, each replicated three times with 3.0×3.0m² plot size.

List 1 :The treatment factors included the following treatments

Treatments	Products	Dose/acre	No. of application	Time of Application
T1	AGMA Foliar(Kazuki Gold/Yoshi Gold)	500 ml	1	25-30DAP
T2	AGMA Foliar(Kazuki Gold/Yoshi Gold)	500ml	1	40-45 DAP
T3	AGMA Foliar(Kazuki Gold/Yoshi Gold)	500ml	2	Ist application: 25-30DAP IIInd application: 40-45 DAP
T4	AGMA Foliar(Kazuki Energy)	500ml	1	25-30DAP
T5	AGMA Foliar(Kazuki Energy)	500ml	1	40-45 DAP
T6	AGMA Foliar(Kazuki Energy)	500ml	2	Ist application: 25-30DAP IIInd application: 40-45 DAP
T7	Control (water only)		Nil	

The rice cultivar IET 4786 (Shatabdi) was under investigation. A full Recommended Dose of Fertilizers (RDF) was applied (120 kg N, 60 kg P₂O₅, 60 kg K₂O/ha). Phosphate, potash, and half the nitrogen were applied basally; the remaining nitrogen was top-dressed at 30 and 60 days after transplanting (DAT). All recommended agronomic practices and plant

protection measures were adopted for rice crop production. Growth-attributing characters and yield parameters were observed in five randomly selected and tagged plants from each plot, which were monitored up to harvesting. 31-day-old seedlings were transplanted with care at a 20 cm x 15 cm spacing, placing 3-4 seedlings per hill at a depth of 2-3 cm. The F-test was computed to determine the significance of treatment impacts on the rice crop. Standard errors of variance and critical differences of various treatments were computed at the 5% level of significance to assess the authenticity of each respective treatment.

RESULTS AND DISCUSSION

Plantheight

The plant height of rice was recorded at 30, 60, and 100 days after transplanting (DAT) under different treatments, showing significant variation that are presented in table 1 and fig 1. At 30 DAT, plant height ranged from 33.35 to 41.42 cm, with a variation of 24.19%. The highest plant height of 41.42 cm was observed in the T3 treatment (AGMA Kazuki Gold applied at 30-35 DAT and pre-panicle initiation stage), followed by the T6 treatment (AGMA Foliar Kazuki Emerge applied similarly), both statistically similar. The control plot had the lowest height of 33.35 cm.

At 60 DAT, plant height ranged from 72.20 to 80.99 cm, with a variation of 12.17%. Again, the T3 treatment recorded the maximum height of 80.99 cm, followed by T6, both statistically comparable.

At 100 DAT, no significant difference in plant height was observed among treatments. The T3 treatment still showed the maximum height of 93.00 cm, followed by T6, while the control plants had the lowest height of 82.27 cm. Treatments were statistically non-significant at this stage. Similar type result founded by Jha et al., 2024 and Kantwaet *al.*, 2019.

Drymatterproduction:

The dry matter production of transplanted kharif rice at 30, 60, and 100 days after transplanting (DAT) was significantly influenced by different treatments, as shown in Table 1 and Figure 2. Regardless of the observation date, dry matter accumulation per plant increased with crop age, peaking at harvest.

At 30 DAT, treatment T3 had the highest dry matter production at 58.41 gm⁻², followed by T6, with a range of 45.90 to 58.41 gm⁻² across treatments (Arunet *al.*, 2019).

At 60 DAT, foliar application of AGMA significantly influenced total dry matter accumulation. T3 recorded the highest production at 582.07 gm⁻², followed by T6 at 562.54 gm⁻², while the control had the lowest at 475.92 gm⁻², significantly differing from other treatments.

At harvest (100 DAT), T3 again showed the maximum dry matter accumulation at 983.66 gm⁻², followed by T6 at 952.93 gm⁻². The control had the lowest dry matter production at 844.53 gm⁻²

Table-1 Effect of AGMA FOLIAR (Kazuki Gold/Yoshi Gold & Kazuki Energy) on Plant height and on Dry matter accumulation (gm⁻²) of rice

Treatment	Plant height(cm)			Dry matter accumulation(gm ⁻²)		
	30DAT	60DAT	At Harvest	30DAT	60DAT	100DAT
T ₁	37.90	75.27	84.36	53.36	551.15	948.38
T ₂	38.36	78.24	89.36	56.99	562.54	952.93
T ₃	41.42	80.99	93.00	58.41	582.07	983.66
T ₄	35.14	74.36	83.02	48.75	484.10	882.60
T ₅	36.61	78.13	86.96	54.78	519.52	933.47
T ₆	38.81	79.26	91.44	57.01	546.40	925.60
T ₇	33.35	72.20	82.27	47.58	475.92	844.53
SEm(±)	0.638	0.792	NS	0.827	3.750	1.141
CDat5%	1.935	2.403	NS	2.508	11.372	3.459

Total number of grains. panicle-1

The most important yield component of rice in terms of total number of grains. panicle-1 was found statistically significant as influenced by different AGMA foliar application at different stage of application. (Table 2 and Fig4). It has been observed that the total number of grains. panicle-1 was to tune of 126.86 to 180.05 among the treatments. The maximum number of total number of grains. panicle-1 was recorded at T3 (180.05) followed by treatment T6 (170.86) which were statistically at par. The lowest number of total number of grains. Panicle-1 was observed in the control treatment (126.86)

Number of filled grains panicle-1

Number of filled grains panicle-1 was significantly influenced by different application of AGMA foliar at different treatments. (Table 2. And Fig.) Number of filled grains panicle-1 varied from 99.26 to 142.73. The application of foliar AGM kazuki gold @ 500ml /acre at two times, first application at 30-35 DAT and 2nd application at pre panicle initiation stage exhibits the maximum number of 142.73 of of filled grains panicle -1. In the similar manner when Kazuki gold was applied as foliar application second highest number of filled grains panicle -1 recorded from T6 treatment. The lowest number of filled grains panicle-1 was obtained in T1 treatment. The other treatments are significantly differed from each other.

Panicle length (cm)

The Panicle length was found significantly different with the treatments (Table 2 and Fig3). It has been observed that the panicle length of rice varied in their length from 22.12 to 25.74 cm. The maximum panicle length (25.74 cm) was achieved in T3 treatment i.e. when the plant is sprayed with foliar AGM kazuki gold @ 500ml /acre at two times, first application at 30-35 DAT and 2nd application was given at pre panicle initiation stage. The second highest panicle length of 25.51 was observed in T6 treatment i.e. when AGMA Kazuki Energy sprayed as foliar @500ml /acre at two times, first application at 30-35 DAT and 2nd application was given at pre panicle initiation stage. The very short panicle length (22.12 cm) was observed by the control treatment. Similar type of result found by Ghodakeet *al.*,2022 Kunduet. Al.2023

Thousand seed weight (Test weight)

The test weight (1000 grain weight) was found significant. (Table 2 and Fig5.). The test weight in the different treatments varied from 18.65 to 20.58g. However, the highest and

lowest values were obtained with T3 (20.58g) and T7 (18.65g) treatments, respectively. From the observation of the present investigation, it was seen that AGMA foliar Kazuki Gold when applied in the two stages @ 500ml/acre was found to be a best for getting the highest Thousand seed weight (Test weight). Arun *et al.*, 2019 observed similar results.

Yield attributes and yield

Grain yield (t. ha-1)

AGMA foliar application at different growth stages improved significantly the grain yield of rice due to the improvement in yield attributing characters (Table 2 and Fig6.). The grain yield of rice cv. IET 4786 (Satabdi) varied to the range of 3.96 to 5.26 t ha⁻¹. The highest grain yield (5.26t/ha) was recorded in T3 treatment i.e. when the plant is sprayed with foliar AGM Kazuki gold @ 500ml /acre at two times, first application at 30-35 DAT and 2nd application was given at pre panicle initiation stage. Lowest yield was recorded in control plot (3.96 t. ha⁻¹). Ghodakeet *al.*, 2022 and Pramanicket *al.*, 2014 both reported similar outcomes.

Straw yield

The data on straw yield of rice as influenced by AGMA foliar application (Kazuki Gold/Yoshi Gold & Kazuki Energy) are presented in Table 2 Fig. 6. The differences in the straw yield due to different treatments were found significant. The straw yield of rice significantly increased from 7.32 to 7.69 t ha⁻¹. Application AGMA foliar Kazuki gold @ 500ml/acre at 30-35 DAT and application at pre panicle initiation stage. (T3) recorded the highest straw yield of 7.69 t/ha, followed by T6 (7.61 t/ha) The lowest straw yield was recorded in control plot (5.92 t ha⁻¹)(Ghodakeet *al.*, 2022).

Harvest index

The harvest index was found statistically significant with different AGMA foliar application. The harvest index of rice increased from 34.24% to 41.44%. The data on harvest index (%) as influenced by different treatments are presented in Table 2 and Fig7. The harvest index differed significantly among different treatment. However, treatment T3 (AGMA foliar Kazuki gold @ 500ml/acre at 30-35 DAT and application at pre panicle initiation stage) gave highest value of harvest index (41.44%) compared to rest of the treatment combinations. The lowest value of 34.24% was recorded in T7. The higher values of harvest index indicated the

greater translocation of photosynthates from source to sink and also better portioning towards reproductive growth. Pramanick *et al.*, 2014 discovered similar type of results.

Table-2 Effect of AGMA FOLIAR (Kazuki Gold/Yoshi Gold & Kazuki Energy) on Yield and yield attributing characters.

Treatment	Total number of grains. panicle ⁻¹	Number of filled grains. panicle ⁻¹	Panicle length (cm)	1000 grain weight(g)	Grain Yield (t. ha ⁻¹)	Straw yield t. ha ⁻¹)	Harvest Index (%)
T ₁	159.11	121.72	24.27	19.50	4.55	7.55	37.16
T ₂	167.67	130.59	25.13	19.83	4.85	7.60	39.49
T ₃	180.05	142.73	25.74	20.58	5.26	7.69	41.44
T ₄	134.82	111.82	23.20	19.14	4.39	7.49	36.08
T ₅	142.98	106.25	24.05	19.26	4.34	7.43	36.75
T ₆	170.86	138.11	25.51	20.23	5.12	7.61	40.58
T ₇	126.86	99.26	22.12	18.65	3.96	5.92	34.24
CD (5%)	3.27	1.50	0.29	0.17	0.21	0.08	1.07

Chlorophyll Content (mg g⁻¹)

Total Chlorophyll, Chlorophyll a and b contents of leaf were measured at 45 Days After Transplanting. Highest Total chlorophyll (2.431) Chlorophyll a (1.50) and Chlorophyll b (0.931) content were recorded in T3 that presented in Table 3 and Fig. These results were at par with treatments T6. Remaining other treatments recorded lower chlorophyll content. While the lowest were obtained from T7. presented in Table 3 and Fig.

Table-3 Effect of AGMA FOLIAR (Kazuki Gold/Yoshi Gold & Kazuki Energy)

on Chlorophyll a(mg g^{-1}), Chlorophyll b(mg g^{-1}) and Total Chlorophyll (mg g^{-1})

Treatment	Chlorophyll A (mg g^{-1})	Chlorophyll B (mg g^{-1})	Total Chlorophyll (mg g^{-1})
T ₁	1.36	0.868	2.228
T ₂	1.39	0.884	2.274
T ₃	1.50	0.931	2.431
T ₄	1.26	0.779	2.039
T ₅	1.30	0.807	2.107
T ₆	1.45	0.894	2.339
T ₇	1.07	0.707	1.777
CD (5%)	3.27	1.50	0.29

It can be inferred from the present finding that, application of AGMA FOLIAR is essential to improve Rice yield. Although the application of stages is also one of the important factors for vegetative parameters of crop growth.

Based on the finding of the experiments, the following conclusions were drawn.

- ✓ AGMA Foliar (Kazuki Gold/ Yoshi Gold) application resulted higher growth and yield of kharif paddy grown in new alluvial soil of West Bengal.
- ✓ The highest grain yield (5.09 t/ha) was recorded in T3 treatment i.e. First application 30-35 DAT and Second application during Pre Panicle initiation stages.
- ✓ Kazuki Energy also has some pronounced effect but Kazuki Gold in overall has found to be superior for obtaining higher yield and yield attributing characters.

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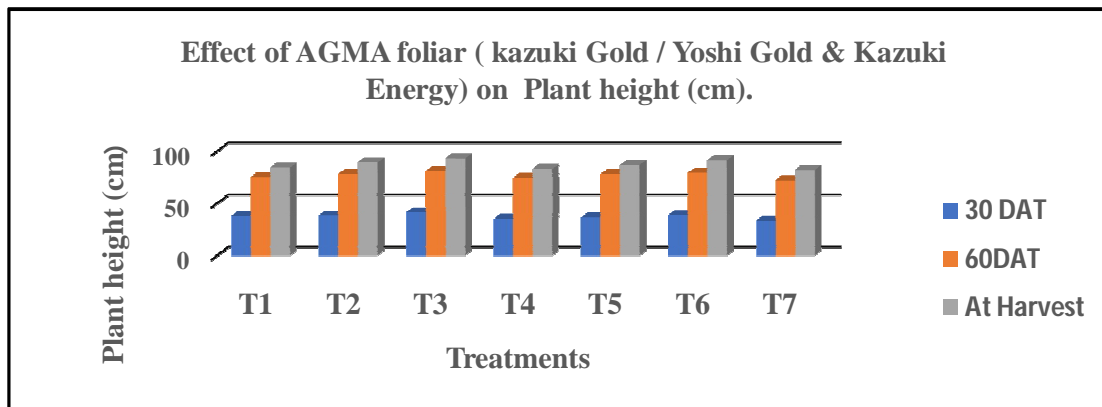


Fig: 1 Effect of AGMA foliar (kazuki Gold / Yoshi Gold & Kazuki Energy) on Plant height (cm).

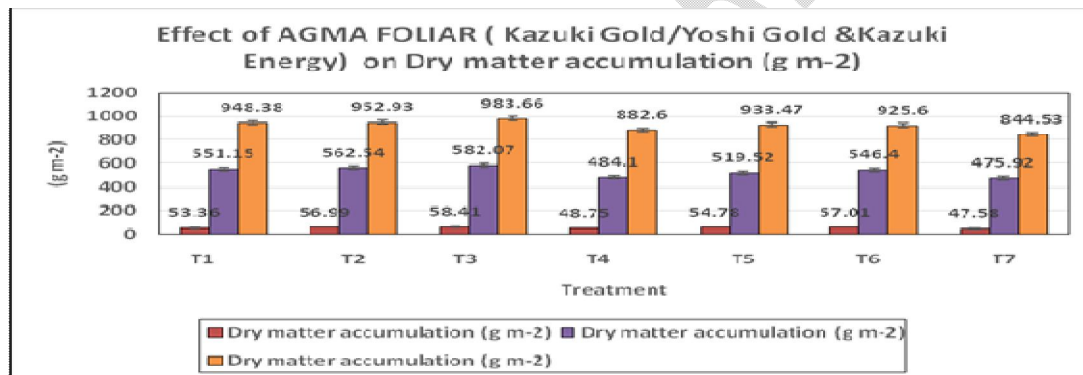


Fig: 2 Effect of AGMA foliar (kazuki Gold / Yoshi Gold & Kazuki Energy) on Dry matter accumulation (g m⁻²).

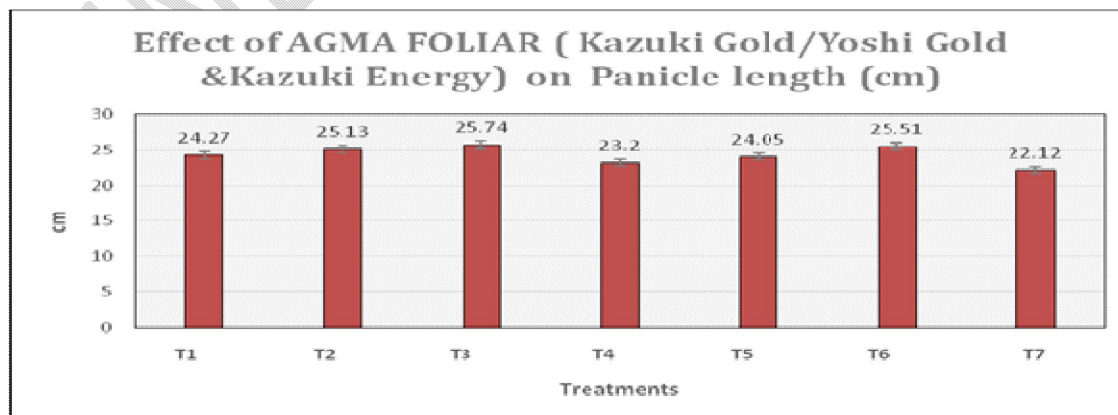


Fig: 3 Effect of AGMA foliar (kazuki Gold / Yoshi Gold & Kazuki Energy) on Panicle length (cm).

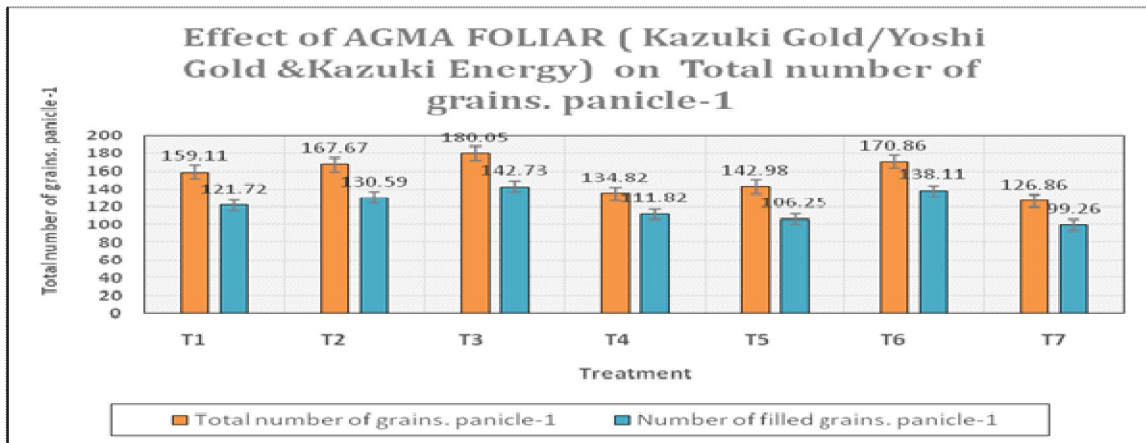


Fig: 4 Effect of AGMA foliar (kazuki Gold / Yoshi Gold & Kazuki Energy) on Total number of grain panical 1 (cm).

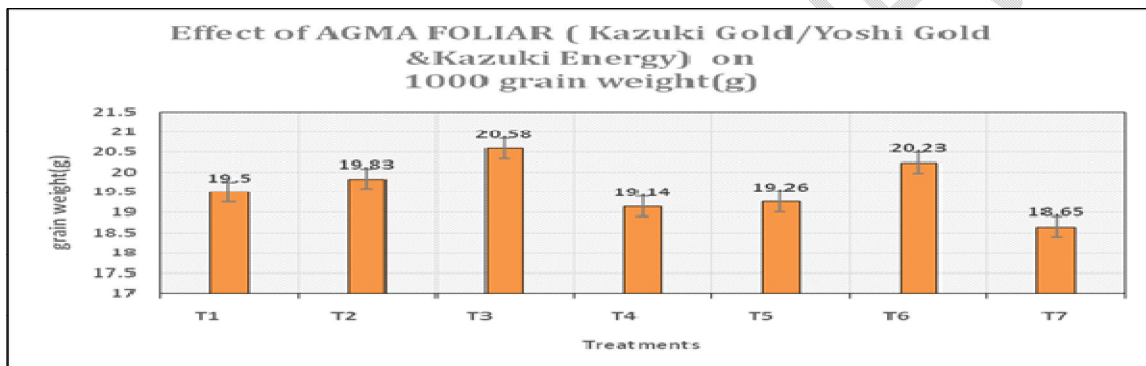


Fig: 5 Effect of AGMA foliar (kazuki Gold / Yoshi Gold & Kazuki Energy) on 1000 grain weight (g).

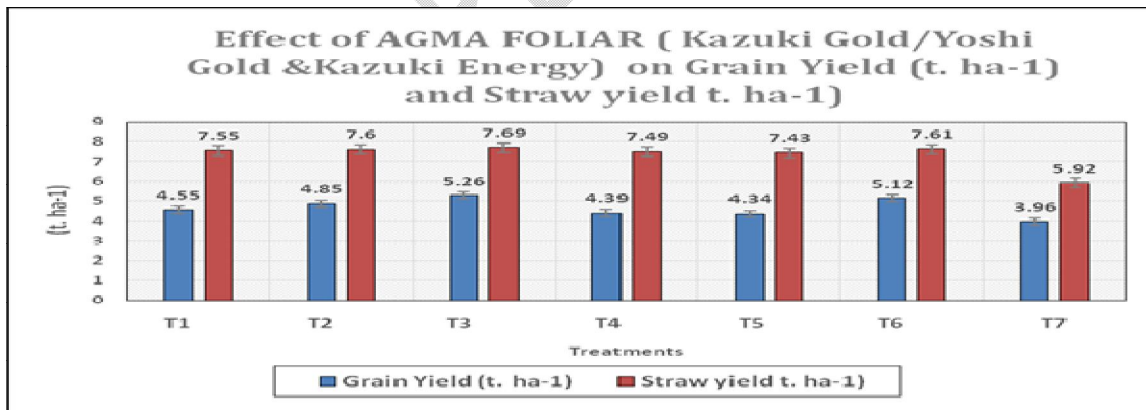


Fig: 6 Effect of AGMA foliar (kazuki Gold / Yoshi Gold & Kazuki Energy) on grain weight (t/ha-1) and straw yield (t/ha-1).

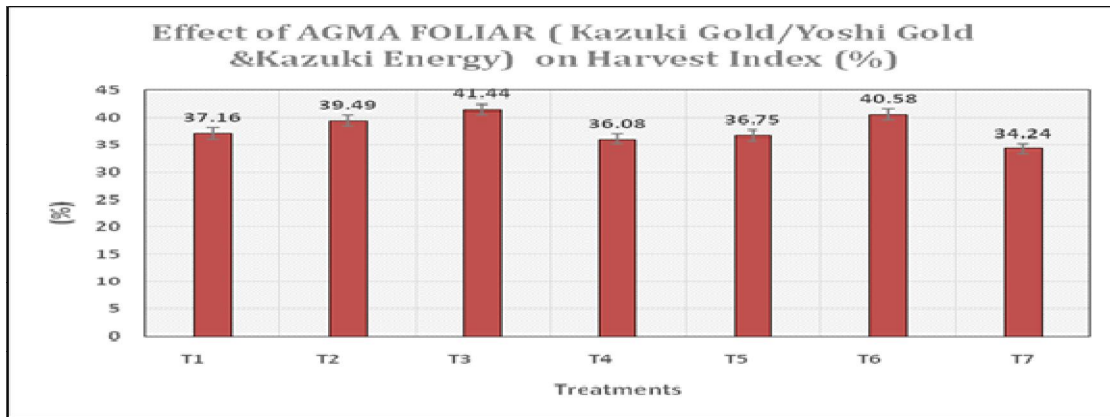


Fig: 7Effect of AGMA foliar (kazuki Gold / Yoshi Gold & Kazuki Energy) on Hervest Index (%).

UNDER PEER REVIEW