Ringkasan Laporan Kajian

Satu Perjanjian Kolaborasi untuk menjalankan kajian di antara MARDI dan IBG Manufacturing Sdn. Bhd. telah dimeterai pada 11 April 2017. Kajian ini dilaksanakan di MARDI Tanjong Karang selama 6 musim penanaman dalam tempoh jangkamasa 40 bulan. Objektif utama kajian ini ialah untuk menentukan kombinasi IBG Multipurpose Bio Fertilizer dan baja subsidi untuk keperluan pembajaan tanaman padi. Dapatan kajian menunjukkan aplikasi rawatan T17 (kombinasi nisbah 50:50 (IBG:baja subsidi) dengan kadar 5 liter/ha merupakan rawatan yang terbaik kerana trend hasil yang tertinggi secara ketara pada musim 3, 4 dan 6. Perbezaan peningkatan hasil bagi musim terakhir iaitu ke-6 adalah sebanyak 40% berbanding dengan T26 (plot kawalan tiada pembajaan). Bilangan tangkai turut dipengaruhi secara ketara oleh rawatan dan mempunyai kolerasi positif dengan hasil. Penggunaan produk IBG juga didapati turut meningkatkan populasi mikrob di dalam tanah yang turut mempengaruhi peningkatan positif terhadap nitrogen, fosforus, kalium dan konduktiviti di dalam tanah.

FINAL REPORT ON

DEVELOPMENT OF IBG MULTIPURPOSE BIO FERTILIZER FOR RICE CULTIVATION

15th February 2017 – 30th May 2020 (6 Seasons)

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PREFACE

A memorandum of agreement to conduct collaboration research between MARDI and IBG Manufacturing Sdn. Bhd. was sealed on 11 April 2017. The project entitled '**Development of IBG Multipurpose Bio Fertilizer for rice cultivation**' was conducted for a period of 40 months. However, the implementation schedule may be subjected to extension to accommodate unexpected circumstances as agreed by both parties.

The primary objectives of this project are to determine the rate of IBG Multipurpose Bio Fertilizer for rice cultivation and to identify proper combination of IBG Multipurpose Bio Fertilizer and subsidy fertilizer for rice cultivation. This project consisting of field experiments conducted in MARDI Tanjong Karang. This report comprises results of work as planned and stated in the MoA.

I am very grateful to IBG Manufacturing Sdn. Bhd. for providing the funds and entrusting me with the project. Sincere thanks go to all collaborators for their commitment in conducting this project.

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DEVELOPMENT OF IBG MULTIPURPOSE BIO FERTILIZER FOR RICE CULTIVATION

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1. INTRODUCTION

IBG Manufacturing Sdn. Bhd. (IBG) is a pioneer in manufacturing biofertilizer utilizing local technology and has been in the biofertilizer production for over 20 years with Bio-Nexus status awarded by Malaysia Bioeconomy Development Corporation Sdn. Bhd. The IBG factory equipped with Research & Development facilities with the certification of ISO 9001 and ISO/IEC 17025 (for Microbiology and Chemical Laboratory). IBG intends to collaborate with the government and private sector to help planters and farmers recover damaged and infertile lands, due to the improper management of chemical fertilizer, insecticides, and herbicides. Healthy soil will strengthen crops and increase yields in the future. Geisseler et al. (2017) indicated one of the indicators for healthy soil is soil microorganism.

IBG produces a large volume of microbial liquid biofertilizers and supplies in large quantities to plantations in Malaysia, Philippines, Myanmar, Thailand, China, etc. At the IBG factory, the four 6000-liter fermenters can produce 5 million liters of biofertilizer with local microbes per year. IBG technology is applied to maintain microbes under a dormant state during storage. The microbes will be activated for field application when mixed with water, thus easing transportation, storage, and shelf life. While IBG biofertilizer is in liquid form with no less than 10^8 CFU/ml microbes with shelf life of up to 2 years. It’s could give advantage on fertilizer storage capacity and ease in the transportation process.

A memorandum of agreement to conduct collaborative research between MARDI and IBG Manufacturing Sdn. Bhd. was sealed on 11 April 2017. This project was conducted for 40 months. The primary objectives of this project are to determine the rate of IBG Multipurpose Bio Fertilizer for rice cultivation and to identify the proper combination of IBG Multipurpose Bio Fertilizer and chemical fertilizer (Padi 1) for rice cultivation. This project consisting of field experiments conducted in MARDI Tanjong Karang. This report comprises results of work as planned and stated in the MOA.

2. MATERIALS AND METHODS

The experiment with 3 replications was arranged in Randomized Complete Block Design (RCBD) that was conducted in MARDI Tanjong Karang for six planting seasons (15^{th} February 2017 until 30^{th} May 2020). 81 plots were layout. The treatments consist of the rates of IBG Multipurpose Bio

Fertilizer at 9, 10, 11, 12 and 13 liter/hectare with 3 times of applications (25% at 25 DAT, 37.5% at 50 DAT and 37.5% at 75 DAT) and combination used of IBG Multipurpose Bio Fertilizer and subsidy fertilizer in percentage at 20:80, 30:70, 40:60, 50:50 and 60:40 while the use of Padi 1 as a control (Table 1). The plot size for each treatment was 5 m x 5 m cultivated with MARDI Siraj 297 rice variety. Soil sampling was carried out before and end of trial for total plate count and soil chemical properties. Data on plant growth were taken at 4 sampling point at 35, 55 days after transplanting (DAT) and at maturity stage, the whole plant was taken at the same point during maturity stage for yield component and harvesting index. While grain yield data was sampled at centre point of each plot with size of 4 m x 4 m.

Table 1. Treatments and rate of fertilizer application.

Code	**Ratio Bio fertilizer*: Subsidy**	**Code**	**Dosage L/ha**
R1	20:80	D1	9
R2	30:70	D2	10
R3	40:60	D3	11
R4	50:50	D4	12
R5	60:40	D5	13
C1	No fertilizer		
C2	Subsidy Padi 1 without Foliar subsidy		

Label	**Treatments**	**Label**	**Treatments**	**Label**	**Treatments**	**Label**	**Treatments**	**Label**	**Treatments**
T1	R1D1	T6	R2D1	T11	R3D1	T16	R4D1	T21	R5D1
T2	R1D2	T7	R2D2	T12	R3D2	T17	R4D2	T22	R5D2
T3	R1D3	T8	R2D3	T13	R3D3	T18	R4D3	T23	R5D3
T4	R1D4	T9	R2D4	T14	R3D4	T19	R4D4	T24	R5D4
T5	R1D5	T10	R2D5	T15	R3D5	T20	R4D5	T25	R5D5
T26	No fertilizer (Code C1)								
T27	Padi 1 without Foliar subsidy (Code C2)								
T28	3 ml @ 25DAT,3ml @50 DAT and 4ml @ 75 DAT of IBG Multipurpose Bio Fertilizer and without NPK Tambahan								

* IBG Multipurpose Bio Fertilizer (All individual treatment plots were treated with IBG under standard rate of 1 liter/hectare during -7 DAT)

The data collected from location and seasons were subjected to combined analysis of variance (ANOVA). Treatment means were compared using the Duncan's Multiple Range Test (DMRT) where F-test was significant. All the analyses were done followed Statistical Analysis System (SAS) Software.

3. RESULTS AND DISCUSSION

3.1 Total Plate Count (TPC)

Microorganisms number varies between different soil types and conditions, with bacteria being the most numerous. Normally, the bacteria count in different soil range from $4x10^6$ to $2x10^9$ CFU/g in soil (Vieira and Nahas 2005). Any counts that are less than 10^6 CFU/g revealed unhealthy or poor soil.

The test report before applying IBG biofertilizer shows that the bacteria count in the paddy field range from 3.2 to $7.9x10^5$ CFU/g which is less than 10^6 CFU/g. The low bacteria count may be caused by excessive use of chemical fertilizer and lead to a lack of nutrients or organic matter in the soil, abiotic stress due to extreme soil pH, soil contamination, and temperature (Kaiser 2020). The continuous use of chemical fertilizer will degrade the soil health and quality hence causing soil pollution and no longer suitable for bacteria living (Chandini et al. 2019). The adverse effect of these synthetic chemicals on the environment can only be reduced or eliminated by adopting new agricultural technology and one of the ways is using biofertilizer (also known as microbial fertilizer) instead of chemical fertilizer. Biofertilizer is environment-friendly, non-bulky, cost-effective, and plays a significant role in improving soil nutrients and plant growth (Sun et al. 2017).

The 3 years (6 seasons) field trial using IBG biofertilizer revealed a significant increase in soil bacteria. This was reflected in Figure 1 where the trend revealed that the treated plots have much higher TPC than untreated plots (control plots). The ANOVA results also revealed a significant result between before application (season 0) and season 6 ($P<0.05$). The control plot T26 and T27 showed the lowest TPC (lower than $3x10^6$ CFU/g). The plots applied with IBG biofertilizer showed a positive trend where the TPC is much higher than control plots. T17 showed the highest TPC of 5.5x 10^6 CFU/g after season 6. The increase in soil bacteria count was most likely due to the high organic matter in IBG biofertilizer. The organic matter can be used by microorganisms for tissue building. The surviving microbes use the tissue of the dead microorganism as food for building biomass and energy, start replicated in soil (Soil Biology & organic matter 2015). As a result, the increase in soil microbes will initiate the activities of the biochemical cycles especially nitrogen fixation, phosphate solubilizing, potassium solubilizing, and cause the soil to restore fertility.

IBG biofertilizer consists of a high number of nitrogen fixation bacteria (10^8 CFU/ml) which is important in the nitrogen cycle. Nitrogen-fixing bacteria fix the atmospheric N, adding it to the soil nitrogen pool. Nitrogen is a nutrient that is often limiting to plant growth. Through nitrogen fixation, the plant benefits from using the endless source of nitrogen from the atmosphere, and this process simultaneously contributes to soil fertility.

The TPC results showed that the bacteria count in the control plot (T26 and T27) also increase to 10^6 CFU/g but slightly lower than the application plot. This was because the bacteria in IBG biofertilizer is free-living bacteria and can spread around the paddy field through water movement under the soil or during the rainy season. The other reason may be due to the soil will remix before the new season start.

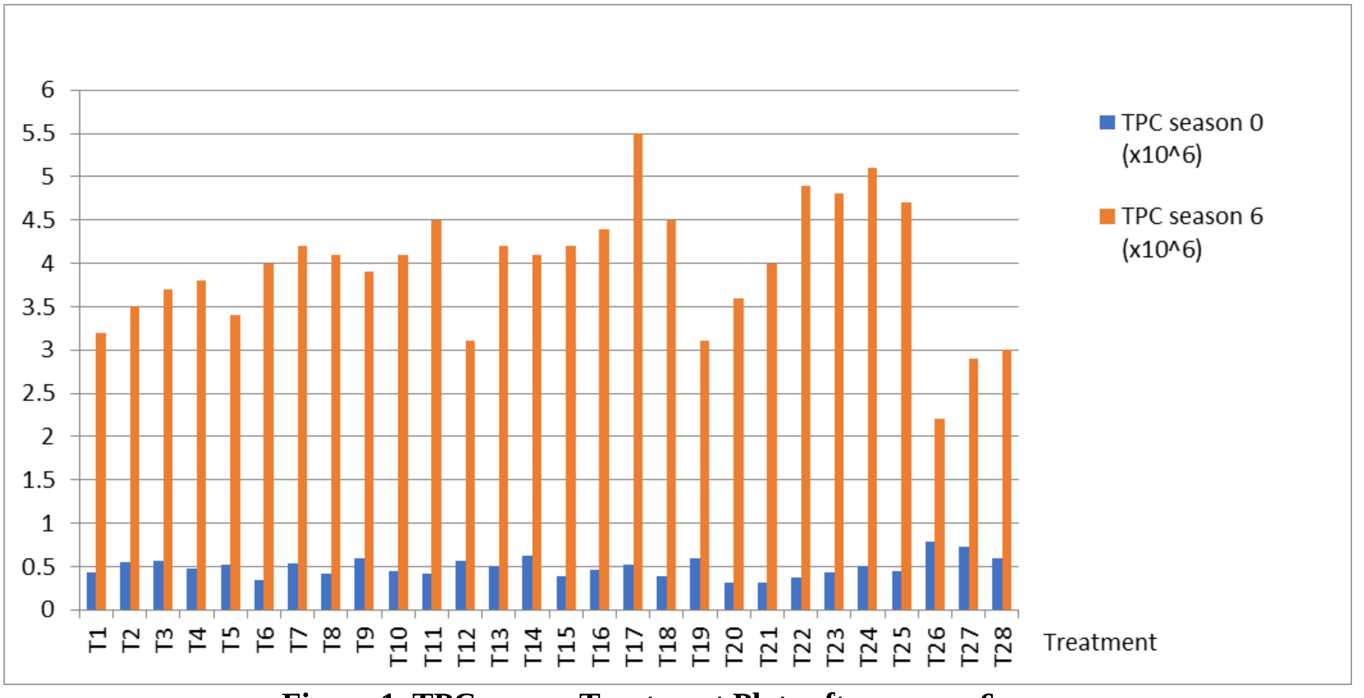

Figure 1. TPC versus Treatment Plots after season 6.

3.2 Soil Chemical Properties

The soil's pH value was increase after the experiment with the range before experiment were between 4.71 and 6.26 while after the experiment the range were between 5.43 and 6.16 (Table 2b). The highest percent increment observed in T8 (28.87%) as showed in Table 2a which from 4.71 to 6.07 showed in Table 2b. The ideal pH value for rice cultivation is between 5.5 and 6.5 (Muhammad Naim et al. 2015).

The total carbon was range between 2.29% and 3.21% before experiment (Table 2b). Positive increment in total carbon were observe in T1, T4, T8, T9, T10, T12, T13, T15, T19, T23, T25, T26 and T28 with the highest increment observed in T9 (17.47%) as showed in Table 2a. While total nitrogen before experiment were recorded between 0.30% and 0.42% (Table 2b). There was positive increment in total nitrogen in all treatment at the end of experiment with average increment is 85.80% but lower in control plots (T26, T27 and T28) as showed in Table 2a. The highest percent increment observed in T12 with 162.50% (Table 2a) from 6.32% to 0.84% (Table 2b). The increase in soil's total nitrogen and reduction in total carbon after experiment has affected the value of carbon-nitrogen (C:N) ratio after experiment which range between 2.99 and 7.12 compared to C:N ratio before the experiment which range between 6.62 and 9.09 (Table 2b).

Great increment in total phosphorus (P) and available P with average percent increment of

414.99% and 1013.19% (Table 2a). Total P before experiment were between 350mg/kg and 827mg/kg (Table 2b). The highest percentage of total P increment observed in T3 with 714.79% while reduction in total P observed in T27, lowest total P also observed in T26, T27 and T28 (Table 2a). Positive increment was also observed in available P in all treatment with highest percent increment observed in T4 (2381.31%) as showed in table 2a which is from 19.80mg/kg to 491.30mg/kg (Table 2b). Lowest percent increment of available P also observed in T26, T27 and T28 (Table 2a). Cerozi and Fitzsimmons (2016) recommended pH at range 5.5 and 7.2 for phosphorus availability and uptake by plant. While Gaind (1989) found pH 5.4 was the optimum pH for phosphate solubilization by the phosphate solubilizing bacteria.

The exchangeable K by percentage were increase in all treatment after the experiment except in T26, T27 and T28 as showed in Table 2a. The highest percent increase observed in T1 from 0.95cmol/kg to 20.65cmol/kg (Table 2b). Reduction in exchangeable Mg after the experiment observed in T1, T3, T5, T15, T17, T19, T21, T23, T25, T26, T27 and T28, while the highest percent increment in exchangeable Mg was in T9 (42.50%) as showed in Table 2a. Positive increment in exchangeable Ca observed in T1, T2, T4, T5, T7, T14 and T20 with the highest percent increment observed in T8 with 87.85% increment (Table 2a). Positive increment observed in exchangeable Na in all treatment except T19, T26, T27 and T28 (Table 2a). The highest percent increment observed in T24 (122.09%) as showed in Table 2a.

Reduction in Cation Exchange Capacity (CEC) was observed in all treatments except in T4, T11, T17, T18, T26, T27 and T28 with the highest percent increment in T27 (20%) as in Table 2a which is from 23.00cmol/kg to 27.60cmol/kg (Table 2b). CEC value for rice cultivation should be more than 16cmol/kg (Muhammad Naim et al. 2015). Increment in soil's conductivity were observed in all treatments except in T26, T27 and T28. The highest percent increase in soil conductivity observed in T1 with 2072.79% increment (Table 2a) which from 0.27mS/cm to 5.91mS/cm (Table 2b).

Changes in pH probably induced changes in the microbial community structure and functionality which leads to the reduction in total soil carbon, total phosphate and available phosphate. The product which contain nitrogen fixation bacteria gave a great increased in total nitrogen and contributed to the changes in soil C:N ratio.

Table 2a. Changes of soil's chemical properties after the experiment in percentage.

Treatments	pH (%)	Total C (%)	Total N (%)	C:N Ratio (%)	Total P (%)	Available P (%)	Exchangeable (%)				CEC (%)	Conductivity (%)
							K	Mg	Ca	Na		
T1	9.70	1.57	126.67	-55.19	581.31	1092.91	2073.68	-1.08	3.42	73.05	-0.86	2072.79
T2	13.82	-20.45	58.97	-49.96	398.77	1261.82	1418.26	23.12	2.33	56.71	-12.35	741.91
T3	10.00	-4.62	150.00	-61.85	714.79	1843.02	1587.30	-9.25	-29.12	44.08	-25.62	1745.97
T4	14.10	0.73	113.89	-52.90	575.36	2381.31	1570.99	15.47	0.83	119.89	4.46	1222.89
T5	10.92	-4.27	121.05	-56.69	510.59	1159.63	1140.35	-12.88	-40.93	11.28	-29.96	1251.22
T6	10.44	-13.33	81.82	-52.33	266.53	869.88	941.22	15.98	4.45	25.30	-11.20	373.36
T7	12.48	-9.81	128.57	-60.54	667.27	1438.54	1541.27	0.13	-5.68	81.41	-4.55	1359.66
T8	28.87	11.02	91.89	-42.14	611.53	1023.24	1466.19	24.60	87.85	89.22	-4.55	568.25
T9	-2.56	17.47	138.71	-50.79	658.46	1045.79	1355.63	42.50	-16.95	87.10	-2.04	469.23
T10	9.33	12.20	130.30	-51.28	521.93	1034.07	1199.24	0.12	-16.52	35.17	-18.95	739.53
T11	5.81	-3.97	59.46	-39.78	184.58	508.57	817.56	12.97	-11.12	55.25	1.21	922.29
T12	12.41	12.60	162.50	-57.10	520.15	1184.76	1285.14	0.00	-6.84	25.71	-2.86	960.87
T13	9.96	6.67	83.33	-41.82	482.20	958.97	709.47	0.53	-7.78	14.93	-5.62	724.38
T14	11.76	-13.08	43.90	-39.60	230.77	770.98	899.24	20.98	15.12	33.33	-16.54	421.08
T15	13.63	7.51	100.00	-46.25	399.82	747.89	827.45	-1.96	-13.13	9.52	-4.12	659.58
T16	8.57	-8.05	87.88	-51.06	358.06	1152.45	1113.49	8.09	-9.29	87.59	-10.04	1342.86
T17	8.75	-8.62	97.44	-53.72	388.42	1070.20	1433.80	-2.98	-17.30	26.50	9.55	971.57
T18	9.65	-8.93	50.00	-39.29	464.61	1608.87	1149.62	20.12	-1.34	108.00	1.82	1567.87
T19	9.16	8.08	75.00	-38.24	377.71	943.23	674.43	-3.41	-11.63	-0.78	-1.72	500.68
T20	17.51	-2.55	84.21	-47.10	638.92	1510.68	1456.35	18.29	5.57	69.72	-10.62	1085.19
T21	12.38	-2.85	81.58	-46.50	430.78	808.88	748.59	-10.40	-23.39	27.76	-3.98	633.22
T22	10.54	-8.96	75.68	-48.18	527.02	786.69	1064.29	9.79	-3.62	120.24	-19.60	1158.93
T23	17.11	0.39	102.86	-50.51	569.94	1552.84	971.62	-2.54	-3.81	47.85	-11.20	963.26
T24	11.61	-3.79	105.71	-53.23	595.70	1323.33	1452.50	14.23	-10.14	122.09	-2.18	1198.94
T25	10.17	0.35	68.42	-40.42	251.03	1134.51	1153.38	-2.01	-15.80	37.60	-8.43	845.80
T26	14.26	1.36	10.53	-8.30	43.88	135.09	-23.20	-19.71	-26.00	-18.07	8.61	-22.62
T27	0.56	-2.81	0.00	-2.81	-15.04	211.58	-32.11	-33.14	-41.56	-26.32	20.00	-42.47
T28	8.65	4.00	20.00	-13.33	56.00	66.49	-4.44	-3.74	-42.44	-3.16	6.52	-4.76
Average	10.86	-1.69	85.80	-44.93	414.99	1013.19	1069.49	4.01	-10.22	45.19	-5.88	806.40

Table 2b. Effects of treatments on soil's chemical properties.

Treatments		pH	Total C (%)	Total N (%)	C:N Ratio	Total P (mg/kg)	Available P (mg/kg)	Exchangeable, cmol+/kg				CEC (cmol+/kg)	Conductivity (mS/cm)
								K	Mg	Ca	Na		
T1	Before	5.36	2.54	0.30	8.47	396	40.90	0.95	14.85	11.69	1.67	23.20	0.27
	After	5.88	2.58	0.68	3.79	2698	487.90	20.65	14.69	12.09	2.89	23.00	5.91
T2	Before	5.21	3.13	0.39	8.03	488	29.60	1.15	14.49	12.44	2.31	24.30	0.54
	After	5.93	2.49	0.62	4.02	2434	403.10	17.46	17.84	12.73	3.62	21.30	4.58
T3	Before	5.30	3.03	0.38	7.97	514	26.50	1.26	15.90	13.36	2.45	28.10	0.41
	After	5.83	2.89	0.95	3.04	4188	514.90	21.26	14.43	9.47	3.53	20.90	7.55
T4	Before	5.25	2.73	0.36	7.58	491	19.80	1.31	15.26	13.28	1.86	22.40	0.42
	After	5.99	2.75	0.77	3.57	3316	491.30	21.89	17.62	13.39	4.09	23.40	5.49
T5	Before	5.13	2.81	0.38	7.39	529	32.70	1.14	14.83	13.07	1.95	24.70	0.41
	After	5.69	2.69	0.84	3.20	3230	411.90	14.14	12.92	7.72	2.17	17.30	5.54
T6	Before	5.27	3.00	0.33	9.09	484	34.20	1.31	15.21	11.92	2.53	25.00	0.66
	After	5.82	2.60	0.60	4.33	1774	331.70	13.64	17.64	12.45	3.17	22.20	3.11
T7	Before	5.21	2.65	0.35	7.57	501	30.10	1.26	15.24	12.32	1.99	24.20	0.41
	After	5.86	2.39	0.80	2.99	3844	463.10	20.68	15.26	11.62	3.61	23.10	5.97
T8	Before	4.71	2.45	0.37	6.62	321	42.60	1.39	13.05	7.90	1.67	22.00	0.63
	After	6.07	2.72	0.71	3.83	2284	478.50	21.77	16.26	14.84	3.16	21.00	4.21
T9	Before	6.26	2.29	0.31	7.39	390	40.40	1.42	13.20	17.35	2.17	24.50	0.72
	After	6.10	2.69	0.74	3.64	2958	462.90	20.67	18.81	14.41	4.06	24.00	4.07
T10	Before	5.36	2.54	0.33	7.70	488	31.70	1.31	16.04	12.59	2.36	24.80	0.51
	After	5.86	2.85	0.76	3.75	3035	359.50	17.02	16.06	10.51	3.19	20.10	4.29
T11	Before	5.51	2.77	0.37	7.49	681	42.00	1.31	15.27	13.76	1.81	24.70	0.31
	After	5.83	2.66	0.59	4.51	1938	255.60	12.02	17.25	12.23	2.81	25.00	3.21
T12	Before	5.32	2.46	0.32	7.69	521	37.40	1.48	15.19	12.72	2.45	24.50	0.58
	After	5.98	2.77	0.84	3.30	3231	480.50	20.50	15.19	11.85	3.08	23.80	6.10
T13	Before	5.42	2.70	0.36	7.50	500	29.00	1.69	15.17	12.60	2.21	26.70	0.48
	After	5.96	2.88	0.66	4.36	2911	307.10	13.68	15.25	11.62	2.54	25.20	3.99
T14	Before	5.44	3.21	0.41	7.83	585	41.00	1.31	14.35	12.37	2.31	25.40	0.59
	After	6.08	2.79	0.59	4.73	1935	357.10	13.09	17.36	14.24	3.08	21.20	3.09
T15	Before	5.21	2.53	0.35	7.23	558	35.50	1.53	15.82	13.18	2.73	26.70	0.57
	After	5.92	2.72	0.70	3.89	2789	301.00	14.19	15.51	11.45	2.99	25.60	4.36
T16	Before	5.37	2.61	0.33	7.91	546	26.50	1.26	14.96	12.48	1.45	23.90	0.28
	After	5.83	2.40	0.62	3.87	2501	331.90	15.29	16.17	11.32	2.72	21.50	4.04
T17	Before	5.37	2.90	0.39	7.44	570	39.60	1.42	15.42	14.10	2.00	22.00	0.50
	After	5.84	2.65	0.77	3.44	2784	463.40	21.78	14.96	11.66	2.53	24.10	5.39
T18	Before	5.39	2.80	0.42	6.67	534	20.30	1.31	14.91	12.65	2.00	22.00	0.28
	After	5.91	2.55	0.63	4.05	3015	346.90	16.37	17.91	12.48	4.16	22.40	4.62
T19	Before	5.35	2.60	0.36	7.22	516	30.30	1.76	16.15	13.41	2.55	23.30	0.59
	After	5.84	2.81	0.63	4.46	2465	316.10	13.63	15.60	11.85	2.53	22.90	3.55
T20	Before	5.14	2.75	0.38	7.24	501	23.40	1.26	14.82	12.03	2.18	22.60	0.46
	After	6.04	2.68	0.70	3.83	3702	376.90	19.61	17.53	12.70	3.70	20.20	5.44
T21	Before	5.25	2.81	0.38	7.39	497	33.80	1.42	16.25	13.04	2.63	22.60	0.57
	After	5.90	2.73	0.69	3.96	2638	307.20	12.05	14.56	9.99	3.36	21.70	4.15
T22	Before	5.41	2.79	0.37	7.54	507	33.80	1.26	14.81	12.43	1.68	25.00	0.34
	After	5.98	2.54	0.65	3.91	3179	299.70	14.67	16.26	11.98	3.70	20.10	4.23
T23	Before	5.26	2.57	0.35	7.34	509	22.90	1.48	15.74	12.33	2.09	24.10	0.41
	After	6.16	2.58	0.71	3.63	3410	378.50	15.86	15.34	11.86	3.09	21.40	4.37
T24	Before	5.34	2.64	0.35	7.54	419	27.00	1.20	15.32	12.72	1.72	22.90	0.38
	After	5.96	2.54	0.72	3.53	2915	384.30	18.63	17.50	11.43	3.82	22.40	4.91
T25	Before	5.31	2.89	0.38	7.61	827	33.90	1.48	16.39	14.05	2.50	24.90	0.57
	After	5.85	2.90	0.64	4.53	2903	418.50	18.55	16.06	11.83	3.44	22.80	5.41
T26	Before	5.12	2.95	0.38	7.76	449	22.80	1.25	15.02	12.54	2.49	24.40	0.47
	After	5.85	2.99	0.42	7.12	646	53.60	0.96	12.06	9.28	2.04	26.50	0.37
T27	Before	5.40	2.85	0.39	7.31	665	25.90	1.09	15.30	12.80	1.90	23.00	0.44
	After	5.43	2.77	0.39	7.10	565	80.70	0.74	10.23	7.48	1.40	27.60	0.25
T28	Before	5.20	2.50	0.35	7.14	350	38.20	0.90	11.50	14.35	1.58	23.00	0.27
	After	5.65	2.60	0.42	6.19	546	63.60	0.86	11.07	8.26	1.53	24.50	0.26
Average	Before	5.32	2.73	0.36	7.56	512.04	31.85	1.32	15.02	12.84	2.12	24.10	0.47
	After	5.89	2.69	0.67	4.16	2636.93	354.55	15.42	15.62	11.53	3.07	22.69	4.23

3.3 Effect of IBG Multipurpose Bio Fertilizer on Rice Yield and Yield Components under 6 Seasons

Mean square ANOVA analysis (Table 3) suggest that panicle number, panicle length, 1000 grain weight, harvest index and yield was significantly affected by treatments. Consequently, yield is also significantly affected by interaction between season and treatments. Percent filled and spikelet per panicle was not significantly affected by treatments.

Table 3. Combined season ANOVA Analysis on the Effect of IBG Multipurpose Bio Fertilizer on Rice Yield and Yield Components under 6 Seasons

Sources of variance	Paramter						
	Panicle number	Percent filled	Panicle length	1000 grain weight	spikelet per panicle	Harvest index	Yield
Season	354223.95	1258.03	49189.08	9.38	16078.41	1.604	321330343.0
Rep	4805.33	154.81	17.16	8.32	2153.48	0.009	755036.0
Rep (season)	3401.33	129.56	34.56	9.19	1178.57	0.007	6921681.0
Trt	1765.16*	21.36	5.45*	2.94**	162.46	0.006**	2600195.0**
Trt * season	1003.29	24.35	3.29	1.25	138.43	0.002	1418313.0*
Grand mean	203.83	84.82	33.14	27.71	107.77	0.48	7077.3
C.V. (%)	14.1	5.4	5.3	3.8	11.5	9.2	13.2

Note: Mean followed by* is significant at 0.05
Note: Mean followed by ** is significant at 0.01

3.3.1 Panicle number

Both treatment T24 and T26 contributed to highest significant reading compared to lowest reading by T9 (Figure 2). The difference is at least 20.88%. The rest of the treatments exhibits statistical parity among each other. According to Jafari et al., (2013), panicle was significantly affected by nitrogen level. This may suggest that this product may have the potential to increase N uptake in rice. Another study on the use sulphur foliar fertilizer also contributed significantly higher number of panicle number in rice (Badawi et al., 2019). Application of 20 kg of foliar P_2O_5/ha contributed to the highest panicle number in rice. Phosphate in foliar application has the potential to increase panicle number.

3.3.2 Spikelet per panicle

No significant difference can be observed for spikelet per panicle (Table 3). Highest observation was found under treatment T28 which is 118.2 (Figure 3*)*. T11 contributed to the lowest reading which is 103.4.

3.3.3 Percent filled grain

Percent filled was not significantly affected by treatments (Table 3). T5 and T7 contributed to highest observation which is 86.8% whereas T13 recorded lowest reading with only 83.1% (Figure 4).

3.3.4 Panicle length

Panicle length was significantly affected by treatments with T5 contributed the highest significant reading which is 34.5 cm. T28 contributed to lowest significant reading which only 24.0. The rest of the treatments are at par with T26 which contributed to the second lowest reading (Figure 5).

3.3.5 1000 grain weight

1000 grain weight was significantly affected by treatments applied (Table 3). T9 exhibitted highest significant reading with value of 28.5 g (Figure 6). T28 contributed to the lowest reading with only 26.8 g. The difference is 6.34%.

3.3.6 Harvest Index

Harvest index was significantly affected by treatments (Table 3). Highest significant observation was discovered for treatment T17 which is 0.52. T25 contributed to the lowest significant reading which is 0.45 (Figure 7). The difference was 15.5%.

3.3.7 Yield

Combined season analysis suggest there is no significant difference in season 1 (Figure 8). As entry to season 2, a significant results as T10 contributed the highest significant yield compared to control. A trend can be observed in both season 3 and 4 as T17 contributed to highest significant yield. This may suggest the product application achieved stability in season 3. In season 5, T16 contributed to the highest yield. T16 is slightly lower concentration compared to T17. Finally in season 6, T17 and 22 contributed to the highest significant yield compared to T26. The difference is at least 40%.

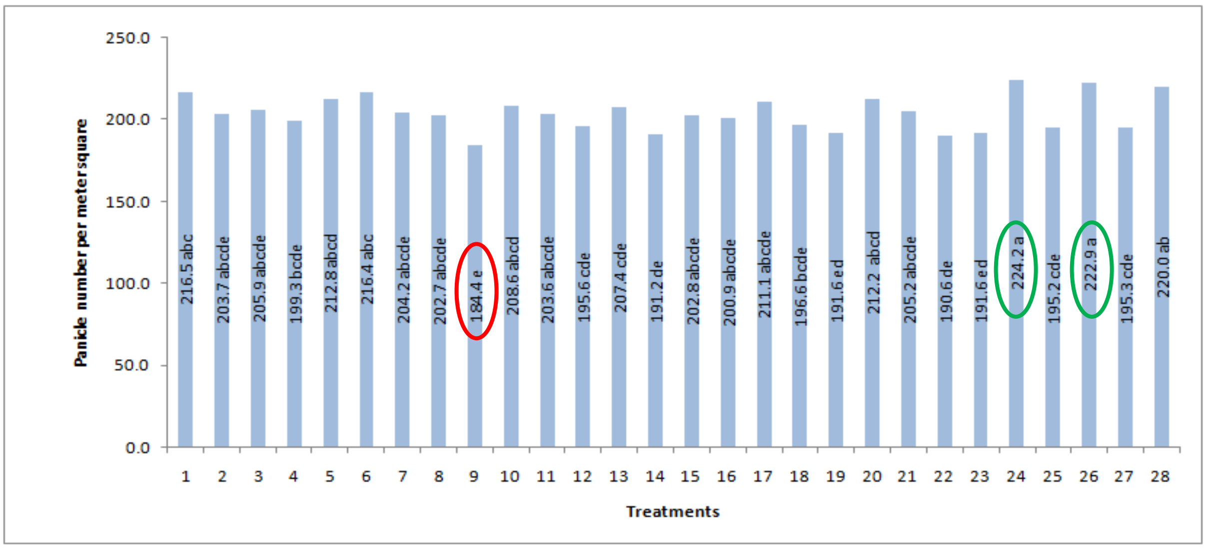

Figure 2. Effect of IBG Multipurpose Bio Fertilizer on Panicle Number.

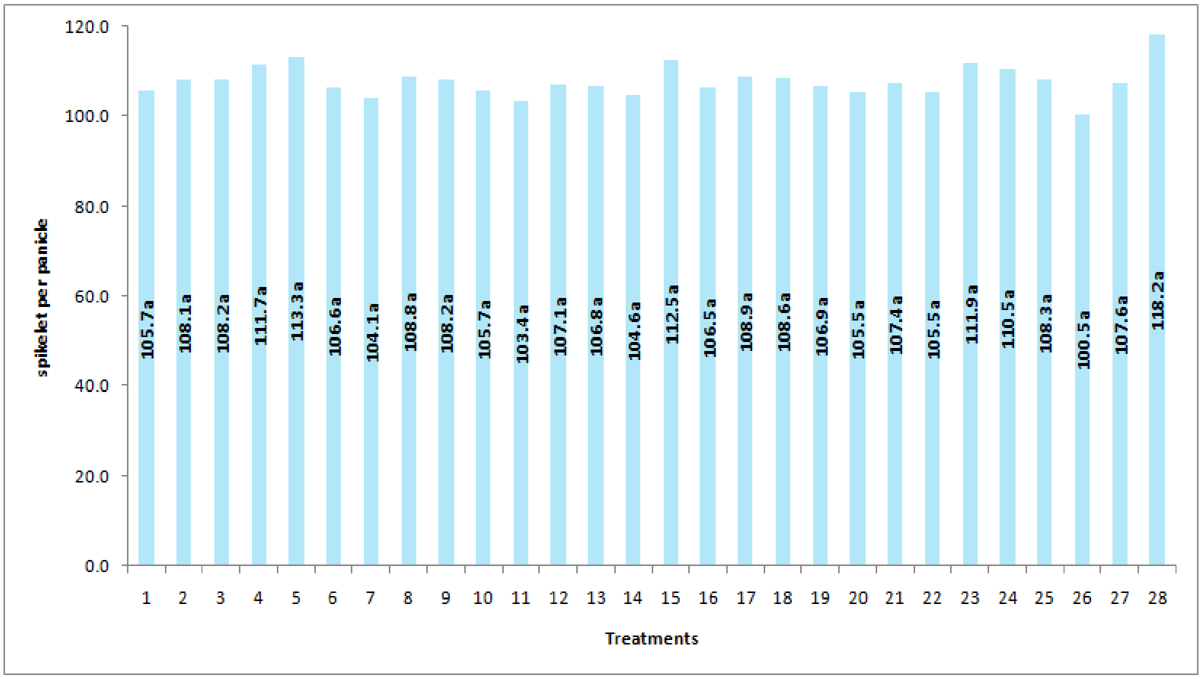

Figure 3. Effect of IBG Multipurpose Bio Fertilizer on Spikelet Per Panicle.

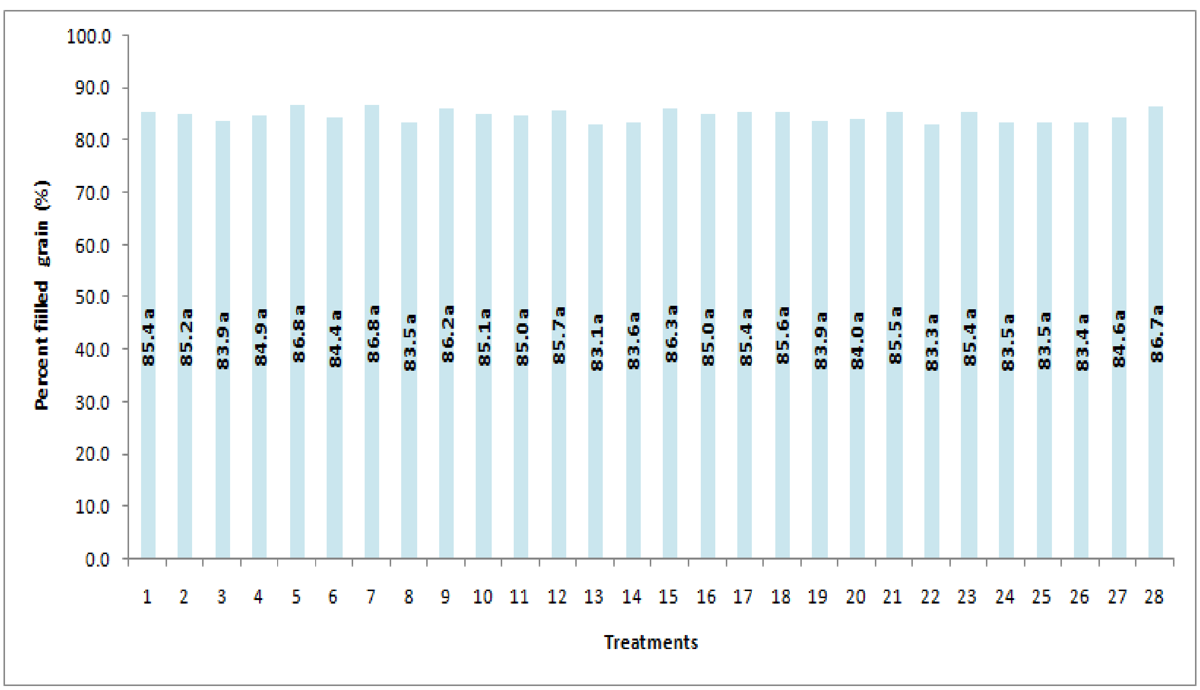

Figure 4. Effect of IBG Multipurpose Bio Fertilizer on Percent Filled Grain.

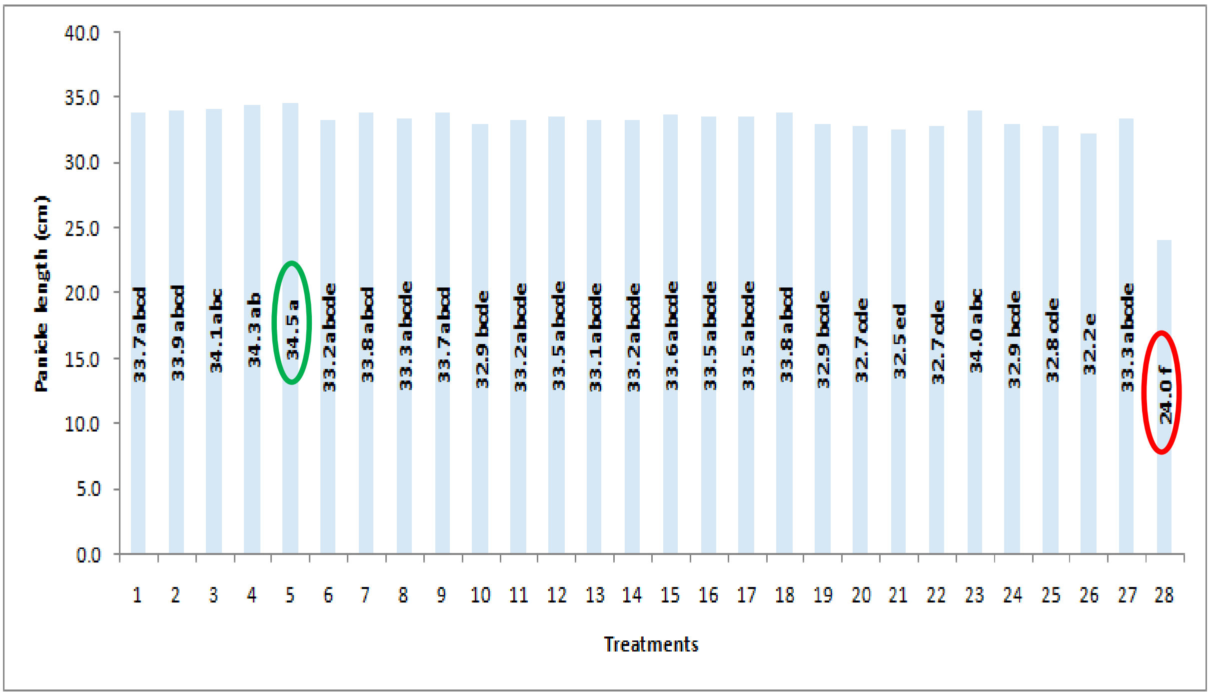

Figure 5. Effect of IBG Multipurpose Bio Fertilizer on Panicle Length.

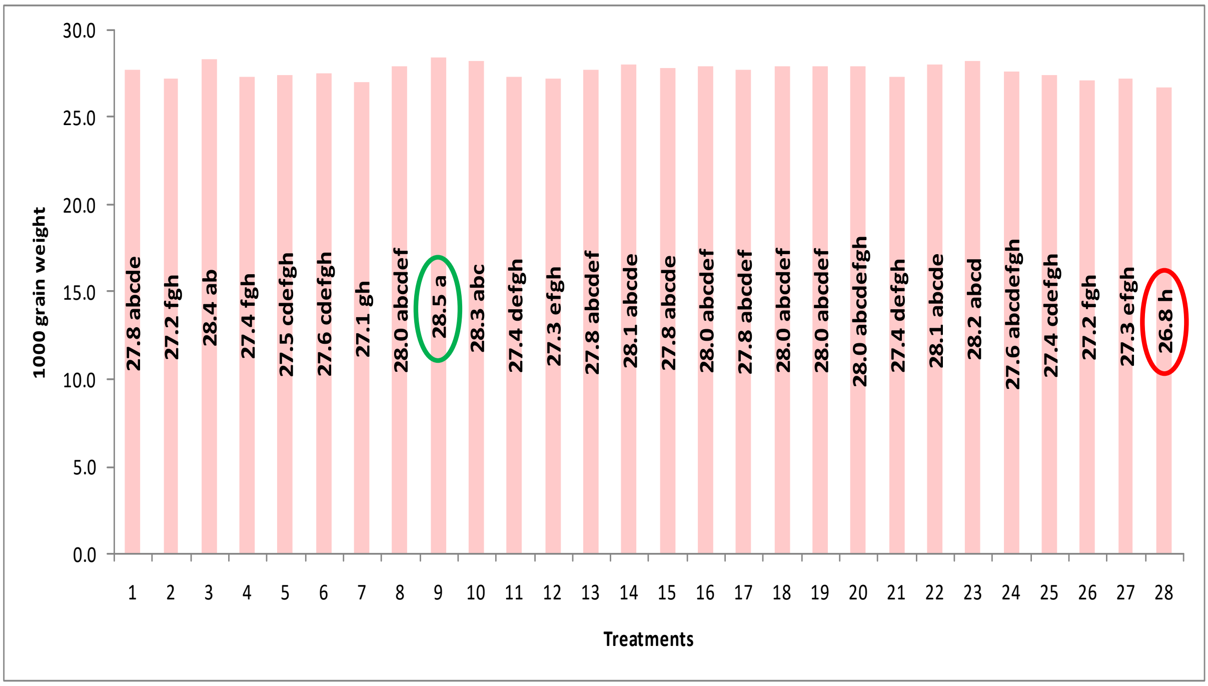

Figure 6. Effect of IBG Multipurpose Bio Fertilizer on 1000 Grain Weight.

Figure 7. Effect of IBG Multipurpose Bio Fertilizer on Harvest Index.

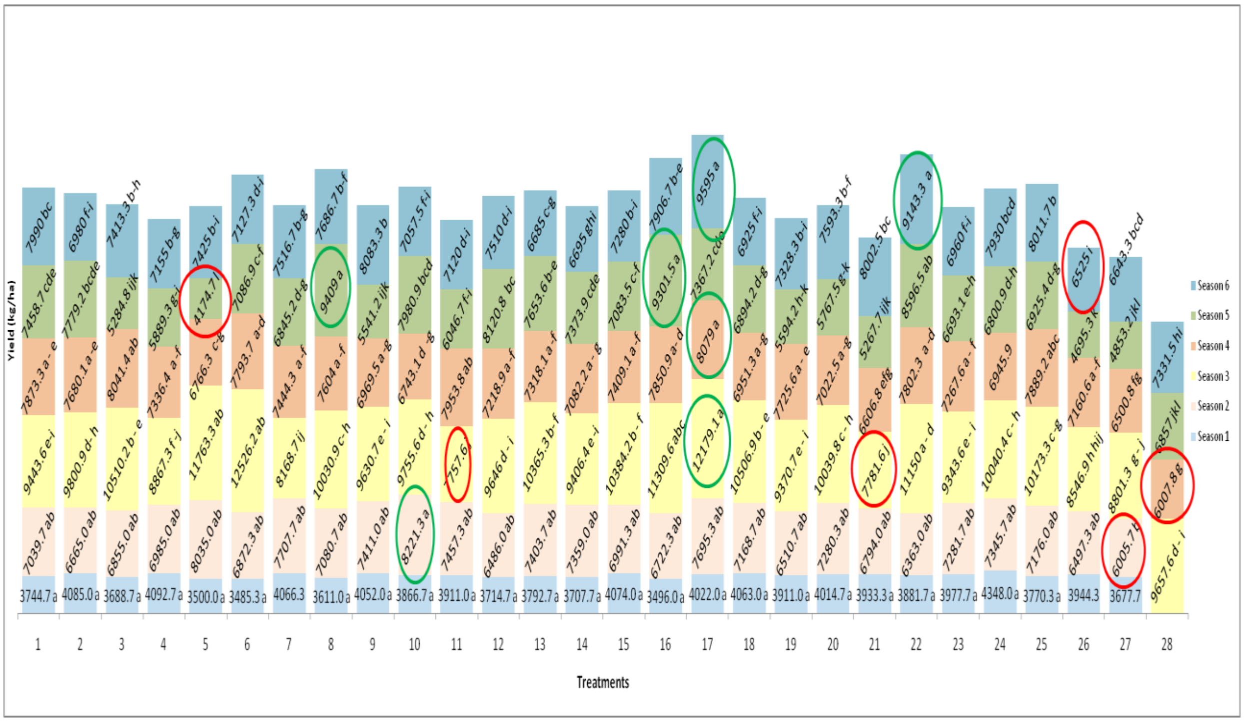

Figure 8. Effect of IBG Multipurpose Bio Fertilizer on Yield.

3.4 Effect of IBG Multipurpose Bio Fertilizer on Rice Growth Performance under 6 Seasons

3.4.1 Tiller number

Table 4. ANOVA Analysis on the Effect of IBG Multipurpose Bio Fertilizer on Tiller Number.

Sources of variance	Parameter		
	Tiller 35 DAT	Tiller 55 DAT	Tiller 90 DAT
Season	4723.02	7111.20	672.30
Rep	89.57	46.66	13.24
Rep (season)	109.87	35.66	4.88
Trt	10.61	3.02	7.97*
Trt * season	8.54	3.76	4.18
Grand mean	21.4	23.5	17.8
C.V. (%)	13.41	8.72	12.12

Note: Means followed by * is significant at 0.05

There was no significant effect on tiller number at 35 and 55 DAT (Table 4). At 90 DAT, T13 contributed to the highest significant tiller number while T9 was the lowest (Figure 9). The difference was 2.7%. No significant interaction between treatment and season observed. Attaining higher number of tiller was not necessarily advantegous since it has significant negative association with yield.

3.4.2 Height

Height is significantly affected by treatments at 90 DAT (Table 5). No significant effect at 35 and 55 DAT. There was no significant interaction between treatment and season. At 90 DAT, T28 scored highest significant reading with value of 101.4 cm while T1 contributed to significant lowest reading with value of 82.9 cm (Figure 10). The difference was at least 18.5%.

Table 5. ANOVA Analysis on the Effect of IBG Multipurpose Bio Fertilizer on Height.

Sources of variance	Parameter		
	Height 35 DAT	Height 55 DAT	Height 90 DAT
Season	9649.00	29135.53	79794.33
Rep	170.97	104.56	29.15
Rep (season)	115.95	61.58	14.61
Trt	11.00	7.89	32.02*
Trt * season	11.76	6.29	7.44
Grand mean	54.4	75.3	86.2
C.V. (%)	5.79	3.75	2.87

Note: Means followed by * is significant at 0.05

3.4.3 SPAD

Table 6. ANOVA Analysis on the Effect of IBG Multipurpose Bio Fertilizer on SPAD.

Sources of variance	Parameter		
	SPAD 35 DAT	SPAD 55 DAT	SPAD 90 DAT
Season	651.03	1103.54	752.32
Rep	50.88	11.88	56.36
Rep (season)	8.30	13.65	9.64
Trt	3.70*	7.03**	3.63*
Trt * season	2.87	2.75	1.81
Grand mean	35.9	36.6	33.0
C.V. (%)	4.27	4.60	4.55

Note: Means followed by * is significant at 0.05

There was significant effects on SPAD at all growth stages (Table 6). No significant interaction between treatment and season. At 35 DAT, T28 contributed to highest significant reading with value of 36.7 while T20 was the significant lowest with value 35.0 (Figure 11). The difference was 1.7%. At 55 DAT, both T11 and T15 recorded highest significant reading with value of 37.8 and 37.7 respectively. Both T26 and T28 contributed to lowest significant reading with value of 35.4. At 90 DAT, T1 scored the highest significant reading with value of 33.7 while T26 contributed to lowest which is 31.9.

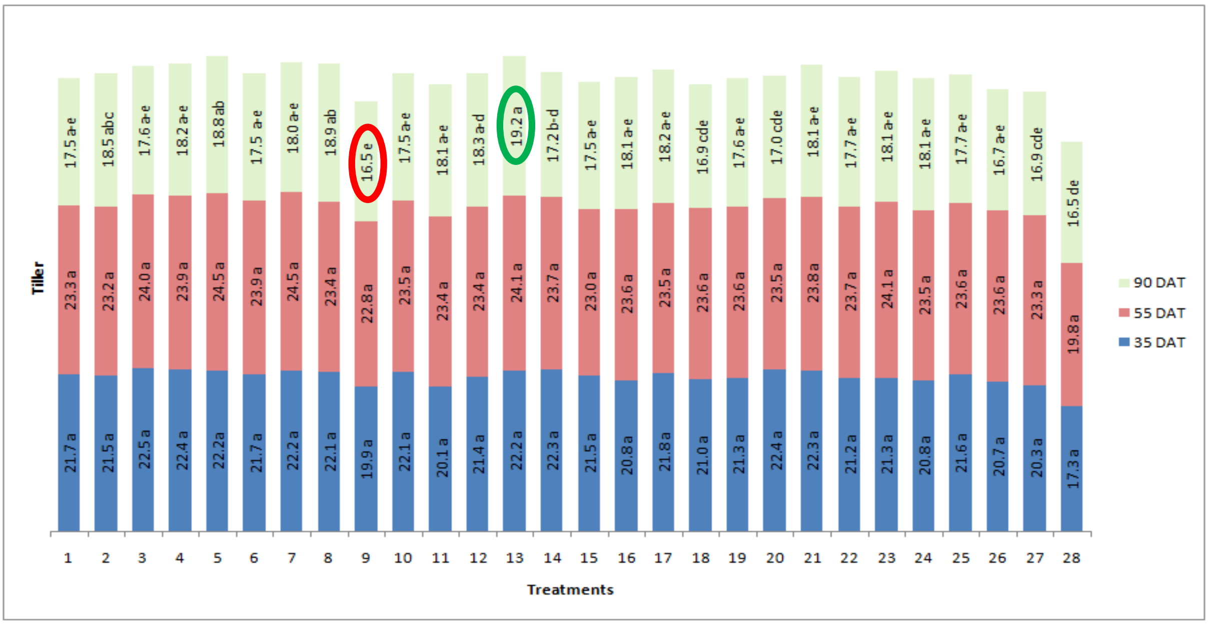

Figure 9. Effect of IBG Multipurpose Bio Fertilizer on Tiller Number.

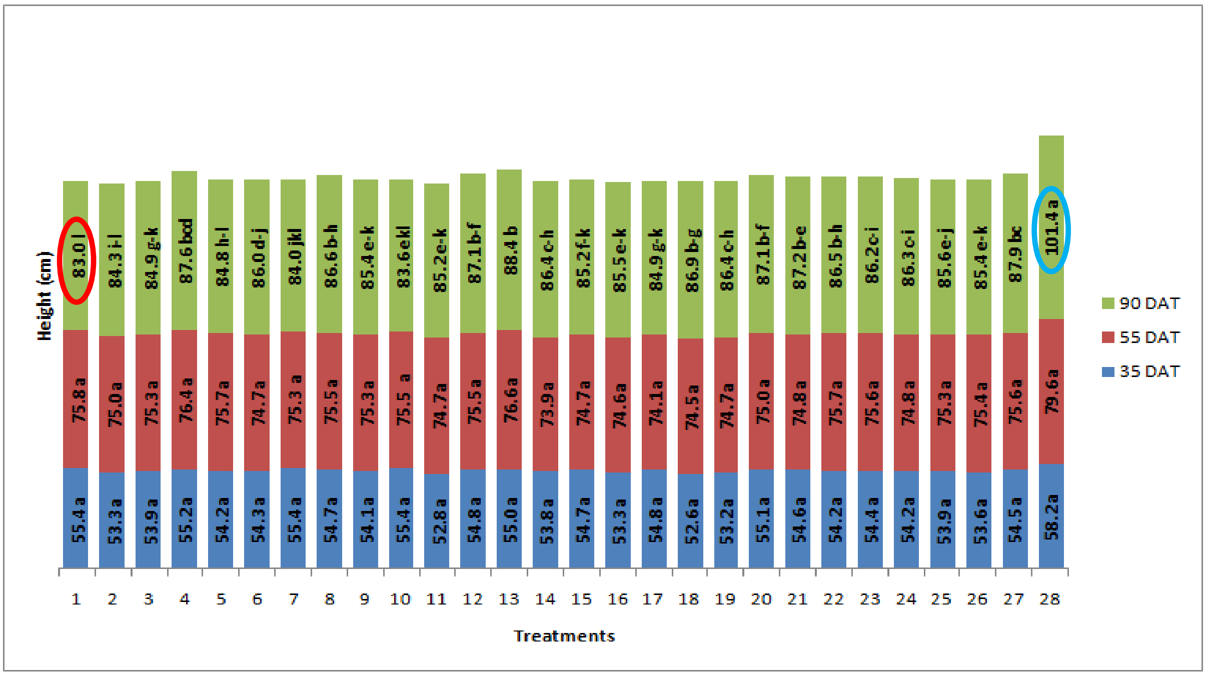

Figure 10. Effect of IBG Multipurpose Bio Fertilizer on Height.

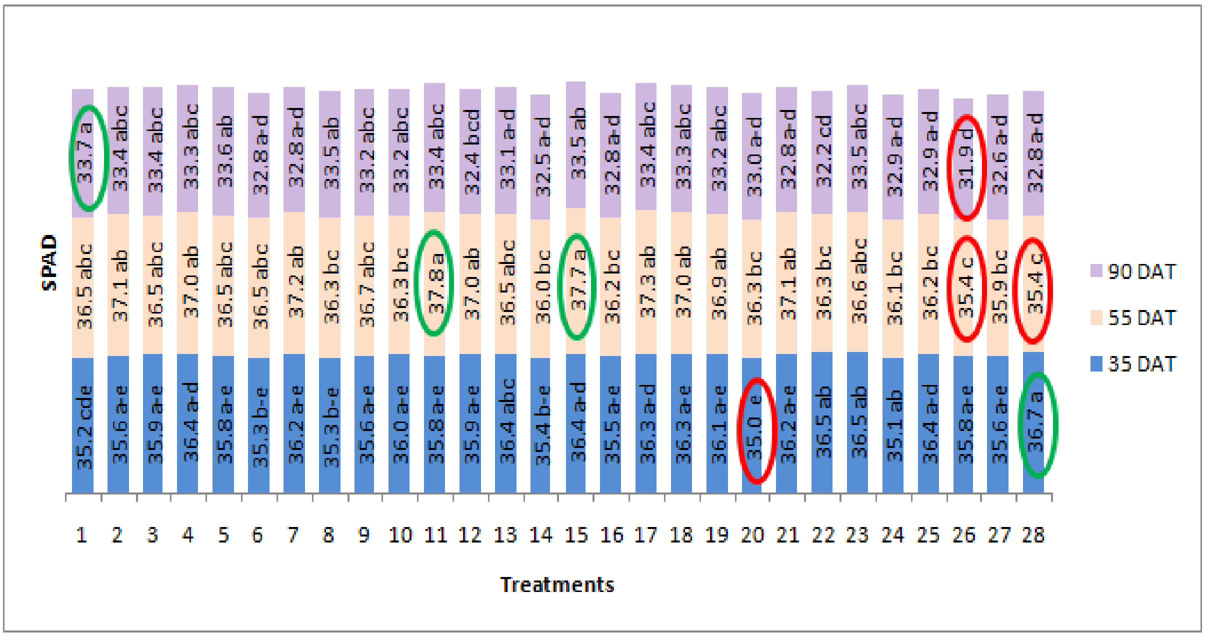

Figure 11. Effect of IBG Multipurpose Bio Fertilizer on SPAD.

4. CONCLUSION

Application T17 (combination of 50:50 (IBG:subsidy) ratio with dosage of 5 L/ha) was concluded the best overall treatment since it exhibited highest significant yield in season 3, 4 and 6. Panicle number is both significantly affected by treatment and positively correlated with yield. Proper used of the product in combination with chemical fertilizer could increased microbe population which could leads to the positive increment in soil nitrogen, phosphate, kalium and conductivity.

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APPENDIX

Table 7. Correlation for yield components with yield

	Panicle number	Percent filled	Panicle length	1000 grain weight	Spikelet per panicle	Harvest index	Yield
Panicle number	1	0.10	0.27	-0.10	-0.05	0.40	0.58
		*	**	*	ns	**	**
Percent filled		1	-0.05	0.07	0.39	-0.20	0.31
			ns	ns	**	**	**
Panicle length			1	0.10	-0.06	-0.03	0.03
				*	ns	ns	ns
1000 grain weight				1	-0.09	0.03	-0.02
					*	ns	ns
Spikelet per panicle					1	-0.44	0.15
						**	**
Harvest index						1	-0.06
							ns
Yield							1

Table 8. ANOVA test analysis of TPC (season 0 with season 6)

	Treatment	log10		SS total		SS Within
Before application	T1	5.633468		0.248402		0.000899
	T2	5.740363		0.153276		0.005916
	T3	5.755875		0.141371		0.008542
	T4	5.672098		0.211389		7.48E-05
	T5	5.716003		0.172943		0.002762
	T6	5.544068		0.345509		0.014252
	T7	5.724276		0.166131		0.0037
	T8	5.623249		0.258693		0.001616
	T9	5.770852		0.130333		0.011535
	T10	5.643453		0.23855		0.0004
	T11	5.623249		0.258693		0.001616
	T12	5.755875		0.141371		0.008542
	T13	5.70757		0.180029		0.001947
	T14	5.792392		0.115244		0.016626
	T15	5.591065		0.292468		0.00524
	T16	5.662758		0.220064		4.79E-07
	T17	5.716003		0.172943		0.002762
	T18	5.579784		0.304797		0.007
	T19	5.770852		0.130333		0.011535
	T20	5.50515		0.392775		0.025059
	T21	5.50515		0.392775		0.025059
	T22	5.568202		0.31772		0.009072
	T23	5.633468		0.248402		0.000899
	T24	5.70757		0.180029		0.001947
	T25	5.643453		0.23855		0.0004
After application	T1	6.50515		0.139339		0.009051
	T2	6.544068		0.169909		0.003161
	T3	6.568202		0.190387		0.001029
	T4	6.579784		0.200628		0.00042
	T5	6.531479		0.159689		0.004735
	T6	6.60206		0.221081		3.14E-06
	T7	6.623249		0.241456		0.000527
	T8	6.612784		0.23128		0.000156
	T9	6.591065		0.210862		8.51E-05
	T10	6.612784		0.23128		0.000156
	T11	6.653213		0.2718		0.002801
	T12	6.491362		0.129236		0.011865
	T13	6.623249		0.241456		0.000527
	T14	6.612784		0.23128		0.000156
	T15	6.623249		0.241456		0.000527
	T16	6.643453		0.261719		0.001863
	T17	6.740363		0.370266		0.019621
	T18	6.653213		0.2718		0.002801

	T19	6.491362		0.129236		0.011865
	T20	6.556303		0.180145		0.001935
	T21	6.60206		0.221081		3.14E-06
	T22	6.690196		0.31173		0.008084
	T23	6.681241		0.301811		0.006554
	T24	6.70757		0.331433		0.01151
	T25	6.672098		0.291848		0.005157
	Total average	6.135972	Total	11.435	Total	0.271992

*T26, T27 and T28 as a control and not include in ANOVA calculation

df between=1

df within=50-2=48

$F(1,48)=4.043$ $(P<0.05)$

SS between= SS total-SS within=11.163

Mean square between=SS between/df between=11.163

Mean square within=SS within/df within=0.271992/48=0.0056665

F=Ms between/Ms within=11.163/0.0056665=1969.999

1969.999>4.043, reject H_o hipotesis

Season 0 and season 6 have significant different