BioAg Demonstration

Pakistan Rice Production Trial 2012

Pakistan	2012
Location	Year
Land Resources Research Institute National Agriculture Research Centre BioAg Australia	Rice
Conducted by	Crop
Randomised block	
Trial Type	

Introduction

In 2012, BioAg commissioned Pakistan's National Agricultural Research Centre (NARC) to evaluate the performance of BioAg products on rice growth and yield. The project became a collaborative venture between Land Resources Research Institute (LRRI), National Agricultural Research Centre (NARC) Islamabad-Pakistan and BioAg Australia.

The field and greenhouse experiments were undertaken by LRRI, while funding and the products for evaluation were provided by BioAg.

The field experiments were conducted at the Rice Research Institute, Kala Shah Kaku, Lahore while the greenhouse experiment was undertaken at LRRI, Islamabad.

The trials commenced with site selection and soil testing in June 2012, and concluded at harvest in November of the same year. The final report was received March 2013.

The principal findings of the field trial were as follows.

The most favourable results were achieved by substituting 50% of the phosphorus applied as DAP with *BioAgPhos*® (as units of P), and the application of BioAg's liquid nutrients *Soil & Seed*® (6L/ha), *Balance & Grow*® (L/ha) and *Fruit & Balance*® (2L/ha) at the recommended times after planting. This protocol is described in the report as 'Treatment T4'.

The benefits achieved were:

- An increase in grain weight (g per 1,000 grains) – a measure of crop quality – of 21.4%
- An increase in crop yield of 8.2%
- An increase in return on investment (ROI), as measured by the additional revenue received on the sale of the crop over the increase in input costs, of 19%.

In the greenhouse trials at Land Resources Research Instituted (LRRI):

- The plants under Treatment T4 maintained better electrical conductivity (Ec) throughout the cropping period compared with the control. Electrical conductivity provides a measure of plant available nutrients.
- Plant height and root biomass at 60 days after planting were significantly higher in the plants under Treatment T4 than those of the control.

Evaluation of BioAg Products on Rice Growth in Pakistan

Studies have been initiated to evaluate the performance of BioAg products on rice growth and yield. This is a collaborative venture between Land Resources Research Institute (LRRI), National Agricultural Research Centre (NARC) Islamabad-Pakistan and M/S BioAg (Pvt) Australia. Field and greenhouse experiments were undertaken by LRRI, while funding as well as testing products were provided by M/S BioAg (Pvt) Australia through PATCO, Islamabad. Field experiments were conducted at Rice Research Institute, Kala Shah Kaku, Lahore while greenhouse experiment was initiated at LRRI, Islamabad. Various activities carried out are detailed below.

Field Experiment

Plot Selection and Soil Analysis

A plot measuring 40m x 60m was selected at Agricultural Farm, Rice Research Institute, Kala Shah Kaku, Lahore. The field is under Rice-Wheat rotation for many years. The field was not cultivated since wheat harvest (May 2012). On June 13, 2012, the field was visited and samples were collected at two depths i.e. 0-15 and 15-30cm to determine fertility status of the selected plot presowing rice trial. The samples were analysed for various physic-chemical determinations. Table 1 indicated fertility status of soil before sowing rice trial.

Field Preparation

After field selection, the plot was ploughed with two passes of disk ploughing during the last week of June. On July 5, the plot was flooded and puddling was performed periodically. The plot was kept constantly flooded during the puddling operation. The last puddling pass was done on July 17 and the plot was finally ready for transplanting.

Layout and Transplanting

As per instructions received by M/S BioAg, Australia, a layout plan was prepared. There were 5 treatments and 4 replications of each assigned in randomised complete block design. Each individual plot measured was 5 x 5= 25m^2.

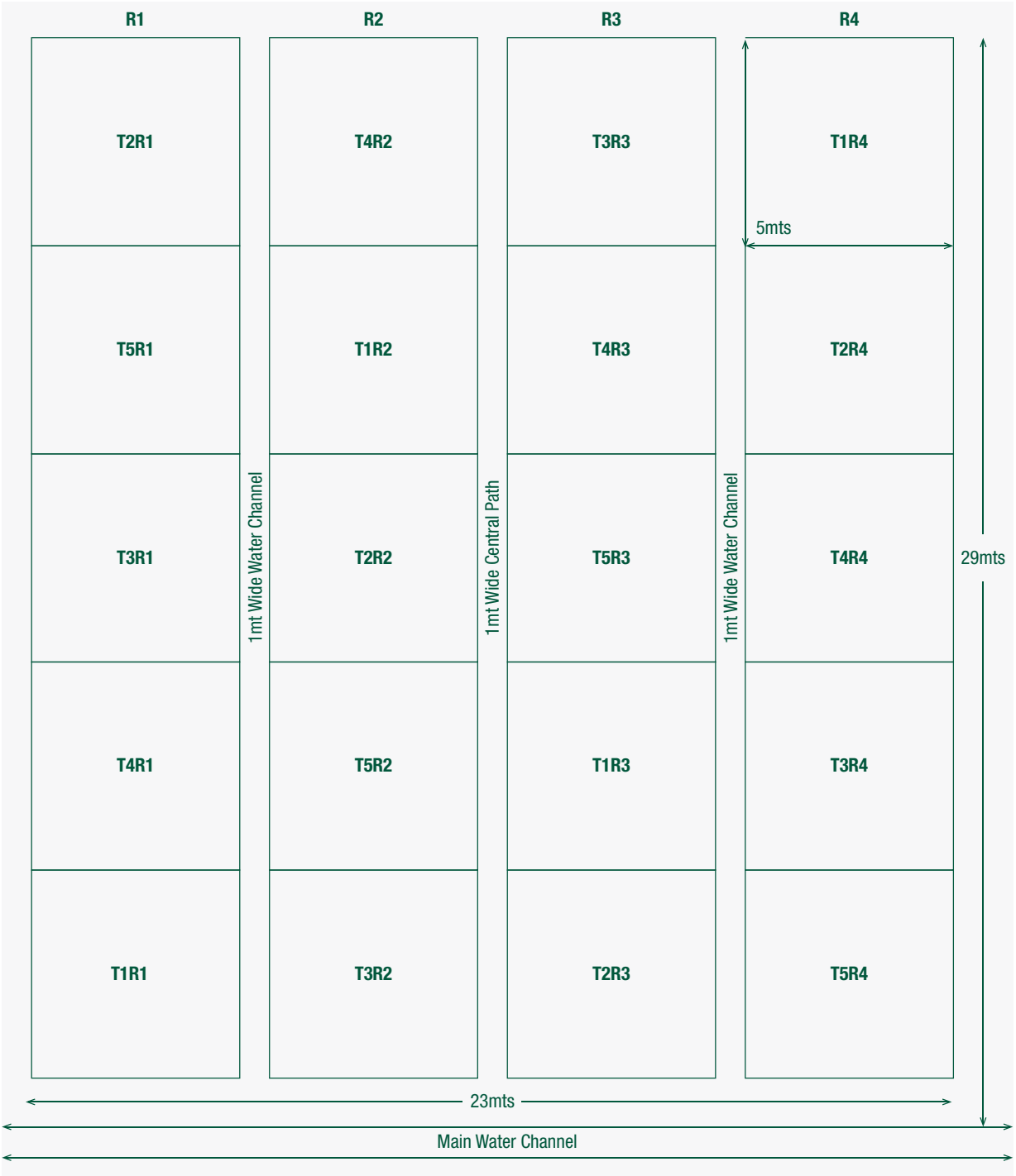
‘Super Basmatti’ was the rice variety used, rice was first cultivated in a nursery (Figure 1) then transplanted manually to the plots at 25 days, July 18, 2012 (Figure 3). The plot was laid out (Figure 2) according to the layout plan.

Table 1 – Soil analysis report

Determination	Unit	Soil Depth (cm)	
		0-15	15-30
Soil pH (1:1)	–	7.78	7.55
Soil Ec (1:1)	–	0.47	0.65
Organic Matter	(%)	0.46	0.97
P	(mg kg^{-1})	2.64	1.32
K	(mg kg^{-1})	80	94
NO_3-N	(mg kg^{-1})	1.27	1.55
Fe	(mg kg^{-1})	31.63	32.08
Cu	(mg kg^{-1})	1.62	1.68
Zn	(mg kg^{-1})	0.96	1.28
Na	(mg kg^{-1})	180	368
Sand	(%)	20	19
Silt	(%)	50	48
Clay	(%)	30	31
Textural Class	–	Silty Clay Loam	Silty Clay Loam

Layout of Field Experiment

BioAg Product Evaluation in rice at KSK, Lahore



No. of Treatments	5
No. of Replications	4
Plot Size	5 x 5=25m^2
Variety	Super Basmatti
Date of Transplanting	18/07/2012

T1	Standard Fertiliser (SF)
T2	SF + *Soil & Seed (S&S)*
T3	*S&S* + Bio P (25% DAP + 75% Bio P)#
T4	*S&S* + Bio P (50% DAP + 50% Bio P)#
T5	*S&S* + Bio P (50% DAP + 50% Bio P+ low K)*

N and K was applied at the same rates and same products as T1

* N was applied at the same rate and same products as T1

List of Treatments

T1 Control; Standard fertiliser as applied in Pakistan (110:60:60; NPK applied as urea, DAP and MOP).

T2 Standard fertiliser + application of BioAg products at recommended times and rates.

T3 75% of P substituted by *BioAgPhos* in addition to application of BioAg products at recommended rates and time.

T4 50% of P substituted by *BioAgPhos* in addition to application of BioAg products at recommended rates and time.

T5 50% of P substituted by BioAgPhos with ½ dose of MOP in addition to application of BioAg products at recommended rates and time.

Figure 1 – Uprooting of rice at the nursery

Figure 2 – Trial layout being performed

Figure 3 – Transplanting of nursery rice in the field

Bund Making and Treatment Application

At transplanting the treatment was not applied as the plot was freshly puddled (a prerequisite for transplanting). Therefore the soil was muddy and unstable. An excessive quantity of water was standing in the plots. This restricted the making of boundaries (bunds) around each plot. Application of fertiliser treatments in the absence of boundaries was meaningless because of easy movement of fertiliser nutrients, particularly of N, between the plots. On July 21, 2012, the boundaries were made around each plot after muddy soil had settled down and excessive standing water had dried. Fertiliser treatments were also applied as per the layout plan to each plot. BioAg product *Seed & Soil* was applied as spray in respective plots. After treatment, the application plot was flooded again.

Crop Management

All agronomic practices were carried out as and when required to meet crop needs and weedicide 'Clover' was sprayed two times to control weeds. The experimental field was irrigated with canal water throughout the growth period. Application of BioAg product *Balance & Grow* was performed on September 12, 2012 and *Fruit & Balance* on October 5, 2012. The crop was continuously monitored during growth for insect pest infestation and irrigation requirement, and remedial measures were taken promptly, as and when required.

Mr. Safdar Hussain from BioAg Australia visited the field experiment on September 12, 2012 at Kala Shah Kaku, Lahore and observed crop growth performance on site (Figure 4-5).

At the booting stage flag sampling of rice plants was performed. The leaves were air dried, ground, and digested for N, P and K analysis. At maturity, agronomic data was recorded and the crop was harvested.

Figure 4 – Field visit of rice experiment at Rice Research Institute, Kala Shah Kaku, Lahore on September 12, 2012

Figure 5 – Evaluation of crop growth performance and application of BioAg product Balance & Grow to rice

T2R3

T5R4

T3R4

T2R4

BioAg *Balance & Grow* being applied

Pest scouting

Chemical Analysis of Recently Mature Leaves at Panicle Initiation Stage (Flag Leaf)

Flag leaf sampling was done and N, P, K concentrations were determined to ascertain if these nutrients were within the optimum range. Figure 5 indicated N, P and K concentrations in rice flag leaves. The data indicated that all three elements were within limit. Variation in N concentration was significant. Treatment 2 showed symptoms of the highest N concentration followed by T4, T3 and T5. Visual observations of the crop did not show any symptoms of N deficiency.

Variation in plant P concentration in flag leaf (Figure 5b) indicated that T2 had higher P concentrations than T1. All other treatments had lower P levels than T1. None of the treatments showed P deficiency during crop growth.

Potassium (K) concentration in rice flag leaf (Figure 5c) indicated significant variation. Treatment 4 showed greater K concentration than T1. But T2, T3 and T5 had lower K concentrations. K concentrations in all treatments were within target range.

Figure 5a – Effect of BioAg treatments on N concentration in rice flag leaf

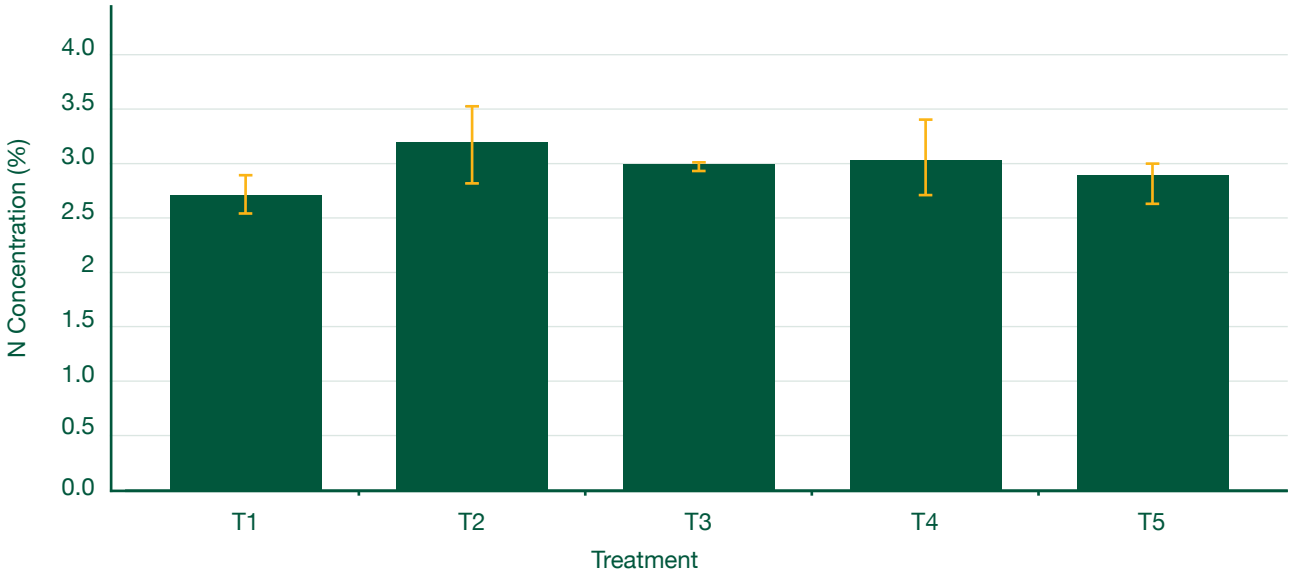


Figure 5b – Effect of BioAg treatments on P concentration in rice flag leaf

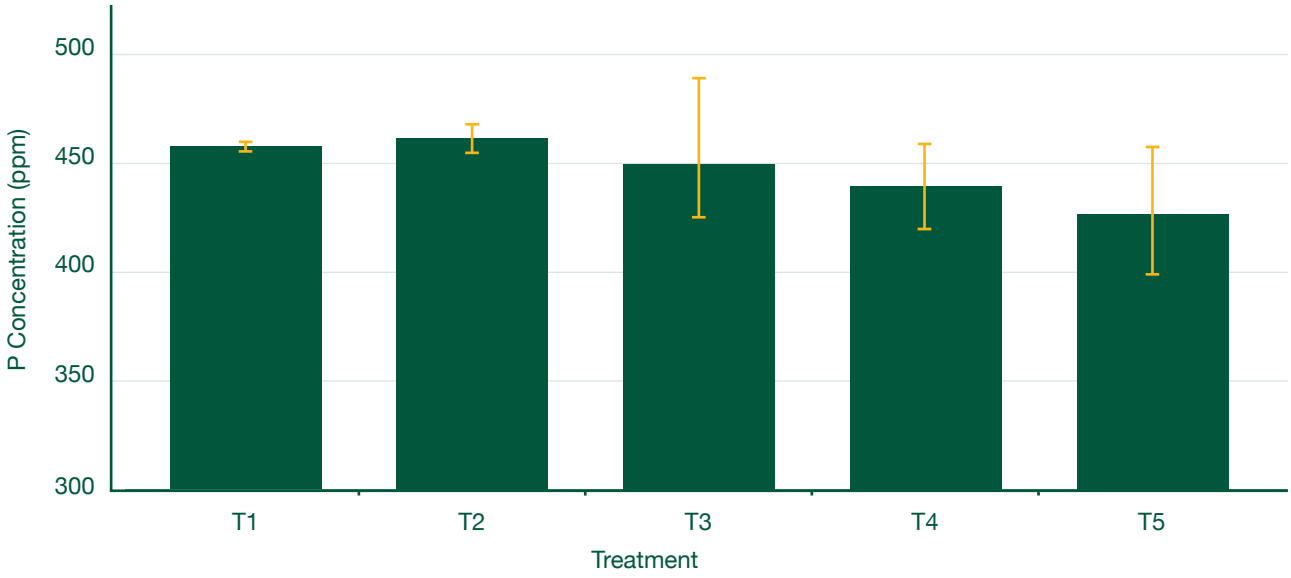
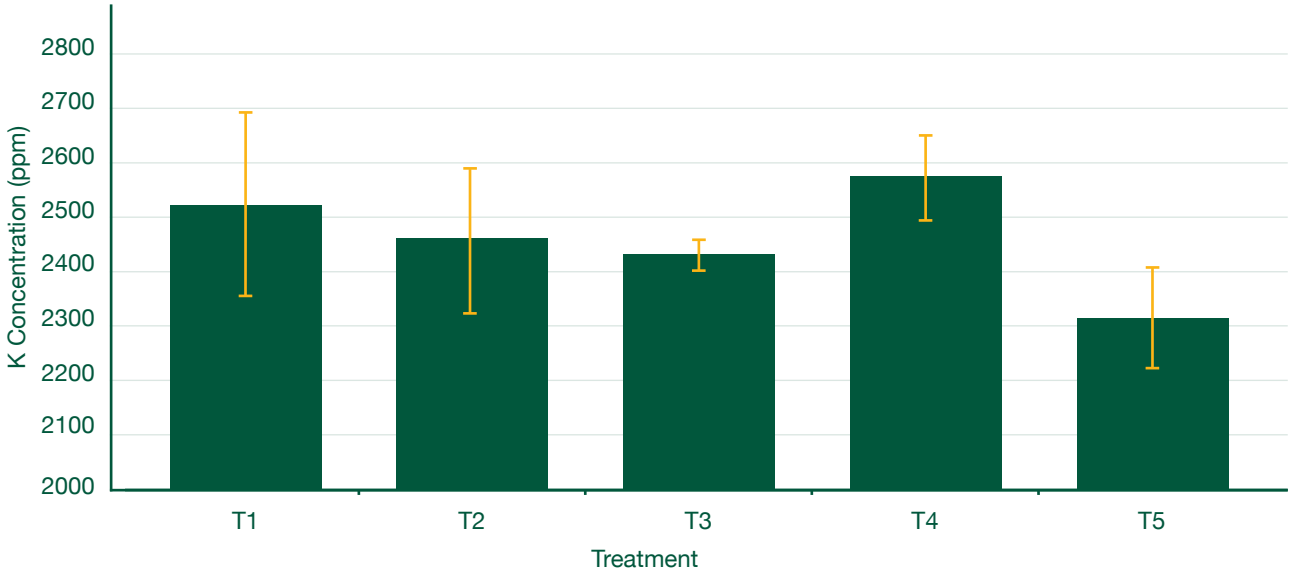


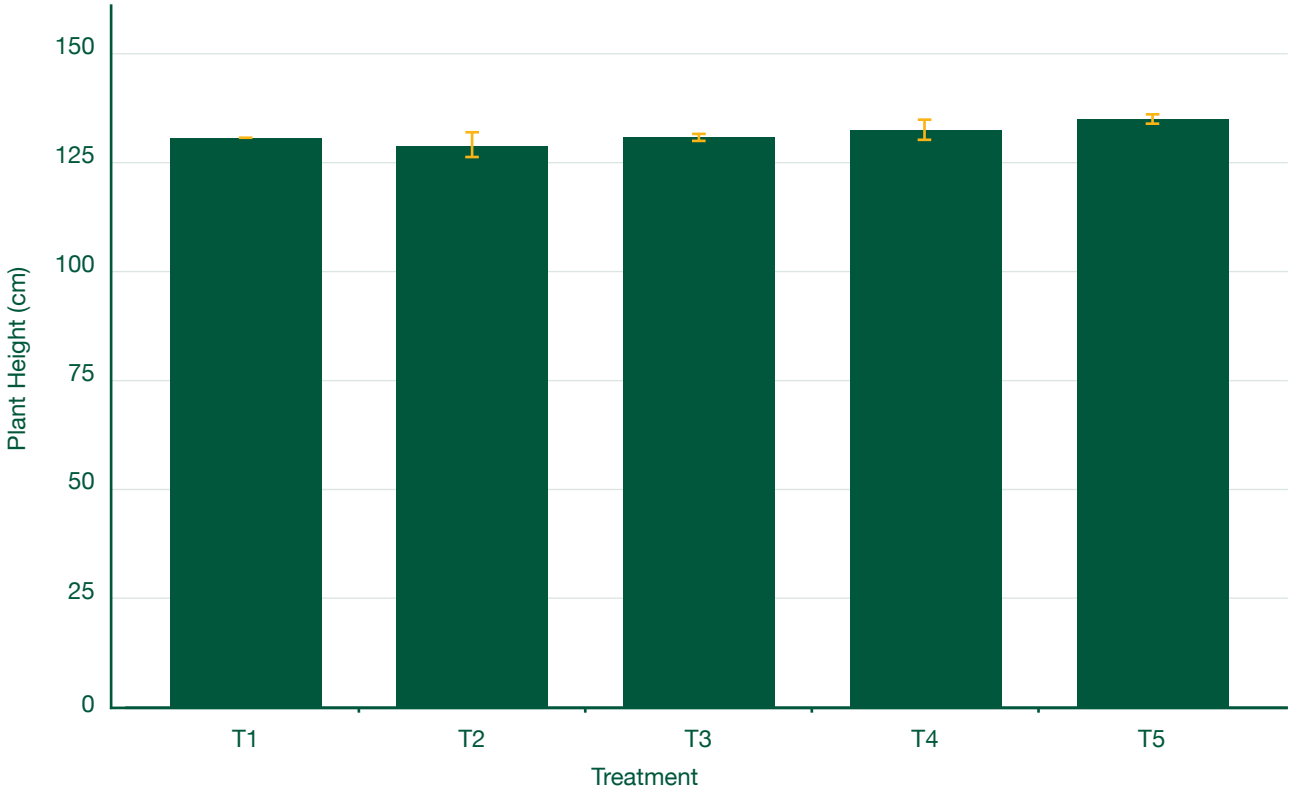
Figure 5c – Effect of BioAg treatments on K concentration in rice flag leaf



Plant Height

Plant height variation in 124 days old rice variety Super Basmatti is presented in Figure 6. Analysis revealed that there was not a significant treatment effect on plant height at the probability level 0.05. But treatment 3 showed the highest mean plant height. Plant height recorded on 30, 60, 90 days also did not show any difference in plant height.

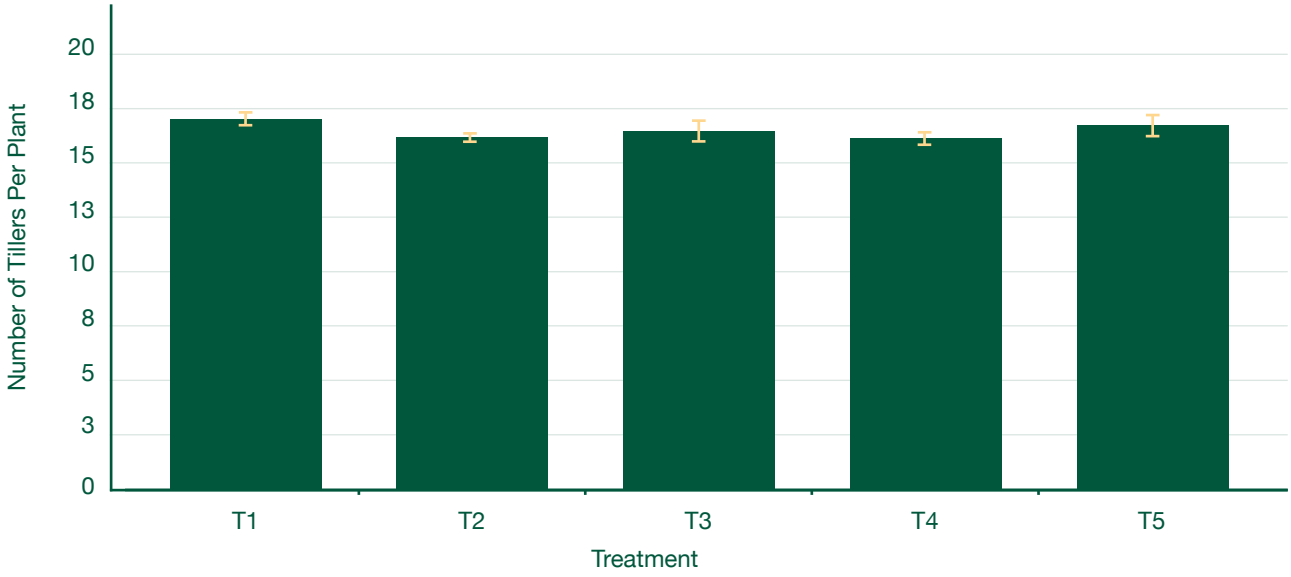
Figure 6 – Variation of plant height in different treatments of 124 days old rice plants



Number of Tillers Per Plant

Data on the number of tillers per plant are provided in Figure 7. These show that there was no significant treatment effect on the number of tillers per plant. Visual observation recorded during crop growth also gave similar results.

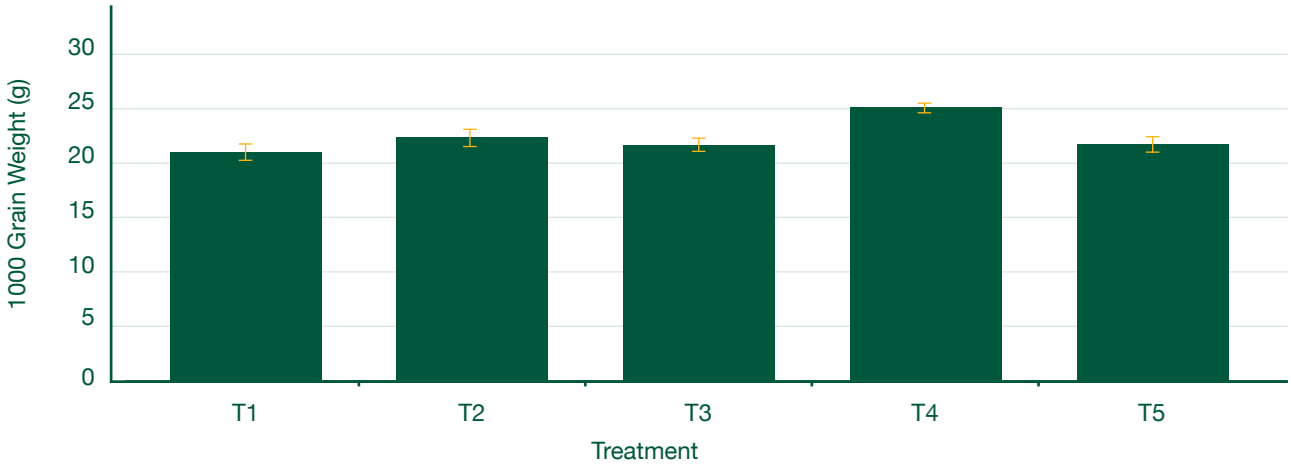
Figure 7 – Effect of different BioAg treatments on the of number of tillers per plant in 124 day old rice



1000 Grain Weight (g)

Figure 8 shows the effect of BioAg treatments on 1000 grain weight in paddy. The data revealed that various treatments affected 1000 grain weight significantly at the probability level 0.05. Treatment 4 showed the highest 1000 grain weight.

Figure 8 – Effect of different BioAg treatments on 1000 grain weight of paddy



Reproductive Maturity and Paddy Yield

Time taken to 50% panicle initiation under different fertiliser treatments did not show any significant difference (data not shown). Rice yield under different fertiliser treatments is provided in Figure 9. Statistical analysis revealed that there was a significant treatment effect on paddy yield (kg/ha) at the probability level 0.05.Highest (8.2%) grain yield was recorded in treatment 4 followed by the treatment 2 (6.2%) and treatment 3 (4.9%). Treatment 5 had lower yield than control (T1).

Economic Analysis

The economic analysis of various BioAg products is presented in Table 2. Statistical analysis revealed that there was a significant treatment effect on gross revenue per unit area. Highest gross revenue was recorded in T4 followed by T2 and T3. T5 gave lower gross revenue than the control treatment.

Figure 9 – Effect of different BioAg treatments on paddy yield of rice

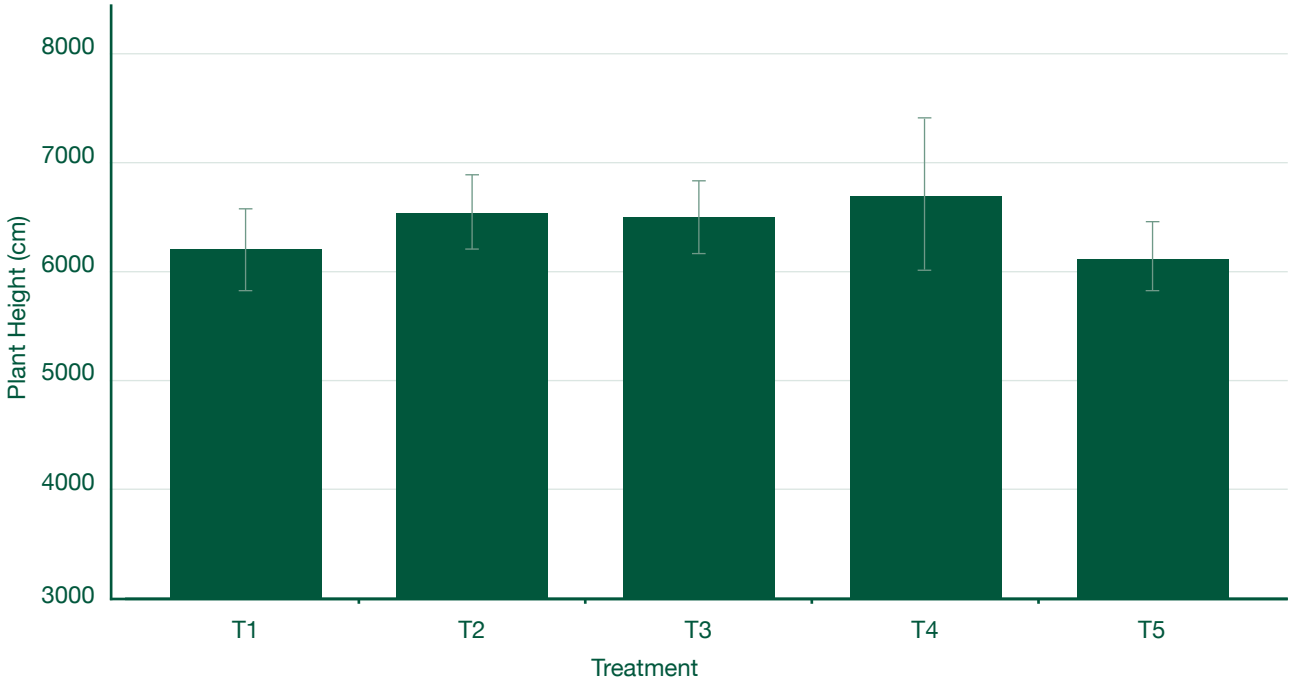


Table 2 – Economic analysis of BioAg product application

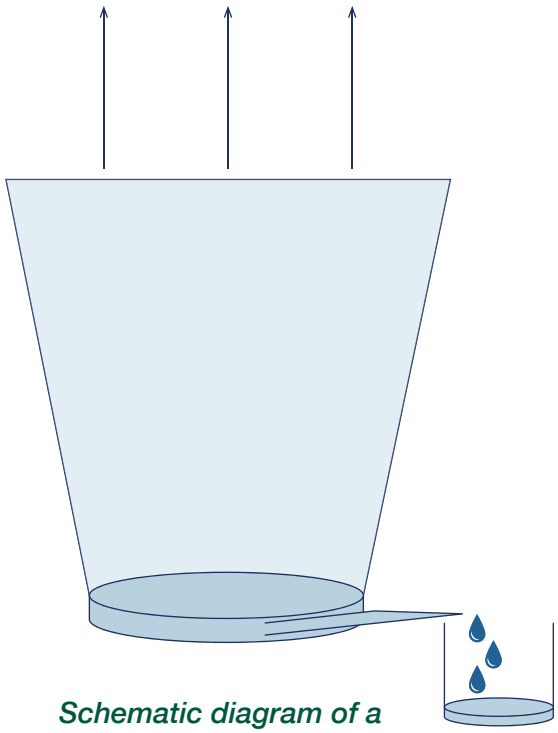
	Height (cm)	Tillers/m^2	1000 Grain Weight (g)	Yield (T/ha)	Fertiliser Cost (PKR) per ha	Value of Rice (PKR) per ha	Gross Revenue (PKR) per ha
T1	130.0	328	38.2	6.21	38,088	302,884	264,796
T2	129.0	343	40.8	6.58	42,588	320,726	278,796
T3	130.0	395	39.5	6.49	37,965	316,436	278,472
T4	132.3	317	38.6	6.70	40,720	326,528	285,808
T5	133.3	310	39.7	6.13	38,740	298,838	260,098

Rice value (paddy) per ton (Rs 1950 per 40kg) = Rs 48750/=T

Pot Experiment for Determining Nutrient Leaching and Root Biomass

BioAg fertilisers provide sustained release of nutrients applied. A greenhouse study was undertaken to determine this behaviour. Surface soil from the same field where the field trial was planted was brought to NARC. The soil was prepared and 10kgs of soil was filled in each pot. Prior to filling soil was mixed with BioAg fertilisers. A schematic diagram is provided.

Pots were filled with soil leaving 3 inches of space at both the top and bottom. Space at top was left to receive irrigation water while the space at bottom was used to collect leachate. The bottom space was filled with sand (~1mm diameter). Treatments equivalent to the field experiment were applied and 3 plants of the same rice variety were transplanted on August 8, 2012. Leachate on weekly intervals was collected and analysed for N, P and K. Further, plants after 30, 45 and 60 days were extracted and data on plant height, tillering and root biomass were recorded.



Schematic diagram of a leaching pot experiment

On August 13, 2012, Mr. Safdar Hussain from BioAg visited NARC. He was briefed about the ongoing activities, particularly the pot experiment, to discuss the mechanisms governing nutrient release rate and nutrient availability for plant growth.

An overview of pot experiment at soil-plant headhouse, NARC

Effect of BioAg Treatments on Soil Solution (Leachate) Collected on Different Days After Transplanting

Effect on solution pH

Data on the effect of treatments on chemical composition of soil solution (leachate) collected on 15, 30, 45 and 60 days is presented below. Table 1 indicated that changes in pH varied significantly with time. The pooled data indicated that application of BioAg products resulted in significantly increased pH values throughout the growth period. The pH value in the T5 treated pot was highest (7.84) followed by T4 (7.72), T3 (7.66) and T2 (7.64). Treatment 1 had the lowest pH throughout the study period. Variation in solution pH among various days was also significant. On the 30th day the highest pH was recorded followed by day 45 and day 15. On the 60th day the lowest pH was recorded.

Table 1 – Effect of BioAg treatments on pH of solution (leachate) collected on different days after rice transplanting

Treatments	Days After Transplanting (DAT)				Means
	15	30	45	60	
T1	7.48	8.00	7.52	6.89	**7.47 B**
T2	7.65	8.67	7.34	6.89	**7.64 AB**
T3	7.80	8.78	6.96	7.11	**7.66 AB**
T4	7.98	8.78	7.33	6.80	**7.72 AB**
T5	8.04	9.09	7.35	6.91	**7.84 A**
Means	**7.79 B**	**8.66 A**	**7.30 C**	**6.92 D**	–

LSD value at α 0.05 for sampling days = 0.261

LSD value for treatments = 0.258

LSD value for sampling days x treatments = 0.516

Effect on Ec (dS m^{-1})

Changes in soil solution Ec are presented in Table 2. The data indicated that higher values of Ec were recorded in BioAg treated pots. However, these changes were not statistically significant at 5% probability level. T4 had the highest Ec followed by T3. The T2 had lower Ec than T1 (control). Variations in solution Ec recorded on different days were significantly greater. Higher mean Ec values were recorded on day 15 (5.17) followed by day 30 (3.93), day 45 (1.45) and day 60 (1.23).

Table 2 – Effect of BioAg treatments on Ec (dS m^{-1}) of leachate collected on different days after rice transplanting

Treatments	Days After Transplanting				Means
	15	30	45	60	
T1	5.18	3.95	1.43	1.20	**2.92 A**
T2	4.23	3.28	0.85	0.91	**2.32 B**
T3	5.16	3.90	2.08	1.29	**3.11 A**
T4	5.87	4.25	1.54	1.30	**3.24 A**
T5	5.41	4.24	1.33	1.36	**3.09 A**
Means	**5.17 A**	**3.93 B**	**1.45 C**	**1.23 D**	–

LSD value at α 0.05 for sampling days = 0.529

LSD value at α 0.05 for treatments = 0.109

LSD value at α 0.05 for sampling days x treatments = 0.557

Effect on NO_3-N (mg kg^{-1}) Concentration

Variations in solution nitrate nitrogen concentration during rice growth period is presented in Table 3. The data indicated that treatments did not differ significantly in NO_3 levels in the solution. However, T4 and T1 had relatively greater NO_3 concentration than other treatments while T2 had the lowest concentrations.

NO_3 concentration on various sampling days differed significantly. The highest value of 133.6 was recorded on day 15. However, NO_3-N concentration decreased rapidly being negligible (non detectable) on day 60.

Table 3 – Effect of BioAg treatments on NO_3-N (ppm) of leachate collected on different days after rice transplanting

Treatments	Days After Transplanting				Means
	15	30	45	60	
T1	145.7	2.30	0.73	0.00	**36.92 A**
T2	103.7	0.87	0.63	0.00	**26.30 A**
T3	136.1	1.73	0.50	0.00	**34.58 A**
T4	146.7	1.47	1.00	0.00	**37.28 A**
T5	135.9	1.30	0.67	0.00	**34.46 A**
Means	**133.6 A**	**1.33 B**	**0.77 B**	**0.00 B**	–

LSD value at α 0.05 for sampling days = 12.61

LSD value at α 0.05 for treatments = 14.52

Effect on NH4-N (mg kg^{-1}) Concentration

Effect of BioAg products application on ammoniacal nitrogen concentration in solution during different days is presented in Table 4. Table 4 indicated that N content varied significantly by application of BioAg products. The highest N content was recorded in T4 followed by T3 and T5. Though three treatments did not differ among each other but were statistically significantly higher than T1 and T2. Both T1 and T2 had lower N contents and had alike N concentrations.

Data further indicated that N concentrations also varied significantly on various days during study period. Higher N concentrations were recorded on day 45 and 60 than earlier period. Significantly lower N concentrations were observed on day 15 and day 30.

Table 4 – Effect of BioAg treatments on NH4-N (ppm) of soil solution (leachate) collected on different days after transplanting

Treatments	Days After Transplanting				Means
	15	30	45	60	
T1	0.80	0.69	1.50	1.29	**1.08 B**
T2	0.44	0.73	1.60	1.23	**1.03 B**
T3	1.72	1.13	1.90	1.63	**1.62 AB**
T4	1.90	1.52	2.67	1.66	**1.69 A**
T5	1.55	1.67	1.74	1.30	**1.31 AB**
Means	**1.08 B**	**0.96 B**	**1.91 A**	**1.42 AB**	**–**

LSD value at α 0.05 for sampling days = 0.487

LSD value at α 0.05 for treatments = 0.61

Effect on K (mg kg^{-1}) Concentration

Potassium (K) concentrations variations in solution (leachate) are presented in Table 5. Analysis revealed that there was statistically significant treatment effect on K concentration at probability level of 0.05. However, significant changes on different days were recorded. The highest K concentration was noted on 60th day.

Table 5 – Effect of BioAg treatments on K (ppm) in leachate collected at different days after transplanting

Treatments	Days After Transplanting (DAT)				Means
	15	30	45	60	
T1	1.58	1.12	1.13	3.09	**1.73 A**
T2	1.81	1.17	1.27	2.66	**1.73 A**
T3	1.69	1.37	1.37	2.62	**1.76 A**
T4	1.27	1.20	1.45	2.49	**1.59 A**
T5	1.28	1.29	1.49	2.51	**1.64 A**
Means	**1.51 B**	**1.23 C**	**1.34 C**	**2.67 A**	**–**

LSD value at α 0.05 for sampling days = 0.156

LSD value at α 0.05 for treatments = 0.233

Effect on P (mg kg^{-1}) Concentration

Variations in solution P concentrations are presented in Table 6. Analysis revealed that there were no statistically significant treatment effects on P concentration at probability level of 0.05. However, T1, T2 and T3 showed highest mean P concentrations. Higher P levels were recorded during early growth period but lower values were noted on later days.

Table 6 – Effect of sampling days and treatments on soil solution P (ppm)

Treatments	Days After Transplanting				Means
	15	30	45	60	
T1	0.49	0.22	0.19	0.107	**0.25**
T2	0.54	0.25	0.09	0.140	**0.26**
T3	0.31	0.26	0.26	0.110	**0.24**
T4	0.11	0.02	0.15	0.100	**0.11**
T5	0.13	0.33	0.13	0.097	**0.17**
Means	**0.32**	**0.23**	**0.16**	**0.11**	–

Effect on Plant Height

Variations in height of 15, 30, 45 and 60 day old rice plants are presented in Table 7. Analysis revealed that plant height in BioAg applied treatments was significantly higher statistically at a probability level of 0.05. Control T1 had the lowest height. Plant height also varied with the age of the plants.

Table 7 – Effect of sampling days and treatments on plant height (cm)

Treatments	Days After Transplanting (DAT)				Means
	15	30	45	60	
T1	33.60	47.23	56.77	60.10	**49.43 B**
T2	31.77	48.60	69.93	71.10	**55.35 A**
T3	31.60	44.53	68.80	71.47	**54.10 A**
T4	32.53	49.73	69.83	69.17	**55.32 A**
T5	33.53	50.23	70.50	71.03	**56.33 A**
Means	**32.60 C**	**48.70 B**	**67.17 A**	**68.57 A**	–

LSD value at α 0.05 for sampling days = 3.26

LSD value at α 0.05 for treatments = 3.44

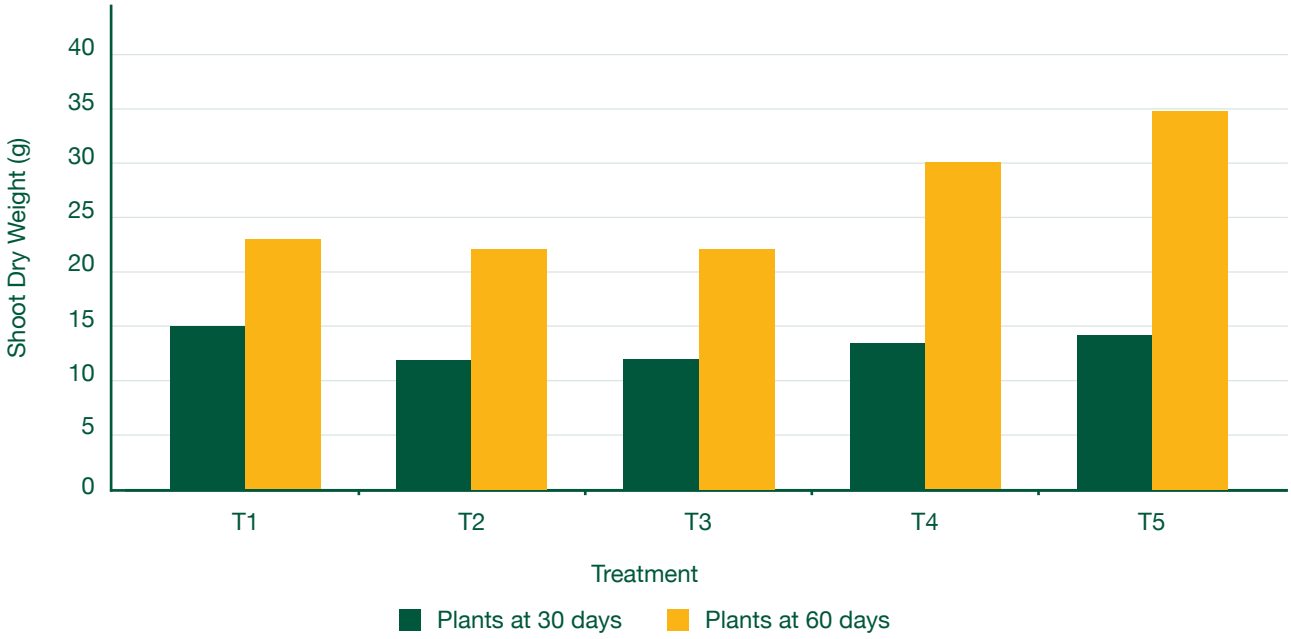
LSD value at α 0.05 for sampling days x treatments = 6.88

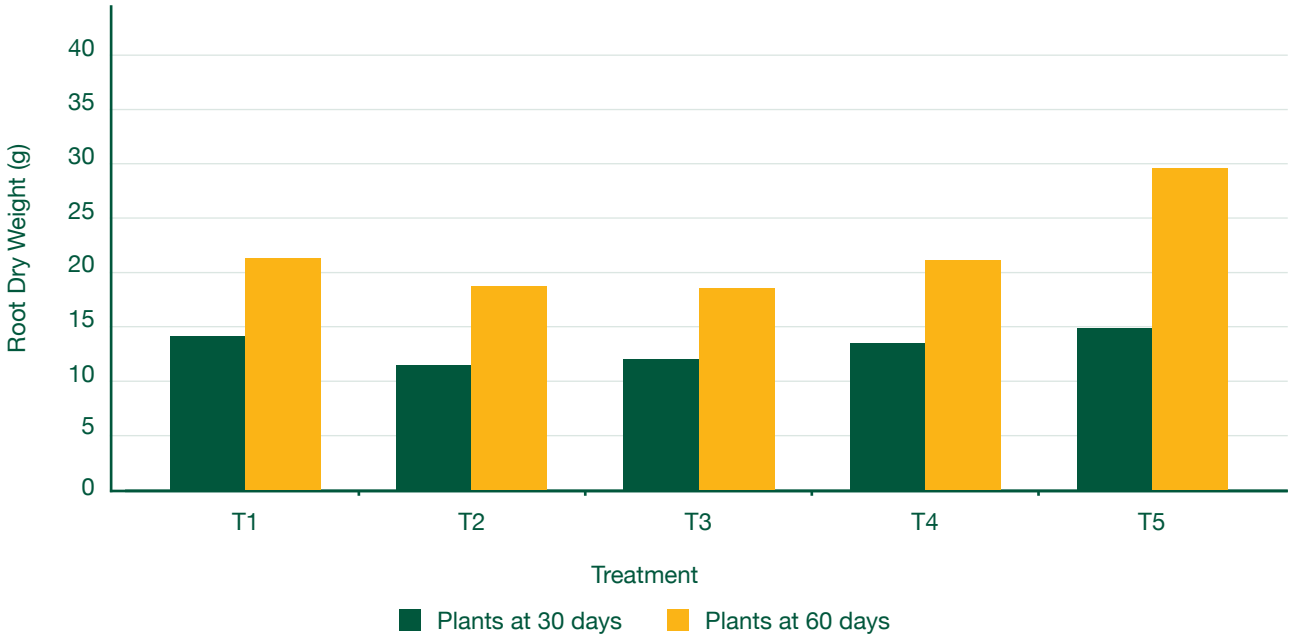
Root and Shoot Biomass in 30 and 60 Day Old Rice Plants

Rice plants were extracted on day 30 and day 60 and their roots and shoots were separated. The roots and shoots were washed, dried and photographed before recording dry root weights. The results are presented below. Results revealed that there was no significant treatment affect on root biomass on day 30 but relatively intense rooting was recorded on day 60.

Dry root and shoot weight data is presented in Figure 10. Data indicated that dry weights were affected significantly for 60 day old plants. Higher biomass weights were found in T4 and T5 both in root and shoots.

Figure 10 – Shoot and root dry weights of rice plants





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