ASSESSMENT OF TOTAL FAT CONTENT AND YIELD INCREASE IN SOME RICE CULTIVARS UPON ADDITION OF ZN AND B.

MUHAMMAD ABBAS BHUTTO[1], FAIZA ANWAR[2,3], MOHEYUDDIN KALOI[4], RIAZUDDIN[2], ALI HASSAN MARI[4], SAJID IQBAL[5], ANUM HAFEEZ[3]

[1]AZRI (TFS) PARC, Department of Botany, Shah Abdul Latif University, Khairpur.
[2]Food Quality & Safety Research Institute, Pakistan Agricultural Research Council, University Of Karachi.
[3]Federal Urdu University of Arts, Science & Technology Karachi.
[4]NSTHRI, Pakistan Agricultural Research Council, Thatta.
[5]Department of Education & Literacy, Government of Sindh.
Corresponding author e-mail: faizaanwar488@gmail.com

Abstract

The experiment to investigate the impact of Zn and B on yield of some rice cultivars was carried out during 2013 to 2015 at the experimental field of Shaheed Benazir Bhutto Rice Research Institute (previously RRI) Dokri, Larkana. Five rice varieties (IR6, IR8, DR92, DR83 and Shahkar) were selected for the purpose. B at 5 $Kgha^{-1}$ as Boric Acid (H_3BO_3) in addition to Zn at 15 $Kgha^{-1}$ as Zinc Sulphate di-hydrate ($ZnSO_4.2H_2O$) along with recommended doses of nitrogen as Urea $CO(NH_2)_2$; phosphorus as DAP $(NH_4)_2HPO_4$ were applied in each plot with treatments viz. control (N+P); T1 (N+P+Zn) and T2 (N+P+Zn+B). Yield (tons ha^{-1}) of paddy rice was calculated as total paddy weight Kg/plot /15X10000/1000. Data statistically was analyzed using SPSS software version 17. Differential insignificant ($P<0.05$) response by cultivars was found over application of control (nitrogen and phosphorus only) whereas application of both Zn and B in joint venture with recommended doses of N and P paddy yield of cultivars increased significantly ($P<0.05$) by 44.83 to 60.29 percent. The harvest years irrespective of varieties showed no significant impact, whereas varieties were found to be important factor that showed differential responses upon yield, might be due to parental inheritance impact upon all fertilizer applications in each harvest year. Application of recommended doses of N and P along with B and Zn at 5.0 and 15 $Kgha^{-1}$, respectively boosted the profitability by increasing yield quantum of paddy rice.

Introduction

Agriculture is the largest income generating sector in Pakistan (GOP, 2011). Different type of crops that are cultivated in Pakistan include; cotton, sugarcane, banana, rice, wheat, different type of fruits and vegetables. Wheat (Triticum aestivum) and rice (*Oryza sativa*) are the major cereal crops that besides fulfilling the domestic food demand huge quantities of these crops particularly rice is also exported to the rest of world. Rural economy and prosperity and livelihood of farmers is of this country is dependent on rice cultivation; production and processing. Sindh province alone contributes about one and half million tons (Mollah *et. al.*, 2009).

Food security has become major concern of increasing population of world. It is estimated that the population scores may increase upto two billion in the twenty years of which half of this total increase may be found in Asia continent where rice may be staple food to avoid hunger (Gangaiah and Prasad, 1999). In Pakistan alone food growth rate is only one percent over increasing population growth which is about three percent. According to estimates, by 2025 around seven hundred sixty million tons of rice shall be the regular food stuff for hungry world. Contrary to the future needs, rice production is about thirty five percent less than the actual requirement. Therefore there is pressing need to increase the total areas of cultivation of yielding varieties of rice. The objective may be achieved by executing good agricultural practices and by supplying balanced quantities of required nutrients to the plant. Present study therefore, is conducted to investigate the impact of recommended doses of Boron and Zinc fertilizer's application on five varieties viz: IRRI-6, IRRI-8, DR-83, DR92 and Shahkaar.

Material and Methods

The experiment to assess the effect Zn and Boron fertilizers application allowing with recommended NP doses on yield and fat content of some rice varieties. The experiment was conducted in the experiment plot at Rice Research Institute, Dokri, Larkana was divided into forty five (45) sub-plot of 3x5 m^2. Five rice varieties (IR6, IR8, DR92, DR83 and Shahkar) were selected for the proposed study. Each rice variety grown and the fertilizer doses applied were in Triplicate. Sub plots were design in such a way that each plot was irrigated separately from irrigation channel. This design of separate irrigation was made to avoid the chance of transportation of applied fertilizer doses of one sub-plot to another one adjacent to it. Nursery bed of 3x3m^2 was

prepared separately for each variety. The beds separately were prepared for each variety. Straw and dried leaves were spread in these beds and burnt. All required fertilizers were applied as basal doze and then paddy seed were broadcasted in the nurseries. When seedlings of rice attained the height of approximately 9 cm after 30 days the transplantation was carried out. Three replicates of each treatment and variety were taken and experimental plots in the field were designed respectively.

At 135Kg N, 90Kg P, 10Kg Zn and 2 Kg B per hectare Fertilizer treatment were calculated for each plot and applied as (Control) C: 390.2 g Urea as N + 281g of DAP as P; (Treatment 1)T1: 390.2 g Urea as N + 281g of DAP as P + 150g $ZnSO_4$ as Zn ; (Treatment 2) T2= 390.2 g Urea as N + 281g of DAP as P + 150g $ZnSO_4$ as Zn + 17g Boric acid as B. For nursery bed, all DAP (168.75 g) was applied as basal dose before broadcasting seed and Urea 233 g was applied into two equal split doses – 116.5 g with DAP and remaining 116.5 g when tillers reached to length of 3 cm. After 30 days, the seedlings of rice varieties were transplanted to their respective plot according to experimental layout. Sowing was done following the recommended procedures which include sowing in living with 0.9 cm plant to plant distance. For each experimental plot of 15 m^2 all DAP (281g) was applied as basal dose before transplanting of rice seedlings whereas Urea 390.2 g was applied in two equal split doses; 195.1 after 20 days of transplanting and remaining 195.1 g was applied after 65 days of transplanting or at panicle initiation stage before flowering. Zinc ($ZnSO_4$) 150g and Boric acid (H_3BO_3) 17g were mixed with one Kg of dry soil and broadcasted after twenty days of transplanting and along with first doze of Urea.

The entire harvested paddy crop of particular plot of specific variety was kept separately on the field and then hand threshing was done for all the varieties. Total collected paddy samples of each variety were kept into the polyethylene bags and were brought to the laboratory. Yield in kilogram per plot first was recorded using electrical balance and then were converted into tons per hectare by using formula Yield (Tons ha^{-1}) = total paddy weight (kg) / 15 X 10000. De-husking was done by hand then fat content (%) of the samples were determined. Two g of mashed rice grain samples were dried and extracted using petroleum ether for four hours at condensation rate of 6 drop per hour. Ether was separated from separating funnel and dried in the oven at temperature of 80^oC for thirty minutes and then was cooled down in the desiccator. The samples then were weighed and repeated the oven drying of fat containing beaker. Calculation was done using formula: Crude Fat (%) = Weight of extract - blank reading/weight of mashed rice samples taken X 100.

Results

Data depicted in Fig. 1 shows the mean yield of the studied varieties over three harvested years. Minimum yield (6.8 tons/ha) in a variety DR92 and maximum (8.7 tons/ha) was found in IR6. All of these varieties were found to be insignificantly ($P > 0.05$) different from each other in yield of paddy rice.

Analysis of variance for yield of paddy rice, given in Table 1 shows the effects of treatment, variety and harvest year. Result given in the table indicates the influence of the treatment, variety and harvest year on yield of paddy rice was found to be highly significant ($P<0.001$). However, the magnitude of impact of treatment was found to be much larger followed by variety and year. Influence of interactions was also statistically highly significant. However the impact of T×Y was found to be the lowest.

Data presented in Fig. 2 shows that yield of each variety of paddy rice obtained in control and over treatments, T1 (N+P+Zn) and T2 (N+P+Zn+B). The impact of T1 and T2 on yield of varieties like IR8, DR83 and Shahkar was found to be significantly ($P<0.05$) different over control. Furthermore, in IR6 and DR92, only T2 was found to be significantly ($P<0.05$) different from control.

Yield of all varieties grown under control conditions and upon T1 and T2 addition is shown in Fig. 3. Amongst all the rice varieties, Zn added samples (T1) shown to have higher yield as compared to control samples. However, the significant ($P<0.05$) difference was only found in IR8 and DR83 and Shahkar. While Zn + B added samples (T2) shown to have higher and significant ($P<0.05$) yield as compared to control.

Both treatments increased the yield of all the rice varieties as shown in Fig. 4. However, the increase was higher upon T2. The percent increase upon T1 and T2 were ranging from 16.67 to 34.62 and from 44.83 to 60.29%, respectively. Minimum and maximum increase upon T1 was shown by varieties IR8 and DR83, respectively. The maximum increase upon T2 was found in DR92 followed by DR83 and Shahkar where the differences in their yields among these varieties were statistically insignificant.

On dry weight basis estimates a major fraction around 20 % fat was exhibited in the rice bran. Contents of fat varying from 1.5 to 1.7 % depending on genotype was present in white polished rice grain. Data presented in Fig. 5 showed that mean fat content amongst studied varieties was minimum fat (2.5%) in DR92 and Shahkar and the maximum (2.8%) was in DR83. All of these varieties were found to be insignificantly ($P > 0.05$) different from each other in accumulation of fat in grain of rice.

Analysis of variance for yield of paddy rice, given in Table 2 shows the effects of treatment, variety and harvest year. The table indicated that influence of the variety and year was found to be highly significant

whereas the treatment was found to be insignificant ($P > 0.05$). Influence of all interactions except T×Y was found to be statistically insignificant with the exception of V×HY.

Effects of treatments T1, T2 and control on fat content in all varieties is shown in Fig. 6. It was found that T1 has insignificant effect on fat of all five varieties. With the application of T2 rice varieties of IR6 and DR83 samples shown to have slightly decreased fat content and only DR92 shown to have slightly increment of fat content as compared to control.

On comparison of effects of T1 and T2 on fat content over control on yield in all varieties (Fig. 7). It was found that the slight increase and decrease of fat contents over T2 was found to be statistically insignificant ($P>0.05$). Further, impact of Zn+B (T2) application was found to be statistically insignificant on fat of all the varieties.

It is noticed that both the treatments T1 and T2 has increased the fat content in DR92 by 4 %. In IR6 and DR83, the fat contents were decreased over T1 and T2 by 3.85% and 3.57%, respectively (Fig. 8). However, rest of the varieties remained non responsive over both the treatments.

Discussion

Boron is a mineral which plays important role in cell wall structure its pore size and its function. Deficiency of Boron inhibits growth of tissues specifically reproductive tissue. A boron deficient plant may exert symptoms like necrosis of terminal bud, shedding of fruit and abortion of flower initials. (Brown *et al.*, 2002)

Zinc was discovered to be essential for the growth of living organisms in 1869. Zinc works as a co-factors for several enzymes like oxidase, peroxidase. It plays an important role in nitrogen metabolism, cell multiplication, and photosynthesis. Zinc toxicity can inhibit root growth. Deficiency of zinc cause chlorosis, necrosis, malformed leaves and stunt growth of plant. (Gyana and Premananda 2003)

Yield of paddy grain is a result of holistic factors – environmental and biological that contribute to the yield components. Research results of (Bozdar, 1991) revealed that varietal difference in paddy yield and his results showed difference in yield because of the difference in genotypes. (Brady, 1990; Rajan, 1993) reported that cultivars that produce higher number of effective tillers/hill and high number of grain/panicle gave higher paddy grain yield. Micronutrients such as zinc and boron in rice fields have exerted beneficial effects not only over yield but also on quality of rice grain. Researchers (Brown and Hu, 1997; Cakmak *et al.,* 1997) have reported that application of Zn and B fertilizers in addition to N and P showed significant increase in yield and yield contributing attributes**.** Findings of present study are in line with investigations of (Cao *et al.,* 2004; Sahrawat, 2000) who reported that significant effect of Zn and B on yield and variety.

Juliano and Goddard (1986) have reported that short period of growth and cloudy weather at the time of grain development particularly submerged surroundings, are major factors for increased protein percent. This happens due to enhanced availability and uptake of nitrogen to plants and low volatilization losses of the element. But at the same time they reported that environmental factor such as soil type ambient temperatures at grain ripening stage and duration growth showed no-significant response over fat percent. Fertilize application, and residual mineral nutrient elements present in soil and organic matter showed significant impact on protein percent of rice grain. Similar responses of fat content were found in the present study. The results of the present study are in agreement with those obtained by (Duhan and Singh, 2002*;* Rahmatullah, *et al.,* 2006) who reported that nitrogen uptake by rice plant root system ultimately increased protein percent of rice grain. It is estimated that 20% of fat is present in the rice bran while only 1.5 to 1.7 % of fat reside in white polished rice, depending on genotype of rice that primarily is found as non-starch lipids (Qadar, 2002). Present study revealed that fat contents were influenced in non-significant manner over treatments. The results of the present study obtained are in agreements with (Gangaiah and Parsad, 1999).

(Farshid, 2011) has conducted an experiment and found that there is an antagonism between Boron and Zinc that when there was no B content in the soil it helped increasing leaf Zn content, but presence of B in the soils prevented from increase of leaf Zn content. While in our studies it was found that application of Zn+B (T2) fertilizer increased the crop production could be the reason that less antagonism had occurred between these two minerals as both Zn and Boron is essential for growth of plant.

Conclusion

It is concluded from the studies that application of the Zn fertilizer has increased the yield as compare to control while application of Zn + B has remarkably increased the yield of paddy rice. It is noticed that when Zn + B is used; yield has doubled itself as compare to the paddy rice treated with fertilizers contain only Zn. Where else no difference has been observed in fat content of the rice as compared to the control. It is therefore recommend that farmers should opt Zn + B or only Zn fertilizer to increase their yield and hence income.

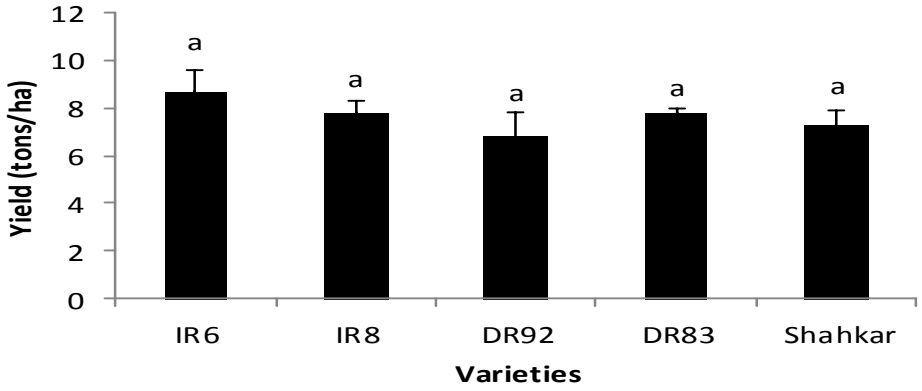

Fig 1.Average yield of verities at control over the three harvested years. Bars labelled with same letters are not significantly different at P<0.05.

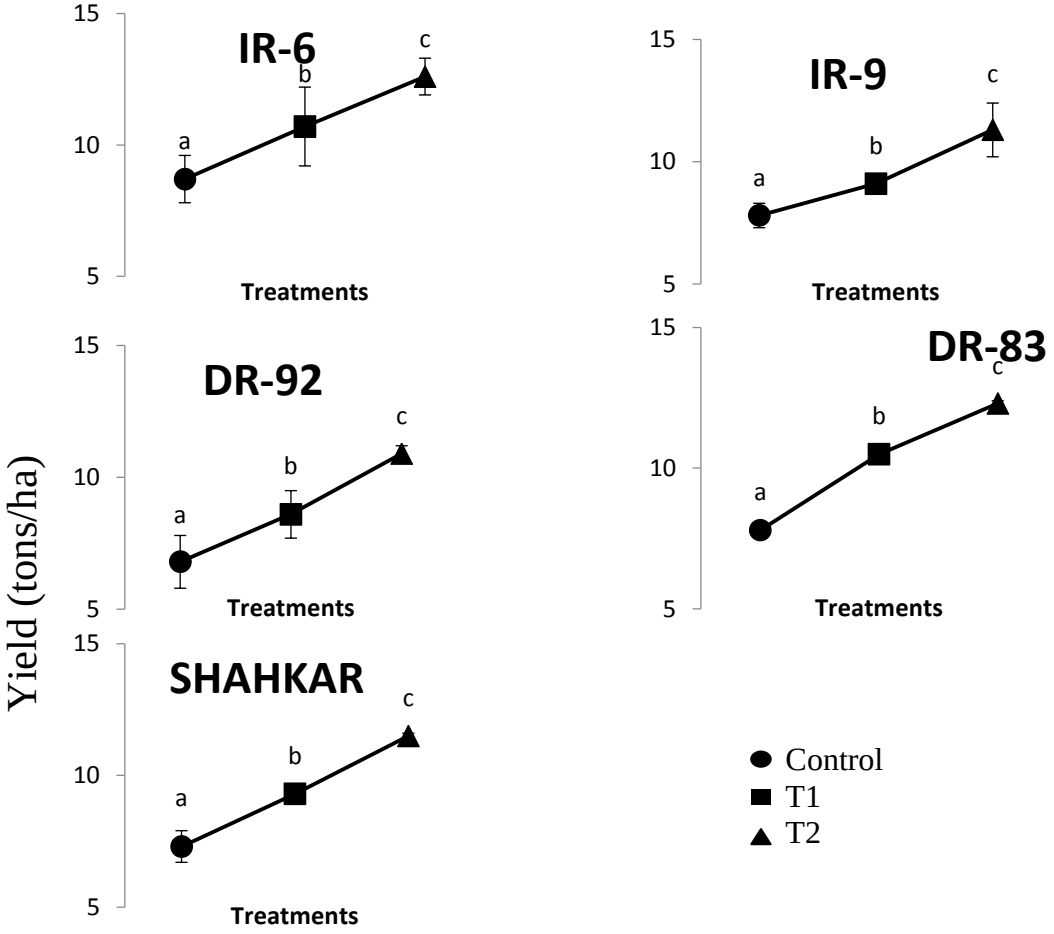

Fig.2. Variety wise influence of treatment on yield. Markers labelled with same letters are not significantly different at P<0.05.

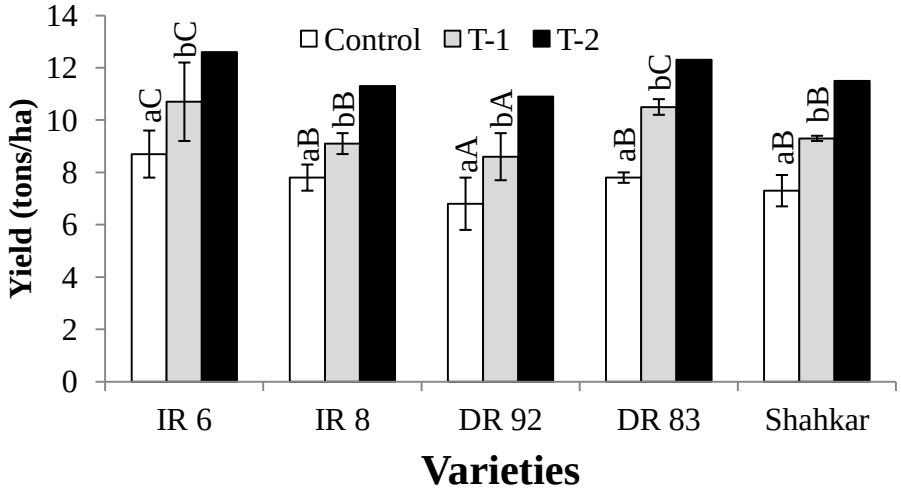

Fig.3. Comparison of effects of T1 and T2 over control in yield . Bars labelled with "b" means significantly different from control at P<0.05

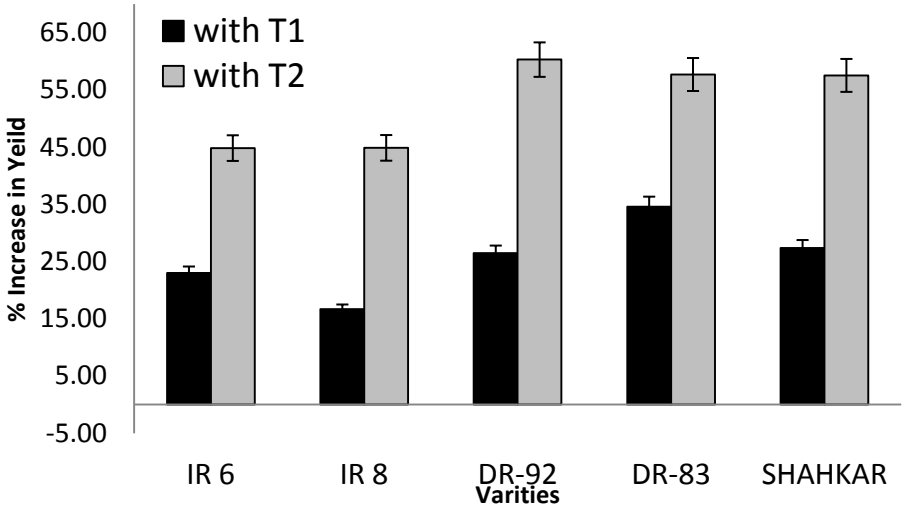

Fig.4. Percent increase in yield of verities over treatments T1 and T2.

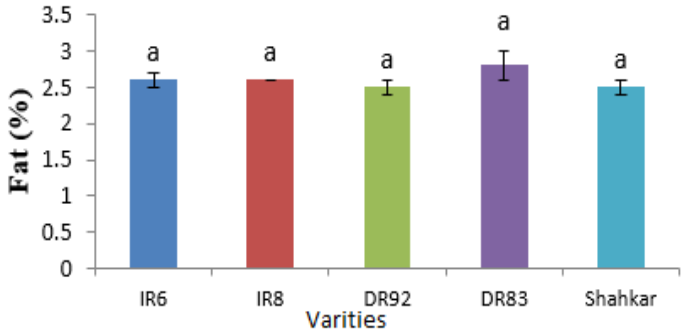

Fig.5. Average fat of rice verieties at control over three harvested years. Bars labeles with same letters are not significantly different at P<0.05.

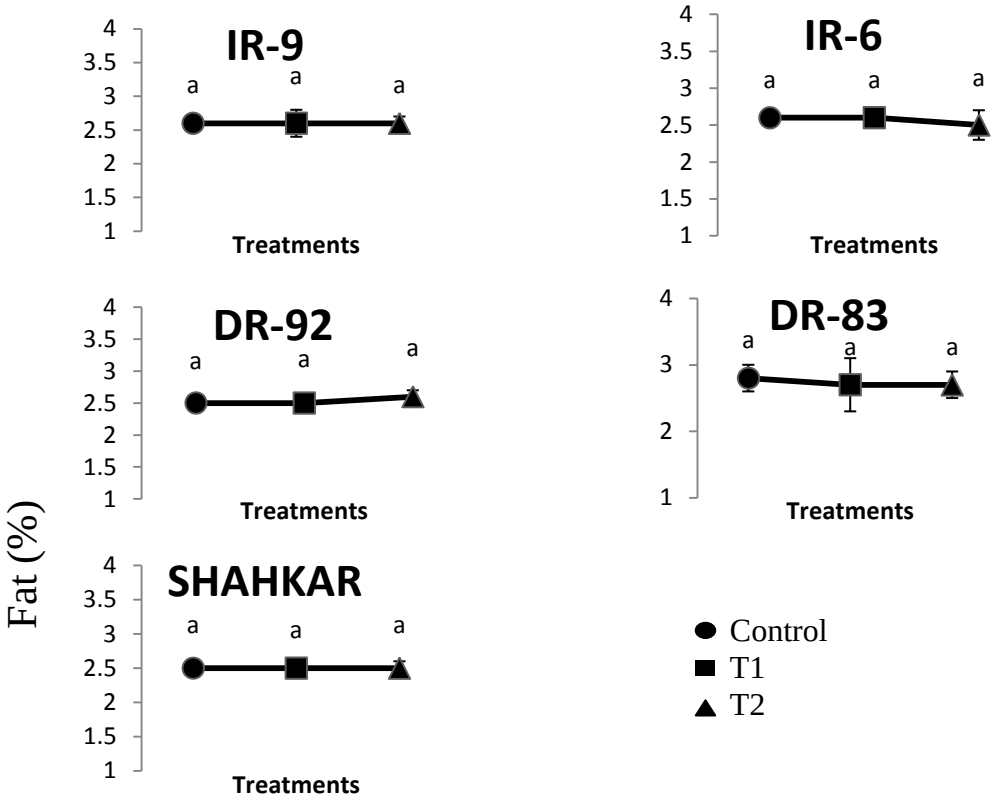

Fig. 6. Effects of treatments on fat content variety-wise in each harvest year

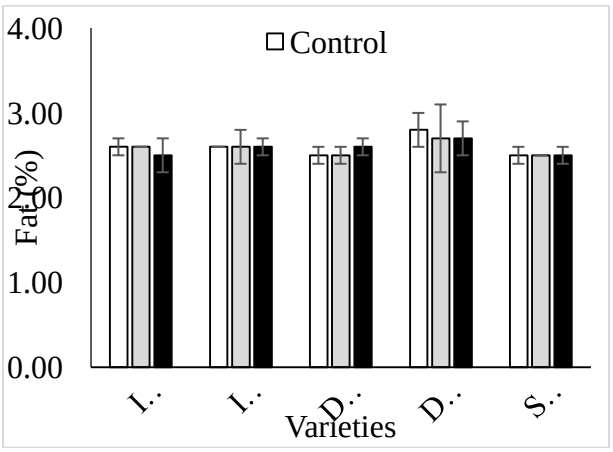

Fig.7. Comparison of effects of T1 and T2 in fat content over control in all varieties.

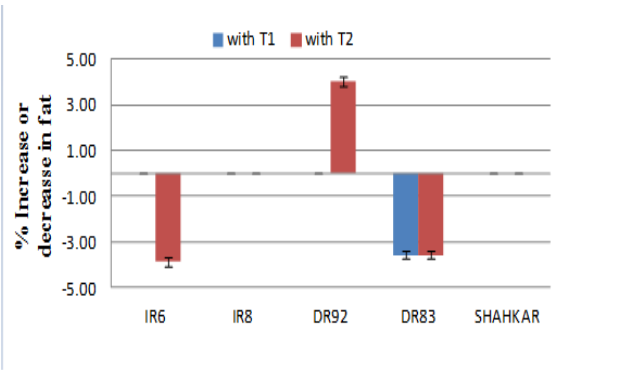

Fig.8. Showing percent increase in fat content over treatments. Similar small and capital letters are not significantly *(P<0.05)* different.

Table 1.Analysis of variance for yield of rice varieties.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3236.011	44	73.546	132.856	.000
Intercept	85432.782	1	85432.782	154329.450	.000
Variety (V)	401.161	4	100.290	181.169	.000
Treatment (T)	2490.083	2	1245.041	2249.096	.000
V × T	37.122	8	4.640	8.382	.000
T × HY	5.834	4	1.459	2.635	.034
V × T × HY	49.774	16	3.111	5.620	.000
Error	199.287	360	.554		
Total	88868.080	405			
Corrected Total	3435.298	404			

A R Squared =0.942 (Adjusted R Squared = 0.935)
HY= Harvest Year

Table 2.Analysis of variance for fat in rice grain of varieties.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6.217	44	.141	2.217	.000
Intercept	2735.720	1	2735.720	42927.809	.000
Variety (V)	2.317	4	.579	9.090	.000
Treatment (T)	2.257E-02	2	1.128E-02	.177	.838
V × T	.370	8	4.628E-02	.726	.668
T × HY	.197	4	4.936E-02	.775	.542
V × T × HY	.999	16	6.241E-02	.979	.479
Error	22.942	360	6.373E-02		
Total	2764.880	405			
Corrected Total	29.160	404			

A R Squared = 0.213 (Adjusted R Squared = 0.117)
HY= Harvest Year

References

Brady, N.C. (1990). *The nature and properties of soils*. 10th Ed. Macmillan Publishers. New York (U.S.A.).

Brown, P. H., Bellaloui. N., Wimmer, M. A., Bassil, E. S., Ruiz, J., Hu, H., Pfeffer, H., Dannel, F. (2002). Boron in Plant Biology. *Plant Biol.* 4: 205-223.

Brown, P. H. and Hu, H. (1997) "Does Boron play only a structural role in the growing tissues of higher plants?" *Plant Soil*. 196: 211–215.

Bozdar, L. (1991). *Assessing Zn availability status of wheat areas of district Hyderabad through analysis of soil and associated plant tissue*. M.Sc. thesis. *Deptt. Soil Sci., Sindh Agric. Univ. Tandojam*, Hyderabad (Pakistan).

Cakmak I. O., Eker S., Torun B., Kalfa H.I., Yilmaz A. (1997). Concentration of zinc and activity of copper/zinc-superoxide dismutase in leaves of rye and wheat cultivars differing in sensitivity to zinc deficiency. *J. Plant Physiol.* 151: 91–95.

Cao, C.F., Kong, L.C. Wang, J.L. Zhao, B. and Zhao, Z. (2004). Effect of nitrogen nutrition on quality of different type of grain. *J. Triti crops.* 24(1): 47-50.

Duhan, B. S. and Singh, M. (2002). Effect of green manuring and nitrogen on the yield and nutrient uptake of micronutrient by rice. *J. Indian Soc. Soil Sci.* 50(2): 178 – 180.

Farshid A. (2011). Zinc and Boron Content by Maize leaves from Soil and Foliar Application of Zinc Sulfate and Boric Acid in Zinc and Boron Deficient Soils. *Middle-East Journal of Scientific Research*.7 (4): 610-618.

Gyana, R. R. and Premananda, D. (2003). Effect of metal toxicity on plant growth and metabolism: I. Zinc. *Agronomie*. 23: 3–11.

Gangaiah, B., Parsad, R. (1999). Response of Scanted Rice (Oryza sativa) to fertilization. *Indian J. of Agronomy*. vol. 44 (2) 294-296.

G.O.P. (2011). Economic Survey of Pakistan, Federal Bureau of Statistics, Ministry of Food and Agric. Government of Pakistan, URL:http:/www.minfal.gov.pk

Juliano, B.O. and Goddard, M.S. (1986). Cause of varietal difference in insulin and glucose responses to ingested rice. Qual. Plant. *Plant Foods Hum. Nutr.* 36: 35-41.

Mollah, M.Z., Talukder, N.M., Islam, M.N., Rehman, M.A., Ferdous, I. (2009). Effect of nutrient content in rice as influenced by In-fertilization, *World Applied Science Journal*, 6 (8) 1082-1088.

Qadar, A. (2002). Selecting rice genotypes tolerant to zinc deficiency and sodicity stresses. Differences in zinc, iron, manganese, copper, phosphorus concentrations, and phosphorus/zinc ratio in their leaves. *J. Plant. Nutr*. 25: 457–473.

Rahmatullah, K., Akbar, H., Raza, J. G. and Zia M.S. (2006). Effect of Boron application on Rice yield under wheat rice system. *International J. Agric. and Bio (IJAB*), 8(6), 805-808.

Rajan, A.R. (1993). Relative utilization of different Zn-Carrier in rice (*Oriza sativa* L.). *Indian J. of Agric. Chem*. 26(1): 1-4.

Sahrawat, K.L. (2000). Macro and micronutrients removed by upland rice cultivars in West Africa. C*ommunication in soil and plant Analysis*. 31(5&6), : 717-723.