Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(1): 1017-1025
Received: 04-11-2017
Accepted: 05-12-2017

Jai Prakash Gupta
Seed Technology Section, Department of Genetics and Plant Breeding, NDUAT, Kumarganj, Faizabad, U. P., India

SC Vimal
Seed Technology Section, Department of Genetics and Plant Breeding, NDUAT, Kumarganj, Faizabad, U. P., India

Ajay Kumar
Seed Technology Section, Department of Genetics and Plant Breeding, NDUAT, Kumarganj, Faizabad, U. P., India

GD Kushwaha
Seed Technology Section, Department of Genetics and Plant Breeding, NDUAT, Kumarganj, Faizabad, U. P., India

Pankaj Kumar
Seed Technology Section, Department of Genetics and Plant Breeding, NDUAT, Kumarganj, Faizabad, U. P., India

Correspondence
Jai Prakash Gupta
Seed Technology Section, Department of Genetics and Plant Breeding, NDUAT, Kumarganj, Faizabad, U. P., India

Optimization of seed technological parameters and micronutrients supplementation on yield contributing characters, seed recovery and quality in rice (*Oryza sativa* L.)

Jai Prakash Gupta, SC Vimal, Ajay Kumar, GD Kushwaha and Pankaj Kumar

Abstract
The present investigation were conducted during *Kharif* 2015 and 2016 at Student Instructional Farm and lab experiments were carried out in Seed Testing Laboratory of Seed Technology Section, N. D. University of Agriculture and Technology, Kumarganj, Faizabad (U.P.) India with objective of the study was to optimization of seed technological parameters and micronutrients supplementation on yield contributing characters, seed recovery and quality in rice (*Oryza sativa* L.) for yield contributing traits and seed quality parameters *i.e.* days to 50% flowering, no of tillers per plant, productive tillers per hill, Plant height (cm), panicle length, Days to maturity, spikelet fertility, harvest index, seed recovery, seed yield (q/ha), 1000 seed weight (g), germination (%), vigour index and electrical conductivity. The experiment was laid out in Split Plot Design with three replications keeping two methods of transplanting *viz*. C_1 (Normal method) and C_2 (SRI method) in the main plot and three foliar spray of micronutrient doses *viz*. M_1 (Zn, Fe and Mn @0.25%, 0.50%&0.25%), M_2 (Zn, Fe and Mn @0.50%, 1.00%&0.50%) and M_3 (Zn, Fe and Mn @0.75%, 1.50%&0.75%) in sub plot. The two transplanting spacing *viz.* S_1 (15×20 cm) and (25×25 cm) were also applied in the sub plots with three genotype *viz.* NDR 97, NDR359 and BPT 5204. The result revealed that inoculation of transplanting method, spacing and foliar spray of micronutrients doses significantly improved days to 50% flowering, no. of tillers per plant, productive tillers per hill, Plant height (cm), panicle length, Days to maturity, spikelet fertility, harvest index, seed recovery, seed yield (q/ha), 1000 seed weight (g), germination (%), vigour index and reduce electrical conductivity. Overall the treatment of findings revealed that rice crop should be transplanted on 25×25 cm under SRI method with the foliar spray application of Zn, Fe and Mn @0.75%, 1.50%&0.75%, for obtaining high seed yield potential of the variety producing good quality seeds.

Keywords: Micronutrients supplementation, Foliar spray, SRI method, Transplanting spacing, seed recovery, Rice seed.

1. Introduction
Rice (*Oryza sativa* L.) is a semi-aquatic annual grass plant belongs to the genus *Oryza*, tribe Oryzeae and family Poaceae. It is the second largest principal food crop in the world after wheat and is one of the main staple food crop in India. Besides being the staple food crop, it has been the cornerstone of food and culture for our people. Among seven billion people on the earth, more than half of them depend on this crop for principal source of energy in their daily diet. Rice is distributed over a wider range of latitude from 50 ^{0} N to 40 ^{0} S and is being grown up to an altitude of 2500 meters. It evolved in humid tropics as a semi aquatic plant and it has got unique adaptive nature to hot humid environment, which is not seen in any other major cereal crop.
Rice yield in India fluctuate greatly in time and space on account of its cultivation under diverse weather, ecological and socio-economic conditions. Out of the total 43.86 million ha. under rice, 20 million ha. area is irrigated and the remaining 23.86 million ha. area is cultivated in rainfed conditions. Rice can be grown under different agro-ecological environments.
Seed quality plays a crucial role in realizing the full genetic potential of varieties as well as benefits of other agricultural inputs (Seshu and Dadlani, 1993) [21]. The use of quality seeds alone increases the productivity to the extent of 15-20 per cent (Dahiya *et al.*, 1993) [7]. Only seeds with assured genetic and physical purity can be expected to response to the other inputs in agriculture. Among the inputs used by the farmers for agriculture production seed is the cheapest one and it forms only part of the cultivation expenses. All the efforts and investment would be unremunerative if farmer does not get good quality seeds. Only seed with good

germination and vigour can give a good stand of the crop, otherwise there will be inadequate plant population and low yields. A mere increase in the seed rate may compensate for poor germination, but it cannot ensure vigourous and uniform growth of the crop. Thus, quality seed is a crucial factor to enhance grain production in rice.

Plant spacing directly affects the normal physiological activities through intra-specific competition. When the planting density exceed the optimum level, competition among plants for light above ground or for nutrients below the ground becomes severe and consequently the plant growth slows down and the grain yield decreases. On the other hand, wider space allows the individual plants to produce more tillers but it provides the smaller number of hills per unit area which results in low grain yield. Therefore, optimum plant spacing for a specific crop is needed to be explored.

In the case of rice production seedling stage and method of transplanting also performance of individual hills was significantly improved with wider spacing compared with closer-spaced hills in terms of root growth and xylem exudation rates, leaf number and leaf sizes, canopy angle, tiller and panicle number, panicle length and grain number per panicle, grain filling and 1000grain weight and straw weight.

Micronutrient deficiency is considered as one of the major causes of the declining productivity trends observed in rice growing countries. Zinc plays an important role in different metabolic processes in plant. Iron deficiency chlorosis is caused by imbalance of metallic ions as Cu^{+2} and Mn^{+2}. The levels of micronutrients in soil is depleted due to continuous rowing of high yielding crop varieties and non-addition of organic manures having these elements which are essential for normal growth and development of plants for profitable crop yield.

Foliar sprays are widely used to apply micronutrients, especially iron and manganese, for many crops. Soluble inorganic salts are generally as effective as synthetic chelates in foliar sprays, so the inorganic salts are usually chosen because of lower costs. Correction of deficiency symptoms usually occurs within the first several days and then the entire field could be sprayed with the appropriate micronutrient source. It was found that micronutrients showed towards to increasing the yield of different crops.

Material and methods

The field experiments was conducted on three varieties of rice (*Oryza sativa*) *viz*. NDR-97, NDR-359 and BPT-5204 to study the optimization of seed technological parameters and micronutrients supplementation on yield contributing characters, seed recovery and quality in rice (*Oryza sativa* L.) during *kharif* season 2015 and 2016 at Narendra Deva University of Agriculture & Technology Kumarganj Faizabad. It is situated at 26.47^0 N latitude and 82.12^0 E longitude and at an altitude of 113 m above mean sea level. The soil is silty loam in texture with moderate salinity. It has a semi-arid and sub-tropical climate characterized by extreme hot and cool winters. The experiment was conducted in Spilt plot design in field and CRD in laboratory.

The nursery beds of 8 m (length) X 1.5 m. (width) and 4 inches height were prepared and seeds of all the varieties were line sown in month of June. The seeds were then covered with soil and sprinkled with water. Fertilizer application, plant protection measures and regular watering were done as per recommendations.

SRI Method- Twelve day old seedlings of all the varieties were transplanted at single seedling per hill with the spacings of 25 cm × 25 cm.

Simple Method- Twenty one day old seedlings of all the varieties were transplanted at single seedling per hill with the spacings of 20 cm × 15 cm.

Before transplanting, 50 per cent of the recommended nitrogen as ammonium sulphate entire dose of phosphorus as single super phosphate and potassium as Muriate of potash were applied to the experimental plot as basal dose. Nitrogen was applied in 2 equal splits, 10 and 50 days after transplanting.

After transplanting the seedling applied micronutrient treatment combination wise Zn, Fe and Mn @0.25%, 0.50%&0.25%, Zn, Fe and Mn @0.50%, 1.00%&0.50% and Zn, Fe and Mn @0.75%, 1.50%&0.75% in the form of Foliar spry at vegetative stage (30 day after transplanting) and reproductive stage (at flowering) respectively. The observations were recorded at days to 50% flowering, no. of tillers per plant, productive tillers per hill, Plant height (cm), panicle length, Days to maturity, spikelet fertility, harvest index, seed recovery, seed yield (q/ha), 1000 seed weight (g), germination (%), vigour index and electrical conductivity.

In each plot, number of plants at flowering was recorded on alternate days. The date on which about 50% of plants attained flowering was taken as the date of 50 % flowering and days taken for the same was computed.

Total number of tillers were observed and recorded manually on ten randomly selected plants in the field from each plot of different rice varieties. Among the total number of tillers recorded on ten randomly selected plants in each plot, the tillers which were bearing panicles were counted and recorded as productive tillers.

Plant height was recorded on ten randomly selected plants in each plot at the time of maturity from the base of the stem at ground level to the base of main panicle.

The mean length of panicle was obtained by measuring from the base to the tip of panicle on ten randomly selected panicles in each plot.

In each plot, the number of plants at maturity was recorded on alternate days. The data on which about more than 50% of plants attained maturity was taken as the date of maturity and days taken for the same was computed.

Numbers of fertile spikelet ware recorded from ten selected plants from each plot and the data obtained was computed in to percentage.

$$\text{Spikelet fertility (\%)} = \frac{\text{Filled grains per panicle}}{\text{Total grains per panicle}} \times 100$$

Harvest index was calculated by using following formula,

$$\text{Harvest index (\%)} = \frac{\text{Economical yield (kg)}}{\text{Biological yield (kg)}} \times 100$$

Total amount of pure seed was obtained by separating under sized and light seeds after processing of raw seed. The amount was recorded in the kilogram and it was recorded in percentage by computing with suitable conversion factor. The seeds obtained from the corresponding plots were sun dried, weighed and recorded. The seed yield per hectare was computed with appropriate conversion factor.

Test weight (g) was determined by counting manually one hundred seeds of eight replicates from each genotype and weighed up to four significant figures on top pan precision balance. Coefficient of variation was calculated, replication showing C.V. less than 6.0 were selected and mean was calculated. The mean was multiplied by 10 to get the final 1000 seed weight. The weight was expressed in grams.

Germination test was conducted by using 'between paper' method as per (ISTA, 2008). Four replicates of one hundred seeds from each treatmented genotype were placed equidistantly on moist germination paper. The rolled towels were incubated at 25±1 ^{0}C for fourteen days. The first and final counts were recorded on fifth and fourteenth day, respectively. The germination percentage was recorded on the basis of normal seedling only at the final count and expressed in percentage. Ten seedlings from each replication were taken at random after fourteenth day of incubation to determine the seedling length. The seedling length was measured from the tip of the primary root to the tip of the primary leaf and mean of ten seedlings was calculated and expressed in centimetres. The seedlings used to measure seedling length were dried in a hot air oven maintained at 80 ± 2^{0}C for 24 hours. Later they were cooled over silica gel and weighed. The mean dry weight of seedlings was computed and expressed in milligram. Seedling vigour index was calculated by using seedling growth parameters and expressed as a whole number as suggested by Abdul-Baki and Anderson (1973) [1] and it is given below.

Vigour index I = Germination (%) x Mean seedling length (cm)

Vigour index II = Germination (%) x Mean seedling dry weight (mg)

Four replicates of fifty seeds each for each treatmented genotype were soaked in 50 ml distilled water for 24h at 20 ± 1^{0}C. At the end of soaking, the steeped water (seed leachate) was decanted and electrical conductivity of the seed eachate was measured with the help of Conductivity Bridge and expressed in dS/m/gm (ISTA, 2008).

Results and Discussion

The data recorded on various characters were analyzed statistically to authenticate the effects of different variety, transplanting spacing, transplanting methods, varied doses of foliar spray micronutrients (Zn, Fe and Mn) on rice seed production and its quality. The conspicuous findings of the present investigation entitled "Optimization of Seed technological parameters and micronutrients supplementation on yield contributing characters, seed recovery and quality in rice (*Oryza sativa* L.) varieties" have been elaborated under following heads and presented in corresponding tables.

Days to 50 % flowering

The days to 50% flowering differed significantly due to different varieties. The number of days to 50% flowering was recorded maximum (119.38 days and 121.38 days) with variety BPT 5204 and minimum (69.85 days and 71.85 days) with variety NDR 97 in 2015 and 2016, respectively. (Table 1 & 2). A significant decrease in days to 50% flowering was noticed under each increment of foliar spray of micronutrient doses in the year 2015 but non- significant effect was noticed during 2016. The minimum days to 50% flowering (95.53 days) was observed under foliar spray Zn, Fe and Mn @0.75%, 1.50% & 0.75%, which was found superior to other levels of foliar spray micronutrients doses in 2015. Similar results had been observed by Rao and Shrivatsav (1999) [17].

No. of tillers per plant

Number of tillers per plant was significantly influenced with the transplanting spacing in both the years of present investigation. Maximum number of tillers per plant (17.75 and 19.75) was recorded with transplanting spacing 25×25 cm than transplanting spacing 15×20 cm (16.92 and 18.92) in 2015 and 2016, respectively (Table 1 & 2). Similar results had been observed by Aziz and Hasan (2000) [5]. Number of tillers per plant was also significantly influenced with the transplanting method in both the years of present investigation. Higher number of tillers per plant (20.76 and 22.76) was recorded with transplanting SRI method than normal transplanting (13.92 and 15.92) in 2015 and 2016, respectively (Table 1 & 2). Similar results had been observed by Saina (2001) [18]; Garcia *et al*. (1995) [9] and Akbar (2004) [2]. A significant increase in number of tillers per plant was noticed under each increment of micronutrients doses in both the years. The maximum number of tillers per plant (20.06 and 22.06 respectively) was observed under foliar spray Zn, Fe and Mn @0.75%, 1.50%&0.75%, which was found significantly superior to other levels of micronutrients supplementations in 20015 and 2016 (Table 1 & 2). The present findings are in accordance with the results obtained by Zayed *et al*. (2011) [25].

Productive tillers per hill

Number of productive tillers per hill was significantly influenced with the transplanting spacing in both the years of present investigation. Higher number of productive tillers per hill (15.75 and 15.58) was recorded with transplanting spacing 25×25 cm than transplanting spacing 15×20 cm (14.92 and 15.22) in 2015 and 2016, respectively (Table 1 & 2). Number of productive tillers per hill was also significantly influenced with the transplanting method in both the years of present investigation. Higher number of productive tillers per hill (18.76 and 18.93) was recorded with transplanting SRI method than normal transplanting (11.90 and 11.88) in 2015 and 2016, respectively (Table 1 & 2). A significant increase in number of productive tillers per hill was noticed under each increment of micronutrients doses in both the years. The maximum number of productive tillers per hill (18.06 and 18.81 respectively) was observed under foliar spray Zn, Fe and Mn @0.75%, 1.50%&0.75%, which was found significantly superior to other levels of micronutrients supplementations in 2015 and 2016 (Table 1 & 2). Similar results had been observed by Sarkar *et al*. (2002) [20].

Plant height (cm)

The transplanting spacing had significant effect on this character in both the years of study. Significantly higher plant height (92.44 cm and 93.81 cm) was recorded with transplanting spacing 25×25 cm as compared to transplanting spacing 15×20 cm in 2015 and 2016, respectively (Table 1 & 2). The methods of transplanting had also significant effect on this character in both the years of study. Significantly higher plant height (91.22 cm and 92.59 cm) was recorded with SRI method of transplanting as compared to normal method of transplanting in 2015 and 2016, respectively (Table 1 & 2). The present findings are in accordance with the results obtained by Hossain *et al*. (2003) [13] and Husain *et al*. (2003) [14]. The verity had significant effect on plant height both the year of study. Significantly higher plant height (94.93 cm and 97.14 cm) was recorded in NDR359 as compared to others genotypes in 2015 and 2016, respectively (Table 1 & 2). Other treatment and possible interactions had non-significant influence on plant height in both the years.

Panicle length (cm)
The transplanting methods showed significant influence on the length of panicle in both the years of present investigation. The maximum panicle length of 23.67 cm and 24.71 cm were recorded under transplanting SRI method, which was significantly superior to normal method of transplanting during first and second year, respectively (Table 1 &.2). Similar results had been observed by Salahuddin *et al.* (2009) [19]. Increased foliar spray of micronutrients doses had shown significant increase in panicle length during both the years. The maximum panicle length of 23.79 cm and 24.83 cm was registered under the treatment of foliar spray Zn, Fe and Mn @0.75%, 1.50%&0.75%, which showed significant superiority over other doses of foliar spray of micronutrients doses in 2015 and 2016, respectively (Table 1 & 2). The shortest panicle length (22.50 cm and 23.54 cm) was recorded with foliar spray Zn, Fe and Mn @0.25%, 0.50%&0.25% during first and second year, respectively. The effect of variety had significant in panicle length during both the years. The maximum panicle length of 24.27 cm and 25.37 cm was registered in genotype NDR 359 during 2015 and 2016, respectively (Table 1 & 2).

Days to maturity
The days to maturity differed significantly due to different varieties. The days to maturity was maximum (150.06 days and 153.06 days) was recorded with variety BPT 5204 and minimum days to maturity (98.06 days and 100.06 days) with variety NDR 97 in 2015 and 2016, respectively (Table 3 & 4).

Spikelet fertility (%)
The spikelet fertility (%) differed significantly due to different varieties. The spikelet fertility (%) was maximum (89.47% and 90.27%) was recorded with variety NDR 359 and minimum spikelet fertility (%) (83.42% and 85.71%) with variety NDR 97 in 2015 and 2016, respectively (Table 3 & 4). The present findings are in accordance with the results obtained by Zeidan *et al.* (2010) [26]

Harvest Index (%)
The harvest index differed significantly due to different varieties. The harvest index was maximum (30.16% and 30.86%) was recorded with variety NDR 359 in 2015 and 2016, respectively and minimum harvest index (27.65%) with variety NDR 97 in 2015 but (28.57) with variety BPT 5204 in 2016, respectively (Table 3 & 4). The transplanting spacing had significant effect on harvest index during both the years. Higher harvest index (30.67% and 31.65%) was recorded under transplanting spacing 25×25cm than transplanting spacing 20×15 cm (26.35% and 27.16%) in 2015 and 2016, respectively (Table 3 & 4). Similar results had been observed by Aziz and Hasan (2000) [5]. The transplanting method had significant effect on harvest index during both the years. Higher harvest index (32.24% and 33.26%) was recorded under transplanting SRI method than normal transplanting method (24.78% and 25.55%) in 2015 and 2016, respectively (Table 3 & 4). Similar results had been observed by Longxing *et al*. (2002) [15] and Hamid *et al.* (2011) [11]. A significant increase in harvest index was noticed under each increment of foliar spray micronutrients doses in both the years. The maximum harvest index (32.24% and 33.24%) was observed under foliar spray Zn, Fe and Mn @0.75%, 1.50%&0.75%, which was found significantly superior to other levels of foliar spray micronutrients doses in 2015 and 2016, respectively (Table 3 & 4). The present findings are in accordance with the results obtained by Yassen *et al.* (2010) [24] and Zayed *et al.* (2011) [25].

Seed recovery (%)
The seed recovery differed significantly due to different varieties. The seed recovery was maximum (84.60% and 86.58%) was recorded with variety BPT 5204 and minimum seed recovery (80.04% and 82.12%) with variety NDR 359 in 2015 and 2016, respectively (Table 3 & 4). The transplanting method had significant effect on seed recovery during both the years. Higher seed recovery (85.44% and 87.84%) was recorded under transplanting SRI method than normal transplanting method (78.51% and 80.82%) in 2015 and 2016, respectively (Table 3 & 4). Similar results had been observed by Sheehy *et al.* (2004). A significant increase in seed recovery was noticed under each increment of foliar spray micronutrients doses in both the years. The maximum seed recovery (86.70% and 89.11%) was observed under foliar spray Zn, Fe and Mn @0.75%, 1.50%&0.75%, which was found significantly superior to other levels of foliar spray micronutrients doses in 2015 and 2016, respectively (Table 3 & 4).

Seed Yield
The seed yield differed significantly due to different varieties. The seed yield was maximum (50.14q/ha and 50.79q/ha) was recorded with variety BPT 5204 and minimum seed yield (26.67q/ha and 27.63q/ha) with variety NDR 97 in 2015 and 2016, respectively (Table 3 & 4). The transplanting method had significant effect on seed yield during both the years. Higher seed yield (41.47q/ha and 42.29q/ha) was recorded under transplanting SRI method than normal transplanting method (39.63q/ha and 40.45q/ha) in 2015 and 2016, respectively (Table 3 & 4). The present findings are in accordance with the results obtained by Zheng *et al.* (2004) [27] and Devarajan (2005) [8]**.** A significant increase in seed yield was noticed under each increment of foliar spray micronutrients doses in both the years. The maximum seed yield (42.40q/ha and 43.22q/ha) was observed under foliar spray Zn, Fe and Mn @0.75%, 1.50%&0.75%, which was found superior to other levels of foliar spray micronutrients doses in 2015 and 2016, respectively (Table 3 & 4). Similar results had been observed by Yan *et al.,* 2012
1000 seed weight (gm)
The 1000 seed weight differed significantly due to different varieties. The 1000 seed weight was maximum (26.40g and 26.52g) in variety NDR 359 and minimum in variety BPT 5204 (19.05g and 19.16g) in 2015 and 2016, respectively (Table 5 & 6). The transplanting method had significant effect on 1000 seed weight during both the years. Maximum 1000 seed weight (23.30g and 23.41g) was recorded under transplanting SRI method than normal transplanting method (21.86g and 21.97g) in 2015 and 2016, respectively (Table 5 & 6). Similar results had been observed by Aziz and Hasan (2000) [5]. A significant increase in 1000 seed weight was noticed under each increment of foliar spray micronutrients doses in both the years. The maximum 1000 seed weight (23.29g and 23.40g) was observed under foliar spray Zn, Fe and Mn @0.75%, 1.50%&0.75%, which was found superior to other levels of foliar spray micronutrients doses in 2015 and 2016, respectively (Table 5 & 6). Similar results had been observed by Yassen *et al.* (2010) [24] and Zeidan *et al.* (2010) [26].

Germination test (%)

The germination differed significantly due to different varieties. The germination was maximum (88.08% and 89.08%) was recorded with variety NDR 359 and minimum germination (85.08% and 87.08%) with variety NDR 97 in 2015 and 2016, respectively (Table 5 & 6). The transplanting spacing had significant effect on germination during both the years. Maximum germination (87.51% and 88.84%) was recorded under transplanting spacing 25×25cm than transplanting spacing 20×15 cm (85.98% and 87.31%) in 2015 and 2016, respectively (Table 5 & 6). A significant increase in germination was noticed under each increment of foliar spray micronutrients doses in both the years. The maximum germination (90.23% and 91.56%) was observed under foliar spray Zn, Fe and Mn @0.75%, 1.50%&0.75%, which was found significantly superior to other levels of foliar spray micronutrients doses in 2015 and 2016, respectively (Table 5 & 6).

Seedling vigour index

The seedling vigour index differed significantly due to different varieties. The seedling vigour index I was maximum (2176.64 and 2253.85) was recorded with variety NDR 97 but seedling vigour index II (1771.96 and 1809.88) with variety NDR 359 and minimum seedling vigour index I (1984.37 and 2043.25) and also seedling vigour index II (712.87 and 741.41) with variety BPT 5204 in both year 2015 and 2016, respectively (Table 5 & 6). The transplanting method had significant effect on seedling vigour index during both the years. Maximum seedling vigour index I and II (2123.62 and 2188.61) and (1343.25 and 1381.84) ware recorded under transplanting SRI method than normal transplanting method (1991.59 and 2054.50) and (1279.37 and 1317.00) in 2015 and 2016, respectively (Table 5 & 6). A significant increase in seedling vigour index was noticed under each increment of foliar spray micronutrients doses in both the years. The maximum seedling vigour index I and II (2188.20 and 2254.17) and (1383.89 and 1371.32) was observed under foliar spray Zn, Fe and Mn @0.75%, 1.50%&0.75%, which was found superior to other levels of foliar spray micronutrients doses in 2015 and 2016, respectively (Table 5 & 6).

Electrical conductivity (dS/m/gm)

The electrical conductivity differed negatively significantly due to different varieties. The electrical conductivity was minimum (0.98 dS/m/gm and 0.87 dS/m/gm) was recorded with variety BPT 5204 and maximum electrical conductivity (1.36 dS/m/gm and 1.25 dS/m/gm) with variety NDR 97 in 2015 and 2016, respectively (Table 5 & 6). The transplanting spacing had also negatively significant effect on electrical conductivity during both the years. Minimum electrical conductivity (1.15 dS/m/gm and 1.04 dS/m/gm) was recorded under transplanting spacing 25×25cm than transplanting spacing 20×15 cm (1.22 dS/m/gm and 1.11 dS/m/gm) in 2015 and 2016, respectively (Table 5 & 6). The transplanting method had negatively significant effect on electrical conductivity during both the years. Minimum electrical conductivity (1.11 dS/m/gm and 1.00 dS/m/gm) was recorded under transplanting SRI method than normal transplanting method (1.25 dS/m/gm and 1.14 dS/m/gm) in 2015 and 2016, respectively (Table 5 & 6). A significant decrease in electrical conductivity was noticed under each increment of foliar spray micronutrients doses in both the years. The minimum electrical conductivity (1.05 dS/m/gm and 0.94 dS/m/gm) was observed under foliar spray Zn, Fe and Mn @0.75%, 1.50% & 0.75%, which was found significantly superior to other levels of foliar spray micronutrients doses in 2015 and 2016, respectively (Table 5 & 6).

Table 1. Analysis of variance for days to 50% flowering, tillers per plant, productive tillers per hill, plant height and panicle length in rice varieties during 2015 and 2016

Source of variation	d.f.	Mean Sum of Squares									
		50% Flowering		Tillers/Plant (No.)		Productive Tillers/hill (No.)		Plant Height (cm)		Panicle length (cm)	
		2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Replication	2	8.583	8.583	12.25	12.25	12.25	16.674	9.694	9.694	1.52	1.517
Variety (V)	2	30320.27*	30575.27*	202.56*	202.56*	202.56*	208.778*	3084.58*	3395.88*	167.92*	143.42*
Spacing (S)	1	73.674	73.674	25.00*	25.00*	25.00*	4.694*	1174.78*	1174.78*	2.13	2.127
Transplanting method(C)	1	122.840	122.840	1694.69*	1694.64*	1694.69*	1792.11*	385.79*	385.795*	100.17*	100.18*
Interaction (V×S)	2	27.549	27.549	55.56*	55.56*	55.56*	29.861*	6.565	6.565	3.575	3.575
Interaction (V×C)	2	25.215	25.215	6.382*	6.382*	6.382*	8.111*	0.433	0.433	3.109	3.109
Interaction (S×C)	1	465.84*	465.84*	552.25*	552.25*	552.25*	625.00*	4.375	4.375	192.52*	192.52*
Interaction (V×S×C)	2	39.632	39.632	38.021*	38.021*	38.021*	55.750*	28.990	28.990	6.451	6.451
Error (a)	22	28.76	42.40	1.25	1.25	1.25	2.204	50.067	45.067	2.772	4.136
Micronutrients (M)	3	71.192*	71.192	199.31*	199.31*	199.31*	295.083*	68.514	68.514	21.87*	21.87*
Interaction (V×M)	6	2.345	2.345	4.016*	4.016*	4.016*	9.556*	0.470	0.470	0.024	0.024
Interaction (S×M)	3	0.081	0.081	2.500	2.500	2.500	4.713	0.170	0.170	0.386	0.386
Interaction (C×M)	3	0.137	0.137	7.935*	7.935*	7.935*	7.685*	1.011	1.011	0.192	0.192
Interaction(V×S×M)	6	1.289	1.289	0.701	0.701	0.701	1.546	0.982	0.982	0.161	0.161
Interaction (V×C×M)	6	1.012	1.012	0.317	0.317	0.317	2.685	0.517	0.517	0.019	0.019
Interaction (S×C×M)	3	0.655	0.655	1.602	1.602	1.602	8.500	1.307	1.307	0.273	0.273
Interaction (V×S×C×M)	6	0.725	0.725	1.012	1.012	1.012	2.861	0.499	0.499	0.296	0.296
Error (b)	72	16.296	41.296	0.954	0.954	0.954	2.086	28.091	27.937	2.262	4.068

Table 2: Effect of transplanting spacing, method and foliar spray of micronutrients does on days to 50% flowering, tillers per plant, productive tillers per hill, plant height and panicle length in rice varieties during 2015 and 2016

Treatment	50% Flowering		Tillers/Plant (No.)		Pro. Tillers/hill (No.)		Plant Height (cm)		Panicle length (cm)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
NDR 97 (V_1)	69.85	71.85	15.48	17.48	13.48	13.38	80.37	81.38	20.72	21.98
NDR 359 (V_2)	102.08	105.08	19.54	21.54	17.54	17.54	94.93	97.14	24.27	25.37
BPT 5204 (V_3)	119.38	121.38	16.98	18.98	14.98	15.29	93.46	94.35	23.52	24.27
SEm ±	0.77	0.94	0.16	0.16	0.16	0.21	1.02	0.97	0.24	0.29
CD 5%	2.27	2.76	0.47	0.47	0.47	0.63	3.00	2.84	0.70	0.86
15×20 cm (S_1)	97.82	100.15	16.92	18.92	14.92	15.22	86.73	88.10	22.72	23.75
25×25 cm (S_2)	96.39	98.72	17.75	19.75	15.75	15.58	92.44	93.81	22.96	24.00
SEm ±	0.63	0.77	0.13	0.13	0.13	0.17	0.83	0.79	0.20	0.24
CD 5%	1.85	2.25	0.39	0.39	0.39	0.51	2.45	2.32	0.58	0.70
Normal transplanting (C_1)	98.03	100.36	13.90	15.90	11.90	11.88	87.95	89.32	22.00	23.04
SRI transplanting (C_2)	96.18	98.51	20.76	22.76	18.76	18.93	91.22	92.59	23.67	24.71
SEm ±	0.63	0.77	0.13	0.13	0.13	0.17	0.83	0.79	0.20	0.24
CD 5%	1.85	2.25	0.39	0.39	0.39	0.51	2.45	2.32	0.58	0.70
Control (M_0)	98.83	101.17	14.47	16.47	12.47	12.11	88.01	89.38	21.97	23.01
Zn, Fe and Mn @0.25%, 0.50%&0.25% (M_1)	97.50	99.83	16.69	18.69	14.69	14.31	89.04	90.41	22.50	23.54
Zn, Fe and Mn @0.50%, 1.00%&0.50% (M_2)	96.56	98.89	18.11	20.11	16.11	16.39	90.06	91.43	23.09	24.12
Zn, Fe and Mn @0.75%, 1.50%&0.75% (M_3)	95.53	97.86	20.06	22.06	18.06	18.81	91.23	92.60	23.79	24.83
SEm ±	0.67	1.07	0.16	0.16	0.16	0.24	0.88	0.79	0.25	0.34
CD 5%	1.90	3.02	0.46	0.46	0.46	0.68	2.49	2.32	0.71	0.95

Table 3: Analysis of variance for days to maturity, spikelet fertility, harvest Index, Seed recovery and Seed yield in rice varieties during 2015 and 2016

Source of variation	d.f.	Mean Sum of Squares									
		Dayes to Maturity		Spikelet fertility (%)		Harvest Index (%)		Seed Recovery (%)		Seed Yield(q/ha)	
		2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Replication	2	4.396	4.396	0.016	0.01	1.231	1.263	2.686	2.686	1.970	1.970
Variety (V)	2	32899.56*	34248.56*	562.78*	303.97*	98.086*	77.091*	267.163*	238.802*	7272.64*	7110.55*
Spacing (S)	1	38.028	38.028	0.319	0.25	672.747*	727.275*	149.084	149.084	0.191	0.191
Transplanting method (C)	1	72.250	72.250	175.858	126.98	2004.43*	2140.22*	1728.065*	1728.065*	122.047*	122.047*
Interaction (V×S)	2	0.132	0.132	0.850	0.71	35.068*	38.085*	0.000	0.000	0.000	0.000
Interaction (V×C)	2	0.146	0.146	26.725	14.86	47.068*	47.913*	0.000	0.000	0.000	0.000
Interaction (S×C)	1	373.78*	373.78*	346.87*	286.37*	2106.89*	2249.75*	4148.004*	4148.004*	276.973*	276.973*
Interaction (V×S×C)	2	72.965	72.965	18.833	10.814	15.191	18.286	0.000	0.000	0.000	0.000
Error (a)	22	43.25	52.343	58.637	55.910	4.59	6.87	41.919	44.646	12.296	12.751
Micronutrients (M)	3	46.333	46.333	34.647	30.306	289.542*	306.092*	438.94*	438.94*	81.938*	81.938*
Interaction (V×M)	6	0.368	0.368	0.801	0.502	12.02*	12.648	0.000	0.000	0.000	0.000
Interaction (S×M)	3	0.176	0.176	0.076	0.064	0.716	0.816	55.398	55.398	0.040	0.040
Interaction (C×M)	3	0.176	0.176	0.007	0.011	44.399*	47.658*	23.141	23.141	0.370	0.370
Interaction(V×S×M)	6	0.141	0.141	0.045	0.038	8.341	8.983	0.000	0.000	0.000	0.000
Interaction (V×C×M)	6	0.100	0.100	0.106	0.097	3.418	3.507	0.000	0.000	0.000	0.000
Interaction (S×C×M)	3	0.630	0.630	0.102	0.101	16.85*	18.287*	21.096	21.096	2.388	2.388
Interaction(V×S×C×M)	6	0.567	0.567	0.061	0.055	18.29*	19.678*	0.000	0.000	0.000	0.000
Error (b)	72	42.847	44.236	28.612	44.584	3.917	6.001	29.189	39.606	9.197	10.030

Table 4: Effect of transplanting spacing, method and foliar spray of micronutrients on days to maturity, spikelet fertility, harvest Index, Seed recovery and Seed yield in rice varieties during 2015 and 2016

Treatment	Days to Maturity		Spikelet fertility (%)		Harvest Index (%)		Seed Recovery (%)		Seed Yield(q/ha)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
NDR 97 (V_1)	98.06	100.06	83.42	85.71	27.65	28.78	81.27	84.43	26.67	27.63
NDR 359 (V_2)	129.38	132.38	89.47	90.27	30.16	30.86	80.04	82.12	44.84	45.70
BPT 5204 (V_3)	150.06	153.06	89.22	89.83	27.72	28.57	84.60	86.58	50.14	50.79
SEm ±	0.95	1.04	1.11	1.08	0.31	0.38	0.93	0.96	0.51	0.52
CD 5%	2.78	3.06	3.24	3.17	0.91	1.11	2.74	2.83	1.48	1.51
15×20 cm (S_1)	126.35	129.01	87.32	88.56	26.35	27.16	80.96	83.36	40.51	41.34
25×25 cm (S_2)	125.32	127.99	87.42	88.64	30.67	31.65	82.99	85.40	40.59	41.41
SEm ±	0.78	0.85	0.90	0.88	0.25	0.31	0.76	0.79	0.41	0.42
CD 5%	2.27	2.50	2.65	2.58	0.74	0.91	2.24	2.31	1.21	1.23
Normal transplanting (C_1)	126.54	129.21	86.27	87.66	24.78	25.55	78.51	80.92	39.63	40.45
SRI transplanting (C_2)	125.13	127.79	88.48	89.54	32.24	33.26	85.44	87.84	41.47	42.29
SEm ±	0.78	0.85	0.90	0.88	0.25	0.31	0.76	0.79	0.41	0.42
CD 5%	2.27	2.50	2.65	2.58	0.74	0.91	2.24	2.31	1.21	1.23
Control (M_0)	127.14	129.81	86.16	87.47	25.60	26.41	78.59	81.00	38.92	39.74

Zn, Fe and Mn @0.25%, 0.50%&0.25% (M_1)	126.25	128.92	87.09	88.34	27.27	28.13	80.32	82.73	39.84	40.66
Zn, Fe and Mn @0.50%, 1.00%&0.50% (M_2)	125.47	128.14	87.77	88.97	28.94	29.84	82.28	84.68	41.04	41.86
Zn, Fe and Mn @0.75%, 1.50%&0.75% (M_3)	124.47	127.14	88.46	89.62	32.24	33.24	86.70	89.11	42.40	43.22
SEm ±	1.09	1.11	0.89	1.11	0.33	0.41	0.90	1.05	0.51	0.53
CD 5%	3.08	3.13	2.51	3.14	0.93	1.15	2.54	2.96	1.42	1.49

Table 5: Analysis of variance for 1000 seed weight, germination test, seedling vigour index and electrical conductivity in rice varieties during 2015 and 2016

Source of variation	d.f.	Mean Sum of Squares									
		1000 Seed weight (g)		Germination (%)		Seedling vigour index I		Seedling vigour index II		E.C. (dS/m/gm)	
		2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Variety (V)	2	867.11*	871.11*	149.333*	64.000*	692201.45*	849595.45*	18858061.0*	19316081.99*	2.348*	2.398*
Spacing (S)	1	4.032	4.032	112.547*	112.547*	63814.12*	65595.13*	5517.05	5563.14	0.214*	0.214*
Transplanting method(C)	1	99.998*	99.998*	64.172	64.172	836717.68*	863220.47*	195819.67*	201823.58*	0.873*	0.873*
Interaction (V×S)	2	2.817	2.817	0.000	0.000	1387.04	1411.06	2210.25	2270.88	0.015	0.015
Interaction (V×C)	2	5.116	5.116	0.000	0.000	8608.79	9233.41	3595.53	3739.87	0.032	0.032
Interaction (S×C)	1	457.42*	457.42*	223.17*	223.17*	2873964.80*	2965564.39*	621906.79*	640662.37*	2.248*	2.248*
Interaction (V×S×C)	2	19.66*	19.661*	0.000	0.000	17565.70	19333.40	11121.50	11393.19	0.037	0.037
Micronutrients (M)	3	17.37*	17.374*	488.547*	488.547*	632863.58*	652787.32*	199248.53*	204812.20*	0.605*	0.605*
Interaction (V×M)	6	0.698	0.698	0.000	0.000	4532.52	4696.32	8732.965	8744.629	0.115*	0.115*
Interaction (S×M)	3	0.038	0.038	13.672	13.672	20845.76	21518.98	6151.937	6339.505	0.023	0.023
Interaction (C×M)	3	0.015	0.015	10.797	10.797	8558.25	8805.45	2484.288	2546.686	0.034	0.034
Interaction(V×S×M)	6	0.042	0.042	0.000	0.000	902.11	937.27	520.940	531.555	0.012	0.012
Interaction (V×C×M)	6	0.071	0.071	0.000	0.000	294.76	305.04	362.236	370.804	0.017	0.017
Interaction (S×C×M)	3	0.100	0.100	17.047	17.047	14732.05	15049.65	2537.286	2565.644	0.036	0.036
Interaction (V×S×C×M)	6	0.097	0.097	0.000	0.000	203.23	211.32	455.596	470.561	0.003	0.003
Error	144	3.721	5.166	17.406	16.220	11008.52	13239.01	12414.987	4900.190	0.013	2.398*

Table 6: Effect of treatments on 1000 seed weight, germination test, seedling vigour index and electrical conductivity in rice varieties during 2015 and 2016

Interaction	1000 Seed weight (g)		Germination (%)		Seedling vigour index I		Seedling vigour index II		E.C. (dS/m/gm)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
NDR 97 (V_1)	22.29	22.40	85.08	87.08	2176.64	2253.85	1449.10	1497.07	1.36	1.25
NDR 359 (V_2)	26.40	26.52	88.08	89.08	2011.79	2067.56	1771.96	1809.88	1.20	1.09
BPT 5204 (V_3)	19.05	19.16	87.08	88.08	1984.37	2043.25	712.87	741.31	0.98	0.87
SEm ±	0.24	0.28	0.52	0.50	13.12	14.38	13.93	8.75	0.01	0.01
CD 5%	0.68	0.80	1.46	1.41	36.72	40.27	39.00	24.50	0.04	0.03
15×20 cm (S_1)	22.44	22.55	85.98	87.31	2039.37	2103.07	1305.95	1344.04	1.22	1.10
25×25 cm (S_2)	22.73	22.84	87.51	88.84	2075.83	2140.04	1316.67	1354.80	1.15	1.04
SEm ±	0.20	0.23	0.43	0.41	10.71	11.74	11.37	7.14	0.01	0.01
CD 5%	0.55	0.65	1.19	1.15	29.99	32.88	31.84	20.01	0.03	0.02
Normal transplanting (C_1)	21.86	21.97	86.17	87.50	1991.59	2054.50	1279.37	1317.00	1.25	1.14
SRI transplanting (C_2)	23.30	23.41	87.32	88.66	2123.62	2188.61	1343.25	1381.84	1.11	1.00
SEm ±	0.20	0.23	0.43	0.41	10.71	11.74	11.37	7.14	0.01	0.01
CD 5%	0.55	0.65	1.19	1.15	29.99	32.88	31.84	20.01	0.03	0.02
Control (M_0)	21.89	22.00	82.60	83.94	1915.15	1976.87	1230.43	1267.41	1.31	1.20
Zn, Fe and Mn @0.25%, 0.50%&0.25% (M_1)	22.35	22.46	86.35	87.69	2030.85	2094.40	1298.02	1335.94	1.23	1.12
Zn, Fe and Mn @0.50%, 1.00%&0.50% (M_2)	22.79	22.90	87.79	89.13	2096.21	2160.78	1332.91	1371.32	1.14	1.03
Zn, Fe and Mn @0.75%, 1.50%&0.75% (M_3)	23.29	23.40	90.23	91.56	2188.20	2254.17	1383.89	1423.00	1.05	0.94
SEm ±	0.28	0.33	0.60	0.58	15.14	16.61	16.08	10.10	0.02	0.01
CD 5%	0.78	0.92	1.69	1.63	42.41	46.50	45.03	28.29	0.05	0.03

The above findings are in accordance with the results obtained by Hammes (1969) [12] found positive relationship between seed quality parameters and size of seeds. There was an increase in shoot length, root length and dry matter with increase in seed weight. According to Cicero and Orsie (1978) [6] vigour was greater in the heavy seeds than in the light seeds. Amral and Dos (1979) [3] observed that rice seeds of higher weight and size had better physiological quality as shown by higher longevity, germination capacity and higher vigour, than lighter seeds. Gasper and Bus (1981) [10] reported that, in seeds of higher 1000 seed weight were superior both in germination capacity and seedling vigour. Mathur *et al.* (1982) [16] observed a significant positive association between 1000 seed weight (g), dry matter (mg/10 seedlings), germination per cent, germination index, root length and shoot length. Vannagamudi and Ramaswamy (1984) [23] reported that co-efficient of variation in seed weight and vigour parameters like root, shoot and coleoptiles lengths of the seedlings varied significantly within and between size grades of seed. Tomar and Prasad (1993) [22] reported that germination percentage decreased as specific gravity of seed decreased.

Interaction effect

The results over two years revealed that significant interactions between variety and transplanting spacing;

variety and transplanting method; transplanting spacing and transplanting method; variety, transplanting spacing and transplanting method; variety and micronutrients doses; and transplanting method and micronutrients doses have been registered for most of the growth and yield parameters.

Quality parameters of seed such as germination rate and 1000 seed weight were also significantly affected due to interactions effects of transplanting spacing and method (Table 5), whereas also effect on days to 50 % flowering and maturity (Table 1 & 3). Interaction effects transplanting method and micronutrients significantly influenced the number of tillers per plant, productive tillers per hill, harvest index and electrical conductivity of rice (Table 1, 3 & 5). Other possible interaction effects were found to be non-significant for most of the characters.

Conclusion

The SRI method of transplanting was found suitable for obtaining early and high seed yield with maximum seed recovery and quality seeds. Among doses of foliar spray of micronutrient, Zn, Fe and Mn @0.75%, 1.50% & 0.75% may be utilized in rice for seed production as it produced higher seed yield and maintained the quality of seeds. In future, more increased doses of foliar spray of micronutrient should be tested for optimization of doses up to critical level of hunger in seed crop of rice. Generally increase in seed weight at successive stages of seed development and significant effect of transplanting methods, spacing and micronutrients at various stages of seed development suggested that harvesting of the rice should be done at low moisture content as and when increase in seed weight totally stopped.

Finally, it is recommended from the present findings revealed that rice crop should be transplanted with 25×25 cm spacing under SRI method along with foliar spray application of Zn, Fe and Mn @0.75%, 1.50%&0.75%, for obtaining high seed yield potential of the variety producing good quality seeds.

References

1. Abdul-Baki AA, Anderson JD. Vigour determination in soybean seeds by multiple criteria. *Crop Sci*., 1973; 13:630-633.
2. Akbar MK. Response of hybrid and inbred rice varieties to different seedlings ages under system of rice intensification in transplant aman season. M.S.(Ag.) Thesis. Dept. Agron., BAU, Mymensingh, 2004.
3. Amral AS, Dos P. Effect of weight and size of seeds on physiological quality and yield of rice grain. *Lavoora Arrozeira.* 1979; 32(317):24-26.
4. Anonymous. International seed testing Rules-ISTA. Zurich, Switzerland, 2008.
5. Aziz MB, Hasan R. Evaluation of System of Rice Intensification (SRI) in Bangladesh. Locally Intensified Farming Enterprises Project, CARE, Bangladesh. 2000, 4-9.
6. Cicero SM, Orsie WDL. Effect of Seed weight of rice (*Oryza sativa* L.) on vigour. *Solo*, 1978; 70(1):5-12.
7. Dahiya BS, Deswal DP, Duhan JC, Kashyap R. Status of seed quality at farmer's level in field crops. *Paper presented in International Seminar on Quality Seed for* Higher Production, held at CCS HAU, Hissar, India. 1993, 22-24.
8. Devarajan P. The foreign hand in Agartala. Financial Daily from The Hindu group of publications, 2005.
9. Garcia FV, Peng S, Cassaman KG. Yield potential of transplanted and wet seeded rice in high yield environments in the Philippines. In: Constraints, Opportunities and Innovations for Wet Seeded Rice. K. Moody (ed.). Intl. Rice Res. Inst., Philippines. 1995, 246-256.
10. Gasper S, Bus A. Relationship between 1000 seed weight and germination capacity and seed longevity in small seeded Fabaceae. Seed Sci. Technol. 1981; 9:457-467.
11. Hamid RB, Amin F, Reza KD, Abdolkarim K, Ebrahim A, Fereshteh T. Effect of plant density on yield and yield components of rice. World Applied Sci. Journal., 2011; 12(11):2053-2057.
12. Hammes PS. Seed characteristics and seedling growth of graded maize seed. Fld. Crop. Abstr. 1969; 24:347-349.
13. Hossain MZ, Hossain SMA, Anwar MP, Sarker MRA, Mamun AA. Performance of BRRI Dhan 32 in SRI and Conventional Methods and Their Technology Mixes. Pakistan J. Agron. 2003; 2(4):195-200.
14. Husain MM, Haque MA, Khan MAI, Rashid MM, Islam MF. Direct wet-seeded method of establishment of rice under irrigated condition. The Agriculturists., 2003; 1(1):106-113.
15. Longxing T, Xi W, Shaokai M. Physiological effects of SRI methods on the rice plant. China National Rice Res. Inst., Hangzhou, 2002. *[*http://ciifad. cornell.edu/sri/proc1/sri_29.pdf].
16. Mathur PN, Sinnha NC, Singh RO. Effect of seed size on germination and seed vigour in oat (*Avena sativa* L.). *Seed Res*., 1982; 10(2)**:**109-113.
17. Rao SS, Shrivatsav MN. Association among yield attributes in upland rice. *Oryza.* 1999; 8:23-27.
18. Saina T. More rice with less water. Approp. Technol., 2001; 28(3):8-11.
19. Salahuddin KM, Chowhdury SH, Munira S, Islam MM, Parvin S. Response of nitrogen and plant spacing of transplanted aman rice. Bangladesh J of Agric. Res. 2009; 34(2):279-85.
20. Sarkar MAR, Paul SK, Ahmed M. Effect of row arrangement and tiller separation on the growth of transplant aman rice. Pakistan J Biol. Sci. 2002; 5(4):404-406.
21. Seshu DV, Dadlani M. Seed vigour in rice (*Oryza sativa*): its assessment and impact on crop performance. *Seed Res.*, 1993; (2):700-706.
22. Tomar JB, Prasad SC. Studies on seed vigour and quantities characters and their relationship in rice. J. Maharashrtra Agric. Univ. 1993; 18:181-183.
23. Vannagamudi K, Ramaswamy KR. Relationship between seed weight, germination and seedling vigour. *Madras Agric. J*., 1984; 71(4):252-254.
24. Yassen A, Abou El-Nour EAA, Shedeed S. Response of wheat to foliar Spray with urea and micronutrients. *J. Am. Sci.*, 2010; 6(9).
25. Zayed BA, Salem AKM, El Sharkawy HM. Effect of different micronutrient treatments on rice (Oriza sativa L.) growth and yield under saline soil conditions. World J. Agric. Sci. 2011; 7(2):179-184.
26. Zeidan MS, Manal I, Mohamed F, Hamouda HA. Effect of Foliar Fertilization of Fe, Mn and Zn on Wheat Yield and Quality in Low Sandy Soils Fertility. World J. Agric. Sci., 2010; 6(6):696-699.
27. Zheng J, Lu X, Jiang X, Tang Y. The System of Rice Intensification (SRI) for super-high yields of rice in Sichuan Basin. New directions for a diverse planet: Proceedings of the 4th International Crop Science Congress Brisbane, Australia, 2004.