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Shishir Kant Singh
Krishi Vigyan Kendra, Sitapur - II, Post- Ulra, Biswan, Sitapur, Uttar Pradesh, India

VN Singh
Crop Research Station, Masodha (N.D. University of Agriculture & Technology) Post-Dabhasemer, Faizabad, Uttar Pradesh, India

DP Singh
Crop Research Station, Masodha (N.D. University of Agriculture & Technology) Post-Dabhasemer, Faizabad, Uttar Pradesh, India

Correspondence
Shishir Kant Singh
Krishi Vigyan Kendra, Sitapur - II, Post- Ulra, Biswan, Sitapur, Uttar Pradesh, India

Effect of nursery nutrient management on yield and economics of Swarna and Swarna-Sub 1 in submergence prone ecosystem of eastern Uttar Pradesh

Shishir Kant Singh, VN Singh and DP Singh

Abstract
A field experiment was conducted at Crop Research Station (NDUAT), Masodha, Faizabad during kharif 2011 & 2012 to access the effect of nursery nutrient management on yield and attributing traits of Swarna and Swarna Sub-1 in submergence/flood prone ecosystem of eastern Uttar Pradesh. The experiment was comprised of seven different nutrient combinations viz. T1 - N_{100}:P_{50}:K_0 kg/ha, T2 - N_{60}:P_{40}:K_{40} kg/ha, T3 - N_{20}:P_{40}:K_{40} kg/ha, T4-N_{20}:P_{40}:K_{60} kg/ha, T5 - N_{20}:P_{60}:K_{40} kg/ha, T6 - N_0:P_{60}:K_{40} kg/ha and T7-N_0:P_{40}:K_{60} kg/ha in nursery plots. Highest grain yield of rice (38.28 q/ha) during 2011 and (38.46 q/ha) during 2012 was obtained under variety Swarna Sub1 with nursery nutrient treatment T_4-$N_{20}P_{40}K_{60}$. The economic analysis also exhibits profitability of this treatment combination (T_4-$N_{20}P_{40}K_{60}$) over the other treatments with submergence tolerant rice variety Swarna Sub-1. Maximum benefit: cost ratio of 1.79 and 1.83 during both respective years was recorded under combination of variety Swarna Sub1 and T_4- $N_{20}P_{40}K_{60}$ nutrient treatments.

Keywords: swarna-sub 1, submergence, flood prone, harvest index, economics

1. Introduction
Rice is the staple food for more than 3 billion peoples of Asia and South East Asia. Of the total global rice production, 90% was produced and consumed in this region of the world. Rice is not only the staple food for the rice eating population of Asia and South East Asia but it is also the chief source of their dietary energy. India is the second largest rice producer of the worlds just behind, China. About 1/3rd of total area under rice cultivation in the world is in India. India produced 104.80 million tons of rice form an area of 43.90 mha which was spread over all the existing ecologies of rice cultivation. As per an estimate of the total area under rice cultivation in India, 17 mha is rainfed, submergence prone and drought prone (Singh *et al*, 2013) [12]. About 15% of the rainfed lowland rice fields in South and Southeast Asia can experience both drought and submergence during the growing season. Flash flood or submergence is a common phenomenon in lowland ecosystem of rice cultivation, subject to monsoon rains, adversely affecting crop establishment as well as survival of seedlings, resulted in severe yield losses. About 1/3rd of India‘s rice area was affected by submergence (Sarkar *et al*, 2006) [19]. Submergence substantially reduces crop stand, if it occurs during early vegetative stage of crop growth and prolongs for more than a 7-10 days. The average rice productivity of submergence prone areas of eastern Uttar Pradesh is about 0.5-0.8 t/ha, whereas it is more than 2.0 t/ha for favourable rainfed lowlands, which being much lower than the input-intensive irrigated system (5.0 t/ha). But, these flood-prone ecosystems have enormous potential for more food production to meet the required food demand of continuously growing population. These submergence prone areas posses' nutrients rich soils and have freshwater resources. Development of submergence tolerant rice varieties and location specific production technologies are major options to increase the rice productivity of these flood/submergence prone areas. International Rice Research Institute (IRRI), Manila Philippines has made considerable progress in development of submergence tolerant rice varieties by introgression of SUB 1 gene in the background mega varieties through Marker Assisted Backcross Breeding. These new varieties having sub-1 gene possess high degree of submergence tolerance due to high seedling survival percentage even after 15 days of complete submergence. These varieties can be boon for resource poor farmers of submergence prone areas of eastern Uttar Pradesh. Optimal nutrition of rice seedling before submergence and post submergence is necessary to equip plants with cellular and metabolic requirement essential for survival of flooding, and also for recovery after flood water recedes.

Damage from submergence is most likely when rice plants are small, and the damage seems higher if the plant nutrition is unbalanced. Therefore, improving seedling health in nursery through nursery nutrients management may lead to better crop establishment.

The present experiment was designed to examine the effect of nutrient management in nursery on the grain yield of transplanted rice under submergence stress. The hypothesis was that the benefits from fertilizing the nursery were related to larger and more vigorous seedlings better able to withstand submergence stress.

2. Material & Methods

A Field experiment was conducted at Crop Research Station (NDUAT), Masodha, Faizabad during Kharif 2011 & 2012 to evaluate the effect of nursery nutrient management on grain yield and yield contributing traits of submergence tolerant rice variety Swarna-Sub 1 in submergence prone ecology of lowland rice. The economics of nursery nutrient management was also analyzed. The experimental site is located at 26^0 47' N latitude, 82^0 08' E Longitude and 113 m altitude above mean sea level. Soil samples were collected prior to the start of experimentation and analyzed using standard methods. The soil of the experimental site was silty loam in texture while slightly basic in nature. The detailed physico-chemical characteristics of the soil is presented in Table 1. The climate of eastern Uttar Pradesh in general is, humid subtropical with dry winter which creates a conducive environment for the growth of rice. The average annual temperature is 25.3 °C while the average rainfall was 1143 mm. The temperature normally varies from 25 ˚C to 45 ˚C during summer and from 5 ˚C to 28 ˚C during winter.

The experiment was laid out in randomized complete block design with three replications using submergence tolerant rice variety Swarna-Sub1 and Swarna as test variety. Treatments were comprised of seven different nutrient combinations viz. T1 - N_{100}:P_{50}:K_0 kg/ha, T2 - N_{60}:P_{40}:K_{40} kg/ha, T3 - N_{20}:P_{40}:K_{40} kg/ha, T4 - N_{20}:P_{40}:K_{60} kg/ha, T5 - N_{20}:P_{60}:K_{40} kg/ha, T6 - N_0:P_{60}:K_{40} kg/ha and T7 - N_0:P_{40}:K_{60} kg/ha in nursery plot. Inorganic fertilizers Urea, Single Super Phosphate (SSP) and Muriate of Potash (MOP) were use as source of Nitrogen (N), Phosphorous (P_2O_5) and Potash (K_2O) respectively. Full dose of phosphate, potash and half dose of Nitrogen was applied as basal dose in nursery field while the remaining half dose of nitrogen was applied 20 days after sowing (DAS). The pre-germinated seeds of Swarna - Sub 1 crop were sown in raised nursery beds in 1^{st} week of June and 25 days old seedling were transplanted in the 1^{st} week of July in both the year of study. Individual plot size was 2×1 m for nursery bed and 5×4 m for main field experiments. $1/10^{th}$ area was used for nursery seeding and accordingly fertilizer doses were determined for each treatment plot. Seedlings were transplanted at a spacing of 20×15 cm with 2-3 seedlings $hill^{-1}$. Recommended fertilizer dose of N-P_2O_5-K_2O at 80-40-40 kg ha^{-1} along with 25 kg $ZnSO_4 \cdot 7H2O$ ha^{-1} was used for the proper crop growth of in main experimental field of. Half dose of Nitrogen, full doses of phosphate and potash along with full dose of Zn were added as basal at one day before transplanting. The remaining half dose of nitrogen was applied in two equal splits at active tillering and panicle initiation stages of crop growth. After 12 days transplanting submergence tanks were completely filled up by water. Water depth was measured regularly and maintained by fresh water till 12^{th} day of submergence. At 13^{th} days after submergence, water drain out from tanks.

Observation on yield attributing traits and yield were recorded and statistically analysed mean data was presented in table -2 & 3. Economics of nursery nutrient management of rice varieties grown under submergence prone ecosystem was also analysed following standard method and presented in tabl-4

3. Results and Discussion

Yield and yield attributes

On the perusal of data presented in table-2 & 3 it was observed that plant crop stand, panicle length, test weight, total number of grains/panicle, sterile percent, fertile grain/panicle, yield (q/ha) and harvest index significantly enhance with enrichment of seedling nutrient and survival. Yield and yield contributing characters significantly influenced by irrespective doses and integrated nutrient management in nursery and N application just after de submergence (5^{th} day after submergence. Maximum, panicle length and grain number/ panicle, fertile grain numbers, test weight, grain yield and harvest index were obtained with T_4 (N_{20}:P_{40}:K_{60}) whereas, maximum straw yield was observed in T_5 (N_{20}:P_{60}:K_{40}) at par with T_4 (N_{20}:P_{40}:K_{60}). In case of sterility, maximum percent sterility was observed in T_1 when N @ 100kg/ha with combination of P @ 50 kg ha^{-1} in nursery. Biomass (g m^{-2}) at maturity was found maximum in T_4 (N_{20}:P_{40}:K_{60}). Similarly, yield (q/ha) was also higher in T_4 (N_{20}:P_{40}:K_{60}) followed by T_5 (N_{20}:P_{60}:K_{40}) because of these treatments had maintained higher crop stand after 12 days of de-submergence. Although yield (q ha^{-1}) was higher inT_4 and T_5 when P and K were applied comparatively high in nursery with low N due to relatively lower seedling mortality crop stand was increased. Therefore aggregate plot yield was also increased. It is also reflected from test weight which is at par with ob T_4 (N_{20}:P_{40}:K_{60}) and T_5 (N_{20}:P_{60}:K_{40}). Since, that phosphorus and potassium both helpful in re-establishment of plant and maintain the plant growth during submergence than nitrogen. Although higher Harvest Index was observed in higher nitrogen containing treatmentsT_1 (N_{100}:P_{50}:K_0) followed without N. Similarly, minimum harvest index was obtained in higher doses of phosphorus (Singh *et al*, 2005 and Singh *et al*, 2005a) [22, 23].

Economics

The net return were much influenced due to the treatment effect on yield in both variety Swarna Sub-1 and Swarna both years. It recorded maximum (Rs. 40081.30/ha and Rs. 41491.8/ha) under the treatment of V_1T_4 ($N_{20}P_{40}K_{60}$) in Swarna Sub-1 in both year 2011 and 2012 respectively, followed by Rs. 37733.7/ha and Rs. 37060.2/ha under V_1T_5 ($N_{20}P_{60}K_{40}$). Minimum net return of Rs. 373.41/ha and 2458.41/ha during 2011 and 2012 respectively was noted in variety Swarna when its nursery was fertilized with T_1 ($N_{100}P_{60}K_0$).

Like net return benefit cost ratio was also more in combination of CV Swarna Sub1and T_4 ($N_{20}P_{40}K_{60}$). Lowest benefit: cost ratio was associated with combination of CV Swarna and T_1 ($N_{100}P_{60}K_0$). The trend of data was similar during both the years of study.

Table 1: Physicochemical properties of soil of nursery and main experimental field

Characteristics	Nursery Field	Main Field
Sand	35.2 %	35.1 %
Silt	48.6 %	48.8 %
Clay (%)	16.2 %	16.1 %
Texture class	39.6 %	39.5 %
Soil reaction (pH)	7.5	7.5
Organic carbon (%)	0.30	0.32
Electrical conductivity (m.mhos/cm. at 25 ºC	0.28	0.28
Available N (Kg ha^{-1})	134.20	128.9
Available P2O5 (Kg ha^{-1})	14.20	14.20
Available K2O (Kg ha^{-1})	219.40	220.50

Table 2: Influence of nutrient management in nursery on yield attributing traits of rice variety Swarna and Swarna Sub-1 in submergence prone ecosystem of eastern Uttar Pradesh

Treatments	Length of Panicle (cm)		Number of Panicle (m^{-2})		No. of grain $panicle^{-1}$		No. of fertile grain $panicle^{-1}$		Sterility %		Test weight (g)	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Varieties												
Swarna Sub-1	28.58	29.07	239.29	239.57	271.76	273.19	222.06	224.21	18.67	18.6	18.27	18.42
Swarna	26.09	26.5	153.29	153.43	262.16	264.4	209.71	213.06	20.23	20.09	18.6	18.7
SEm±	0.411	0.461	3.143	3.936	4.481	3.765	3.514	3.035	0.369	0.332	0.07	0.149
CD (p=0.05)	1.196	1.34	9.138	11.441	NS	NS	10.215	8.821	1.073	0.965	0.203	0.433
Nutrient levels												
T_1- $N_{100}P_{50}K_0$	28.23	29.1	147	148	231.35	233.65	166.7	168.3	27.95	28	17.73	17.65
T_2-$N_{60}P_{40}K_{40}$	28.25	28.7	179.5	173.5	262.5	260.6	207.65	210.3	21	20.8	18.5	17.98
T_3-$N_{20}P_{40}K_{40}$	28.2	28.75	224	230.5	277	279.45	220.2	221.95	20.55	20.5	18.63	18.8
T_4-$N_{20}P_{40}K_{60}$	28.35	28.6	252.5	251.5	307	306.3	264	264.3	14	13.5	18.83	19.03
T_5-$N_{20}P_{60}K_{40}$	27.45	27.65	245.5	245.5	286.85	289.15	243	245.65	15.3	15.2	18.65	19.02
T_6-$N_0P_{60}K_{40}$	27.45	27.8	156	155.5	254	257.6	202.35	208.8	20.3	20.2	18.48	18.53
T_7-$N_0P_{40}K_{60}$	26.9	27.4	169.5	171	250	254.8	207.3	211.15	17.05	17.2	18.18	18.88
SEm±	0.77	0.862	5.881	7.363	8.384	7.043	6.574	5.677	0.691	0.621	0.131	0.279
CD (p=0.05)	NS	NS	17.095	21.405	24.371	20.475	19.111	16.503	2.008	1.805	0.38	0.81

Table 3: Influence of nutrient management in nursery on grain & straw yield (q ha^{-1}) and harvest index of variety Swarna and Swarna Sub-1 in submergence prone ecosystem of eastern Uttar Pradesh

Treatments	Grain yield q ha^{-1}		Straw yield q ha^{-1}		Harvest index %	
	2011	2012	2011	2012	2011	2012
Varieties						
Swarna Sub-1	38.28	38.46	59.06	63.87	39.21	37.56
Swarna	22.69	22.77	49.99	59.7	30.97	27.37
SEm±	0.503	0.54	0.795	1.016	0.472	0.571
CD (p=0.05)	1.462	1.57	2.31	2.953	1.373	1.659
Nutrient levels						
T_1- $N_{100}P_{50}K_0$	23.3	23.65	48.63	53.7	31.53	29.93
T_2-$N_{60}P_{40}K_{40}$	29.42	29.65	53.47	56.35	34.8	33.91
T_3-$N_{20}P_{40}K_{40}$	32.22	32.6	57.5	63.88	35.45	33.4
T_4-$N_{20}P_{40}K_{60}$	38.52	38.7	58.4	67.54	39.48	36.23
T_5-$N_{20}P_{60}K_{40}$	36.23	35.85	60.84	67.6	37.06	34.57
T_6-$N_0P_{60}K_{40}$	25.89	25.7	51.2	60.8	32.87	28.87
T_7-$N_0P_{40}K_{60}$	27.85	28.15	51.67	62.65	34.47	30.35
SEm±	0.941	1.011	1.487	1.901	0.884	1.068
CD (p=0.05)	2.736	2.938	4.322	5.525	2.569	3.103

Table 4: Economics of nutrient management of rice varieties grown under submergence prone ecosystem of eastern Uttar Pradesh

Treatments	Economics of different treatments							
	Cost of cultivation (Rs ha^{-1})		Gross Income (Rs ha^{-1})		Net return (Rs ha^{-1})		Benefit : Cost	
	2011	2012	2011	2012	2011	2012	2011	2012
V_1T_1	22381.59	22681.59	45220	44725	22838.4	22043.4	1.02	0.97
V_1T_2	22395.26	22695.26	52891	53390	30495.7	30694.7	1.36	1.35
V_1T_3	22368.67	22668.67	55177	56525	32808.3	33856.3	1.47	1.49
V_1T_4	22398.23	22698.23	62479.5	64190	40081.3	41491.8	1.79	1.83
V_1T_5	22406.79	22706.79	60142.5	59767	37735.7	37060.2	1.68	1.63
V_1T_6	22393.49	22693.49	48785.5	50198	26392	27504.5	1.18	1.21
V_1T_7	22384.93	22684.93	51599.5	52415	29214.6	29730.1	1.31	1.31
V_2T_1	22381.59	22681.59	22755	25140	373.41	2458.41	0.02	0.11
V_2T_2	22395.26	22695.26	31339.5	32005	8944.24	9309.74	0.4	0.41
V_2T_3	22368.67	22668.67	36860.5	37750	14491.8	15081.3	0.65	0.67

V_2T_4	22398.23	22698.23	45488	46067	23089.8	23368.8	1.03	1.03
V_2T_5	22406.79	22706.79	42599.5	43378	20192.7	20671.2	0.9	0.91
V_2T_6	22393.49	22693.49	26167	26212	3773.51	3518.51	0.17	0.16
V_2T_7	22384.93	22684.93	28359.5	30490	5974.57	7805.07	0.27	0.34

4. Conclusion

On basis of the results of both the year of study it was concluded that that proper nutrient management (N_{20}:P_{40}:K_{60} kg/ha) in nursery can contribute considerably to maximizing submergence tolerance and grain yield of the rice crop in the main field. Economic analysis of rice cultivation in submergence prone ecosystem following nursery nutrient management also revealed profitability of this cultural practice.

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