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Dual culture of azolla in rainfed transplanted rice

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ABSTRACT

An experiment was conducted at Agricultural Research Station (Paddy), Sirsi during kharif seasons of 2009 to 2011 (three years) to study the effect of dual cropped Azolla and its time of release on yield of rice crop and on soil fertility. The treatments consist of four levels of Azolla release time (A_1 - Two to three weeks before planting; A_2 - At 15 days after planting (DAP); A_3 - At 30 DAP and A_4 - At 45 DAP) and two levels of nitrogen (N_1 - 50% recommended dose of nitrogen (RDN) and N_2 - 100% RDN). These treatment combinations were compared with one control i.e., without Azolla but with recommended dose of nitrogen (75 kg/ha). The results indicate that the differences were not significant with respect to grain yield, straw yield and net returns due to time of release of Azolla in paddy as dual crop (inter crop). The interaction effect showed that the net returns realised with all combinations of Azolla release time and 100% recommanded dose of nitrogen (RDN) levels was significantly higher as compared to that that obtained with recommended package of practice.

Key words: *Azolla, rice, dual culture, release time, nutrient content*

Rice is the major crop in hill zone of Karnataka grown mainly in lowland situation as rainfed transplanted crop during kharif season. Nitrogen is the single most limiting factor in rice cultivation, strongly affecting the crop yield. To sustain rice production in lowland situation where farmers are unable to afford the cost of inorganic fertilizers, it is imperative to look at cheaper organic sources of fertilizer as alternative or supplement to inorganic fertilizers (Singh et al., 2011). In this context, use of Azolla was recommended as green manure for rice long back by considering its high nitrogen fixing capacity, rapid multiplication in waterlogged rice fields, rapid decomposition and relatively easy availability of its nitrogen to the standing crop (Watanabe et al., 1977; Lumpkin and Plucknett, 1982; Singh and Singh, 1989). But, the technology was not widely practiced by the farmers because of difficulty in multiplying Azolla in main field due to non availability of water two months prior to planting of rice for growing Azolla in main paddy field. To overcome this, dual cropping of Azolla (growing of Azolla along with rice) was suggested by several workers (Kannaiyan, 1993; Mvukiye and Msumali, 2000; Nath et al., 2012). In this practice, release time of Azolla into the rice field is important. Hence, the present investigation was conducted to know the effect of dual cropped Azolla and its time of release on yield of rainfed transplanted rice crop.

An experiment was conducted at Agricultural Research Station (Paddy), Sirsi during *kharif* seasons of 2009 to 2011 (three years) to study the effect of dual cropped Azolla and its time of release on yield of rainfed transplanted rice crop and on soil fertility. The experiment was laid out in complete randomized block design with three replications. The treatments consist of four levels of Azolla release time (A_1 - Two to three weeks before planting, A_2 - At 15 days after planting (DAP), A_3 - At 30 DAP and A4 - At 45 DAP) and two levels of nitrogen (N_1 - 50% recommended dose of nitrogen (RDN) and N_2 - 100% RDN). The treatment combinations of these two factors were compared with one control *i.e.*, without Azolla but with recommended dose of nitrogen (75 kg/ha). A common recommended dose of P_2O_5 (75 kg/ha) and K_2O (87.5 kg /ha) was given to all the treatments. Thirty days old seedlings of

long duration (150-155 days) rice verity Abhilash were used in the experiment. Two to three seedlings were planted at each hill with a spacing of 20 x 10 cm. The fertilizers were applied in accordance with the treatments. Half of N and K_2O and entire dose of P_2O_5 was applied at the time of planting. The first top dressing was done with 25% N and 50% K_2O at 25 DAP and the second top dressing with remaining 25% N was done at 50 days after planting the crop. The Azolla (*Azolla pinnata* R. Br.) obtained from the University of Agricultural Sciences, Dharwad was used in the experiment. The Azolla was released at the rate of 500 kg/ha as per treatments in the standing rice crop. In treatment where, the Azolla was released 2-3 weeks before planting, the multiplied Azolla was incorporated at final land preparation. Thereafter, the grown up Azolla mat in all the treatments was allowed for self decomposition during rice growing period and left over Azolla was incorporated into the soil by ploughing after the harvest of paddy. The necessary plant protection measures were taken for the rice crop. The observations on grain and straw yield were made at harvest of the crop during each season. The soil samples were collected from 0-20 cm depth by using posthole auger from each treatment at the end of 3rd year. These soil samples were analysed for pH, EC, organic carbon and major (N, P and K), secondary (Ca, Mg and S) and micro (Zn, Fe, Mn and Cu) nutrients by using standard methods as suggested by Tandon (1995). The data of individual years as well as pooled was analyzed statistically under M-STAT-C programme by adopting completely randomised block design.

The data on rice grain and straw yield and its economics as influenced by release time of Azolla in rice crop are presented in Table 1. The data clearly indicates that there was no significant difference in grain yield, straw yield and its economics of rice recorded in treatment where Azolla was grown 2-3 weeks before and incorporated at planting and other treatments where Azolla released at 15, 30 and 45 days after planting of rice in two years out of three years of experimentation as well as in pooled data. On an average over three years, the grain yield, straw yield and net returns were maximum in treatment where Azolla was grown 2-3 weeks before and incorporated at planting (6561 and 8184 kg/ha and Rs. 45340/ha, respectively) and were found on par with that of Azolla released at 15 DAP (6209 and 7695 kg/ha and Rs. 43085/ha, respectively), 30 DAP (6199 and 7520 kg/ha and Rs. 44120/ha, respectively) and 45 DAP (6259 and 7497 kg/ha and Rs. 43818/ha, respectively). Similar results reporting positive effect of dual cultured Azolla on rice were reported by several workers (Nyalemegbe et al., 1996; Mvukiya and Msumali, 2000; Rajarathinam et al., 2010 ; Yadav et al., 2014).

On an average over three years, among the different nitrogen levels, 100% RDN recorded maximum grain and straw yield (6582 and 8628 kg/ha, respectively) and was found to be on par with that of 50% RDN (6407 and 8213 kg/ha, respectively). However, the net returns realised with 100% RDN (Rs.44474/ha) was significantly higher as compared to that of 50% RDN (Rs. 42904/ha).

The interaction effect of Azolla and N levels on any of the parameters was not significant during individual years as well as in pooled data. On an average over three years, the comparison of recommended package of practice (RPP) with treatment combinations of Azolla release time and N levels showed that the grain and straw yield recorded with RPP treatment (6190 and 8129 kg/ha, respectively) was on par with all treatment combinations except A_1N_1 (6561 and 8818 kg/ha, respectively) and A1N2 (6200 and 8907 kg/ha, respectively). However, the net returns realized with RPP was significantly less as compared to that obtained with all combinations of Azolla release time and 100% RDN levels.

The soil analysis data done to know the effect of dual cultured Azolla on nutrient content of soil indicates that there was improvement in nutrient status of soil at the end of three year study (Table 2). There was slightly improvement in soil pH and EC of soil as compared to initial values. The organic carbon content of soil increased to a greater extent (0.67 to 0.78%) in different treatments as compared to its initial value (0.56%) and that of RPP treatment (0.61%). Similarly, there was improvement in major (N, P and K), secondary (Ca, Mg and S) and micro (Zn, Fe, Mn and Cu) nutrient content of soil in Azolla treatments as compared to that of initial value and that of RPP. Yadav et al. (2014) reported that inoculation of Azolla contributes significant amounts of nitrogen phosphorus, potassium, sulphur, zinc, and iron in addition to sustaining

Table 1. The yield and economics of rainfed transplanted rice as influenced by dual culture of Azolla

Treatments	Grain yield (kg/ha)				Straw yield (kg/ha)				Net returns (Rs./ha)			
	2009	2010	2011	Pooled	2009	2010	2011	Pooled	2009	2010	2011	Pooled
Azolla Release time (A)												
A_1 –2-3 weeks before planting	7194	6071	6828	6561	10888	8969	6731	8184	47449	48497	42183	45340
A_2 – At 15 DAP	6693	5822	6634	6200	9484	8501	7141	7695	41678	45313	40856	43085
A_3 – At 30 DAP	6539	6018	6678	6199	9092	8395	7031	7520	40101	47106	41134	44120
A_4 – At 45 DAP	6780	6066	6611	6259	9263	8653	6494	7497	42322	47976	39659	43818
S.Em±	151	121	113	92	486	378	155	168	1540	1563	1175	756
C.D. at 5%	457	NS	NS	255	NS	NS	470	468	4671	NS	NS	2096
Nitrogen levels (N)												
N_1– 50% RDN	6540	6101	6579	6407	9111	8804	6723	8213	40336	48764	39611	42904
N_2 – 100% RDN	7063	5887	6796	6582	10253	8455	7175	8628	45439	45682	42302	44474
S.Em±	107	86	80	69	344	267	109	238	1089	1105	831	535
C.D. at 5%	323	NS	NS	191	1043	NS	332	NS	3303	NS	2519	1482
Interactions (A x N)												
A_1N_1	7252	6020	6778	6683	10845	8887	6722	8818	48125	48075	41874	46025
A_1N_2	7136	6121	6880	6712	10930	9051	6740	8907	46814	48919	42492	46075
A_2N_1	6555	5949	6492	6322	9073	8918	6729	8240	40430	47410	39054	42298
A_2N_2	6801	5696	6775	6424	9896	8083	7553	8511	42926	43216	42658	42933
A_3N_1	6024	6160	6660	6281	7803	8720	6549	7691	34645	49225	40466	41445
A_3N_2	7053	5875	6665	6531	10482	8070	7512	8688	45556	44987	41803	44115
A_4N_1	6327	6277	6388	6331	8723	8690	6093	7835	38143	50347	37053	41848
A_4N_2	7233	5855	6833	6640	9802	8615	6895	8437	46502	45604	42256	44787
RPP	6883	5644	6044	6190	10601	7552	6234	8129	45684	42358	34967	41003
Interactions (A x N) S.Em±	213	171	160	130	688	534	219	237	2178	2210	1661	1070
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
RPP v/s Others S.Em±	197	136	151	95	654	473	221	227	2051	2124	1612	1050
C.D. at 5%	592	408	451	264	1961	1418	663	628	6150	4625	4833	2910

DAP – Days after planting, RDN-Recommended dose of nitrogen, RPP-Recommended package of practice, S.Em± - Standard error mean, C.D-Critical difference, NS- Non significant

Table 2. The Nutrient content of soil in different treatments at the end of study (2011) in Dual Culture Azolla Experiment.

Treatments	pH	EC	OC%	N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)	S (kg/ha)	Ca(ppm)	Mg(ppm)	Zinc(ppm)	Iron(ppm)	Mn(ppm)	Copper(ppm)
A_1N_1	5.5	0.158	0.78	149.5	28.7	72.9	18.32	441.4	80.9	4.75	173.9	10.39	4.37
A_1N_2	5.5	0.143	0.76	149.5	22.1	75.1	18.15	483.1	86.3	4.72	186.9	11.32	4.77
A_2N_1	5.5	0.133	0.86	146.2	21	70.1	19.47	384.1	82.7	4.96	200.1	11.88	4.81
A_2N_2	5.5	0.123	0.84	144.5	24.4	74.1	18.00	441.6	80.7	5.19	189.3	13.80	4.59
A_3N_1	5.5	0.176	0.74	142.8	20.3	70.1	19.64	515.4	82.3	5.46	200.1	10.89	4.86
A_3N_2	5.4	0.148	0.71	149.5	22.3	73.0	18.71	398.3	83.3	5.22	210.3	10.02	4.86
A_4N_1	5.5	0.167	0.67	146.4	21.6	70.3	21.24	343.4	76.9	4.76	195.8	11.18	4.68
A_4N_2	5.6	0.157	0.81	156.2	22.8	71.5	18.86	433.2	84.8	5.00	199.0	13.96	4.64
RPP	5.5	0.155	0.61	127.7	20.0	62.5	17.84	364.0	74.9	4.31	157.3	9.40	4.36
Initial Value	5.27	0.112	0.56	125.2	21.5	55.8	18.00	360.5	70.5	4.19	148.2	8.9	4.21

A_1 – Azolla release 2-3 weeks before planting, A_2 – Azolla release at 15 DAP, N_1 – 50% RDN, A_3 – Azolla release at 30 DAP, N_2 – 100% RDN, A_4 – Azolla release at 45 DAP

rice yields.

It can be concluded from the study that Azolla can also be grown as dual crop (inter crop) in rice without detrimental effect on rice yields and economics. This helps in overcoming the problem of non availability of time and water 2-3 weeks prior to transplanting of paddy. The farmer can release the Azolla at convenient time from 15 DAP up to 45 DAP.

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