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Integrated sources of nitrogen on the growth, yield, quality and economics of aromatic rice and their residual effect on succeeding lentil under rice-lentil crop sequence

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Abstract
To study the direct and residual effect of integrated sources of nitrogen on the growth productivity and economics of rice (aromatic)-lentil cropping system investigation was conducted at the instructional farm of Uttar Banga Krishi Viswavidyalaya located at Pundibari, Cooch Behar, West Bengal during 2016-17 and 2018-19. The experiment was laid out in split plot design with 2 aromatic rice varieties (Gobindabhog' and 'Kalonunia') in main plots and 12 treatments of nitrogen management in sub-plot. The results of the experiment showed that the variety 'Gobindabhog' (main plot) recorded higher growth, yield attribute, yield and quality (Carbohydrate, protein content, aroma, hulling percentage, milling percentage and Head rice recovery) as compared to Kalonunia. For the sub-plot, the treatment 50% RDN through fertilizer + 50% RDN through VC recorded to give maximum growth, yield attribute, yield and protein content. Application of 50% RDN through VC + 50% RDN through FYM brought about positive response on the hulling (%), milling (%) and head rice recovery (%) and aroma. The highest rice carbohydrate content was found with 50% RDN through fertilizer + 25% RDN through VC + 25% N through FYM treatment. The maximum grain yield of residual effect of succeeding lentil crop was observed in plots of Gobindabhog and 50% RDN through fertilizer + 50% RDN through FYM treated plots. The highest gross and net returns were obtained with the application of 75% RDN through fertilizer + 25% RDN through VC in the plots, where the crop was 'Gobindabhog' rice and the benefit: cost ratio was also higher in the same set of treatment.

Keywords: INM, Aromatic rice, Nitrogen, FYM, Vermicompost, Lentil, Gobindabhog, Kalonunia

Introduction
Rice is being grown in 117 countries and is a staple food for more than 70 per cent of global population. At global level, rice is grown on an area of about 163.2 million hectare with a production of 719.7 million tonnes. Among the rice growing countries, India is having the largest share in area for rice in the world and in case of production it ranks second in the world, only after China. India produces about 120.32 million tonnes from 42.62 million hectare with an average productivity of 2.82 tonnes per hectare (FAO stat, 2014) [7]. Among the rice varieties, aromatic or scented (fragrant) rice occupies a prime position on account of its excellent quality characters and thereby having great export potentiality. Among the agricultural commodities exported, aromatic rice holds a major share. Aromatic rice is very popular and highly priced due to its inherent aroma and cooking characteristics. It emits specific aroma in fields at the time of flowering, at harvesting, in storage even during milling, cooking and eating (Gibson, 1976; Efferson, 1985) [9, 6]. It is known that aroma is best developed when aromatic rice cultivars are grown in areas where temperature becomes cooler during maturity. Aroma is due to certain chemicals present in the endosperm which depends on the extent of 2-acetyl-1-pyrroline content (Nadaf *et al.*, 2006) [16].
Many unique varieties of non-basmati aromatic rice like Gobindabhog, Tulaipanji, Kalonunia, Tulsibhog, Kataribhog, Radhunipagal, Radhatilak, Badshabhog, Kalojeera, Harinakhuri, etc. are cultivated in India especially in the state of West Bengal. All these traditional rice varieties are tall with weak stem, prone to lodging, photosensitive and having moderate to very strong aroma. These varieties have long duration and are low yielding. They are susceptible to many diseases and pests and their cultivation is restricted to certain areas only.

The issue of lower productivity of local aromatic rice is mainly due to inadequate as well as imbalanced use of nutrients which can be addressed through proper agronomic management in which selection of appropriate variety with balanced nutrient management may hold the key role. Declining soil health and increase in cost of inorganic fertilizers focus on the feasibility and use of organic sources to partially supplement the need of nitrogen to the crop as low priced organic manures. Efforts were carried out to investigate the effect of integrated nutrient management practices on the increase productivity of the rice crop and the beneficial residual effect on succeeding crop lentil.

Materials and Methods

The experiment was laid out in split plot design in sandy loam soil of West Bengal at Instructional farm of Uttar Banga Krishi Vishwavidyalaya, Pundibari, Cooch Behar with 2 aromatic rice varieties (Gobindabhog' and 'Kalonunia') in main plots and 12 treatments of nitrogen management in sub-plot.

T_1 - Control
T_2 - 100% RDN (40 kg N ha^{-1}) through fertilizer
T_3 - 25% RDN through fertilizer + 75% RDN through vermicompost
T_4 - 25% RDN through fertilizer + 75% RDN through FYM
T_5 - 25% RDN through fertilizer + 37.5% RDN through vermicompost + 37.5% N through FYM
T_6 - 50% RDN through fertilizer + 50% RDN through vermicompost
T_7 - 50% RDN through fertilizer + 50% RDN through FYM
T_8 - 50% RDN through fertilizer + 25% RDN through vermicompost + 25% N through FYM
T_9 - 75% RDN through fertilizer + 25% RDN through vermicompost
T_{10} - 75% RDN through fertilizer + 25% RDN through FYM
T_{11} - 75% RDN through fertilizer + 12.5% RDN through vermicompost + 12.5% N through FYM
T_{12} - 50% RDN through vermicompost + 50% RDN through FYM

As per the treatments specification, Nitrogen fertilizers were applied in the form of urea at different doses. However in case of 100% of recommended dose of N fertilizer, 50%N was applied before transplanting through respective sources and rest 50% was applied as top dressing through pilled urea in two equal splits coinciding maximum tailoring and panicle initiation stage. A uniform dose of 20 kg P_2O_5 ha^{-1} and 20 kg K_2O_5 ha^{-1} was applied to rice in the form of single super phosphate and mutate of potash. All the plots were treated with FYM or vermicompost accordingly except T_1 (Control) and T_2 (100% RDN through fertilizer). In *Kharif*, rice was transplanted on 16th June (2014) and 15th June (2015) in the spacing of 20 x 15 cm and harvested on 28th October (2014) and 26th October (2015). After rice, in *Rabi* lentil as a succeeding crop were sown on 7th November (2014) and 5th November (2015) with spacing of 25 cm and harvested on 4th April (2014) and 1st April (2015). For both the respective years 2014-2015 and 2015-2016, pooled mean was calculated for each and every parameter recorded. The different growth parameters of rice (Plant Height, Dry matter accumulation, crop growth rate, Leaf area index) were recorded at 30 days interval till up to 120 DAS. Yield attributing characters, Yield and quality parameter was calculated.

In the succeeding lentil crop no fertilizer was applied and lentil variety mitre was raised on residual fertility following data such as growth parameters (plant height, number of nodules per plant), yield attributes (number of pods per plant, 1000 grain weight) and yield (grain and Stover) was collected and calculated. Protein content of rice was determined using Lowry's method and Carbohydrate content was estimated by the method of Sadasivam and Manickam (1996) [23]. The effect of the experiment was recorded according to the varieties, nitrogen management and interaction between the varieties and nitrogen management for every parameters. Statistical analysis of all the collected data from the experiment was computed on analysis of variance method as suggested by Gomez and Gomez (1984) [24] at 5% level of probability.

Results and Discussion

Effect of varieties and nitrogen management on growth parameters of aromatic rice

From the pooled mean recorded, Table 1. reveals that Gobindobog variety recorded maximum plant height, dry matter accumulation (DMA) and Leaf area index (LAI) in all the stages of observation i.e. 30 DAT (72.8 cm, 172.78 g m^2 and 1.160), 60 DAT (111.5 cm and 347.08 g m^2 and 3.170), 90 DAT (128.3 cm, 477.76 g m^2, 3.150) and 120 DAT (128.4 cm, 597.93 g m^2 and 2.060) compared to Kalonunia variety. The crop growth rate between 90 - 120 DAT reported significantly highest in Gobindobog variety (4.01 g m^{-2} d^{-1}) but at 30 – 60 DAT (6.06 g m^{-2} d^{-1}) and 60 – 90 DAT (4.41 g m^{-2} d^{-1}), the variety Kalonunia recorded maximum.

In the present study it is found that plant height at 30 DAT (73.2 cm) and 60 DAT (110.6 cm) increase by the application of 50% RDN through fertilizer + 25% RDN through VC + 25% RDN through FYM but at 90 DAT (126.2) and 120 DAT (125.9) highest was recorded by the application of 50% RDN through fertilizer + 50% RDN through VC. The results of the experiment (table 1.) showed that plant height and crop growth rate did not differ significantly due to different treatments in both the years of experimentation at all the stages. The different combinations of nutrient sources in the study had significant effect on dry matter accumulation and Leaf area index. The maximum pooled mean of dry matter accumulation at 30 and 60 DAT was found with 75% RDN through fertilizer + 25% RDN through VC (T_9, 173.93 and 352.7 g m^2) followed by 50% RDN through fertilizer + 50% RDN through VC (T_6, 172.00 and 351.23 g m^2). At 90 and 120 DAT, highest was observed under T_6 (486.24 and 601.04 g m^2) followed by T_9 (483.53 and 599.44 g m^2). These results are in conformity with the findings of Jadhav *et al.* (1997) [10]. In all the stages of observation, LAI was recorded highest with T_6 (1.158 at 30 DAT, 3.123 at 90 DAT, 2.038 at 120 DAT) except at 60 DAT observed T_9 (3.143). The lowest of all the treatments in growth parameters was recorded in control plot (T1) during both the years. Result also reveal that most of the parameters of growth give a positive response by the application of 50% RDN through fertilizer + 50% RDN through VC and earlier Jain and Poonia (2003) [11] also reported that use of FYM and vermicompost at half the rates in integration with inorganic sources recorded higher growth of the crop.

Among the interaction effect between the varieties and nitrogen management, all the growth parameters was found to be insignificant except the crop growth rate between 30 and 60 DAT.

Effect of varieties and nitrogen management on yield attributes and yields of aromatic rice

Results (table 2) indicated that the yield attributes (number of tillers m^{-2}, number of panicles m^{-2}, panicle length, number of filled grains $panicle^{-1}$ and test weight) and yield varied appreciably due to the effect of varieties and was found to be statistically significant. Among the varieties, Gobindobog varieties had highest number of tillers m^{-2} (371), number of panicles m^{-2} (287), number of filled grains $panicle^{-1}$ (155) and test weight (21.2) as well as the yield of aromatic rice i.e. grain yield (2.32 t ha^{-1}), straw yield (5.85 t ha^{-1}) and harvest index (29.33%) whereas maximum panicle length was observed in Kalonunia variety (27.95).

There was a significant variation in the number of tillers m^{-2}, number of panicles m^{-2}, panicle length, number of filled grains $panicle^{-1}$, test weight, straw yield, grain yield and harvest index of aromatic rice due to various treatments during both the years. Incorporation of 50% RDN through fertilizer + 50% RDN through VC (T_6) brought about significant improvement in the number of tillers m^{-2} (395), number of panicles m^{-2} (317), number of filled grains $panicle^{-1}$ (156) and test weight (20.8) which was closely followed by T_8 (50% RDN through fertilizer + 25% RDN through VC + 25% RDN through FYM) and T_9 (75% RDN through fertilizer + 25% RDN through VC) in all the parameters recorded. Result of the experiment also reveal that application of 50% RDN through fertilizer + 50% RDN through VC showed appreciable response in the grain yield (2.41 t ha^{-1}) and straw yield (5.84 t ha^{-1}) of aromatic rice as compared with plots receiving 25% RDN through organic manure, plots receiving 25% RDN through fertilizer and plots receiving 100% RDN through fertilizer. Combined use of inorganic fertilizer and organic manure enhanced all the yield attributes of aromatic rice might be due to higher availability and efficient use of nutrients throughout the growing period as a result of plant nutrients from organic manures by greater microbial activities. The increase in yield attributes in turn helped the grain yield of aromatic rice. These results were in agreement with the finding Jeyabel and Kuppuswami, 2001 [13], Adhikari and Mishra, 2004 [1], Solunke *et al*., 2006 [20], Dinesh *et al*., 2006 [3], Kumar *et al*., 2014 [14], Yadav Lalji and Meena, 2014 [14, 21]. But the treatment 75% RDN through fertilizer + 25% RDN through VC found to have increase in panicle length (27.66 cm). Jayaraman and Purushothaman (1988) [12] also obtained similar results.

Harvest index remain unaffected by different nitrogen treatments which remained at par with each other in respect of grain yield. In case of the interaction effect between the varieties and nitrogen management, all the yield components was found to be insignificant.

Effect of varieties and nitrogen management on quality parameters of aromatic rice

Under the effect of the varieties (table 2), the result reveal that the quality parameters of aromatic rice, viz. hulling (74.83% and 75.08%), milling (65.42% and 66.50%) and head rice recovery (51.25% and 53.33%), carbohydrate content (64.22% and 65.63%), protein content (10.42% and 11.04%) and aroma were found to be highest with 'Gobindabhog' variety.

Among the nitrogen treatment, 50% RDN through vermicompost applied in conjunction with 50% RDN (T_{12}) through FYM brought about maximum hulling % (76.70%), milling % (69.00%) and Head rice Recovery (57.70%) whereas 50% RDN through fertilizer applied with 50% RDN through vermicompost (T_6) and 75% RDN through fertilizer combined with 25% RDN through VC (T_9) remain at par in respect to hulling %, milling% and Head rice recovery (%). These can be concluded that application of 50% RDN through fertilizer + 50% RDN through vermicompost (T_6), 50% RDN through fertilizer + 25% RDN through VC + 25% N through FYM (T_8) and 50% RDN through VC + 50% RDN through FYM (T_{12}) brought about positive response in aroma content. Similar finding was reported by Dutta, *et al.*, 1999. From the pooled data recorded, the highest rice carbohydrate content was found with 50% RDN through fertilizer + 25% RDN through VC + 25% N through FYM treatment (T_8, 72.48) whereas the protein content of rice was observed highest with 50% RDN through fertilizer + 50% RDN through VC (T_6, 12.20) which was at par with 75% RDN through fertilizer + 25% RDN through VC (T_9, 12.11). This result was fully supported by Dinku, *et al.*, 2014 [4]; Saha *et al.*, 2007 [17], Sekhar, *et al.*, 2014 [18].

In term of quality parameters, interaction effect between varieties and nitrogen management was found to be non-significant except the protein content of rice.

Effect of varieties and nitrogen management on succeeding lentil crop

From the pooled data (Table 3), Kalonunia transplanted plot obtain maximum residual effect of succeeding lentil crop in plant height (3.35 cm), number of nodules/plant (20.33), number of pods/plant (47.65) and 1000 grain weight (17.82) as well as the grain yield of lentil (1.13 t ha^{-1}) and stover yield (9.12 t ha^{-1}).

Residual effect of various nitrogen treatments (organic or inorganic) applied to preceding rice influenced significantly the plant height, number of nodules per plant, number of pods/plant, 1000-grain weight, grain and stover yield of succeeding lentil crop. In general, the plot receiving 50% RDN through organic manure (vermicompost or FYM or vermicompost + FYM) showed significant residual response in terms of plant height, number of nodules/plant and yield attributes of lentil as compared to plots receiving 25% RDN or 75% RDN or 100% RDN through organic manure except the plot receiving 75% RDN through fertilizer + 25% RDN through vermicompost and plot receiving 100% RDN through inorganic fertilizer. Nitrogen applied at the rate of 50% of the recommended dose through combination of inorganic fertilizer and organic FYM had more pronounced residual effect on number of nodules/plant (21.19), number of pods per plant (50.87), 1000-grain weight (17.93), grain yield (1.20 t/ha) and stover yield (9.71 t/ha). However, no marked differences was observed in grain yield of the plot incorporated with 50% RDN through fertilizer + 25% RDN through VC + 25% RDN through FYM. The higher grain yield of lentil recorded due to residual effect of organic and inorganic nutrient together may be accounted for enhanced availability and gradual release of plant nutrient through organic sources. Similar results have also been reported by many workers (Gaur, 1984; Das and Mandal, 1986; Maskina, 1989, Singh *et al*., 2002 and Singh *et al*., 2004) [8, 2, 15, 22, 19].

The interaction effect of succeeding lentil crop between varieties and nitrogen management was found to be significant in the number of pods/plant and 1000-grain weight (g).

Economic of rice lentil cropping system

The results (Table 4) showed that maximum gross return of Rs. 155483 ha^{-1} were obtained with application of 50% RDN through fertilizer +25% RDN through vermicompost + 25% RDN through FYM i.e. V_2N_8) closely followed by Rs. 152179 ha^{-1} with application of 50% RDN through fertilizer and 50% RDN through FYM i.e. V_2N_7 in the plots where rice crop was transplanted with the variety Gobindabhog. Among all combination of variety and different nitrogen management, V_2N_8 also registered the maximum net return to the tune of Rs. 81152 ha^{-1} followed by the plot transplanted with Gobindobog and treated with 75% RDN through fertilizer + 25% RDN through VC i.e. V_2N_9 (Rs. 80725 ha^{-1}). The highest benefit cost ratio (2.14) was noticed in the treatment combination of V_2N_9 i.e. 75% RDN through fertilizer + 25% RDN through vermicompost. Though V_2N_8 recorded highest gross return and net return, the cost of cultivation of V_2N_9 were found to be lower compared to other combination treatment. So, 50% RDN through fertilizer +25% RDN through vermicompost + 25% RDN through FYM of Gobindobog variety reported to have higher benefit cost ratio.

Table 1: Effect of varieties and nitrogen management on growth parameters of aromatic rice

Treatment	Plant Height				Dry matter Accumulation ($g\ m^{-2}$)				Crop Growth Rate ($g\ m^{-2}\ d^{-1}$)			Leaf Area Index			
	30 DAT	60 DAT	90 DAT	120 DAT	30 DAT	60 DAT	90 DAT	120 DAT	60 - 30 DAT	90 - 60 DAT	120 - 90 DAT	30 DAT	60 DAT	90 DAT	120 DAT
Main Plot	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled
Kalonunia	70.4	108.0	122.6	122.0	159.68	340	472.44	580.8	6.06	4.41	3.61	1.120	3.050	3.030	1.960
Gobindobog	72.8	111.5	128.3	128.4	172.78	347.1	477.76	597.9	5.87	4.36	4.01	1.160	3.170	3.150	2.060
SEm±	0.957	1.038	0.69	0.808	1.58	3.17	3.57	1.68	0.1	0.05	0.08	0.002	0.003	0.003	0.006
CD(P=0.05)	7.749	6.316	4.21	4.916	9.62	N.S.	N.S.	10.21	N.S.	N.S.	0.48	0.01	0.021	0.015	0.034
Sub plot treatment															
T1	69.5	108.4	124.1	124.4	153.84	331.07	456.98	569.94	5.91	4.20	3.76	1.121	3.047	3.020	1.971
T2	72.0	109.7	125.6	125.2	164.01	341.85	471.44	586.77	5.93	4.32	3.85	1.139	3.107	3.090	2.000
T3	71.1	109.4	125.1	125.0	166.95	340.42	476.89	589.11	5.78	4.55	3.74	1.134	3.098	3.080	1.997
T4	70.3	109.3	124.5	124.8	162.17	339.30	465.90	580.22	6.04	4.22	3.81	1.130	3.098	3.076	1.989
T5	70.7	109.7	125.2	125.1	167.85	343.53	477.09	592.69	5.94	4.45	3.85	1.137	3.110	3.092	2.015
T6	73.0	110.4	126.2	125.9	172.00	351.23	486.24	601.04	5.98	4.50	3.83	1.158	3.131	3.123	2.038
T7	72.8	110.1	126.2	125.5	169.36	349.36	480.32	591.94	6.25	4.36	3.72	1.147	3.120	3.099	2.006
T8	73.2	110.6	126.0	125.6	170.83	351.20	483.52	597.66	6.07	4.41	3.80	1.148	3.133	3.108	2.028
T9	72.9	110.3	126.2	125.8	173.93	352.47	483.53	599.44	6.01	4.37	3.86	1.149	3.143	3.121	2.029
T10	72.3	110.1	126.0	125.3	165.38	340.89	471.66	587.86	5.88	4.36	3.87	1.135	3.102	3.080	2.003
T11	71.5	110.0	125.6	124.8	169.47	346.20	481.61	595.41	5.94	4.51	3.79	1.147	3.114	3.100	2.020
T12	70.5	109.5	125.0	124.7	158.98	335.09	466.03	580.09	5.87	4.36	3.80	1.127	3.085	3.068	1.993
SEm±	1.490	1.572	2.098	1.503	3.26	9.64	8.58	6.32	0.33	0.42	0.13	0.005	0.007	0.009	0.011
CD(P=0.05)	N.S.	N.S.	N.S.	N.S.	9.3	N.S.	N.S.	18.01	N.S.	N.S.	N.S.	0.015	0.02	0.027	0.031
Interaction effect (AB)															
SEm±	2.108	2.224	2.967	2.126	4.62	13.63	12.13	8.94	0.47	0.6	0.19	0.008	0.01	0.013	0.015
CD(P=0.05)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Table 2: Effect of varieties and nitrogen management on yield attributes, yields and quality of aromatic rice

Treatment	No. of effective tillers m^{-2}	No. of panicles m^{-2}	Panicle length (cm)	No. of filled grains $panicle^{-1}$	Test weight (g)	Grain yield ($t\ ha^{-1}$)	Straw yield ($t\ ha^{-1}$)	Harvest index (%)	Milling (%)	Hulling (%)	Head Rice Recovery (%)	Carbohydrate Rice	Protein Rice
MAIN PLOT	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled
Kalonunia	305	228	27.95	134	19.4	2.18	5.34	28.97	63.42	73.55	50.92	11714	50.1
Gobindabhog	371	287	24.92	155	21.2	2.32	5.59	29.33	65.96	74.96	52.29	12985	53.64
SEm±	6.1	4.59	0.29	0.83	0.10	0.004	0.0159	0.034	0.27	0.09	0.26	898.6	0.27
CD(P=0.05)	37.14	27.94	1.75	5.02	0.30	0.025	0.0965	0.208	1.63	0.56	1.55	5468	1.63
Sub plot treatment													
T1	254	206	24.64	126	19.6	2.08	4.98	29.47	60.80	71.80	44.80	8421	37.66
T2	329	237	26.23	142	20.4	2.23	5.52	28.75	63.50	73.80	51.30	12898	47.72
T3	330	249	26.25	141	20.0	2.23	5.49	28.98	63.80	74.00	52.80	11793	51.26
T4	293	221	25.75	135	19.8	2.16	5.19	29.39	62.30	72.50	46.80	10760	41.35
T5	356	270	26.76	148	20.1	2.28	5.57	29.03	65.30	74.30	53.30	12324	54.97
T6	395	317	27.57	156	20.8	2.41	5.84	29.19	68.70	76.50	56.30	14097	60.98
T7	352	257	26.22	147	20.7	2.29	5.56	29.08	65.00	74.80	51.30	13298	54.77
T8	379	303	27.15	154	20.8	2.34	5.69	29.23	68.00	76.00	55.80	14557	58.85
T9	390	300	27.66	153	20.8	2.36	5.62	29.55	68.00	76.50	56.00	14155	60.52
T10	328	246	26.21	143	20.6	2.23	5.34	29.54	63.00	73.50	49.00	12963	52.17
T11	367	250	27.08	151	20.2	2.3	5.67	28.82	65.80	75.30	54.50	12984	56.16
T12	285	232	25.72	134	19.7	2.16	5.23	29.38	69.00	76.70	57.70	9948	46.03
SEm±	17.27	23.44	0.42	5.91	0.10	0.019	0.0584	0.284	0.91	0.82	0.93	1846	0.91
CD(P=0.05)	49.22	66.8	1.21	16.85	0.30	0.054	0.1664	0.808	2.58	2.33	2.63	5261	2.6
Interaction effect (AB)													
SEm±	24.42	33.14	0.60	8.36	0.20	0.027	0.0826	0.401	1.28	1.16	1.31	2610	1.29
CD(P=0.05)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Table 3: Effect of varieties and nitrogen management on succeeding lentil crop

Treatment	**Plant Height (cm)**	**No. of nodule/plant**	**No. of pods/plant**	**1000 grain weight (g)**	**Grain yield of lentil (t ha^{-1})**	**Stover yield (t ha^{-1})**
Main Plot	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled
Kalonunia	34.35	20.33	47.65	17.82	1.13	9.12
Gobindobog	31.41	19.32	46.06	17.29	1.12	8.95
SEm±	0.084	0.189	0.11	0.08	0.0041	0.0133
CD(P=0.05)	0.513	1.15	0.68	0.48	0.0247	0.0809
Sub plot treatment						
T1	31.31	17.39	35.92	16.7	1.00	7.58
T2	33.89	19.62	49.37	17.55	1.12	9.55
T3	32.69	19.75	47.04	17.46	1.11	9.22
T4	33.46	20.35	45.73	17.55	1.12	8.79
T5	32.09	18.91	45.13	17.6	1.12	8.56
T6	33.29	19.21	48.57	17.67	1.15	9.32
T7	33.89	21.19	50.87	17.93	1.20	9.71
T8	32.41	20.63	50.15	17.88	1.20	9.45
T9	32.63	19.78	46.21	17.74	1.15	8.95
T10	33.52	20.59	49.69	17.64	1.13	9.59
T11	31.46	18.56	43.4	17.05	1.07	8.01
T12	33.94	21.12	50.23	17.85	1.17	9.66
SEm±	0.387	0.662	0.59	0.13	0.0088	0.0866
CD(P=0.05)	1.104	1.886	1.68	0.36	0.0250	0.2469
Interaction effect (AB)						
SEm±	0.548	0.936	0.83	0.18	0.0124	0.1225
CD(P=0.05)	N.S.	N.S	2.38	0.51	N.S.	N.S.

Table 4: Economic of rice lentil cropping system

Variety and treatment combination	**Total cost of cultivation of rice + lentil (Rs./ha)**	**Gross return from rice + Lentil Rs./ha)**	**Net return of rice + lentil (Rs./ha)**	**B:C ratio**
	Pooled	**Pooled**	**Pooled**	**Pooled**
V1N1	65740	120500	54761	0.83
V1N2	67870	127860	59990	0.88
V1N3	76172	131300	55128	0.72
V1N4	79446	131673	52228	0.66
V1N5	77562	133870	56308	0.73
V1N6	73354	136840	63486	0.87
V1N7	75259	142537	67278	0.89
V1N8	74332	140997	66665	0.9
V1N9	70637	136903	66266	0.94
V1N10	71564	133633	62069	0.87
V1N11	71101	130527	59426	0.84
V1N12	79524	136763	57239	0.72
V2N1	66204	105083	38879	0.59
V2N2	67870	137675	69805	1.03
V2N3	76172	145696	69524	0.91
V2N4	79446	145646	66200	0.83
V2N5	77562	146858	69296	0.89
V2N6	73404	151263	77858	1.06
V2N7	75259	152179	76920	1.02
V2N8	74332	155483	81152	1.09
V2N9	70637	151363	80725	1.14
V2N10	71564	147188	75623	1.06
V2N11	71101	144058	72958	1.03
V2N12	79524	147713	68189	0.86

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