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Intercropping of rice with groundnut and soybean with different nutrient management practices under rainfed upland conditions of Nagaland

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ABSTRACT

A field experiment was conducted during the kharif season of 2019 and 2020 in the experimental farm, Department of Agronomy, School of Agricultural Sciences, Nagaland University, Medziphema campus, to study the effect of intercropping of groundnut and soybean with upland rice under different nutrient management practices in the rainfed condition of Nagaland. The experiment was conducted in a randomized block design with the factorial concept with three replications. The treatment consisted of five cropping systems and three nutrient management practices. Among the different intercropping systems, the rice + soybean (3:1) cropping system recorded the highest dry matter plant^{-1}, leaf area index, crop growth rate, grain yield, straw yield and rice equivalent yield. Among different nutrient management practices, application of 75% RDF + FYM @ 5 t ha^{-1} + biofertilizer consortium @ 20 g kg^{-1} seed recorded significantly higher dry matter plant^{-1}, leaf area index, crop growth rate, grain yield, straw yield and rice equivalent yield grain yield and straw yield.

Keywords: Dry matter, leaf area index, FYM, RDF

INTRODUCTION

Rice is the most dominant rainy season crop of Nagaland. It constitutes about 90% of the crop area and is a major food item in this region. Most farmers sow rice (direct seeded upland) and other crops as mixed crops. Crop diversification through intercropping has long been recognized as biological insurance against risks and aberrant rainfall behavior in dry environments (Dutta and Bandyopadhyay, 2006). It increases the cropping intensity, productivity, profitability, and optimized utilization of soil, water, nutrients, and sunlight (Kumar and Singh, 2006). Besides increased overall productivity and income, intercropping of legumes with cereals helps conserve moisture by reducing runoff, improving the physical properties of soil and building up soil fertility. As short-duration herbs, legumes like green gram/black gram may constitute potential intercrop in upland rice under rainfed conditions. Chemical fertilizers have initially increased crop growth and output however, the yields are not long-term sustainable. The soil's overall condition has also worsened due to the frequent application of large amounts of chemical fertilizers, particularly nitrogen and phosphorus. The increased use of chemical fertilizers in India is directly related to the rise in acidic areas (Subehia *et al.,* 2005). Farmyard manure (FYM) significantly impacted the soil’s organic matter concentration (%) compared to applying the recommended NPK. Therefore, a current study was made to diversify upland rice through intercropping with groundnut and soybean for improving and stabilizing the productivity of rainfed uplands under different nutrient management practices.

MATERIALS AND METHODS

A field experiment was carried out during the *kharif* seasons of 2019 and 2020 at the Experimental Research Farm of the School of Agricultural Sciences, Nagaland University, Medziphema Campus. The site was well-drained sandy loam, low in available N, low in available P and medium in available K during 2019 and 2020. The experimental site is situated at 25^{0}45$^/$43$^{//}$N latitude and 95^{0}53$^/$04$^{//}$E longitude at 310 m above mean sea level. The experiment was conducted in a randomized block design with the factorial concept with three

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replications. The treatment consisted of five cropping system *viz*., C_1: Sole rice, C_2: Sole groundnut, C_3: Sole soybean, C_4: Rice + groundnut (3:1), C_5: Rice + soybean (3:1) and three nutrient management practices *viz*., N_1: 100% RDF + FYM @ 2.5 t ha^{-1} + biofertilizer consortium @ 20 g kg^{-1} seed, N_2: 75% RDF + FYM @ 5 t ha^{-1} + biofertilizer consortium @ 20 g kg^{-1} seed, N_3: 50% RDF + FYM @ 7.5 t ha^{-1} + biofertilizer consortium @ 20 g kg^{-1} seed. The net plot size of 4m x 3m and the spacing of rice was done at 20 cm row to row and 10 cm plant to plant. In the case of groundnut and soybean, planting was done by dibbling in furrows at the spacing of 40 cm row to row and 15 cm plant to plant for groundnut crop and 10 cm plant to plant for soybean crop. The groundnut and soybean as intercrop were sown with a row-to-row spacing of 20 cm for both crops and plant-to-plant spacing of 15 cm for groundnut and 10 cm for soybean intercrops in 3:1 method of planting. The base and components crops were sown in all these years on the last week of June. The amount of FYM was calculated for each plot separately and applied three weeks before sowing of rice, groundnut and soybean as per treatment as mentioned earlier. Fertilizer requirements of the crops were met through Urea (46% N), Single Super Phosphate (16% P_2O_5) and Muriate of Potash (60% K_2O). Intercrop and sole crop of rice received different levels of fertilizer, i.e. for 100% NPK-60 kg ha^{-1} N + 30 kg ha^{-1} P_2O_5 + 20 kg ha^{-1} K_2O, for 75% NPK- 45 kg ha^{-1} N + 22.5 kg ha^{-1} P_2O_5 + 15 kg ha^{-1} K_2O and for 50% NPK- 30 kg ha^{-1} N + 15 kg ha^{-1} P_2O_5 + 10 kg ha^{-1} K_2O. The total quantity of P and K and one-third (⅓) of nitrogen at the sowing was applied. The remaining two-thirds (⅔) of N in two equal doses at tillering and panicle initiation stage was applied as per treatment as mentioned earlier. No additional fertilizer was given to groundnut and soybean in intercropping with rice. The sole crop of groundnut received different levels of fertilizer, i.e. for 100% NPK-20 kg ha^{-1} N + 40 kg ha^{-1} P_2O_5 + 30 kg ha^{-1} K_2O, for 75% NPK- 15 kg ha^{-1} N + 30 kg ha^{-1} P_2O_5 + 22.5 kg ha^{-1} K_2O and for 50% NPK- 10 kg ha^{-1} N + 20 kg ha^{-1} P_2O_5 + 15 kg ha^{-1} K_2O. The sole crop of soybean received different levels of fertilizer, i.e. for 100% NPK-20 kg ha^{-1} N + 60 kg ha^{-1} P_2O_5 + 40 kg ha^{-1} K_2O, for 75% NPK- 15 kg ha^{-1} N + 45 kg ha^{-1} P_2O_5 + 30 kg ha^{-1} K_2O and 50% NPK- 10 kg ha^{-1} N + 30 kg ha^{-1} P_2O_5 + 20 kg ha^{-1} K_2O. In the case of sole groundnut and soybean, full dose of nitrogen, phosphorous and potassium were applied as basal doses at the time of sowing. The variety used in the study were: 'Sahbhagi Dhan' rice, 'ICGS 76' groundnut and 'JS 9752' soybean. The remaining agronomic practices were followed as per recommendations for the region.

The rice equivalent yield was calculated by converting the groundnut and soybean seed yield into rice yield based on the existing market price of the crops. The harvested crop was sun-dried, threshed and winnowed properly. The grains/ seeds were packed separately for each plot and marked. The weight of the grains/seeds was taken, recorded and converted to t ha^{-1}. The straw/stover was sun-dried properly for a few days to reduce the moisture and weight was taken separately for each plot, recorded and converted to t ha^{-1}.

RESULTS AND DISCUSSION

Growth attributes of rice

The pooled data of both the years on leaf area index at 30, 60 and 90 DAS revealed that the highest leaf area index was recorded in sole rice, which was at par with rice + soybean intercropping system. In contrast, the rice's minimum leaf area index was recorded from the rice + groundnut (3:1) intercropping system (Table 1). The leaf area index is an essential factor determining the dry matter production of a crop and, subsequently, the yield. The reason being the leaf area index depends on the number of leaves and leaf area of a plant which was recorded maximum in the treatment and directly reflected on the leaf area index. Putra *et al.* (2017) also reported that among intercropping systems, rice + soybean gives the highest leaf area.The pooled data of both years also revealed a significant difference with the highest leaf area index at 30, 60 and 90 DAS, when the crop was applied with 75% RDF + FYM @ 5 t ha^{-1} + biofertilizer consortium @ 20 g kg^{-1} seed. The lowest leaf area index was recorded when the crop was applied with 50% RDF + FYM @ 7.5 t ha^{-1} + biofertilizer consortium @ 20 g kg^{-1} seed (Table 1). This could be due to the increase in organic carbon content in treatments with a combination of both organic and inorganic sources may be attributed to higher biomass addition to the soil through crop residues resulting in a higher leaf area index. Increasing LAI resulted in higher dry matter production (Fageria, 2007). The cumulative effect of organic sources combined with inorganic and biofertilizer proved instrumental in effective photosynthesis. These results closely conform with the findings of Jat *et al.* (2016) and Yadav and Meena (2014).

Table 1: Effect of cropping systems and nutrient management practices on LAI, CGR (g m^{-2} day^{-1}), RGR (g g^{-1} day^{-1}) and NAR (g m^{-2} day^{-1}) at different growth stages of rice

Treatments	Leaf area index (LAI)			CGR (g m^{-2} day^{-1})		RGR (g g^{-1} day^{-1})		NAR (g m^{-2} day^{-1})	
Cropping system (C)	30 DAS	60 DAS	90 DAS	30-60 DAS	60-90 DAS	30-60 DAS	60-90 DAS	30-60 DAS	60-90 DAS
C_1	1.09	2.63	2.87	29.00	27.91	0.079	0.021	16.62	9.94
C_4	0.95	2.24	2.47	25.86	22.17	0.078	0.019	17.22	9.11
C_5	1.05	2.49	2.72	28.03	26.12	0.118	0.020	16.87	9.81
SEm±	0.01	0.05	0.06	0.41	1.10	0.022	0.001	0.34	0.45
CD (P=0.05)	0.04	0.14	0.17	1.18	3.18	NS	NS	NS	NS
Nutrient management (N)									
N_1	1.02	2.42	2.69	26.39	24.70	0.079	0.020	16.31	9.58
N_2	1.18	2.95	3.05	33.26	28.65	0.079	0.019	17.24	8.83
N_3	0.88	1.98	2.32	23.25	22.85	0.117	0.021	17.17	10.45
SEm±	0.01	0.05	0.06	0.41	1.10	0.022	0.001	0.34	0.45
CD (P=0.05)	0.04	0.14	0.17	1.18	3.18	NS	NS	NS	NS
Interaction (C X N)	NS	NS	NS	NS	NS	NS	NS	NS	NS

C_1: Sole rice, C_2: Sole groundnut, C_3: Sole soybean, C_4: Rice + groundnut (3:1), C_5: Rice + soybean (3:1) and three nutrient management practices viz., N_1: 100% RDF+FYM @ 2.5t ha^{-1} + biofertilizer consortium @ 20 g kg^{-1} seed, N_2: 75% RDF+FYM @ 5 t ha^{-1} + biofertilizer consortium @ 20 g kg^{-1} seed, N_3: 50% RDF + FYM @ 7.5 t ha^{-1} + biofertilizer consortium @ 20 g kg^{-1} seed

An inquisition of the pooled data of the years on the crop growth rate at 30-60 DAS and 60-90 DAS revealed significant variation among the different treatments. It was evident from the data that the highest was recorded in C_1 (Sole rice), which was at par with rice intercropped with soybean (Table 1). The lowest was recorded in C_4 (Rice + groundnut with a ratio 3:1).The crop growth rate showed a similar tendency to dry matter accumulation. The dry matter production was limited due to the low light received by upland rice due to the shade of soybean and groundnut leaf. It results in a lower carbohydrate supply and the proportion of dry matter distribution throughout the crop growth rate (CGR). These results align with the results of Adeniyan *et al.* (2014). Among intercropping rice + soybean (3:1) treatment resulted in the highest crop growth rate. Ghosh *et al.* (2006) explained that a high crop growth rate gave a high yield. An adequate supply of nitrogen influenced the crop growth rate. Crop use nitrogen for metabolic processes in crop cell division and enlargement. The increased soybean proportion influenced the increase in crop growth rate and yield per clump. The increasing soybean proportion provided nitrogen from N_2 fixation to be utilized by upland rice. Through this explanation, it could be assumed that the presence of soybean in upland rice crops has a positive effect on nitrogen supply.

Statistically pooled data of both years also showed a significant difference with the maximum CGR in treatment N_2 (75% RDF + FYM @ 5 t ha^{-1} + biofertilizer consortium @ 20 g kg^{-1} seed) and the minimum was at N_3 (50% RDF + FYM @ 7.5 t ha^{-1} + biofertilizer consortium @ 20 g kg^{-1} seed) at 30-60 and 60-90 DAS (Table 1). CGR depends on how much radiation the crop intercepts and the efficiency of converting intercepted radiation into dry matter (Sinclair and Horie, 1989). Therefore, higher CGR indicates high dry matter accumulation with increased leaf area (Azarpour *et al.,* 2014; Nwokwu *et al.,* 2015).

There was no significant difference in relative growth rate and net assimilation rate due to cropping systems and nutrient management at various growth stages (Table 1).

Yield of rice

The highest grain and straw yield was sole rice treatment which was at par with rice intercropped with soybean (Table 2). The highest grain yield of rice was obtained in sole cropping of rice in all the intercropping systems. These results confirm the findings of Mandal *et al.* (1997), who also obtained more yield of rice in sole cropping than the inclusion of intercrop. Among intercropping systems, the highest grain yield was recorded in the rice + soybean (3:1) intercropping system. The effect of nutrient management on grain and straw yield showed a significant increase in yield. It was observed that the application of 75% RDF along with FYM @ 5 t ha^{-1} and biofertilizer consortium @ 20 g kg^{-1} seed significantly increased the yield. The minimum value was registered at the application of 50% RDF + FYM @ 7.5 t ha^{-1} + biofertilizer consortium @ 20 g kg^{-1} seed (Table 2). The highest grain yield in FYM and fertilizer treatment plots might be due to higher values of yield attributing characters *viz*, number of panicles m^{-2} and panicle length. Sravan and Singh (2019) also got similar results that applying recommended nutrients in an integrated approach (75% RDF + 25% FYM) enhanced rice grain yield. The application of different cropping systems did not show any significant effect on the harvest index. The effect of different nutrient management practices did not bring a significant impact on the harvest index of rice (Table 2).

Table 2: Effect of cropping systems and nutrient management practices on the yield of rice

Treatments	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)	Rice equivalent yield (t ha^{-1})
Cropping system (C)				
C_1	3.08	5.05	37.87	3.08
C_4	2.64	4.52	36.68	4.25
C_5	2.98	4.87	37.96	4.63
SEm±	0.04	0.08	0.51	0.05
CD (P=0.05)	0.11	0.24	NS	0.13
Nutrient management (N)				
N_1	2.94	4.82	37.90	3.99
N_2	3.15	5.16	37.95	4.43
N_3	2.60	4.47	36.66	3.54
SEm±	0.04	0.08	0.51	0.05
CD (P=0.05)	0.11	0.24	NS	0.13
Interaction (C X N)	S	NS	NS	S

There was a marked influence of different crop management practices on rice equivalent yield. The significantly highest values of rice equivalent yield were reflected in C_5 treatment (Rice + soybean at 3:1 row ratio), followed by rice intercropped with groundnut. Significantly lowest was achieved in sole rice (Table 2). A similar finding was reported by Virdia and Mehata (2010). The data indicated that the effect of different nutrient management on rice equivalent yield was significant. Significantly highest rice equivalent was observed in N_2 (75% RDF + FYM @ 5 t ha^{-1} + biofertilizer consortium @ 20 g kg^{-1} seed) treatment. The lowest was in treatment N_3 (50% RDF + FYM @ 7.5 t ha^{-1} + biofertilizer consortium @ 20 g kg^{-1} seed) (Table 2). It may be attributed to various yield attributes of component crops. It may be ascribed to the assimilation and translocation of more photosynthates towards sink at integrated use of organic manures and chemical fertilizers.

Growths attribute and yield of groundnut

Pooled data revealed a significant effect on leaf area index, crop growth rate and net assimilation rate at 30-60 DAS, seed yield, and stover yield due to cropping systems. Significantly highest leaf area index, crop growth rate, and net assimilation rate at 30-60 DAS, seed yield and stover yield were recorded in sole groundnut, and the lowest was recorded in rice intercropped with groundnut (Table 3). According to the results reported by Ghosh (2004), a significant reduction in LAI was observed in the groundnut+ pearl millet system over the sole groundnut. Furthermore, Sutaria and Mehta (2000) also recorded higher LAI under sole groundnut than pearl millet +groundnut in 2:1 row ratio, while the pearl millet benefitted under the intercropping system. Ghosh (2004) reported a 40.40% reduction in CGR in intercropped groundnut associated with pearl millet compared to sole groundnut. Nambiar *et al.* (1983) GAURI demonstrated that intercrops like pearl millet, maize, and sorghum limited the light reaching the groundnut canopy by at least 33% thereby reducing photosynthesis. Lower CGR further showed this restricted photosynthesis. The NAR of intercropped groundnut with cereal was less. This may be attributed to the less efficient conversion of light energy into dry matter in intercropped groundnut. Reddy and Willey, 1979 observed similar results. This result corroborates the findings of Razzaque *et al.* (2007), who also reported that less groundnut yield was obtained from the intercropping system than the sole crop due to the shading effect of chili on groundnut.

Table 3: Effect of cropping systems and nutrient management practices on growth and yield of groundnut

Treatments	Leaf area index (LAI)			CGR ($g\ m^{-2}\ day^{-1}$)		RGR ($g\ g^{-1}\ day^{-1}$)		NAR ($g\ m^{-2}\ day^{-1}$)		Seed yield ($t\ ha^{-1}$)	Stover yield ($t\ ha^{-1}$)	Harvest index (%)
Cropping system (C)	30 DAS	60 DAS	90 DAS	30-60 DAS	60-90 DAS	30-60 DAS	60-90 DAS	30-60 DAS	60-90 DAS			
C_2	0.59	2.33	2.64	6.19	5.48	0.072	0.020	4.87	2.21	1.26	3.36	27.22
C_4	0.47	2.10	2.39	4.42	4.88	0.063	0.023	4.04	2.20	0.59	1.67	25.88
SEm±	0.01	0.03	0.03	0.18	0.30	0.003	0.001	0.17	0.14	0.02	0.04	0.41
CD (P=0.05)	0.04	0.10	0.09	0.53	NS	NS	NS	0.50	NS	0.04	0.12	NS
Nutrient management (N)												
N_1	0.52	2.21	2.54	5.17	5.22	0.071	0.021	4.42	2.19	0.90	2.50	26.22
N_2	0.61	2.43	2.69	6.59	5.59	0.065	0.019	4.96	2.17	1.05	2.73	27.59
N_3	0.46	1.99	2.31	4.17	4.73	0.067	0.023	3.98	2.25	0.82	2.31	25.85
SEm±	0.02	0.04	0.04	0.22	0.37	0.004	0.002	0.21	0.18	0.02	0.05	0.51
CD (P=0.05)	0.05	0.12	0.11	0.65	NS	NS	NS	NS	NS	0.05	0.15	NS
Interaction (C X N)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

The pooled data of both years also revealed a significant difference with the highest leaf area index, crop growth rate at 30-60 DAS, seed yield, and stover yield when the crop was applied with 75% RDF + FYM @ 5 t ha^{-1} + biofertilizer consortium @ 20 g kg^{-1} seed. The lowest leaf area index, crop growth rate, seed yield, and stover yield were recorded when the crop was applied with 50% RDF + FYM @ 7.5 t ha^{-1} + biofertilizer consortium @ 20 g kg^{-1} seed (Table 3). Applying chemical fertilizer in combination with organic fertilizer increased the fertilizer use efficiency of added chemical fertilizers, which helped increase nutrient availability and improved the physical and biological health of the soil. Organic manure also contains almost all the essential elements in variable quantities, which synergizes with other essential elements for their availability. This effect might be reflected in increased plant height, spread, number of branches and leaf area in groundnut. This result was confirmed by Rayer, 1984.

Application of different cropping systems did not significantly affect CGR at 60-90 DAS, RGR, NAR at 60-90 DAS, and the harvest index of groundnut. Different nutrient management practices did not significantly impact CGR at 60-90 DAS, RGR, NAR, and the harvest index of groundnut (Table 3).

Growths attribute and yield of soybean

Significantly highest leaf area index, crop growth rate, relative growth rate, and net assimilation rate at 30-60 DAS, seed yield, and stover yield were recorded at sole soybean. The lowest was recorded for rice intercropped with soybean (Table 4). In all the growth stages highest leaf area index was recorded as the highest in sole soybean and the lowest was in rice intercropped with soybean, which might be due to vice versa for space and light. Mandal *et al.* (2014) reported that the intercrop's LAI (legumes) was reduced under intercropping treatments. Sole soybean crop exhibited significantly higher CGR than soybean as an intercrop. Alom *et al.* (2010) reported that the reduction of leaf area and availability of sunlight underneath of canopy in intercropping situations may be the reasons for the lower CGR of intercrop (legumes). A similar finding was reported by Rathiya *et al.,* 2010. A higher relative growth rate of soybean was observed in monoculture compared to intercropping systems might be due to no intercrop competition for light, nutrients, moisture, and space. The NAR of intercropped soybean with cereal was less. This may be attributed to the less efficient conversion of light energy into dry matter in intercropped soybean.

Table 4: Effect of cropping systems and nutrient management practices on growth and yield of soybean

Treatments	Leaf area index (LAI)			CGR ($g\ m^{-2}\ day^{-1}$)		RGR ($g\ g^{-1}\ day^{-1}$)		NAR ($g\ m^{-2}\ day^{-1}$)		Seed yield ($t\ ha^{-1}$)	Stover yield ($t\ ha^{-1}$)	Harvest index (%)
Cropping system (C)	30 DAS	60 DAS	90 DAS	30-60 DAS	60-90 DAS	30-60 DAS	60-90 DAS	30-60 DAS	60-90 DAS			
C_3	0.61	2.44	2.68	10.46	7.36	0.076	0.017	7.35	2.92	1.77	3.61	32.86
C_5	0.53	2.21	2.49	7.81	6.43	0.072	0.018	6.09	2.68	0.83	1.77	31.78
SEm±	0.01	0.03	0.04	0.26	0.40	0.001	0.001	0.20	0.18	0.02	0.08	0.51
CD (P=0.05)	0.03	0.08	0.11	0.76	NS	0.003	NS	0.60	NS	0.07	0.22	NS
Nutrient management (N)												
N_1	0.56	2.32	2.57	8.66	6.99	0.074	0.018	6.48	2.87	1.26	2.58	32.55
N_2	0.65	2.56	2.78	11.59	8.49	0.078	0.017	7.76	3.20	1.53	3.11	33.11
N_3	0.49	2.10	2.41	7.16	5.20	0.071	0.016	5.92	2.33	1.10	2.38	31.30
SEm±	0.01	0.03	0.04	0.31	0.48	0.001	0.002	0.25	0.22	0.03	0.09	0.62
CD (P=0.05)	0.03	0.10	0.13	0.93	1.43	0.004	NS	0.74	NS	0.09	0.27	NS
Interaction (CXN)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

The pooled data of both years also revealed a significant difference with the highest leaf area index, crop growth rate (CGR) at 30-60 and 60-90 DAS, relative growth rate (RGR), and net assimilation rate (NAR) at 30-60 DAS, seed yield and stover yield when the crop was applied with 75% RDF + FYM @ 5 t ha^{-1} + biofertilizer consortium @ 20 g kg^{-1} seed. The lowest leaf area index, crop growth rate (CGR) at 30-60 and 60-90 DAS, relative growth rate (RGR), and net assimilation rate (NAR) at 30-60 DAS, seed yield, and stover yield were recorded when the crop was applied with 50% RDF + FYM @ 7.5 t ha^{-1} + biofertilizer consortium @ 20 g kg^{-1} seed (Table 4). The feasible reason for higher values of leaf area index could be because of the integration and availability of mineral fertilizers, organic manures and consortia throughout the growing period of the crop; this leads to ease of nitrogen availability to the crop. This plant did not expose to nutrient stress conditions at any stage. This outcome was already obtained by Devi *et al.* (2013) and Morya *et al.* (2018). The significant interactive effect of organic manures and fertilizers on crop growth rate might be due to the supply of additional plant nutrients and increased availability of native soil nutrients due to increased microbial activity. The advantage of the combined application of organic manures and fertilizer is quite obvious, as these provide a steady supply of nutrients leading to better growth of plants. Moreover, the increased availability of P and K, in addition to other plant nutrients released by the organic manures, might have contributed to enhancing the yield attributes like net assimilation rate. These findings are near Verma *et al.,* 2017.

Different cropping systems did not significantly affect CGR, RGR, and NAR at 60-90 DAS and the harvest index of groundnut. The effect of different nutrient management did not bring a significant impact on RGR and NARat 60-90 DAS and the harvest index of groundnut (Table 4).

CONCLUSION

Among the different intercropping systems, the rice+ soybean system was more suitable than rice+ groundnut intercropping. This system recorded the highest grain yield and the highest rice equivalent yield. Among the different doses of nutrient management applied, N_2-75% RDF along with FYM @ 5 t ha^{-1} and biofertilizer consortium @ 20 g kg^{-1} seed was found to be most suitable as it registered the highest production under the rainfed condition of Nagaland.

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