Indian Journal of Agricultural Sciences **85** (3): 404–8, March 2015/Article

Production potential of congosignal grass (*Brachiaria rosensis*) in silvi-pastoral system in North East India

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Received: 28 January 2014; Revised accepted: 15 December 2014

ABSTRACT

A field experiment was conducted during 2009–12 at ICAR Research Complex for NEH Region, Umiam, Meghalaya to study the performance of congosignal grass (*Brachiaria rosensis* L*)* under silvi-pastoral based agroforestry system in mid hill altitude of North East India. Congosignal grass was planted in open as well as intercrop with *Simingtonia populanea* and fertilized with 0, 30, 60 and 90 kg N/ha. The study showed that growth attributes and yield of congosignal was reduced under tee canopy, while crude protein content was 5.35 % higher under tree canopy. Dry fodder production was significantly higher in open (119.55 q/ha) than under tree canopy (87.46 q/ha). The content and uptake of NPK by congosignal grass were higher in open area, while organic carbon and residual NPK status improved under tree canopy. Application of nitrogen at increased level improved plant height, no. of tillers and leaf:stem ratio. The green and dry biomass yield was significantly higher with 60 kg N/ha. The content and uptake as well as residual NPK were significantly improved with 60 kg N/ha. The soil organic carbon improved under tree canopy than open. Higher gross and net return were recorded with application of 90 and 60 kg N/ha in open and tree canopy, respectively. The B:C ratio (3.08) was higher with 90 kg N/ha in open planting, while under tree canopy highest B:C ratio of 2.19 was recorded with 60 kg N/ha.

Key words: Agro-pastoral system, Congosignal, Gross and net return, Green fodder, Nitrogen, Nutrient content and uptake, *Simingtonia populanea*

Livestock being an integral part of agriculture plays an important role in the activities of crop production and rural economy. The cattle population in north eastern region represents 6.42 per cent of country's cattle population. The man : animal ratio in North East part of India is very high as compared to national average. The animals are dependent on local feed and fodder whose quality is very poor as locally available pasture contain 3.13–3.14% crude protein (Verma *et al.* 1988) which is much less than the improved grasses. The animals are reared with open grazing and to some extent with paddy straw. These animals require judicious and nutritious forage for obtaining optimum levels of production. One of major reasons for the poor performance of livestock is their malnutrition and it has been estimated that the supply of green fodder is less than one third of the actual requirements. Therefore, improvement of marginal and sub marginal land for sustained herbage production with suitable leaf fodder tree species is necessary in order to meet the forage demand in the region, because grasses are ecologically a very successful group of plant being adjusted to wide range of environmental conditions (Sharma and Sood 1994). Amongst the introduced grass fodder species, congosignal has been successfully established in the region in open as well as in silvi-pastoral system. This system facilitates improvement of soil fertility through litters fall and root biomass. In this system the yield in grasses is reduced but the digestibility and crude protein (%) increased (Samarakoon *et al.* (1990). If nitrogen is applied to fodder crop, it not only improve its yield but enhance soil fertility also. Keeping this fact in view, the present study was undertaken to study the effect of tree shade and nitrogen levels on yield and quality of congosignal grass under mid hill altitude conditions.

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MATERIALS AND METHODS

The experiment was conducted at the research farm of Natural Resource Management division, ICAR Research Complex for NEH Region, Umiam, Meghalaya during three consecutive *kharif* seasons of 2009-12 in 25 years old well established leaf fodder tree species of *Simingtonia populanea* having plant spacing of 4 × 4 m spacing. The site lies between 25'41'[21]" N and 91'55'25" E longitude and at an altitude of 980 above mean seas level. It receives an average annual rainfall of 2 349 mm. The mean daily temperature varies between 2.5°C in August. The green leaf fodder of *Simingtonia* is utilized for goat during lean season. The experimental soil was sandy loam having pH 5.1, organic carbon (1.34 %), low in nitrogen (225 kg/ha), phosphorus (8.8 kg/ha) and medium in potassium (250 kg/ha). Treatments consisted of open planting of grass and second silvi-pastoral system were kept in main plot, while four nitrogen levels (0, 30, 60, and 90 kg/ha) were arranged in sub plots. The treatments were tested in split plot design with three replications. The field was applied with lime @ 1 tonne/ha and farmyard manure (FYM) @ 10 tonnes/ha and incorporated into the soil 15 days before planting. Congosignal variety of DRSB 7 was planted during August 2008-09 under tree and in open area in 8-10 cm deep pit @ 2-3 rooted slips with 60 × 45 cm spacing. All recommended packages of practices were followed for proper establishment of the rooted slips of congosignal. During winter season the green fodder part of the plants were cut down and treatments were imposed next year during March 2009-10 and were repeated continuously for two more years. Half dose of nitrogen and full dose of phosphorus and potash through urea, single super phosphate and muriate of potash, respectively were applied during first week of March 2009, 2010 and 2011. While remaining nitrogen was split in two and given after first and second cut during all the three years of experimentation.

First year, a total three cuttings were taken and fodder yield under different treatments were recorded at 85, 135 and 185 days after plantings which falls on 20 July, 9 September and 31 October. All the plots were kept undisturbed after November to March and again treatments were imposed on the some date. The same date of fodder harvesting was adopted for second the third years as were during first years. Biometric observations were recorded with 10 randomly selected and tagged plants. The green fodder yield of each cutting was recorded immediately after harvesting the crop. For dry matter content, three samples on one kilogram freshly harvested green fodder in each treatment were oven dried at 60°C till content weight of the sample was obtained and dry matter yield was determined from green fodder data. The N, P and K contents in fodder were determined by using standard procedure. For determining protein content, nitrogen content in fodder was multiplied with 6.25 and protein yield was obtained by multiplying protein content with dry matter yield. The soil chemical properties, viz OC and available N, P and K were determined separately for 0-15, 15-30 and 30-45 cm soil depth using standard methods and total of NPK values were obtained by summing over three depths.

The environmental conditions varied during study period with regards to temperature and precipitation (Fig 1). In the first year temperature remained high up to of September causing profuse tillering and growth of grass. The rains experienced up to first week of November, thereafter no rains were observed. During second year, rainfall was received at active growth stage of grass and lasted up to November. The temperature and moisture were conducive during growth period; hence the yield levels were high. The data of three years was pooled and analysed statistically. It was further evaluated for different economically parameters such as gross return, net return and B: C ratio based on prevailing market price. The nutrient balance of soil was worked out on the basis of initial and final values of N, P and K respectively.

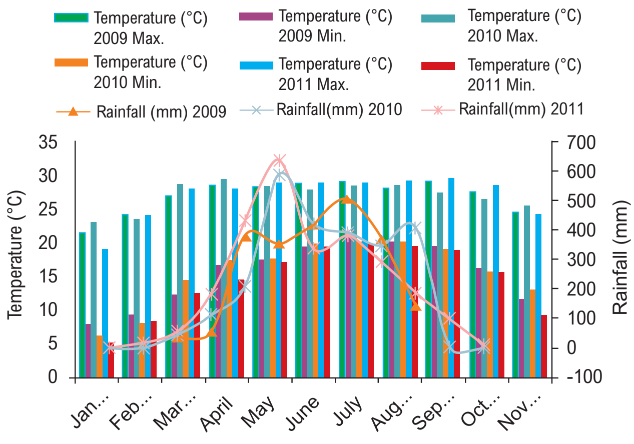

Fig 1 Climatic parameters of experimental site

RESULTS AND DISCUSSIONS

Effect of tree canopy

Growth and yield attributes of congosignal significantly reduced due to intercropping with tree species of *Simingtonia populnea* (Table 1) as compared to open area. Plant height was lowest at first cutting which increased at 2nd cutting followed by slight reduction in plant height at 3rd cutting was observed. The number of tillers were more in open treatment highest being 44.96/tussock at 3rd cut stages which were 73.85% higher over tillers recorded under tree canopy. The leaf:stem ratio was significantly higher in open area (0.99) might be due to less PRA under tree canopy. The effect of growth attributes in open treatment markedly improved forage yield which was 29.38, 33.84 and 32.79 % higher over green forage yield recorded under tree canopy, at 1st, 2nd and 3rd cut, respectively. The total

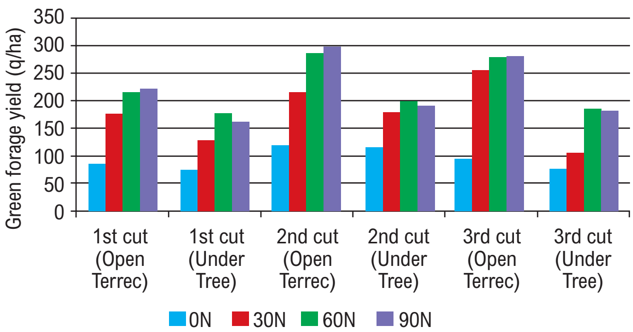

Fig 2 Green fodder yield as influence by nitrogen and tree canopy

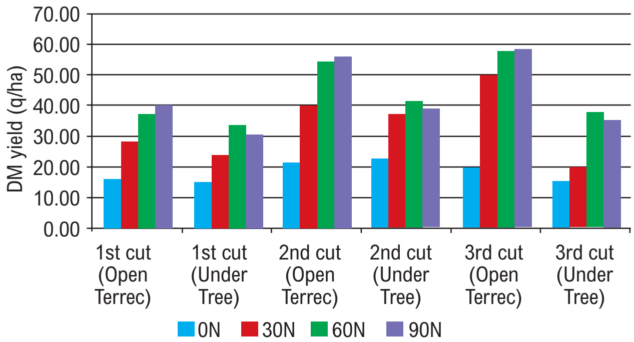

Fig 3 Dry matter yield as influence by nitrogen and tree canopy

Table 1 Effect of tree canopy and nitrogen on growth and yield of congosignal

Treatment	Plant height (cm)			Tillers/tussock			Leaf : stem ratio			Dry matter (%)			Green forage yield (q/ha)			
	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut	Total
Silvi-pasture system																
Open	115.53	152.53	148.26	13.68	24.48	44.96	0.63	0.71	0.99	17.92	18.59	20.46	174.62	228.97	227.18	630.77
Under Tree	101.74	138.78	138.56	10.88	20.75	25.86	0.60	0.73	0.90	19.07	20.35	19.50	134.96	171.08	136.98	443.02
SEM ±	2.17	1.94	1.91	0.78	0.32	0.95	0.02	0.02	0.01	0.68	0.21	0.45	3.99	3.28	3.96	3.46
CD (P=0.05)	8.42	7.51	7.41	NS	1.24	3.75	NS	NS	0.02	NS	0.82	NS	15.45	12.70	15.35	13.42
Nitrogen levels																
N0	89.01	118.55	121.84	10.50	16.55	21.35	0.48	0.70	0.68	19.20	18.77	20.10	80.30	117.04	85.76	283.10
N30	104.91	145.66	140.74	12.10	21.65	35.01	0.58	0.72	0.86	18.11	19.61	19.11	152.22	197.31	180.20	529.72
N60	119.12	156.86	152.47	13.19	25.90	42.00	0.69	0.73	1.14	18.13	19.88	20.57	195.84	241.91	231.77	669.52
N90	121.50	161.56	158.61	13.35	26.36	43.29	0.71	0.72	1.11	18.53	19.64	20.14	190.81	243.84	230.59	665.23
SEM ±	1.04	1.44	1.28	0.42	0.38	0.49	0.03	0.04	0.02	0.45	0.21	0.38	3.86	2.55	2.84	3.23
CD (P=0.0.5)	3.05	4.21	3.75	1.25	1.12	1.45	0.12	NS	0.02	NS	0.62	NS	11.30	7.45	8.32	9.45

green forage yield of 630.77 q/ha was recorded in open area while under tree canopy, it was 443.02 q/ha. The dry matter yield also followed the similar trend by recording 119.55 q /ha which was 36.70% higher than dry matter obtained under tree canopy. The green forage yield was maximum at 2nd cut stage but the dry matter yield was highest at 3rd and 2nd cut stages in open and under tree canopy, respectively (Fig 2 and 3). The roots of *Simingtonia populnea* exerts competitive interactions with grasses grown under their canopy as roots determine the spatial distribution of water and nutrient uptake and finally decrease in resource availability (Smit 2005). The suppressive effect of the tree species on the dry matter (DM) production was pronounce as DM production significantly decreased under tree canopy treatment as compared to open. These results confirm the findings of Patrick and Claude (1995) who reported reduction in yield of grasses grown under tree species.

Crude protein (CP) content in congosignal was higher under tree canopy as compared to open area in all the three cuttings. The CP values were in the range of 6.13 to 6.72% in open area while under tree canopy it was 6.44 to 7.14% indicated higher protein content under tree canopy. On the other hand crude protein yield was lower under tree canopy as compared open area. On the basis of three year average, CP in congosignal grown in open area recorded 797.03 kg/ ha which was 30.22% higher over the crude protein recorded under tree canopy. Crude protein yield is a product of CP% and DM yield and since the DM yield lower under tree canopy the crude protein yield was also less under tree canopy these findings are in conformity with Sarkar and Mahasin (2007). Contrary to this, Kumar and Faruki (2010) indicated that the crude protein yield of guinea grass was found to be higher under open condition than shade. Significantly higher NPK uptake of 127.52, 17.35, and 59.94 kg/ha were observed in open areas which were 30.22, 33.56 and 35.92% higher over tree canopy, respectively. Under tree canopy soil tends to be cooler, wetter and less aerated which may influence nutrient absorption by slowing root growth and nutrient absorption by roots of tree. Marked variation in N, P, and K uptake by grass was noted. The higher uptake of nutrients was due to higher forage yield in open area (Table 1). Further residues of tree leaves and decaying roots enriched the soil organic carbon OC being 45.46 % higher over open cropping. The available soil nutrients after harvest of crop were significantly higher under tree canopy. Growing of congosignal grass under tree canopy increased available N, P and K content of soil by 6.23, 11.90 and 1.24 %, respectively over open treatment. The build up of soil available N, P and K content could be attributed to greater multiplication of microbes due to addition of tree leaves and twigs and fibrous roots (Lakminarayan 2009).

Effect of nitrogen

Application of nitrogen at increased level significantly improved growth and yield of congosignal. Plant height and tillers/tussock increased significantly up to 60 kg N /ha

Table 2 Effect of tree canopy and nitrogen on dry fooder production, crude protein yield, nutrient uptake and residual fertility

Treatment	Dry fodder production (q/ha)				Crude protein content (%)			Crude protein yield (kg/ha)				Nutrient uptake (kg/ha)				Residual fertility (kg/ha)		
	1st cut	2nd cut	3rd cut	Total	1st cut	2nd cut	3rd cut	1st cut	2nd cut	3rd cut	Total	N	P	K	OC (%)	N	P	K
Silvi-pasture system																		
Open	30.28	42.84	46.43	119.55	6.13	6.63	6.72	189.43	287.83	319.77	797.03	127.52	17.35	59.94	1.32	257.03	9.83	322.54
With tree	25.61	34.97	26.88	87.46	6.44	7.14	7.08	166.88	251.54	193.65	612.06	97.93	12.99	44.10	1.92	273.63	11.00	326.54
SEM ±	2.78	1.49	1.65	2.51	0.85	0.10	0.10	1.32	1.66	1.48	1.57	0.37	0.61	1.11	0.08	0.89	0.54	0.44
CD (P=0.05)	NS	5.78	6.42	9.75	NS	0.42	0.41	5.12	6.45	5.74	6.08	1.45	2.37	4.35	0.31	3.45	2.11	1.74
Nitrogen levels																		
N0	15.42	21.97	17.23	54.62	5.69	6.44	6.25	87.35	141.54	107.31	336.20	53.79	7.78	27.00	1.57	262.85	9.85	321.01
N30	27.56	38.68	34.43	99.17	6.31	6.84	6.75	162.77	263.18	232.27	658.23	105.32	14.45	49.79	1.62	264.75	10.31	324.43
N60	35.50	48.09	47.66	130.78	6.53	7.09	7.31	230.45	336.22	348.01	914.68	146.35	19.33	65.96	1.63	265.52	10.60	326.15
N90	35.36	47.88	46.44	129.46	6.59	7.16	7.28	232.03	337.79	339.25	909.06	145.45	19.11	65.32	1.66	268.20	10.90	326.57
SEM ±	0.48	0.72	0.76	0.77	0.09	0.08	0.10	2.88	3.68	4.34	5.25	1.85	0.72	1.07	0.05	0.83	0.23	2.31
CD (P=0.05)	1.42	2.13	2.24	2.27	0.28	0.24	0.31	8.42	10.75	12.70	15.35	5.42	2.12	3.15	0.16	2.45	0.68	6.75

in all the three cutting stages but leaf: stem ratio and dry matter content improved during 2nd cutting only by recording highest leaf:stem ratio and dry matter content at 60 kg N/ha. Since congosignal is a heavy feeder of all essential nutrients in general and that of N in particular, so application of N resulted in significant taller plants with increased values of dry matter content and production. The overall improvement in growth of congosignal with addition of N can be ascribed to its pivotal role in several physiological and biochemical process. These results are in close conformity with the results obtained by Ram and Bhagwan Singh (2006). Leaf: stem ratio is a valid character of forage nutritive value indicating leafiness of forage was not influenced due to nitrogen but highest leaf:stem ratio was recorded with 60 kg N/ha. Green forage yield increased significantly up to 60 kg N/ha might be due to enhanced vegetative growth characters like plant height, tillers and dry matter accumulation. These results are in conformity with the findings of Chonamki *et al.* (2003) and Kumar and Faruqui (2010). Increase in dry matter production due to application of nitrogen might be because of stimulating effect of nitrogen on various physiological properties of plants which increased the photosynthetic area and utilization of more radiation which ultimately reflected on DM yield. The interaction of tree canopy and nitrogen were significant in improving green forage yield. Application of nitrogen at increased level significantly improved green forage yield up to 60kg/ha in both the treatments (Table 3). Application of 60 kg N/ha improved forage yield to the tune of 167.01 and 26.55 % higher over its respective control and 90 kg N/ha in open area while under tree canopy the improvement was 136.50 and 6.45% in the same orders, respectively. The interaction effect of system and nitrogen were significant for green forage yield (Table 3). In open, application of nitrogen significantly increased yield up to 90 kg N/ha. While under tee canopy, the green forage yield increased up to 60 Kg N/ha, thereafter the yield decreased significantly.

Congosignal resulted in maximum crude protein content at all cuts up to 60 kg N/ha. Crude protein (CP) content is function of percent nitrogen uptake. There was better assimilation of N in the presence of higher levels of N resulting into increased synthesis of protein. The higher CP yield obviously due to higher dry matter yield combined with higher crude protein content. Since N is important

Table 3 Interaction effect of tree canopy cover and nitrogen on green forage yield of congosignal

Treatment	Open	With tree	Mean
N_0	298.94	267.25	283.10
N_{30}	646.49	412.95	529.72
N_{60}	779.43	559.6	669.52
N_{90}	798.20	532.26	665.23
Mean	630.77	443.02	
SEM±	8.43		
CD (P=0.05)	26.55		

Table 4 Economic of congosignal in silvi-pasture system

Treatment	Cost of cultivation		Gross return		Net return		B : C ratio	
	Open	With tree	Open	With tree	Open	With tree	Open	With tree
N0	24880	24880	29894	26725	5014	1845	1.20	1.07
N30	25240	25240	64649	41295	39409	16055	2.56	1.64
N60	25600	25600	77943	55960	52343	30360	3.04	2.19
N90	25900	25900	79820	53226	53920	27326	3.08	2.06

constituent of plant protein which plays an important role in protein synthesis and hence higher crude protein could be expected at increased level of nitrogen (Tomar 1976).

The nitrogen uptake by plants at all cut was increased significantly with increased levels of nitrogen. This might be due to the fact that when available nitrogen in soil was increased, the uptake of nitrogen increased linearly. There is a positive significant correlation between available nitrogen in soil and N content in crop as well as uptake, which ultimately reflected in higher biomass yield in terms of green and dry forage yield. During experimentation, the residual available nitrogen status decreased as compared to initial status. Application of 60 kg N resulted build up of higher soil N, P and K status after harvest. The OC found to increase with the successive increase of nitrogen dose. Build up of organic carbon might be due to organic deposit from perennial grasses in soil.

Higher gross return of ₹ 79 820 and ₹ 55 960/ ha was estimated with 90 and 60 kg N/ha in open and under tree canopy. Like wish the net return was higher in open and under tree canopy, respectively. The highest B:C ratio was recorded with 90 kg N/ha in open, while with tree it was highest with 60 kg N/ha (Table 4). Based on three years study, the congosignal be fertilized with 90 and 60 kg N/ha in open and with tree under mid hill altitude of North East India.

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