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Integrated nutrient management in intercropping system of *Cenchrus* and cowpea under semi-arid condition of Rajasthan

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Abstract
An investigation was carried out during *Kharif* seasons 2012-13 to study the effect of integrated nutrient management on intercropping systems of *Cenchrus* and cowpea under semi-arid condition of Rajasthan. The results revealed that alternate intercropping row ratios (1:1, 2:1 and 1:2) had brought significant effect on green fodder, dry matter, Protein content and economic return during both the years. However, aforesaid indices were the highest with *Cenchrus* and cowpea planted in 1:2 row ratio followed by 1:1 and 2:1 row ratio, respectively. Among the integrated nutrient management application of 40 kg N + 60 kg P_2O_5 + bacterial inoculation resulted in significant increase in the green fodder, dry matter, protein and economic return as compared to other treatments (control, bacterial inoculation, 40 kg N/ha, 60 kg P_2O_5 and 40 kg N + 60 kg P_2O_5). The data on soil fertility status after post-harvest showed that physical and chemical properties of the soil had improved remarkably with 1:2 row ratio between *Cenchrus* and cowpea along with application of 40 kg N + 60 kg P_2O_5 + bacterial inoculation as it is compared with other treatments combinations. Maximum economic return was obtained with the treatment of 40 kg N + 60 kg P_2O_5 + bacterial inoculation treatment (Rs99695/ha) and benfit:cost ratio(1.91).

Keywords: nutrient management, intercropping system, semi-arid

Introduction
Livestock plays an important role in rural economy of the India by supplementing the farm family income and ascertaining additional employment generation opportunities. Live stock sector contributes about 26% of the total agriculture income (GDP). In this regard, supply of nutritious green fodder is very much essential for the development of livestock component of integrated farming system. However, at present, the country is facing an acute deficiency of green fodder (35.6%), dry crop residues (26%) and concentrate ration(41%) as per the reported of (ICAR-DARE, report, 2013) [3]. Intercropping of grass and legume is a prospective way to ensure availability of high quality fodder in appreciable quantity with more economy through saving of plant nutrients through nitrogen fixation (Meena *et al.,* 2011) [6]. However, more studies on intercropping of dual-purpose legume like cowpea with dhaman grass is needed and their impact on forage yield and quality is also required. On the other hand, protein rich forage legumes offer an opportunity to provide a cheaper source of quality fodder to animals. Hence, balance use of nutrients have pivotal role in increase productivity of fodder crops when they were grown together in different intercropping systems. Information on intercropping of cereal and legume system along with balanced use of nutrients is measure in the study area. Hence, the present experiment was planned to develop the most productive and profitable system for quality forage production under semi-arid condition of Rajasthan.

Material and Methods
A field experiment was conducted at ICAR-CSWRI, Avikanagar (Rajasthan) during rainy seasons of 2012 and 2013. The soil of the experimental site was sandy loam in texture and alkaline in reaction (pH 8.1). It contains low in organic carbon content (0.43%), low in available nitrogen (165.5 kg/ha) and available P (12.8 kg/ha) and medium in available K (193.8 kg/ha). The EC was 0.21 dS $m^{-1}$and bulk density 1.47 g/cc. The rainfalls were received of 418 mm and 478 mm during both the consecutive years. The experiment comprised of different intercropping row rations between *Cenchrus* grass and cowpea viz. (1:1, 2:1 and 1:2) as main plot treatments and six fertility levels (control, bacterial inoculation, 40 kg N/ha, 60 kg P_2O_5/ha, 40 kg N/ha + 60 kg P_2O_5/ha and 40 kg N/ha + 60 kg P_2O_5/ha + bacterial inoculation) as sub plots treatments.

The experiment was conducted in split plot design with three replications. *Cenchrus setigerus* seeds was sown in lines at 50 cm apart with a seed rate of 6 kg/ha and cowpea was sown in lines at 30 cm apart with a seed rate of 40 kg/ha, respectively. The test varieties of *Cenchrus* and cowpea were IFGRI-3108 and C-152. The crops were fertilized as per the recommended doses. Half doseof nitrogen and full doses of phosphorus and potassium was applied at the time of sowing and remaining half dose of nitrogen was applied 30 days of after sowing. The biometric observations pertaining to growth and yield were recorded at the time of harvest. The green fodder and dry matter yields were recorded on the basis of per square meter area under each treatment and then yield converted into ton per hectare. Statistically data were analyzed. For the nitrogen content in grass and legume plants, the samples were collected at the harvesting time and estimated by following the standard laboratory procedures of AOAC (1990) [1].

Result and Discussion

Planting under different intercropping systems(1:1, 1:2 and 2:1) had significant effect on growth and yield parameters of both grass and legume such as plant height(cm), dry matter accumulation (g/plant), tillers/plant, ear length(cm) and seed weight/plant(g) in *Cenchrus* and branches/plant in cowpea. However, these were the maximum with 1:2 intercropping rowratio than 1:1 and 2:1 row rations. This might be due to beneficial effect of cowpea on associated *Cenchrus* growth when both was sown either in paired or in alternative row ratios. Meena *et al.*, 2014 [5] also reported beneficial effects of cereal and legume association in silvi-pastoral system under semi-arid condition of Rajasthan (2015). However, the highest green herbage and dry matter yield were recorded in 1:2 row ratio (12.49 and 3.46 t/ha, respectively) on the mean data basis over two years) followed by 1:1 and 2:1 intercropping systems. This might be due to symbiotic effect of cowpea on counter part of *Cenchrus* grass with reference to growth and yield parameters, which resulting in higher green and dry fodder production. The higher crude protein content in dry matter was estimated (12.69%) where *Cenchrus* and cowpea was planted in 1:2 row ratios. While, the lower crude protein content was estimated in higher proportion of *Cenchrus* than cowpea (7.72%). Similar, higher economic return and benefit cost ratio were accrued in*Cenchrus* and cowpea was sown 1:2 (Rs 94764./ha and 1.98) and the lowest was noticed at 2:1 ratio (Rs.65449 /ha and 1.39). Use of various fertility levels result in significant increase in growth and yield attributing parameters viz. plant height, dry matter production/plant tillers/plant, ear length and seed yield/plant in *Cenchrus* and branches/plant in cowpea. However, these were the maximum influenced with the use of 40 kg N/ha + 60 kg P_2O_5/ha + bacterial seed inoculation during both the years. This was possible due to prolonged availability of nutrients during the growth period of grass and legume through fixation of atmospheric nitrogen into the soil profile and solubilization of phosphorus by phosphor bacteria. However, 40 kg N/ha + 60 kg P_2O_5/ha + bacterial treatment was found statistically on par with 40 kg N/ha + 60 kg P_2O_5/ha in respect of growth and development. Further, all the fertility levels were found superior over the control treatment in respect of growth and yield attributing characters. Application of nitrogen and phosphorus in conjunction with bacterial strains (*Rhizobium*, *Azospirillium* and PSB) had brought significant improvement in green fodder, dry matter, crude protein content, net returns and B: C ratio over other treatments like control, bacterial inoculation, 40 kg N/ha, 60 kg P_2O_5/ha, 40 kg N + 60 P_2O_5/ha and 40 kg N+ 60 P_2O_5/ha + bacterial inoculation treatments, respectively. This might be due to significant increase in growth and yield parameters of both pasture species resulted higher biomass production. The forage production of mixed pasture of *Cenchrus ciliaris* + *Stylohamata* improved by fertilizer application also reported by Ram and Kumar (2010) [8].

Table 1: Green fodder, dry matter, protein content and economic return as influenced by different intercropping systems and integrated nutrient management

Treatment	Green fodder yield (t/ha)		Dry fodder yield (t/ha)		Crude Protein content (%)		Cost of production (Rs/ha)	Economic return(Rs/ha)	Benefit: cost ratio
	2012	2013	2012	2013	2012	2013			
Inter cropping system (Cenchrus: cowpea in alternate paired rows)									
1:1	10.88	11.93	3.12	3.14	9.26	9.30	29885	82073	1.74
2:1	8.98	10.31	2.50	2.64	7.39	8.06	27280	65449	1.39
1:2	12.52	13.01	3.54	3.84	12.31	13.08	31707	94764	1.96
CD (P=0.05)	0.61	0.65	0.33	0.35	2.01	2.45	-	-	-
Integrated nutrient management									
Absolute control	9.0	10.50	2.65	2.81	7.84	8.07	27075	67283	1.48
Bacterial inoculation	10.04	11.17	2.91	3.02	8.67	9.10	30152	79245	1.63
40 kg N/ha	10.71	11.74	3.00	3.20	9.08	10.05	30515	81245	1.66
60 kg P_2O_5/ha	10.97	11.92	3.11	3.27	9.66	10.40	31635	86613	1.73
40 kg N +60 kg P_2O_5/ha	11.83	12.44	3.31	3.41	11.04	12.10	34075	93535	1.74
40 kg N +60 kg P_2O_5/ha + bacterial Inoculation	12.15	12.83	3.42	3.51	11.60	13.02	34195	99695	1.91
CD (P=0.05)	0.74	0.83	0.31	0.34	2.18	2.63	-		-

Table 2: Effect of intercropping row ratios and integrated nutrient management on physico-chemical properties changes after 2 year

Treatment	Bulk density(MG/M^3)		SOC (%)		pH		EC (dS m^{-1})		Available N (kg/ha)		Available P (kg/ha)	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Inter cropping ratio (Cenchrus: cowpea in alternate paired rows)												
1:1	1.34	1.31	0.329	0.349	7.5	7.4	0.236	0.208	144.07	151.10	10.44	12.05
2:1	1.21	1.20	0.300	0.334	7.7	7.5	0.243	0.223	113.04	117.20	9.06	10.10
1:2	1.35	1.33	0.383	0.401	7.3	7.2	0.207	0.196	169.03	175.09	12.08	13.07
CD (P=0.05)	0.11	0.08	0.025	0.030	NS	NS	0.034	0.035	9.46	9.50	1.00	1.09
Integrated nutrient management												
Control	1.37	1.32	0.276	0.296	7.8	7.8	0.266	0.244	129.12	132.29	8.08	8.25
Bacterial inoculation	1.32	1.31	0.306	0.327	7.4	7.4	0.198	0.187	134.40	143.29	8.32	9.08
40 kg N/ha	1.31	1.30	0.331	0.351	7.5	7.5	0.250	0.191	141.12	147.29	10.02	11.06
60 kg P_2O_5/ha	1.30	1.28	0.351	0.383	7.5	7.5	0.212	0.205	146.12	153.37	11.00	12.22
40 kg N +60 kg P_2O_5/ha	1.26	1.25	0.366	0.385	7.5	7.5	0.243	0.225	147.14	156.48	12.05	13.32
40 kg N +60 kg P_2O_5/ha + bacterial inoculation	1.25	1.23	0.394	0.426	7.8	7.4	0.202	0.201	156.10	159.03	14.06	15.42
CD (P=0.05)	0.16	0.12	0.035	0.042	NS	NS	0.048	0.052	13.38	13.99	1.41	1.54
Initial soil status	1.38	1.34	0.263	0.287	7.8	7.8	0.217	0.248	123	127	7.42	7.45

Conclusion

Based on two years study results it can be concluded that dhaman grass (*Cenchrus setigerus*) should be intercropped with cowpea at the ratio of 2:1 to ascertain the higher quality fodder production and more profit.

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