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RESEARCH PAPER

Consequence of nutrient management on growth and yield of lucerne (*Medicago sativa* L.) – paddy (*Oryza sativa* L.) sequential cropping

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Abstract **:** A field experiment was conducted on nutrient management on lucerne (*Medicago sativa* L.) and their residual effect on succeeding *Kharif* rice (*Oryza sativa* L.)" during *Rabi* and *Kharif* seasons of 2004-2005 and 2005-2006. The growth and yield attributing characters of lucerne significantly enhanced due to application of 2nd cutting then left for seed production + 50 per cent RD of phosphorus + PSB (T_9) over rest of the treatments during both the years as well as in pooled data. The highest values of growth and yield attributes like grain and straw yield of rice were recorded under the treatment combination of application of 2nd cutting than left for seed production + 50 per cent RD of phosphorus + PSB (T_9) to preceding lucerne and 100 per cent recommended dose of fertilizer (F_3) to rice being at par with treatments combinations T_8F_3, T_7F_3 and T_6F_3 indicating that the treatment combination of T_9 x F_3 was adequate for obtaining comparable grain and straw yields from succeeding rice.

Key Words **:** Lucerne, Paddy, Cropping sequence

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INTRODUCTION

Lucerne is one of the crops that respond well to phosphatic fertilizers as compared to nitrogen and potassium fertilizers in all the territories and in all soil types. It plays a vital role in plant nutrition. It is a key nutrient in cell division and tends to be concentrated in actively growing young plants tissues. Its deficiency in soil severely limits root and shoot growth and thereby decreases the yield. Since phosphorus fixation is usually more common in heavy textured soil and under heavy irrigation, the deficiency of phosphorus to lucerne is most likely under South Gujarat conditions requiring heavy demands to support luxuriant plant growth. It is reported by many scientists that yield of lucerne increases with increase in dose of phosphorus up to 120 to 150 kg $P_2O_5ha^{-1}$ (Singh and Bajpai, 1972 and Anonymous, 1989).

The demand of rice in India is projected to be 100 million tons in 2006 A.D., which is to be produced from 42.3 million hectares of paddy area. Therefore, country has to reach an average production level of 2454 $kgha^{-1}$, from the present level of 1851 kg ha^{-1} (Siddiqui *et al.,* 1999). In India, 45 per cent of yield advantage obtained with modern technologies over traditional package of practices could be attributed from a single factor *viz*., fertilizer, which had played a significant role in the success of green revolution. Fertilizer management seems to be the most important component influencing rice yields with the increase in the intensity of cropping in the rice multiple cropping system and continuous removal of plant nutrients. Nitrogen is one of the costliest and perhaps the most crucial nutrient limiting rice yield. The second mineral element, phosphorus plays a key role in vigorous root growth and proliferation, early tillering with more panicles, higher percentage of filled spikelet's, early maturity/ripening and good grain quality of rice.

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Phosphorus fertilizers after their application in the soil undergo changes and enrich the soil with non-liable phosphate pool which in turn, benefits the succeeding crops. Legumes respond well to phosphate application and the residual phosphorus left in the soil can be an important source of P for the succeeding crop in legume-based cropping system. Further residual effect of P fertilization to *Rabi*/summer crops on succeeding *Kharif* crops has been found more profitable. Therefore, attempts are being made to recommend a dose of P fertilizer for a cropping system rather than individual crop.

Lucerne is one of the legume crop included in an Indian cropping system. Similarly, rice is main cereal grown in *Kharif* season. The increased irrigation potential in south Gujarat has made it possible to raise summer legume in crop root action.

MATERIALS AND METHODS

Field experiments were conducted at Navsari Agricultural University, Navsari, during *Rabi*-summer and *Kharif* seasons of 2004-05 and 2005-06, in ten treatments for *Rabi* lucerne comprised of T_1 - Entire cutting + RD of nitrogen and phosphorus, T_2 - Entire cutting + 100 per cent RD of phosphorus, T_3 - Entire cutting + 50 per cent RD of phosphorus + PSB, T_4 - 1st cutting than left for seed production + RD of nitrogen and phosphorus, T_5 - 1st cutting than left for seed production + 100 per cent RD of phosphorus, T_6 - 1st cutting then left for seed production + 50 per cent RD of phosphorus + PSB, T_7 - 2nd cutting then left for seed production + RD of nitrogen and phosphorus, T_8 - 2nd cutting then left for seed production + 100 per cent RD of phosphorus, T_9 - 2nd cutting than left for seed production + 50 per cent RD of phosphorus + PSB and T_{10} – Fallow and replicated four times in a Randomized Block Design. The succeeding *Kharif* rice crop was superimposed on the same layout keeping *Rabi* lucerne treatments as main plots and three fertility levels as sub plots (50% + *Azotobacter* (F_1), 75% (F_2) and (F_3) as 100 per cent of the recommended dose of 120 kg N + 30 kg P_2O_5 + O kg K_2O ha^{-1}), with total thirty treatment combinations in a Split Plot Design with four replications. The experiments were conducted on the same site during both the years. The pure seed of lucerne variety, Anand-2 was obtained and sowing was done manually by broad casting, using recommended seed rate of 5 kg ha^{-1}. The seeds were treated with bacterial culture *i.e. Rhizobium meliloti* having 10^7 bacterial count per gram of soil covered with soil manually and the crop was irrigated with tube well water.

The certified seeds of rice variety Gurjari were obtained from the College Farm, Navsari and treated with the fungicide thirum @ 3 g kg^{-1} seed. To assess the effect of treatments on the growth and development of crop plants, periodic observations (At 30 day's interval from sowing/transplanting to harvesting) were recorded. Heights of 10 randomly selected plants were measured from ground level to the tip of the upper most axis of shoot. Average value of each plot was computed and recorded at 30 and 60 days after sowing.

The yield of green forage and seed per net plot was worked out at every cutting. The weight of green forage and seed from the total weight of the produce in each net plot and then converted into kilogram per hectare.

The height of randomly selected five hills was measured from ground level to the tip of the longest upper leaf in case of juvenile plants and for panicle $plants^{-1}$; it was measured from ground level to the tip of the tallest panicle of the hill. The total number of tillers was counted from the randomly selected five hills and their mean was recorded as number of total tillers $hill^{-1}$. The produce of each net plot was threshed, cleaned and the grain and straw yield was recorded in kilogram net $plot^{-1}$. The grain and straw yield net $plot^{-1}$ obtained was converted to yield in quintals $hectare^{-1}$.

RESULTS AND DISCUSSION

The magnitude of significantly increase in growth and yield (fodder + seed) of lucerne recorded by treatment T_9 (2nd cutting than left for seed production + 50 per cent RD of phosphorus + PSB) was to the tune of 92.30 and 62.76 per cent over T_4 (1st cutting + RD of nitrogen and phosphorus); 72.25 and 50.83 over T_5 (1st cutting + 100 % RD of phosphorus) and 60.00 and 43.11 per cent over T_6 (1st cutting + 100% RD of phosphorus +PSB alone) during 2004-2005, 2005-2006 and in pooled data, respectively. Therefore, increase in yield with application of 2nd cutting then left for seed production + 50 per cent RD of phosphorus + PSB (T_9), 2nd cutting then left for seed production + 100 per cent RDF of phosphorus (T_8) and 2nd cutting then left for seed production + RD of nitrogen and phosphorus (T_7) along with *Rhizobium* and PSB may be due to improvement in yield attributes (Table 1a and 1b). The increase in yield under these treatments (T_9, T_8 and T_7) may be due to combined effect of RD of N and P, 100 per cent RD of P, *Rhizobium*, PSB with 50 per cent RD of P may be attributed to improve nitrogen and phosphorus nutrition and therefore, better root and shoot growth, more nodulation and higher nitrogen fixation and release of growth promoting substances by PSB. Significant improvement in seed and straw yields of gram with *Rhizobium* inoculation in the presence of phosphorus fertilizer were also observed by Sonboir and Sarawgi (2000) who had reported significant increase in yield attributes and seed yield due to application of N, P and bio-fertilizers. The same was also reported by Patel and Chauhan (2010).

The various yield attributes of rice *viz.*, number of panicles per hill, number of filled grains per panicle, test weight and eventually the grain yield per hill were increased significantly with successive increase in levels of fertilizer application except panicle length during both the years. This

Table 1(a) : Plant height and number of tillers per plant of lucerne at various growth stages as influenced by different nutrient management treatments

Treatments	Plant height (cm)				Numbers of tillers plant^{-1}			
	At 30 DAS		At 60 DAS		At 30 DAS		At 60 DAS	
	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06
T_1	35.28	37.19	53.89	56.34	69.80	76.87	88.20	95.71
T_2	37.53	39.56	57.15	58.46	73.40	82.44	94.75	101.23
T_3	38.22	40.58	57.45	59.68	75.30	84.49	95.60	101.91
T_4	39.76	41.75	58.00	60.50	75.80	84.81	95.90	102.46
T_5	40.14	42.39	59.15	62.20	76.70	85.35	96.85	103.74
T_6	40.38	42.68	60.25	62.95	78.50	87.65	97.80	104.28
T_7	41.06	43.76	61.37	65.25	80.60	88.76	101.30	107.48
T_8	42.12	44.81	63.22	66.76	82.30	92.53	105.20	112.68
T_9	43.84	46.52	64.80	68.15	88.80	95.41	110.7	116.81
S.E. $\pm$	1.18	1.29	1.55	1.82	2.36	2.51	2.76	3.25
C.D. (P=0.05)	3.43	3.77	4.52	5.31	6.87	7.32	8.05	9.49
C.V. %	5.90	6.13	5.20	5.84	6.04	5.80	5.60	6.18
G. M.	39.83	42.14	59.49	62.25	77.58	86.48	98.20	105.14

Table 1(b) : Plant height (cm) and total number of tillers hill-1 of rice at various growth stages as influenced by different treatments

Treatments	Total number of tillers hill^{-1}						Plant height (cm)					
	At 30 DAT		At 60 DAT		At harvest		At 30 DAT		At 60 DAT		At harvest	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Residual effect on nutrient management in succeeding rice												
T_1	8.13	9.17	14.43	15.47	14.01	17.56	63.44	65.56	81.30	88.15	106.72	119.12
T_2	8.21	9.26	14.60	15.66	14.18	17.99	64.42	65.87	81.83	90.35	107.07	122.4
T_3	8.31	9.31	14.78	15.83	14.91	18.32	64.55	66.03	82.12	90.56	107.30	122.76
T_4	8.37	9.37	14.93	15.97	15.36	18.57	64.73	65.82	84.70	90.69	107.51	123.19
T_5	8.53	9.53	15.03	16.07	15.69	18.90	65.32	66.78	82.96	90.89	107.68	123.55
T_6	8.72	9.72	15.12	16.83	16.55	19.36	65.53	66.98	83.46	91.19	107.84	123.83
T_7	8.87	9.92	15.21	16.91	17.35	19.5	65.75	67.13	84.88	91.42	109.05	124.10
T_8	8.99	10.06	15.32	17.02	17.80	19.69	66.24	67.67	85.54	93.27	110.03	127.87
T_9	9.22	10.31	15.40	17.10	18.44	20.49	67.10	68.33	87.39	95.22	116.00	130.60
T_{10}	8.07	9.09	14.36	15.39	13.50	17.33	62.95	65.04	80.50	87.28	103.42	119.06
S.E. $\pm$	0.18	0.25	0.23	0.26	0.39	0.57	1.13	1.24	1.42	1.46	2.13	1.99
C.D. (P=0.05)	0.52	0.72	0.68	0.48	1.14	1.64	NS	NS	4.13	4.22	6.19	5.77
CV %	7.32	8.96	5.49	5.18	8.66	10.44	6.03	6.44	5.91	5.55	6.83	5.57
Fertilizer levels												
F_1	7.35	8.38	13.81	14.81	14.10	16.55	60.64	62.97	78.91	85.07	101.24	118.58
F_2	8.48	9.51	14.87	15.87	15.96	18.84	65.74	66.94	83.39	91.47	108.92	123.59
F_3	9.79	10.83	16.08	18.00	17.28	20.92	68.62	69.66	88.11	96.18	114.63	128.78
S.E. $\pm$	0.09	0.14	0.12	0.13	0.21	0.10	0.71	0.77	0.84	0.86	1.02	1.04
C.D. (P=0.05)	0.27	0.41	0.34	0.38	0.60	0.29	2.003	2.18	2.37	2.44	2.90	2.93
CV %	6.14	8.30	4.43	4.47	7.37	3.04	5.97	6.34	5.51	5.19	5.18	4.59
Interaction												
S.E. $\pm$	0.26	0.39	0.33	0.29	0.58	0.29	1.94	2.11	2.30	2.36	2.81	2.84
C.D. (P=0.05)	NS	NS	NS	1.03	NS	0.81	NS	NS	NS	NS	NS	NS
CV %	6.14	8.30	4.430	4.47	7.37	3.04	5.97	6.34	5.51	5.19	5.18	4.59
G.M.	8.54	9.58	14.92	16.23	15.78	18.77	65.00	66.52	83.47	90.90	108.26	123.65

NS=Non-significant

was due to the significant improvement in growth characters of rice which favourably reflected on the yield attributes with increased levels of fertilizer application.

A perusal of data in Table 2 would evince that application of 100 per cent recommended level of fertilizers (120 kg N + 30 P_2O_5 ha^{-1}) (F_3) increased the grain yield of rice significantly over the 75 per cent recommended level of fertilizer (90 kg N + 22.5 kg P_2O_5 ha^{-1}) (F_2) and 50 per cent recommended level of fertilizer (60 kg N + 15 kg P_2O_5 ha^{-1}) (F_1) during both the seasons as well as when the data were pooled over seasons. Further, it was observed that the increase in grain yield of rice over the 50 per cent recommended level of fertilizer (F_1) was 13.22, 19.82 and 17.08 per cent with the application of F_3 (100 per cent of the recommended level of fertilizers) during 2005, 2006 and in pooled data, respectively. The increase in grain yield of rice with increasing levels of fertilizers was due to the significant improvement in yield attributes like number of panicles per hill, number of filled grains per panicle and grain yield per hill which finally resulted in increase in the grain yield, similar results were observed by Chavan (2003) with the application of 20 kg P ha^{-1} to preceding green gram over control and 10 kg P ha^{-1}.

Conclusion:

Application of 2nd cutting then left for seed production + 50 per cent RD of phosphorus + PSB (T_9) and 2nd cutting then left for seed production + 100 per cent RD of phosphorus (T_8) increased the yield (fodder and seed) per hectare of lucerne during both the years as well as in pooled analysis recorded almost identical, higher net realization and benefit cost ratio.

The yield attributes, namely, number of panicles per hill, panicle length, number of filled grains per panicle, test weight, biological yield and eventually grain and straw yields per hectare of succeeding rice with the application of 2nd cutting than left for seed production + 50 per cent RDF of phosphorus + PSB (T_9) to preceding lucerne recorded higher grain, straw and biological yields of succeeding rice than fallow (T_{10}) and rest of the treatments except the treatment T_8 (2nd cutting then left for seed production + 100 per cent RD of phosphorus)

Table 2 : Yield of lucerne and rice (Grain and Straw) as influenced by different treatments under lucerne-paddy cropping sequence

Treatments	Grain yield (q ha^{-1})			Straw yield (q ha^{-1})			Lucerne yield (q ha^{-1}) (Fodder +Seed)		
	2005	2006	Pooled	2005	2006	Pooled	2005	2006	Pooled
Residual effect on nutrient management in succeeding rice									
T_1	51.04	56.44	53.74	61.75	66.15	63.95	226.16	238.85	232.51
T_2	51.33	56.60	53.965	62.58	68.57	65.57	237.62	250.31	243.97
T_3	51.47	56.74	54.11	63.31	69.28	66.29	243.65	256.34	250.00
T_4	51.96	56.99	54.48	63.94	71.94	67.94	54.36	67.85	61.11
T_5	52.50	59.54	56.02	64.31	72.13	68.22	58.34	71.83	65.08
T_6	55.98	63.40	59.67	65.66	73.99	69.83	62.26	75.75	69.01
T_7	55.05	63.57	59.31	66.23	75.23	70.73	66.11	79.60	72.85
T_8	56.35	64.85	60.60	67.44	76.11	71.77	70.25	83.75	77.00
T_9	57.48	65.59	61.54	70.10	78.40	74.23	72.22	85.71	78.97
T_{10}	50.77	54.74	52.76	59.95	64.62	62.28			
S.E. ±	1.60	1.85	1.22	1.73	2.02	0.59	4.42	4.81	4.62
C.D. (P=0.05)	4.65	5.37	3.47	5.03	5.85	1.69	12.91	14.03	13.48
CV %	10.39	10.72	10.58	9.30	9.75	6.20	7.30	7.15	7.23
Fertilizer levels									
F_1	44.73	50.10	47.41	54.95	59.90	57.42			
F_2	54.56	59.33	56.94	66.71	74.50	70.57			
F_3	60.89	70.10	65.50	71.95	80.57	76.26			
S.E. ±	0.79	0.92	0.52	0.51	0.64	0.35			
C.D. (P=0.05)	2.24	2.59	1.47	1.44	1.82	0.99			
CV %	8.12	8.39	8.29	4.31	4.92	4.66			
Interaction									
S.E. ±	2.20	2.51	1.66	1.39	1.76	1.12			
C.D. (P=0.05)	NS	7.10	4.64	NS	4.98	3.14			
CV %	8.12	8.39	8.29	4.31	4.92	4.66			
G.M.	53.39	59.84	56.62	64.52	71.64	68.08	121.22	134.45	127.84

NS=Non-significant

during both the years as well as in pooled data during both the individual years of experimentation.

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