



Effect of crop rotation and fertility schedules in isabgol (*Plantago ovata* Forsk.) based cropping systems in hot arid region of Rajasthan

TANOJ CHOUDHARY*, S.K. SHARMA¹ AND R.K. SHIVRAN²
College of Agriculture, Rajasthan Agricultural University, BIKANER (RAJASTHAN) INDIA

Abstract : A field experiment was conducted to study the effect of crop rotation and fertility schedules in isabgol based cropping systems in loamy sand soil under irrigated conditions at Agronomy Farm, College of Agriculture, Rajasthan Agricultural University, Bikaner for two *Rabi* and *Kharif* seasons from 2003-04 and 2004-05. The results showed that a significant influence of crop rotation when mothbean was grown after isabgol found highest soil available nitrogen (77.72 kg ha⁻¹), phosphorus (14.30 kg ha⁻¹) and zinc (0.55 ppm) after harvest of *Kharif* crops, per cent organic carbon and available potassium were at par with the crops. Among four *Kharif* crops viz., pearl millet, clusterbean, sesamum and mothbean, highest yield of *Kharif* crops equivalent to isabgol (9.31 q ha⁻¹), cropping systems equivalent yields (19.75 q ha⁻¹), gross return (Rs. 33371 ha⁻¹), net return (Rs. 15225 ha⁻¹) and B:C ratio (1.94) were recorded in clusterbean growth after isabgol compared to other *Kharif* crops. Among seven fertility schedules (N, NP, NK, NPK, NPK+Zn, NPK+FYM and FYM) applied as per recommendation of concerned crop, treatment NPK+FYM was found superior among all in terms of per cent organic carbon (0.10), soil available nitrogen after harvest of each crop (79.62 kg ha⁻¹), phosphorus (15.27 kg ha⁻¹) and potassium (154.02 kg ha⁻¹), available zinc was found highest under NPK + Zn. Further highest yield of *Kharif* crops equivalent to isabgol (8.10 q ha⁻¹), cropping systems equivalent yields (21.51 q ha⁻¹) and gross return (Rs. 34541 ha⁻¹) were recorded under NPK+FYM, net return (Rs. 14247 ha⁻¹) and B:C ratio (1.88) were found highest under treatment NPK+Zn, but statistically at par to NPK+FYM.

Key Words : Crop rotation, Cropping systems, N, P, K, Zn, FYM, Isabgol, *Kharif*

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INTRODUCTION

Blond psyllium (*Plantago ovata* Forsk.), is one of the important medicinal plant and mainly grown in Jalore, Pali, Jodhpur and Bikaner districts of Rajasthan. This crop is mainly valued for mucilaginous rosy white husk, which is composed of reserved carbohydrates particularly pantosans and used in medicines.

India holds monopoly in the world trade of psyllium, more than 90 per cent of total Indian produce exported to all over the world. Cropping system research indicates inclusion of *Kharif* crop in monoculture of isabgol, keeping this in view, attention is now being paid to more productive agriculture

by growing isabgol with FYM followed by *Kharif* crops in sequence. Inclusion of clusterbean provides good monetary return, whereas, mothbean build up soil available nitrogen, phosphorus and zinc status. FYM along with recommended dose of NPK, provides highest yield and monetary return among all fertility combinations.

MATERIAL AND METHODS

The field experiment was conducted at Agronomy Farm, College of Agriculture, Rajasthan Agricultural University, Bikaner during *Rabi* and *Kharif* seasons of 2003-04 and 2004-05. The experiment consisted of four isabgol based

* Author for correspondence (Present Address) : ¹Dryland Farming Research Station (M.P.U. Ag. & Tech.), Arjia, BHILWARA (RAJASTHAN) INDIA
²Agricultural Research Station, Ummedganj, KOTA (RAJASTHAN) INDIA

Table A : Recommended dose of nutrients for different crops					
Nutrients	Isabgol	Pearlmillet	Mothbean	Sesamum	Cluster bean
N (Kg N ha ⁻¹)	40	80	20	40	20
P (Kg P ₂ O ₅ ha ⁻¹)	30	40	40	25	40
K (Kg K ₂ O ha ⁻¹)	20	20	20	20	20
Zn (Kg Zn ha ⁻¹)	5	5	5	5	5
FYM (t ha ⁻¹)	10	10	10	10	10

cropping systems (isabgol-pearl millet, isabgol-clusterbean, isabgol-sesamum and isabgol-mothbean) and seven nutrients schedules (N, NP, NK, NPK, NPK+Zn, NPK+FYM and FYM) was laid out in split plot design with three replications. Recommended doses of fertilizers were applied to *Rabi* and *Kharif* crops, accordingly (Table A).

The soil of the experimental site was very low in available nitrogen (67.74 kg ha⁻¹), phosphorus (14.85 kg ha⁻¹) and potassium (151.07 kg ha⁻¹) with 8.3 pH, 0.64 ppm available zinc and 0.08 per cent organic carbon. The gross and net plot sizes were 3.0 x 4.0 m and 2.2 x 3 m, respectively. After harvest of crops soil samples were taken treatment wise and analysed for organic carbon, available nitrogen, phosphorus, potassium and zinc. Gross and net monetary returns and cost of cultivation were worked out considering input and output prices of commodities prevailed during the corresponding year of experimentation. B:C ratio was calculated by gross return divided by total cost of cultivation. Yield of *Kharif* crops equivalent to isabgol were calculated by multiplying the yield of crop by the price of concerned crop and then divided by price of isabgol. Yearly cropping systems equivalents yields calculated by addition of isabgol (main crop) in to yield of *Kharif* crops equivalent to isabgol.

$$\text{Isabgol grain equivalent yield (qha}^{-1}\text{)} = \frac{\text{Yield of } Kharif \text{ crop (q)} \times \text{Price of crop (Rs. q}^{-1}\text{)}}{\text{Price of isabgol (Rs. q}^{-1}\text{)}}$$

$$\text{Cropping systems equivalent yield (qha}^{-1}\text{)} = \frac{\text{Yield of } Kharif \text{ crop (q)} \times \text{Price of crop (Rs. q}^{-1}\text{)}}{\text{Price of isabgol (Rs. q}^{-1}\text{)}} + \text{Isabgol crop yield (q ha}^{-1}\text{)}$$

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Effect of cropping system:

Significantly highest yield of *Kharif* crops equivalent to isabgol (9.31 q ha⁻¹) and cropping systems equivalent yield (19.75 q ha⁻¹) for both the years and on pooled basis was observed under clusterbean when grown after isabgol in *Rabi*

(Table 2). Isabgol-sesamum was next to this (6.54 and 16.97 q ha⁻¹) but superior to isabgol-mothbean (6.06 and 16.50 q ha⁻¹). Cropping system isabgol-pearl millet (5.44 and 15.88 q ha⁻¹) was poor among all.

Further nutrient status after harvest of *Kharif* crops significantly influenced by different crops (Table 3). Highest available nitrogen (77.72 kg ha⁻¹), phosphorus (14.30 kg ha⁻¹) and zinc (0.55 ppm) were measured in mothbean harvested plots and least available nitrogen (69.05 kg ha⁻¹), phosphorus (12.70 kg ha⁻¹) and zinc (0.50 ppm) measured after harvest of pearl millet, on both the years and pooled basis. Balyan and Seth (1989), Arya and Singh (2001) opined that, inclusion of legumes in cropping system improves nitrogen status of soil and helps in increasing the yield of succeeding cereal crops. Organic carbon (%) and available potassium does not significantly influenced by different crops.

Effect of fertility schedules:

Among seven fertility schedules NPK+FYM found significantly superior among all by producing yield of *Kharif* crops equivalent to isabgol (8.10 q ha⁻¹) and cropping systems equivalent yield (21.51 q ha⁻¹) for both the years and on pooled basis. Treatment NPK+Zn was found at par to NPK + FYM in terms of yield of *Kharif* crops equivalent to isabgol (8.01 q ha⁻¹), only nitrogen treatment recorded poor (5.19 q ha⁻¹) among all. Soil analysis after harvest of *Kharif* crops presented in Table 3 revealed that highest organic carbon (0.10%), available N (79.62 kg ha⁻¹), P (15.27 kg ha⁻¹) and K (154.02 kg ha⁻¹) were measured under treatment NPK+FYM. However highest available zinc (0.70 ppm) was measured under schedule NPK+Zn, treatment N was poor among all. This might be due to application of all major nutrients in balanced form along with FYM, which improves soil biological properties. These results are in close conformity with the results of Hedge (1998), and Antil and Singh (2007).

Interaction effect:

Interaction effect of cropping systems and fertility schedules on available N and P (Pooled) found significant (Table 4 and 5). Highest available N (83.53 kg ha⁻¹) on pooled basis was measured under isabgol-mothbean cropping system with the treatment NPK+FYM, isabgol-clusterbean was next lower (80.64 kg ha⁻¹), but significantly better than isabgol-sesamum cropping system (78.56 kg ha⁻¹). Isabgol-pearl

Table 1 : Effect of Isabgol based cropping systems and fertility schedules on organic carbon, equivalent yield to Isabgol (q/ha) and yearly total cropping system yield (q/ha)

Treatments	Yield of <i>Kharif</i> crops equivalent to Isabgol (q ha ⁻¹)				Cropping systems equivalent yields (q ha ⁻¹)				Gross return (Rs. ha ⁻¹)				Net return (Rs ha ⁻¹)				B:C ratio				
	2004	2005	Pooled	2004	2005	Pooled	2004	2005	Pooled	2004	2005	Pooled	2004	2005	Pooled	2004	2005	Pooled	2004	2005	Pooled
Cropping systems																					
Isabgol-Pearlmillet	5.54	5.35	5.44	15.92	15.83	15.88	26454	26174	26314	8122	7541	7831	1.51	1.47	1.49						
Isabgol-Clusterbean	9.90	8.74	9.31	20.28	19.22	19.75	33970	32772	33371	15974	14476	15225	1.99	1.89	1.94						
Isabgol-Sesamum	7.00	6.08	6.54	17.38	16.56	16.97	26221	25095	25657	8202	6776	7489	1.52	1.43	1.47						
Isabgol-Mothbean	6.70	5.44	6.06	17.08	15.92	16.50	26900	25298	26099	9262	7359	8311	1.61	1.44	1.53						
S.E. \pm	0.06	0.11	0.06	0.06	0.11	0.07	544	233	296	544	233	296	-	-	-						
C.D. (P=0.05)	0.24	0.40	0.20	0.24	0.40	0.20	1881	807	911	1881	807	911	-	-	-						
Fertility schedules																					
N	5.74	4.66	5.19	13.40	11.89	12.64	21560	19349	20454	5335	2823	4079	1.33	1.16	1.25						
NP	7.18	6.26	6.71	16.51	15.65	16.08	26570	25441	26006	9305	7876	8591	1.60	1.49	1.54						
NK	6.34	5.38	5.85	14.87	13.81	14.33	24192	22410	23301	7666	5584	6625	1.48	1.33	1.41						
NPk	7.39	6.63	7.00	19.11	17.96	18.53	30555	28983	29769	12977	11105	12041	1.82	1.68	1.75						
NPk+Zn	8.45	7.58	8.01	20.93	20.25	20.59	33525	32803	33164	14758	13736	14247	1.93	1.84	1.88						
NPk+FYM	8.39	7.82	8.10	21.38	21.65	21.51	34206	34876	34541	13547	13978	13732	1.87	1.86	1.86						
FYM	7.51	6.51	7.01	17.47	16.99	17.23	28097	27481	27789	9141	8226	8684	1.59	1.52	1.56						
S.E. \pm	0.21	0.18	0.14	0.28	0.33	0.14	705	510	435	705	510	435	-	-	-						
C.D. (P=0.05)	0.61	0.51	0.39	0.30	0.94	0.40	2005	1451	1221	2005	1451	1221	-	-	-						

Table 2 : Effect of Isabgol based cropping systems and fertility schedules on available nitrogen, available phosphorus available potassium and available zinc after harvest of *Kharif* crops

Treatments	Organic carbon (%)				Available nitrogen (kg ha ⁻¹)				Available phosphorus (kg ha ⁻¹)				Available potassium (kg ha ⁻¹)				Available zinc (ppm)				
	2004	2005	Pooled	2004	2005	Pooled	2004	2005	Pooled	2004	2005	Pooled	2004	2005	Pooled	2004	2005	Pooled	2004	2005	Pooled
Cropping systems																					
Isabgol-Pearlmillet	0.0898	0.0902	0.0900	68.35	69.76	69.05	12.75	12.65	12.70	150.98	151.42	151.00	0.49	0.52	0.50						
Isabgol-Clusterbean	0.0899	0.0890	0.0895	73.08	74.80	73.94	13.36	14.40	13.88	152.08	151.70	151.89	0.53	0.53	0.53						
Isabgol-Sesamum	0.0894	0.0891	0.0893	71.48	72.64	72.06	13.07	13.85	13.46	152.33	153.39	152.86	0.53	0.53	0.53						
Isabgol-Mothbean	0.0890	0.0890	0.0890	76.65	78.78	77.72	13.93	14.67	14.30	152.34	152.77	152.55	0.55	0.56	0.55						
S.E. \pm	0.0004	0.0005	0.0003	0.41	0.87	0.48	0.22	0.33	0.20	2.33	2.19	1.60	0.01	0.006	0.006						
C.D. (P=0.05)	NS	NS	NS	1.42	3.02	1.49	0.76	1.17	0.52	NS	NS	NS	0.03	0.02	0.01						
Fertility schedules																					
N	0.0830	0.0820	0.0825	68.72	79.66	69.19	11.97	12.12	12.04	148.96	149.34	149.15	0.45	0.44	0.44						
NP	0.0828	0.0818	0.0823	69.75	71.56	70.66	12.91	13.53	13.22	150.00	150.55	150.27	0.48	0.45	0.46						
NK	0.0827	0.0814	0.0820	70.19	71.50	70.84	12.67	13.01	12.84	152.18	152.51	152.34	0.48	0.47	0.47						
NPk	0.0830	0.0821	0.0825	72.60	74.16	73.38	13.48	14.23	13.86	152.98	152.97	152.97	0.50	0.50	0.50						
NPk+Zn	0.0825	0.0812	0.0818	72.82	73.87	73.35	13.97	14.74	14.86	152.97	153.53	153.25	0.68	0.73	0.70						
NPk+FYM	0.1063	0.1083	0.1073	78.32	80.92	79.62	14.73	15.80	15.27	153.51	154.53	154.02	0.57	0.60	0.58						
FYM	0.1064	0.1086	0.1075	74.32	76.31	75.31	13.20	13.83	13.52	152.92	152.81	152.86	0.53	0.56	0.55						
S.E. \pm	0.0008	0.0008	0.0006	0.50	0.38	0.31	0.13	0.17	0.11	0.95	0.93	0.66	0.007	0.004	0.004						
C.D. (P=0.05)	0.002	0.002	0.002	1.43	1.08	0.88	0.39	0.50	0.31	2.72	2.64	1.87	0.018	0.010	0.011						

Table 3 : Combined effect of cropping systems and fertility schedules on available nitrogen (kg ha⁻¹) after harvest of Kharif crops (Pooled)

Treatments	Isabgol - Pearlmillet	Isabgol - Clusterbean	Isabgol - Sesamum	Isabgol - Mothbean	Mean
N	65.43	69.54	69.39	72.40	69.19
NP	65.50	70.97	69.54	76.62	70.66
NK	66.51	70.94	68.99	76.94	70.84
NPK	69.82	73.68	71.80	78.22	73.38
NPK+Zn	69.85	73.47	71.58	78.50	73.35
NPK+ FYM	75.75	80.64	78.56	83.53	79.62
FYM	70.51	78.37	74.57	77.81	75.31
Mean	69.05	73.94	72.06	77.72	
				S.E. ±	C.D. (P=0.05)
Crop at same level and nutrient at different level				0.63	1.77
Crop at different level and nutrient at same level				0.59	1.72

Table 4 : Combined effect of cropping systems and fertility schedules on available phosphorus (kg ha⁻¹) after harvest of Kharif crops (Pooled)

Treatments	Isabgol - Pearlmillet	Isabgol - Clusterbean	Isabgol - Sesamum	Isabgol - Mothbean	Mean
N	10.83	12.12	12.28	12.94	12.04
NP	12.12	13.89	12.95	13.93	13.22
NK	12.11	13.24	12.44	13.57	12.84
NPK	13.39	14.16	13.44	14.44	13.86
NPK+ Zn	13.71	14.77	14.16	14.79	14.36
NPK+FYM	14.60	15.55	15.08	15.84	15.27
FYM	12.13	13.45	13.89	14.60	13.52
Mean	88.89	97.17	94.24	100.11	
				S.E. ±	C.D. (P=0.05)
Crop at same level and nutrient at different level				0.23	0.63
Crop at different level and nutrient at same level				0.24	0.69

millet was significantly lower among all (75.75 kg ha⁻¹). Under treatment FYM highest residual N (77.81 kg ha⁻¹) was recorded from mothbean harvested plots, but statistically at par to clusterbean (78.37 kg ha⁻¹). Isabgol-pearl millet cropping system measured least available N (70.51 kg ha⁻¹). Sesamum harvested plots revealed higher available N (74.57 kg ha⁻¹) than pearl millet. Only N applied treatment along with pearl millet crop poor among all in residual N. Cropping system isabgol-mothbean revealed highest available P under NPK+FYM (15.84 kg ha⁻¹), which was statistically at par to isabgol-clusterbean (15.55 kg ha⁻¹) and significantly better over isabgol-sesamum (15.08 kg ha⁻¹) and isabgol-pearl millet (14.60 kg ha⁻¹). Under treatment FYM, isabgol-sesamum (13.89 kg ha⁻¹) and isabgol-clusterbean (13.45 kg ha⁻¹) were non-significantly different but isabgol-mothbean (14.60 kg ha⁻¹) was higher among all in terms of available P after harvest of Kharif crops. Isabgol-pearl millet was poor among all (12.13 kg ha⁻¹). All isabgol-based cropping systems were poor when only N applied to all crops as treatment. Improvement in available nutrients when recommended doses of fertilizer applied with organic manures improves soil biological activities, and some part of nutrient involve in this, this finding also in close conformity with Repsiene

(2001) and Bharti (2002).

Economics:

Highest gross return (Rs. 33371), net return (Rs. 15225) and B:C ratio (1.94) were observed when clusterbean grown after isabgol. Further under fertility schedules highest net return (Rs. 14247) and B:C ratio (1.88) were observed under treatment NPK+FYM. Isabgol-clusterbean cropping system along with NPK+FYM found significantly superior over all other cropping systems and fertility schedules.

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