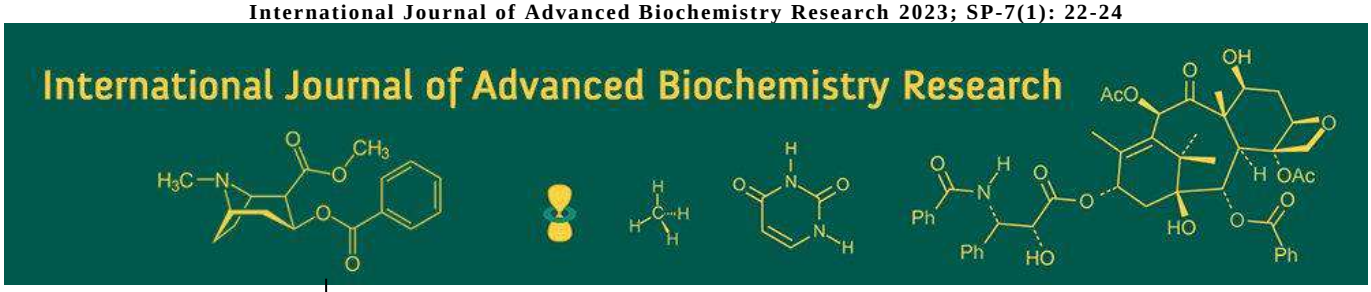

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Growth and yield of chickpea (*Cicer arietinum* L.) as Influenced by seed rate and level of phosphorus

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Abstract
A field investigation was conducted at Agronomy research farm A. S. (P.G) College, Lakhaoti, Bulandshahr during rabi seasons of 2006 and 2007. The treatments consisted of combination of four cropping systems *viz*. chickpea sole (M1), linseed sole (M2), chickpea+ linseed 2:1 ratio (M3) and pigeonpea + linseed 4:2 ratio (M4) in main plots; two irrigations *viz*. two irrigations at vegetative stages (30-40 days) and flowering stage (70-75 days) (S1) and one irrigation at flowering stage (70-75 days) (S2) in sub plots and three levels of phosphorous *viz*. control (L1), 30 kg P_2O_5/ha (L2) and 60 kg P_2O_5/ha (L3) in sub-sub plots in split plots design replicated thrice during the rabi season. The chickpea variety BG-362 and linseed variety neelam were used in the cropping systems during rabi season. The soil of the experimental site was low in organic carbon (0.47 and 0.48 kg/ha) and total nitrogen (154.0 and 155.1 kg/ha). It was low in available phosphorus (9.2 and 9.24 kg/ha) and medium in available potassium (203.0 and 203.6 kg/ha) and sandy loam in texture having alkaline reaction (pH 7.5). The weather during the both years of the experiment was by and large normal and devoid of any extreme conditions. The net return was found to be maximum under chickpea: linseed in 4:2 row ratio with two irrigations and 60 kg P_2O_5/ha. (Rs. 21,632 and Rs. 22,128) followed by sole chickpea with two irrigation and 60 kg P_2O_5/ha. Due to relatively higher gross return. The maximum B:C ratio of 1.87 and 1.91 was obtained from chickpea: linseed in 4:2 with one irrigation at flowering and 60 kg P_2O_5/ha, because of reduced cost of on irrigation and higher gross return of the system.

Keywords: Cropping system, irrigation, levels of phosphorous, chickpea

Introduction
Chickpea (*Cicer arietinum* L.) is the most important crop amongst the rabi pulses. Its contribution to the total pulses production in the country is 33 percent. The area under chickpea in India is 6.1 million hectare with the production of 5.27 million tonnes at an average productivity of 717 kg/ha (G0I, 2008). Area under chickpea (*Cicer arietinum* L.) in U.P. is 0.87 million hectare, production is 0.78 million tonne and average yield is 896 kg/ha. Among various pulses grown in India, chickpea occupies major place. It is mainly cultivated in the states of Rajasthan, UP., M.P., Haryana, Maharashtra and Punjab. Moreover, presently area under chickpea has been decreasing on account of stiff competition from high productive crops like cereals, secondly, chickpea is predominantly grown under rainfed areas where due to low rainfall, area again has decreased. In spite of the importance of pulses in our daily diet, their production has not been increased proportionately to the cereal production. As a result their availability has declined from 64 g/capita/day during 1950-1951 to less than 40 g/capita/day. The main reasons for low productivity are non-adoption of improved agronomic practices comprising timely sowing, optimum, plant population, application, of fertilizers, protective irrigation, weed management and adequate plant protection measures.

Inter cropping is an agronomic refinement of the old practice of crop mixture, where in the crop components, usually two are sown in separate rows, their population ratios are known and they can be harvested singly and produce recorded separately. The crop components often have. Different growth period and growth habits, statistical analysis and interpretation of the total and individual products is, thus, possible and valid, for drawing conclusion of the propriety or otherwise of the system in a given region. Among various measures adopted for improving the productivity of oil seed crops, one technique may be to grow these crops with legumes. It has been observed that intercropping of oil seed with cereals, pulses and fibers is one of the best techniques to increase production. Phosphorus is the most vital

Plant nutrient, which contributes directly to both yield and quality of chickpea. It plays an important role to various physiological processes. Moreover, it is constituent of ADP, ATP, nucleic acids and nucleo proteins and several co-enzymes, which are of great importance in energy transformation and metabolic activities of the plant. Phosphorus deficiency is usually the key factor for poor yield of pulses on most of the soils. In absence of inadequate supply of phosphorus sometimes, other nutrient elements also become ineffective for plant use. A good supply of phosphorus to the plants helps in better root development and hastens maturity. Optimum levels of phosphorus increases growth, nodulation and nitrogen fixation in legumes (Ahlawat, 1976) [1]. However, there is a considerable variation in its requirement, which need careful study before making any recommendation for getting economical yield.

Materials and Methods

A field investigation was conducted at Agronomy research farm A. S. (P.G) College, Lakhaoti, Bulandshahr during rabi seasons of 2006 and 2007 to study 'Growth and yield performance of chickpea as influenced by chickpea (Cicer arietinum L.) + linseed (*Linum usitatissimum*.) cropping system, irrigation and phosphorous. The treatments consisted of combination of four cropping systems *viz*. chickpea sole (M1), linseed sole (M2), chickpea+ linseed 2: 1 ratio (M3) and chickpea + linseed 4:2 ratio (M4) in main plots; two irrigations *viz*. two irrigations at vegetative stages (30-40 days and flowering stage (70-75 days) (S1) and one irrigation at flowering stage (70-75 days) (S2) in sub plots and three levels of phosphorous *viz*. control (L1), 30 kg P_2O_5/ha (L2) and 60 kg P_2O_5/ha (L3) in sub-sub plots in split plots design replicated thrice during the rabi season. The chickpea variety BG-362 and linseed variety neelam were used in the cropping systems during rabi season. The soil of the experimental site was low in organic carbon (0.47 and 0.48 kg/ha) and total nitrogen (154.0 and 155.1 kg/ha). It was low in available phosphorus (9.2 and 9.24 kg/ha) and medium in available potassium (203.0 and 203.6 kg/ha) and sandy loam in texture having alkaline reaction (pH 7.5). The weather during the both years of the experiment was by and large normal and devoid of any extreme conditions. The experiment was conducted as per the standard procedures and all the pre and post-harvest observations were recorded and analyzed as per the prescribed statistical procedures. The experimental data pertaining to each character were subjected to statistical analysis by using the technique of analysis of variance (ANOVA) and their significance was tested by "F" test. Standard error of means (SEm+) and least significant difference (LSD) at 0.05 probabilities were worked out for each character studied to evaluate differences between treatment means.

Table 1: Protein content and protein yield of chickpea as influenced by cropping systems, irrigation and phosphorus levels

Cropping systems	Protein content (%)		Oil yield kg/ha)	
	2006-07	2007-08	2006-07	2007-08
Sole chickpea	21.59	21.73	374.56	388.11
Chickpea + Linseed (2:1)	21.83	21.95	274.61	281.85
Chickpea + Linseed (4:2)	21.99	22.09	298.72	308.12
SEm±	0.12	0.14	1.73	1.73
CD at 5%	NS	NS	5.46	5.44
Irrigation				
Vegetative + Flowering	21.86	21.99	329.52	340.31
Stage				
Flowering stage	21.75	21.86	302.40	311.74
SEm±	0.10	0.11	1.42	1.41
CD at 5%	NS	NS	4.46	4.44
Phosphorus levels				
(kg/ha)				
Control	21.53	21.66	267.70	276.31
30 kg P_2O_5/ha	21.90	21.97	327.51	337.68
60 kg P_2O_5/ha	21.99	22.15	352.68	364.09
SEm±	0.19	0.27	3.79	4.92
CD at 5%	NS	NS	11.06	14.37

Competition assessment as influenced by cropping systems, irrigation and phosphorus levels

Treatments	LER		Aggressivity		RCC (Chickpea)		RCC (Linseed)		CR	
	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08
Cropping Systems										
Sole chickpea	1.000	1.000								
Chickpea + Linseed (2:1)	1.178	1.169	-0.088	-0.088	2.684	2.617	0.824	0.815	0.805	0.805
Chickpea + Linseed (4:2)	1.203	1.200	-0.015	-0.013	3.673	3.732	0.726	0.719	0.933	0.939
Irrigation										
Vegetative + Flowering stage	1.128	1.123	-0.026	-0.025	2.237	2.270	0.496	0.486	0.601	0.607
Flowering stage	1.126	1.124	-0.042	-0.043	2.001	1.963	0.537	0.537	0.558	0.556
Phosphorus levels (kg/ha)										
Control	1.134	1.138	-0.034	-0.032	2.203	2.377	0.526	0.522	0.581	0.590
30 kg P_2O_5/ha	1.119	1.118	-0.033	-0.030	2.005	2.062	0.507	0.496	0.579	0.590
60 kg P_2O_5/ha	1.128	1.113	-0.035	-0.040	2.150	1.910	0.517	0.516	0.578	0.563

Economics of combination of cropping systems, irrigation and phosphorus

Treatments	Total cost	Net return (Rs/ha)		B:C ratio	
	(Rs/ha)	2006-07	2007-08	2006-07	2007-08
C $l_{VF}P_0$	10500	13308	13900	1.27	1.32
C $l_{VF}P_{30}$	11130	18790	19366	1.69	1.74
C lv_FP_{60}	11760	20416	21840	1.74	1.86
C l_FP_0	9250	14270	14606	1.54	1.58
C l_FP_{30}	9880	17800	18632	1.80	1.89
C l_FP_{60}	10510	18722	19890	1.78	1.89
L $l_{VF}P_0$	9500	9045	9409	0.95	0.99
L $l_{VF}P_{30}$	10130	10394	11252	1.03	1.11
L $l_{VF}P_{60}$	10760	10040	10782	0.93	1.00
L l_FP_0	8250	7052	7314	0.85	0.89
L l_FP_{30}	8880	9011	9287	1.01	1.05
L l_FP_{60}	9510	8817	8934	0.93	0.94
C_2 L_1 lv_FP_0	11000	15416	15599	1.40	1.42
C_2 L_1 lv_FP_{30}	11630	19659	20550	1.69	1.77
C_2 L_1 lv_FP_{60}	12260	19961	20739	1.63	1.69
C_2 L_1 l_FP_0	9750	14593	15297	1.50	1.57
C_2 L_1 l_FP_{30}	10380	17083	17525	1.65	1.69
C_2 L_1 l_FP_{60}	11010	18095	18378	1.64	1.67
C_4 L_2 lv_FP_0	11000	15905	17208	1.45	1.56
C_4 L_2 lv_FP_{30}	11630	19870	20419	1.71	1.76
C_4L_2 lv_FP_{60}	12260	21632	22128	1.76	1.80
C_4 L_2 l_FP_0	9750	14342	14720	1.47	1.51
C_4 L_2 l_FP_{30}	10380	18602	19773	1.79	1.90
C_4 L_2 l_FP_{60}	11010	20580	20987	1.87	1.91

Discussion

The competition indices *viz* LER, RCC and CR were higher in chickpea: linseed in 4:2 row ratio as compared to 2:1 row ratio in cropping system. These indices were also higher in 2: 1 row ratio than sole crop of chickpea and linseed. The better utilization of resources (space, nutrients and moisture) by the crops under cropping system resulted in higher values of these indices in these systems. On the contrary aggressivity was decreased under cropping system. Row ratio of 2:1 (chickpea: linseed) recorded the highest reduction as compared to row ratio 4:2 in the present investigation.

Chickpea + linseed intercropping at 2:1 and 4:2 row ratio were suitable in terms of chickpea equivalent yield. These systems produced higher yield equivalent and proved more advantageous than pure stands of either of crops. Irrigation at vegetative and flowering stage gave higher equivalent yield compared to one irrigation at flowering stage. The highest chickpea equivalent was achieved with the application of 60 kg P2O5/ha. This is in agreement with the findings of Prasad *et al*. (2003) [2].

The acceptance of any cultivation practice depends largely on the comparative monetary return of the new practice over the established one. However, other factors such as the cost of the treatments, easy application and the effect on the yield of the crop, need also to be taken into account while, making any conclusion regarding the merit of a treatment.

In the present investigation sole linseed with one irrigation and no phosphorus application resulted in minimum net return because of lower yield of the compared to two irrigations and phosphorus application under cropping systems. The net return was found to be maximum under chickpea: linseed in 4:2 row ratio with two irrigations and 60 kg P2O5/ha. (Rs. 21,632 and Rs. 22,128) followed by sole chickpea with two irrigation and 60 kg P2O5/ha. Due to relatively higher gross return. The maximum B: C ratio of 1.87 and 1.91 was obtained from chickpea: linseed in 4:2 with one irrigation at flowering and 60 kg P2O5/ha, because of reduced cost of on irrigation and higher gross return of the system. Similar results were also reported by Prasad *et al*. (2003) [2], Sharma *et al*. (2003) [4] and Rana and Pachauri (2006) [3]

Conclusion

In recent decades, several studies have revealated tha one irrigation and phosphorus level in resulted in maximum returns.

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