Influence on Intercropped Cajanus Cajan Caused By Land Configuration, Post-Monsoon Irrigation, and P Fertilization

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Abstract*: An on-field examination was performed at the Experimental Farm of Annamalai University during the rainy season of 2016. The main aim of the study was to assess the impact of the various factors on performance of pigeon-pea yield. In this experiment, the Cajanus cajan (L.) Millsp. [pigeon-pea] is the sole grown variety and intercropped with urdbean [Vigna mungo (L.) Hepper]. The two methods of planting are the broad-bed and furrow planting. At an irrigation of 0.4 IW: CPE ratio during post-monsoon period showed improved yield in case of pigeon pea. However, taking into consideration the flat bed planting with no irrigation, also showed similar increase in yield by 10%. The intercropping technique used for pigeon-pea with urdbean had no impact on the yield of pigeon-pea; however the yield increased in case of the additional urdbean, which eventually increased the total production rate of the pigeon-pea yield. The pigeon-pea yield increased up to 40 kg P_2O_5/ha, whereas the total productivity of pigeon-pea increased with the increased rates of Phosphorus up to 80 kg P_2O_5/ha.

***Index Terms*: Land configuration, Intercropping, Phosphorus, Pigeonpea, Post-monsoon irrigation, Urdbean**

I. INTRODUCTION

India, the largest global producer of pigeonpea with 3.53 million ha of area and 2.31 million tonnes of production in 2003-04, has the lowest productivity (653 kg/ha), occupying a dismal 9th place at world level. The low productivity has been largely attributed to nutrient, moisture and biotic stresses. Among the nutrients, phosphorus is most limiting in soils where pigeonpea is mainly grown [1]. Hence responses to P fertilization have been highly rewarding. Further, the short-duration pigeonpea cultivars bred for pigeonpea-wheat cropping system are more susceptible to water logging [2], especially in early stages of crop growth. Waterlogging conditions hamper nodula-tion, enhance *Phytophthora* blight and root-rot incidence often leading to complete crop failure. Desai et al. [3] advocated with an intention to solve the problems related to water logging and modified land configuration (broad-bed and furrow). With about 5% total area under irrigation, the crop is also exposed to moisture stress at reproductive stage, hence post-monsoon irrigation has been recommended [4]. The intercropping technique has been used for the short-term legumes like mungbean [*Vigna radiata* (L.) wilczek] and urdbean in order to stabilize and enhance the yielding ability of pigeon pea. However, the information on the effect of land configuration, post-monsoon irrigation and P fertilization on pigeonpea intercropped situations are lacking. Keeping this in view the present investigation was undertaken.

II. MATERIALS AND METHODS

A field experiment was conducted during the rainy season 2016 at Experimental Farm, Annamalai University. The soil was sandy loam with pH 8.1, having low organic carbon (0.39%), total N (0.0186), available P (8.2 kg/ha) and K (180.2 kg/ha). The initial analysis of the soil revealed that the water content in soil at field capacity, permanent wilting point, and bulk density at the respective depths, i.e. 0-30, 30-60 and 60-90 cm depths, were recorded as 18.9, 19.3 and 19.4%;
6.5, 6.7, and 6.8%; and 1.52, 1.56 and 1.57 g/cc, respectively. The treatments consisted of 2 land configurations (flat and broad-bed and furrow system), 2 levels of irrigation (unirrigated and post-monsoon irrigation at 0.4 IW : CPE ratio) and 2 cropping systems (sole pigeonpea and pigeonpea + urdbean intercropping in 1:1 row ratio) as main plots and 3 phosphorus levels (0,40 and 80 kg P_2O_5/ha) as sub-plots replicated thrice in split-plot design. A seed rate of 15 kg/ha was used for both pigeonpea ('UPAS 120') and urdbean ('T 9'). A spacing of 60 cm × 25 cm was adopted for pigeonpea and between 2 rows of pigeonpea; a row of urdbean was sown. The crops were sown on 12 July in 2001 and 25 June in 2002. Broad-beds of 150 cm width with a furrow of 30 cm between beds were made, and 3 rows of pigeonpea and 2 rows of urdbean were planted on each bed. Based on 0.4 IW : CPE ratio, pigeonpea received 1 irrigation only on 10 November in 2001 and 24 October in 2002. Urdbean was harvested earlier than this irrigation on 24 September in 2001 and 20 September in 2002, while pigeonpea was harvested on 3 December in 2001 and 30 November in 2002. Phosphorus through single superphosphate as per the treatments along with a common dose of 20 kg N /ha as urea was applied before sowing of the crops. The amount of sulphur applied through single superphosphate was balanced in each plot through elemental sulphur.

III. RESULTS AND DISCUSSION

A. Pigeonpea

As per the findings of the

Revised Manuscript Received on May 22, 2019.

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study, factors like land configuration, post-monsoon irrigation and P fertilization showed significant impact on the growth and yield attributes of pigeon-pea along with its overall productivity over the seasons (Table 1). At the 0.4 IW:CPE ratio along with the Pigeon-pea plantation in broad-bed and furrow system with post-monsoon irrigation type, the plants were found to be taller with increased quantity of pods/plants and seeds/pod compared to the flat system and un-irrigated type of plantation technique. The improvement in yield attributes in pigeonpea in both broad-bed and furrow planting and post-monsoon irrigation led to a similar increase of 10% in grain yield. Maintenance of favourable moisture and avoidance of waterlogging were the principal reasons for better performance of pigeonpea under these treatments. Similar effects of modified land configuration [3] and post-monsoon irrigation have also been reported [4]. Hence, there was no impact recorded in the performance or productivity of pigeon-pea due to the changes in the cropping system. Urdbean, having diverse growth features compared to pigeon-pea, did not show any positive results in this competitive analysis.

Phosphorus fertilization at 40 kg P_2O_5 /ha being at par with 80 kg P_2O_5/ha increased plant height, pods/plant and seeds/pod over unfertilized pigeonpea. The improvement in growth (plant height) and yield attributes finally led to increased grain and stalk yields. Application of 40 kg P_2O_5/ha increased the grain yield by 20.6% over no phosphorus. The optimum dose of P was 59.8 kg P_2O_5/ha for sole pigeonpea and 61.2 kg P_2O_5/ha for pigeonpea in intercropping system. The favourable effects of P fertilization on root growth and nodulation might have resulted in improved growth and development of higher yield attributes and yield. Jat and Ahlawat [4] also reported similar effects of P in pigeonpea.

B. Urdbean

The land configuration did not affect the grain yield of urdbean. However, broad-bed and furrow system of planting recorded more haulm yield than flat-planted urdbean, probably because of relatively better growth of plants. Further, P fertilization significantly increased plant height, grains/pod and grain yield up to 40 kg P_2O_5/ha, whereas pods/plant and haulm yield increased up to 80 kg P_2O_5/ha (Table 2).

C. Total productivity

In regard to the pigeon-pea equivalent yield, the total productivity was found to be higher in case of the broad-bed and furrow planting system compared to the flat plantation system (Table 3). Similarly, pigeonpea receiving post-monsoon irrigation recorded higher PEY over unirrigated crop. Over the seasons, pigeonpea + urdbean intercropping system gave 6.2% higher PEY over sole pigeonpea. This could be attributed to additional urdbean yield without any effect of intercropping on yield of pigeonpea. Phosphorus application markedly increased the PEY up to 40 kg P_2O_5/ha only.

D. Phosphorus uptake and water-use functions

Phosphorus uptake by individual crops and system were significantly more in broad-bed and furrow system of planting, post-monsoon irrigation at 0.4 IW:CPE ratio and 40 kg P_2O_5/ha over flat planted, unirrigated and unfertilized crop respectively. The consumptive use and water-use efficiency also followed the similar trend to that of P uptake. An increase in water-use efficiency due to P fertilization and modified land configuration has also been reported [4], [5].

Table 1. Effect of land configuration, post-monsoon irrigation and phosphorus on growth, yield attributes and yield of pigeonpea

Treatment	Plant height (cm)	Pods/ plant	Grains/pod	1,000-grain weight (g)	Yield (q/ha)	
					Grain	Stalk
Land configuration						
Flat sown	146.2	151.5	3.3	68.7	14.9	69.5
Broad-bed and furrow sown	154.2	162.2	3.6	70.3	16.4	77.1
CD (P=0.05)	7.6	8.0	0.2	NS	1.0	5.2
Post-monsoon-irrigation (IW: CPE ratio)						
0	144.4	150.0	3.2	68.6	14.9	69.9
0.4	156.0	163.8	3.6	70.3	16.4	76.7
CD (P=0.05)	7.6	8.0	0.2	NS	1.0	5.2
Cropping system						
Sole pigeonpea	148.6	159.9	3.5	70.1	16.1	75.6
Pigeonpea + urdbean	151.8	153.8	3.9	68.9	15.2	71.0
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Phosphorus level (kg Pf)Jha)						
0	144.0	148.8	3.0	67.3	13.6	63.8
40	152.2	160.0	3.6	70.4	16.4	76.6

80	154.5	161.9	3.7	70.9	17.0	79.5
CD (P=0.05)	4.8	7.6	0.2	NS	0.7	3.8

Table 2. Effect of land configuration and phosphorus or growth, yield attributes, and yield of urdbean

Treatment	Plant height (cm)	Pods/ plant	Grains/ pod	1,000-grain weight (g)	Yield (q/ha)	
					Grain	Haulm
Land configuration						
Flat sown	48.3	14.9	4.6	35.4	1.88	8.29
Broad-bed and furrow sown	51.1	15.9	4.8	36.0	2.03	9.08
CD (P=0.05)	NS	0.9	NS	NS	NS	0.69
Phosphorus (kg Pfi/ha)						
0	46.2	14.3	4.4	34.6	1.57	7.02
40	50.9	15.6	4.8	36.1	2.07	9.17
80	51.9	16.3	4.9	36.4	2.22	9.87
CD (P=0.05)	2.6	0.7	0.5	NS	0.23	0.60

Table 3. Effect of land configuration, post-monsoon irrigation, cropping system and phosphorus on pigeon-pea equivalent yield (PEY), P uptake, consumptive use (CU) and water-use efficiency

I. Treatment	PEY (q/ha)	P uptake (kg/ha)			CU (mm)	WUE (kg/ha-mm)
		Pigeonpea	Urdbean	Total		
Land configuration						
Flat sown	15.80	12.71	1.52	14.23	240.4	6.57
Broad-bed and furrow sown	17.48	14.38	1.74	16.12	251.2	7.06
CD (P=0.05)	0.96	0.97	0.21	1.20		
Post-monsoon irrigation (IW: CPE ratio)						
0	15.93	13.92		13.92	239.3	6.80
0.4	17.36	13.18	1.63	14.82	252.3	6.83
CD (P=0.05)	0.96	NS		NS		
Cropping system					.	
Sole pigeonpea	16.14	12.75	1.64	14.39	230.4	6.94
Pigeonpea+ urdbean	17.14	14.34	1.63	15.97	261.4	6.69
CD (P=0.05)	0.96	NS		1.20		
Phosphorus (kg P_2OJha)						
0	14.37	11.40	1.22	12.62	231.2	6.30
40	17.41	14.28	1.78	16.06	250.4	7.00
80	18.15	14.95	1.91	16.86	255.8	7.14
CD (P=0.05)	0.65	0.69	0.17	0.90		

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