Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(6): 525-527
Received: 21-09-2018
Accepted: 24-10-2018

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Effect of intercropping systems on pigeon pea equivalent yield under different land configuration

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Abstract
A field experiment was conducted at experimental farm of AICRP for dryland Agriculture, V.N.M.K.V., Parbhani to study the effect of different intercropping systems on pigeonpea equivalent yield under various land configurations entitled "Performance of different land configuration under pigeonpea based intercropping systems" It was observed that pigeonpea equivalent yield were significantly affected due to different intercropping systems. Pigeonpea+greengram intercropping system (I_2) tended to give the highest pigeonpea seed eqivalent yield (1832 Kg ha^{-1}). Among different land configiration highest pigeonpea equivalent yield recorded by broad bed (1823 Kg ha^{-1}) furrow followed by ridges and furrow (11759 Kg ha^{-1}) and lowest recorded in flat bed sowing (1416 Kg ha^{-1}). The gross monetary returns was influenced significantly due to different intercropping systems. Pigeonpea+greengram recorded maximum gross monetary returns than other intercropping system.

Keywords: pigeon pea, intercropping system, equivalent yield and land configuration

Introduction
In Indian agriculture role of pulses needs hardly any special importance. India is major pulse growing country. The pulses are integral part of cropping system all over the country. Pulses are considered as lifeblood of agriculture because they occupy a unique position in every known system of farming as a main, catch, cover, green manure, intercrop, relay and mixed crop. The area under pigeonpea during 2016-17 was 3.86 million hectares with production of 2.90 million tonnes and average productivity of 751 kg ha^{-1}. In Maharashtra the area under pigeonpea was 1.53 million hectares with production of 1.17 million tonnes and average productivity of 764 kg ha^{-1} and in Marathwada the area is 5.3 lakh hectares with production of 1.3 lakh tonnes (Anonymous, 2016) [1]. When pigeonpea is grown as a sole crop, it is relatively inefficient because of its slow initial growth rate and low harvest index (Willey, 1980); therefore it is grown as intercrop, which helps in efficient utilization of available resources for enhancing the productivity and profitability. Pigeonpea is suitable for intercropping with different crops like soybean, greengram, blackgram and cowpea for increasing production and maintaining soil fertility.
The initial slow growth rate and deep root system of pigeonpea offers a good scope for intercropping with fast growing early maturing and shallow rooted crops. Hence in this experiment we have taken short durational legumes soybean, green gram, black gram and cowpea as intercrops with pigeonpea in 2:1 ratio.

Material and Methods
The field experiments were conducted at Research Farm, AICRP for Dryland Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during *Kharif* seasons of 2015-16 and 2016-17. The soil was medium deep black with low in available nitrogen, medium in available phosphorus and high in available potassium.
The experiment was laid out in split plot design with three replications. The present investigation consists of 12 treatment combinations comprising of three land configurations in main plot and four intercropping systems in sub plots. The treatments were allotted randomly in each replication. The trials were conducted during *Kharif* 2015 and 2016.
The main plot treatments comprised of three Land configurations L_1 – Broad bed furrow (BBF), L_2 - Ridges and furrow, L_3 - Flat bed method while the sub plot comprised of four intercropping systems *viz.* I_1 - Pigeonpea + Soybean (2:1), I_2 - Pigeonpea + Green gram (2:1), I_3 - Pigeonpea + Black gram (2:1), I_4 - Pigeonpea + Cowpea (2:1).

The Pigeonpea, soybean, greengram, blackgram and cowpea seed yield was considered for converting in to Pigeonpea equivalent yield on the basis of prevailing market price of both the seeds. The Pigeonpea equivalent yield was calculated by the following formulae for respective treatments for both the years.

$$\text{Seed equivalent of Pigeonpea (kg ha}^{-1}\text{)} = \frac{\text{Seed yield of intercrops x price (Rs kg}^{-1}\text{)}}{\text{Pigeonpea seed price (Rs kg ha}^{-1}\text{)}} + \text{PSY (kg ha}^{-1}\text{)}$$

The gross monetary returns (Rs. ha^{-1}) accrued due to different treatments in the present study were worked out by considering market prices during the experimental years.

Results and Discussion

Pigeonpea equivalent yield

The data can be recorded and analyzed for pigeonpea equivalent yield (Table 1). Data on pigeonpea equivalent yield are presented in (Table 1) as influenced by the various treatments during 2015-16, 2016-17 and pooled analysis. It was observed that pigeonpea equivalent yield was 1436, 1895 and 1666 kg ha^{-1} in 2015-16, 2016-17 and in pooled analysis, respectively.

The effect of pigeonpea equivalent yield (kg ha^{-1}) was influenced significantly due to different intercropping systems. PEY by greengram found significantly superior over PEY by blackgram, soybean and cowpea during 2015-16, 2016-17 and in pooled analysis. PEY by cowpea recorded significantly lowest during both the year and in pooled analysis. The mean pigeonpea equivalent yield (kg ha^{-1}) was not influenced significantly due to interaction between land configuration and intercropping systems during both the years of experimentation and in pooled data. Similar results have been reported earlier (Goyal *et al.*, (1991) [5]; Verma and Warsi, (1997) [13]; Sharma *et al.*, (1998) [12]; Jain *et al.*, (2001) [7]. The results are also in tune with the findings of Dubey *et al.* (1991) [3], Itnal *et al.* (1992) [6], Pujari (1996) [11] and Dwivedi and Bajpai (1997) [4]. The land configuration treatment of broad bed furrow (L_1) recorded higher pigeonpea equivalent yield of 1595, 2051 and 1823 kg ha^{-1} during 2015-16, 2016-17 and in pooled data, respectively and found significantly superior over flat bed (L_3) but it was found at par with treatment ridges and furrow (L_2) during both the year and in pooled analysis.

Yield of Intercrops

The data can be recorded seed yield of different intercrops (Table 2). Yield of intercrops influenced by different land configuration. Broad bed furrow recorded highest seed yield followed by ridges and furrow and lowest yield recorded in flat bed sowing.

Seed yield is greatly influenced by soil moisture content. Maintaining high soil moisture content favours better root development which extend to lesser depths but to a greater horizontal distance thereby coming in contact with larger soil mass which enable the pants to absorb higher amount of nutrients. This might have improved the proportion of nutrient uptake to the greater extent producing higher dry matter in pods ultimately resulting in higher total dry matter production. Similar observations were made by the previous workers (Bhagwandin and Bhatia, 1989 and Yadav *et al.* 1998) [2, 5].

Patil *et al.* (1994) [10] reported that in the vertisols of Maharashtra, among the different in situ moisture conservation practices tried, moisture content was highest with BBF.

Gross monetary returns

The data can be recorded and analyzed for Gross monetary returns (Table 3). The gross monetary returns (Rs.ha^{-1}) was influenced significantly due to different intercropping systems. Intercropping system pigeonpea+greengram recorded maximum gross monetary returns of 82594, 108890 and 95744 ` ha^{-1} during the year 2015-16, 2016-17 and in pooled analysis, respectively and it was significantly higher over the other intercropping systems. Maximum gross return was recorded under treatment pigeonpea+greengram (2:1) and minimum gross return found with pigeonpea+cowpea in both year of study and pooled analysis. The increase in gross return might be due to better growth and yield attributes in higher seed yield of pigeonpea and higher price of greengram. Kumar *et al.*, (2003[a]), Sharma *et al.*, (2012) [12] and Lewade (2017) also reported similar results.

Conclusion

Pigeonpea + greengram (2:1) intercropping system recorded highest pigeonpea equivalent yield. Pigeonpea + greengram (2:1) intercropping system on broad bed furrow (BBF) and ridges & furrow were found productive and profitable as compared to other intercropping systems.

Table 1: Pigeonpea equivalent yield (kg ha^{-1}) as influenced by different treatments during 2015-16, 2016-17 and in pooled analysis.

Treatments	Pigeonpea equivalent yield (kg ha^{-1})		
	2015-16	2016-17	Pooled mean
Land configurations (L)			
L_1- Broad bed furrow	1595	2051	1823
L_2- Ridges and furrow	1517	2000	1759
L_3- Flat bed	1197	1635	1416
S.E. ±	28.28	53.23	43.41
C.D. at 5 %	83.92	157.93	126.34
Intercropping systems (I) (2:1)			
I_1 – Pigeonpea+soybean	1425	1900	1663
I_2 – Pigeonpea+greengram	1579	2084	1832
I_3 – Pigeonpea+blackgram	1432	1896	1664
I_4 – Pigeonpea+cowpea	1309	1701	1505
S.E. ±	37.82	59.02	48.41
C.D. at 5 %	112.21	175.11	140.39
Interaction (L x I)			
S.E. ±	65.51	102.24	83.62
C.D. at 5 %	NS	NS	NS
General mean	1436	1895	1666

Table 2: Mean seed yield (kg ha^{-1}) of intercrops as influenced by different land configurations.

Treatments/Land configuration	Soybean	Green gram	Black gram	Cowpea
2015-2016				
L_1-BBF	428	244	196	173
L_2-Ridges and furrow	403	232	187	154
L_3-Flat	372	216	171	129
Mean	401	231	185	152
2016-2017				
L_1-BBF	548	280	239	201
L_2-Ridges and furrow	520	269	228	188
L_3-Flat	409	253	216	176
Mean	492	267	227	188

Table 3: Gross monetary returns (` ha^{-1}) as influenced by different treatments during 2015-16, 2016-17 and in pooled analysis.

Treatments	Gross monetary returns (Rs. ha^{-1})		
	2015-16	2016-17	Pooled mean
Land configurations (L)			
L_1- Broad bed furrow	83478	107180	95352
L_2- Ridges and furrow	79426	104660	92013
L_3- Flat bed	62877	85783	74330
S.E. ±	1450.6	2713.8	2080.4
C.D. at 5 %	4303.4	8050.7	5825.1
Intercropping systems (I) (2:1)			
I_1 – Pigeonpea+soybean	74733	99536	87135
I_2 – Pigeonpea+greengram	82594	108890	95744
I_3 – Pigeonpea+blackgram	75034	99240	87137
I_4 – Pigeonpea+cowpea	68683	89085	78884
S.E. ±	1915.4	2990.5	2451.1
C.D. at 5 %	5682.2	8871.6	6863.1
Interaction (L x I)			
S.E. ±	3317.5	5179.7	4268.4
C.D. at 5 %	NS	NS	NS
General mean	75226	99189	87225

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