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IMPACT OF LAND CONFIGURATION, GROWTH REGULATORS AND INTEGRATED NUTRIENT MANAGEMENT ON GROWTH AND YIELD OF PIGEONPEA

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Abstract

The field experiments were conducted during *kharif* season 2015-16 and 2016-17 on clayey soil at experimental farm, Annamalai University to find out the suitable land configuration, growth regulators and integrated nutrient management in pigeonpea. Treatment consists of twenty four treatment combinations comprising three land configurations and two foliar applications in main plot whereas, four integrated nutrient levels in sub plot. Main plot Land Configuration L_1: Flat bed L_2: Ridges and furrow L_3: Broad Bed Furrow Foliar Application F_1: Foliar application of Mepiquat chloride @ 100 ppm at 50% flowering F_2 Foliar application of Cycocel @ 50 ppm at 50% flowering Sub plot Integrated Nutrient Management N_1:100% RDF + Rhizobium + PSB N_2:75% RDF + 2.51FYM ha^{1} + Rhizobium + PSB N_3:50% RDF + 51FYM ha^{-1} + Rhizobium + PSB N_4: RDN through 1/3 FYM +1/3 Vermicompost + 1/3 Neem cake + Rhizobium + PSB. The treatments were assigned in a split-plot design with two replication, foliar application of Mepiquat chloride @ 100 ppm at 50% flowering stage and application of 50% RDF + 5t FYM ha^{-1} + Rhizobium + PSB grown on broad bed furrow obtaining higher seed and straw yields of better quality and maximum economic returns by sustaining soil fertility, pigeonpea.

Key words : *Foliar application, Integrated Nutrient Management, Land Configuration, Pigeonpea, Ridges and furrow.*

Introduction

Pigeonpea is one of the important pulse crop of Maharashtra state. Pigeonpea is long duration crop and suits under different cropping system either in intercropping or sequence cropping systems. Mostly it is grown as sole crop as well as intercrop with sorghum or soybean in most parts of Maharashtra state. During the year 2016-17, area under pigeonpea in India was 3.86 million hectares with production 2.90 million tonnes (Anonymous, 2016). In Maharashtra, pigeonpea production during *kharif* 2016-17 was 14.35 lakh hectares and production 20.89 lakh tone with the productivity of 1455 kg ha'^{1}. In Marathwada, during the year 2016-17 was 6.04 lakh hectares and production 9.59 lakh tonnes with the productivity 1459 kg ha'^{1} (Anonymous, 2018).

In recent years, uncertainties in rain water availability, the swings in the onset, continuity and withdrawal pattern of monsoon has made crop production more risky in *rainfed* areas (Singh, 2000). Under these circumstances efficient rain water management practices acts as insurance for crops during abnormal rainfall situation. For getting a sustainable crop production system under *rainfed* condition, the conservation of rain water and its efficient recycling are imperative. The rain water can be conserved either *in-situ* or *ex-situ* in natural or manmade structures for supplemental irrigation. *In-situ* rain water conservation can be carried out either through tillage or land surface management (Singh and Singh, 2015). Among the various land surface management practices ridges and furrow, broad bed furrow, tied ridges and furrow are very promising in controlling surface runoff, reducing the soil loss through erosion and increasing infiltration.

The soil health and ecological hazards due to long term excessive use of chemical fertilizers also pose a serious problem. Although, chemical fertilizers are playing a crucial role to meet the nutrient requirement of the crop, the persistent nutrient depletion is posing a great threat to sustainable agriculture. Therefore, integrated

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use of both chemical fertilizers and organic manures is needed to check the depletion of soil health and enhance the yield levels. The importance of organic manures in promoting soil health and better plant nutrition has started receiving much recognition in the world as a whole in recent years. The supplementary and complementary use of organic manures along with chemical fertilizers, besides improving physico-chemical properties also improve the use efficiency of applied fertilizers. On this backdrop there is need to evolve an appropriate agro-technology for successful cultivation of pigeonpea that results in efficient rain water conservation through land configuration use, growth regulators to get desired results and integrated nutrient management for higher productivity of pigeonpea crop. Keeping the above fact in view the present investigation on the effect of land configuration, growth regulators and integrated nutrient management on growth and yield of pigeonpea was carried out.

Materials and Methods

The experiments were conducted at experimental farm, Annamalai University during *kharif* season of 2015-16 and 2016-17. The topography of the experimental field was fairly uniform and levelled. The soil of the experimental plot was clayey in texture and slightly alkaline in reaction having low in organic carbon, available nitrogen and phosphorus, but marginally high in available potassium. The climate of Parbhani is semi-arid and characterized by three distinct seasons *viz.,* summer being hot and dry during March to May, warm and humid monsoon in June to October and winter with mild cold from November to February. Most of the rainfall received from south-west monsoon during June to October with mean annual normal precipitation.

Treatment consists of twenty four treatment combinations comprising three land configurations and two foliar applications in main plot whereas, four integrated nutrient levels in sub-plot. The treatments were allotted randomly in each replication. Details of the treatments along with symbols used in plan of layout are given in Table 1. The treatments were assigned in a split-split plot design with two replication.

Certified seed for each crop under experimentation was used. Sowing was done by drilling method. The seed used for Pigeonpea c.v. BSMR-736. The distance in between two rows was 90 cm and in between two plants was 20 cm. The recommended dose of fertilizer (RDF) used for soybean was 25 : 50 : 25 kg N, P_20_5 and K_20 ha^{-1} respectively. The well decomposed FYM, vermicompost and neem cake was applied uniformly before sowing in the respective plots as per the treatment specifications. The foliar application of Mepiquat chloride @ 100 ppm and Cycocel @ 50 ppm was done at 50% flowering stage of pigeonpea crop. The foliar application of plant growth regulators was done by knapsack sprayer with capacity of 15 litres.

Pigeonpea is grown as rainfed crop therefore it does not require any irrigation but in case of dry spell one or two life saving irrigation were given as protective irrigation. Five plants from each net plot were selected randomly to represent the population in each net plot and labelled for recording growth observations. Various observations were recorded on these plants periodically after 30 days of sowing at an interval of 30 days till maturity of the crops, respectively. Observations on yield components were recorded after harvest of crop.

Results and Discussion

(A) Growth attributes of pigeonpea

(i) Land configuration

The plant height, number of functional leaves, number of branches $plant^{-1}$, dry matter accumulation $plant^{-1}$ of pigeonpea was recorded the highest in broad bed furrow (L_3) followed by ridges and furrow (L_2) which were at par with each other but found significantly superior over flat bed (L_1) in that descending order of significance. Significantly, the lowest plant height was observed in the flat bed than rest of the land configuration during both the years.

(ii) Foliar application

In the year 2015-16 and 2016-17, foliar application of Cycocel @ 50 ppm at 50% flowering (F_2) recorded significantly highest plant height, number of functional leaves $plant^{-1}$, dry matter accumulation $plant^{-1}$ than foliar application of Mepiquat chloride @ 100 ppm at 50% flowering (F_2) at 120, 150 DAS and at harvest. However, foliar application of Mepiquat chloride @ 100 ppm at 50% flowering (F_2) recorded shortest plant height during 120, 150 DAS and at harvest as compare to foliar application of Cycocel @ 50 ppm at 50% flowering during both the years of experimentation.

(iii) Integrated nutrient management

Among the integrated nutrient management treatments application of 50% RDF + 5 t FYM ha^{-1} + *Rhizobium* + PSB (N_3) produced significantly taller plants, number of functional leaves $plant^{-1}$, number of branches $plant^{-1}$ dry matter accumulation $plant^{-1}$ over rest of the treatments from 60 DAS to harvest during both the years. Treatment 75% RDF + 2.51 FYM ha^{-1} + *Rhizobium* + PSB (N_2) remained at par with 100% RDF + *Rhizobium* + PSB (N_1) and both the treatments

Table 1: Growth attributes of pigeonpea as influenced by different treatments during 2015-16 and 2016-17.

Treatments	Plant height(cm)		No.of leaves Plant^{-1}		No.of branches Plant^{-1}		Dry matter accumulation Plant^{-1} (g)	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Main Plot-Land configuration								
L_1 - Flat bed	138.64	144.11	273.75	284.30	14.91	15.96	78.09	89.90
L_2 - Ridges and furrow	149.13	155.38	288.10	304.97	17.61	18.40	85.41	99.64
L_3 - Broad bed furrow	157.63	163.40	300.41	317.88	18.36	19.54	90.14	103.74
S.E.(m)+	2.54	2.64	3.69	4.23	0.34	0.38	1.49	1.71
C.D. at 5%	9.24	9.59	13.41	15.38	1.25	1.38	5.44	6.22
Foliar application								
F_1 - Foliar application of Mepiquat chloride @	144.28	149.54	280.27	294.42	17.75	18.71	80.84	94.28
100 ppm at 50% flowering								
F_2 - Foliar application of Cycocel @ 50 ppm at	153.45	159.06	294.57	310.30	16.17	17.38	88.25	101.23
50% flowering								
S.E.(m)+	2.07	2.15	3.01	3.45	0.28	0.31	1.22	1.39
C.D. at 5%	7.55	7.84	10.98	12.60	1.04	1.15	5.50	6.29
Sub Plot-Integrated Nutrient Management								
N_1 -100% RDF + *Rhizobium* + PSB	146.26	152.04	285.12	296.25	16.30	17.51	83.38	95.63
N_2 - 75% RDF + 2.5 t FYM ha^{-1} + *Rhizobium* + PSB	150.84	156.52	289.92	305.34	17.48	18.65	86.45	99.70
N_3 - 50% RDF + 5 t FYM ha^{-1} + *Rhizobium* + PSB	162.25	167.69	304.77	325.18	19.09	20.19	93.66	108.75
N_4 - RDN through 1/3 FYM + 1/3 Vermicompost	134.76	140.94	269.87	280.73	14.97	15.79	74.22	86.86
+ 1/3 Neem cake + *Rhizobium* + PSB								
S.E.(m)+	3.59	3.66	5.03	6.51	0.45	0.51	2.06	2.55
C.D. at 5%	10.68	10.90	14.95	19.35	1.35	1.52	6.12	7.60
L X F Interaction								
S.E.(m)+	3.59	3.73	5.21	5.98	0.49	0.54	2.11	2.42
C.D. at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
L X N Interaction								
S.E.(m)+	6.23	6.35	8.71	11.28	0.79	0.88	3.57	4.43
C.D. at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
F X N Interaction								
S.E.(m)±	5.08	5.18	7.11	9.21	0.64	0.72	2.91	3.61
C.D. at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
L X F X N Interaction								
S.E.(m)±	8.81	8.98	12.33	15.95	1.12	1.25	5.05	6.26
C.D. at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
General Mean	148.45	154.29	287.42	302.38	16.96	18.01	84.49	97.75

recorded significantly more height of pigeonpea as compared to RDN through 1/3 FYM + 1/3 Vermicompost + 1/3 Neem cake + *Rhizobium* + PSB (NJ) at all crop growth stages

(B) Yield attributes of pigeonpea

(i) Land configuration

Number of pods plant^{-1}, weight of pods plant^{-1}, number of seeds plant^{-1} and seed yield plant^{-1} recorded highest when the pigeonpea crop was adopted with land configuration broad bed furrow (L_3) than ridges & furrow (L_2) and flat bed (L,). The higher growth attributes followed by more synthesis and translocation of food material to the source might have resulted in more pods and bold seed size also. The similar results were obtained by Kantwa *et al.* (2005), Kalokhe (2010) and Singh and Singh (2015).

(ii) Foliar application

Yield contributing characters *viz.,* number of pods plant^{-1}, weight of pods plant^{-1}, number of seeds plant^{-1} and seed yield plant^{-1} were improved due to growth

Table 2: Yield attributes of pigeonpea as influenced by different treatments during 2015-16 &2016-17.

Treatments	Number of pods Plant^{-1}		Weight of pods Plant^{-1}		No.of Seeds Plant^{-1}		Seed Yield Plant^{-1} (g)	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Main Plot-Land configuration								
L_1 - Flat bed	70.72	81.87	34.02	40.66	225.29	298.12	27.70	31.17
L_2 - Ridges and furrow	83.50	93.93	39.82	46.70	293.15	355.39	32.63	37.65
L_3 - Broad bed furrow	89.14	101.08	43.22	48.63	341.60	400.42	34.13	39.09
S.E.(m)+	2.11	2.63	0.96	0.55	7.76	14.63	0.43	0.67
C.D. at 5%	7.67	9.75	3.51	1.99	28.21	53.47	1.59	2.46
Foliar application								
F_1 - Foliar application of Mepiquat chloride @ 100 ppm at 50% flowering	88.24	98.89	41.29	46.40	340.10	383.78	33.47	37.25
F_2 - Foliar application of Cycocel @ 50 ppm at 50% flowering	74.04	85.70	36.77	44.29	233.25	318.84	29.50	34.62
S.E.(m)+	1.72	2.19	0.78	0.44	6.33	13.27	0.50	0.55
C.D. at 5%	6.27	7.99	2.84	1.60	23.10	47.77	1.82	2.00
Sub Plot-Integrated Nutrient Management								
N_1 - 100% RDF + *Rhizobium* + PSB	79.53	89.25	38.29	44.37	272.84	327.98	31.18	35.61
N_2 - 75% RDF + 2.5 t FYM ha^{-1} + *Rhizobium* + PSB	84.14	95.47	39.78	45.99	302.52	367.92	32.10	36.53
N_3 - 50% RDF + 5 t FYM ha^{-1} + *Rhizobium* + PSB	96.25	108.50	44.45	49.80	364.92	444.79	35.63	39.41
N_4 - RDN through 1/3 FYM + 1/3 Vermicompost + 1/3 Neem cake + *Rhizobium* + PSB	64.54	75.95	33.56	41.17	206.27	264.56	27.03	32.30
S.E.(m)±	3.53	3.53	1.32	0.91	15.20	16.28	0.88	0.86
C.D. at 5%	10.50	10.49	3.93	2.72	45.16	59.11	2.63	2.58
L X F Interaction								
S.E.(m)+	2.98	3.79	1.36	1.58	10.71	22.99	0.86	0.96
C.D. at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
L X N Interaction								
S.E.(m)+	6.12	6.12	2.29	1.29	26.33	25.34	1.53	1.50
C.D. at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
F X N Interaction								
S.E.(m)±	5.00	4.99	1.87	2.24	21.49	25.34	1.25	1.22
C.D. at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
L X F X N Interaction								
S.E.(m)+	8.66	8.65	3.24	2.24	37.23	35.84	2.17	2.12
C.D. at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
General Mean	81.10	92.29	39.02	45.33	286.67	351.31	31.48	35.95

regulator treatment of Mepiquat chloride @ 100 ppm at 50% flowering (F_1) during both the years. Foliar application of Mepiquat chloride @ 100 ppm at 50% flowering (F_1) was recorded significantly higher number of pods plant^{-1}, weight of pods plant^{-1}, number of seeds plant^{-1} and seed yield plant^{-1} in pigeonpea compared to other treatment foliar application of Cycocel @ 50 ppm at 50% flowering (F_2) during both the years. The increase in number of pods plant^{-1} with Mepiqaut chloride application was due to improved source sink relationship and setting percentage, increased number of branches. The results are in conformity with the results reported by Prakash *et al.,* (2003) and Chandewar *et al.,* (2016).

Integrated nutrient management

Integrated nutrient management treatments and most of them followed, more or less similar trend as that of growth characters, indicating that the application of 50% RDF + 5 t FYM ha^{-1} + *Rhizobium* + PSB (N_3) was significantly superior over other integrated nutrient management treatments during both the years. In general, supplying nutrient through integration of inorganic sources with organic sources responded better in terms of growth

Table 3: Mean seed yield and straw yield (kg ha) of pigeonpea as influenced by different treatments during 2015-16, 2016-17 & pooled mean.

Treatments	Seed yield kg (ha^{-1})		Straw yield kg (ha^{-1})				Biological yield kg (ha^{-1})	
	2015-16	2016-17	Pooled Mean	2016-17	2015-16	Pooled Mean	2015-16	2016-17
Main Plot-Land configuration								
L_1 - Flat bed	1042.00	1329.00	1187.00	3148.00	3748.00	3446.00	4192.00	5074.00
L_2 - Ridges and furrow	1312.00	1658.00	1485.00	3644.00	4234.00	3939.00	4956.00	5893.00
L_3 - Broad bed furrow	1423.00	1776.00	1600.00	3747.00	4367.00	4057.00	5170.00	6144.00
S.E.(m)+	35.32	36.96	40.30	56.15	70.59	61.61	60.13	74.54
C.D. at 5%	128.42	134.20	116.49	203.87	256.28	179.91	218.62	270.97
Foliar application								
F_1 - Foliar application of Mepiquat chloride @	1338.00	1660.00	1498.00	3334.00	3927.00	3631.00	4670.00	5587.00
100 ppm at 50% flowering								
F_2 - Foliar application of Cycocel @ 50 ppm at	1183.00	1516.00	1349.00	3692.00	4302.00	3997.00	4876.00	5818.00
50% flowering								
S.E.(m)+	28.84	30.18	29.18	45.85	57.64	49.98	49.10	60.86
C.D. at 5%	104.71	109.58	84.34	166.46	209.25	145.96	179.21	222.13
Sub Plot-Integrated Nutrient Management								
N_1 - 100% RDF + *Rhizobium* + PSB	1230.00	1554.00	1394.00	3452.00	4085.00	3768.00	4682.00	5643.00
N_2 - 75% RDF + 2.51 FYM ha' + *Rhizobium* + PSB	1284.00	1632.00	1460.00	3569.00	4169.00	3869.00	4854.00	5805.00
N_3 - 50% RDF + 5 t FYM ha + *Rhizobium* + PSB	1467.00	1821.00	1644.00	3885.00	4389.00	4127.00	5354.00	6211.00
N_4 - RDN through 1/3 FYM + 1/3 Vermicompost	1059.00	1342.00	1199.00	3145.00	3817.00	3481.00	4202.00	5159.00
+ 1/3 Neem cake + *Rhizobium* + PSB								
S.E.(m)+	44.06	49.02	46.21	76.74	88.26	80.74	83.03	100.48
C.D. at 5%	130.72	145.45	133.56	227.67	261.85	235.76	246.84	298.55
L X F Interaction								
S.E.(m)+	49.95	52.28	55.48	79.41	99.83	87.86	85.05	105.41
C.D. at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
L X N Interaction								
S.E.(m)±	76.32	84.91	83.51	132.92	152.88	141.14	143.90	174.04
C.D. at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
F X N Interaction								
S.E.(m)+	62.31	69.33	65.49	108.53	124.82	114.91	117.49	142.10
C.D. at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
L X F X N Interaction								
S.E.(m)±	107.93	120.09	118.17	187.98	216.20	200.33	203.50	246.13
C.D. at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
General Mean	1259.00	1587.00	1424.00	3512.00	4115.00	3813.00	4772.00	5703.00

and yield parameters over inorganic or organic sources alone, which may be due to balanced availability of nutrients throughout the growth period in integrated nutrient management treatments. The results are in agreement with those of Reddy *et al.,* (2011), Kumawat *et al.,* (2013) and Jha *et al*., (2015).

(i) Seed yield

The broad bed furrow produced significantly higher seed yield (1423, 1776 and 1600 kg ha^{-1}) over flat bed and it was found at par with ridges and furrow. The ridges and furrow method was next best land configuration method which produced significantly higher seed yield (1312, 1658 and 1485 kg ha^{-1}) as compared to flatbed method. Flat bed (1044, 1329 and 1187 kg ha^{-1}) recorded significantly lower seed yield as compared to rest of the land configuration treatments during both the year of experimentation and in pooled mean, respectively. In case of foliar application of Mepiquat chloride @ 100 ppm at 50% flowering (F_1) produced 1336, 1660 and 1498 kg

ha^{-1} seed yield in 2015-16, 2016-17 and in pooled mean, respectively and it was found significantly higher than foliar application of Cycocel @ 50 ppm at 50% flowering (F_2) during both the years and in pooled analysis.

Among the integrated nutrient management treatments, application of 50% RDF + 5 t FYM ha^{-1} + *Rhizobium* + PSB (N_3) produced maximum and significantly higher seed yield (1467 and 1821 kg ha^{-1}) over rest of the treatments during year 2015-16 and 2016-17, respectively. Application of 75% RDF + 2.51 FYM ha^{-1} + *Rhizobium* + PSB (N_2) and 100% RDF + *Rhizobium* + PSB (NJ remained at par with each other and both the treatments produced significantly higher seed yield over RDN through 1/3 FYM + 1/3 Vermicompost + 1/3 Neem cake + *Rhizobium* + Phosphobacteria (N_4) during both the years.

(b) Straw and Biological yield

Ridges and furrows method produced higher straw yield (3644, 4234 and 3939 kg ha'^{1}) over flat bed (3148, 3744 and 3446 kg ha'^{1}). However, the broad bed furrow and ridges and furrow methods were found to be at par with each other during both the years and pooled mean, broad bed furrow (L_3) recorded significantly higher biological yield (5170 and 6144 kg ha'^{1}) followed by ridges and furrow (L_2) which were found at par with each other but found significantly superior over flat bed method (L_1) that descending order of significance.

Foliar application of Cycocel @ 50 ppm at 50% flowering (F_2) showed higher straw yield in 2015-16 (3692 kg ha^{-1}), 17 (4302 kg ha^{-1}) and in pooled analysis (3997 kg ha^{-1}) and it was significantly superior to foliar application of Mepiquat chloride @ 100 ppm at 50% flowering (F_1) in both the years and in pooled analysis Treatment of foliar application of Cycocel @ 50 ppm at 50% flowering (F_2) in pigeonpea recorded biological yield of 4876 and 5818 kg ha^{-1} in 2015-16 and 2016-17, respectively and it was found significantly higher than foliar application of Mepiquat chloride @ 100 ppm at 50% flowering (F_1) in both the years.

Pigeonpea supplied with of 50% RDF + 5 t FYM ha^{-1} + *Rhizobium* + PSB (N_3) produced maximum and significantly higher straw yield (3885, 4389 and 4127 kg ha^{-1}) over rest of the integrated nutrient management treatments during both the years and in pooled mean. Application of 75% RDF + 2.51 FYM ha^{-1} + *Rhizobium* + PSB (N_2) and 100% RDF + *Rhizobium* + PSB (N_1) were found to be at par with each other and both the treatments recorded significantly higher straw yield than RDN through 1/3 FYM + 1/3 Vermicompost + 1/3 Neem cake + *Rhizobium* + PSB (N_4) during both the years.

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