International Journal of Agriculture Sciences
ISSN: 0975-3710&E-ISSN: 0975-9107, Volume 9, Issue 1, 2017, pp.-3606-3609.
Available online at http://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

EVALUATION OF PLANT POPULATION AND CROP GEOMETRY OF PIGEONPEA BASED SOYBEAN INTERCROPPING SYSTEM (ADDITIVE SERIES) UNDER RAINFED ECOSYSTEM

SINGH DESHRAJ*, KURHADE N.G., VERMA CHANCHAL AND KUMAR PRADEEP

Experimental Farm, Department of Agronomy, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, 431 402, Maharashtra
*Corresponding Author: Email-deshrajsinghsuman10@gmail.com

Received: December 12, 2016; Revised: December 28, 2016; Accepted: December 29, 2016; Published: January 06, 2017

Abstract- The field experiment was conducted at Experimental farm, Department of Agronomy, College of Agriculture, Parbhani under Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani (M.S.) during *Kharif* 2014-15 to assess performance of pigeonpea + soybean intercropping system under different row proportions and planting geometry in rainfed condition. Among all the treatments, pigeonpea- soybean row proportion (1:2) with 90 cm x 30 cm recorded higher pigeonpea equivalent yield (1721.01 kg ha^{-1}) and B : C ratio (3.67) which was comparable with row ratio 1 : 3 (120 cm x 30 cm) and row ratio 1 : 4 (150 cm x 30 cm). It means pigeonpea intra-row spacing 30 cm under row spacing of 90 cm, 120 cm and 150 cm with 1 : 2, 1 : 3 and 1 : 4 pigeonpea – soybean row proportions respectively produce higher pigeonpea equivalent yield (kg ha^{-1}) rather than 45 cm.

Keywords- Intercropping, Pigeonpea, Soybean, Row proportion, Planting geometry, Growth parameters, Yield attributes and seed yield

Citation: Singh Deshraj, et al., (2017) Evaluation of Plant Population and Crop Geometry of Pigeonpea Based Soybean Intercropping System (Additive Series) under Rainfed Ecosystem. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 9, Issue 1, pp.-3606-3609.

Academic Editor / Reviewer: Dr S.S. Rana

Introduction

India is the 2nd largest country in the world by population, which is increasing day by day. But, increasing in the rate of food grain production is not matching to meet the requirements of this growing population of India as well world. In India most of the land available has been brought under cultivation and there is a little scope to get additional land for cultivation because of the commercialization and industrialization. The only strategy now available to improve the present production level by adopting improved agricultural practices, for sustainable agricultural production with the minimum resources *i.e.* intercropping.

Amongst evolved agricultural practices; intercropping proved better in dryland agriculture for increasing production under present circumstances. Pigeonpea crop has compensatory behaviour in respect of plant population and crop geometry to economic yield. In that case there is minimum or no adverse effect on yield with decrease or increase in plant population of pigeonpea crop. Intercropping of pigeonpea with short duration legumes like soybean, greengram, blackgram, cowpea and groundnut proved successful without any loss in yield. In the initial stage, vegetative growth of pigeonpea is slow, whereas, that of soybean is fast. Therefore, soybean completes its life cycle faster than pigeonpea. Soybean as an intercrop with pigeonpea seems to be most appropriate[1]. Pigeonpea being deep rooted and waxy foliage crop foliage withstands effectively in drought situation.[5] Intercropping is one of the ways to increase oilseed and pulse production as intercropping is more advantageous than sole cropping of either oilseed or pulses[2].

Materials and Methods

The field experiment was conducted at Experimental farm, Department of Agronomy, VNMKV, Parbhani (M.S.), India during *Kharif*, 2014. The soil of experimental site was black in colour, clayey in texture (52.17 % clay), low in organic carbon (0.26 organic carbon), poor in nitrogen (217 kg available N ha^{-1}) and medium in available phosphorus (16.2 kg available phosphorus ha^{-1}) and high in potash (566 kg potash ha^{-1}). The soils in experimental plot was slightly saline (pH 7.7) in chemical reaction. The experiment was laid out in Randomized Block Design (RBD). There were total 8 treatments consisting of 3 row spacings of pigeonpea combined with 2 intra-row spacings and 2 sole cropping treatments of pigeonpea and soybean in the recommended spacing of respective crops. Crop varieties BSMR-736 and MAUS-71 (SAMRUDHI) were used for pigeonpea and soybean respectively. The intercropping system of pigeonpea + soybean crops was tried with row proportions of 1 : 2, 1 : 2, 1 : 3, 1 : 3, 1 : 4 and 1 : 4 in 90 cm x 30 cm, 90 cm x 45 cm, 120 cm x 30 cm, 120 cm x 45 cm, 150 cm x 30 cm and 150 cm x 45 cm planting geometry of pigeonpea in treatments T_1, T_2, T_3, T_4, T_5 and T_6 respectively. Recommended planting geometry of sole crop treatments T_7 and T_8 of pigeonpea and soybean were 90 cm x 20 cm and 45 cm x 5 cm respectively. Inter row and intra row spacing of soybean used in intercropped treatments were uniform *i.e.* 30 cm x 7.5 cm. These treatments were replicated thrice. The size of gross plot was 7.5 m x 4.5 m. Five plants were tagged at random in net plot area for recording various growth attributes *viz.* plant height, number of branches, leaf area, dry matter accumulation and as well as yield components like weight of pods per plant (g), seed yield (g) per plant, test weight (g) (1000-seeds weight), seed yield (kg ha^{-1}). Pigeonpea equivalent yield (kg ha^{-1}) was worked out by converting the yields of intercrops to the sole yield of pigeonpea on the basis of prevailing market price of each crop. Competition function like land equivalent ratio (LER) was computed as suggested by Willey (1979)[3]. The economics of different crops and combinations were computed on the basis of prevailing market rates of agro-inputs and produce.

Result and Discussion

The data on effect of row spacing and planting geometry on growth attributes, yield components, seed yield, PEY and LER of pigeonpea based soybean

Table -1 *Effect of row spacing and planting geometry at harvest stage on growth attributes, yield attributes, yield, PEY and LER of pigeonpea based soybean intercropping system.*

Row proportion with pigeonpea planting geometry		Plant height (cm)		Number of branches		Leaf area (dm^2)		Dry matter (g)		Pod weight (g) $plant^{-1}$		Seed weight (g) $plant^{-1}$		Test weight (g)		Seed yield (kg ha^{-1})		PEY (kg ha^{-1})	LER
		PP	SOY	PP	SOY	PP*	SOY*	PP	SOY	PP	SOY	PP	SOY	PP	SOY	PP	SOY		
T_1	(PP: Soy) (1 : 2) 90 cm x 30 cm	143	50	12	0.96	88	1.76	96	23	98	11.59	66	6.27	109	100	1271	765	1721.01	1.33
T_2	(PP: Soy) (1 : 2) 90 cm x 45 cm	139	45	13	1.12	92	1.83	110	24	96	14.09	66	6.80	106	106	1083	774	1538.75	1.22
T_3	(PP: Soy) (1 : 3) 120 cm x 30 cm	140	52	13	0.95	91	1.77	97	23	92	11.56	61	6.31	109	97	1061	917	1600.07	1.30
T_4	(PP: Soy) (1 : 3) 120 cm x 45 cm	136	49	13	1.02	98	2.07	125	27	101	12.95	68	7.82	115	101	976	990	1558.79	1.29
T_5	(PP: Soy) (1 : 4) 150 cm x 30 cm	140	53	13	0.95	91	1.78	103	23	93	11.18	63	6.55	108	94	845	1282	1599.46	1.40
T_6	(PP: Soy) (1 : 4) 150 cm x 45 cm	136	50	15	0.99	106	1.89	150	24	110	11.64	74	7.05	114	100	765	1301	1530.92	1.36
T_7	*Sole pigeonpea 90 cm x 20 cm*	149	----	12	----	76	-----	91	----	90	----	59	----	106	----	1553	----	1552.80	1.00
T_8	*Sole soybean 45 cm x 05 cm*	----	60	-----	0.81	----	1.50	----	19	----	9.92	----	5.93	----	93	----	1527	898.66	1.00
	SE ±	6	2.60	0.52	0.05	4.35	0.09	9.21	1.21	6.54	0.92	4.68	0.63	3.70	5.77	32.68	86.63	59.72	0.05
	CD at 5 %	NS	7.86	1.61	0.15	13.4	0.28	28.40	3.65	NS	NS	NS	NS	NS	NS	98.67	266.96	180.32	0.16
	Mean	140	51	13	0.97	92	1.80	110	23.15	97	11.85	65	6.67	109	99	1079.11	1079.43	1500.06	1.24

Note :- * = Peak level of crop growth for leaf area (dm^2) at 150 DAS and 75 DAS in pigeonpea and soybean, respectively.

intercropping system are depicted in [Table-1]. The results showed that, sole pigeonpea and sole soybean recorded significantly higher grain yield (1553 and 1527 kg ha^{-1} respectively) while the yield of the component crops was reduced significantly in the intercropping system.

Pigeonpea growth attributes: Growth attributing character *i.e.* plant height recorded non-significant values at the harvest stage. Plant height was substantially reduced as the row spacing was increased at all growth stages. The probable reason behind the increase in plant height (cm) in narrow spacing may be due to more competition for light and CO_2 between plants. These findings were in conformity with Yadav and Maurya (2012)[4]who reported that closely spaced pigeonpea plants grow rapidly. Similar results were also reported by Lingaraju *et al*. (2008) [5]. In the narrow or dense planted pigeonpea, the numbers of branches were less than wider ones. The probable reason for more branching in wider planting geometry is the compensatory behaviour of the crop with adequate availability of occupying space, nutrients and moisture in the soil. These results are in conformity with the research findings concluded by Sonawane *et al.* (2011) [6]. Mean leaf area (dm^2) of pigeonpea per plant was increased substantially with the increased spacing at all observations except at harvest. Narrow planting geometry of pigeonpea (90 cm x 20 cm) recorded lower number of leaves per plant as compare to wide geometry. Sharma and Guled (2012)[7] also reported lower leaf area per plant with closely spaced pigeonpea plant than the plants with wide planting geometry. Significantly higher total dry matter accumulation (g) per plant was recorded in wider geometry (150cm). This was due to more number of leaves and leaf area per plant which might have increased photosynthates produced and its accumulation at a higher rate and quantity through process of plant metabolism which ultimately reflected in dry matter production. These findings are in agreement with Darshan (2008)[8] who recorded higher accumulation of dry matter plant^{-1} with 120 cm x 15 cm spacing of pigeonpea crop.

Pigeonpea yield attributes: Weight of pods (g) per plant and weight of seeds (g) per plant were substantially higher under wider geometry of 150 cm x 45 cm over other planting geometry combinations. Substantial improvement in pod weight (g) per plant and seed weight (g) per plant under wider geometry might be due to more unit area per plant under wider geometry. Besides this wide planting geometry had more dry matter coupled with higher leaf area per plant, thereby increased the weight of pods (g) plant^{-1} and seed weight (g) plant^{-1} of pigeonpea. Tuppad *et al.* (2012)[9] reported that widely spaced plants grow slowly in height and produces more pod and seed weight (g) per plant.

Pigeonpea yield: Various growth and yield attributes were influenced due to different row spacings and plating geometries. They ultimately resulted into significant variation in pigeonpea yield per hectare. Pigeonpea seed yield (kg ha^{-1}) was substantially higher under dense planting geometry *i.e.* sole pigeonpea (90 cm x 20 cm) and it was reduced significantly with increase in spacing. Such type of advantages with dense planting geometry on pigeonpea yield was reported by Patil and Joshi (2002)[10]. Stalk yield (kg ha^{-1}) and biological yield (kg ha^{-1}) of pigeonpea showed similar trend as that of seed yield (kg ha^{-1}) of pigeonpea. The higher Stalk yield (kg ha^{-1}) and biological yield (kg ha^{-1}) of pigeonpea was recorded in dense planting geometry *i.e.* sole pigeonpea (90 cm x 20 cm) and it was significantly higher than rest of the planting geometries. This might be attributed to higher growth rate of pigeonpea under dense planting, whose planting geometry helped for better light interception by crop coupled with high plant population as compared to other row spacings and planting geometries. These results are in agreement with the research findings of Sonawane *et al.* (2011)[6]. Who reported that sole pigeonpea produced higher grain yield (18.07 q ha^{-1}) and straw yield (40.38 q ha^{-1}).

Soybean growth attributes: Sole soybean recorded higher plant height at harvest and it was followed by pigeonpea-soybean row proportion 1: 4. This might be due to more competition for light amongst plants. Sonawane *et al.* (2011)[6] also reported that closely spaced soybean plants grow rapidly. Number of branches in soybean crop was higher in the treatment having planting geometry 90 cm x 45 cm followed by similar intra row spacing. Number of functional leaves, leaf area (dm^2) and dry matter accumulation per plant of soybean was recorded higher under planting geometry 120 cm x 45 of pigeonpea followed by planting geometry 150 cm x 45 cm and 90 cm x 45 cm than the pigeonpea intra row spacing 30 cm. This might be due to wider pigeonpea intra row spacing, responsible for less competition for nearer rows of soybean to soil moisture and space for leaf proliferation.

Soybean yield attributes: None of the yield attributing characters recorded significant differences *viz.* weight of pods (g), weight of seeds (g) and test weight (g) per plant of soybean.

Soybean yield: Higher soybean seed yield (1527 kg ha^{-1}), straw yield (2318 kg ha^{-1}) and biological yield (3845 kg ha^{-1}) were recorded in sole planting of soybean (45 cm x 5 cm).Similar findings were also reported by Patil and Joshi (2002)[10] and Yadav and Maurya (2012)[4].

Performance of intercropping system:

Pigeonpea equivalent yield (kg ha^{-1}) differed markedly among the treatments comprising of planting geometry adapted to pigeonpea and proportions of soybean rows. Significantly higher pigeonpea equivalent yield (1721 kg ha^{-1}) was obtained in narrow pigeonpea planting geometry (90 cm x 30 cm) with row proportion 1 : 2 followed by (120 cm x 30 cm) 1 : 3 (1600 kg ha^{-1}) and 1 : 4 (150 cm x 30 cm) (1599 kg ha^{-1}) row proportion. The higher pigeonpea equivalent yield was due to higher seed yield of pigeonpea and soybean in intercropping system and higher minimum support prices (MSP) of pigeonpea. The results are in conformity with the findings of research conducted on soybean + pigeonpea and pigeonpea + greengram by Sharma and Guled (2012)[7] and Singh and Rahman (1999)[11] respectively. Dubey *et al.* (1991)[1] reported higher pigeonpea equivalent yield in pigeonpea + soybean intercropping system than sole pigeonpea. Land equivalent ratio (LER) differed significantly due to intercropping treatments comprising of different planting geometry of pigeonpea crop. In general, all the intercropping treatments recorded higher LER values than sole cropping treatments. The significantly higher LER was recorded when soybean intercropped with pigeonpea in 150 cm x 30 cm in 1 : 4 row proportion followed by planting geometry 150 cm x 45 cm with similar row proportion. The study conducted at Kolhapur (M.S.) Gare *et al.* (2004)[12] revealed higher LER in pigeonpea + soybean intercropping system in wider row spacing than sole crop. Similar findings were also reported by Srinivasulu *et al.* (2000)[13] and Narkhede and Katare (1998)[14], wherein pigeonpea + sesame intercropping combination recorded maximum LER values over other intercrops with pigeonpea.

Conclusion

Based on the result findings of research investigation, the conclusions may be drawn. Thus, it can be concluded that intercropping of pigeonpea with soybean in 1: 2 row proportion with closer planting geometry of 90 cm x 30 cm gave higher pigeonpea equivalent yield (kg ha^{-1}). Planting geometry 90 cm x 30 cm, 120 cm x 30 cm and 150 cm x 30 cm were comparable in producing pigeonpea equivalent yield. Hence, they may be termed as optimum for cultivation of pigeonpea – soybean intercropping system.

Author Contributions

Deshraj Singh: Researcher, Department of Agronomy, VNMKV, Parbhani (M.S.)
N. G. Kurhade: Major Research Guide, Associate Professor, Department of Agronomy, VNMKV, Parbhani (M.S.)
Chanchal Verma & Pradeep Kumar: For assistance in the research conductance as well as funding for the necessary requirements to publish work.

Conflict of Interest: None declared

References

[1] Dubey O.P., Garg D.C., Dixit J.P. and Tiwari K.P. (1991) *Indian Journal of Agronomy*, 38(2), 253-254.

[2] Prakash Ved, Pandey A.K. and Srivastva A.K. (2004) *Annals Agriculture Research* New series, 25(2), 312-315.
[3] Willey R.W. (1979) Intercropping – its importance and research needs I. Competition and yield advantage. Field Crops Abstracts. 32, 1 – 10 and 73 - 85.
[4] Yadav P.S. and Maurya B.M. (2012) *JNKVV Research Journal*, 46(3), 355-359.
[5] Lingaraju, B.S., Marer S.B. and Chandrashekar S.S. (2008) *Karnataka Journal of Agriculture Science*, 21(1), 1-3.
[6] Sonawane D.A., Ilhe S.S., Bahale T.M. and Dalavi N.D. (2011) *JNKVV Research Journal*, 45(1), 81-84.
[7] Sharma Arjun and Guled M.B. (2012) *Karnataka Journal of Agriculture Science,* 25(1), 18-24.
[8] Darshan R. (2008) Intercropping of pigeonpea with sesame cultivars under different planting geometry and row proportions in northern transition zone of Karnataka. M.Sc. (Agri.) Thesis, Department of Agronomy, UAS, Dharwad (Karnataka), India.
[9] Tuppad Giramallappa B., Koppalkar B.G., Halepyati A.S. and Desai B.K. (2012) *Karnataka Journal of Agriculture Science,* 25(2), 179-182.
[10] Patil P.A. and Joshi P.K. (2002) *J. of Maharashtra Agric. Univ.*, 27(3), 268-270.
[11] Singh R.S. and Rahman A. (1999) *Journal of Research,* 11, 27-30.
[12] Gare B.N., More S.M., Jadhav M.G. and Burli A.V. (2004) *Journal of Maharashtra Agric. Univ,* 29(2), 170-172.
[13] Srinivasulu K., Singh R.P. and Madhavi K. (2000) *Crop Res.,* 20, 56-61.
[14] Narkhede W. N. and Katare R.A. (1998) *J. Maharashtra Agric. Univ*., 23, 330-331.

Abbreviations

Cm	:	centimetre
PEY	:	Pigeonpea equivalent yield
LER	:	Land equivalent ratio
RBD	:	Randomized Block Design
dm^2	:	decimetre square
Ha	:	Hectare
Kg	:	kilograms
PP	:	Pigeonpea
Soy	:	Soybean
DAS	:	Days after sowing
NS	:	Non-significant