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## Performance of different crop geometry on yield and economics of pigeonpea (*Cajanus cajan*) + niger (*Guizotia abyssinica*) intercropping system

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### Abstract

The field experiment was conducted during *Kharif* 2017 at the Experimental Farm, Agronomy Section, College of Agriculture, Parbhani (Maharashtra). An experiment was laid out in randomized block design with three replications. There were total 8 treatments combination consisting 3 row spacing of pigeonpea combined with 2 intra-row spacings and 2 sole cropping treatments of pigeonpea and niger in the recommended spacing of respective crops added. The intercropping system of pigeonpea + niger crops was tried with row proportion of 1: 2, 1: 2, 1: 3, 1: 3, 1: 4 and 1: 4 in 90 x 30cm, 90 x 45cm, 120 x 30cm, 120 x 45cm, 150 x 30cm and 150 x 45cm planting geometry of pigeonpea in treatments T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub>, T<sub>5</sub> and T<sub>6</sub> respectively. Studied planting geometry of sole treatments T<sub>7</sub> and T<sub>8</sub> of pigeonpea and niger were 90 x 20cm and 30 x 10cm respectively. Inter row and intra row spacing of niger in intercropping treatments were same i.e. 30 x 10cm.

Among all the treatments of pigeonpea + niger intercropping system under rainfed condition, T<sub>7</sub> i.e., sole pigeonpea with planting geometry (90 x 20cm) recorded higher pigeonpea equivalent yield (1650 kg ha<sup>-1</sup>) and B: C ratio (3.74) which was followed by treatment T<sub>3</sub>, T<sub>5</sub> and T<sub>1</sub> i.e., row ratio 1: 3 (120 x 30cm), 1: 4 (150 x 30cm) and 1: 2 (90 x 30cm). Hence intra-row spacing 30cm under 90cm, 120cm and 150cm of pigeonpea row spacing along with 1: 2, 1: 3 and 1: 4 pigeonpea + niger row proportion produced higher yield than intra row spacing 45 cm in intercropping system.

**Keywords:** Economics, intercropping, niger, pigeonpea, yield

### Introduction

Change in climate is likely to aggravate the problems of future food security by exerting pressure on agriculture. India is more vulnerable to climate change in view of the high population depending on agriculture, excessive pressure on natural resources and poor coping mechanisms. In India significant impacts have been implied with medium term (2010-2039), climate change, predicted to reduce yields by 4.5-9%, which is roughly up to 1.5% of GDP per year (Jasna *et al.*, 2014) [2]. Intercropping, an important feature of traditional dryland farming has been successfully exploited to increase productivity per unit of land and water in semiarid tropics. The system of intercropping not only saves the crops against natural hazard but also helps in better utilization of farm resources. Intercropping, under rainfed ecosystem, ensures stability in yield and minimizes risk of crop loss due to aberrant weather condition. Therefore under rainfed condition where the chances of crop failure are more, intercropping is more stable and dependable than sole crops (Willey *et al.*, 1980) [9]. The main advantage of the intercropping is that the component crops are able to use the growth resources differently and make better overall use of growth resources than grown separately (Willey 1979) [8].

Limited and scanty rainfall in the rainfed areas makes pigeonpea vulnerable to experience moisture stress conditions during the latter part of its growth, resulting in severe yield reduction as it was observed during *Kharif* - 2014. Sufficient soil moisture is the key to successful crop production in dryland areas. The cropping system and planting patterns are effective in increasing the productivity and water use by pigeonpea under rainfed conditions (Ghosh *et al.* 2005) [1]. Pigeonpea based intercropping systems have proved sustainable in respect of yield and income with short duration intercrops of cereals, pulses and oilseed crop across diverse rainfed agro ecologies in India (Rao *et al.*, 2003) [5]. In the scarcity zone of Maharashtra, pigeonpea is cultivated during *kharif* under diverse biophysical (soil and rainfall types) and socioeconomic settings, thus always risk prone due to in-season drought, particularly in shallow to medium black soils, abiotic factors often resulting in unsustainable yields and income. Among the abiotic constraints, the methods of planting and plant population play an important role in production of grain yield of pigeonpea. Thus it becomes necessary to develop an efficient and profitable pigeonpea based intercropping system for

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scarcity zone of Maharashtra. Pigeonpea is a highly drought resistant crop it can successfully grow in areas receiving only 65 cm annual rainfall, as the crop matures fast and pest damage is low. It is mostly photoperiodic sensitive and short days result in reduced vegetative phase and onset of flowering. Pigeonpea can be knitted into many cropping systems, viz., intercropping, mixed cropping and sequential cropping etc. The initial slow growth, deep rooting pattern, ability to tolerate drought and low soil moisture has made it highly suitable crop for intercropping systems. It is intercropped with many short duration legumes, cereals and commercial crops.

Niger [*Guizotia abyssinica*] commonly known as ramtil, kalatil, gurellu, tilangi and noong is a minor oilseed crop of India. The important feature of this crop is that it gives reasonable seed yield even under poor marginal growing conditions like less fertile soil the oil from niger is valued for using different purposes like – culinary, anointing the body, manufacturing of paints and soft soaps, lightening and lubrication and as a base oil by the perfume industries. The oil is good absorbent of fragrance of flowers due to which it is used as base oil by perfume industry. Niger oil is a substitute for sesamum oil for pharmaceutical purposes. An account of these facts in view, an experiment was undertaken to study “Performance of different crop geometry on yield and economics of pigeonpea (*Cajanus cajan*) + niger (*Guizotia abyssinica*) intercropping system under rainfed condition”.

### Material and Methods

The experiment was conducted during *kharif* 2016 on a medium black soil at the research farm of Division of Agronomy, Vasantrao Naik Marathwada Krishi Vidhyapeeth, Parbhani. Geographically location of the site is situated at 19° 16' North latitude and 76° 47' East longitudes and at 409 altitudes above sea level and has a semi-arid climate. The experimental soil was black soil having pH 8.1, medium in organic carbon (0.56%), low in available nitrogen 215.03(kg/ha) medium in available phosphorus (14.96 kg/ha) medium in available K (506.6 kg/ha) as determined by standard methods. The experiment was laid out in RBD with 3 replications. There were 8 treatment combinations comprised of 2 cropping system viz., sole pigeonpea, niger and pigeonpea + niger. Among them 6 treatments consists of three row spacings viz. 90cm,120cm and150cm with each intra-row spacing 30cm and 45cm with row proportion of 1:2, 1:3 and 1:4 respectively in intercropped treatments tried. Other two sole cropping treatments of both the component crops (pigeonpea - 90 x 20cm and niger – 30 x10cm). The plants from net plot were harvested from the ground level and were left for sun drying *in-situ*. The pigeonpea and niger were threshed manually. Grains were cleaned and weighed for expressing yields in kg ha<sup>-1</sup>. The weight of stalks was recorded separately and used for estimating stover yield. Pigeonpea-equivalent yield was calculated by converting the

grain yield of niger into pigeonpea yield on the basis of existing market price of the crops. Net monetary returns and benefit: cost ratio was computed by using the prevailing rates of produce and agro-inputs.

### Result and Discussion

#### Yield

The increased pigeonpea yield per hectare in narrow planting geometry might be attributed to increased plant population pressure which facilitated more uptakes of nutrients and soil moisture per unit area coupled with better interception of light which might have increased leaf area and leaf mass which resulted in better translocation of photosynthates which might have contributed towards the development of plant and finally increased pigeonpea seed yield (kg ha<sup>-1</sup>). Such type of advantages with dense planting geometry on pigeonpea yield was reported by Patil and Joshi (2002) [4], Yadav and Maurya (2012) [10], Sonawane *et al.* (2011) [7] and Rathod *et al.* (2004). Stalk yield (kg ha<sup>-1</sup>) and biological yield (kg ha<sup>-1</sup>) of pigeonpea showed similar trend as that of seed yield (kg ha<sup>-1</sup>) of pigeonpea. The higher Stalk yield (kg ha<sup>-1</sup>) and biological yield (kg ha<sup>-1</sup>) of pigeonpea was recorded in dense planting geometry i.e. sole pigeonpea (90 x 20cm) and it was substantially higher than rest of the row spacings and planting geometries (Table 1). 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. This indicated that higher plant population with better crop geometry harvested maximum sun light, space and nutrients and resulted into higher growth and more dry matter accumulation with agreement of the research findings of Sonawane *et al.* (2011) [7].

Higher niger seed yield (853.9 kg ha<sup>-1</sup>), straw yield (4652.66 kg ha<sup>-1</sup>) an biological yield (5506.56 kg ha<sup>-1</sup>) were recorded in sole planting of niger (30 x 10cm) (table 1). Similar findings were also reported by Patil and Joshi (2002) [4], Yadav and Maurya (2012) [10] and Sonawane *et al.* (2011) [7].

Pigeonpea equivalent yield (kg ha<sup>-1</sup>) differed markedly among the treatments comprising of planting geometry adapted to pigeonpea and proportions of pigeonpea and niger (Table 2). Significantly higher pigeonpea equivalent yield (1721.01 kg ha<sup>-1</sup>) was obtained in narrow planting geometry of sole pigeonpea (90 x 20cm). The higher pigeonpea equivalent yield was due to higher seed yield of pigeonpea. The results are in line with the findings of research conducted on competitive performance of pigeonpea based intercropping systems in northern transitional zone of Karnataka by Rathod *et al.* (2004). The lower pigeonpea equivalent yield (kg ha<sup>-1</sup>) was recorded in wider planting geometry of pigeonpea + niger (150 x 45cm) row proportion (898.66 kg ha<sup>-1</sup>). This could be attributed to lesser aggressivity of pigeonpea in pigeonpea + niger intercropping system.

**Table 1:** Seed yield (kg ha<sup>-1</sup>), stalk yield (kg ha<sup>-1</sup>), biological yield (kg ha<sup>-1</sup>) and harvest index (HI) (%) of pigeonpea and niger as influenced by different treatments.

Treatment	Seed yield (kg ha <sup>-1</sup> )		Stalk yield (kg ha <sup>-1</sup> )		Biological yield (kg ha <sup>-1</sup> )		Harvest index (%)	
	Pigeonpea	Niger	Pigeonpea	Niger	Pigeonpea	Niger	Pigeonpea	Niger
T <sub>1</sub> (PP + Niger) (1: 2) 90 x 30cm + 30 x 10cm	1070.74	699.8	3725.26	3398.82	4796.0	4098.62	22.35	17.07
T <sub>2</sub> (PP + Niger) (1: 2) 90 x 45cm + 30 x 10cm	734.56	703.4	2968.43	3451.08	3703.0	4154.48	19.83	16.93
T <sub>3</sub> (PP + Niger) (1: 3) 120 x 30cm + 30 x 10cm	1022.77	760.8	3213.24	3796.70	4236.0	4557.50	24.14	16.69
T <sub>4</sub> (PP + Niger) (1: 3) 120 x 45cm + 30 x 10cm	718.66	762.5	2617.35	3828.62	3336.0	4591.12	21.54	16.60
T <sub>5</sub> (PP + Niger) (1: 4) 150 x 30cm + 30 x 10cm	722.80	790.0	2871.20	3882.65	3594.0	4672.65	20.11	16.90

T <sub>6</sub> (PP + Niger) (1: 4) 150 x 45cm + 30 x 10cm	494.14	795.2	2382.85	3901.32	2877.0	4696.52	17.15	16.93
T <sub>7</sub> (Sole pigeonpea) 90 x 20cm	1650.00	---	5165.00	---	6815.0	---	24.21	---
T <sub>8</sub> (Sole niger) 30 x 10cm	---	853.9	---	4652.66	---	5506.56	---	15.50
SE ±	24.996	23.76	318.9	261.58	280.60	282.69	---	---
CD at 5%	95.64	72.0	966.29	792.60	850.24	856.56	---	---

**Table 2:** Yield of crops and pigeonpea equivalent yield as influenced by different treatments

Treatment	Seed yield (kg ha <sup>-1</sup> )		Pigeonpea equivalent yield (kg ha <sup>-1</sup> )
	Pigeonpea	Niger	
T <sub>1</sub> (PP + Niger) (1: 2) 90 x 30cm + 30 x 10cm	1070.74	699.8	1311.81
T <sub>2</sub> (PP + Niger) (1: 2) 90 x 45cm + 30 x 10cm	734.56	703.4	1077.77
T <sub>3</sub> (PP + Niger) (1: 3) 120 x 30cm + 30 x 10cm	1022.77	760.8	1384.05
T <sub>4</sub> (PP + Niger) (1: 3) 120 x 45cm + 30 x 10cm	718.66	762.5	1127.64
T <sub>5</sub> (PP + Niger) (1: 4) 150 x 30cm + 30 x 10cm	722.80	790.0	1321.16
T <sub>6</sub> (PP + Niger) (1: 4) 150 x 45cm + 30 x 10cm	494.14	795.2	981.99
T <sub>7</sub> (Sole pigeonpea) 90 x 20cm	1650.00	---	1650.00
T <sub>8</sub> (Sole niger) 30 x 10cm	---	853.9	646.76
SE ±	24.996	23.76	188.00
CD at 5%	95.64	72.0	564.00

Minimum support price: pigeonpea – Rs.5050/- q<sup>-1</sup> (Recommended /Fixed).

Minimum support price: niger – Rs. 3825/- q<sup>-1</sup> (Recommended /Fixed).

Source of MSP - [cacp.dacnet.nic.in](http://cacp.dacnet.nic.in) (Anonymous, 2017).

### Economics

Costs of cultivation (Rs.23,325/- ha<sup>-1</sup>) were recorded maximum when pigeonpea + niger crops were planted in narrow planting geometry i.e. 90 x 30 cm. It might be due to maximum seed requirement of pigeonpea + niger for sowing under respective treatment.

The maximum gross monetary return (Rs.87198/- ha<sup>-1</sup>) and net monetary return (Rs.63914/- ha<sup>-1</sup>) from sole pigeonpea were recorded in narrow planting geometry (90 x 20cm) which was significantly higher than rest of the different row proportions and planting geometries (pigeonpea + niger) which may be due to higher yield and absence of aggressivity of the intercrop. Among different pigeonpea and niger row proportions, 1:3 recorded highest net returns (Rs.49983/- ha<sup>-1</sup>)

<sup>1</sup>). The results are in conformity with those reported by Lingaraju *et al.* (2008) from Bheemarayanagudi (Karnataka). Maximum B: C ratio was recorded with narrow planting geometry of sole pigeonpea (3.74) i.e. 90 x 20cm, lowest with sole niger (1.12) i.e. 30 x 10cm and intermediate (2.26-3.14) with different intercropping system, due to variance in gross monetary returns of different treatments.

From the results, it could be concluded that, farmer can obtained higher pigeonpea equivalent yield (PEY), GMR, NMR. B:C ratio under sole pigeonpea T<sub>7</sub> with closer planting geometry of 90 × 20cm (1650 kg ha<sup>-1</sup>) (Table 3). Among intercropping system T<sub>3</sub> (120 × 30cm) recorded highest PEY, LER, GMR, NMR. B:C ratio over all other treatments.

**Table 3:** Gross monetary returns (GMR) (× 10<sup>3</sup>/- ha<sup>-1</sup>), Cost of cultivation (× 10<sup>3</sup>/- ha<sup>-1</sup>), net monetary returns (NMR) (× 10<sup>3</sup>/- ha<sup>-1</sup>), and benefit: cost ratio (B: C ratio) of pigeonpea + niger intercropping system as influenced by different treatments.

Treatment	GMR (× 10 <sup>3</sup> /- ha <sup>-1</sup> )	COC (× 10 <sup>3</sup> /- ha <sup>-1</sup> )	NMR (× 10 <sup>3</sup> /- ha <sup>-1</sup> )	B:C
T <sub>1</sub> (PP + Niger) (1: 2) 90 x 30cm + 30 x 10cm	69.890	23.325	46.565	2.95
T <sub>2</sub> (PP + Niger) (1: 2) 90 x 45cm + 30 x 10cm	57.516	23.192	34.324	2.47
T <sub>3</sub> (PP + Niger) (1: 3) 120 x 30cm + 30 x 10cm	73.253	23.270	49.983	3.14
T <sub>4</sub> (PP + Niger) (1: 3) 120 x 45cm + 30 x 10cm	59.866	23.171	36.695	2.58
T <sub>5</sub> (PP + Niger) (1: 4) 150 x 30cm + 30 x 10cm	69.842	23.225	46.617	3.00
T <sub>6</sub> (PP + Niger) (1: 4) 150 x 45cm + 30 x 10cm	52.353	23.146	29.206	2.26
T <sub>7</sub> (Sole pigeonpea) 90 x 20cm	87.198	23.284	63.914	3.74
T <sub>8</sub> (Sole niger) 30 x 10cm	25.901	23.062	2.839	1.12
SE ±	3.252	1.22	3.19	----
CD at 5%	9856.23	NS	9.6	----

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