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GROWTH AND YIELD ADVANTAGES OF PIGEONPEA WITH SESAME INTERCROPPING SYSTEM INFLUENCED BY NUTRIENT MANAGEMENT

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KEYWORDS

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ABSTRACT

A field experiment was conducted at Agricultural College Farm, Raichur during *kharif* 2014 to find out optimum dose of fertilizer to intercropping system and to assess the crop growth and assessment of yield advantages. The experiment was laid out in randomized block design (RBD) with three replications and ten treatment combinations. The results revealed that the application of 100 per cent recommended dose of fertilizers (T_1 and T_2 respectively) significantly found higher leaf area at 90 days (42.49 dm^2 $plant^{-1}$ and 256.13 cm^2 $plant^{-1}$), leaf area index (1.574 and 0.569) and dry matter production at harvest (166.33 and 29.93g $plant^{-1}$) in sole pigeonpea and sesame crops compared to other intercropped treatments. However, application of 100 per cent recommended dose of fertilizer to both the component crops in pigeonpea + sesame intercropping system significantly increased the yields of both crops over other lower doses of fertilized treatments. The maximum pigeonpea equivalent yield (2312 and 2615 kg ha^{-1}), land equivalent ratio (1.46 and 1.65), and area time equivalent ratio (1.23 and 1.36) (T_5 and T_6 respectively). This finding with judicious application of fertilizers will be affordable to achieve higher productivity of the system.

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INTRODUCTION

The greatest challenge of the 21st century in many developing countries is to produce more and more basic necessities namely food, fodder, fuel and fibre for ever increasing human and animal population from the limited available land. Nearly 90 per cent of the food requirements will have to come from land based farming. The availability of land for agriculture is shrinking every day as it is increasingly utilized for non-agricultural purposes. Under this situation, one of the important strategies to increase agricultural productivity and intensive land use is development of high intensity cropping systems including intercropping system.

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is the second most important pulse crop of India after chickpea. It is cultivated in a multitude of production systems for a diversity of uses *viz.,* grain as dhal, green seed as a vegetable and stalk as fuel wood. Pigeonpea is commonly known in India as redgram or arhar or tur. Pigeonpea is predominantly grown in India during *kharif* season both as a sole crop and as intercrop, and found in wide range of Agro-ecological situations. In India, pigeonpea occupied around 3.89 million ha with the production of 3.02 million tones and 776 kg ha^{-1} productivity (DAC, 2014). Pigeonpea offers a good scope for intercropping with fast growing early maturing and shallow rooted crops (Ramamoorthy *et al.,* 2004). Its deep rooting and drought tolerating character make it a successful crop in areas of low and uncertain rainfall.

Sesame or gingelly (*Sesamum indicum* L.) is an ancient oilseed crop grown in India and it occupies an important place in oilseed scenario of the country next only to groundnut, rapeseed and mustard. Sesame seed is a rich source of edible oil (46 – 52%). In India, 78 per cent of sesame production goes for oil extraction, 20 per cent for domestic use (culinary purpose) and two per cent for next sowing. It is grown in an area of 74.058 lakh hectares with production of 39.592 lakh tonnes and productivity of 535 kg ha^{-1} (Anon., 2012).

Pigeonpea, a deep rooted crop with slow initial growth rate between 45 and 60 days after sowing is well suited for intercropping. Intercropping is an intensive land use system with an objective to utilize the space between the rows of main or base crop and to produce more crop per unit area. The space between the rows could be effectively utilized by growing a short duration crop which may generate an additional income without adversely affecting the yield of pigeonpea (Jat and Ahlawat, 2010). Sesame being a short duration crop fits well as an intercrop with pigeonpea. These crops are grown without any fertilizers or the fertilizers are being applied only for the main crop and that too in small quantity. This coupled with lack of proper management practices has led to lower production of both the crops. But similar scientific research on nutrient management practices for pigeonpea and sesame intercropping system is lacking and as such there are no recommendations. Keeping these points view, a field investigation was carried out to work out the suitable nutrient management practice as well as cropping system for higher productivity and monetary advantage in rainfed pigeonpea and sesame intercropping system.

MATERIALS AND METHODS

The soil of the experiment field was medium black having bulk density of 1.32

mg m^{-3}. The soil had 8.38, 0.16 dS/m and 0.56 per cent of pH, electrical conductivity and organic carbon, respectively. The soil had fertility status of 235.29 kg nitrogen ha^{-1}, 33.23 kg phosphorus ha^{-1} and 258.12 kg potassium ha^{-1}. The distribution of rainfall was good during the crop season (875 mm). The experiment comprised of 10 nutrient treatments (8 intercropped treatments and 2 sole crop treatments). The experiment was laid out in randomized block design with three replications. The gross plot was 7.2m x 4.8m and net plot size of intercropped treatments, sole pigeonpea and sole sesame was 5.4 m x 3.6 m, 5.4 m x 3.6 m and 6.0 m x 4.2 m, respectively. Pigeonpea (TS-3R) and sesame (DS-1) were sown in 1:2 row ratio by providing 90cm x 30cm spacing for sole pigeonpea, 30cm x 15cm for sole sesame and in intercropping 30cm was given as intra row space for pigeonpea and 15cm for intra row space for sesame. The fertilizers were applied as per treatment on the basis of actual population occupied by component crop considering their recommended dose of fertilizers. The fertilizers was applies 5cm away from seed line. Observations on growth and yield attributes were recorded for both the component crops. Data on yield parameters was collected and economics of cropping system was estimated.

Land equivalent ratio (LER): It was calculated by the formula suggested by (Willey, 1979).

$$\text{LER} = \frac{\text{Yield of pigeonpea in intercropping system}}{\text{Yield of sole pigeonpea}} + \frac{\text{Yield of sesame in intercropping system}}{\text{Yield of sole sesame}}$$

Pigeonpea equivalent yield (PEY): calculated by the formula

$$\text{PEY} = \frac{\text{Yield of sesame x Price of sesame}}{\text{Price of pigeonpea}} + \text{Yield of pigeonpea}$$

Area Time Equivalent Ratio (ATER): It was calculated according to formula given by Hiebsch (1980).

$$\text{ATER} = \frac{(\text{RYs x ts}) + (\text{RYp x tp})}{\text{T}}$$

Where,

RY = Relative yield of species s and p

$$= \frac{\text{Yield of intercrop per hectare}}{\text{Yield of monocrop per hectare}}$$

t = duration (days) for species s and p

T = Total duration (days) of the intercropping system

RESULTS AND DISCUSSION

Growth of pigeonpea and sesame

The data regarding leaf area and leaf area index has been presented in Table 2. Significantly the highest leaf area (42.49 dm^2 $plant^{-1}$ and 256.13 cm^2 $plant^{-1}$) and leaf area index (1.574 and 0.569) was recorded in sole pigeonpea and sesame crops with 100 per cent recommended dose of fertilized treatments (T_1 and T_2). The observations revealed that better leaf area development (37.01 dm^2 $plant^{-1}$ and 224.57 cm^2 $plant^{-1}$) was recorded over treatments which received 100 per cent RDF to both pigeonpea and sesame crops (T_4 and T_6 respectively,). This might be attributed to competition between inter and intra row plants for the resources and space which encouraged vertical growth rather than horizontal growth. Same outcome was reported by Darshan (2008). The depletion of nutrients from low fertilized treatements over time because of competitive interaction, plants owing to inadequate supply of nutrients lower thickness of individual leaf, which in turn might have reduced the photosynthetic efficiency of plant leading lower leaf area in intercrops. This finding was consonance with

Table 1: Productivity, land equivalent ratio and area time equivalent ratio of pigeonpea and sesame intercropping (1:2) system influenced by nutrient management

Treatments	Pigeonpea yield (kg ha^{-1})	Sesame yield (kg ha^{-1})	PEY (kg ha^{-1})	LER	ATER
T_1 Sole pigeonpea with 100% RDF	1613	-	1613	1.00	1.00
T_2 Sole sesame with 100% RDF	-	584	1557	1.00	1.00
T_3 100% RDF to pigeonpea and no fertilizer to sesame	1362	185	1855	1.18	1.05
T_4 125% RDF to pigeonpea and no fertilizer to sesame	1412	190	1919	1.22	1.09
T_5 100% RDF to pigeonpea and 50% RDF to sesame	1371	353	2312	1.46	1.23
T_6 100% RDF to pigeonpea and 100% RDF to sesame	1399	456	2615	1.65	1.36
T_7 100% RDF of pigeonpea to all rows of both the crops and without RDK to sesame	1175	286	1938	1.22	1.04
T_8 125% RDF of pigeonpea to all rows of both the crops and without RDK to sesame	1184	311	2013	1.27	1.07
T_9 100% RDF of pigeonpea to all rows of both crops and100% RDK to sesame based on population	1179	361	2142	1.35	1.12
T_{10} 125% RDF of pigeonpea to all rows of both crops and 100% RDK to sesame based on population	1188	384	2212	1.40	1.15
S. Em.±	58	12	42	0.02	0.02
C.D.(P=0.05)	173	36	125	0.07	0.06

RDF: Recommended Dose of Fertilizer ; RDF of pigeonpea: 25:50 kg ha^{-1} of N and P_2O_5; RDK: Recommended Dose of Potassium; RDF of sesame: 50:25:25 kg ha^{-1} of N, P_2O_5 and K_2O

Table 2: Leaf area, leaf area index and dry matter production of pigeonpea and sesame intercropping (1:2) system as influenced by nutrient management

Treatments	Leaf area at 90 Days		Leaf area index (LAI)		Dry matter production at harvest (g plant^{-1})	
	pigeonpea (dm^2 plant^{-1})	sesame (cm^2 plant^{-1})	pigeonpea	sesame	pigeonpea	sesame
T_1 Sole pigeonpea with 100% RDF	42.49	-	1.574	-	166.33	-
T_2 Sole sesame with 100% RDF	-	256.13	-	0.569	-	29.93
T_3 100% RDF to pigeonpea and no fertilizer to sesame	36.05	123.49	1.335	0.183	132.97	16.21
T_4 125% RDF to pigeonpea and no fertilizer to sesame	37.01	123.61	1.371	0.183	133.60	16.35
T_5 100% RDF to pigeonpea and 50% RDF to sesame	36.30	189.43	1.344	0.281	133.12	23.72
T_6 100% RDF to pigeonpea and 100% RDF to sesame	36.77	224.57	1.362	0.333	133.38	26.13
T_7 100% RDF of pigeonpea to all rows of both the crops and without RDK to sesame	31.17	115.15	1.154	0.230	124.73	21.39
T_8 125% RDF of pigeonpea to all rows of both the Crops and without RDK to sesame	32.53	156.98	1.205	0.233	125.14	21.59
T_9 100% RDF of pigeonpea to all rows of both crops and100% RDK to sesame based on population	31.18	190.04	1.155	0.282	124.93	23.87
T_{10} 125% RDF of pigeonpea to all rows of both crops and 100% RDK to sesame based on population	32.77	191.12	1.214	0.283	125.36	23.99
S. Em.±	1.06	10.49	0.039	0.016	2.17	0.54
C.D.(P=0.05)	3.17	31.45	0.117	0.046	6.44	1.63

RDF: Recommended Dose of Fertilizer; RDF of pigeonpea : 25:50 kg ha^{-1} of N and P_2O_5; RDK: Recommended Dose of Potassium; RDF of sesame : 50:25:25 kg ha^{-1} of N, P_2O_5 and K_2O

Thippeswamy and Alagundagi (2001). The improvement in leaf area may be attributed to good leaf area index was found significantly higher in T_4 and T_6 (125 and100 per cent RDF to both pigeonpea and sesame) respectively in intercropped treatments. This may due to intercropping with pigeonpea to that of sole crop of sesame.LAI 90 DAS was decreased due to intercropping, but there no remarkable difference between the sole and intercrop pigeonpea. Similar findings reported by (mandal *et al.,* 2014).

Dry matter production was highly influenced by nutrient application. The observations for dry matter production indicated in (Table 2). The dry matter production at harvest was mainly influenced by assimilatory surface area and its photosynthetic ability. Dry matter production increased steadily with advancing growth stages and reached maximum at harvest (Udaya nandini *et al.,* 2015). Significantly higher dry matter production (166.33 and 29.93g plant^{-1}) was recorded in treatments assisted with 100 per cent RDF to both crops

(T_1 and T_2). Among the intercropping system higher dry matter production (133.60 and 26.13g plant^{-1}) found more to be treatments with 125 and 100 per cent RDF to pigeonpea and sesame crops (T_4 and T_6 respectively.) This may due to competition for nutrients more in intercrops compared sole crops leading lower nutrient availability resulted in reduced leaf area which reduces the dry matter production at harvest in intercropping system was mainly attributed to reduced dry matter producing ability of intercropping system was led to the stress, which reduced the source strength and photosynthetic ability, thereby reducing sink strength by decreased translocation photosynthates lowering dry matter production (Ramamoorthy *et al.,* 2004).

Yield of pigeonpea and sesame

Intercropping reduced the yield of pigeonpea and sesame when compared to sole crop yields of both the crops. Among the different fertilizer treatments, the treatments which received 100 per cent RDF to both the crops gave significantly higher seed yield of pigeonpea (1399 and 1412 kg ha^{-1} in T_6 and T_4, respectively). Seed yield of sesame (384 and 456 kg ha^{-1} in T_{10} and T_6, respectively) when compared to low fertilized treatement (T_7) (Table 1). This was due to availability of optimum amount of nutrients at disposal of pigeonpea and sesame and reducing the competition between both the crops which enhanced better root development and greater dry matter production by the crops under an adequate and balanced nutritional environment, Similar results have been reported by jain *et al.* (2001). Itnal *et al.* (1994), paslawar *et al.* (1997), Gupta and Rathore (1995).

Pigeonpea equivalent yield

The intercropping system had a significant influence in gaining higher pigeonepa equivalent yield over either of sole cropping except unfertilized treatment (T_3). This was extent over sole cropped pigeonpea. Among the intercropping treatments, T_5 and T_6 indicated significantly higher pigeonpea equivalent yield over other treatments (2312 and 2615 kg ha^{-1}) (Table 1). This was due to higher seed yield of component crops owing to optimum nutrient availability (100 % RDF to both the crops) coupled with higher price of both the crops contributed to higher pigeonpea equivalent yield. Similar results were obtained (Behera *et al.,* 1999), (Ved Prakash *et al.,* 2004) (Arjun Sharma and Guled, 2012).

Land equivalent ratio (LER) and area time equivalent ratio (ATER)

The land equivalent ratio and area time equivalent ratio revealed the merits of intercropping system. All the intercropped fertilized treatments recorded significantly higher land equivalent ratio except unfertilized treatment (T_3). Higher land equivalent ratio of 1.46 and 1.65 was obtained in the treatments T_5 and T_6, respectively. Thus, the yield advantage of about 18 to 65 per cent was obtained due to fertilization of pigeonpea and sesame intercropping over their sole cropping. Higher area time equivalent ratio of 1.36 was recorded in treatment T_6 (100% RDF to pigeonpea and 100% RDF to sesame). These values indicated that intercropping system was highly efficient in utilizing the growth resources than sole cropping of both crops (Table 1). Land equivalent ratio and area time equivalent ratio obtained in unfertilized treatment suggested that without proper fertilizer management in intercropping system yield advantages could not be achieved. Similar results of higher LER and ATER were reported by several workers (Agasimani *et al.,* 1994, Rakesh and Rajput, 1996, Jain *et al.,* 2001, Verma *et al.,* 2005).

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