The Bioscan 10(3): 339-343, 2015 (Supplement on Agronomy)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

EFFECT OF INCORPORATION OF FYM, PIGEONPEA STALK, PHOSPHOCOMPOST ON GROWTH, YIELD AND NUTRIENT UPTAKE IN PIGEONPEA BASED INTERCROPPING SYSTEM

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KEYWORDS
FYM
Intercropping
Nutrient uptake
PEY and Yield

Received on :
18.09.2015

Accepted on :
29.11.2015

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ABSTRACT
A field experiment was conducted to study the response of organic manure (FYM) and crop residue (Pigeonpea stalk) on pigeonpea intercropped with greengram and blackgram (1:2) on Inceptisolat Pulses Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra) during *kharif* season of 2013-14. Among different cropping system Pigeonpea + blackgram intercropping system recorded maximum number of branches (16.31), dry matter accumulation (97.53 g), number of pods plant^{-1} (106.7), test weight (8.49 g), grain weight plant^{-1} (33.88 g), pigeonpea equivalent yield(2002 kg ha-1)and harvest index (26.1 %)while highest plant height (175.3 cm), seed yield, straw yield, biological yield(1601, 5146, 6710 kg ha^{-1} respectively) and N, P, K, uptake(92.5, 9.6, 58.4 kg ha-^{1} respectively) were recorded in sole pigeonpea. In case of total nutrient uptake highest uptake of [N and P(105.8, 19.3 kg ha^{-1}) respectively] was recorded with Pigeonpea + blackgram intercropping system over remaining intercropping system, however, uptake of potassium was more with (58.4kg ha^{-1}) sole pigeonpea. Among nutrient management application of inorganic fertilizer (25:50 kg N:P_2O_5 ha^{-1}) and organic manures in combination with phosphocompost recorded statistically equivalent growth and yield attributes andNPK uptake.

INTRODUCTION

Pigeonpea (*Cajanuscajan*(L.)Millsp.)ranks sixth in global grain legume production and worldwide it is cultivated in about 4.70 M ha area with annual production of 3.69 M t and a mean productivity of 783 kg ha^{-1}. India is largest producer is the largest producer, with about > 3 million tons, accounting of about 80% of total world production. Production is concentrated in central and southern part of India. However, area under this crop in Maharashtra is 11.80 lakh ha with production of 9.66 lakh tonnes (DAC, 2014).

Pigeonpea, a deep rooted crop with slow initial growth rate between 60 and 70 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 produce per unit area(Singh et al., 1986).The space between the rows could be effectively utilized by growing a short duration crop, which may generate an additional income besides the benefits of suppressing weeds and spreading the risk involved without adversely affecting the yield of pigeonpea(Jat and Ahlawat, 2010).There is a growing interest among the farmers to cultivate crops under organic farming because of the escalating cost of inorganic fertilizers' decreased soil fertility, environmental and health concerns due to pesticide usage and expected premium prices for organically grown crops (Ramesh *et al.,* 2005).

In order to make organic farming more viable in pulse based intercropping system where phosphorous requirement is crucial and to meet phosphorous requirement judicious use of manures like farm yard manure (FYM) or crop residues like pigeonpea stalk with phosphocompost is found to be useful. However, biomass production through a legume cover cropping and its incorporation in the soil can be another strategy to overcome the limitation of organic matter availability (Venkateswarlu*et al*. 2005). The sole use of inorganic fertilizer depleted the natural resources. Excessive applications of these fertilizers not only pollute underground water, but also produce certain undesirable chemicals through the process like volatilization, denitrification, etc. thereby causing various diseases in plants and animals. Keeping all the views in mind an experiment was conducted to study the effect of incorporation of fym, pigeonpea stalk, phosphocompost on growth, yield and nutrient uptake in pigeonpea based intercropping system.

MATERIALS AND METHODS

A field experiment was conducted at Pulses Research Unit, Dr.Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra which is geographi cally located at north latitude of 220 42' and East longitudes of 770 02' and at an altitude of 307.42 m above mean sea level during *kharif*season of 2013-14 on Inceptisol. Pigeonpea crop cultivar PKV TARA was used as main crop and greengram cultivar PKV Greengold and blackgram cultivar PKV Udid-15 were used as intercrops for study.The experiment was laid out in split plot design (SPD) with three replication consisting three cropping system *viz.,* pigeonpea + greengram (1:2), pigeonpea + blackgram (1:2)

and sole pigeonpeaand three levels of organic manure FYM + phosphocompost, Pigeonpea stalk + phosphocompost and RDF (25:50 kg N:P_2O_5 ha^{-1}). Five plants in each treatment in the net plot area were selected at random and tagged for biometric observations. While taking observations, five plants from sampling rows were pulled off in each treatment plot for recording dry matter production.Theintercrops were incorporated within the interspaces after picking of pods of greengram and blackgram. Seed and straw sample were analysed for nutrient content by standard procedure given by Piper (1966). Based on nutrient content of plants and dry matter production, uptake of nitrogen, phosphorus and potassium were worked out. The economics was computed by considering 15% higher organic price premium over RDF (Gopinath and Mina, 2011).The statisticalanalysis was done as per procedure suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Growth attributes

Results of the experiment shows that growth attributes(plant height, number of branches and dry matter accumulation) of pigeonpea were significantly influenced by the intercropping system at harvesting stages but did not significantly influence by organic manure system. Higher plant height was recorded with sole pigeonpea (175.3cm) compared to intercropping system at harvest. Among intercrops greengram recorded higher plant height than blackgram at different growth stages and it did not showed any ailing effect on the growth of the base crop. Here, it may be pointed out that the competition under sole pigeonpea for space, sunlight, nutrients and water was more than pigeonpea + blackgram and pigeonpea + greengram intercropping system which resulted poor growth and development of pigeonpea under sole cropping. Further blackgram and greengram also improved the fertility status and physical condition of soil which augmented growth of pigeonpea under pigeonpea + blackgram and pigeonpea + greengram intercropping system. The results were in conformity with Rathod *et al*. (2004), Shanmugam (2008), Kumawat *et al*. (2013) and Kumar *et al*. (2015). While significantly highest numbers of total branches (16.31) and dry matter accumulation (97.53 g) were recorded with pigeonpea + blackgram and pigeonpea + greengram intercropping system compared to sole pigeonpea. This observation was in conformation with Verma and Warsi (1997) and Kumar (2012) were observed that the intercropped pigeonpea recorded significantly more branches and dry matter accumulation when compared to sole pigeonpea as it is free from competition. Combined application of organic manure (FYM) and crop residue (pigeonpea stalk) along with phosphocompost and chemical fertilizer alone showed statistically identical increase in plant height, total number of branches and dry matter accumulation per plant at all the growth stages of pigeonpea. However, higher values for plant height of base and intercrops were recorded with RDF alone as compared to combined application of FYM + phosphocompost and pigeonpea stalk + phosphocompost. It might be due to nutrient management through organic manure (FYM), crop residue (Pigeonpea stalk) with phosphocompost and chemical fertilizers alone enhanced the availability of these nutrients (major and micronutrients) to plants resulted in profuse shoot and root growth, and thereby activating greater absorption of these nutrients from soil. Among component crops numerically higher plant height of greengram and blackgram was recorded at 30 DAS to harvest with the application of RDF.Similar results were also confirmed with Ramesh *et al*. (2006).

Yield attributes

Number of pods per plant (106.7) and seed weight (33.88 g) per plant was significantly highest with pigeonpea + blackgram followed by pigeonpea + greengram and lowest with sole pigeonpea. The results of present investigations are in harmony with the findings of Shanmugam (2008) and Tiwari *et al*. (2011). Whereas numerically highest test weight of pigeonpea was recorded in pigeonpea + blackgram (8.49 g)intercropping system over pigeonpea + greengram (8.47 g) intercropping system followed by sole pigeonpea (8.46 g). It might be due to better utilization of moisture and nutrient. Similar results were reported by Tiwari *et al*. (2011).Number of pods per plant, seed weight per plant and test weight of pigeonpea was not significantly influenced by combined application of organic manure viz. FYM + phosphocompost and pigeonpea stalk + phosphocompost and RDF alone.Due to addition of organic sources improve the soil physical properties thereby increase the porosity and infiltration rate consequently reduce the runoff and soil loss and conserve the moisture for longer period. The result is in cohesion with of Ramesh *et al*. (2006).

Effect on yield

The highest seed yield (1601 kg ha^{-1}),straw yield (5146 kg ha^{-1}) and biological yield (6710 kg ha^{-1}) were recorded in sole pigeonpea followed by pigeonpea + blackgram and lowest with pigeonpea + greengram. Whereas in blackgram and greengram were recorded 859 and 607 kg ha^{-1}. The higher seed yield was obtained in sole pigeonpea due to higher plant population resulted. Cumulative effects of these factors resulted in more yield of pigeonpea with blackgram followed by greengram as an intercrop. Similar results were found by Shanmugam (2008) and Dudhade *et al*. (2009).The higher biological yield obtained from sole pigeonpea, this might be due to higher dry matter accumulation of pigeonpea over

Table 1: Chemical composition and quantity of nutrient added to soil through different sources

Sr.n.	Organic manures	Nutrient content of organics sources (%)			Quantity of nutrient added in soil (kg/ha)		
		N	P	K	N	P	K
1.	25% N through FYM(12.50 q/ha)	0.48	0.20	0.44	6.25	2.50	5.50
2.	Phosphocompost(24.4 q/ha)	1.23	1.94	0.70	30.25	47.35	17.08
3.	25% N through Pigeonpea stalk (4.46 q/ha)	1.40	0.20	0.89	6.25	0.90	4.00
4.	Phosphocompost (25 q/ha)	1.23	1.94	0.70	30.75	48.50	17.50
5.	100% RDF	-	-	-	25	50	00

Table 2: Growth and yield attributes of pigeonpea, greengram and blackgram as influenced by different treatments

Treatment	Plant height (cm)			Number of branches plant^{-1}			Dry matter accumulation plant^{-1} (g)			No. of pods plant^{-1}			Seed weight plant^{-1} (g)			Test weight (g)		
	At harvest			At harvest			At harvest			At harvest			At harvest			At harvest		
	Main crop	Intercrop		Main crop	Intercrop		Main crop	Intercrop		Main crop	Intercrop		Main crop	Intercrop		Main crop	Intercrop	
	PP	GG	BG	PP	GG	BG	PP	GG	BG	PP	GG	BG	PP	GG	BG	PP	GG	BG
A) Main plot (Cropping systems)																		
C_1 - PP + Greengram (1:2)	168.7	40.6	-	15.69	5.3	-	96.11	5.9	-	103.3	11	-	32.1	5.2	-	8.47	3.2	-
C_2 - PP + Blackgram (1:2)	169.9	-	36	16.31	-	6	97.53	-	6.7	106.7	-	16	33.88	-	6.8	8.49	-	4.1
C_3 - Sole pigeonpea	175.3	-	-	14.64	-	-	88.72	-	-	96.1	-	-	29.59	-	-	8.46	-	-
SE(m) ±	0.54	-	-	0.1	-	-	0.83	-	-	0.97	-	-	0.13	-	-	0.04	-	-
CD at 5%	2.12	-	-	0.38	-	-	3.26	-	-	3.81	-	-	0.5	-	-	NS	-	-
B) Subplot (Organic manure)																		
M_1 - 25% N through FYM (12.5 q/ha) + PC (24.4q/ha)	171.3	41.6	36	15.53	5.1	6	94.23	5.9	6.7	102.3	10	16	31.78	5.1	6.7	8.47	3.2	4.1
M_2 - 25% N through PP stalk (4.46 q/ha) + PC (25 q/ha)	171.1	38	34	15.42	5.1	5.9	93.84	5.8	6.5	100.5	11	16	31.67	5.2	6.8	8.44	3.2	4.1
M_3 - RDF (25:50 kg N:P_2O_5/ha)	171.5	42.1	37	15.69	5.6	6.2	94.29	6.1	6.8	103.3	12	16	32.12	5.3	6.9	8.51	3.2	4.2
SE(m) ±	0.43	-	-	0.1	-	-	0.7	-	-	0.77	-	-	0.13	-	-	0.03	-	-
CD at 5%	NS	-	-	NS	-	-	NS	-	-	NS	-	-	NS	-	-	NS	-	-

*PP-Pigeonpea, GG-Greengram, BG-Blackgram, PC- Phosphocompost, FYM-Farm yard manure, RDF-Recommended dose of fertilizer

intercropping system. The significantly highest pigeonpea equivalent yield was computed in pigeonpea + blackgram intercropping system (2002 kg/ha), followed by pigeonpea + greengram intercropping system (1725 kg/ha) and lowest with sole pigeonpea (1601 kg/ha). This might be due to higher grain yield of pigeonpea coupled with higher market price of component crops under the same intercropping system. Similar results of higher pigeonpea equivalent yield were also earlier reported by Sarma *et al*. (1995), Tiwari *et al*. (2011),SaiSarvan and Ramna Murty (2014), Kumar *et al*. (2015) and Dhandayutha pani *et al*. (2015). In case of different intercropping system maximum harvest index of pigeonpea was recorded with pigeonpea + blackgram followed by pigeonpea + greengram intercropping system and sole pigeonpea. Nutrient management through combine use of FYM + phosphocompost and pigeonpea stalk + phosphocompost and RDF alone did not influence the seed yield, straw yield, biological yield and pigeonpea equivalent yield significantly. The crop of pigeonpea and component crops responds well to the combine application of FYM + phosphocompost and pigeonpea stalk + phosphocompost are good source of different primary, secondary and micronutrients. They act as slow release source of nutrient. Further, combine application of organic manure (FYM and pigeonpea stalk) with phosphocompost also helps in conversion of unavailable nutrients to available form through increased microbial activity and enabled the crop to absorb nutrients resulting in statistically identical dry matter accumulation. Besides, nutrients management through combine application of organic manure improves the physical, chemical and biological properties of the soil, which provided better conditions to the base crop (pigeonpea) as well as intercrops (blackgram and greengram). Same outcome was reported byRamesh *et al*. (2006)

Nutrient uptake

N, P, K uptake were significantly maximum with sole pigeonpea followed by pigeonpea + blackgram and pigeonpea + greengram intercropping system. With intercrops higher N, P, K uptake were recorded with blackgram followed by greengram. This might be due to sole pigeonpea recorded more biological yield over intercropping system and due to higher availability, higher uptake and greater conversion efficiency of applied nutrients by pigeonpea, through secretion of organic acids (Citric, malic, malonic, succinic and piscidic acids) from roots of pigeonpea. Similar results were also recorded by Ishikawa *et al*. (2002) and Kumar (2012). In intercropping system where the base crop is not affected by intercrop and a bonus yield of intercrop is obtained, the total system N, P, uptake by the pigeonpea + blackgram and pigeonpea + greengram intercropping system over sole pigeonpeawhereas maximum K was recorded in sole cropping than intercrop will always be higher as is evident in the present investigation. Combine application of organic manures with phosphocompost failed to affect the nitrogen, phosphorus and potassium uptake by pigeonpea and its total uptake because the growing conditions available to pigeonpea for growth and development was found to be same with combine application of organic manure (FYM) and crop residue (pigeonpea stalk) with phosphocompost and RDF alone. Similar

Table 3: Seed, straw and biological yield per hectare of base and component crops, harvest index and pigeonpea equivalent yield (PEY) as influenced by different treatments

Treatment	Seed yield (kg ha^{-1})			Straw yield (kg ha^{-1})			Biological yield (kg ha^{-1})			PEY (kg ha^{-1})	Harvest index of Pigeonpea (%)
	Main crop	Intercrop		Main crop	Intercrop		Main crop	Intercrop			
	PP	GG	BG	PP	GG	BG	PP	GG	BG		
A) Main plot (Cropping systems)											
C_1-PP + Greengram (1:2)	1125	607	-	3222	862	-	1469	-	4371	1725	25.7
C_2-PP + Blackgram (1:2)	1151	-	859	3242	-	999	-	1859	4401	2002	26.1
C_3-Sole pigeonpea	1601	-	-	5146	-	-	-	-	6710	1601	23.5
SE(m)±	36.1	-	-	54.6	-	-	-	-	76.0	33.8	-
CD at 5%	141.9	-	-	214.2	-	-	-	-	298.2	114.9	-
B) Subplot (Organic manure)											
M_1-25% N through FYM (12.5 q/ha) + PC (24.4 q/ha)	1288	582	847	3929	862	992	5216	1444	1839	1764	25.0
M_2-25% N through PP stalk (4.46 q/ha) + PC (25 q/ha)	1259	610	858	3810	855	995	5066	1464	1854	1732	24.6
M_3-RDF (25:50 kg N:P_2O_5/ha)	1330	631	873	3871	869	1011	5202	1500	1884	1832	25.7
SE(m)±	35.1	-	-	65.7	-	-	74.7	-	-	33.4	-
CD at 5%	NS	-	-	NS	-	-	NS	-	-	NS	-

*PP- Pigeonpea, GG-Greengram, BG-Blackgram, PC- Phosphocompost, FYM-Farm yard manure and RDF- Recommended dose of fertilizer.MSP (2013-14) - GG = Rs4500, BG = Rs4300 and PP = Rs4300.

Table 4: Nutrient uptake (kg ha^{-1}) by greengram, blackgram and pigeonpea and total uptake by system as influenced by different treatments

Treatment	Uptake by greengram			Uptake by blackgram			Uptake by pigeonpea			Total uptake by system		
	N	P	K	N	P	K	N	P	K	N	P	K
A) Main plot (Cropping systems)												
C_1-PP + Greengram (1:2)	30.3	9.0	12.5	-	-	-	63.4	6.7	38.5	93.7	15.7	51.0
C_2-PP + Blackgram (1:2)		-	-	41.1	12.3	17.7	64.7	6.9	38.6	105.8	19.3	56.4
C_3-Sole pigeonpea	-	-	-	-	-	-	92.5	9.6	58.4	92.5	9.6	58.4
SE(m)±	-	-	-	-	-	-	1.31	0.36	0.76	0.74	0.43	0.77
CD at 5%	-	-	-	-	-	-	4.04	1.42	3.01	2.91	1.69	3.01
B) Subplot (Organic manure)												
M_1-25% N through FYM (12.5 q/ha) + PC (24.4 q/ha)	30.5	9.2	12.6	41.4	12.5	17.9	75.5	8.0	46.4	99.5	15.4	56.6
M_2 -25% N through PP stalk (4.46 q/ha) + PC (25 q/ha)	30.2	9.0	12.4	40.8	12.2	17.7	72.0	7.5	44.5	95.7	14.5	54.6
M_3-RDF (25:50 kg N:P_2O_5/ha)	30.3	9.0	12.5	41.3	12.3	17.8	73.0	7.6	44.6	96.9	14.7	54.8
SE(m)±	-	-	-	-	-	-	1.30	0.11	0.68	1.72	0.27	0.68
CD at 5%	-	-	-	-	-	-	NS	NS	NS	NS	NS	NS

* PP-Pigeonpea, GG-Greengram, BG-Blackgram, PC- Phosphocompost, FYM-Farm yard manure, RDF-Recommended dose of fertilizer.

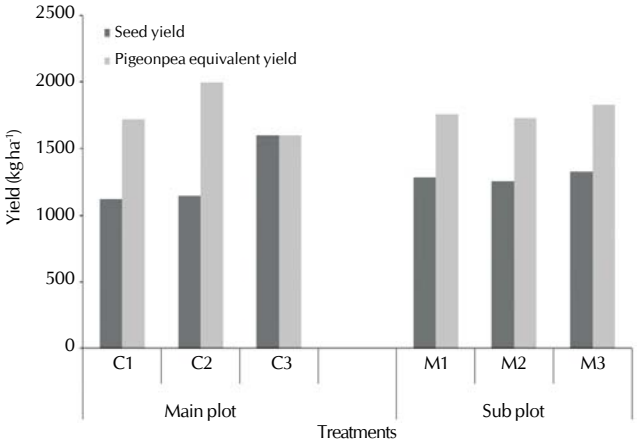

Figure 1: Seed yield and pigeonpea equivalent yield (PEY) as influenced by different treatments

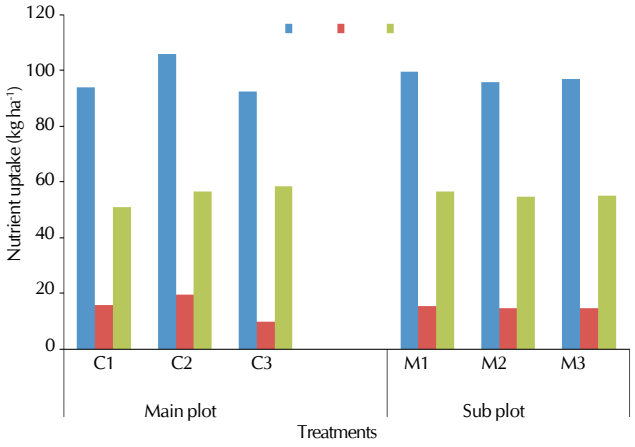

Figure 2: Total nutrient uptake of pigeonpea as influence by different treatment

trend was found with greengram and blackgram with combine application of organic manure with phosphocompost and RDF alone. It might be due to consistent supply of nutrients (N and P) and reduced rate of loss of releasing nutrients during the process of decomposition of organic manure with phosphocompost and also due to improved root growth and its functional activity which helped in greater extraction of P nutrient. The increased yield together with N and P content, by P application resulted in higher uptake of these nutrients. The observation is in close conformity to those obtained by Patra *et al*. (2011).

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