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Standardization of organic sources in pigeon pea (*Cajanus cajan* (L) Mill sp.) cultivation in scarcity condition

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Abstract
A field experiment on the Standardization of Organic Sources in Pigeon pea (*Cajanus cajan* (L) Mill sp.) cultivation in scarcity condition was conducted during *kharif* season of 2017. The experiment was laid out in Randomized Block Design (RBD) consisting of Eight treatments T_1: FYM 5 ton ha^{-1}, T_2: Vermicompost 3 ton ha^{-1}, T_3: FYM 2.5 + Vermicompost 1.5 t ha^{-1}, T_4: 100 % N through FYM, T_5: 100 % N through Vermicompost, T_6: 50 % N through FYM + 50 % N through Vermicompost, T_7: RD of Fertilizers and T_8: Control with three replications. Findings of present study showed significant differences among the performance of different organic sources. the different growth attributes of pigeon pea like plant height (210.63 cm), number of primary branches plant-^{1} (7.89), number of secondary branches plant-^{1} (18.21), dry matter plant-^{1} (221.47g) and yield attributing characters like number of pods plant-^{1} (174.49), number of seeds pod-^{1} (3.91), and higher seed yield (16.05 qt.ha-^{1}), stover yield (41.62 qt.ha-^{1}) recorded significantly maximum due to the application of 100 % N through Vermi compost (T_5) treatment which was at par with Vermi compost 3 ton ha-^{1} (T_2), and FYM 2.5 + vermi compost 1.5 ton ha-^{1} (T_3) treatment, 100 % N through FYM (T_4) than the control treatment(T_8). The]' like nitrogen, phosphorus in the soil after harvest of pigeon pea due to various organic sources treatments were observed to be significantly higher in 100 % N through vermin compost treatment which was at par with all other treatments except control. The Microbial population of bacteria (38.11 CFU × 10^{-6} g^{-1} soil), fungi (36.45 CFU × 10^{-4} g^{-1} soil) and actinomycetes (48.06 CFU × 10^{-4} g^{-1} soil) in the soil were also recorded significantly higher in the treatment 100 % N through vermicompost and all other treatment except control. Similarly, gross monetary returns (91635 ha^{-1}) was recorded maximum due to the application of 100 % N through vermicompost than the all other treatment, but Net returns(34454 ha^{-1}) was recorded maximum in Recommended Dose of fertilizers (T_7) treatment. Benefit cost ratio (1.77) was recorded maximum in the treatment application of 100 % N through FYM (T_4). Hence the application of 100 % N through vermi compost, or FYM 5 ton ha^{-1}, or 100 percentage N through FYM, was more beneficial for pigeon pea variety BSMR-736 under scarcity conditions of Dhule.

Keywords: Vermicompost, recommended dose of fertilizers pigeon pea, vegetative growth, yield attributes, grain yield

Introduction
Increased dependence on agro-chemicals including fertilizers has led to several ill effect not only on the environment but also on the health of flora and fauna including human beings. Existence of pesticide residues and heavy metals in seed spices and their products above maximum residue level (MRL) leading to less preference in markets of importing countries. The adverse impact of the modern agriculture and excess use of agro chemicals is visible everywhere throughout the world on the environment and soil health (Lal *et al.*, 2012) [5]. Recent trends in agriculture are centred on reducing the use of inorganic fertilizers by organic manures and biofertilizers (Gyaneshwar *et al.*, 2002 and Darzi *et al.*, 2011) [3, 2]. Besides improving soil health, organic manures supply the major nutrients and micronutrients (Palaniappan and Annadurai, 1999) [9].
It occupies 4.75 million hectare area in world producing 3.68 million tons with average productivity of 722 kg ha^{-1} during 2014. In India, area and production of pigeon pea is 36.3 lakh hectare and 27.6 lakh tons, respectively with average productivity is 760 kg ha^{-1} during *kharif*- 2014. In Maharashtra, the area and production of pigeon pea is about 12.37 lakh ha and4.44 lakh tons respectively, with average productivity is 359 kg ha^{-1} during 2016.

Hence, there is lot of scope to increase the yield of pigeon pea in Maharashtra as compared to world's average production. The yield of pigeon pea is limited by number of factors such as agronomic, pathogenic, entomological, genetic and there interaction with environment. Among the different factors, soil moisture becomes the most limiting factor in production of pigeon pea especially in areas having scanty and erratic rainfall. 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) [13]. One of the important aspects of organic farming is the soil fertility or nutrient management to optimize the crop productivity. The use of manures from livestock and the composts prepared from farm wastes is an important way of recycling nutrients to the soil. The management of manures within a crop rotation can have large effects on yield and crop quality. The present experiment was therefore conducted on "Standardization of organic sources in pigeon pea (*Cajanas cajan* (L) Mill Sp.) cultivation in scarcity condition" was undertaken during *kharif* season of the year 2017

Materials and methods

A field experiment on "Standardization of Organic Sources in Pigeon pea (*Cajanus cajan* (L) Mill sp.) cultivation in scarcity condition." was carried out at Agronomy Research Farm, College of Agriculture, Dhule, Maharashtra, during '*kharif* season of the year. The soil of the research farm is well drained clayey in nature, having pH 7.65, EC 0.32 dsm^{-1}. The soil samples were collected from the experimental plot before the initiation of the experiment show that initial organic carbon low (0.70 %), low in available nitrogen (165.28 kg/ha), medium in available phosphorus (18.30 kg/ha) and high in potash(356.28 kg/ha). The rainfall in the area is highly erratic and more than 90% of the rain is received during July to September with several intermittent long dryspells. The experiment comprised eight treatments *viz*., T_1 : FYM 5 ton ha^{-1}, T_2 : Vermicompost 3 ton ha^{-1}, T_3 : FYM 2.5 + Vermicompot 1.5 ton ha^{-1}, T_4 : 100 % N through FYM, T_5 : 100 % N through vermicompost, T_6 : 50 % N through FYM + 50 % N through vermicompost, T_7 : RD of fertilizers and T_8 : controlwas laid out in RBD with three replications keeping Gross plot size of 6.00 m x 5.40 m and Net plot size 5.20 m x 3.60 m seeds were treated with *Rhizobium* @ 25g/kg seed, PSB @25g/kg seed and *Trichoderma* @10 g/kg seed and then sown at 90 row spacing and 20 cm plant to plant spacing covered with soil properly. Intercultural operations performed as per existing recommendations for the crop. Sowing of seed was done on 24 June 2017and harvesting was done on the 28th December 2017. Observations on various growth and yield parameters such as days to germination, plant height, number of branches per plant, days to 50% flowering, number of pods per plant, numbers of seeds per pod and grain yield per hectare were recorded. The soil samples after harvesting of the crop were collected again from the same plots and OC,N, P and K were analyzed using the standard procedures to see the effect on soil fertility status. The data during the investigation were subjected to statistical analysis by adopting appropriate method of analysis of variance as described by Panse and Sukhatme (1985) [10]. Whereas the variance ratios (F- values) were found significant at 5 percent level of probability, the critical difference (CD) values were computed for making comparison among treatment means.

Results and discussion

Vegetative growth parameters: Findings of present study reveals that plant height of pigeon pea was influenced significantly with the application of different organic sources, though the height of the plants increased from germination to harvest irrespective of the treatments applied. the treatment with application of 100 % N through Vermicompost exhibited maximum plant height of 30.61, 81.47, 154.66, 189.88 and 210.63 cm at 28,56,84,112 and at harvest, respectively as compared control treatment but it was at par with treatment T_2 Vermicompost 3 ton ha^{-1}, T_3 FYM 2.5 + V. C. 1.5 ton ha^{-1}, and $T_4$100 % N through FYM. Data of this study further showed that numbers of primary and secondary branches of pigeon pea plants were significantly affected with the application of different organic treatments (Table 1). The maximum number of primary and secondary branches (7.89/ plant and 18.21/plant) were recorded in the treatment with application of 100 % N through Vermicompost as compared to minimum (4.92/ plant and 13.47/ plant) in control treatment. Vermicompost proved best with respect to vegetative growth parameters of pigeon pea crop. Vermicompost is an important organic source of plant nutrients, contains a higher amount of N, P and K, necessary for plant growth in readily available forms (Nagavallemma *et al*., 2004). Vadiraj *et al.* (1998) [16] reported that application of vermicompost in coriander crop produced herbage yields that were comparable to those obtained with chemical fertilizers. There is evidence that humic acids extracted from vermicompost stimulated to increase in the number of roots, giving the plant ability to scavenge nutrient from the growing environment for growth and development (Pritam *et al*., 2010) [12]. The application of PSB enhances root and shoot length, plant biomass and vigour, all leading to a better growth of the plant due to the production of metabolites such as phytohormone and antibiotics which finally promotes the plant growth and grain yield (Balachandran and Nagarajan, 2002) [1]. This might have helped in improved growth parameters with *Rhizobium* inoculation. These findings are in corroboration with the results reported by Patil *et al*. (2004) [11] and Sharma *et al*. (2009) [14].

Yield attributes, seed yield and economics: It is inferred from the data of the present investigation that the number of pods per plant, numbers of seeds per pod seed yield and straw yield, net returns and B:C ratio were influenced significantly with the application of various organic treatments (Table 2). The treatment 100 % N through Vermicompost) were recorded significantly the highest number of pods (174.49/plant) and no. seeds (3.91/ pod) with maximum grain yield (16.05 q/ha) and straw yield (41.62 q/ha) than control followed by Vermicompost 3 ton ha^{-1} (T_2) treatment (13.93 qt. ha^{-1}). The numerically minimum seed yield was registered by control (T_8) treatment (6.95 qt. ha^{-1}). However the Net returns (₹ 52254 ha^{-1}) was recorded maximum in RD of fertilizers (T_7) treatment. Benefit cost ratio (2.97) was recorded maximum in the treatment application of 100 % N FYM (T_4), followed by FYM 5 ton ha-1 (T_1), RD of fertilizers (T_7) treatment as compared to the control (T_8) treatment.

It is evident from results of this study that application of 100 % N through Vermicompost proved best among the different treatment tested with respect to yield attributing characters, grain and straw yield of pigeon pea crop. Here it is clear that 100 % N through Vermicompost increased the values of vegetative and reproductive characters and seed yield per hectare over other treatments. It is established fact that vermicompost improves the physical and biological properties of soil including supply of almost all the essential plant nutrients for the growth and development of plants. Thus balanced nutrients under favourable environment might have helped in production of new tissues and development of pigeon pea plants, which ultimately increased the yield attributes and grain yield. The gradual release and steady supply of nutrients from vermicompost through out the growth and development of plants maintained the later on the translocation of photosynthates to various sinks resulting in to higher seed yield. Similar findings were also reported by Helkiah *et al.* (1981) [4]

The numerically higher net monetary return (₹. 52254 ha^{-1}) was recorded in the treatment (T_7) RD of Fertilizers at par with 100 % N through FYM (T_4), FYM 5 ton ha^{-1} (T_1) than the other treatments, The minimum net monetary returns (₹. 20983 ha^{-1}) were recorded in control (T_8) treatments. The highest B:C ratio (2.97) was recorded in the treatment 100 % N through FYM (T_4) followed by FYM 5 ton ha^{-1} (T_1), RD of fertilizers) (T_7) treatment. The minimum B: C ratio was observed in treatment (T_8) control treatment.

Soil fertility: Soil available N, and P in soil after harvest of the crop due to application of organic inputs improved to the magnitude of 176.53and 22.38kg/ha over the initial values of 165.28 and 18.30kg/ha, respectively (Table 2). This may be attributed to increased application of organic sources. The increased N2 fixation, solubilisation of P and the root system of the legumes has capacity to solubilise soil phosphorus through extraction of amino acid which encourage the growth and multiplication of soil microbes which finally led to mineralization of unavailable P to available P in soil. The results corroborate the findings of Malik, *et al.*, 2013 [6] and Singh *et al.*, 2013 [6].

Microbial population: The available bacteria, fungi and actinomycetes in soil after harvest of Pigeon pea influenced significantly higher in 100 % N through Vermicompost (T_5) treatment as compared with rest of the treatments and it was at par with vermicompost 3 ton ha^{-1} (T_2), 50 % N through FYM + 50 % N through V.C. (T_6), FYM 2.5 + V. C. 1.5 ton ha^{-1} (T_3). Whereas significantly minimum value of bacteria was registered by control (T_8) treatment. From the above findings it is concluded that for higher yield and net monetary return organic Pigeon pea application of 5 ton ha^{-1} or 100 % N through FYM or vermicompost was more beneficial in scarcity conditions of Dhule region.

Table 1: Plant height, No. of primary, secondary branches $plant^{-1}$ at harvest and Dry matter $plant^{-1}$ (g) of Pigeon pea as influenced periodically by different treatments

Treatments	Plant height (cm)					No. of primary branches $plant^{-1}$ at harvest	No. of secondary branches $plant^{-1}$ at harvest	Dry matter $plant^{-1}$ (g)
	28 DAS	56 DAS	84 DAS	112 DAS	At harvest			
T_1 : FYM 5 ton ha^{-1}	28.47	78.97	146.00	180.03	204.11	6.55	14.57	199.53
T_2 : Vermicompost 3 ton ha^{-1}	28.74	79.73	151.70	186.96	209.78	6.82	16.65	205.91
T_3 : FYM 2.5 + V. C. 1.5 ton ha^{-1}	28.61	79.47	153.33	183.17	206.13	6.69	16.67	205.74
T_4 : 100 % N through FYM	28.57	78.97	152.19	187.72	205.00	6.70	15.62	201.32
T_5 : 100 % N through Vermicompost	30.61	81.47	154.66	189.88	210.63	7.89	18.21	221.47
T_6 : 50 % N through FYM + 50 % N through Vermicompost	27.74	78.13	152.40	186.51	208.41	5.87	15.48	208.50
T_7 : RD of Fertilizers	27.94	79.10	153.06	187.16	208.39	6.09	15.22	215.89
T_8 : Control	25.49	62.94	137.50	174.29	194.07	4.92	13.47	176.38
S.E.(m) ±	1.04	0.97	1.47	1.23	1.52	0.58	0.66	3.23
C.D. at 5 %	2.96	2.75	4.16	3.50	4.32	1.64	1.89	9.16

Table 2: Number of pods $plant^{-1}$, No. of seeds pod^{-1}, seed yield $plant^{-1}$ and Test weight as influenced by different treatments

Treatments	Number of pods $plant^{-1}$	Number of seeds pod^{-1}	Seed yield (qt. ha^{-1})	straw yield (qt. ha^{-1})	Net returns (₹ ha^{-1})	B:C ratio
T_1 : FYM 5 ton ha^{-1}	139.80	3.71	13.58	32.15	51161	2.96
T_2 : Vermicompost 3 ton ha^{-1}	163.10	3.83	13.93	36.32	42985	2.17
T_3 : FYM 2.5 + V. C. 1.5 ton ha^{-1}	168.13	3.85	13.57	35.42	46183	2.47
T_4 : 100 % N through FYM	170.30	3.80	13.60	35.25	51280	2.97
T_5 : 100 % N through Vermicompost	174.49	3.91	16.05	41.62	49070	2.15
T_6 : 50 % N through FYM + 50 % N through Vermicompost	162.10	3.78	13.47	35.17	41115	2.20
T_7 : RD of Fertilizers	167.57	3.86	13.86	36.15	52254	2.94
T_8 : Control	129.47	3.65	6.95	16.70	20983	2.13
S.E.(m) ±	4.34	0.04	0.96	0.54	469.29	-
C.D. at 5 %	12.32	0.12	2.73	1.53	1329.15	-

Table 3: Soil available Nutrients after harvest of Pigeon pea as influenced by different treatments

Treatments	Soil available N	Soil available P	Bacteria (CFU x 10^{-6} g^{-1} soil)	Fungi (CFU x 10^{-4} g^{-1} soil)	Actinomycetes (CFU x 10^{-4} g^{-1} soil)
T_1 : FYM 5 ton ha^{-1}	174.76	20.74	29.76	33.92	38.92
T_2 : Vermicompost 3 ton ha^{-1}	173.87	21.42	35.78	35.65	47.46
T_3 : FYM 2.5 + V. C. 1.5 ton ha^{-1}	172.54	21.17	33.71	34.74	46.92
T_4 : 100 % N through FYM	176.05	21.00	30.38	34.12	39.16
T_5 : 100 % N through Vermicompost	176.53	22.38	38.11	36.45	48.06

T_6 : 50 % N through FYM + 50 % N through Vermicompost	174.85	20.71	34.50	34.36	46.83
T_7 : RD of Fertilizers	171.87	20.06	28.75	29.90	37.56
T_8 : Control	167.70	19.99	27.82	29.27	36.58
S.E.(m) ±	5.02	1.45	0.73	0.098	0.14
C.D. at 5 %	14.22	4.11	2.06	0.28	0.41
Initial Value	165.28	18.30	29.13	24.67	33.71

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