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Encouraging effect of organic fertilizers on the growth and biochemical performance of pigeon pea (*Cajanus cajan* (L.) Millsp.)

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Abstract
A nursery experiment was conducted to study the beneficial effect of various organic fertilizers such as vermicompost, *Azospirillum*, farmyard manure, agricultural waste, organic manure, wood ash and neem cake on growth and biochemical characters of pigeon pea *Cajanus cajan.* The results revealed that there was significant response in both growth as well as biochemical parameters of pigeon pea. Amendment of organic fertilizers was increased the shoot length in plants with neem cake and in the case of root length, the effect was higher neem cake followed by wood ash. All the organic fertilizers greatly affected the fresh weight of pigeon pea over the control. Among them, the plant fresh weight was higher with neem cake followed by organic manure. The effect was directly reflected in the plant dry weight also. In addition to growth characters, the biochemical characters of pigeon pea such as chlorophyll, carotenoid, protein, glucose, free amino acid and *in vivo* nitrate reductase activity were higher in organic fertilizers treated soil compared to the control plants.

Keywords: organic fertilizers, nursery, growth, biochemical

1. Introduction
Organic agriculture is attractive for marginalized farmers who primarily produce food crops for home consumption because food self-sufficiency and self-reliance for soil fertility is improved. Organic practices are more environmentally sustainable than most conventional practices, inherently better-adapted to prevailing agro-ecological conditions and offer a better perspective for equitable development because it tends to increase farmers' self-reliance for food and inputs and contributes to their autonomy and self confidence. Organic agriculture is getting hold of movement in India due to individual as well as group efforts to protect the environment and contamination of farm produce from use of chemical fertilizers and pesticides. The heavy use of chemicals has led to degradation of soil, water and ultimately the quality of food materials. So, at this moment a keen awareness has started in all parts of India for adoption of organic cultivation to cure the ills of modern chemical agriculture [8].

Organic farming has all round favourable effects in long term sustainability of the production system. Higher level of biological activity and increased microbial populations are found in cultivated soil managed organically. The aggregate stability and porosity is increased under organic management. Such changes in soil structure largely result from changes in the management of crop residues and organic matter inputs and may lead to increased aeration and water holding capacity of soils under organic management. Lower rates of run-off and soil erosion have also been measured in organic systems. Organic manures generally improve the soil physical, chemical, biological properties along with conserving the moisture holding capacity of soil and thus resulting in enhanced crop productivity along with maintaining the quality of crop production [9, 1].

Organic fertilizers are constitute a dependable source of macro and micro nutrients and are helpful in improving physical, chemical and biological health of soil, reduce nutrient losses, increases nutrient availability and uptakes leading to sustainable production devoid of harmful residues, besides improving quality of vegetables. Organic manures are the valuable byproducts of farming and allied industries derived from plant and animal resources. These organic manures being slow in release of nutrients, assume greater significance in a cropping sequence than individual crops and their usefulness needs to be investigated on long term basis [2]. Farmyard manure (FYM), compost, oil cake, vermicompost and green manure are the most important and widely used bulky organic manures. Biofertilizers are being essential component of organic farming are the preparations containing live or latent cells of efficient strains of nitrogen fixing, phosphate solubilizing or cellulolytic microorganisms [17, 14].

2. Material and Methods
A nursery experiment was conducted to study the nursery performance of different organic fertilizer on red gram. The manures were incorporated with red gram with regular interval. The biometric parameters such as shoot length, root length, plant fresh weight, plant dry weight and the biochemical parameters such as chlorophyll, Carotenoid, protein, glucose, amino acid, nitrate reductase activity were analyzed. The experimental details were T1 - Control; T2 - Vermicompost; T3 - *Azospirillum*; T4 - Farmyard manure; T5 – Agriculture waste; T6 - Organic manure; T7 - Wood ash and

T8 - Neem cake.

The growth parameters such as shoot length, root length, plant fresh and dry weight were analyzed in both treated and untreated control plants. Plants were uprooted without causing any damage to the seedlings and it was thoroughly washed with tap water in order to remove soil and debris particle. Then the shoot length was measured with the help of meter scale. In uprooted plants, the root length was measured with the help of meter scale and expressed in centimeter. The fresh weight of whole plant parts (shoot, leaves and root) was weighed using electronic balance. The fresh undamaged whole plant system of seedlings were kept in the oven at 80°C 4-6 hours and the dried seedlings were weighed using electronic balance.

The biochemical parameters such as chlorophyll and carotenoid [20], protein [10], glucose [7], free aminoacid [7] and nitrate reductase activity [6] were analyzed.

3. Results & Discussion

The different types of organic fertilization had significant effect on growth characters of red gram such as shoot length, root length, plant fresh weight and plant dry weight. There was a significant difference was observed in the shoot length of *Cajanus cajan.* The highest shoot length was observed in plants treated with neem cake followed by wood ash. The root length was higher in all treated plants over control and the response varied with organic manures. The maximum root length was obtained with the plants treated with the neem cake. The fresh weight of *Cajanus cajan* seedling was found to be ranging from 2.23-4.85g. There were less significant differences in the fresh weight between the seedlings grown in treatments. The response was higher with plants treated with neem cake. The analysis of the dry weight of the plant system was ranging from 0.61-1.47g. The maximum dry weight of the plant system was found in plants treated with neem cake (Table 1).

The beneficial effect of organic manures in combination with each other was also noticed in the yield components namely number of tillers per meter row length, number of ear heads per meter square and seed weight. Significantly higher number of tillers per meter row length was recorded with vermicompost + poultry manure followed by RDF. The number of ear heads per meter square, seed weight and seed yield per meter square were significantly higher with treatment combination of vermicompost and poultry manure. The other organic manure combination such as FYM + poultry manure, FYM + vermicompost and poultry manure + green leaf manure have recorded on par yield with above treatments [11].

The seedling vigour index and dry weight of seedlings which really indicate the overall seed quality has varied significantly with the organic treatments and these values were significantly higher with application of organic manure. The increase in plant weight with application of organic manures may be due to better nutrient availability and its uptake by mother plant. This might have lead to accumulation of higher quantities of seed components like calcium carbonate and increased the lipid metabolisms which help in increasing the protein content in seed. The combined effect of vermicompost and nitrogen fertilizer significantly increased the plant height, fresh biomass production and dry biomass production. Rice grown on worm casts produced higher shoot fresh weight and dry weight and showed higher nutrient uptake, lower fertilizer response than rice grown on surface soils [5, 16, 19].

In the nursery experiment, application of organic manures with red gram significantly increased the biochemical parameters such total chlorophyll, carotenoid, protein, amino acids, glucose and NR activity. The application organic manures showed a promoting effect on the biochemical characters of red gram. The effect was varied with types of organic manures. It was observed that the study of the total chlorophyll content showed much significance in the different types of organic manure. The chlorophyll content was more in plants treated with organic manure followed by vermicompost. Among different organic manures, carotenoid was more in plants treated with organic manure and least with *Azospirillum*. The control plant showed the carotenoid content only 0.40mg/g LFW. The protein content was comparatively more in plants treated with organic manure (43.72mg/gLFW) followed by farmyard manure. The result revealed that there was marked difference in the glucose content among treatments. Among them, glucose content was higher in plants treated with farmyard manure (2.14mg/g LFW) and least in wood ash (0.69mg/g LFW) and agriculture waste (0.70mg/g LFW). The application of organic manures increased the free amino acid content in leaves. But effect was not significant among treatments. NR activity was estimated in leaves of treated and control plants. The results indicated that there was not much variation in NRA among treatments. But effect was far better than control plants (Table 2).

Application of organic manure, especially sheep manure, resulted in a significant increase in chlorophyll content of barley leaves. Except chicken manure pellet, cow dung and compost, the application of organic manure resulted in higher leaf chlorophyll content than inorganic fertilizer. The chlorophyll content can potentially provide an estimate of the N status of crops (Matsuzaki *et al*., 1980) [13]. The significantly higher chlorophyll content of barley leaves observed in the pots with organic manures could be due to differences in nitrogen content of the organics manures and its uptake. The greater chlorophyll values in leaves on plots treated with organic manure are of importance because photosynthetic activity and crop yield may increase with increased chlorophyll content of leaves [21].

Biofertilizers had a beneficial effect on growth and biochemical parameters. Treatments of *Azospirillum* and *Azotobacter* plus 100% urea resulted in significant increases in total chlorophyll, total sugar and total nitrogen as compared to the control treatment at the 20^{th}, 40^{th} and 60^{th} days. The beneficial effects of bacterial inoculation on increased chlorophyll content might have been due to the supply of higher amount nitrogen to the growing tissue and organs supplied by N_2 fixing *Azospirillum* and *Azotobacter*. The effect of *Azospirillum* on various growth and yield characters in Okra significantly increased the total chlorophyll content [3, 18].

Application of recommended doses of NPK fertilizers, earthworm and cow dung has much significantly increased the protein contents of mulberry leaves (Ravignanam and

Gunathiagaraj, 1996) [15]. Earthworms increased the concentration of nutrients which can be ascribed to the increased availability of nutrients and their uptake from the soil. There is considerable evidence that earthworms can increase plant growth. Application of organic inputs such as compost, neem cake, wood ash and rock phosphate along with biofertilizers gave higher yield. Inoculation of biofertilizers along with organic manure gave better results than their individual application and combination of two or three bioinoculants [4].

Table 1: Effect of organic fertilizers on the growth performance of *Cajanus cajan*

S. No.	Treatment	Shoot length (cm)	Root length (cm)	Fresh weight (g)	Dry weight (g)
1.	Control	35.8 ± 0.665 (100)	11.3 ± 0.057 (100)	1.09 ± 0.008 (100)	0.54± 0.014 (100)
2.	Vermicompost	37.1 ± 0.664 (103)	12.7 ± 0.656 (112)	2.35 ± 0.012 (215)	1.20 ± 0.025 (222)
3.	*Azospirillum*	42.0 ± 0.472 (117)	15.6 ± 0.536 (138)	3.83 ± 0.011 (351)	0.61 ± 0.020 (112)
4.	Farmyard manure	48.3 ± 0.352 (134)	16.3 ± 0.504 (144)	3.17 ± 0.043 (290)	0.90 ± 0.017 (166)
5.	Agriculture waste	45.7 ± 0.669 (127)	15.2 ± 0.497 (134)	2.76 ± 0.042 (253)	0.77 ± 0.006 (142)
6.	Organic manure	48.6 ± 0.536 (135)	16.9 ± 0.550 (149)	4.26 ± 0.017 (390)	1.17 ± 0.024 (216)
7.	Wood ash	51.2 ± 1.306 (143)	17.5 ± 0.612 (154)	3.95 ± 0.029 (362)	1.04 ± 0.023 (192)
8.	Neem cake	52.6 ± 0.648 (146)	19.7 ± 0.578 (174)	4.85 ± 0.009 (444)	1.47 ± 0.034 (272)

Table 2: Effect of organic fertilizers on the biochemical performance of *Cajanus cajan*

S. No.	Treatment	Total chlorophyll (mg/g LFW)	Carotenoid (mg/g LFW)	Protein (mg/g LFW)	Glucose (mg/g LFW)	Free amino acid (mg/g LFW)	NRA (µ moles /g LFW)
1.	Control	1.40 ± 0.053 (100)	0.23 ± 0.141 (100)	21.96 ± 0.589 (100)	0.51 ± 0.018 (100)	0.10 ± 0.009 (100)	0.19 ± 0.015 (100)
2.	Vermicompost	2.90 ± 0.012 (194)	0.50 ± 0.004 (217)	32.28 ± 0.356 (146)	1.03 ± 0.015 (201)	0.18 ± 0.008 (180)	0.26 ± 0.024 (136)
3.	*Azospirillum*	2.48 ± 0.049 (167)	0.46 ± 0.012 (199)	38.75 ± 0.266 (176)	0.81 ± 0.018 (158)	0.19 ± 0.005 (190)	0.27 ± 0.021 (142)
4.	Farmyard manure	1.72 ± 0.017 (116)	0.45 ± 0.006 (195)	41.00 ± 0.307 (186)	2.14 ± 0.023 (419)	0.23 ± 0.006 (230)	0.28 ± 0.014 (147)
5.	Agriculture waste	2.87 ± 0.011 (191)	0.41 ± 0.003 (243)	26.53 ± 0.373 (120)	0.70 ± 2.236 (137)	0.19 ± 0.005 (190)	0.29 ± 0.012 (152)
6.	Organic manure	3.10 ± 0.008 (205)	0.50 ± 0.005 (217)	43.72 ± 0.226 (199)	1.18 ± 0.014 (231)	0.21 ± 0.005 (210)	0.27 ± 0.017 (142)
7.	Wood ash	1.16 ± 0.017 (109)	0.40 ± 0.005 (173)	30.98 ± 0.329 (141)	1.39 ± 0.027 (272)	0.20 ± 0.004 (200)	0.29± 0.015(147)
8.	Neem cake	1.43 ± 0.011 (96)	0.39 ± 0.004 (169)	32.15 ± 0.553 (146)	1.04 ± 0.011 (203)	0.21 ± 0.007 (210)	0.25 ± 0.010 (131)

4. Conclusion

Organic farming is to reduce the chemical inputs and sustain crop production. Organic cultivation is at the conservation of ecology and natural habitat without polluting soil, air and water and yet maintaining sustainable production. In organic, naturally occurring, mined products and bulky and concentrated organic manures such as compost, neem cake, wood ash, bone meal, fish meal, rock phosphate, biofertilizers and biodynamic formulation are used for nutrition and maintenance of soil fertility. Organic matter influences physical, chemical and biological properties of soil despite the small proportion present in the soil. From the present study, it helps to achieve sustainable yield without affecting soil as well as environmental pollution. In particular, as arid crop of pigeon pea, we can attain the maximum growth, development and yield. Even though various organic fertilizers are available, the crop specific/reliable organic fertilizer should be identified in the organic nutrient management.

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