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Effects of organic amendments in comparison with chemical fertilizer on cowpea growth

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Abstract
Stumpy soil fertility is caused by continue crop and using chemical fertilizer. The organic amendments able to boost soil fertility. The reason of this research was to investigate the effect of organic amendments in comparison with chemical fertilizer on cowpea plants growth parameters under pot culture experiments. Results indicated that all the organic amendments showed better plant growth and nutrient uptake when compared to chemical fertilizer and control. Obtained results highlight the prospects and potentials of using organic fertilizers as renewable natural fertilizers for cowpea growth. Several studies indicated that the applications of organic fertilizers in adequate quantities improves soil condition and growth parameters in field crops. The study suggested that application of organic fertilizer improve growth of plants.

Keywords: Organic farming, Chemical fertilizers, Growth parameters, Cowpea.

1. Introduction
Land is the major non-renewable resource and faces the biggest threat of degradation. Land resources of the country are degrading at an alarming rate and causing environmental problems. Because of continued cultivation, the soils of Pakistan are becoming low and deficient in organic matter contents (Baloch *et al.*, 2014) [1]. Crop cultivation requires supplementation of available nutrients to the plant for achieving yield potentialities. The supplementation is generally achieved through application of chemical fertilizer in the soil at different stages of crop life. These chemical fertilizers have hazardous effect (Savci, 2012; Ogbodo, 2013) [2, 3].

The hazardous environmental consequences and high cost of inorganic fertilizers make them not only undesirable but also uneconomical and out of reach of the poor farmers (Oyedeji *et al.*, 2014) [4].Organic manuring is becoming an important component of environmentally sound sustainable agriculture. Residual nature of organic sources makes them more value based for the whole system compared to individual crops (Neena Aroraand PramilaMaini., 2011) [5]. Recently, the use of organic materials as fertilizers for crop production has received attention for sustainable crop productivity (Dong *et al*., 2012; Arif *et al.*, 2014) [6, 7]. Organic materials hold great promise as a source of multiple nutrients and ability to improve soil characteristics (Orrell& Bennett, 2013) [8].

Organic sources like farm yard manure (FYM), poultry manure (PM), green manuring and compost etc not supply the organic matters but also increase the fertility status of soil (Mohammadi *et al.*, 2011) [9]. They provide organic acids that help dissolve soil nutrients and make them available for the plants (Husson, 2013) [10].In recent times, attention has been directed towards organic manure because of the rising cost of inorganic fertilizers coupled with their inability to give the soil the desired sound health (Oyedeji *et al*, 2014) [4].

Cowpea an annual legume is also commonly referred to as southern pea, black eye pea, lubia, niebe, coupe or frile (Aleem *et al.*, 2014) [11]. Cowpea grain provides a cheap and nutritious food for relatively poor urban communities (Aliyu, 2011) [12].

Therefore, the present study was undertaken to estimate the effect of organic and inorganic fertilizers on growth and biochemical parameters of Cowpea plants.

2. Material and methods

2.1 Treatments used in the experimental setup

S. No.	Treatments	Source and processing	Amount
1	Seaweeds	Collected from coast of Arabian Sea Karachi, Pakistan. Shade dried for (27°C to 30°C) 10 days. Dried material was then grounded.	10 tons/ha
2	Farmyard Manure	Collected from the fertilizer's shop. Dried and grinded in mortar pestle.	10 tons/ha
3	Wheat Bran	Collected from the local market than grounded with the help of a Mixer grinder.	10 tons/ha
4	Coconut coir	Collected from the vegetable market. Dry and then ground it in Mixer grinder	10 tons/ha
5	Garden Clipping	Dried leaves were collected from the Garden of Jinnah University for Women. The leaves were grinded in Mixer grinder.	10 tons/ha
6	Chemical Fertilizer	N.P.K as a chemical fertilizer.	10 tons/ha

2.3 Control

In control garden soil was used in natural conditions without any additional treatment.

2.4 Experimental seed

Healthy seeds of cowpea (*Vignaunguiculata* (L.) Walp.) are selected, with uniform size; color and weight for the experimental purpose.

2.5 Experimental Procedure

Six experimental treatments were used for a group of plant. In each pot respective treatments were mixed as 10 tons/ha. Five seeds were transferred to the respective pot and allowed to germinate, at a depth of 1.5 cm. The watering was done once in a day. Complete randomized design was applied for experimental purpose. The plants were uprooted after 30 days and subjected to them measurement of various growth parameters including root length, shoot length, fresh weight, and dry weight after that plants of each treatment analyze biochemically in terms of estimation of photosynthetic pigment (Arnon,1949) [13] and soluble carbohydrate (Yemm & Willis 1956) [14].

2.6 Statistical Analysis

Result of present pot experiments are expressed as mean ± standard deviation (SD). The data was analyzed by using One-way ANOVA followed by LSD (least significance difference) test through SPSS 16 (version 4). The difference was considered significant at $p<0.05$ when treatments' mean compared with control.

3. Results

3.1 Physical parameters

All five treatments of organic fertilizers (table, 1) showed positive effect on root length of experimental plants. Coconut coir, farmyard manure and garden clippings as organic fertilizers significantly enhance root length of cowpea plants while chemical fertilizer gave gloomy effect on root length of tested plants (table, 1).All treatments of organic fertilizer are beneficial for shoot length when supplied to plants. In all five types of organic fertilizers coconut coir and farmyard manure gives more positive result i.e. 44% and 52% as compared to the control (table, 1). Whereas plants treated with chemical fertilizer showed negative effect on plants shoot length (table, 1).

Table 1: Effects of organic amendments and chemical fertilizer on physical Parameters of Cowpea

S. No.	Treatments	Root length (cm)	Shoot length (cm)	Fresh weight (g)	Dry weight (g)
1	Control	10.97±1.5	27.21±3.56	1.63±.24	.13±.03
2	NPK	6.61±.36 (-39.79)	25.5±4.51 (-6.28)	1.13±.21 (-30.32)	.09±.01 (-27.81)
3	Coconut	17.92a±1.87 (63.32)	39.43a±3.13 (44.93)	2.46c±.36 (51.29)	.21±.04 (57.9)
4	FYM	15.1b±1.08 (37.57)	41.48a±.41 (52.44)	2.48c±.32 (52.52)	.20±.05 (54.87)
5	Algae	12.37±.99 (12.73)	35.18c±.85 (29.28)	1.87±.8 (14.15)	.17±.03 (24.81)
6	Garden Clipping	13.23d± .67 (20.63)	37.73±1.77 (38.65)	2.31±.50 (41.82)	.22c±.06 (65.41)
7	Wheat bran	11.43± .86 (4.15)	36.43b±.60 (33.88)	2.35c±.21 (42.43)	.20±.02 (54.87)

Each value is a mean ± S.D (standard deviation) of 3 replicates. Means bearing superscripts in each column are significantly different with respective control at $P < 0.05$.

Data presented in Table, 1 showed that treatment of chemical fertilizer has negative effect on plants fresh weight. Whereas it also showed that organic fertilizer including five different types gave positive effect on fresh weight of plants. Coconut coir, Farmyard manure and wheat bran significantly increased fresh weight of plants (table,1).Application of garden clippings significantly promote the dry weight of cowpea plants as compared to control up to 65% (table, 1) while chemical fertilizer showed negative effect on plants dry weight.

3.2 Biochemical parameters

Coconut coir showed better result among all organic fertilizers, it enhance chl-a content up to 117%. Rest of organic fertilizers also increased the chl-a content significantly except garden clippings. Chemical fertilizer also showed better effect on chlorophyll a contentin experimental plants after 30 days (fig.1). All treatments significantly improved the clh-b concentration in cowpea plants as showed in fig.1, except seaweed application. Wheat bran treatment more significantly increased chl-b content of cowpea plants (fig.1).All treatments showed remarkable effect on plants total chlorophyll content. Coconut coir and farmyard manure significantly promoted total chlorophyll content of cowpea plants up to 101-103% (fig.1).

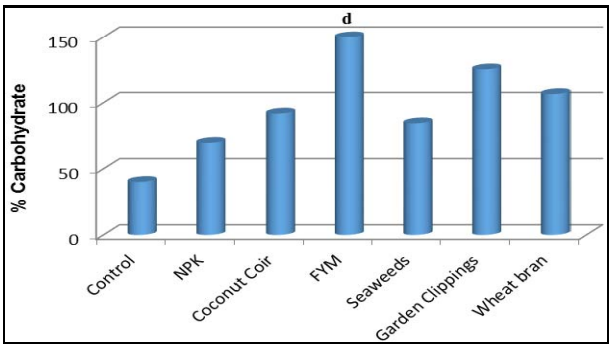

Fig 1: Effects of organic amendments and chemical fertilizer on % carbohydrate of cowpea. Columns bearing superscript are statistically significant (p<0.05 LSD) with respective control.

All treatments have positive effect on the carbohydrate content of the experimental plants. Only farmyard manure significantly increased % carbohydrate in experimental plants after 30 day as compared to control (fig.2).

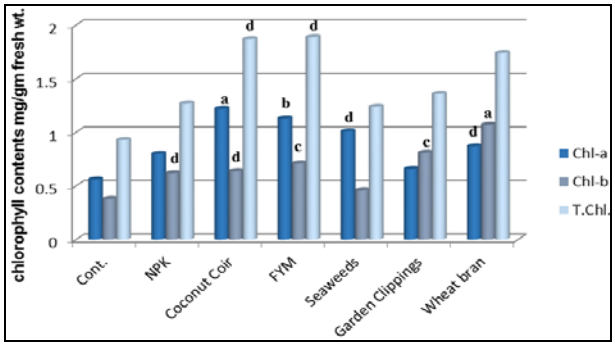

Fig 2: Effects of organic amendments and chemical fertilizer on Chlorophyll contents of cowpea. Columns bearing superscript are statistically significant (p<0.05 LSD) with respective control.

4. Discussion

Organic farming is one of the fastest growing sectors of agriculture worldwide. Its main objective is to create a balance between the interreconnected systems of soil organisms, plants, animals and human. System to regulate the nutrition regime with organic farming is based on balanced crop rotations, application of compost, green or barnyard manures, bone meal or straw, leaves and sawdust mulches (Karanatsidis and Berova, 2009) [15]. The target in the application of organic fertilizers should therefore two fold- first to obtain reasonable yields and second to increase soil fertility, water holding capacity to optimum levels (Teboh, 2009) [16].

In modern agriculture, special emphasis is placed on soil amendment, improved agricultural equipments, techniques and improved varieties of tolerant plants for increasing the quality and quantity of yield per hectare. However, full potential of the improved varieties can be realized only if essential inputs, particularly organic fertilizers are applied both in requisite quantities and in timely manner (Teboh, 2009) [16]. Organic manure play direct role in plant growth as a source of all necessary macro and micronutrients in available forms during mineralization and improving physical and chemical properties of soils (Chaterjee *et al*., 2005) [17]. Organic manures improve soil fertility by activating soil microbial biomass. Application of manures sustains cropping system through better nutrient recycling (Gulshan *et al*., 2013) [18].

4.1 Physical parameters

According to the results, all five treatments of organic fertilizers showed positive effect on root lengths of plants. Coconut coir and farmyard manure showed much better results. Its soft structure promotes easy root penetration and healthy growth. Farmyard manure treatment showed positive effect on growth root and shoot (Gulshan *et al*, 2013) [18]. The beneficial effect of seaweeds on seed germination and plant growth were reported by (Elumalai & Rengasamy, 2012) [19]. The growth enhancement potential of seaweed has been attributed to phenyl acetic acid [PAA] and micro and macro elements, vitamins and plant growth regulators such as gibberellins and cytokinin also contains Fe, Cu, Zn, Co, Mo, Mn, Ni, vitamins and amino acids. Kumar in (2006) [20] reported that garden clipping can be used for improving soil health and nutrient status. While chemical fertilizer showed negative effect on root length of experimental plants. (Hussein E. Osman *et al*., in 2010) [21] reported the negative effect of chemical fertilizer on plant height. Manure improved soil physical properties, finally, better root growth, better plant growth and biological yield. On the other hand, the growth of shoots with increasing manure fertilizer could be due of microorganisms activity in soil (Gryndler *et al*., 2008) [22]. Development of mineral nutrients in the manure increased root growth, absorption and nutrients, ultimately leading to increased plant yield (Valiki and Ghanbari, 2015) [23]. Use of organic manures such as compost, vermicompost, dry leaf powder on growth and yield of crop was also studied and result into increased productivity (Ghadge 2013; Fatahi *et al*., 2014) [24, 25].

Organic fertilizers including five different types i.e. algae, coconut, farmyard manure, wheat bran, and garden clipping all gave positive effect on fresh weight of plant in the present study. Leguminous plant fresh weight is highly responsive to increased levels of farmyard manure (Tesfaye*etal*, 2008) [26]. Wheat Bran reported as a good source of protein and mineral for plants (Kumar *et al.*, 2011) [27]. Garden clippings are major sources of nutrients and have the potentials for improving soil conditions (Ogbodo, E.N. 2010) [28]. (Badar *et al*., 2015) [29] also reported the beneficial effects of organic fertilizers on growth of cowpea plants.

In all organic fertilizers garden clipping, coconut coir showed more positive result then others and between these two, garden clipping showed much better effect on dry weights of cowpea plants. Garden clipping has demonstrated to be one of the ways of improving soil nutrient content and maintaining soil productivity (*E.N. Ogbodo*2011) [30]. Recent studies shows that soil status can be improved using plant materials such as coconut coir (S. Jothi Ramalingam *et al.*, 2013) [31]. Farmyard manure increases the dry matter content up to 54% and increases in dry matter resulted due to the ability of farmyard manure to increase the nutrient content of soil, increase the soil moisture holding capacity, reduction in soil pH and improvement in other physico-chemical properties of the soil (Lawal and Girei 2013) [32]. Adding manure in soil improve soil physical and biological conditions. Also, by creating a more favorable environment for root growth and nutrient availability, increased plant growth and dry matter (Kaplan *et al*., 2009) [33] and **(**Valiki and Ghanbari, 2015) [23]. Chemical fertilizer showed negative impact on plants dry weight. The use of inorganic fertilizer continuously will cause damage on physical, chemical and biological properties of soil, so that the soil fertility will be more decreased (Altuhaish *et al.*, 2014) [34]. Chemical fertilizers often have low use efficiency,

meaning that only a portion of the applied nutrients are taken up by plants (Adesemoye *et al.*, 2009) [35].

4.2 Biochemical parameters

Results presented in fig.1 showed that all treatments have positive effect on the carbohydrate content of the plants. The total sugar and protein contents in *Vigna catjang* and *Dolichosbiflorus* showed a significant increase due to seaweed application (Paul J and Devi D 2014) [36]. In 2014, Ibrahim and Erum reported that different agro wastes applications as organic fertilizers increased the carbohydrate contents of green grams. (Oyedeji *et al.*, in 2014) [4] reported that inorganic (NPK) fertilizer increased the growth. Both organic and biofertilizers increased maximum content of carbohydrate in experimental plants (Badar *et al.*, 2014) [37].

Coconut coir showed better result among all organic fertilizers as it increased maximum amount of chl-a in cowpea plants. Coconut coir enhances chlorophyll content of plant hence it has been proposed as an alternative substrate component as an organic fertilizer (Evans *et al.*, 1996) [38]. Rest of organic fertilizers also showed good results to promote the chl-a content of experimental plants. At present it is extensively speculated that beneficial effect of the seaweeds on germination and growth of various land plants may be due to the presence of plant growth-promoting substances/hormones in the extracts (Thorsen *et al.*, 2010; Prasad *et al.*, 2010; Blunden *et al.*, 2010) [39, 40, 41]. Marine algae have been shown to contain some cytokinins, gibberellins, auxins, auxin-like and other growth-promoting compounds (Stirk *et al.*, 2003; Yokoya *et al.*, 2010) [42, 43]. Various cytokines were identified in Chlorophyta, Phaeophyta and Rhodophyta (Stirk*etal*, 2003; Yokoya *et al*, 2010; Zhang and Ervin, 2004, 2008;) [42, 43, 44, 45].

Garden clipping and wheat bran showed more positive effect on chl-b content of plants then all others. Wheat Bran reported as a good source of protein and mineral for plants. (Kumar *et al.*, 2011) [27]. Garden clipping treated soils provided a good soil environment for effective nutrient and gaseous exchange which improved crop productivity (Ogbodo, E.N. 2010) [28]. Farmyard manure play direct role in plant growth as a source of all necessary macro and micronutrients in available forms during mineralization and improving physical and chemical properties of soils (Chaterjee *et al.*, 2005) [17]. Coconut coir has got many enviable characteristics making it a highly potential resource (Prabhu SR and Thomas GV2002) [46]. Treatments showed good effect on plants total chlorophyll content. In all organic fertilizers coconut coir and wheat bran showed positive effect. Chlorophyll content is of particular significance to precision in agriculture as an indicator of photosynthetic activity. All characteristics of coconut coir make it ideal for use as an organic fertilizer (S.R. Prabhu and Thomas GV 2002) [46]. Wheat bran contains several important compounds such as phenolic acids, carotenoids, lignans etc., which are distributed unequally in different wheat bran tissues, (Muhammad Mohsin *et al.*, 2012) [47]. Jan *et al.*, reported in (2014) [48] that utilization of organic fertilizers induced chlorophyll content and the ability of wheat plant to stand stress. These results are also in accordance with the work of (Badar and Qureshi, 2014) [49] who reported such increase in chlorophyll content of sunflower plants due to application of organic manures.

5. Conclusion

From obtained results it was concluded that using of organic fertilizers as a soil drench management has the prospective to enhanced cowpea plant nutrient status, and boost plant growth. These outcomes recommend that the use of organic amendments should be considered more in organic farming because it is not only an environmentally sound replacement for growth media, but may also be considered a substitute fertilizer for organic crop production.

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