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Investigation of Potential Use of Soya-waste on the Growth and Yield of Chilli Plant (*Capsicum annum*)

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Abstract

The physicochemical characterization of soya waste (industrial waste), three different soils S_1, S_2, S_3 and irrigation water was carried out by standard methods. The soya waste-soil blends for all the three soil like 0% (control), 5%, 10%, 15%, 20% and 25% and their replicates were prepared. These are then powdered, dried and filled in different polyethene bags. Three seeds of chilli (of make Jwala) sown in each bag and all the systems were watered equally with same period and the same water. Growth of each plant was regularly monitored after every month up to the three months from the date of sowing and plant parameters were recorded. After fully maturation of plants, data showed that 10% for soil S_1, 20% for S_2 and 15% for S_3 blending improved the physical properties of the soil and also contributed to the better growth and yield of chilli plants than the control in winter season. Thus, the present study provides the feasible alternative for the safe disposal of industrial wastes like soya waste by using them in proper ratio by blending for better plant growth.

Key words: Soil analysis, Growth parameters, Waste characterization, Blended soil, Chilli plant

Increased rate of industrialization leads to large discharge of industrial effluent into the environment which may pollute the ecosystem. The characterization of industrial effluent showed high alkalinity, COD, BOD, total dissolved salt, total suspended solids which are very harmful to the human health and environment. There are many industries in and around India like paper, textile, sugar, pharmaceutical, dairy etc. These industries discharge wide range of untreated pollutants into the environment which is responsible for serious water, air and soil pollution [1-2] and are considered to be the one of the major causes for low crop productivity. Many untreated and contaminated sewage and effluents may have high concentration of several heavy metals such as Cd, Ni, Pb and Cr which can cause decrease [3-4] in cell activities of living cells, inhibition of growth and various deficiency/diseases in plants. It has been also found that [5] the continuous disposal of industrial effluents on agricultural soils has resulted in soil sickness [6] and reduces the crop yield. A considerable number of studies have been made on the effect of different industrial effluents on different crops [7].

The nutritional status is a major determinant of the productivity of a soil. Many waste materials containing essential plant nutrients are available in huge quantities which when applied at appropriate rates enhance nutrient status as well as other soil properties. The use of industrial effluents for irrigation purpose has been practiced throughout the world due to scarcity of water [8-9]. But this practice is done without knowing the ill effects of the contaminants present in the effluents on the growth and quality of plant.

Effects of different concentrations of industrial wastes on the seed germination and growth of crops were found to vary from crop to crop [10]. Saomashekar *et al*. [11] reported the application of diluted effluents of paper, automobile, textile and food industry was favorable to the seed germination and seedling growth. Increased yield of sugarcane to about 20% by the irrigation of effluent from an integrated pulp paper mill was also recorded [12]. Shaista Chalkoo *et al*. [13] concluded that application of wastewater and fertilizer dose 20 kg ha^{-1} N and 60 kg ha^{-1} P proved effective for growth and yield study of chilli. It has also minimized the fertilizer consumption thus decreasing the pollution load and expenditure on expensive inorganic fertilizers. The distillery effluent (raw spent wash) did not show inhibitory effect on seed germination of some crops at low concentration. But at higher concentration (75% and diluted) complete failure was observed for germination irrespective of the crop [14]. Dongale and Savant [15] found a significantly higher yield of sugarcane and increase in available N content of soil (300 kg N ha^{-1}) by controlled application of spent wash and concluded that spent wash is a good source of potassium. Some negative effects of effluent irrigation have been reported in literature which might be due excessive concentration of effluent used for irrigation. However, a proper management strategy has to be developed to abate the pollution of land from the pollutants present in the industrial waste.

Chilli (*Capsicum annuum* L) belongs to the nightshade family Solanaceae. It is remunerative and is widely used in almost all states of India. Chillies are rich in Vitamin A and C and are used for the purpose of vegetables, sauces and spices.

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Its leaves are also consumed as salad and eaten with rice [16]. The aim of present study is a part of systematic work undertaken to study the growth of Chilli plant in the soil blended with soya waste (an oil industry waste) thereby to control the pollution load.

MATERIALS AND METHODS

Collection of industrial waste and irrigation water

The soya waste, the soyabean oil industry waste from Rasoya Proteins Pvt. Limited, Wani, Dist. Yavatmal (India) was collected in a clean and dry polythene bottle of 5-liter capacity without leaving any air gap and closed tightly. This bottle was first cleaned with chromic acid and then by distilled water before filling. The sample was then transported to the laboratory for analysis and stored in a cool place away from light [17-18]. The soya waste was then analyzed at the beginning of winter season. Similarly, irrigation water sample was collected from the well after dipping bucket in the well to a sufficient depth and withdrawing water from the middle of the well and then taken in clean polythene bottles without leaving any air gap. The samples were then transported to the laboratory for analysis.

Selection of agricultural crop species and experimental soil

The seeds of Chilli (*Capsicum annuum* L) of make Jwala were procured from market. Three soil samples were procured from three different fields of Dongargaon village Dist. Yavatmal State- Maharashtra (India). The samples were taken at 25cm depth from the surface and sampling was carried out by quartering method [19]. The soil samples were then air dried and powdered and stored in clean and dry polythene container. These samples were subjected for the evaluation of pH, EC, Texture, bulk density, WHC, porosity, Ca, Mg, K, Na, P and micronutrients like Cu Zn, Mn, Fe were determined using AAS Chemito AA 203 [20].

Experimental details preparation soil Soya waste blends

Three different soils S_1, S_2 and S_3 were dried and powdered and each soil was mixed thoroughly with 0, 50, 100, 150, 200, 250 gms of soya waste to get 1 kg of soil-Soya waste blends. Thus, 0% (Control), 5%, 10%, 15%, 20% and 25% blendings were prepared. Similarly, replicate of each system was prepared. All these different blends were then dried and filled in a different polythene bag. Three seeds of chilli sown in each bag and all the systems were watered equally with same period and the same irrigation water. The height, number of leaves, number of flowers, number of fruits of each plant recorded (Mean values of each parameter of each system and its replicate was recorded) when the plants were fully matured. Finally dry weight of each plant was noted after drying.

RESULTS AND DISCUSSION

Soya waste is a dark brown in colour and contains excess of TDS (2110 ppm), Chlorides (2.7 me/L), Sodium (0.96 me/L), Ca (4.0 me/L), Mg (1.9 me/L), Sulphates (4.21 me/L), K (0.52 me/L), pH (8.42), high COD and BOD, oil, grease etc. and considerable amount of macro and micro nutrients. High TDS value [21] in effluent would retard the plant growth by enriching the salinity and conductivity of the solute which were being absorbed by plant. Table 1 shows the results of physico-chemical parameters of soya waste and irrigation water. The physico-chemical characteristics of the soils S_1, S_2 and S_3 are shown in Table 2. Observations of mean values of growth parameters of chilli plants with respect to plant height, number of leaves, flowers and fruits for three soils and their replicates were recorded.

Table 1 Physiochemical characteristics of soya waste and irrigation water

Parameters	Soya waste	Irrigation water
TDS (ppm)	2110	892
pH	8.42	7.33
EC (mS/cm)	1.33	3.23
Calcium (me/L)	4.0	4.8
Magnesium (me/L)	1.9	2.2
Sodium (me/L)	0.96	0.77
Potassium (me/L)	0.52	0.43
Bicarbonates (me/L)	1.7	2.5
Chlorides (me/L)	2.7	2.3
Sulphates (me/L)	4.21	1.54

Table 2 Physico- chemical characteristics of three different soils

Parameters	S_1	S_2	S_3
Bulk density g/cc	1.40	1.68	1.25
W.H.C %	77.83	79.83	67.42
pH	7.70	7.90	7.80
Conductivity ms/cm	0.57	0.63	0.70
P as phosphate kg/hectre	19	22	27
Na %	0.52	1.78	0.63
K kg/hectre	560	655	300
Organic C %	0.40	0.42	0.58
Ca %	40	30	30.25
Mg %	3.78	9.80	4.69
Porosity %	60.05	54.52	35.63
Moisture %	8.99	7.16	10.02
Zn ppm	0.25	0.48	0.47
Cu ppm	1.16	2.84	1.41
Fe ppm	0.29	0.56	0.64
Mn ppm	2.04	5.21	1.62

From the data obtained, it was observed that, in winter season, the plant height (10.5 inch), number of leaves (44), flowering (25), number of fruits (23) and dry weight (9.3 g) in S_1 were recorded maximum at 10% blending concentration. In case of S_2, the highest values of plant height (11.5 inch), number of leaves (53), flowering (29), number of fruits (26) and dry weight (10.3 g) found at 20% blending. Similarly, in S_3 the optimum values of growth parameters were reported at 15% blending as plant height (13.5 inch), number of leaves (69), flowering (32), number of fruits (33) and dry weight (11.8g). Thus, 10% for S_1, 20% for S_2 and 15% blending for soil S_3 was reported as optimum level blending concentration of Chilli plant in winter season. The fairly good results for S_3 may be attributed to the better % of organic C, P and Fe in S_3. This study clearly indicates that up to certain limit there is an encouraging correlation between the growth parameter and the blending concentration of the soya-waste. With increase in blending concentration from 0 to 10% for S_1, 0 to 20% for S_2 and 0 to 15% for S_3, there is a gradual but steady increase in growth parameter. But further increase in effluent concentration causes decrease of growth parameters which might be due to beyond these concentrations, toxicity level of chemicals in the effluent increased that resulted in decreased plant growth. This indicates that, the ingredients present in the blends of soya waste and a particular soil at particular concentration are supportive to the growth of plant. These findings are in accordance with the observations recorded [11] in jowar, bajra and rice. Similar results were also obtained [22] in rice crop wherein they noticed that at 5% effluent concentration, the overall growth was better than in control whereas at higher concentration the growth was retarded.

Islam *et al*. [23] studied the impact of effluents on plant growth and soil properties and observed that the contaminated soil exerted significant negative effect on the growth, yield and nutrition of rice and grass plant grown in it and the reduction were more pronounced in rice. Some negative effects were also reported but these may be due to excessive concentrations of industrial waste which may lead to nutrient toxicity and other soil disorder [24]. From the commercial view point overall maximum number of fruits was found in winter season at 10% for soil S_1, 20% for S_2 and 15% for S_3 blending concentration (Fig 1).

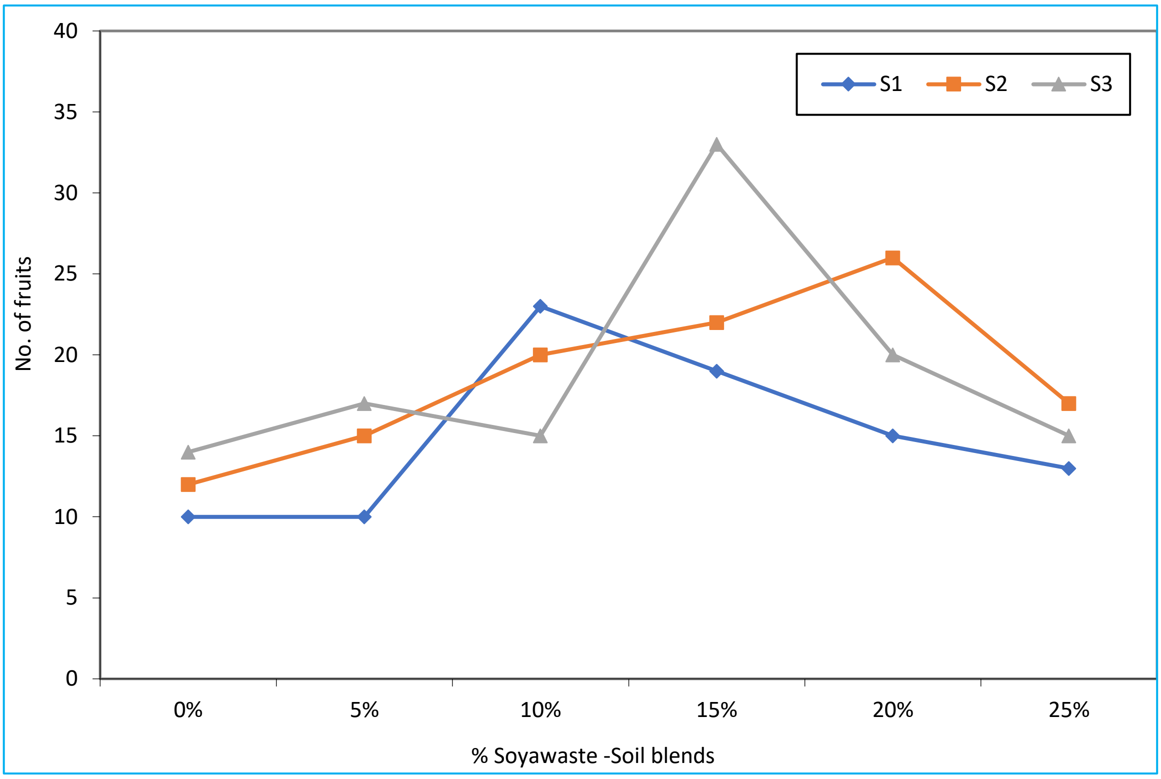

Fig 1 No. of fruits at different blendings

Therefore, this investigation showed that, at 10, 20 and 15% blending concentration for three soils S_1, S_2 and S_3, there was a promotional influence on the plant growth which might be due to the optimum level plant nutrients in the effluent at these concentrations.

CONCLUSION

From the results it can be concluded that soyawaste acts as an excellent source of essential nutrients for appreciably improving the texture and fertility with significant increase in crop yield over the control at a particular blending concentration only and is supportive to plant growth. Hence, there is an opportunity with soya waste to be used as an eco-friendly and non-conventional fertilizer at controlled blending concentration. However, there is a need of detail and time series study to declare it is totally safe and eco-friendly to be used for the crop productivity.

Conflict of interest

There are no conflicts of interest.

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