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FRESH WATER CONSERVATION PROSPECTIVE: CULTIVATION OF CHILLI (*CAPSICUM ANNUUM* L. VAR. *PUSA JWALA*) USING WASTE WATER IN PRESENCE OF PHOSPHORUS FERTILIZER

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Abstract

The experiment was conducted to study the comparative effect of wastewater on the physico-morphological characteristics of chilli. The crop was supplemented with four basal doses of phosphorus with the rates of 0, 45, 60 and 75 kgha-1P with uniform basal dose of nitrogen and potassium with the rates of 60 kgha-1N and 50 kgha-1K respectively. Data was recorded at 30 and 60 day after sowing (DAS). Wastewater irrigation resulted significant increase in plant shoot length, root length, fresh weight and dry weight, leaf area, leaf number plant-1, chlorophyll content, nitrate reductase activity and carbonic anhydrase activity. Among phosphorus doses P60 along with wastewater proved best for growth and physiology of the plant. Thus it may be concluded that WW reduce the demand of fertilizers and it may be used profitably for the cultivation of chilli.

***Keywords**: Carbonic anhydrase; Chilli; Nitrate reductase; Phosphorus; Wastewater.*

Introduction

Rapidly growing population of the country has increased the consumption of fresh water resources. More than 70% of the valuable water was diverted towards the irrigation of crops. The reuse of waste water in agriculture has prevented the colossal wastage of our scarce fresh water resources which is gaining importance nowadays because it contains valuable potential nutrients. The municipal waste carries almost 99% water together with relatively small concentrations of suspended and dissolved organic and inorganic solids. The planned use of municipal waste water alleviates surface water pollution problems and not only conserves valuable resources, but takes advantage of nutrients contained in it which might reduce or even overcome the requirements of commercial inorganic fertilizers as well.

Previous studies [1-5] recorded that in India almost 32 municipal committees are utilizing about 82,000m^3 of partially treated sewage water per day for irrigation. It has been calculated that for about 17,400ha of land the sewage available for big cities of India could annually contribute 33,000 tones of N, 7,000 tones of P and 20,000 tonnes of K. In Aligarh alone about 24 $million^2$/annum waste water is discharged and vast areas of agricultural lands are being irrigated with this waste water.

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F.B. Salisbury and C.W. Ross [6] stated that out of about 60 elements only 17 elements were known as essential. Nitrogen, phosphorus and potassium plays very important role in growth and productivity of chilli. Phosphorus is relatively immobile, inaccessible and less available nutrient [7] and has an important role in crop production [3]. Among vegetables and spices chilli is an important cash crop grown for its pungent fruits [8]. Chilli is strictly tropical and subtropical plant. It is grown in many parts of India, especially in Tamil Nadu, Bihar, Andhra Pradesh, Maharashtra and to a lesser extend in the plains of north India. It contains over 125 volatile oils as well as glycosides and vitamins (vitamin A, vitamin C, vitamin E). The main component of capsicum peppers is the glycoside capsaicin which is used in pain balms, chilli is also used as vegetable for making pickles [9].

To make fresh water long lasting proper management of fresh water is to be done so as to make benefit for growing human population. With the increasing demand day by day, more and more land is to be brought under cultivation, thereby increasing the demand for inorganic fertilizers as well as irrigation water, hence focus shifted toward various non-conventional sources which in turn are easily accessible. Among others, one of the important irrigation and nutrient source in waste water [10-16], provides fertilizing benefits to crop [16]. An experiment was conducted to study the comparative effect of the ground water (GW) and urban waste water (UWW) on the growth and physiological characters of *Capsicum annuum* L. var. Pusa Jwala under four levels of phosphorus doses i.e. 0, 45, 60 and 75kg·ha^{-1} with uniform basal doses of nitrogen and potassium at the rate of 60 kg·ha^{-1} each.

Experimental

The experiment was conducted in earthen pots of 10-inch diameter in the net house of the department of Botany, AMU - Aligarh, UP, India. The soil was thoroughly mixed with manure to maintain the organic matter. The NPK fertilizers were calculated on the basis of their composition one hectare of land contains 2×10^6kg effective soil [17] and each pot had 5 kg of soil. The crop was supplemented with uniform basal dose of nitrogen and potassium with the rates of 60kg·ha^{-1}N and 50kg·ha^{-1}K. Four basal doses of phosphorus with the rates of 0, 45, 60 and 75kg·ha^{-1}P. These fertilizers were added to the soil one day before sowing along with the light application of ground water. The seeds were disinfected with 0.01% aqueous solution of mercuric chloride followed by repeated washing with double distilled water and then dried in the shade. The treatments were arranged in completely randomized block design. Each treatment was replicated thrice. The plants were randomly selected from sample from each treatment at 30 and 60 DAS.

Soil and water analysis

To illustrate the physico-chemical characteristics of irrigating water (i.e. ground water and waste water) the parameters analyze were pH, electrical conductivity (EC), total dissolve solids (TDS), total solids (TS), total suspended solid (TSS), biochemical oxygen demand (BOD), chemical oxygen demand (COD), hardness, calcium (Ca^{2+}), magnesium (Mg^{2+}), and nitrate-nitrogen (NO_3-N), carbonate (CO_3^{2-}), bicarbonate (HCO_3^-), potassium (K), phosphorous (P) and phosphate (PO_4^{3-}) (APHA, 1985) (Table 1). For the filling of pots, soil from the university agriculture farm was collected and analyzed for various parameters such as texture, pH, cation exchange capacity (CEC), electrical conductivity (EC), total dissolve solids (TDS), phosphorus (P), calcium (Ca), magnesium (Mg), carbonate (CO_3^{2-}), and bicarbonate (HCO_3^-) (Table 2) [17].

Table 1. Physico-chemical parameters of ground water and waste water

Determinant	Ground water	Waste water
Color	colorless	Softly black
Odor	Odorless	unpalatable
pH	7.5	8.7
Electrical conductivity ($mhoscm^{-1}$)	554	1402
Total solids	976	2567
Total dissolve solids	532	1532
Total suspended solid	427	1170
Biochemical oxygen demand	15.9	165.4
Chemical oxygen demand	39.9	378
Hardness	100.1	130.2
Calcium ($mg \cdot L^{-1}$)	25.8	186.9
Magnesium ($mg \cdot L^{-1}$)	27.2	143.7
Nitrate-nitrogen ($mg \cdot L^{-1}$)	0.65	1.45
Carbonates ($mg \cdot L^{-1}$)	18.9	96.6
Bicarbonates ($mg \cdot L^{-1}$)	67.8	231.8
Potassium ($mg \cdot L^{-1}$)	5.5	12.2
Phosphorous ($mg \cdot L^{-1}$)	0.05	0.92
Phosphate ($mg \cdot L^{-1}$)	0.70	1.82

Table 2. Physico-chemical parameters of soil collected before sowing

Parameters	Soil
Texture	Sandy loam
pH	7.790
Cation exchange capacity (meq $100g^{-1}$soil)	3.330
Electrical conductivity (μ $mhos \cdot cm^{-1}$)	291.0
Total dissolve solids ($mg \cdot L^{-1}$)	789.0
Phosphorus ($g \cdot kg^{-1}$soil)	0.110
Potassium ($mg \cdot L^{-1}$)	17.50
Calcium ($mg \cdot L^{-1}$)	30.10
Magnesium ($mg \cdot L^{-1}$)	15.22
Carbonate ($mg \cdot L^{-1}$)	19.20
Bicarbonate ($mg \cdot L^{-1}$)	198.0

Growth Parameters

Root and shoot length was measured in centimetres with a measuring tape. The shoots and roots were dried in a hot air oven (universal oven, memmert type) at 80ºC for 24 hours and then weighed with an electrical balance. Leaf area was calculated by graph paper method.

Physiological Parameters

Nitrate reductase (NR) activity was determined in fresh leaf samples, following the method of [18]. Chlorophyll content was quantified by the procedure of [19]. The CA activity in the leaves was measured by following the procedure described by [20].

Statistical Analysis

The data obtained was analyzed statistically taking into consideration the variables in each experiment according to [21]. The 'F' test was applied to assess the significance of data at 5% level of probability ($P \leq 0.05$). Critical difference (CD) was calculated to compare the mean values of the various treatments.

Results

Waste water along with different doses of phosphorus (P_0, P_{45}, P_{60} and P_{75}) proved more effective than ground water for all growth and physiological parameters of *C. annum*. Shoot length at 30 DAS was observed non significant over WW and GW treatment. Whereas at 60 DAS stage an enhancement of 9.19% in shoot length was recorded over GW irrigated plants and 36.46% increment was recorded under $WWxP_{60}$ (Fig. 1).

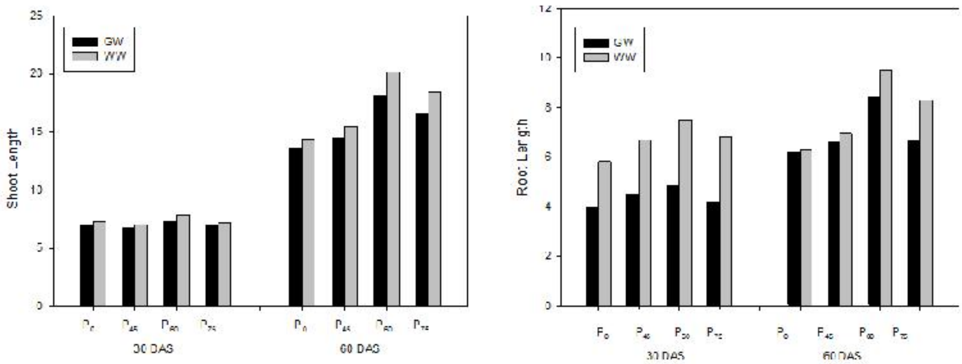

Fig. 1. Effect of ground water (GW) and wastewater (WW) on Shoot Length (cm) and Root Length (cm) on *C. annuum* L. grown with different levels of phosphorus at 30 and 60 days before sowing (DAS)

In root length, an increment of 53.33% and 12.23% were recorded over GW at 30 DAS and 60 DAS respectively (Fig. 1). WW × P_{60} proved optimum combination and an enhancement of 52.94% over GW × P_0 was observed in root length. The significant accumulation of dry matter was observed at 60 DAS i.e. 72.73% over 30 DAS i.e. 71.73%. P_{60} dosage with combination of WW proved to be best in dry weight of the crop (Fig. 2).

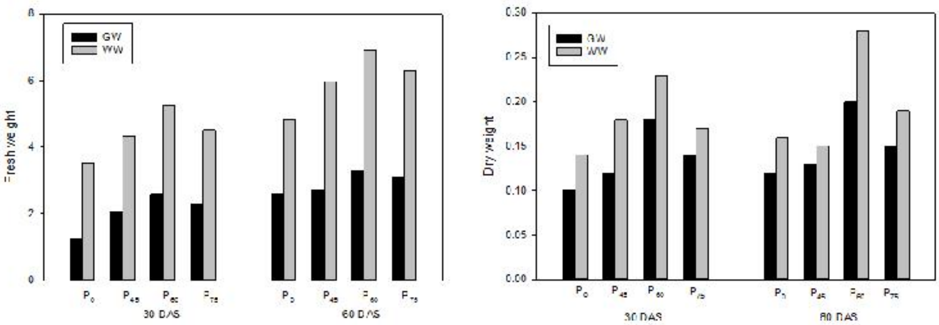

Fig. 2. Effect of ground water (GW) and wastewater (WW) on fresh weight (g) and dry weight (g) on *C. annuum* L. grown with different levels of phosphorus at 30 and 60 days before sowing (DAS).

Waste water proved efficient as it increased leaf areas by 27.63% and 10.82% at 30 and 60 DAS over GW (Fig. 3). P_{60} proved optimum at both samplings and recorded an increase of 36.58% and 14.51% over P_0. NR activity was significantly enhanced by waste water irrigated plants and an increase of 3.92% and 2.34% was recorded at 30 and 60 DAS respectively over GW (Fig. 4). Among the phosphorus levels, P_{60} x WW proved optimum and an increase of 16.30% and 6.24% over P_0 where observed at both sampling stages. CA activity along WW proved an effective source of nutrients and thereby increased the CA activity by 13.80% and 5.37% over GW irrigated plants (Fig. 4). Among different phosphorus levels, P_{60} × WW proved best recording an increase of 27.02% and 37.57% were over P_0 at 30 and 60 DAS in CA activity. Like other parameters waste water proved effective source of nutrients in increasing the Chlorophyll content i.e. A, B and Total Chlorophyll by 8.98% and 16.46%, 22.21% at 30 DAS and 16.70%, and 11.69% and 16.00% at 60 DAS over GW (Fig. 5).

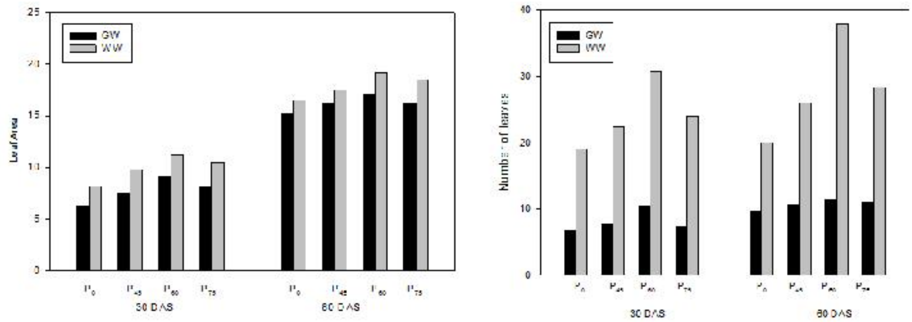

Fig. 3. Effect of ground water (GW) and wastewater (WW) on leaf area (cm^3) and number of leaves plant^{-1} on *C. annuum* L. grown with different levels of phosphorus at 30 and 60 days before sowing (DAS)

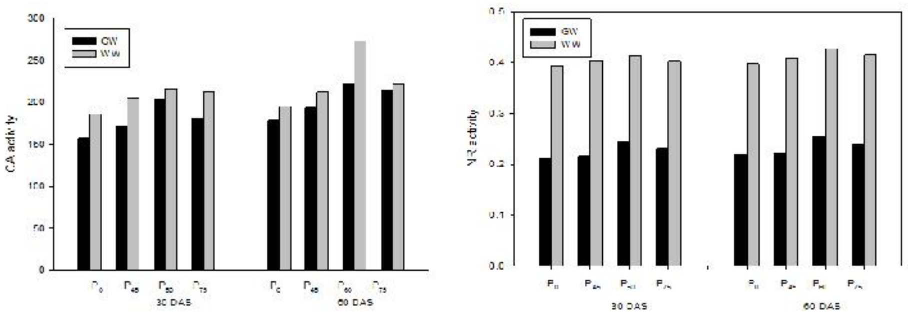

Fig. 4. Effect of ground water (GW) and wastewater (WW) on CA activity and NR activity on *C. annuum* L. grown with different levels of phosphorus at 30 and 60 days before sowing (DAS)

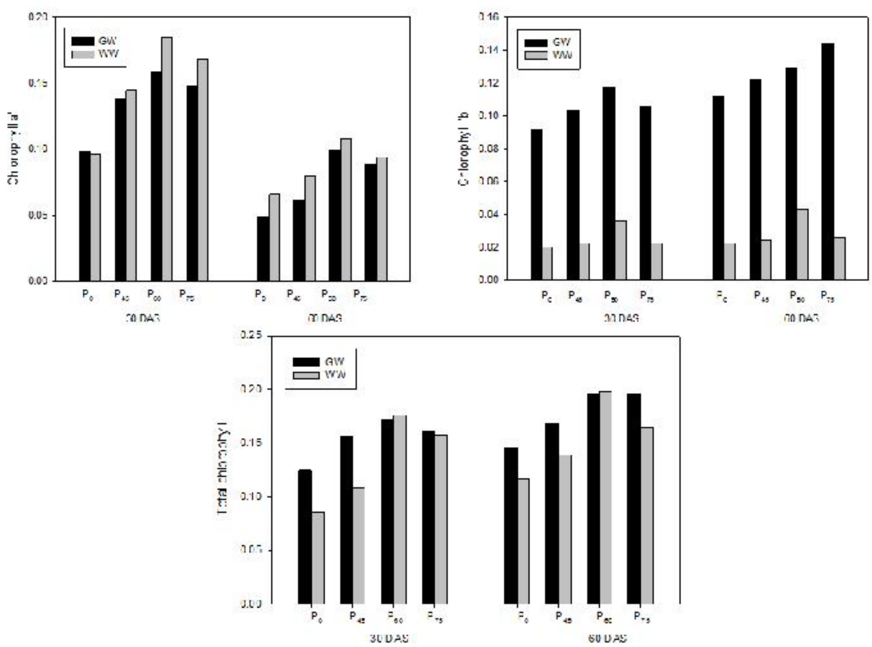

Fig. 5. Effect of ground water (GW) and wastewater (WW) on Chlorophyll A, Chlorophyll B and Total Chlorophyll on *C. annuum* L. grown with different levels of phosphorus at 30 and 60 days before sowing (DAS)

From various dosages of phosphorus, $P_{60} \times WW$ proved best for all parameters registered an increase of 74.84%, 79.25% and 89.86% at 30 DAS over, P_0 in Chlorophyll A, B and total. $P_{60} \times WW$ proved most effective combination followed by $WW \times P_{75}$ and $GW \times P_{60}$ in Chlorophyll A. However, the combination $GW \times P_{60}$ and $WW \times P_{75}$ were most effective for Total Chlorophyll content.

Discussions

Waste water can also act as beneficial alternative for fresh water resource. The great potential of waste water to reuse as a source of irrigating water as well as nutrient and soil conditioning agent [4] that enhance growth and productivity of crop plants [15, 22, 23, 24]. Permissible quantity of EC, TDS, TS, TSS, BOD, COD, Ca^{2+}, Mg^{2+}, HCO_3^-, CO_3^{2-}, NO_3^- N, K, P, and PO_4^{3-} are present in waste water which is use for irrigation [2] (Table 1). Some micronutrient and inorganic ions are present in fewer amounts in waste water which is essential for the plant growth and development [22]. Use of waste water can increase the nutrient availability to the plants by enhancing the density of soil microorganism including bacteria, fungi and actinomycetes [6, 8, 12-14, 23]. Among NPK Phosphorus when supplied in limiting amounts has much greater impact on growth and photosynthesis characteristics of *C. annum* [24, 25]. Thus, P which was also present in wastewater could have ensured its availability and thereby led to improving growth (Figs. 1, 2, 3 and 4). The application of phosphorus also significantly affected plant shoot length, root length, dry mass of root and shoot and it is well known that it is indispensable nutrient for normal growth and development, and its deficiency retards plant growth, cell and leaf expansion [7]. The application of Phosphorus was significant at both sampling stages and P_{60} proved more optimum and pronounced when given with wastewater. The increased photosynthetic area probably led to the accumulation of dry matter (Figs. 1 and 5). These results tune with the finding of [13, 26]. The leaf NR activity and CA activity is also likely to be improved with P_{60} [12] and wastewater (Fig. 3). Thus, it may infer from the present study phosphorus application at the rate of 60 $kg \cdot ha^{-1}$ proved more pronounced most beneficial and the effect was more pronounced when given with wastewater.

Conclusion

It may be deducted from the present study that waste water could supplement the entire nutrient requirement of the crop, yet it proved beneficial source of nutrients and at the same time served as a source of water. It also minimized the fertilizer consumption and decreases the pollution load from the environment. The use of waste water for the cultivation of *C. annuum* is economically good with the application of phosphorus at the rate of 60 $kg \cdot ha^{-1}$ and it's trialed to be most beneficial when marked with waste water.

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