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Comparative studies of effluent dilution, FYM and BF amendment on crop plant

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SUMMARY

Studies on the effect of paper mill effluent in combination with farmyard manure and bio-fertilizers on growth, biochemical constituents, rhizosphere analysis, nodulation, yield and seed characteristics of green gram were carried out under potted condition. Effluent concentration (50%) in combination with FYM and BF amendment promoted the growth parameters (shoot length, root length and biomass), bio chemical constituents (chlorophyll and protein), microbial population and nodulation of green gram, whereas the higher concentrations (75 and 100%) reduced all the above said parameters. The yield parameters studied *viz*., pod length, number of pods per plant and number of seeds per pod exhibited marked increases in the plants raised in 50% effluent concentration in combination with FYM and BF treatment. A similar observation was observed in protein content of the harvested seeds. The 40 – day – old test plants registered higher biochemical, microbial populations and nodulation of green gram.

Key words : Green gram, Paper mill effluent, Phytotoxicity, F.Y.M., Biofertilizer

As the saying "Nothing is a waste under gods creation" almost all the wastes generated can be reused after proper treatment. In the same way the effluents and solid wastes let out from industries after undergoing primary and secondary treatments can be made use for agricultural purpose. It is estimated that if 20 per cent of waste water is regenerated, water withdrawal needs in 2000 AD could appreciably be reduced throughout the world (Falkenmark and Lindh, 1974). If the waste water from paper and pulp industry be successfully used for irrigation, it would be possible to prevent river water pollution. Irrigation of raw effluent often alters the physico-chemical properties of the treated soils and retardation of plant growth (Rajannan and Oblisami, 1979, Lakshmi and Sundaramoorthy, 2001; Kaushik *et al.*, 2004). The combined use of FYM and BF might provide the soil with need based nutrients and with better physical and microbiological environment, thus improving the soil fertility and productivity. (Baronia, 2000; Kalaichelvi, 2001; Sundaramoorthy *et al.*, 2007).

MATERIALS AND METHODS

Uniform seeds of *vigna radiata* (L.) R. Wilczek obtained from department of pulses, Tamil Nadu Agricultural University, Coimbatore were surface sterilized with 0.1% $HgCl_2$ and washed thoroughly. Earthern pots (30 cm x 20 cm) filled with field soil and farmyard manure in the ratio of 5 : 1 (Soil : FYM). In biofertilizers the pot is filled with 5: 1 ratio (Soil: Biofertilizer). The carrier based inoculum packets of Rhizobium and Phosphobacteria were obtained from Department of Agricultural Microbiology, Tamil Nadu Agricultural University, Coimbatore. The pots were drenched with different concentrations (25, 50, 75 and 100%) of the effluent and left as such for 1 weak. Five replicates were maintained for each treatment. The pots were sown with KM_2 variety of green gram at the rate of 10 seeds per pot and watered with the respective effluent concentration. Well water was used for intermittent watering whenever necessary and also used for control set. No pesticide was applied to the plants during the course of the study.

The plants were uprooted on 20, 40, 60 and 80th day after sowing. The measurement for length (shoot and root) and biomass were made. The number of root nodules in the root system was counted and expressed as individuals (plant^{-1}). Chlorophyll was estimated as per Yoshida *et al.* (1976). Protein estimation was done by following Lowry *et al.* (1951) method. Dilution plate method was employed for the enumeration of microbial population in the soil samples. Statistical analysis of data was according to DMRT – Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

The effect of different concentrations of effluent, in combination with farmyard manure and biofertilizer amendment on the growth, biochemical constituents, bacterial, fungal population and nodulation of *vinga radiata* has been shown in Table 1, 2, 3 and 4 at different

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intervals (20, 40, 60 and 80th days).

The shoot, root length and biomass were in the range of 9.92 to 25.52 cm, 3.92 to 17.40cm and 0.120 to 2.160, respectively. Among the different treatments, the 50% concentration and biofertilizer treatment supported higher growth. The results of the present investigation revealed that coinoculation of *Rhizobium* and Phosphobacteria enhanced the growth parameters of green gram which indicates mixed inoculation was superior to individual inoculation in enhancing the growth and yield indicating the synergistic effect of the introduced organisms. The results are in conformity with the findings of (Alagawadi and Gaur, 1988). FYM and BF treatments of the soil uniformly enhanced the growth of the test plant in all treatments and in different growth stages, the changes were often significant (Joshi *et al.*, 2000; Sundaramoorthy *et al.*, 2007).

In the present investigation pronounced increase in the total chlorophyll and protein content were observed in the 25 and 50% effluent concentrations and biofertilizer treatment. Pronounced decreases in the total chlorophyll contents indicating various host tissue injury in the leaves of *Vigna radiata*. The contents of chlorophyll and protein were not adversely affected by the effluent treatment upto 75% concentration in both FYM and BF. The 40 – day – old plants registered maximum chlorophyll and protein. The results are in conformity with the findings of (Thamizhvendan and Sheerin, 1998; Sharma and Namdeo,

Table 1: Impact of differnent concentrations of treated paper mill effluent in combination with FYM and BF on growth, biochemical constituents, rhizosphere analysis and nodulation of *Vigna radiata* (L.) R. Wilczek on 20th day after sowing

Effluent concentration (%)	Shoot length (cm)*	Root length (cm)*	Biomass (g plant $^{-1}$)*	Chlorophyll (µg g^{-1} fresh leaf weight)*	Protein (mg g^{-1} leaf dry weight)*	Bacterial population (x 10^6 cfu g^{-1})*	Fungal population (x 10^3 ppg g^{-1})*	Nodules (plant $^{-1}$)
Control	11.38 c	4.10 fghi	0.150 fgh	2.35 d	57.8 cde	13.20 d	3.00 defg	8.80 bcde
25% + FYM	12.12 c	4.52 cde	0.206 cd	2.52 bc	56.4 def	23.40 bc	5.20 bc	10.00 abcd
25% + BF	12.32 bc	4.60 cd	0.222 bc	2.54 abc	56.6 cdef	23.80 abc	5.60 abc	10.60 abc
50% + FYM	14.22 a	4.90 ab	0.246 ab	2.60 a	62.8 b	27.40 ab	6.60 ab	12.60 a
50% + BF	14.42 a	5.02 a	0.268 a	2.62 a	66.6 a	28.00 a	7.20 a	13.00 a
75% + FYM	11.66 c	4.34 defg	0.156 fg	2.21 e	58.2 cd	23.80 abc	4.20 cdef	8.00 bcdef
75% + BF	11.78 c	4.40 def	0.174 ef	2.22 e	56.2 ef	24.20 abc	4.40 cde	8.60 bcde
100% + FYM	9.92 d	3.92 hi	0.120 i	1.91 f	49.4 g	13.40 d	2.40 fg	6.00 ef
100% + BF	10.12 d	4.04 ghi	0.143 ghi	1.93 f	47.2 h	13.60 d	2.50 efg	6.80 def

* Based on five determinations for each treatment
Values with same alphabet in each sampling day in the columns do not differ significantly from each other (P<0.05)
Statistical analysis of data is DMRT – Duncan's Multiple Range Test.

Table 2 : Impact of differnent concentrations of treated paper mill effluent in combination with FYM and BF on growth, biochemical constituents, rhizosphere analysis and nodulation of *vigna radiata (L.)* R. Wilczek on 40th day after sowing

Effluent concentration (%)	Shoot length (cm)*	Root length (cm)*	Biomass (g plant $^{-1}$)*	Chlorophyll (µg g^{-1} fresh leaf weight)*	Protein (mg g^{-1} leaf dry weight)*	Bacterial population (x 10^6 cfu g^{-1})*	Fungal population (x 10^3 ppg g^{-1})*	Nodules (plant $^{-1}$)
Control	15.44 e	6.26 ef	0.614 d	2.49 e	65.6 b	41.20 c	5.70 c	12.20 cd
25% + FYM	19.26 c	6.90 cde	0.780 c	2.67 cd	64.8 b	63.10 b	7.90 ab	15.80 b
25% + BF	19.40 bc	7.20 bcd	0.768 c	2.70 c	65.0 b	63.49 b	8.00 ab	16.00 b
50% + FYM	2.90 a	7.74 ab	0.838 a	2.94 ab	72.2 a	77.20 a	9.30 a	20.40 a
50% + BF	21.02 a	7.94 a	0.856 a	2.96 a	73.2 a	77.50 a	9.50 a	20.60 a
75% + FYM	17.30 d	6.32 ef	0.540 f	2.40 f	64.2 bc	39.00 cd	7.50 abc	10.80 d
75% + BF	17.48 d	6.50 ef	0.564 e	2.42 f	63.8 bc	39.30 cd	7.60 abc	11.00 d
100% + FYM	13.02 f	5.14 g	0.466 h	2.18 g	56.4 d	31.40 d	3.20 d	9.60 d
100% + BF	13.16 f	5.30 g	0.506 g	2.19 g	56.0 d	31.60 d	3.40 d	9.80 d

* Based on five determinations for each treatment
Values with same alphabet in each sampling day in the columns do not differ significantly from each other (P<0.05)
Statistical analysis of data is DMRT – Duncan's Multiple Range Test.

Table 3 : Impact of differnent concentrations of treated paper mill effluent in combination with FYM and BF on growth, biochemical constituents, rhizosphere analysis and nodulation of *Vigna radiata* (L.) R. Wilczek on 60th day after sowing

Effluent concentration (%)	Shoot length (cm)*	Root length (cm)*	Biomass (g plant $^{-1}$)*	Chlorophyll (µg g^{-1} fresh leaf weight)*	Protein (mg g^{-1} leaf dry weight)*	Bacterial population (x 10^6 cfu g^{-1})*	Fungal population (x 10^3 ppg g^{-1})*	Nodules (plant $^{-1}$)
Control	18.62 e	8.40 f	1.036 d	1.96 de	45.4 f	10.20 c	3.00 cde	3.60 h
25% + FYM	20.32 b	14.50 c	1.174 c	2.10 bcd	47.4 cde	17.20 a	5.20 a	8.00 cd
25% + BF	20.50 b	14.66 c	1.160 c	2.13 abcd	48.0 cd	17.40 a	5.30 a	8.40 bcd
50% + FYM	24.92 a	16.62 ab	1.336 b	2.26 ab	51.8 b	15.40 ab	5.40 a	9.40 ab
50% + BF	25.06 a	16.82 a	1.410 a	2.28 a	53.6 a	15.60 ab	5.50 a	10.00 a
75% + FYM	19.68 cd	12.60 de	1.206 c	2.07 cd	46.8 def	16.10 ab	3.50 bcd	6.00 fg
75% + BF	19.76 cd	12.80 d	1.216 c	2.10 bcd	47.8 cde	16.30 ab	3.60 bc	6.80 ef
100% + FYM	16.46 fg	7.52 g	1.008 d	1.87 e	45.4 f	7.40 d	2.10 e	3.20 h
100% + BF	16.60 f	7.70 g	1.016 d	1.89 e	43.4 g	7.70 d	2.20 de	3.80 h

* Based on five determinations for each treatment
Values with same alphabet in each sampling day in the columns do not differ significantly from each other (P<0.05)
Statistical analysis of data is DMRT – Duncan's Multiple Range Test.

Table 4 : Impact of differnent concentrations of treated paper mill effluent in combination with FYM and BF on growth, biochemical constituents, rhizosphere analysis and nodulation of *Vigna radiata* (L.) R. Wilczek on 80th day after sowing

Effluent concentration (%)	Shoot length (cm)*	Root length (cm)*	Biomass (g plant $^{-1}$)*	Chlorophyll (µg g^{-1} fresh leaf weight)*	Protein (mg g^{-1} leaf dry weight)*	Bacterial population (x 10^6 cfu g^{-1})*	Fungal population (x 10^3 ppg g^{-1})*	Nodules (plant $^{-1}$)
Control	19.06 e	9.10 d	1.400 e	1.26 h	21.0 bc	11.10 c	1.60 bcd	2.60 gh
25% + FYM	20.90 c	15.00 b	1.560 cd	1.45 d	19.8 dc	11.90 bc	1.40 bcde	4.40 de
25% + BF	21.04 c	15.22 b	1.606 c	1.48 c	20.8 bc	12.20 bc	1.60 bcd	4.80 cd
50% + FYM	25.20 ab	17.20 a	2.160 a	1.59 a	21.4 b	13.60 a	2.00 ab	6.20 ab
50% + BF	25.52 a	17.40 a	2.00 b	1.61 a	23.0 a	14.00 a	2.30 a	6.80 a
75% + FYM	20.00 d	13.40 c	1.558 cd	1.29 g	22.0 ab	9.00 d	1.00 de	3.00 fgh
75% + BF	20.14 d	13.60 c	1.502 d	1.32 f	21.8 ab	9.4 d	1.20 cde	3.60 efg
100% + FYM	17.00 f	8.30 e	1.206 f	1.14 i	13.6 f	5.00 e	1.30 cde	2.00 hi
100% + BF	17.12 f	8.50 de	1.260 f	1.16 i	15.8 e	5.50 e	1.40 bcde	2.60 gh

* Based on five determinations for each treatment
Values with same alphabet in each sampling day in the columns do not differ significantly from each other (P<0.05)
Statistical analysis of data is DMRT – Duncan's Multiple Range Test.

Table 5 : Impact of differnent concentrations of treated paper mill effluent in combination with FYM and BF on yield and seed characteristics * of *Vigna radiata* (L.)R. Wilczek

Effluent concentration (%)	Yield		Seed nutrients	
	Number of pods per plant	Pod length (cm)	Number of seeds per pod	Protein (mg/g)
Control	10.80 c	5.18 e	6.60 e	215 b
25% + FYM	12.60 b	5.62 cd	8.00 d	218 b
25% + BF	12.80 b	5.68 c	8.40 d	219 b
50% + FYM	15.60 a	6.52 a	10.80 ab	230 a
50% + BF	15.80 a	6.56 a	11.60 a	233 a
75% + FYM	8.40 d	6.16 b	9.00 cd	191 c
75% + BF	8.60 d	6.12 b	9.00 cd	192 c
100% + FYM	3.40 e	5.10 e	5.80 e	175 d
100% + BF	3.60 e	5.10 e	6.00 e	174 d

*Based on five determinations for each treatment
Values with same alphabet in each sampling day in the columns do not differ significantly from each other (P<0.05)
Statistical analysis of data is DMRT – Duncan's Multiple Range Test.

1999 a; Rajeswari, 2003). All the above said parameters were decreased in 75 and 100%. The same trend was observed in microbial population (El – Husein *et al*., 1988; Gupta *et al.*, 1998; Kalaichelvi, 2001).

The maximum number of nodules were observed in the 20 and 40 – day – old plants. The mean number of nodules per plant ranged between 2 to 20.6. Root nodulation showed a significant increase in the 50% effluent irrigated soil and BF treatment. The nodulation activity significantly decreased in 100% effluent irrigated soil. Similar observations has been made by a number of investigators (Hedge *et al.*, 1994 and Gupta, 2005).

Table 5 revealed the yield and seed characteristics of green gram. All the yield parameters studied *viz*., pod length, number of pods per plant and number of seeds per pod exhibited marked increases in the plants raised in BF treated soils which received 50% effluent concentration. Further, the irrigation of soil with higher concentration (100%) led to significant reduction in both FYM and BF on the yield parameters. A similar trend was observed by (Dashti *et al*., 1997; Subehia, 1998; Dubey, 2000).

Abbreviation:

FYM – Farmyard manure, BF – Biofertilizer

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