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Original Research Paper

Microbial Technology for Production of Biocompost and its Impact on Growth and Yield of *Phaseolus aureus* Roxb.

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ABSTRACT

Biocompost was formed from press mud cake (PMC), flyash, *Eichhornia crassipes* and spent wash by bioinoculant *Trichoderma viride* in treatments *viz.* PTDE, T_1, T_2, T_3 and T_4. Variations in temperature, pH and NPK of compost were also analysed. Biocompost maturity was evaluated by C/N ratio on 8th, 16th, 24th and 32nd days. It was observed that *Trichoderma* growth is higher at pH 6.5 that hastened the decomposition process and improved the quality of compost. Immature and mature compost were evaluated by C:N. Seeds of *Phaseolus aureus* Roxb. cv. K-851 were sown in polybag culture (5 kg soil + 159 g compost) @ 5 qt/acre or @ 12.50 kg/hac during July 2004, 05, 06, and 07. The results revealed significantly higher germination %, Vigour index, length of root and shoot, chlorophyll content, biological yield and harvest index. Bioinoculant decomposes the substrates early in T_4 treatment and showed enhanced growth and yield due to mineralized nutrient status of compost.

INTRODUCTION

Indian sugar factories generate nearly 10 million tonnes of solid press mud cake. In addition, the industries also generate about 8-10 million tonnes of molasses and 45-50 million tonnes of bagasse as a valuable by-product. However, distilleries produce about 10-15 litres of wastewater per litter of alcohol production, which creates major disposal problem (Basker et al. 2004). Distillery spent wash is hazardous, but contains many plant nutrients (Ali Khan & Dhaka 1996).

Solid waste flyash, co-product in a sugar industry is rich source of silica, potash, iron oxide and lime. Water hyacinth (*Eichhornia crassipes*) is a fast growing plant and may be used for decomposition, which will decreased aquatic weed problem (Trivedy 1985). *Trichoderma* is bioinoculant, which enhance the capacity to decompose biowastes into useful nontoxic products. It can be used a decomposing agent as well as prophylactic agent against several diseases of plants (Anandraj & Sharma 1997). The present study has been undertaken for fast decomposition of agroindustrial wastes by cellulolytic fungi *Trichoderma viride* and its impact on beneficial growth parameters of *Vigna radiata* L. (Wilczek) [*Phaseolus aureus* L. (Roxb.)] cv. K-851.

MATERIALS AND METHODS

Compost of agro-industrial wastes (PMC, Flyash and Spent wash) collected from the Simbhaoli Sugar Mill, Simbhaoli (SSML) and its distillery division were analysed for physicochemical properties by standard procedures (Table 1). Water hyacinth (*Eichhornia crassipes*) from ponds and decomposer *Trichoderma viride* in powder form were added for composting and covered by black polythene sheet in plastic trays (heap method).

Organic substrate *viz.* PMC (press mud cake)-6 kg, flyash-100 g, DSW (distillery spent wash)-6 litre, *Eichhornia crassipes*-350 g and *Trichoderma viride*-150 g were mixed in following treatments: Control (No effluent), PTDE (PMC + FA + PTDE + *Eichho* + *Tricho*), T_1 (PMC + FA + DSW), T_2 (PMC + FA + DSW + *Tricho*), T_3 (PMC + FA + DSW + *Eichho*), T_4 (PMC + FA + DSW + *Eichho* + *Tricho*)

During composting process pH, temperature and moisture contents were recorded before turning the substrates. The temperature was recorded every day up to 32nd day in degree centigrade unit (°C) by inserting a thermometer in subsurface layer of bio-resources in heap. The pH of the composting mixture was determined by glass electrode method (1:2) soil:water ratio (Jackson 1967). Organic carbon of compost samples was determined by wet digestion method (Walkey & Black 1934). NPK were analysed by method of soil, plant and fertilizers (Bhargawas & Raghupathi 1993) and prediction of compost maturity was tested through C/N ratio, etc. (Chauhan et al. 2007).

Envirophysiological effects of compost on *Phaseolus aureus* were observed in petri plates and polybags in triplicate treatments (5 kg soil + 150 g compost) @ 5 qt/acres or @ 12.50 kg/hac in treated soil. The data on germination and length of radicle and plumule was studied at 3rd, 5th, 7th and 10th day after sowing (DAS). Seedling vigour index (S.V.I.) has been calculated by following formula of Abdulbaki & Anderson (1973).

S.V.I. = (Root + Shoot length) × Germination %

Chlorophyll content was estimated following the method of Smith & Benitez (1995) at 30th and 60th day. Biological yield per plant was calculated from total plant excluding root at harvest, pooled and weight recorded from each polythene bags. Harvest index (HI) % was measured by following formula :

$$HI = \frac{\text{Seed yield plant}^{-1}}{\text{Biological yield plant}^{-1}} \times 100$$

Data were analysed statistically at 5 % and 1 % CD level.

RESULTS AND DISCUSSION

During the experiment climatic data were also recorded to know about the variations in temperature, rainfall and humidity (%) (Fig. 1). Mature compost samples were analysed for pH, organic carbon and NPK. Different communities of organisms (bacteria, actinomycetes, fungi) predominate during the five composting phases (Ali Khan & Kashyap 2007). The initial temperature phase (psycrophilic), moderate (mesophilic), high temperature (thermophilic), cooling down (stabilization) and maturation (poikilothermic) were recorded (Fig. 2). Maturity evaluation by C/N ratio of compost and its impacts on growth parameters of the test crop were studied.

The mesophillic microorganisms metabolize readily degradable compounds under heat production and temperature reaches maximum (40.5°C) in T_4 and minimum (33.8°C) in PTDE treatment of compost. Once the temperature starts dropping, it is an indication that the thermophiles have completed their job and the mesophiles will again populate in the compost. These microorganisms help in the finishing phase of decomposition and gradually all these bacteria die off resulting in gradual decrease in temperature with 35.0°C in T_4 treatment at cooling down stage of decomposition (Eiland & Iversen 2001).

The high pH value for decomposition of compost at 8th day in all the treatments and then a gradual decline has been observed in PTDE (7.5), T_1 (7.0), T_2 (6.9), T_3 (7.0) and T_4 (6.8) over control. High pH and high NH_3 concentration in thermophilic phase led to NH_3 volatilization. pH was lowered to near neutral in T_2 and T_4 treatment of compost on 32nd day. The high pH and EC might become inhibitory factors responsible for phytotoxicity. This is in conformity with the findings of Lau & Wong (2001).

The data revealed that there was tremendous improvement in the quality of compost with higher value of NPK and lower organic carbon content due to inoculation with cellulolytic fungus (*Trichoderma viride*) of compost. A C/N ratio of 5 to 6 could be used as an essential indicator of compost maturity (Table 1).

The effect of compost on seed germination was maximum in T_4 (96.66 % germination) and minimum (73.33 % germination) in PTDE treatment of compost. Average length of radicle and plumule

Table 1: Mineral constituents of compost from biodegradable PMC, flyash, distillery effluent and *Eichhornia*.

Treatments	Days of decomposition (DD)	pH	OC %	Mineral contents Major Nutrients (kg)			C:N
				N (%)	P %	K %	
Control	0	7.8	36.00	0.96	0.86	0.79	37.50
(No effluent)	8	8.2	36.20	0.97	0.99	0.85	36.20
	16	8.2	34.80	0.98	1.00	0.98	34.05
	24	7.9	33.50	1.00	1.02	0.99	33.05
	32	7.9	30.20	1.08	1.04	1.00	27.96
PTDE (PMC+FA+ PTDE	0	7.6	36.00	0.99	0.93	0.83	36.36
+ Eichho+ Tricho)	8	8.2*	30.20*	1.00**	1.02**	0.86**	30.20*
	16	8.2*	30.00*	1.02**	1.08**	1.02**	29.40*
	24	7.8**	28.90**	1.15**	1.12**	1.09**	25.13**
	32	7.5**	16.36**	1.29**	1.44**	1.14**	12.68**
T_1 (PMC+FA+ DSW)	0	7.1	34.58	1.07	0.98	0.98	32.31
	8	8.2**	28.74**	1.20**	1.18**	1.04**	23.95**
	16	8.1**	27.68**	1.35**	1.21**	1.12*	20.50**
	24	7.6**	22.86**	1.85**	1.53**	1.15*	12.35**
	32	7.0**	12.60**	1.97**	1.72**	1.18*	6.39**
T_2 (PMC+FA+ DSW+ Tricho)	0	6.8	33.90	1.09	0.99	0.99	31.10
	8	8.2**	27.73**	1.28**	1.24**	1.06**	21.66**
	16	8.0**	24.54**	1.47**	1.32**	1.28**	16.69**
	24	7.4**	22.95**	1.95*	1.54**	1.32**	11.76**
	32	6.9**	12.42**	1.99*	1.77**	1.45**	6.24**
T_3 (PMC+FA+ DSW+ Eichho)	0	7.0	33.92	1.12	1.09	1.02	30.28
	8	8.2**	27.81*	1.30**	1.26**	1.08*	21.30**
	16	8.1**	24.78**	1.53**	1.36**	1.32**	16.19**
	24	7.2**	22.98**	1.98**	1.57**	1.46**	11.60**
	32	7.0**	12.48**	1.99**	1.89**	1.57**	6.27**
T_4 (PMC+FA+ DSW+ Eichho	0	6.9	30.65	1.01	1.20	1.04	30.34
+ Tricho)	8	8.1**	28.90**	1.06**	1.29*	1.11**	27.26**
	16	8.0**	23.68**	1.08**	1.38**	1.36**	21.92**
	24	7.1**	22.90**	1.99**	1.84**	1.52**	11.50**
	32	6.8**	11.87**	2.08**	1.96**	1.68**	5.70**

Critical Differece: *Significant at 5 % level; **Significant at 1 % level.
Abbriviations: PMC - Press Mud Cake, FA - Flyash, DSW - Distillery Spent Wash
Eichho - *Eichhornia crassipes*, PTDE - Pre-treated Distillery Effluent; Tricho - *Trichoderma viride*

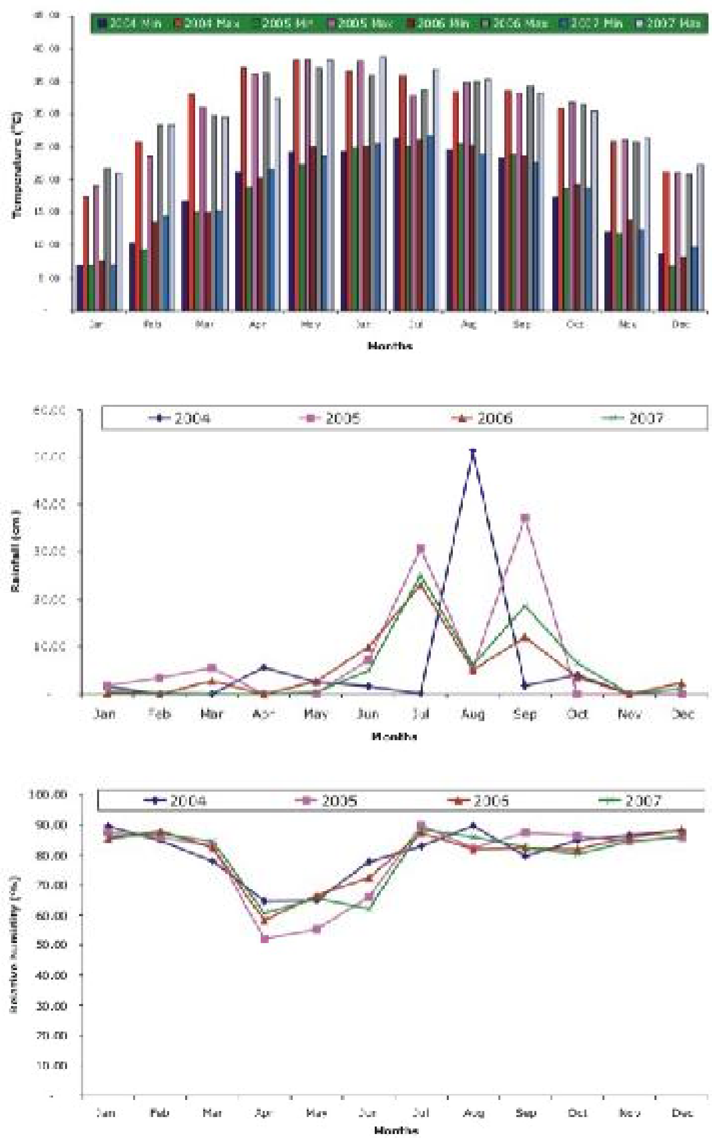

Fig.-1 Meteorological variations in monthly mean temp (min, max), rainfall, and relative humidity (%) during 2004,05,06 & 07.

were measurement and revealed significant reduction sequentially into PTDE treatment. Higher significant results were found radicle and plumule length in T_4 treatment. However, results showed significant decrease in T_1, T_2 and T_3 over control.

The seedling vigour index improved in T_4 treatment over control. The increased vigour index in T_4 due to *Trichoderma viride* inoculation is presumably on account of the growth promoting substances produce by the fungus. The results are in conformity with Girija et al. (1994). The increased

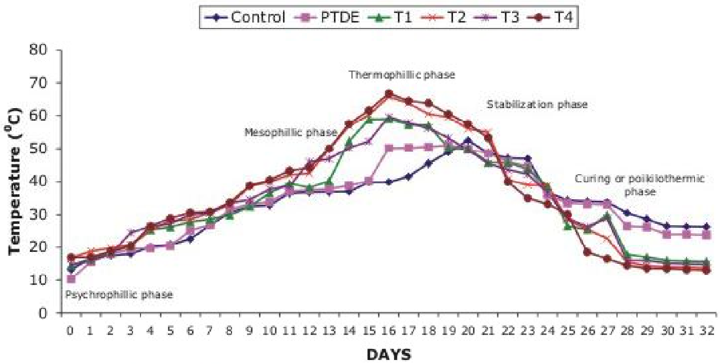

Fig.-2 : Variation in temperature of compost during decomposition process.

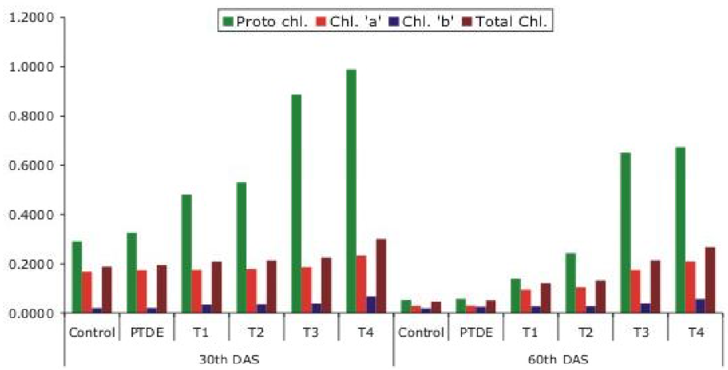

Fig.-3 : Effect of compost on chlorophyll content of *Phaseolus aureus* Roxb. cv. K-851.

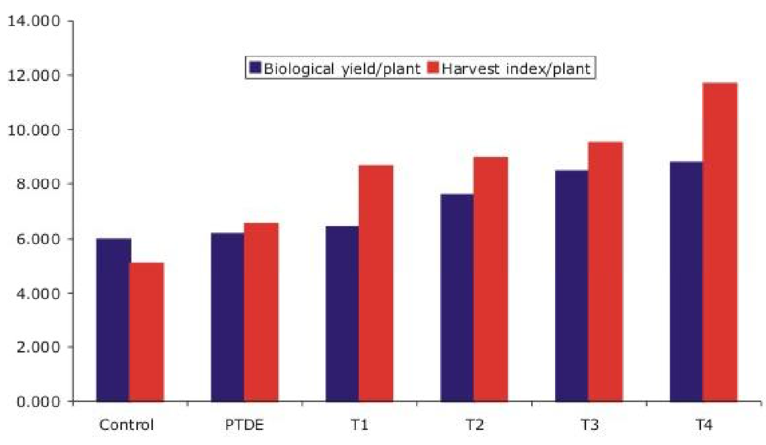

Fig.-4 : Effect of compost on biological yield plant^{-1} and harvest index plant^{-1} of *Phaseolus aureus* Roxb. cv. K-851.

Table 2: Effect of compost on *Phaseolus aureus* Roxb. cv. K-851.

Treatment	DAS %	Germination (V.I.)	Vigour Index	Radicle length (cm/plant)	Plumule length (cm/plant)
Control (No effulent)	3	10.00	-	0.737	-
	5	23.33	92.87	1.025	2.956
	7	46.66	273.47	1.563	4.298
	10	50.00	427.80	2.010	6.546
PTDE (PMC+ FA+ PTDE+ Eichho+Tricho)	3	23.33**	-	0.854**	-
	5	43.33**	212.57*	1.753*	3.153*
	7	66.66**	518.94**	1.987**	5.798*
	10	73.33**	874.24**	2.990**	8.932**
T_1 (PMC+ FA+ DSW)	3	23.33**	135.54*	2.978**	2.832**
	5	46.66**	342.25*	3.659**	3.676**
	7	73.33**	890.00**	5.594**	6.597**
	10	76.66**	1245.03**	6.599**	9.642**
T_2 (PMC+ FA+ DSW+ Tricho)	3	26.66**	258.76**	4.830**	4.876**
	5	53.33*	602.41**	5.480*	5.816**
	7	80.00**	1224.04*	6.420**	8.918*
	10	83.33**	1505.93**	7.430**	10.642**
T_3 (PMC+ FA+ DSW+ Eichho)	3	30.00**	296.55**	4.895**	4.990**
	5	60.00**	725.88**	5.590**	6.508**
	7	86.66**	1483.79**	6.124**	10.998**
	10	90.00**	1823.94**	7.524**	12.742**
T_4 (PMC+ FA+ DSW+ Eichho +Tricho)	3	36.66**	373.93**	4.999**	5.201**
	5	66.66**	971.16**	5.729**	8.834**
	7	93.33**	1942.29**	7.891**	12.920**
	10	96.66**	2214.67**	8.984**	13.928**

Critical differece: *Significant at 5 % level; ** Significant at 1 % level

vigour index observed as a result of seed hardening is seen through an earlier germination, which later reflects in increase of shoot and root length and ultimately the vigour of seedling. Similar improvement in seedling vigour has been achieved through compost treatment. Higher significant results have been recorded in T_4 (2214.67) and lower in PTDE (874.24) treatment (Table 2).

The proto chlorophylls ***a*** and ***b***, and total chlorophyll at 30 and 60 DAS were influenced significantly by compost treatment. The compost has increased the proto chl. ***'a'***, chl. ***'b'*** and total chl. in T_4 treatment of compost. Similar findings were recorded by Sinha & Sakal (1993). Similarly, the proto chl. ***'a'***, chl. ***'b'*** and total chl. increased with increasing value of nutrients of T_4 treatment (Wankhede et al. 1993) (Fig. 3).

The variation in the proportion of harvest index reflected in differences in the total dry matter produced. Higher significance has been observed in biological yield per plant and harvest index per plant in T_4 treatment, while significant reduction has been observed in PTDE treatment. Moreover, significant decrease has been shown in T_1, T_2 and T_3 treatment of ***Phaseolus aureus*** (Fig. 4).

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