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Effect of Sewage and industrial effluents on flowering behavior and yield of pea (*Pisum sativum* L. var. *arkel*)

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Abstract
Municipality Sewage and effluents from Shah Udyog and Dairy Farming were taken to assess the flowering behavior and yield of pea. The effluents from Dairy Farming initiated flowering earlier than the other effluents while effluents of Shah Udyog retarded comparatively. The same trend was followed for anthesis, withering and pod appearance. Duration of anthesis was found increasing in the order: Dairy Farming, Municipality Sewage, Control and Shah Udyog respectively. On the other hand, number of seed per plant and dry weight per seed was found in decreasing order from Dairy Farming to Shah Udyog through Municipality Sewage.

Key words: Effluents; Flowering; Yield; Inhibition and promotion

1. Introduction

Discharge of waste unscientifically is a major problem in the large cities and industrial area like Biratnagar (Lat N $26^0$29', Long E $87^0$16', altitude 72m).The industries viz. Textile , Sugar, Leather, Soap, Plastic, Iron rod, Stainless Steel, Liquors, Biscuits, Dairy, Oil seed extraction mills etc. discharge their untreated waste directly into the natural environments thereby polluting them [1-5].

The liquid waste of this city is discharged mainly to the Singhia River through municipal sewage. The industrial effluents are discharged directly into the neighbouring water bodies or into the agricultural land. The polluted water thus produced is being used by the farmers to irrigate their crop land that adds plant nutrients to some extent and increases fertility of soil but also includes toxicants that change soil fertility and micro-flora [6]. As it needs to investigate the effects of effluents on the different parameters before using them in irrigation, an attempt has been made to find out effect of effluents from Municipality Sewage, Dairy Farming and Shah Udyog on flowering behavior and yield of pea (*Pisum sativum* L. var. *arkel*).

2. Materials and Methods

The seeds of pea were obtained from Siwani Seeds Selling Centre, Biratnagar and were stored in air tight plastic bottle in dark room under ambient conditions. The Municipality Sewage

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was collected from the discharge point of the sewer of Biratnagar Municipality, located at the bank of Singhia River. The effluents were collected directly from the outlet of the factories and were stored inside the air tight polythene containers in dark room under ambient conditions. The colour (visual appearance), pH (pH meter method), dissolved oxygen (Winkler's method), solute particles [7]and organic matter [8] were recorded within three days of effluent collection(table 1).

The concrete pots (diameter 44.5cm, depth 23.4cm) were filled with mixture of garden soil, compost manure and sand in the ratio of 2:1:1 by volume. ¾ parts of them were buried in the field. The seeds were sown in the pots and were irrigated daily with tap water. Each treatment was carried out in triplicates.

The effluent treatment was started when the seedlings were 30 days old. Each pot for particular effluent/control was irrigated with 500ml of 100% effluent/tap water at the interval of 10 days. The seedlings were irrigated with tap water daily except the day of treatment.

When the plants entered in reproductive phase, flowering behavior was observed daily for each treatment/control, the number of plants having floral buds, number of flowers, withered flowers and pods were recorded separately. The former two observations were recorded daily and the rest were recorded at the intervals of twelve hours. For the observation of anthesis, withering of flowers and pod appearance, 40 plants from each treatment were tagged randomly.

For each treatment/control, the smallest visible bud was tagged and the time taken for anthesis was recorded. Three independent observations were carried out to calculate the mean value.

After harvesting, the number of pod(s) per plant and number of seeds per pod were recorded separately. The seeds from each treatment/control were oven dried at 80^0C for 24 hours and the dry weight per seed was calculated. The experiments were conducted in 1999.

3. Results and Discussion

The observation revealed that Dairy Farming and Municipality Sewage effluents initiated reproductive phase earlier (fig.1). The rate of increase in number of flowering plants was initially high in Municipality Sewage effluent but was leaded by Dairy Farming effluent in final days. The Shah Udyog effluent delayed the initiation of reproductive phase and the rate was also low. Comparatively, the Dairy Farming and Municipality Sewage effluents correlated in other flowering and yield parameters i.e.; anthesis (fig.2, table 2), withering (fig.3), pod appearance (fig.4), number of pods, seed set and dry weight of seed (table 3). The Shah Udyog effluent on the other hand delayed all the parameters than the other effluents.

The Municipality Sewage receives the discharge of liquid waste of colleges, hospitals, hotels, nursing homes and large number of household by-products that may contain high amount of organic and inorganic toxicants and stimulants for plant growth and development. The Dairy Farming effluent on the other hand may have less amount of inorganic toxicants but more organic ones as it involves more biological action on the milk and its products. Similarly, Shah Udyog effluent contains different classes of dyes including naphthol, sulphur, chromate, basic and direct dyes used in cotton fabric production. Some of these contain toxic chemicals e. g; Chromium [9].

Shrestha and Niroula [10] reported that Municipality Sewage and Dairy Farming effluents are inhibitory for seed germination while Shah Udyog effluent stimulated this parameter. The inhibitory effect of the former two effluents on seed germination and stimulatory effect in flowering and yield suggests that these effluents are not suitable for the earlier developmental stages of pea but can be used to increase the yield after some chemical treatment. The Shah Udyog effluent on the other hand, though stimulatory in earlier stages of development, proved that it is not useful to get good yield of pea plant as it not only delayed the yield but the seeds set inside the pods were not fully developed.

Plants show different degree of responses with effluents at different stages and also the magnitude of toxicity depends upon species [2,5,11]. The present study also has shown that the

inhibitory effect of the effluents on the same plant in earlier stages of development has changed to stimulatory effect. To understand the exact nature and causes of different effluents/ sewage on the tested plants, it still awaits detail physico-chemical analysis and further research in different growth parameters.

Though the industrial and municipal sewage effluents may contain some useful organic and inorganic nutrients required for plants, their more toxic nature than useful property suggests not bringing them in use for irrigation without proper treatment. It is also indispensable to treat the effluent chemically before discharge to the surrounding water bodies to minimize water pollution and to save the quality of soil and surrounding air.

Table 1: Physico-Chemical Characteristics of Effluents and Tap water (control)

S.N.	Effluents /Tap water	Parameters				
		Color	Solute (g/l)	D.O.(mg/l)	Organic matter	pH
1.	Dairy Farming	Silvery White	1.4	3	Only Small Amount	7.4
2.	Municipality Sewage	Blackish turbid	1.5	2.5	High	7.1
3.	Shah Udyog	Violet	1.7	3.6	Moderate	7.1
4.	Tap Water	----------	0.4	4.15	Negligible	6.9

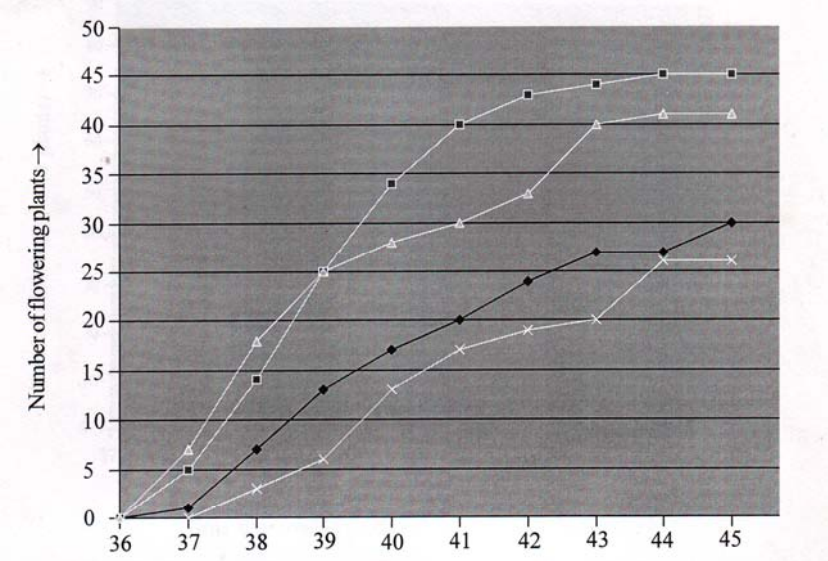

Fig. 1. Comparative effect of effluents on the initiation of reproductive phase (flowering stage) of *P. sativum*:

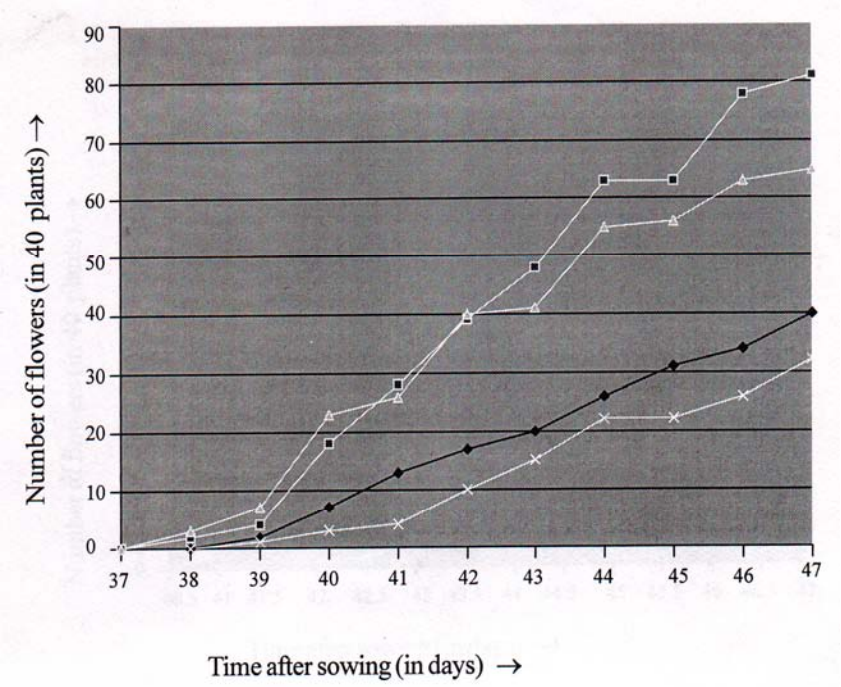

Fig. 2. Comparative effect of effluents on anthesis of *P. sativum*:

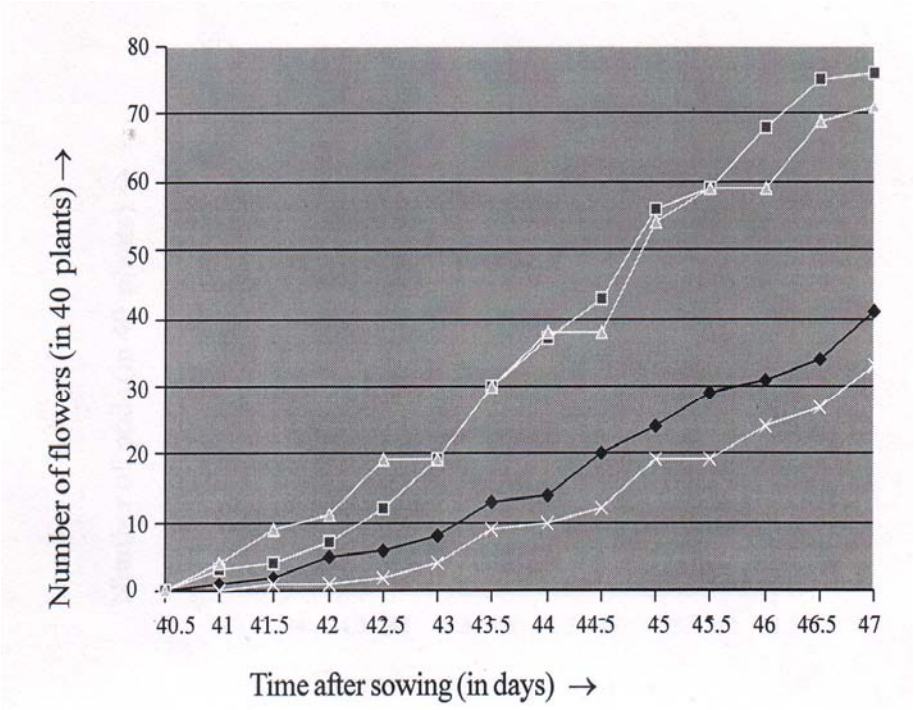

Fig. 3. Comparative effect of effluents on withering of flowers of *P. sativum*:

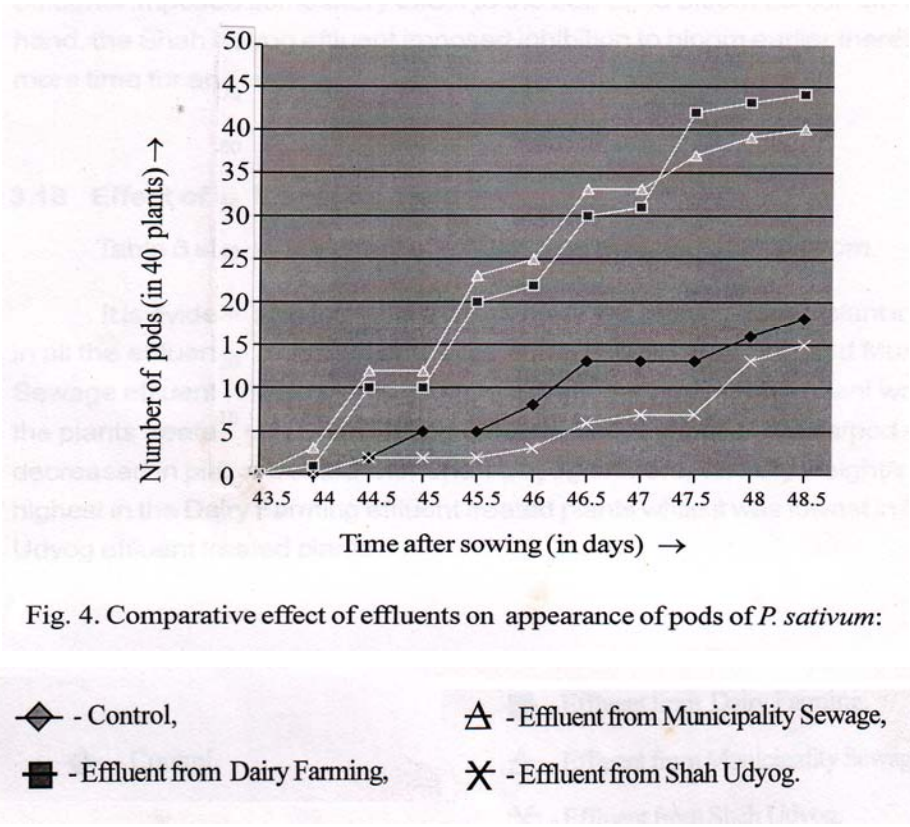

Fig. 4. Comparative effect of effluents on appearance of pods of *P. sativum*:

Table 2. Effect of Effluents on Duration of Anthesis of *P. sativum*.

S.N.	Effluents/Tap Water	Time (in hours)
1.	Control	74.5
2.	Dairy Farming	73.4
3.	Municipality Sewage	73.6
4.	Shah Udyog	76.1

Table 3. Effect of Effluents on Yield of *P. sativum*.

S.N.	Effluents/Tap Water	Pod Number / Plant	Seed	
			Number/Pod	Dry weight seed (mg)
1.	Control	1	1.2	66.7
2.	Dairy Farming	1.2	1.4	87.1
3.	Municipality Sewage	1.2	1.4	76.9
4.	Shah Udyog	1.1	1.1	65.0

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