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Evaluation of Lac Factory Waste on Flower Production

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ABSTRACT

Two separate experiments were conducted to evaluate the suitability and effectiveness of lac mud on flower production of rose and *Chrysanthemum* flowers under pot culture. Lac mud is produced during primary processing of lac to a tune of about 2.5 to 4.5% on dry and wet weight basis, respectively, of the raw material processed. Lac mud was grinded in fine particles and treated with lime (@ 25 g per kg of lac mud) followed by enrichiment with each of N, P and K as per treatments, azotobacter and PSB each @ 25 g/kg of lac mud. Experimental results revealed that lac mud enriched with 0.2% N + 0.2% P_2O_5 + 0.2% K_2O produced the highest number and weight of chrysanthemum and rose flowers which was significantly superior to all other treatments, except lac mud enriched with 0.2% N + 0.2% K_2O for number and weight of rose flowers. The increase in number and weight of flowers with application of lac mud enriched with 0.2% N + 0.2% P_2O_5 + 0.2% K_2O was 47.4 and 38.5 per cent in chrysanthemum and 25.5 and 31.7 per cent in rose over conventional method of manuring (application of vermicompost), respectively. Thus, application of lac mud for manuring in floriculture may give another diversified dimension to lac processing factories along with saving of inorganic fertilizers and improvement in soil fertility status.

KEYWORDS

Lac mud, Floriculture, *Chrysanthemum*, Rose, Vermicompost

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INTRODUCTION

In the present day, rising living standards and unabated urbanization has raised the demand of flowers and their products thereby making the floriculture an important commercial trade. Commercial floriculture has higher potential per unit area than the field crops and is therefore evolving as a lucrative business all over the world (Misra and Sudip, 2016). The area under floriculture in India are about 253.65 thousand hectare with production of 1.652 million tonnes of loose flowers and 76.73 million tonnes of cut flowers. Indian floriculture industry stands 2nd in world production (Shilpa and Narpat, 2016) and occupies 51st in terms of exports and contributes rupees 455 crores which is 0.06 percent of global trade (De and Singh, 2016). Floriculture has vast scope and potential, and it offers a unique scope for judicious employment of existing resources and exploration of avenues yet untouched.

Rose and *Chrysanthemum* are most popular and widely cultivated garden flowers in India. Despite of large demand of these flowers, their production is quite low. The major production constraints in flower production are traditional system of crop management, imbalanced nutrient management, high cost of chemical fertilizers, unavailability of flower germplasm and quality planting material etc. Both flower plants are nutrient loving plant and it needs replenishment in the soil through different sources.

The overall strategy for increasing agricultural yields and sustaining them at high level must include integrated approach to the management of nutrients. The integrated nutrient management program involves maximize biological inputs to crop production and minimize the use of inorganic amendments so as to create a much more sustainable pattern of crop production, not only ecologically but also environmentally (National Research Council, 1991; Singh *et al.*, 2013). Current development in sustainability involves a rational exploitation of different alternative sources of plant nutrients including industrial waste product.

Lac is natural, nontoxic, biodegradable and renewable natural resin. It has gain momentum in cultivation in recent times due to its use in diversified high value field, accounting for about 50–60% of the total world lac production. Total production and export figures of lac in 2012-13 were 19,577 and 4,361 tons, respectively (Yogi *et al.*, 2014). Lac resin is secreted by the tiny lac insects (mainly *Kerria lacca* Kerr). The insects are cultured on tender shoots of lac hosts and derives its nutrition by sucking the saps from the hosts and it secretes natural resins which is deposited all-around the twigs (Monobrullah and Kishor, 2020).Harvesting of lac crop is done by cutting of host twigs deposited with natural resins. The basic raw material for lac industry, sticklac, is obtained by scraping lac incrustation deposited on twigs of hosts. Removing the sticks, stones, other impurities *etc.* as far as possible from sticklac by crushing, sieving, winnowing and washing out the dye with water (primary processing) yields the semi refined product known as seedlac (used for manufacture of value-added lac product shellac, Bleached lac *etc.*) and washed out liquid is passed to the big pits as waste material (Fig. 1). After evaporation from this waste material, solid material left is called as lac mud (Fig. 2)

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which is removed from pits after drying so that further washed out liquid from primary processing of lac may be store in empty pits.

Fig. 1: Washed out waste liquid material of lac processing unit in big pits

Fig. 2: Waste solid material of lac processing unit

It is obtained to a tune of about 2.5 to 4.5% on dry and wet weight basis, respectively, of the raw material (sticklac) processed and mostly dumped due to lack of proper method of disposal which may create pollution hazards. In long run, it is not suitable for sustainability of lac industry and in turn lac production system. Beneficial effect of lac mud has been reported in rice, rose and spinach (Singh *et al*., 2015; Singh *et al*., 2016). However, no other information is available for utilization of lac mud as a part of nutrient management. Therefore, the present investigation was undertaken to evaluate the suitability and effectiveness of lac mud (lac factory waste) on flower production of rose and *Chrysanthemum.*

MATERIALS AND METHODS

Two separate experiments in earthen pots were conducted at the research farm of ICAR- Indian Institute of Natural Resins and Gums, Ranchi, India ($23^0$23″ N latitude, $85^0$23″ E longitude and 650 m above mean sea level) for three consecutive years during 2013-16.The area experiences mild, salubrious climate, with a rather heavy rainfall pattern of about 1400 mm average, of which about 1250 mm is during the monsoon. Soil used for filling earthen pots was lateritic type, pH 4.52 and was having the contents of available organic carbon - 0.55%, nitrogen – 265.46 kg/ha, phosphorus -37.50 kg/ha and potassium -224.76 kg/ha with EC -0.195 dSm^{-1}. Decomposed lac mud was obtained from lac processing factory, Bundu (Ranchi, Jharkhand) and its analysis revealed higher content of organic carbon (23.3%) and organic matter (40.2%). Besides it also contains 0.65% N, 0.31% P_2O_5 and 0.12% K_2O. Sulphur (3442 ppm), copper (20.8 ppm), zinc (182.3 ppm), iron (5853 ppm), boron (15 ppm) and molybdenum content (13.4 ppm) in lac mud was found quite higher. It was grinded in fine particles and was mixed with lime for correcting the pH@ 25 g lime per kg of lac mud and kept for one day. It was enriched with each of N, P and K as per treatments. This mixture was kept for two days. After that, azotobacter and PSB each @ 25 g/kg lac mud was incorporated under sufficient moisture and kept for one day. The experiment consisting of nine different enriched lac mud (ELM) or vermicompost based pot mixture treatments having sand, lac mud or vermicompost and soil in 1:2:3 ratios *viz*., lac mud enriched with 0.2% N, 0.2% P_2O_5, 0.2% K_2O, 0.2% N + 0.2% P_2O_5, 0.2% N + 0.2% K_2O, 0.2% P_2O_5 + 0.2% K_2O, 0.2% N + 0.2% P_2O_5 + 0.2% K_2O, lac mud without enriching and vermicompost in pot mixture (conventional) was laid out in randomized block design with three replications.

Pot mixture (sand, lac mud or vermicompost and soil) @ 11 kg per pot was filled in earthen pots of 12-inch size (30 cm Top diameter x 12 cm bottom diameter x 35 cm height) for both the flower plant. For planting of new rose plant, 11 kg mixture was prepared taking 2.0 kg sand, 3.5 kg ELM and 5.5 kg soil. For established plants of rose during 2^{nd} year and onwards, ELM was applied @ 2.0 kg per pot in the pots after removing 25-30% old soil of pots at pruning. Application of 15 g urea + 25 g SSP + 25 g MOP was done on per plant basis at 10-15 DAP and after first flush of boom (November-December) in new rose planting. In established rose plants, 15 g urea + 25 g SSP + 25 g MOP was applied along with ELM at pruning and after first flush of boom (November-December). *Karanj* cake was also applied @ 50 g per plant as basal or at pruning. For chrysanthemum planting, 11 kg mixture was prepared taking 2.75 kg sand, 0.5 kg ELM and 7.75 kg soil. Additional 3.0 g urea + 28.0 g SSP + 7.5 g MOP was applied at planting. At 30-45 DAP, 3.0 g urea was applied in chrysanthemum. In case of vermicompost treatment, recommended schedule of manuring was followed.

Budded rose plants of 6 months age was transplanted in first week of November 2013 for first year experimentation and it was pruned during October of 2014 and 2015 for second- and third-year experimentation, respectively. Chrysanthemum seedling was planted during November 2013, September 2014 and October 2015 and last flower picking was done in the month of February during all the year of experimentation. All the recommended package of practices was followed for

raising the experimental rose and chrysanthemum flowers in each treatment. To assess the effect of enriched lac mud, observation on number and weight of flowers per plant were recorded separately in rose and chrysanthemum. The data of each crop season were statistically analyzed separately. As the error variance was homogeneous, pooled analysis was done according to Cochran and Cox (1957). Since the variations among two seasons were not significant, the mean data have been presented in the paper for discussion. Various treatments were compared under randomized block design. The critical difference (CD) was computed to determine statistically significant treatment differences. CD = (:2 VEr–1)$t_{5\%}$ where, VE is the error variance, r is the number of replications, $t_{5\%}$ is the table value of t at 5% level of significance at error degree of freedom.

RESULTS AND DISCUSSIONS

Effect of Lac Factory Waste on performance of Rose

Experimental data on growth, number and weight of rose flower presented in Table 1 and 2 revealed that effect of application of enriched lac mud brought significant differences in various growth and yield characters of rose flowers, except flower bud length.

Table 1: Effect of enriched lac mud on growth of rose flower (Pooled data of 3 years)

Treatments	Plant height (cm)	Stalk diameter (cm)	Days to 1st flower bud appearance	Flower bud length (cm)	Flower diameter (cm)
Lac mud fortified with 0.2% N	48.9^{cde}	0.42^{abc}	32.6^{ab}	3.22	2.48^{bcde}
Lac mud fortified with 0.2% P_2O_5	47.4^{de}	0.40^{bc}	33.8^{ab}	3.16	2.39^{de}
Lac mud fortified with 0.2% K_2O	48.3^{de}	0.41^{abc}	33.0^{ab}	3.19	2.43^{cde}
Lac mud fortified with 0.2% N + 0.2% P_2O_5	51.8^{abcd}	0.43^{abc}	31.6^{ab}	3.31	2.59^{abcd}
Lac mud fortified with 0.2% N + 0.2% K_2O	54.7^{ab}	0.45^{a}	30.3^{a}	3.42	2.70^{ab}
Lac mud fortified with 0.2% P_2O_5 + 0.2% K_2O	53.6^{abc}	0.44^{ab}	30.7^{ab}	3.37	2.66^{abc}
Lac mud fortified with 0.2% N + 0.2% P_2O_5 + 0.2% K_2O	56.6^{a}	0.45^{a}	29.9^{a}	3.49	2.76^{a}
Lac mud without fortification	45.1^{e}	0.39^{c}	35.6^{b}	3.12	2.33^{e}
Vermicompost	50.8^{bcd}	0.43^{abc}	32.0^{ab}	3.25	2.55^{abcde}
C. D. (P= 0.05)	5.15	0.041	2.79	NS	0.243

Plant height and stalk diameter were found maximum with application of lac mud in pot mixture fortified with 0.2% N + 0.2% P_2O_5 + 0.2% K_2O (Fig. 3), however it was at par with 0.2% N + 0.2% K_2O, 0.2% P_2O_5 + 0.2% K_2O and 0.2% N + 0.2% P_2O_5 fortification for plant height, and 0.2% N + 0.2% K_2O, 0.2% P_2O_5 + 0.2% K_2O, 0.2% N + 0.2% P_2O_5, vermicompost, 0.2% N and 0.2% K_2O fortification for stalk diameter.

The earliest flower bud appearance was noticed under lac mud fortified with 0.2% N + 0.2% P_2O_5 + 0.2% K_2O and it showed significant earliness over pot mixture without fortification of lac mud, though it was at par with conventional method of manuring. Among the treatments maximum flower diameter was recorded with lac mud fortified with 0.2% N + 0.2% P_2O_5 + 0.2% K_2O followed by lac mud fortified with 0.2% N + 0.2% K_2O. Conventional method

Fig. 3: Rose flower grown with lac mud fortified with 0.2% N + 0.2% P_2O_5 + 0.2% K_2O

Table 2: Effect of enriched lac mud on number and weight of rose flower (Pooled data of 3 years)

Treatments	Number of flowers (Per plant)	Weight of flowers (g/plant)
Lac mud fortified with 0.2% N	15.1^{de}	233.9^{d}
Lac mud fortified with 0.2% P_2O_5	13.9^{e}	211.4^{e}
Lac mud fortified with 0.2% K_2O	14.6^{de}	223.8^{de}
Lac mud fortified with 0.2% N + 0.2% P_2O_5	16.5^{c}	258.1^{c}
Lac mud fortified with 0.2% N + 0.2% K_2O	19.0^{ab}	306.6^{ab}
Lac mud fortified with 0.2% P_2O_5 + 0.2% K_2O	17.9^{b}	287.4^{b}
Lac mud fortified with 0.2% N + 0.2% P_2O_5 + 0.2% K_2O	19.7^{a}	318.6^{a}
Lac mud without fortification	12.0^{f}	182.4^{f}
Vermicompost	15.7^{cd}	241.9^{cd}
C. D. (P= 0.05)	1.21	20.23

of manuring showed almost similar flower diameter of rose to lac mud fortified with 0.2% N + 0.2% P_2O_5 + 0.2% K_2O. Lac mud fortified with 0.2% N + 0.2% P_2O_5 + 0.2% K_2O recorded maximum number and weight of rose flowers and this treatment being at par to application of 0.2% N + 0.2% K_2O fortified lac mud, yielded in significantly higher number and weight of flowers compared to all other treatments, including conventional method of manuring. The increase in number and weight of rose flowers with application of lac mud enriched with 0.2% N + 0.2% P_2O_5 + 0.2% K_2O was 25.5 and 31.7 per cent over conventional method of manuring (application of vermicompost), respectively (Table 2).

Effect of Lac Factory Waste on performance of Chrysanthemum

The data on growth and flower production of Chrysanthemum is presented in Table 3 and 4. Experimental results revealed that plant height and its spread was maximum with application of lac mud in pot mixture fortified with 0.2% N + 0.2% P_2O_5 + 0.2% K_2O (Fig. 4), however it was at par with 0.2% N + 0.2% K_2O, 0.2% P_2O_5 + 0.2% K_2O, 0.2% N + 0.2% P_2O_5, vermicompost and 0.2% N fortification for plant height, and 0.2% N + 0.2% K_2O and 0.2% P_2O_5 + 0.2% K_2O fortification for plant spread.

Maximum duration of flowering of Chrysanthemum flower was recorded with lac mud in pot mixture fortified with 0.2% N + 0.2% P_2O_5 + 0.2% K_2O. Conventional method of manuring showed significantly lower duration of flowering as compared to 0.2% N + 0.2% P_2O_5 + 0.2% K_2O fortified lac mud. In case of Chrysanthemum flowers, 0.2% N + 0.2% P_2O_5 + 0.2% K_2O fortified lac mud showed superiority over all other treatments in producing number and weight of flowers. Second best treatments recording higher number and weight of chrysanthemum flowers was lac mud enriched with 0.2% N + 0.2% K_2O, which being at par with lac mud enriched with 0.2% P_2O_5 + 0.2% K_2O, resulted better than rest of the treatments including conventional method. The lowest value of number and weight of chrysanthemum flowers was found with lac mud without fortification. Per cent increase in number and weight of flowers due to application of fortified lac mud with 0.2% N + 0.2% P_2O_5 + 0.2% K_2O over conventional method of manuring was 47.4 and 38.5, respectively (Table 4).

Table 3: Effect of enriched lac mud on plant height and plant spread of Chrysanthemum flower (Pooled data of 3 years)

Treatments	Plant height (cm)	Plant spread (cm)
Lac mud fortified with 0.2% N	42.2^{abc}	27.0^{cd}
Lac mud fortified with 0.2% P_2O_5	40.1^{cd}	25.7^{de}
Lac mud fortified with 0.2% K_2O	41.2^{bcd}	26.4^{cde}
Lac mud fortified with 0.2% N + 0.2% P_2O_5	43.5^{abc}	28.4^{bc}
Lac mud fortified with 0.2% N + 0.2% K_2O	45.2^{ab}	30.3^{ab}
Lac mud fortified with 0.2% P_2O_5 + 0.2% K_2O	44.7^{ab}	29.5^{ab}
Lac mud fortified with 0.2% N + 0.2% P_2O_5 + 0.2% K_2O	46.0^{a}	31.6^{a}
Lac mud without fortification	37.9^{d}	24.3^{e}
Vermicompost	43.1^{abc}	27.8^{bcd}
C. D. (P= 0.05)	4.15	2.53

Fig. 4: Chrysanthemum flower grown with lac mud fortified with 0.2% N + 0.2% P_2O_5 + 0.2% K_2O

Table 4: Effect of enriched lac mud on flowering, number and weight of Chrysanthemum flower (Pooled data of 3 years)

Treatments	Days to 1st flower bud appearance	Duration of flowering (days)	Number of flowers (Per plant)	Weight of flowers (g/plant)
Lac mud fortified with 0.2% N	42.9	38.5^{bcd}	36.1^{d}	207.5^{e}
Lac mud fortified with 0.2% P_2O_5	44.1	37.2^{cd}	32.8^{d}	182.0^{f}
Lac mud fortified with 0.2% K_2O	43.5	37.7^{cd}	41.0^{c}	209.2^{de}
Lac mud fortified with 0.2% N + 0.2% P_2O_5	41.9	39.8^{abcd}	40.6^{c}	244.8^{c}
Lac mud fortified with 0.2% N + 0.2% K_2O	41.0	42.0^{ab}	49.3^{b}	279.7^{b}
Lac mud fortified with 0.2% P_2O_5 + 0.2% K_2O	41.5	41.0^{abc}	46.9^{b}	265.4^{b}
Lac mud fortified with 0.2% N + 0.2% P_2O_5 + 0.2% K_2O	40.0	43.1^{a}	53.4^{a}	315.1^{a}
Lac mud without fortification	45.5	36.1^{d}	26.5^{e}	150.3^{g}
Vermicompost	42.4	39.1^{bcd}	36.2^{d}	227.5^{cd}
C. D. (P= 0.05)	NS	3.76	3.39	18.41

Beneficial effect of lac mud on number and weight of rose and chrysanthemum flowers was probably due to use of enriched lac mud could have resulted in favourable soil physical conditions, enhanced microbial activity and enhanced availability of applied as well as native soil nutrients, synchronized nutrient demand of the crop with nutrient supply from native and applied sources besides minimizing the deterioration of soil, water and ecosystem by promoting carbon sequestration, reducing nutrient losses to ground and surface water bodies and to atmosphere. Yadav *et al*.(1989) reported that organic manures are good source of nitrogen and are excellent for rose crop. It upon decomposition and mineralization, supplied available nutrients directly to the plants. A large number of workers (Singh *et al*., 2013 and Srivastava *et al*., 2009) reported synergistic interaction among organic manures and inorganic fertilizer nutrients which modified the quantum of nutrient uptake by plants as their effect is not merely added up but is actually enhanced. Beneficial effect of lac mud on grain yield of rice, flower yield of rose and leaf yield of spinach have also been reported earlier (Singh *et al*., 2015, Singh *et al*., 2016).

From present investigation, it may be concluded that enriched lac mud may be used as a substitute of other organic manure for higher number and weight of rose and chrysanthemum flowers. Lac mud may be applied after correcting the pH with lime @ 25 g per kg of lac mud, followed by enriching with 0.2% N + 0.2% P_2O_5 + 0.2% K_2O as well as azotobacter and PSB each @ 25 g/kg lac mud. This may give another diversified dimension to lac processing factories along with saving of inorganic fertilizers and improvement in soil fertility status.

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