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Compost enrichment using different insect species and its influence on growth, yield and nutrient uptake of finger millet (*Eleusine coracana* L.)

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Abstract
An experiment was conducted at the College of Sericulture, Chintamani, Chikkaballapur District, Karnataka, India. The insect species used for the enrichment of composting in the experiment are silkworm pupae, silkworm moth, uzifly and fruit fly, the compost was prepared for 90 days and used to study their influence on finger millet. In the field experiment conducted, with 11 treatments which are replicated thrice, all the treatments with enriched insect biomass compost performed well. But the higher plant height (46.33, 71.67, 113.33 cm at 30, 60 days and at harvest, respectively) were noticed in treatment T_4 which received 100% N equivalent of FYM through silkworm pupae compost and the higher grain and straw yield (28.91 q ha^{-1} and 38.01 q ha^{-1}) was observed in T_4 treatment. Significantly higher nitrogen uptake (86.84 kg ha^{-1}) by grain and straw (79.06 kg ha^{-1}) was recorded in treatment imposed of 100% N equivalent of FYM through silkworm pupae enriched compost (T_4). Higher phosphorus and potassium uptake by grain and straw (P uptake 13.97 and 12.29 kg ha^{-1}) and (K uptake-78.76 and 153.05 kg ha^{-1}) was noticed in treatment imposed of 100% N equivalent of FYM through silkworm pupae enriched compost (T_4), on par with T_6 received 100% N equivalent of FYM through silkworm moth enriched compost. The lower uptake was recorded in T_1 control.

Keywords: Enriched compost, finger millet, nutrient uptake, silkworm pupae, silkworm moth, uzifly and fruit fly

1. Introduction

Prior to the "green revolution," most farming was done naturally and traditionally, which included using organic techniques to keep the soil fertile and manage crop pests. Following the green revolution, the use of high-yielding and fertilizer-responsive varieties and cultivation systems has increased, which has prompted the use of chemical fertilisers and pesticides. Indiscriminate use of chemical fertilisers and pesticides has caused pollution and a decline in the soil's productivity. In actuality, organic farming is an all-encompassing method of farming with the goal of conserving natural resources through agronomic practises and the use of inexpensive local inputs to preserve soil fertility. Organic matter in soil influences its physical, chemical, and biological traits in addition to serving as a repository for macro- and micronutrients. The increase in microbial activity causes enzymes, that have essential for the transformation, recycling, availability, and uptake of plant nutrients, to perform their tasks more effectively. The FYM is an excellent source of organic manure, but to provide the necessary amount of nutrients, it must be used in huge quantities. The most effective approach is to enrich the organic manure by composting since nutrients must be delivered in appropriate levels in order to meet crop demand.

Insects play an essential part in many ecosystems, as they carry out essential functions like pollinating flowers, aerating the soil, and controlling pests and insects. The majority of insects, particularly beetles, are scavengers that recycle nutrients back into the ecosystem by devouring dead animals and fallen trees. In various regions of the world, people consume insects as food. In many third-world countries, insects are considered as delicacy because they are a valuable source of protein, vitamins, and minerals (Jankielsohn, 2018) [7]. In fact, it is challenging to discover an insect that humans do not consume in some way. Cicadas, locusts, mantises, grubs, caterpillars, crickets, ants, and wasps are a few of the most well-liked insects. The idea of incorporating a source of protein in human nutrition is one that is widely acknowledged.

People enjoy roasted insects like grasshoppers or beetles throughout from South America to Japan. (Huis *et al*., 2013) [5]. Because of this reason a study was carried out for enriching of compost by using different insect species and its influence on finger millet

finger millet (*Eleusine coracana* L.), a staple food for the working class, is also great for those with diabetes, heart disease, and blood pressure problems due to its high dietary fibre content. It is an annual plant of the Poaceae family that is commonly grown as millet in dry regions of Africa and Asia. It is a significant cereal crop that is grown on the largest area in Karnataka under rainfed Alfisol conditions. Many rural households rely extensively on finger millet to meet their dietary demands and financial obligations. In Karnataka, the average productivity of finger millet is 1800 kg ha^{-1}, although on-station experiments suggest that the potential output is more than 4000 kg ha^{-1}. (AICSMIP, 2013) [1].

2. Material and Methods

The composts in the field had been produced at the Chintamani College of Sericulture. The experiment was conducted over the course of 90 days, from November 2020 to February 2021.

2.1 Materials used in composting

FYM (farm yard manure), silkworm pupae (*Bombyx mori*), silkworm moth (*Bombyx mori*), uzi fly (*Exorista bombycis* Louis) and fruit fly (Drosophila melanogaster) were the primary raw materials utilised in the making of composts. The Alamagiri village reeling unit in the Chikkaballapur district provided the silkworm pupae. From the Government Sericulture Grainage Unit in Chintamani, Chikkaballapur district (CSB), silkworm moths were collected. Uzi insects were obtained at cocoon markets in Sidlagatta, Chintamani, and Chikkaballapur, and fruit flies were collected using the mass trapping technique in orchards of mango, tomato, and cabbage utilising cue-lure traps that attract male fruit flies. The Agricultural Research Station (ARS), Chintamani, provided the farmyard waste and cow dung for this experiment. One litre of water and 100 grammes of cow dung were combined to create the slurry.

An aerobic method of compost was prepared. The primary raw materials for composting were fruit flies, uzi flies, silkworm moths, and pupae of silkworms. Farmyard manure and cow dung slurry were the organic substances that were employed. In compost pits measuring 7 m X 4 m X 3 m (length X breadth X height), compost was made.

2.1.1 Requirements for insect biomass compost preparation

Raw insect species waste: 05 kg
Farm Yard Manure: 20 kg
Cow dung slurry @ 10% w/w

2.2 Treatments used for the preparation of bio composts:

C1: Control- (FYM) + Cow dung slurry
C2: Silkworm pupae+ FYM + Cow dung slurry
C3: Silkworm moth+ FYM + Cow dung slurry
C4: Uzi fly + FYM + Cow dung slurry
C5: Fruit fly+ FYM + Cow dung slurry

(Insect biomass and FYM mixed in the ratio of 1:4 N equivalent ratios).

Four pits were used to replicate the composting process, which lasted three months. Once every 30 days, the decomposing materials were turned. Throughout the entire composting process, turnings were made. By the 90th day, the compost was ready, and it was used for field evaluation by using finger millet asl a test crop.

2.3 Evaluation of insect biomass composts in the field

The experiment was carried out in the summer of 2021 at ARS, Chintamani, which is located at 13° 40 North latitude and 78° 06 East longitude and has an elevation of 865 m above mean sea level in the eastern dry zone of Karnataka. The texture of the soil at the experimental site was red sandy clay loam. The investigation was conducted in RCBD with 11 treatments that were reproduced three times (Table 1). Finger millet (*Eleusine coracana* L.) was utilised as the test crop; the variety used here is 'ML-365' with a spacing of 30 X 10 cm. An RCBD design was used here, with 11 treatments replicated three times. The suggested fertiliser dosage is 10 t/ha of 100:50:50 N, P2O5, K2O, and FYM. timely Timely required cultural practices like weeding and irrigation were given as crop maintenance.

At 30, 60 DAS, and at harvest, morphological observations such as plant height, number of tillers per hill, leaf area index, and dry matter output were noted. Based on the yield from each net plot, the amount of grain and straw was estimated and expressed as kg ha^{-1}. Following the suggested set of practises allowed the crop to be maintained, and plant samples were obtained at random to assess the crop's nutrient content and uptake at harvest. Then randomly selected destructive plant samples were taken to determine the nutrient content and nutrient uptake at the crop harvest washed and rinsed with distilled water and dried in an oven at 60 °C to constant weight. Further nutritional analysis was carried out using the same samples. The data was statistically analysed using Gomez and Gomez's (1984) [3] methodology.

Both the grain and straw of ragi were examined for major (N, P, K, Ca, Mg, and S) and micronutrients (Fe, Mn, Zn, and Cu). A modified micro Kjeldahl method and a Vanadomolybdate yellow colour method, respectively, were used to evaluate the nitrogen (N) and phosphorus (P) contents of straw and grain (Jackson, 1973) [6]. Potassium (K) content of grain and straw was estimated by flame photometric method and the titration method was adopted for the estimation of calcium (Ca) and magnesium (Mg). The turbidimetric approach was used to estimate the sulphur (S) content (Bradsley and Lancester, 1965) [2]. Micronutrient samples (Fe, Mn, Zn, and Cu) were measured using an atomic absorption spectrophotometer (AAS) after being initially digested using a di-acid mixture (Lindsay and Norwell, 1978) [11]. Nutrient uptake by finger millet grain and straw for all the major, secondary and micronutrients was calculated by using the formula mentioned below.

$$\text{Uptake (kg ha}^{-1}\text{)} = \frac{\text{Nutrient concentration (\%) x Biomass (kg ha}^{-1}\text{)}}{100}$$

3 Result and Discussion

3.1 Growth parameters

In most agricultural crops, a plant's morphology directly affects the crop's eventual yield of grains as well as its growth and performance (Fig 1). Plant height, number of leaves and leaf area determine the photosynthetic capacity of a plant. The plant height differed significantly due to different treatments at 30, 60 and at harvest. The treatment T_4 (100% N equivalent of FYM through silkworm pupae enriched compost) has significantly recorded higher plant height of 46.33, 71.67, 113.33 cm at 30, 60 days and at harvest respectively, which is on par with T_6 (100% N equivalent of FYM through silkworm moth enriched compost) 43.93, 68.93 and 109.00 cm at 30, 60 days and at harvest respectively. Throughout the growth of the crop, plant height increased steadily. However, lower plant height was recorded in T_1 (control) treatment 10.07, 50.40, 87.00 at 30, 60 days and at harvest. The number of leaves differed significantly due to different treatments at different growth period. The treatment T_4 which receives 100% N equivalent of FYM through silkworm pupae enriched compost has significantly recorded a higher number of leaves of 10.87, 14.53, 30.67 at 30, 60 days and at harvest respectively compared to other treatments, which is on par with T_6 (100% N equivalent of FYM through silkworm moth enriched compost) 9.97, 13.53, 28.67 at 30, 60 and at harvest respectively (Fig 1). The data on number of leaves indicate steady increase in number of leaves over a period of time. The lower number of leaves recorded in treatment T_1 (control) 4.67, 5.53 and 12.00 at 30, 60 days and at harvest.

In addition to more tillers, conversion of these tillers into productive tillers is also an important trait, which determines the reproductive efficiency of a crop. The large canopy is desirable for straw purpose, but a greater number of reproductive tillers are desirable from an economic yield perspective. The different treatments differed significantly with respect to number of tillers per plant and leaf area at different stages of crop growth. Significantly higher number of tillers and leaf area were observed in treatment T_4 (100% N equivalent of FYM through silkworm pupae enriched compost) at all stages of growth (10.13, 12.87 and 13.00), (354.65, 932.16 and 945.13) at 30, 60 days and at harvest respectively. Lower number of tillers and leaf area (Fig 2) were recorded in T_1 (Control).

When enriched compost decomposes, nutrients are released that are absorbed by plants at different stages of growth and development from the decomposed enriched insect biomass compost. This could be the reason why the treatment T_4 that imposed 100% N equivalent of FYM through silkworm pupae enriched compost recorded higher growth parameters. Similar findings were also recorded by King *et al*., (1974) [8]; Kanjir *et al*., 2009 [10].

3.2 Yield parameters

Significant difference was observed with test weight of finger millet as influenced by different enriched insect biomass compost (Table 2). Significantly higher test weight (3.04 g) was noticed in T_4 treatment which receives 100% N equivalent of FYM through silkworm pupae enriched compost and it is on par with the treatment T_6 (3.00 g). Lower test weight (2.82 g) was recorded in control (T_1). Among different enriched insect biomass compost, significantly higher grain and straw yield (28.91 and 38.01 q ha^{-1}) were noticed in the treatment T_4 (100% N equivalent of FYM through silkworm pupae enriched compost) which was significantly superior over other enriched insect biomass compost, followed by T_6 (100% N equivalent of FYM through silkworm moth enriched compost) 28.51 and 37.53 q ha^{-1} and T_{10} (27.65 and 53.92 q ha^{-1}) which receives 100% N equivalent of FYM through fruit fly enriched compost). Significantly lower grain and straw yield were recorded with (11.25 and 15.52 q ha^{-1}) T_1 (control).

The yield of finger millet in response to various enhanced insect biomass composts was noted. The T_4 treatment, which received 100% N equivalent of FYM through compost enriched with silkworm pupae, is seen to have higher growth characteristics. The plant's healthy growth, which allowed it to assimilate more biomass in the form of grain and straw, may have contributed to the beneficial response of yield parameters to higher amounts of enriched insect biomass compost. The results are in concordance with the findings of Suryavanshi *et al*. (2008) [17]; Kunjir *et al*. (2009) [10].

3.3 Major nutrients (N, P and K) uptake by finger millet grain and straw

The data in the Fig. 3 showed that nitrogen uptake by finger millet grain differed significantly due to application of different enriched insect biomass compost. Significantly higher nitrogen uptake (86.84 kg ha^{-1}) by grain and straw (79.06 kg ha^{-1}) was recorded in treatment imposed of 100% N equivalent of FYM through silkworm pupae enriched compost (T_4), it was followed by T_6 (82.51 and 78.08 kg ha^{-1} by grain and straw) which received 100% N equivalent of FYM through silkworm moth enriched compost and lower uptake of N among enriched biomass compost was recorded in T_9 (48.68 and 42.13 kg ha^{-1} by grain and straw) which received 50% N equivalent of FYM through uzi fly enriched compost + 50% N through FYM (10 t ha^{-1}).

Phosphorous uptake by finger millet grain and straw shows significant difference among the treatments due to application of different enriched insect biomass compost. Higher phosphorus uptake by grain and straw (13.97 and 12.29 kg ha^{-1}) was noticed in treatment imposed of 100% N equivalent of FYM through silkworm pupae enriched compost (T_4), on par with T_6 (13.71 and 11.22 kg ha^{-1}) received 100% N equivalent of FYM through silkworm moth enriched compost. The lower uptake was recorded in T_1 (2.57 and 2.92 kg ha^{-1}) control.

Perusal of the data on potassium uptake indicated the significant difference among treatments in K uptake by grain and due to application of different enriched insect biomass compost. Significantly higher K uptake by grain and straw (78.76 and 153.05 kg ha^{-1}) was noticed in T_4 imposed of 100% N equivalent of FYM through silkworm pupae enriched compost which wos on par with T_6 (74.86 and 151.93 kg ha^{-1}) where 100% N equivalent of FYM through silkworm moth enriched compost was applied. The lower uptake was recorded in T_1 (4.95 and 22.84 kg ha^{-1}) control.

The increase uptake level of major nutrients in T_4 treatment may be because of increased NPK content of grain and straw of finger millet. Increase in total uptake of N with the application of higher N content in enriched compost, similar findings was also reported by Singh *et al*., 2000 [15]. With respect to P and K results were in N uptake by finger millet which was in agreement with the inferences of Mahamoud *et al*., 1980 [12] who reported that uptake of P and K increased at different growth stages of crop with increased rate of N application

3.4 Secondary nutrients (Ca, Mg and S) uptake by finger millet grain and straw

Perusal of the data on calcium uptake (Fig. 4) indicated that a significant difference among the treatments in calcium uptake by grain and straw and due to different enriched insect biomass compost. Significantly higher Ca uptake in grain and straw (140.44 and 221.17 kg ha^{-1}) was noticed in T_4 100% N equivalent of FYM through silkworm pupae enriched compost, which was on par with T_6 (137.71 and186.35 kg ha^{-1}) 100% N equivalent of FYM through silkworm moth enriched compost and T_{10} (119.59 and 133.09 kg ha^{-1}) which received 100% N equivalent of FYM through Fruit fly enriched compost. However, lower value of calcium was found in control T_1 (27.94 and 33.79 kg ha^{-1}).

Significantly higher magnesium uptake by finger millet grain and straw (111.76 and 147.71 kg ha^{-1}) was found in T_4 received (100% N equivalent of FYM through silkworm pupae enriched compost) compared to all other treatments. However, it was followed by T_6 (104.55 and 135.18 kg ha^{-1}) 100% N equivalent of FYM through silkworm moth enriched compost and T_{10} (94.02 and 127.85 kg ha^{-1}) received 100% N equivalent of FYM through fruit fly enriched compost. The lower uptake was recorded in T_1 (14.77 and 19.13kg ha^{-1}) control.

Due to the application of different enriched insect biomass composts, grain and straw uptake of sulphur varies significantly among the treatments (Fig 2). However, numerically the higher uptake of sulphur in both grain and straw was noticed in T_4 (9.92 and 12.77 kg ha^{-1}) received 100% N equivalent of FYM through silkworm pupae enriched compost followed by T_6 (8.85 and 12.42 kg ha^{-1}) imposed of 100% N equivalent of FYM through silkworm moth enriched compost. Further, numerically lower uptake of sulphur was noticed in T_1 (2.06 and 1.28 kg ha^{-1}) imposed of control and rest of the treatments are intermediate between these values.

Among the treatments the uptake of Ca, Mg and S in grain and straw of finger millet was higher in T_4 and T_6 which received 100% N equivalent of FYM through silkworm pupae and moth compost. Control (T_1) showed lowest uptake of Ca, Mg and S by finger millet. It might be caused by the secondary nutrients that are released during decomposition and mineralization. Compost enriched with rock phosphate were responsible for increased in secondary nutrient content in all the treatment except in control (Spencer and Frency, 1960) [16].

3.5 Micronutrients (Fe, Mn, Zn, Cu and B) uptake by finger millet grain and straw

There was a significant change in the amount of micronutrients (Zn, Mn, Cu, Fe, and B) uptake by finger millet in response to application of enriched insect biomass compost (Table 3). Significantly higher uptake of Zn, Mn, Cu, Fe, and B by finger millet grain (73.88, 187.01, 33.97, 7287.26 and 484.81 mg kg^{-1}, respectively) and straw (1431.93, 4154.65, 312.75, 3303.99 and 812.91 mg kg^{-1}, respectively) was noticed in T_4 containing 100% N equivalent of FYM through silkworm pupae enriched compost followed by T_6 (grain - 66.8, 177.43, 31.88, 6870.73 and 402.65 mg kg^{-1}, respectively) and (straw-1315.30, 3894.21, 282.23, 3183.46 and 717.57 mg kg^{-1}, respectively) which imposed 100% N equivalent of FYM through silkworm moth enriched compost. Further, numerically lower uptake of micronutrients was noticed in T_1 imposed of control and rest of the treatments are intermediate between these values.

Micronutrient uptake by finger millet grain and straw was higher in T_4 than in the other treatments. The control (T_1) had a lower uptake of micronutrients. Application of organic manure may have contributed to the availability of micronutrients by forming soluble complexes. (Kumar *et al.*, 1994; Gupta *et al*., 2000) [9, 4] using FYM in conjunction with recommended fertilizer doses resulted in higher uptake of micronutrients than controls. This might be due to the fact that the inorganic fertilizer lacked organic matter, thereby reducing micronutrient availability.

The increased uptake of primary, secondary and micronutrients in treatment T_4 (100% N equivalent of FYM through C2 (Silkworm pupae enriched compost)) might be due to the supply of nitrogen, phosphorus and potassium in more readily available form from enriched compost along with chemical fertilizers to the crop during the active growing period of the crop resulting in increased uptake of nutrients which ultimately increased the finger millet yields. Similar results were observed by Malagi (2001) [13]. Increased uptake by grain and straw which might be due to constant availability and better uptake of nutrients throughout the crop growth through inorganic fertilizers, enriched compost and release of native soil nutrient at later stages mediated by soil microflora that helped in increased uptake of nutrients and yield. These results are in agreement with Shwetha and Babalad (2008) [14].

Table 1: Treatment details of field experiment

T_1	Control
T_2	Inorganic RDF only
T_3	100% N through C1 (FYM 10 t/ha)
T_4	100% N equivalent of FYM through C2 (Silkworm pupae enriched compost)
T_5	50% N equivalent of FYM through C2 (Silkworm pupae enriched compost) + 50% N through C1 (FYM 10 t/ha)
T_6	100% N equivalent of FYM through C3 (Silkworm moth enriched compost)
T_7	50% N equivalent of FYM through C3 (Silkworm moth enriched compost) + 50% N through C1 (FYM 10 t/ha)
T_8	100% N equivalent of FYM through C4 (Uzi fly enriched compost)
T_9	50% N equivalent of FYM through C4 (Uzi fly enriched compost) + 50% N through C1 (FYM 10 t/ha)
T_{10}	100% N equivalent of FYM through C5 (Fruit fly enriched compost)
T_{11}	50% N equivalent of FYM through C5 (Fruit fly enriched compost) + 50% N through C1 (FYM 10 t/ha)

Table 2: Effect of enriched insect biomass compost on yield parameters of finger millet (*Eleusine coracana* L.)

Treatments	Test weight (1000 seeds)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
T_1: Control	2.82	11.25	15.52
T_2: Inorganic RDF	2.85	14.64	24.72
T_3: 100% N through C1 (FYM 10 t/ha)	2.84	18.11	24.95
T_4: 100% N equivalent of FYM through C2 (Silkworm pupae enriched compost)	3.04	28.91	38.01
T_5: 50% N equivalent of FYM through C2 (Silkworm pupae enriched compost) + 50% N through C1 (FYM 10 t/ha)	2.92	26.51	26.24
T_6: 100% N equivalent of FYM through C3 (Silkworm moth enriched compost)	3.00	28.51	37.53
T_7: 50% N equivalent of FYM through C3 (Silkworm moth enriched compost) + 50% N through C1 (FYM 10 t/ha)	2.90	25.17	26.05
T_8: 100% N equivalent of FYM through C4 (Uzi fly enriched compost),	2.97	27.39	32.25
T_9: 50% N equivalent of FYM through C4 (Uzi fly enriched compost) + 50% N through C1 (FYM 10 t/ha)	2.87	20.24	28.04
T_{10}: 100% N equivalent of FYM through C5 (Fruit fly enriched compost)	2.99	27.65	37.16
T_{11}: 50% N equivalent of FYM through C5 (Fruit fly enriched compost) + 50% N through C1 (FYM 10 t/ha)	2.89	22.64	29.80
SEm ±	0.021	1.39	1.57
CD at 5%	0.06	4.10	4.65

Table 3: Effect of enriched insect biomass compost on micronutrients uptake by grain and straw of finger millet (*Eleusine coracana* L.)

Treatments	Zn (mg kg^{-1})		Cu (mg kg^{-1})		Fe (mg kg^{-1})		Mn (mg kg^{-1})		B (mg kg^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_1	3.14	179.97	2.90	45.86	1254.49	449.73	19.31	819.52	66.24	142.16
T_2	6.43	367.34	11.93	112.20	2360.99	1198.43	61.52	1705.42	129.57	296.31
T_3	13.44	509.31	15.48	121.19	3289.54	1407.26	66.84	1746.13	127.84	281.10
T_4	73.88	1431.93	33.97	312.75	7287.26	3303.99	187.01	4154.65	484.81	812.91
T_5	50.27	695.05	28.23	157.27	5621.48	1958.52	142.38	2384.55	337.03	438.73
T_6	66.81	1315.30	31.88	282.23	6870.73	3183.46	177.43	3894.21	402.65	717.57
T_7	45.76	696.33	24.33	154.67	5286.80	1824.54	133.73	2415.56	287.82	426.18
T_8	59.48	936.97	28.63	215.65	6079.06	2578.58	155.80	3177.36	349.09	557.71
T_9	30.06	668.88	16.18	167.83	5579.26	1962.54	98.91	2489.65	202.66	454.25
T_{10}	64.22	1154.19	29.48	263.34	6471.42	3152.06	159.92	3737.45	367.55	687.21
T_{11}	37.21	725.41	21.32	170.14	4696.81	2120.89	115.27	2660.23	242.00	481.57
SEm ±	4.082	110.68	1.263	23.098	808.258	369.952	10.580	302.621	23.489	43.624
CD at 5%	12.04	326.52	3.72	68.14	2384.36	1091.36	31.21	892.73	69.29	128.69

T_1: Control, T_2:Inorganic RDF only, T_3:100% N through C1 (FYM 10 t/ha).T_4: 100% N equivalent of FYM through C2 (Silkworm pupae enriched compost), T_5:50% N equivalent of FYM through C2 (Silkworm pupae enriched compost) + 50% N through C1 (FYM 10 t/ha), T_6:100% N equivalent of FYM through C3 (Silkworm moth enriched compost), T_7:50% N equivalent of FYM through C3 (Silkworm moth enriched compost) + 50% N through C1 (FYM 10 t/ha), T_8:100% N equivalent of FYM through C4 (Uzi fly enriched compost),T_9: 50% N equivalent of FYM through C4 (Uzi fly enriched compost) + 50% N through C1 (FYM 10 t/ha), T_{10}:100% N equivalent of FYM through C5 (Fruit fly or Black solder fly enriched compost), T_{11}:50% N equivalent of FYM through C5 (Fruit fly or Black solder fly enriched compost) + 50% N through C1 (FYM 10 t/ha)

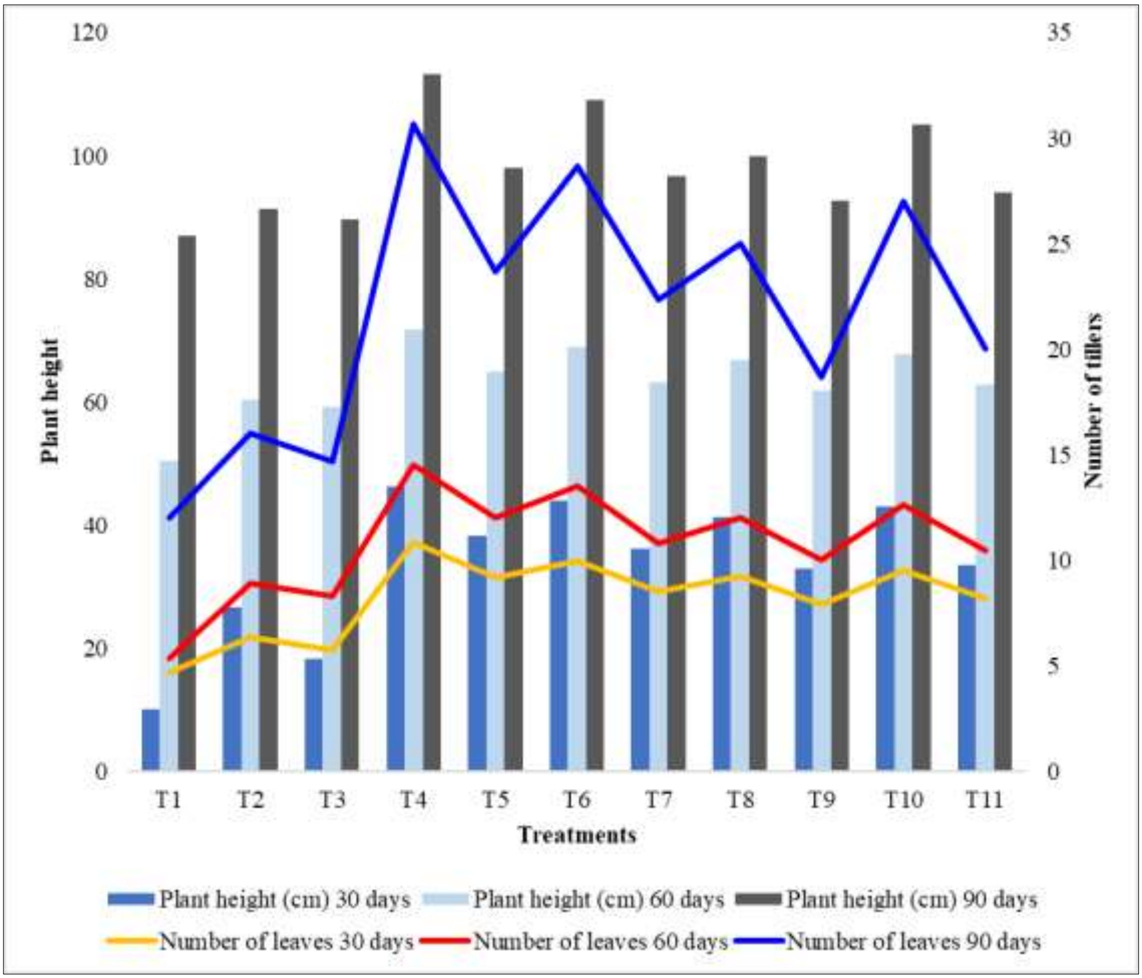

Fig 1: Effect of enriched insect biomass compost on plant height (cm) and number of leaves of finger millet (*Eleusine coracana* L.)

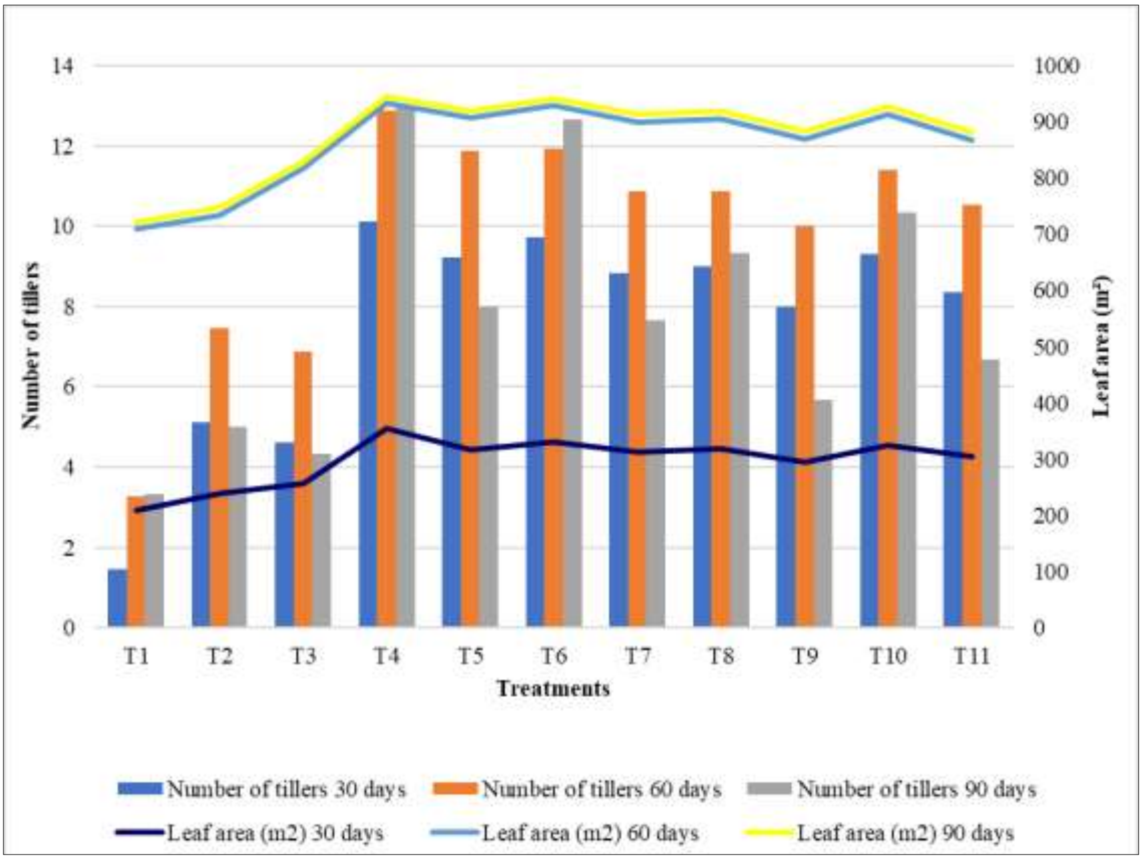

Fig 2: Effect of enriched insect biomass compost on number of tillers and leaf area of finger millet (*Eleusine coracana* L)

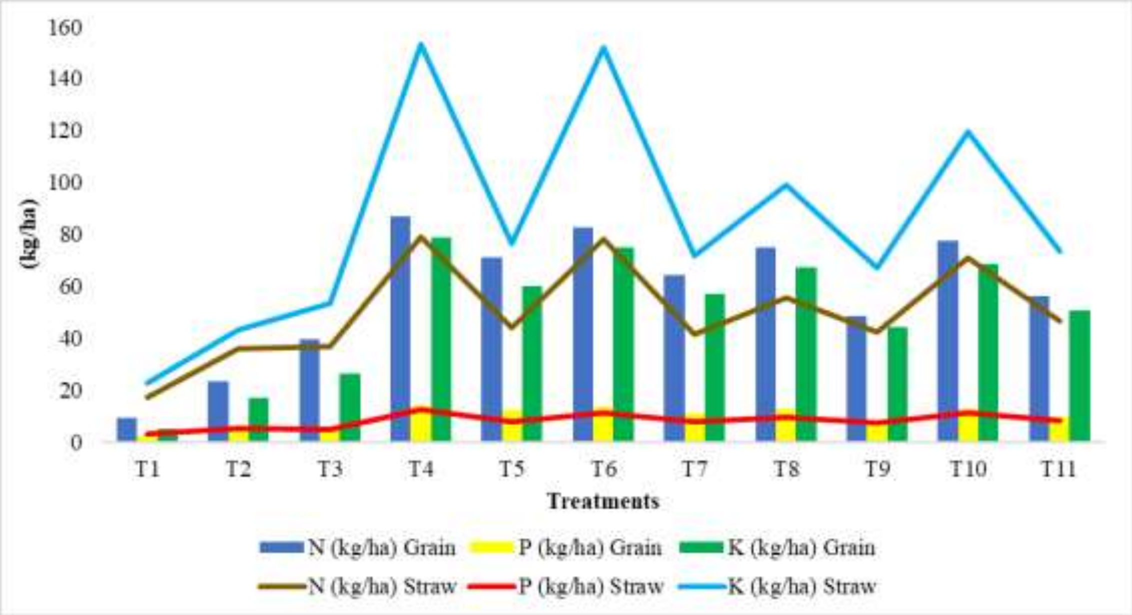

Fig 3: Effect of insect biomass compost on primary nutrient uptake by grain and straw of finger millet (*Eleusine coracana* L.)

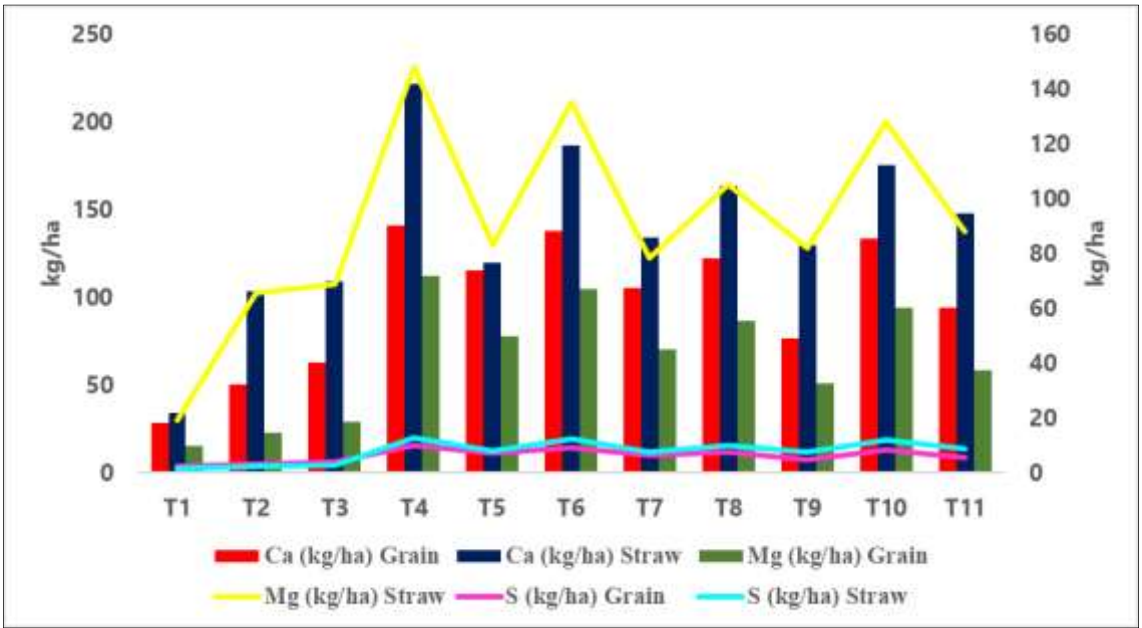

Fig 4: Effect of insect biomass compost on secondary nutrient uptake by grain and straw of finger millet (*Eleusine coracana* L.)

4. Conclusions

The enrichment of compost using different insect species *i.e*., silkworm pupae, silkworm moth, uzifly and fruit fly has showed significant increase (p<.05) in traits like plant height, number of leaves, leaf area, and number of tillers. Similarly, yield traits like number of seeds and grain yield and straw yield have been significantly (p<.05) improved by enriched insect biomass compost. Further, the increase in major and minor nutrient content and nutrient uptake in ragi grain and straw are beneficial for human. Thus, enriched insect biomass compost can also reduce the application of fertilizer and maintain soil and environment sustainability. So, by adopting enriched insect biomass compost, the yield and nutrition of the crops can be improved.

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