SUMMARY AND CONCLUSION
CHAPTER V
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World over, there is an increasing concern about the health hazards due to the manufacture and use of chemicals in crop production. Some of the chemical pesticides are so potent that even after a considerable time of their application, leaves residues in harvested produces. Now a days, there is a greater awareness for the use of natural products obtained through organic methods of cultivation. Though, fertilizers are considered as key inputs for getting higher yields, it has become hazardous in the long run, distorting soil fertility and deteriorating soil health and quality of agricultural produce.

Organic farming system is not new in India and is being followed from ancient time. It is a method of farming system primarily aimed at cultivating the land and raising crops in such a way as to keep the soil alive and in good health by use of organic waste (crop, animal and farm waste, aquatic waste) and other biological material along with beneficial microbes (bio fertilizers). Organic waste and herbal manure (*Aloe vera*) provides many essential micronutrients apart from providing major nutrients, NPK which are not made available by any of the chemical (inorganic) fertilizers. It also acts as a buffer for the soil by maintaining balance between alkalinity and acidity. Therefore, more than being a mere supplier of nutrients to crops for increased sustainable production in an eco-friendly, pollution-free environment, it also acts as a soil conditioner and is highly beneficial to both soil and crops (*Lele, 2008*).
The present investigation entitled “Efficacy of Aloe vera (L.) leaf peeling extract and powder on the growth and yield of vegetable crops” was carried out incorporating Aloe vera leaf peeling extract and powder at different concentrations to evaluate the biostimulant and herbal manure efficacy on test crops, cluster bean (Cyamopsis tetragonoloba) and chilli (Capsicum annuum).

The results of the present investigation are summarized below:

5.1. Biochemical analysis of Aloe vera leaf peeling extract and powder

The A. vera leaf peeling extract was found to have the pH of 4.97, ammoniacal nitrogen of 2.5 per cent, phenol of 5500 μg ml⁻¹ and with the bacterial population of 3 × 10⁶ CFU ml⁻¹. The total NPK content of A. vera leaf peeling powder was found to be 1.40, 0.14 and 1.97 per cent respectively.

5.2. HPTLC analysis of Aloe vera leaf peeling powder for IAA and GA₃

The results of the HPTLC analysis showed that the Aloe vera leaf peeling powder (100 g) extract contained 4.5 mg of IAA and 53.75 mg of GA₃.

5.3. Effect of Aloe vera leaf peeling extract on germination percentage, seedling growth and vigour index

The treatment G₂ (undiluted Aloe vera leaf peeling extract) showed a significant increase in germination percentage of 95 per cent in cluster bean and 90 per cent in chilli over control, G₁ (65 per cent in cluster bean and 55 per cent in chilli). Maximum increase in shoot length (12.3 cm and
4.1 cm) and root length (11.3 and 12.6 cm) were recorded in cluster bean and chilli in the G2 treatment when compared with control, G1 (7.3 and 2.0 cm and 7.2 and 5.5 cm). Vigour index also registered the maximum values in G2 (224.2 and 150.3) when compared with control, G1 (94.2 and 41.2) in cluster bean and chilli.

5.4. Soil enzyme activities under laboratory conditions

The treatment S2 (undiluted, Aloe vera leaf peeling extract incorporated soil) registered maximum α and β amylases enzyme (191.41 and 246.2 enzyme units), dehydrogenase enzyme (85.67 μg TPF g⁻¹ soil) and urease enzyme (195.23 μg NH₃ g⁻¹ soil) activities. The minimum enzyme activities were registered in S1 (control) which were 127.97 and 159.15 enzyme units (α and β amylases), 70.93 μg TPF g⁻¹ soil (dehydrogenase) and 100.3 μg NH₃ g⁻¹ soil for urease respectively.

5.5. Soil microbial population dynamics and CO₂ evolution

A significantly higher number of bacterial colonies of 34 x 10⁶ CFU g⁻¹ and fungal colonies of 46 x 10⁶ CFU g⁻¹ were registered in S2 treatment (undiluted Aloe vera leaf peeling extract incorporated soil) than the control S1 (4 and 30 x 10⁶ CFU g⁻¹). CO₂ evolution was also found to be maximum in S2 treatment which showed an increase from 302.7 to 429.2 mg g⁻¹ soil over 30 days of incubation when compared with control S1 (from 111.2 to 252.0 mg g⁻¹ soil).

5.6. Soil pH and Electrical conductivity (EC)

The experimental soil (post harvest days) sample of T₁₀ treatment of cluster bean and chilli showed a maximum pH of 8.53 and 8.80 and EC of
0.426 dSm⁻¹ and 0.545 dSm⁻¹. The least pH of 7.79 and EC of 0.158 dSm⁻¹ were recorded in the initial soil.

5.7. **Effect of *Aloe vera* leaf peeling extract and powder on test crops, cluster bean and chilli**

5.7.1. **Biometric parameters**

5.7.1.1. **Plant Height**

*D. aloides* leaf peeling powder @ 140 mg/pot (T₁₀) registered a maximum increase in plant height from 45.8 to 78.3 cm in cluster bean and from 22.5 to 83.7 cm in chilli whereas in absolute control (T₁), it was from 20.1 cm to 43.3 cm and from 7.9 to 27.0 cm.

5.7.1.2. **Root Volume**

A significant increase in root volume was registered in T₁₀ treatment of cluster bean and chilli which ranged from 1.15 to 2.27 cu.cm and from 1.07 to 1.99 cu.cm compared to T₁, control (from 0.23 to 0.50 cu.cm and from 0.27 to 1.10 cu.cm).

5.7.1.3. **Number of nodules/plant in cluster bean**

The treatment, T₁₀ (*Aloe vera* leaf peeling powder-140 mg) of leguminous crop, cluster bean recorded maximum number of nodules/plant from 9.0 to 15.3 when compared to control T₁ from 1.0 to 3.3.

5.7.1.4. **Number of leaves/plant and number of flowers/plant**

The treatment T₁₀ (*Aloe vera* leaf peeling powder-140 mg) recorded a significant enhancement in the number of leaves/plant from 11.0 to 50.3 and from 10.0 to 48.0 in cluster bean and chilli over control (from 2.7 to
16.0 and from 3.0 to 12.0) and number of flowers/plant from 6.0 to 12.7 than control (from 1.0 to 1.3) in cluster bean from 30 to 60 DAS. In chilli, the flowers were maximum on 60 DAS (15.0) in T\textsubscript{10} treatment over control, T\textsubscript{1} (3.0).

5.7.1.5. Fresh and dry weights of plant

There was a tremendous increase in fresh and dry weights of cluster bean in T\textsubscript{10} treatment, which ranged from 2.23 to 18.56g and from 0.43 to 5.77 g over the control which was from 0.49 to 5.49 g in fresh weight and from 0.11 to 0.46 g in dry weight of plant. In chilli also, the treatment T\textsubscript{10} showed a remarkable increase in fresh and dry weights which varied from 4.06 to 31.21 g and from 1.18 to 3.53 g over the control, T\textsubscript{1} (from 0.52 to 2.06 g and from 0.14 to 0.57 g).

5.7.2. Yield parameters

5.7.2.1. Number of pods/fruit/plant

Maximum increase in the number of pods/plant observed from 60 to 90 DAS in cluster bean and it was from 9.7 to 13.0 in T\textsubscript{10} than T\textsubscript{1} (from 2.0 to 4.0). In chilli, the number of fruits/plant were maximum in the treatment T\textsubscript{10} (10.0) in comparison with control (2.0) on 90 DAS.

5.7.2.2. Length of pod/fruit

The highest increase in pod length achieved in the treatment T\textsubscript{10} (\textit{Aloe vera} leaf peeling powder–140 mg) which was from 7.83 to 11.50 cm when compared with control, T\textsubscript{1} (from 1.97 to 4.20 cm) from 60 to 90 DAS in cluster bean and in chilli, the fruit length was 12.47 cm on 90 DAS over control (1.10 cm).
5.7.2.3. Fresh and dry weights of pod/fruit

The fresh and dry weights of pod were maximum in T₁₀, Aloe vera leaf peeling powder @ 140 mg (from 3.13 to 6.20 g and from 1.31 to 2.91 g) than control, T₁ (from 0.82 to 1.35 g and from 0.10 to 0.29 g) cluster bean and in chilli, the maximum fresh and dry weights of fruits registered were 5.67 g and 2.72 g in T₁₀ over control, T₁ (2.01 g and 0.65 g).

5.7.2.4. Number of seeds/pod/fruit

The treatment T₁₀ (Aloe vera leaf peeling powder-140 mg) registered the maximum number of seeds/pod/fruit of 9.0 and 89.3 in cluster bean and chilli over absolute control, T₁ (2.3 and 30.6).

5.7.2.5. Hundred seed weight

The treatment T₁₀ recorded the maximum 100 seed weight of 6.53 g and 0.76 g in cluster bean and chilli and the minimum weight was recorded in T₁, control(3.25 and 0.25 g).

5.7.3. Biochemical Parameters

5.7.3.1. Chlorophyll content of leaves

The treatment T₁₀ (Aloe vera leaf peeling powder-140 mg), showed a remarkably significant increase in chlorophyll content from 30 to 60 DAS in cluster bean and chilli which ranged from 1.69 to 2.19 mg g⁻¹ tissue and from 1.78 to 2.60 mg g⁻¹ tissue (chlorophyll a), 1.97 to 2.54 mg g⁻¹ tissue and 1.50 to 2.79 mg g⁻¹ tissue (chlorophyll b) and 1.74 to 2.24 mg g⁻¹ tissue and 1.32 to 2.46 mg g⁻¹ tissue (total chlorophyll) and it decreased gradually to 1.91 mg g⁻¹ tissue and 2.31 mg g⁻¹ tissue (chlorophyll a), 2.09 mg g⁻¹
tissue and 2.41 mg g\(^{-1}\) tissue (chlorophyll b) and 1.85 mg g\(^{-1}\) tissue and 2.13 mg g\(^{-1}\) tissue (total chlorophyll) at 90 DAS.

5.7.3.2. Total protein content of leaves

The treatment, \(T_{10}\) (Aloe vera leaf peeling powder-140 mg) recorded highest protein content of 5.86 mg g\(^{-1}\) tissue from 4.06 mg g\(^{-1}\) tissue and 5.57 mg g\(^{-1}\) tissue from 2.69 mg g\(^{-1}\) tissue in cluster bean and chilli up to 60 DAS and it decreased gradually to 3.96 and 2.74 mg g\(^{-1}\) tissue on 90 DAS. In control, the increase was from 3.33 to 4.48 mg g\(^{-1}\) tissue and declined gradually to 3.62 mg g\(^{-1}\) tissue in cluster bean and in chilli from 2.22 to 4.18 mg g\(^{-1}\) tissue and declined to 2.02 mg g\(^{-1}\) tissue.

5.7.3.3. Carbohydrate content of leaves

Carbohydrate content increased significantly up to 60 DAS with the application of Aloe vera leaf peeling extract (\(T_6\)) of cluster bean and chilli which got increased from 2.63 to 3.43 mg g\(^{-1}\) tissue in cluster bean and from 3.07 to 3.33 mg g\(^{-1}\) tissue in chilli up to 60 DAS and then declined to 2.64 mg g\(^{-1}\) tissue and 2.20 mg g\(^{-1}\) tissue over the control (from 1.96 to 2.73 and declined to 2.55 mg g\(^{-1}\) tissue and from 2.37 to 2.64 and declined to 1.91 mg g\(^{-1}\) tissue respectively at harvest.

5.8. Soil profile

5.8.1. Available soil NPK

Available soil NPK was found to be significantly higher in \(T_{10}\) which were 101.0, 13.0 and 370.0 kg ha\(^{-1}\) respectively in cluster bean planted soil and 109.0, 17.0 and 500.0 kg ha\(^{-1}\) respectively in chilli planted soil over the native levels of 45, 3.0 and 125 NPK kg ha\(^{-1}\).
5.8.2. Enzyme activity in the experimental soil of test crops

5.8.2.1. Amylase enzyme activity

The \( \alpha \) amylase enzyme activity was increased in \( T_{10} \) treatment from 192.60 to 265.40 enzyme units up to 60 DAS and declined to 221.60 enzyme units at 90 DAS in cluster bean and from 165.83 to 271.40 enzyme units up to 60 DAS and declined to 205.40 enzyme units on 90 DAS in chilli over control (\( T_1 \)), where it was from 130.96 to 185.60 enzyme units and from 111.16 to 174.36 enzyme units up to 60 DAS and then declined to 160.80 and 121.33 enzyme units in cluster bean and chilli on 90 DAS.

The \( \beta \) amylase enzyme activity was maximum in \( T_{10} \) treatment which increased from 145.3 to 195.6 enzyme units up to 60 DAS then decreased to 164.1 enzyme units on 90 DAS in cluster bean. In chilli also, the \( \beta \) amylase enzyme activity was maximum in \( T_{10} \) (236.9 to 268.6 enzyme units up to 60 DAS and declined thereafter to 215.7 enzyme units). Minimum \( \beta \) amylase enzyme activity was found to be met with absolute control, \( T_1 \) (increased from 90.3 to 116.0 enzyme units up to 60 DAS and then declined to 100.6 enzyme units on 90 DAS in cluster bean and in chilli it was increased from 154.5 to 190.6 enzyme units up to 60 DAS and then declined to 140.5 enzyme units on 90 DAS).

5.8.2.2. Dehydrogenase enzyme activity

The treatment \( T_{10} \) exhibited maximum enzyme activity both in cluster bean and chilli up to 60 DAS which ranged from 112.90 to 136.63 \( \mu g \) TPF g\(^{-1}\) soil and from 89.06 to 119.76 \( \mu g \) TPF g\(^{-1}\) soil and it gradually decreased to 97.06 \( \mu g \) TPF g\(^{-1}\) and 82.50 \( \mu g \) TPF g\(^{-1}\) soil.
5.8.2.3. Urease enzyme activity

The urease enzyme activity was much pronounced in T_6 treatment of cluster bean which ranged from 126.86 to 161.70 μg NH₃ g⁻¹ soil up to 60 DAS and then declined to 133.13 μg NH₃ g⁻¹ soil on 90 DAS. In chilli, the increase in urease enzyme activity in T₁₀ treatment was from 194.20 to 257.7 μg NH₃ g⁻¹ soil up to 60 DAS and declined gradually to 223.60 μg NH₃ g⁻¹ soil on 90 DAS.

Conclusion

The present study revealed that, the _A.vera_ leaf peels incorporation into the soil enhanced the available NPK content, enzymes like amylases, urease, dehydrogenase, soil microbial population, microbial activity (CO₂ evolution) of the soil and also biometric, yield and biochemical parameters of test crops, cluster bean and chilli.

Thus, it can be deduced from the present investigation that the _Aloe vera_ leaf peels which is thrown out as waste after taking the gel for pharmaceutical and cosmetic purposes can be exploited effectively as a biostimulant as it is found to contain IAA (Indole Acetic Acid) and GA₃ (Gibberellic Acid). Lele (2008) also reported that _Aloe vera_ leaf peels were found to contain amino acids, polysaccharides, enzymes and growth hormones and therefore could be used not only as a biostimulant but also as a herbal manure for stimulating the growth and yield parameters of crops.

Thus, the research findings in the present study indicates that the powder taken from _Aloe vera_ leaf peels (waste) offer practical and
environmentally safer alternative for use as a biostimulant and as a herbal manure.

**Recommendations for future study**

- The potentials of *A. vera* peeling extract and powder can be popularized among the industries which use *A. vera* gel from leaf for pharmaceutical and cosmetic preparation and also among the farmers for use as herbal manure.

- In the field of plant research and cultivation, the expensive growth hormones namely IAA (Indole Acetic Acid) and GA₃ (Gibberellic Acid) can be effectively replaced by cost effective eco friendly *Aloe vera* leaf peeling powder and extract.