



Effect of fish meal extract spray on the yield of Co-47 rice variety

M. Meyyappan^{1*}, E. Balaji¹, M. Ganapathy¹ and A. Angayarkanni²

¹Department of Agronomy, ²Department of Soil Science and Agricultural Chemistry, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu 608002, India

Received 25 September 2019; Revised 25 November 2020

A field experiment was conducted with Co-47 rice variety at Annamalai University experimental farm from July to September 2018 with 12 treatments to evolve a suitable organic and inorganic preparations foliar spray along with the application of 75 and 100% recommended NPK + humic acid granules. The results revealed that the treatment T₆ . 100% NPK + humic acid granules @12.5 kg/ha+ *Panchagavya* + fish meal extract + Auxin Gold seaweed extract spray on 20, 35, and 50 DAT ranked first in terms of tiller number/m² (385), number of filled grains/panicle (105.42), panicle length (23.99), and grain yield (5660). Among the individual organic preparations foliar spray, fish meal extract spray was found to be better and improved the grain yield to the tune of 439 and 387 kg/ha over respective 100 and 75% NPK + humic acid granules @12.5 kg/ha application.

Keywords: Co-47 rice variety, Filled grains, Fish meal extract, *Panchagavya*, Seaweed, Yield.

IPC code; Int. cl. (2015.01)- A01C, C05

Introduction

Among the crops, rice is the staple food of the planet that is cultivated largely on the total available agricultural land in the world. Rice is the most important ancient crop cultivated in 117 countries and about 90% of total rice is grown and consumed in Asia¹. An increasing trend of rice production during recent time is attributed to the release of high yielding varieties and the use of higher doses of fertilizer. But the use of a higher dose of fertilizer (containing only nitrogen (N), phosphorus (P), potash (K) and insufficient use of organics has created deficiencies of secondary and micronutrients. Apart from this, the farmers have to use more and more fertilizer to obtain the same yield level as in previous years. Excess and imbalanced use of chemical fertilizer has reduced the soil fertility status and rice yield by 38%^(ref 2). The dynamics of N in the soil-plant-atmosphere system includes various soil processes like mineralization, immobilization, urea hydrolysis³, nitrification, volatilization, and denitrification. Phosphorus after its application in the soil is either removed by crop or gets converted into various insoluble forms and gets fixed in soil-clays or organic matter. Without organics, usually, P use efficiency does not exceed

20%. A significant amount of P is lost from the soil through surface runoff⁴ and erosion resulting in eutrophication of water bodies. Potassium is the most abundant plant nutrient in the soil. It is more mobile than phosphate and is susceptible to loss by leaching, runoff, and erosion. Fertilizer K use efficiency is about 70%. Foliar application is one of the methods of fertilizer application in which fertilizers are applied in the form of a solution on the foliage of the plant. But foliar application alone may not be sufficient to obtain optimum yield. Foliar applied nutrients enter the plant through stomata. In this method, a small quantity of nutrient is applied at critical stages of crop growth and are absorbed quickly and effectively. The fermented organic formulations supply essential nutrients, vitamins, growth-promoting substances, beneficial microorganisms and result in good quality food⁵. The humic acid attracts positive ions and supplies macro and micronutrients. In transplanted rice, the addition of humic acid increases the nutrient content and enhances the uptake of primary, secondary and micronutrients⁶. *Panchagavya* is used through different means in agriculture, such as foliar spray, soil application along with irrigation water, seed or seedling treatments, etc. *Panchagavya* contains several vitamins, macronutrients, micronutrients, amino acid, growth regulators like auxin, gibberellin and useful microorganisms which are required for the

growth and development of crops⁷. Fish fertilizer is a Korean national farming method invented by Cho Han Kyu in the 1960s. USDA enlisted fish emulsion as part of organic farming. An amino acid is used as a biostimulants^{8,9}. The fish amino acid is a potential source of auxin that promotes vegetative growth by active cell division, cell enlargement, cell elongation, chlorophyll content¹⁰, photosynthetic pigments¹¹, particularly in brinjal (Egg plant)¹² and rice¹³. It helps in improving the number of effective tillers in rice, crop growth rate¹⁴ in lettuce¹⁵ and in *Bhendi* (Ladyfinger)¹⁶. Seaweeds are marine macroalgae. The uses of seaweeds are well known in many countries as food, fodder, and manures. To study the effect of foliar application of *Panchagavya*, fish amino acid, and seaweed extract individually as well as in combination with NPK + humic acid granules, the present study was carried out.

Materials and Methods

A field experiment was conducted at the Experimental Farm, Department of Agronomy, Annamalai University, Annamalai Nagar which is situated at 11°24' N latitude and 79°44' E longitude and an altitude of +5.79 m above MSL during late *Kuruvai* season (July to September 2018) with rice variety Co-47 to study the effect of organic and inorganic preparations on rice along with 100 and 75 % recommended dose of nitrogen, phosphorus, potash (NPK) individually and as a combined spray. The experimental field is clayey loam in texture, low in available nitrogen, medium in available phosphorus, and high in available potassium. The experiment was laid out in a randomized block design with 12 treatments and replicated thrice. The twelve treatments were T₁ - 100 % NPK + humic acid granules @12.5 kg/ha, T₂ - T₁ + *Panchagavya* spray @3 % on 20, 35, and 50 days after transplanting (DAT), T₃ - T₁ + fish meal extract spray @3 % on 20, 35, and 50 DAT, T₄ - T₁ + Auxin Gold seaweed extract spray @ 0.35% on 20, 35, and 50 DAT, T₅ - T₁ + potassium nitrate spray @0.5% on 20, 35, and 50 DAT, T₆ - T₁ + *Panchagavya* + fish meal extract + Auxin Gold seaweed extract spray on 20, 35, and 50 DAT, T₇ - 75% NPK + humic acid granules @12.5 kg/ha, T₈ - T₇ + *Panchagavya* spray @3% on 20, 35, and 50 DAT, T₉ - T₇ + fish meal extract spray @3% on 20, 35, and 50 DAT, T₁₀ - T₇ + Auxin Gold seaweed extract spray @0.35% on 20, 35, and 50 DAT, T₁₁ - T₇ + potassium nitrate spray @0.5% on

20, 35, and 50 DAT, T₁₂ - T₇ + *Panchagavya* + fish meal extract + Auxin Gold seaweed extract spray on 20, 35, and 50 DAT. The recommended dose of 120:40:40 kg/ha was adopted for 100% and from that 75% NPK was calculated and were applied to the plots as per treatment schedule. The various treatment solutions were prepared as per the treatment schedule and were sprayed on 20, 35, and 50 DAT by using water @500 mL/ha with the help of knapsack sprayer. The interaction between the number of filled grains/panicle and the number of tillers/m² and grain yield was worked by the simple correlation coefficient.

Results and Discussion

Number of tillers/m²

Among the treatments tested, T₆ - T₁ + *Panchagavya* + fish meal extract + seaweed extract spray on 20, 35, and 50 DAT ranked first compared to the rest of the treatments and resulted in the highest number of tillers/m² (Table 1) on 30 and 60 DAT (348.8, 385 respectively). This might be due to the combined effect of the recommended dose of NPK plus the foliar application of organic preparations. This combination contains macronutrients, micronutrients, vitamins, cytokinins, auxins and microorganisms which might have positively influenced the growth parameters due to enhanced protein synthesis, cell division and mobilization of nutrients. Earlier similar results were obtained¹⁷⁻²¹. The next in order was T₃ - T₁ + fish meal extract spray @3% on 20, 35, and 50 DAT, T₂ - T₁ + *Panchagavya* spray @3% on 20, 35, and 50 DAT and T₄ - T₁ + Auxin Gold seaweed extract spray @0.35% on 20, 35, and 50 DAT (340.5, 336.1, 332.4 at 30 DAT and 372, 365, 359 at 60 DAT) and all were on par at all the stages of observation. Combined application of *Panchagavya* + fish meal extract + seaweed extract spray along with 100% NPK + humic acid granules @12.5 kg/ha increased the number of tillers/m² to the tune of 27.2 and 38 over T₁- 100 % NPK + humic acid granules application @12.5 kg/ha at both stages of observation respectively. At 60 DAT, among the foliar spraying of organic substances with 75 or 100% NPK, spraying of fish meal extract was observed to be better and improved the number of tillers to the tune of 7, 13, 20 and 5, 10, 8 over-spraying of *Panchagavya*, seaweed extract, potassium nitrate along with 100 or 75% NPK + HA @12.5 kg/ha respectively. The better performance of fish meal

Table 1 — Effect of various treatments on growth, yield parameters and yield of rice

Treatments	Number of tillers/m ²		Panicle length (cm)	Filled grains/panicle	Ill filled grains/panicle	Sterility percentage	Grain yield Kg/ha
	30 DAT	60 DAT					
T ₁ - 100% NPK +humic acid granules @12.5 kg/ha	321.6	347	23.30	88.89	19.56	18.03	5030
T ₂ - T ₁ + <i>Panchagavya</i> spray @3% on 20, 35, and 50DAT	336.1	365	23.61	93.35	17.83	16.03	5402
T ₃ - T ₁ + fish meal extract spray @3% on 20, 35, and 50 DAT	340.5	372	23.77	96.24	15.62	13.96	5469
T ₄ - T ₁ + Auxin gold seaweed extract spray @0.35% on 20, 35, and 50 DAT	332.4	359	23.55	92.05	18.25	16.54	5357
T ₅ - T ₁ + potassium nitrate spray @0.5% on 20, 35, and 50 DAT	327.5	352	23.35	89.46	18.98	17.50	5296
T ₆ - T ₁ + <i>Panchagavya</i> , fish meal extract and seaweed extract spray on 20, 35, and 50 DAT (T ₂ +T ₃ +T ₄)	348.8	385	23.99	105.42	13.58	11.41	5660
T ₇ - 75 % NPK + humic acid granules @12.5 kg/ha	298.6	322	20.20	74.65	26.15	25.94	4240
T ₈ - T ₇ + <i>Panchagavya</i> spray @3% on 20, 35, and 50 DAT	308.6	332	21.89	80.58	21.89	21.36	4627
T ₉ - T ₇ + fish meal extract spray @3% on 20, 35, and 50 DAT	311.3	337	22.03	82.34	21.38	20.61	4627
T ₁₀ - T ₇ + Auxin gold seaweed extract spray @ 0.35% on 20, 35, and 50 DAT	305.8	327	21.51	79.47	22.18	21.81	4638
T ₁₁ - T ₇ + potassium nitrate spray @0.5% on 20, 35, and 50 DAT	302.4	329	21.15	76.10	25.84	25.34	4326
T ₁₂ - T ₇ + <i>Panchagavya</i> , fish meal extract and seaweed extract spray on 20, 35, and 50 DAT (T ₈ +T ₉ +T ₁₀)	317.8	340	22.44	85.62	20.67	19.44	4931
S. Ed	7.65	10	0.40	1.57	0.42	0.41	90
CD (p = 0.05)	15.87	22	NS	3.27	0.87	0.86	186

extract spray might be due to the amino acid present in it which stimulated hormone metabolism, induced the growth and physiological characters of the plant. A similar result was reported earlier²². Foliar application of organic substances or inorganic substances individually + humic acid granules application @12.5 kg/ha with 75% NPK exerted comparable effect. Application of 75% NPK along with humic acid granules @12.5 kg/ha resulted in the reduced total number of tillers/m² up to 23 and 25 compared to 100% NPK + humic acid granules application @12.5 kg/ha at both the stages of observation respectively. The treatment T₇ - 75% NPK + humic acid granules @12.5 kg/ha recorded the least total number of tillers/m² (298.6, 322) at both stages of observation.

Total number of filled grains/panicle

Among the treatments tested, T₆ - T₁ + *Panchagavya* + fish meal extract + seaweed extract spray on 20,35,

and 50 DAT along with the application of humic acid granules 12.5 kg/ha surpassed all other treatments and produced the highest number of filled grains/panicle (105.42) which is 16.53 more filled grains compared to recommended NPK+ humic acid application. Humic acid influence plant growth both directly and indirectly. Indirectly, it improves the physical, chemical, and biological condition of the soils, while directly, it increases the chlorophyll content, accelerate plant respiration, hormonal growth response, and increases penetration in plant membrane. A similar result was obtained earlier²³ This was followed by T₃ - T₁ + fish meal extract spray @3% on 20, 35, and 50 DAT and T₂ - T₁ + *Panchagavya* spray @3% on 20, 35, and 50 DAT and were on par. Application of T₂, T₃, T₄, T₅, or T₆ increased the number of filled grains/panicle to the tune of 4.45,7.35, 3.16, 0.57, and 16.53% over T₁ respectively. Among the foliar spraying of organic substances with 75 or 100% NPK, spraying of fish

meal extract was observed to be better. Foliar application of organic substances or inorganic substances with 75% NPK resulted in a similar effect and it improved the number of filled grains up to 7.69 and 7.35% respectively. The treatment T₇ - 75% NPK + humic acid granules @12.5 kg/ha recorded the lowest total number of filled grains/panicle.

Number of ill filled grains/panicle

Within the treatments tested, T₆ - T₁ + *Panchagavya* + fish meal extract + seaweed extract spray on 20, 35, and 50 DAT along with the application of humic acid granules @12.5 kg/ha resulted in the lowest number of ill filled grains/panicle (13.58). This was followed by T₃ - 100% NPK + humic acid granules application @12.5 kg/ha + fish meal extract spray on 20, 35, and 50 DAT. Combined application of *Panchagavya* + fish meal extract + seaweed extract along with 100% NPK + humic acid granules @12.5 kg/ha resulted in 5.98 lesser number of sterile grains/panicle over T₁ - 100% NPK + humic acid granules @12.5 kg/ha. In addition to 100% NPK + humic acid granules @12.5 kg/ha, spraying of fish meal extract reduced the percentage of ill filled grains to the extent of 2.21, 2.63, and 3.36 over T₂ - T₁ + *Panchagavya* spray @3% on 20, 35, and 50 DAT, T₄ - T₁ + Auxin Gold seaweed extract spray @0.35 % on 20, 35, and 50 DAT and T₅ - T₁ + potassium nitrate spray @0.5 % on 20, 35, and 50 DAT respectively. Among the foliar spraying of organic substances with 75 or 100% NPK, spraying of fish meal extract was found to be better.

Sterility percentage

Among the treatments tested, T₆ - T₁ + *Panchagavya* + fish meal extract + seaweed extract spray on 20, 35, and 50 DAT along with the application of humic acid granules @12.5 kg/ha resulted in the lowest sterility percentage (11.41). This was followed by T₃ - T₁ + fish meal extract spray @3% and T₂ - T₁ + *Panchagavya* spray on 20, 35, and 50 DAT. Among the foliar spraying of organic substances with 75 or 100% NPK, spraying of fish meal extract was found to be better. The highest value was recorded in T₇ - 75% NPK + humic acid granules @12.5 kg/ha.

Panicle length

The data related to panicle length recorded at harvest did not exert any significant influence. However, among the treatments tested, T₆ - T₁ +

Panchagavya + fish meal extract + seaweed extract spray on 20, 35, and 50 DAT along with the application of humic acid granules @12.5 kg/ha recorded the highest panicle length with a value of 23.99 cm.

Grain yield

Among the treatments tried out, T₆ - T₁ + *Panchagavya* + fish meal extract + seaweed extract spray on 20,35, and 50 DAT ranked first with a grain yield of 5660 kg/ha which is 12.52% higher than T₁-100% NPK + humic acid granules @12.5 kg/ha. The increase in yield was due to the quick absorption and assimilation of more nitrogen, phosphorus, potassium, and micronutrients present in inorganic fertilizers and organic substances. This leads to physiological and morphological improvement and finally, it reflected in higher yield. Further, a synergistic effect of inorganic fertilizer and organic substance as well as the slow release of nutrients throughout the crop growth might have contributed to a better performance of this treatment. This combination helps to produce more photosynthates and translocation from source to sink. The immediate release of N and better soil physical properties due to the application of humic acid granules also contributed to improved yield. A higher yield obtained was earlier reported²⁴. The second best was T₃ - T₁ + fish meal extract spray @3% on 20, 35, and 50 DAT which gives 5469 kg/ha. Foliar application of amino acids at critical stages of crop growth was absorbed through stomata. It is used as an ingredient in protein synthesis, influence the physiological processes directly or indirectly. Further, it helped to increase the chlorophyll content in the plants, leading to a higher rate of photosynthesis and yield. This result is in line with the findings of research work in Tomato²⁵, bean²⁶, greengram²⁷, Rice²⁸, cowpea²⁹ and *Amaranthus*³⁰. Foliar application of *Panchagavya* @3% or fish meal extract @3% or seaweed extract @0.35% increased the grain yield to the tune of 372, 439, and 327 kg/ha respectively over T₁- 100% NPK + humic acid granules @12.5 kg/ha. *Panchagavya* provided growth-promoting hormones like IAA, auxin and macronutrients which might have increased the chlorophyll content and finally yield. Seaweed extract is an organic fertilizer containing nutrients that improve the chlorophyll content, photosynthetic rate and yield. In addition to 100% NPK + humic acid @12.5 kg/ha, spraying of fish meal extract improved the grain yield to the tune of 67, 112, and 173 kg/ha over T₂ - T₁ + *Panchagavya*

spray @3 % on 20, 35, and 50 DAT, T₄ - T₁ + Auxin Gold seaweed extract spray @0.35 % on 20, 35, and 50 DAT and T₅ - T₁ + potassium nitrate spray @0.5 % on 20, 35, and 50 DAT respectively. This might be due to the presence of nutrients, amino acids, and auxin in it. Application of 25% less NPK compared to 100% recommended NPK + humic acid granules @12.5 kg/ha reduced the grain yield to the extent of 18.6%. The combined application of *Panchagavya* + fish meal extract + seaweed extract along with 100 or 75% NPK increased the grain yield over individual application of *Panchagavya* @3% or fish meal extract @3% or seaweed extract @0.35% to the tune of 258, 191, 303 and 304, 304, 293 Kg/ha respectively. Foliar application of fish meal extracts either with 100 or 75% NPK + humic acid increased the grain yield to the tune of 439 and 387 Kg/ha respectively over 100 or 75% NPK + humic acid application. Application of 75% NPK along with humic acid @12.5 kg/ha resulted in the least grain yield (4240 kg/ha). The number of filled grains/panicle and the number of tillers/m² and grain yield were positively correlated with a value of 0.6 and 0.5 respectively.

Conclusion

The study highlighted that the foliar application of fish meal extract spray @0.3% on 20, 35, and 50 DAT to low land rice variety Co-47 along with 100 and 75% recommended NPK + humic acid granules @12.5 Kg/ha increased the grain yield up to 8.7 and 9.1% compared to 100 and 75% recommended NPK + humic acid granules @12.5 Kg/ha application alone, respectively. In future, higher doses of fish meal extract spray may be tried along with inorganic fertilizers @50 and 75% recommended dose with and without humic acid.

Conflict of interest

The authors declared that there is no conflict of interest.

References

- Debbarma V, Abraham T, Debbarma S and Debbarma H, Influence of different planting methods and organic nutrients on growth and yield of rice [*Oryza sativa* (L.) sub sp. japonica], *The Ecoscan*, 2015, **9**, 1039-1044
- Priyanka B, Ramesh T, Rathika S and Balasubramaniam P, Foliar application of fish amino acid and egg amino acid to improve the physiological parameters of rice, *Int J Curr Microbiol Appl Sci*, 2019, **8**(2) 3005-3009.
- Sigurdarson J J, Suane S and Karring H, The molecular processes of urea hydrolysis in relation to ammonia emission from agriculture, *Environ Sci Biotechnol*, 2018, **17**, 241-258.
- Bertol O J, Rizzi N E, Favaretto N and Lana M D C, Phosphorus loss by surface runoff in no till system under mineral and organic fertilization, *Sci. Agric*, 2010, **67**(1), 7-77.
- Galindo A, Jeronimo C, Spaans E and Weil M, An introduction to modern agriculture, *Tierra Trop*, 2007, **3**, 91-96.
- Govindasamy R and Chandrasekaran S, Effect of graded levels of humic acid with and without nitrogen on the performance of low land rice, In: Abstrs. National Seminar on "Recent trends on the use of Humic substances for sustainable agriculture" Feb. 27-28, 2002, Annamalai University, Annamalai Nagar, Tamil Nadu, 2002, 5.
- Ram A A M, Panchagavya is a bio-fertilizer in organic farming, *Int J Adv Sci Res*, 2017, **2**(5), 54-57.
- Rouphael Y and Colla G, Synergistic biostimulatory action: Designing the next generation of plant biostimulants for sustainable agriculture, *Front Plant Sci*, 2018, **9**, 1655.
- Rouphael Y, Spíchal L, Panzarová K, Casa R and Colla G, High-Throughput plant phenotyping for developing novel biostimulants: From lab to field or from field to lab?, *Front Plant Sci*, 2018, **9**, 1197.
- Bahari A, Pirdashti H and Yaghubi M, The effect of amino acid fertilizers spraying on photosynthetic pigments and antioxidant enzymes of wheat (*Triticum aestivum* L.) under salinity stress, *Int J Agron Plant Prod*, 2013, **4**(4), 787-793.
- Weinert E J, Miller S A, Ikeda D M, Chang K S, McGinn J M, et al., Natural farming with fish amino acid, *College Trop Agr Human Resour*, 2014, 1-3.
- Balraj T H, Palani S and Arumugam G, Influence of gunapaselam, a liquid fermented fish waste on the growth characteristics of *Solanum melongena*, *J Chem Pharm Res*, 2014, **6**(12), 58-66
- Debbarma V, Abraham T, Debbarma S and Debbarma H, Influence of different planting methods and organic nutrients on growth and yield of rice [*Oryza sativa* (L.) sub sp. japonica], *The Ecoscan*, 2015, **9**, 1039-1044.
- Priyanka B, Ramesh T, Rathika S and Balasubramaniam P, Foliar application of fish amino acid and egg amino acid to improve the physiological parameters of rice, *Int J Curr Microbiol Appl Sci*, 2019, **8**(2), 3005-3009.
- Khan S, Yu H, Li Q, Gao Y, Sallam B N, et al., Exogenous application of amino acids improves the growth and yield of lettuce by enhancing photosynthetic Assimilation and nutrient availability, *Agronomy*, 2019, **9**, 266-283.
- Krishnamoorthy R, Alshatwi A A, Subbarayan S, Vadivel B, Periyasamy V S, et al., Impact of farm-made liquid organic nutrients jevamirtham and fish amino acid on growth and nutritional status in different season of *Abelmoschus esculentus*—a self-sustainable field trial, *Organic Agric*, 2019, **9**(1), 65-79.
- Devi N L and Mani S, Effect of seaweed saps *Kappaphycusalvarezii* and *Gracilaria* on growth, yield and quality of rice, *Indian J Sci Technol*, 2015, **8**(19), 1-6.
- Sunarpi S, Jupri A, Kurnianingsih R, Julisaniah N R and Nikmatullah A, Effect of seaweed extracts on growth and yield of rice plants, *Bio Sci*, 2010, **2**(2), 73-77.
- Muthukumar V B, Velayudham K and Thavaprakash N, Growth and yield of baby corn as influenced by plant growth regulators and different time of nitrogen application, *Res J Agric Biol Sci*, 2005, **1**(4), 303-307.

- 20 Hugar A Y, Chandrappa H, Jayadeva H M, Satish A and Mallikarjun G B, Comparative performance of different rice establishment methods in Bhadra command area, *Karnataka J Agric Sci*, 2009, **22**(5), 992-994.
- 21 Debbarma V and Abraham T, Agronomic performance of certified organic rice [*Oryza sativa* (L.) sub sp. japonica] as influenced by cultural practices, *Res Environ Life Sci*, 2017, **10**(3), 216-220.
- 22 Kauya S, Meyyappan M, Ganapathy M and Angayarkanni A, Effect of liquid inorganic and organic fertilizers on the growth and yield of rice, *J Rice Res*, 2020, **13**(1), 75-78.
- 23 Vanitha K and Mohandoss S, Effect of humic acid on plant growth characters and grain yield of drip fertigated aerobic rice (*Oryza sativa* L.), *The Bioscan*, 2014, **9**(1), 45-50.
- 24 Priyanka B, Ramesh T, Rathika S and Balasubramaniam P, Foliar application of fish amino acid and egg amino acid to improve the physiological parameters of rice, *Int J Curr Microbial Appl Sci*, 2019, **8**(2), 3005-3009.
- 25 Aung L H and Flick G J, The influence of fish solubles on growth and fruiting of tomato, *Hort Sci*, 1980, **15**(1), 32-33.
- 26 Sadak S H, Abdelhamid M T and Schmidhalter U, Effect of foliar application of aminoacids on plant yield and physiological parameters in bean plants irrigated with seawater, *Acta Biol Colomb*, 2015, **20**(1), 141-152
- 27 Priyanka B, Anoob D, Gowsika M, Kavin A, Kaviya S, *et al.*, Effect of fish amino acid and egg amino acid as foliar application to increase the growth and yield of green gram, *The Pharma Innov J*, 2019, **8**(6), 684-686
- 28 Priyanka B, Ramesh T, Rathika S and Balasubramaniam P, Effect of fish amino acid and egg amino acid as foliar application to increase the growth and yield of rice, *Green Farming*, 2019, **10**(2), 240-242.
- 29 Wang D, Deng X, Wang B, Zhang N, Zhu C, *et al.*, Effects of foliar application of amino acid liquid fertilizers, with or without *Bacillus amyloliquefaciens* SQR9, on cowpea yield and leaf microbiota, *PLoS one*, 2019, **14**(9), 1-13.
- 30 Ramesh T, Rathika S, Murugan A, Soniya R, Mohanta K K, *et al.*, Foliar sapray of fish amino acid as liquid organic manure on the growth and yield of amaranthus, *Chem Sci Rev Lett*, 2020, **9**(34), 511-515.