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Kunapajala: A Traditional Organic Formulation for Improving Agricultural Productivity: A Review

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ABSTRACT

Considering the major setback in agricultural productivity received due to unscientific and excessive practice of intensive farming with injudicious use of chemicals (fertilizers and pesticides *etc*.) as well as environmental hazards, there is a need for at least a partial paradigm shift towards eco-friendly organic approach. Practicing organic agriculture with various organic inputs like *Kunapajala* can provide soil health management as well as plant protection against pest and diseases, which finally reflects an increase in agricultural productivity. Although this traditional ITK formulation have been modified over the years according to the raw material availability across the location, it is rich in beneficial micro-organisms, growth promoting hormones, enzymes, vitamins, bio-pesticidal compounds which play key roles in crop growth and development when this organic liquid is applied alone or in combination with other organic/inorganic nutrient sources. However, research works on *Kunapajala* to standardize the dose, time and method of application, quantity of raw materials used for preparation, nutritional properties and response of crop to its application are very limited which further urges for scientific testing through multi-locational, multi-crop research trial and laboratory analysis of the quality of this liquid organic formulation. Afterwards, it requires transfusion to farming community through strong extension works to achieve sustainability in agricultural production.

Key words: Agricultural productivity, ITK, *Kunapajala*, Organic formulation, Sustainability.

Increasing population growth urges for more and more food production and chemical based agriculture is now the dominant practice by the farmers to achieve this. Although application of chemicals (pesticides, fertilizers *etc*.) has played an important role in uplifting the agriculture sector for the initial few decades after green revolution, its charm has gradually faded away, resulting in stagnation in crop production. Excessive and unscientific use of chemical inputs in today's intensive agriculture is creating poor soil health through hampering soil physio-chemical properties such as salinity problem, poor soil aggregation, abrupt changes in soil pH, compaction and less water holding capacity *etc*. as well as depleting soil fertility, hampering micro-organisms' activities, keeping toxic footprints in the environment for a long time, which altogether resulting in poor crop growth, yield and quality (Sharma *et al*., 2021). On the other hand, agricultural land shrinkage due increasing population pressure continuously urges for enhancing crop productivity. In India, before green revolution, agriculture was practiced only using organic inputs and methods. During earlier days, organic agriculture was self-sufficient to produce food for the population. As population growth gradually occurred, it failed to sustain and chemical based agriculture took its place through green revolution (Biswas and Das, 2022). However, setback in crop production due to continuous application of chemicals has become prominent from 1990 onwards and Indian agriculture is showing paradigm shift again towards organic agriculture to an extent (Biswas, 2020). Organic agriculture maintains biodiversity, biological cycle and its proper interaction with environment. It is a well-known fact that organic agriculture is an eco-friendly, safe approach of farming as no chemicals are used. It provides various nutrients and accelerates micro-organisms' activity and other natural functions related to crop production.

Organic agriculture mostly relies on application of organic manures, bio-pesticides, organic mulching etc. and adoption of eco-friendly practices. As organic agriculture is a traditional approach, other than these organic products and practices, various conventional organic formulations are also associated with it in the form of indigenous technical knowledge (ITK). These ITKs are variable with location, availability of raw materials and farmer's practice. They are the good sources of microorganisms, macro and micronutrients, plant growth promoting hormones, enzymes, vitamins etc. and have bio-pesticidal properties (Ram *et al*., 2018). Among all these formulations, some of them are now available to us as ITKs. One such traditional organic

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formulation is *Kunapajala*. It is a liquid organic formulation produced from animal and plant products through fermentation. *Kunapajala* is rich in various nutrients specially, nitrogen, phosphorous and potassium as well as micro-organisms, growth promoting substances *etc.* which are essential for plant growth and development. Mishra (2007) stated that *Kunapajala* has the ability to substitute chemical fertilizers to a high extent. Considering the present population growth, as complete reliance on organic agriculture is not a practical approach at least for now, *Kunapajala* can find its place in integrated nutrient management also as one of the ITKs having beneficial role in agriculture.

Kunapajala

Kunapajala (filthy fluid) or *Kunapambu* (fermented filth) is one of the traditional liquid organic formulations used since ancient times. *Kunapajala* was derived from Sanskrit words '*Kunapa*' (*i.e.* smelling like dead body, corpse) and '*Jala*' (*i.e.* water). Earliest record of this organic formulation was found possibly in two documents *i.e.* '*Vrikshayurveda*' (written by Surapala around 1,000 AD in Eastern India) and '*Lokopakara*' (documented by a poet Chavundaraya around 1,025 AD in Karnataka of South India) (Ali *et al.*, 2012). Interestingly, the preparation, use and beneficial role of *Kunapajala* was forgotten till english translation of *Vrikshayurveda* was published. Even after that, agricultural researcher, scientists showed negligence on this formulation and Valmiki Sreenivasa Ayangarya, a mathematician was the first one who experimented with *Kunapajala* and documented the beneficial role of herbal *Kunapajala* on mango and coconut (Ayangarya, 2004a). Ayangarya also observed enhancement in growth of chilli plant after application of herbal *Kunapajala* prepared from naturally fallen sour mango and soapnut (*Sapindus emarginatus*) (Ayangarya, 2004b). Later, Ayangarya in Arunachal Pradesh, prepared different types of *Kunapajala* like Indsafari (through aerobic fermentation of safari fish in cow urine) (Ayangarya, 2005), Mushika Kunapa (through aerobic fermentation of body parts of rats in cow urine)(Ayangarya, 2006a) and Kukkuta Kunapa (through aerobic fermentation of chicken flesh in cow urine) (Ayangarya, 2006b)to apply in different crops like tea bushes, kiwi fruit garden etc. and obtained positive results through their growth promoting and bio-pesticidal properties.

Kunapajala preparation and its history

Although apart from highlighting the beneficial role of *Kunapajala* in enhancing crop growth and productivity, its detailed preparation procedure was not mentioned in *Lokopakara*, Surapala in *Vrikshayurveda*(verses 101-106) mentioned preparation procedure (Sadhale, 1996) as follows:

According to *Vrikshayurveda*, the flesh, bone marrow, brain, blood and excreta of a dead boar are collected as and when available and mixed with water for further storage under the ground to avoid foul odour as well as to protect from other animals like dog's attack. Although Surapala at first mentioned dead boar, later suggested to use fat, bone marrow, flesh, blood and excreta of any animals (specially, with horns) and fishes as per the availability, which gives flexibility to the farmers to use raw materials properly. Before storage, all the animal and fish excreta or body parts should be boiled in water and kept in earthen pot with sufficient addition of paddy husk. During the time of use, this mixture is cooked after adding sesame oilcake, honey and water soaked black gram. A little ghee can also be poured into the mixture.

In Surapala's *Vrikshayurveda*, there was no mention of the quantity of ingredients required to prepare *Kunapajala* which was documented as a highly effective nutritious liquid organic preparation for trees' growth, flowering and development of reproductive organs (Majumdar, 1935).

About 300 years after Surapala's documentation, one chapter '*Upavanavinoda*' from '*Sarangadhara-paddhati*' (written by Sarangadhara, a scholar in the court of King Hammira of sakambhari-desa i.e. Bundelkhand) mentioned the preparation of *Kunapajala* without giving details about the quantity of ingredients (Majumdar, 1935). According to Sarangadhara, in order to prepare *Kunapajala*, flesh, fat, bone marrow of animals (deer, pig, sheep, goat, rhinoceros *etc.*) and fishes are boiled in water and compound milk, sesame oilcake powder, blackgram (boiled in honey), pulse decoction, ghee and hot water are added into the earthen pot containing the boiled substances. Afterwards, the pot is kept in a warm place for about two weeks to incubate boiled *Kunapajala* before use.

After 250 years of *Upavanavinoda,'Vishvavallabha'*, written by Chakrapani (1577 AD) also described the preparation of *Kunapajala* which was almost similar to Sarangadhara's procedure with animal skin is the only new addition as a raw material (Sadhale, 2004).Nene (1999) expressed that other than animal or fish body parts and wastes, *Kunapajala* can also be prepared using plant based products. This herbal version of *Kunapajala* is popularly known as *Shasyagavya* which is prepared by fermenting the mixture of cow dung, cow urine, weed or plant parts or vegetables wastes and water in 1:1:1:2 ratios, respectively. Over the years, several modifications have been made in order to prepare *Kunapajala*. Some of them are listed below (Table 1).

Nutritional properties of *Kunapajala*

Depending on the raw materials, *Kunapajala* is known to contain various macro and micronutrients, beneficial micro-organisms, plant growth promoting hormones, essential amino acids. According to Martinez (2008), *Kunapajala* is rich in carbohydrates, proteins and alkaloids obtained from milk, sesame and black gram. Further, animal and fish body parts supply ample amount of phosphorus, triacylglycerides, esters, sterolester, phospholoipids, vitamins A, D and E etc. Use of honey in preparation of *Kunapajala* acts as a source for carbohydrates which accelerate fermentation process. It is also rich in microorganisms like *rhizobium, azotobacter,*

Table 1: Different methods of *Kunapajala* preparation.

Ingredients	Preparation
Method given by Narayanan (2006)	
Rat pieces: Few in number Cow urine: 3 litres Cow dung: 5 kg Sugar: 500 g Black gram: 250 g Sesame: 250 g Cow milk: 1 litre Honey: 100 ml	1. Cut pieces of few number of rats collected from field or house are taken in a container. 2. Into it, cow dung, cow urine, sugar, black gram and sesame are added and fermented aerobically for two weeks. 3. Thereafter, cow milk and honey are also mixed into it. 4. Finally, the mixture is filtered and the filtered liquid is called 'Rat Kunapa'.
Method given by Ali *et al*. (2012)	
Animal wastes/Fish bones and fish meal: 1 kg Cow dung: 1kg Cow urine: 1 litre Water: 2 litres	1. All the ingredients are poured in a container of sufficient size and stirred properly. 2. The container is kept for aerobic fermentation of the mixture for at least 25 days. 3. Regularly, the mixture is stirred properly. 4. After 25 days, the solution is obtained through sieving with net/ clean cloth.
Method given by Nene (2012)	
Bombay duck fish (*Harpadon nehereus*): 10 kg Sesame oilcake powder: 4 kg Paddy husk: 4 kg Molasses: 4 kg Fresh cow urine: 30 litres	1. All the ingredients are poured in 80 litres container and mixed thoroughly for proper mixing. 2. The container containing this mixture is then kept at shady place for at least 60 days with intermittent stirring to ensure aerobic fermentation. 3. After that, fermented materials are sieved well with the help of clean cloth.
Method given by Jani *et al*. (2017)	
Fish and mutton : 3 kg Honey: 2.5 kg Milk: 6 litres Sesame: 500 g Black gram: 500 g Water: 12 litres	1. Fish and mutton are boiled in water till 6 litres of meat juice is obtained, which is cooled thereafter. 2. A porcelain jar is fumigated using dried *Guggulu* (*Commiphora wightii*)/*Marica* (*Piper nigrum*)/*Jatamansi* (*Nardostachys grandiflora*). 3. Meat juice is poured into it. 4. Milk, honey, sesame and black gram are then added into it. 5. Mouth of the jar is closed with lid and sealed with mud smeared cloth. 6. The jar is kept for anaerobic fermentation for 15 days. 7. After that, the mouth of the jar is opened and solution is filtered through clean cloth multiple times at regular interval after settling of any solid material(s).
Method given by Thakur (2018)	
Water: 5 litres Animal flesh/fish: 1 kg Milk: 1 litre Ghee: 1 kg Honey: 500 g Cow urine: 1 litre	1. Animal flesh/fish is boiled in water and transferred thereafter in an earthen container. 2. All the other ingredients are then added in to it. 3. 5 litres of hot water is added in to the mixture. 4. Mouth of the container is closed with a clean cloth. 5. Regularly, the mixture is stirred up to 14 days. 6. After that, the materials are sieved well and used on any crop at any time by diluting it (*Kunapajala*) with water in 1:10 ratio.
Method given by Naik *et al*. (2022) **Herbal *Kunapajala* (Nettle based)**	
Cow dung: 20 kg Cow urine: 20 litres Sprouted urd, mustard cake, crushed jaggery: 2 kg (each) Water: 20 litres Milk and butter milk: 1 litre (each) Paddy husk	1. In a plastic drum of 200 litres capacity, cow dung, cow urine, sprouted urd, mustard cake, crushed jaggery and water are added. 2. Thereafter, fresh finely chopped nettle plants are added into it. 3. Paddy husk is boiled in water 2 days prior to *Kunapajala* preparation for 15-20 minutes and filtered contents are added into that plastic drum along with milk and Nettle plants: 20 kg butter milk. 4. All the ingredients are mixed thoroughly with wooden stick and water is mixed up to the mouth of the drum. 5. The lid is closed after preparation.

Table 1: Continue...

Table 1: Continue...

	6. Stirring continues during morning and evening up to 20-25 days. During start of fermentation, bubble appears, which is not visible if preparation is completed. 7. Finally, solution is filtered and stored.
Herbal *Kunapajala* (weed based)	
Cow dung: 20 kg Cow urine: 20 litres Sprouted urd, mustard cake, crushed Jaggery: 2 kg (each) Water: 20 litres Neem (*Azadirachta indica*), wild jasmine (*Clerodendrum* sp.), beal (*Aegle marmelos*), Datura (*Datura* sp.), lantana (*Lantana camara*), Mango (*Mangifera indica*), guava (*Psidium guajava*), Calotropis (*Calotropis* sp.), castor (*Ricinus communis*) and billy goat weed (*Ageratum conyzoides*): 2 kg (each) Milk and butter milk: 1 litre (each) Paddy husk	Preparation process is same as nettle based herbal *Kunapjala* except the use of weeds instead of nettle plants.
Integrated herbal *Kunapajala*	
Ingredients: same as weed and nettle based *Kunapajala*	It is prepared by mixing half of each quantity of nettle plants and weeds. Rest of the process is same.

Table 2: Physical and chemical properties of *Kunapajala* (Chakraborty *et al*., 2019).

Parameters	On the day of preparation (0 day)	20 days after preparation	40 days after preparation
Colour	Light brownish orange	Brownish orange	Dark brownish orange
Odour	Mild alcoholic smell	Foul alcoholic smell	Extreme foul alcoholic smell
Mould growth	No mould growth	Heavy mould growth	No mould growth
Maggot population	No maggot found	Heavy maggot growth	No maggot found
pH	6.74	3.47	8.81
EC (ds/m)	2.55	9.72	8.57
N (mg/dm^3)	3486	7238	4690
P (mg/dm^3)	208.7	296.3	517.7
K (mg/dm^3)	890.4	1590.0	1873.5
Ca (mg/l)	376	452	614
Mg (mg/l)	56	73	88
S (mg/l)	678	857	719
Fe (mg/l)	55	67	72
Zn (mg/l)	6.78	13.63	17.75
Cu (mg/l)	4.76	7.44	8.53
Mn (mg/l)	0.58	1.27	2.06

azospirillum, phosphorus solubilizing bacteria, *trichoderma* and *pseudomonas*. Chakraborty *et al*. (2019) analysed physical and chemical properties of *Kunapajala* and stated that it is rich in various nutrients (Table 2). It can be applied into the soil or as foliar spray or through seed treatment/priming.

Different ingredients used to prepare *Kunapajala* not only add nutritional properties but also ensure bio-pesticidal properties. For instance, addition of paddy husk in *Kunapajala* makes the formulation rich in silica which helps the plants to become robust against pest and disease attacks. Milk used for *Kunapajala* preparation shows resistance against certain viral diseases *viz.* tobacco mosaic virus, rice tungro virus *etc.* Patil (2007) mentioned that there is a risk of pathogen infestation through plant-based compost application, which can be avoided with the use of *Kunapajala* as it is boiled and fermented.

Role of *Kunapajala* in agricultural productivity and crop quality

Kunapajala plays an important role in uplifting crop productivity and quality through providing various nutrients for the plant's uptake from soil or foliar absorption. Firminger (1864) recognised *Kunapajala* as a good source of nutrients for enhancing vegetable productivity. Further, presence of

beneficial micro-organisms, enzymes, plant growth promoting hormones *etc.* in *Kunapajala* can help to boost up the crop yield when applied alone or in combination with other organic/inorganic nutrient sources. Kavya and Ushakumari (2020) observed highest plant height, number of branches, leaf area index and yield of bhindi under application of 50% N as FYM and foliar application of 5% non-herbal *Kunapajala* due to availability of good amount of nutrients, micro-organisms, enzymes, growth hormones *etc.* Sarkar *et al*. (2014) reported that soil drenching of *Kunapajala* along with *Panchagavya* ensured linear growth of root and shoots of vegetable seedlings more prominently over control as well as with each alone. In their study, *Kunapajala* + *Panchagavya* ensured 23.21%, 5-15% and 10-23% more shoot growth in tomato, chilli and cow pea, respectively. They obtained around 50% linear growth of root in all the three vegetables. Lamina size in tomato was also increased when *Kunapajala* was applied either alone (51.13%) or in combination with *Panchagavya* (39.95%). Even, there was an increase of leaf area through application of *Kunapajala* in tomato (51%), chilli (10%) and cow pea (30%). *Kunapajala* also increased plant dry biomass as high as 106.63% in tomato. They observed superiority of *Kunapajala* + *Panchagavya* over others on fruit yield in tomato (115%) and cow pea (127%) as well as fruit number in chilli (107%).Narayanan (2006) also applied the mixture of *Kunapajala* and *Panchagavya* and found improvement in yield of vegetables. Deshmukh *et al*. (2012a and 2012b) observed that in tomato plants, leaf number and biomass, relative water content of leaves, osmotic potential, total chlorophyll, chlorophyll stability index, carotenoids, xanthophylls were higher, while membrane injury was lesser under application of *Kunapajala* than traditional organic farming and inorganic fertilizer application. Quickest attainment of flowering, extended fruiting phase, increments in size, fresh weight and shelf life of tomato fruits were recorded when *Kunapajala* was applied. They also obtained highest contents of soluble protein, carbohydrates, polyphenols, proline, glycine betaine, ascorbic acid as well as anti-oxidant properties (catalase, super oxide dismutase, peroxidase, polyphenol oxidase, indole acetic acid oxidase) of leaves and fruits of tomato grown under application of *Kunapajala*.A positive impact of *Kunapajala* on quality of crop produce was observed by Rajasree *et al.* (2022) (Table 3). In most of the cases, efficacy of *Kunapajala* or such type of ITK formulations depends on the raw materials used for preparation. Naik *et al*. (2022) compared three types of herbal *Kunapajala* and observed that nettle based herbal Kunapajala registered highest chlorophyll (a, b, total) and carotenoid contents in mustard, followed by integrated herbal *Kunapajala* and weed based herbal *Kunapajala*. In a study by Ali *et al.* (2012), *Shasyagavya* (20 and 10%) and *Kunapajala* (5 and 10%) ensured improvement in growth and yield of black gram, while in mustard, *Kunapajala* (3%) recorded the best result due to presence of organic carbon,

Table 3: Influence of *Kunapajala* on growth and quality of rice.

Treatments*	Chlorophyll a (mg/g)			Chlorophyll b (mg/g)			Total chlorophyll (mg/g)			Carotenoids (mg/g)			Soluble protein (mg/g)			Plant height (cm)		
	25 DAT	40 DAT	55 DAT	25 DAT	40 DAT	55 DAT	25 DAT	40 DAT	55 DAT	25 DAT	40 DAT	55 DAT	25 DAT	40 DAT	55 DAT	25 DAT	40 DAT	55 DAT
T_1	1.12	1.65	1.76	0.93	1.44	1.56	1.98	3.09	3.32	2.01	2.95	3.08	10.04	14.15	17.03	30.37	50.83	74.80
T_2	1.76	1.96	2.08	1.49	1.75	1.84	3.23	3.72	3.92	2.83	3.56	3.59	10.33	14.39	17.14	32.23	52.33	77.90
T_3	1.83	2.06	2.18	1.62	1.86	1.99	3.44	3.92	4.17	2.92	3.88	3.47	10.30	14.40	17.09	32.13	52.07	76.03
T_4	1.87	2.31	2.42	1.65	2.08	2.19	3.53	4.39	4.61	3.08	4.08	3.63	10.49	14.49	17.28	33.37	52.80	76.47
T_5	1.88	2.28	2.31	1.66	2.06	2.18	3.53	4.34	4.49	3.18	4.19	3.89	10.39	14.43	18.02	33.33	53.20	76.20
T_6	2.05	2.54	2.66	1.80	2.32	2.44	3.85	4.86	5.10	3.29	4.28	4.06	10.76	14.62	17.89	33.50	54.00	77.31
T_7	2.23	2.91	3.01	2.05	2.70	2.82	4.27	5.61	5.83	3.58	4.78	4.79	11.03	15.03	18.52	34.87	55.00	80.05
T_8	2.19	2.71	2.83	2.00	2.61	2.74	4.18	5.32	5.57	3.62	4.62	4.59	11.01	14.81	18.47	34.77	54.77	76.57
T_9	2.25	3.09	3.11	2.04	2.81	2.88	4.28	5.90	5.99	3.61	4.82	4.81	11.34	15.09	18.75	35.07	55.07	81.25
T_{10}	1.04	1.64	1.76	0.91	1.18	1.27	1.89	2.82	3.03	1.86	2.76	3.11	10.06	14.16	17.11	30.40	50.17	74.53
S.Em ±	0.052	0.030	0.046	0.058	0.129	0.053	0.061	0.123	0.075	0.082	0.071	0.090	0.076	0.078	0.343	0.376	0.338	1.476
C.D. (P= 0.05)	0.11	0.06	0.10	0.12	0.27	0.11	0.13	0.26	0.16	0.17	0.15	0.19	0.16	0.17	0.72	0.79	0.71	3.10

*T_1 - Foliar spray of water, T_2 - Foliar spray of water + cow urine (9:1), T_3 - Foliar spray of *Kunapajala* 3%, T_4 - Foliar spray of *Kunapajala* 3% in water + cow urine (9:1), T_5 - Soil application of *Kunapajala* 10%, T_6 - Foliar spray of water + Soil application of *Kunapajala* 10%, T_7 - Foliar spray of *Kunapajala* 3% + Soil application of *Kunapajala* 10%, T_8 - Foliar spray of water + cow urine (9:1) + Soil application of *Kunapajala* 10%, T_9 - Foliar spray of *Kunapajala* 3% in water + cow urine (9:1) + *Kunapajala* 10% soil application, T_{10} - Control (no foliar spray and soil application).

beneficial micro-organisms and growth promoting hormones. Asha (2006) sprayed *Kunapajala* on langali (*Gloriosa superba* Linn) plants and observed greater growth, flowering and yield over control and chemical fertilization. Mishra (2007) also noticed increment in growth attributes viz. plant height, leaf length, panicle length, number of grains/panicle of rice with application of *Kunapajala* at 10 days' interval. Similarly, in brinjal, Bhat and Vasanthi (2008) obtained more number of branches, greater fruit yield with lesser seeds and less vulnerability to diseases with the use of *Kunapajala* over chemical fertilizer application. Ankad *et al*. (2017) reported that *Kunapajala* application in *Ashwagandha* and *Kalmegha* seeds ensured higher leaf area, leaf area index, crop growth rate, leaf area duration, relative growth rate, net assimilation rate, chlorophyll a, b and carotenoids, dry root yield and root length over other sources of nutrients. Seed priming with herbal *Kunapajala* was done by Halder *et al.* (2022) on chickpea and results indicated that seed priming with 10% *Kunapajala* ensured highest germination %, speed of germination, shoot and root lengths, seedling length, seedling dry weight, vigour index-I and II, water imbibition rate, α-amylase activity and seed metabolic efficiency as well as quickest germination time in chickpea over control, hydropriming and others (Fig 1 a, b, c, d). Earlier, Sudhakar *et al.* (2010) mentioned the presence

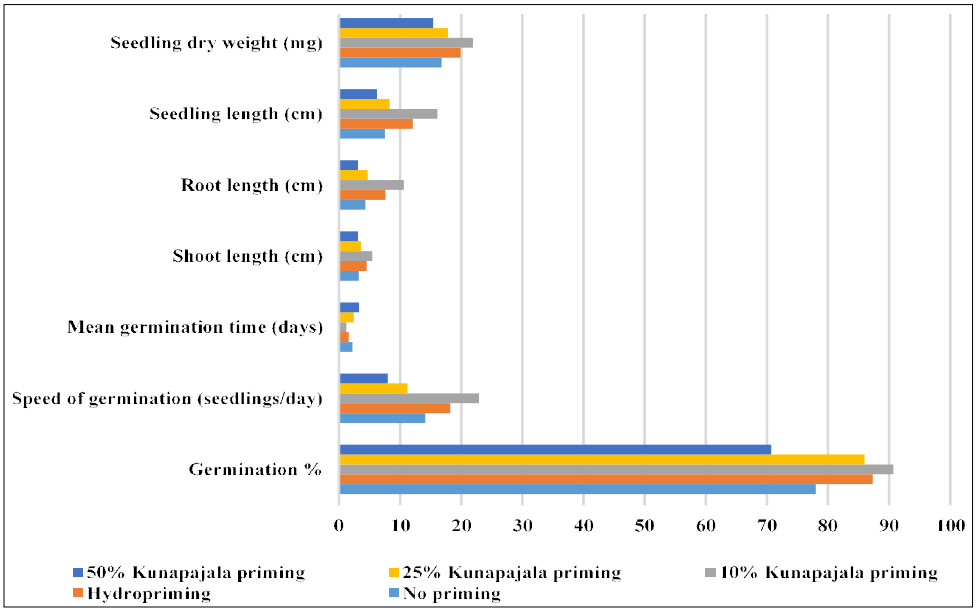

Fig 1(a): Effect of herbal *Kunapajala* priming on germination and seedling quality of chickpea.

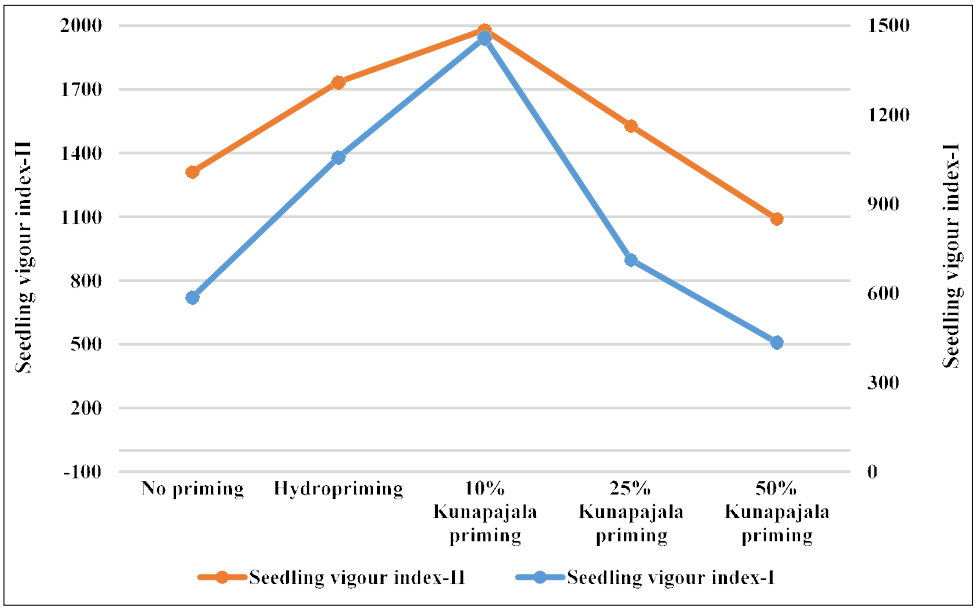

Fig 1(b): Effect of herbal *Kunapajala* priming on vigour index of chickpea.

of beneficial microorganisms, amino acids, vitamins, growth regulators like IAA, GA_3 *etc.* resulting in positive influence on germination and other seedling physiological quality parameters of crops.

Along with the nutritional properties, *Kunapajala* also provides resistance against insects and diseases. Deshmukh *et al.* (2011) stated that *Kunapajala* can enhance the growth and provide greater disease resistance than other contemporary organic formulations, which altogether increase crop yield. Ayangarya (2005) applied his *Kunapajala* preparation (Indsafari) as foliar spray @ 1% and controlled tea mosquito bug (*Helopeltis theivora*) and loopers (*Biston suppressaria*) in tea garden.Being a liquid in nature, it has the property to reach the root zone of the crop when applied in soil, resulting in high uptake of nutrients. Foliar application, however, is more effective as compared to soil application as nutrients are absorbed more efficiently than root uptake. Further, through cooking and fermentation of the raw materials of *Kunapajala*, protein, fat, carbohydrate etc. of this liquid formulation are broken down well into simple products (low molecular weight), resulting in quicker and greater availability of

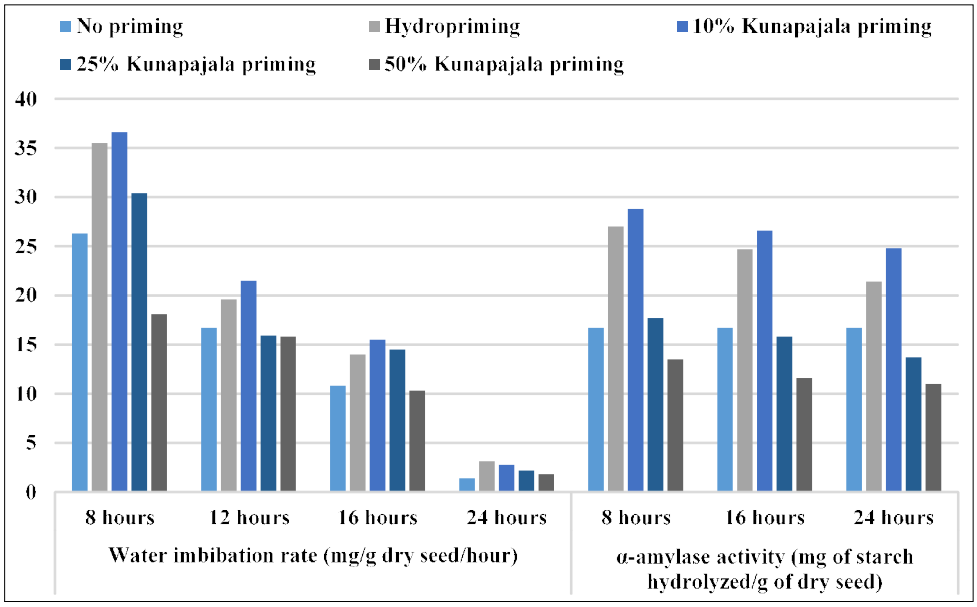

Fig 1(c): Effect of herbal *Kunapajala* priming on water imbibition rate and α-amylase activity of chickpea.

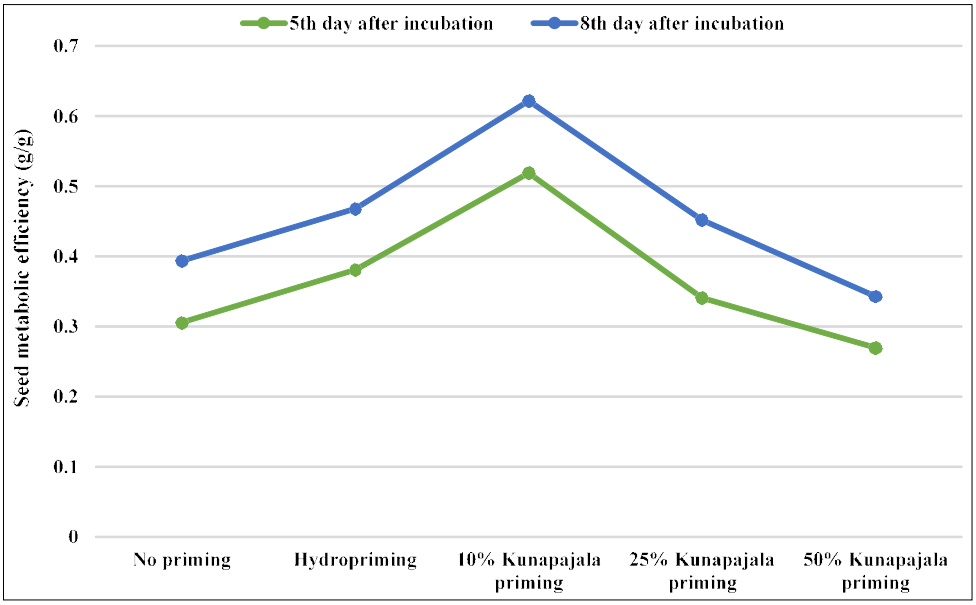

Fig 1(d): Effect of herbal *Kunapajala* priming on seed metabolic efficiency of chickpea.

nutrients to the plants as compared to other conventional organic products (Neff *et al*., 2003).

CONCLUSION

Over the years, various research reports have confirmed that *Kunapajala*, being a traditional organic liquid formulation, can uplift the agricultural productivity in a sustainable way through effectively reviving the soil health degraded due to application of chemicals, improving soil physical, chemical and biological properties, providing variety of nutrients, growth promoting hormones, enzymes, vitamins etc. for crop growth as well as building resistance in crop against insects and diseases. However, it still lacks adequate researches regarding the quality analysis, standardization of raw materials and their quantities, doses, time and method of *Kunapajala* application *etc*. To achieve this, there is an urgent need to use this old ITK formulation in multi-crop, multi-locational research trials as well as bio-chemical analysis in standard laboratories. Further, extension service needs to be strong enough to adequately transfuse standardised form of *Kunapajala* to farming community to achieve a revamp in agricultural productivity in a sustainable manner.

Conflict of interest: None.

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