Enhancing the Shelf Life of *Kunapajala* and *Shasyagavya* and their Effects on Crop Yield

Md. N. Ali*, S. Chakraborty and A. Paramanik

Ramakrishna Mission Vivekananda University, IRDM Faculty Centre, Ramakrishna Mission Ashrama, Narendrapur, Kolkata, West Bengal (700 103), India

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Correspondence to

E-mail: nasimali2007@gmail.com

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Abstract

Organic farming is required for replenishing soil fertility and maintaining environmental sustainability. This exploratory study used two Vedic bio-inoculums *Shasyagavya* (3 different grades) and *Kunapajala* (4 different grades) to spray on black gram and mustard for evaluating the beneficial effects of bio-inoculums on crop yield and improving their shelf life. In black gram, *Shasyagavya* @ 20 and 10% spray and *Kunapajala* @ 5 and 10% spray produced better yields whereas highest yield was recorded with *Shasyagavya* 20% (0.11 kg m^{-2}). In mustard, the only yield indicator which significantly varied among the treatments was 1000 seed weight. The average 1,000 seed weight was maximum (2.56 g) with *Shasyagavya* 10% spray and minimum (1.5 g) in control. Notably, *Kunapajala* 3% spray exhibited better result for most of the characters as compared to other treatments in mustard. Among the two carriers studied, charcoal performed better than glycerol. Further, it can be concluded that carrier based preparations could be stored for at least three months without compromising quality.

1. Introduction

India witnessed the world's worst food disaster in 1943 which claimed four million lives in eastern India alone (Dyson and Maharatna, 1991). The efforts to achieve food self-sufficiency were not entirely successful during a major part of post-independence era as expansion of farming areas was the preference. Though once relied on import and food aids to meet domestic food grain demands, adoption of significant policy reforms, high yielding varieties, and use of synthetic fertilizers in late-1960s led India to become self-sufficient (FAO, 2009). In contrast, researchers indicated that inherent fertility of soil is diminishing as a result of government subsidized intensive farming methods and high yielding varieties/crops which use essential plant nutrients making soil anemic (Hati et al., 2007). Hence, need of the hour is to adapt some alternative approaches for the replenishment of soil fertility. One alternative approach could be successful exploitation of organic farming that relies on ecological processes, biodiversity, and cycles adapted to the local condition rather than use of inorganic/manufactured inputs with adverse effects (Paull, 2011). Organic agriculture combines tradition, innovation, and science to benefit the shared environment and promotes good quality of life for all. In India, poor soil health arising from incessant loss of soil organic matter and soil microbial load is a key problem (Manna et al., 2005). Gutser et al. (2005) recommended that knowledge of short-term and long-term availability of nitrogen after application of organic manure, e.g. farmyard manure, slurry, sewage sludge, composts, etc. provides an important basis to optimize fertilizer use considering environmental and economic benefits. Moreover, Reeves (1997) recommended that maintenance and improvement of soil quality in continuous cropping systems are critical to sustain agricultural productivity and environmental quality. There is a pressing need to develop a system, which is not only productive and cost-effective but also resource conserving and sustainable for centuries to come (Gold, 2009). Vedic literature provides some of the earliest written record of liquid organic manures like *Kunapajala* and *Shasyagavya* and their applications in ancient India. The name *Kunapajala* (water with smell of corpse) came from the Sanskrit words '*Kunapa*' means corpse and '*Jala*' means water. This liquid manure is prepared by mixing cow dung, cow urine, animal waste (flesh, marrow, etc.), and water in 1:1:1:2 ratios, respectively. Documents regarding *Kunapajala* were found in two possibly contemporary documents, viz. *Vrikshayurveda* by Surapala, who possibly lived around 1,000 AD in eastern India and *Lokopakara* compiled by a poet Chavundaraya around 1,025 AD in Karnataka of southern India. The existence and use of *Kunapajala* was virtually forgotten until the Asian

Agri-History Foundation published the English translation of *Vrikshayurveda*. *Kunapajala* was used for improving tree growth, flowering, and general plant nourishment (Majumdar, 1935). *Shasyagavya* (*shasya* means plant product and *gavya* means obtained from cow) is the fermented mixture of cow dung, cow urine, vegetables waste, and water in 1:1:1:2 ratios, respectively. It is generally prepared by chopping and fermenting weeds in water along with cow dung. The product is mixed thoroughly by continuous stirring, strained, and used for soil drenching in tea or as a foliar spray (Nene, 1999). Over the last two decades, several modifications of above mentioned Vedic liquid organic manures have been reported (Nene, 1999; Natarajan, 2002). Increased yield in chili (green pepper) was reported after applying a *herbal kunapa* using naturally fallen sour mango fruits and soapnut *(Sapindus emarginatu*s L.). Nonetheless, less attention has been given to enhance the shelf life of these liquid organic manures by carrier based preparation and remains a considerable task. Generally, organic manures (solid or liquid) cannot be stored for a long period because microbial content decreases with time (Natarajan, 2002). Besides, Cherkasskiy (1999) reported that the generation time of most of the microbes is 48-72 h after which microbial population declines or experiences death phase. In batch culture, microbial population decreases with exhaustion of media (Gilbert et al., 1990). However, microbial population can be maintained for longer time if media is supplemented. Kaljeet et al. (2011) reported enhanced storage life of *Rhizobium* as a result of carrier mixing. Hence, objectives of this research were to study the effect of *Kunapajala* and *Shasyagavya* on black gram and mustard yield, and enhancing the shelf life of both the organic liquid manures by carrier based preparation.

2. Materials and Methods

2.1. Preparation of Kunapajala and Shasyagavya

At first, the *Kunapajala* mother stock was prepared by mixing animal waste (fish bones and fishmeal), cow dung, cow urine and water in 1:1:1:2 ratios and allowed to ferment aerobically for 25 days. The stock solution was strained through nets and clothes. Water was added to formulate four different grades (1, 3, 5 and 10%) of working solution. While, for *Shasyagavya*, the stock solution was prepared by mixing cow dung, cow urine, vegetable waste, and water in 1:1:1:2 ratios, then allowed to aerobically ferment for 10 days. The fermented product was strained through nets and clothes. Working solutions of three different grades (5, 10, and 20%) were prepared by adding water.

2.2. Field experiment

Field experiment was conducted in 2010 and 2010-11 on a deep, fine loamy soil at IRDM Faculty Center Research Farm near Narendrapur, West Bengal (21º56' N, 88º24' W) in the moist sub-humid agro-ecological sub-region. The experimental site has been in a green gram-mustard-rice rotation since 2006. The experimental site was chisel plowed and leveled before planting in both the years. Farm yard manure @ 2.5 t ha^{-1} was applied before plowing. Crystal brand, 'kalindi', an early maturity black gram variety, and Crystal brand 'B9', an early maturity mustard variety were grown following standard agronomic package in *kharif* (rainy) 2010 and *rabi* (winter) 2010-11 seasons, respectively. Good and healthy seeds were planted with a seed driller in 30x10 cm^2 spacing. The furrows were covered by soil after seed sowing and straw mulching was done. The experimental design was a randomized block design, replicated three times for all eight treatments (*Kunapajala* @ 1, 3, 5, and 10%; *Shasyagavya* @ 5, 10, and 20%; and control without fertilizer or manure). The individual plot size was 5x3m^2, oriented in an east-west direction. Statistical package GENRES 3.01 (Pascal Intl. Software Solution) was used for statistical calculation.

2.3. Carrier mixing

To evaluate the feasibility of enhancing the shelf life of *Kunapajala* and *Shasyagavya*, carrier based preparations were evaluated with respect to their microbial count along with control (without any carrier) over a three-month storage period. Wood charcoal and glycerol were used as carrier.

2.4. Biochemical analyses

In laboratory, pH and electrical conductivity of *Kunapajala* and *Shasyagavya* were measured using Systronics 335 digital pH meter and Systronics 306 conductivity meter (Systronics India Ltd., Gujarat, India), respectively. Besides, total organic carbon by wet oxidation method (Walkley and Black, 1934), available phosphorus by Olsen method (Olsen et al., 1954), and total potassium by flame emission technique (Hald, 1947) were estimated in triplicate. Microbial count was conducted in three replications; five plates were taken for each replication. After collecting one ml of sample from mother stock, standard serial dilution technique was followed for microbial count (Harley-Prescott, 2002). Total number of colony forming units (CFUs) were counted by pouring one ml aliquots (10^{-6} dilution for fungal count and 10^{-9} dilution for bacterial count) aseptically in plates inside laminar air flow chamber (pour plate technique) in different selective media, i.e. total bacterial count in nutrient agar media; total fungal count in potato dextrose agar media; phosphate solubilizing bacteria (PSB) in Pikovskaya media; *Rhizobium* in yeast extract manitol agar media; *Azotobacter* in Jenson's media; and *Azospirillum* in nitrogen free malate media) at different days after incubation. Plates were gently rotated and incubated for 48-72 h in BOD incubator at 24±2°C and 32±2°C for fungal and bacterial colonies, respectively.

Counting of CFUs for all the microbes was done using a Chemiline CL 920 colony counter (Chemiline, India).

3. Results and Discussion

The analysis of variance for black gram showed that except yield m^{-2}, the effects of *Kunapajala* and *Shasyagavya* among treatments on other yield contributing factors were insignificant (p>0.01). However, in case of mustardthe effects were only significant (p<0.01) in case of 1,000 seed weight (Table 2), indicating the positive effects of *Kunapajala* and *Shasyagavya* over control. The average highest yield for black gram (0.11 kg m^{-2}) was obtained in case of *Shasyagavya* (20%), *Kunapajala* (5 and 10%) (Table 1). Summarily, *Shasyagavya* (10 and 20%), *Kunapajala* (5 and 10%) were clearly stood out as better treatments as compared to the control for black gram. In case of mustard yield indicators like averages plant height, number of branch $plant^{-1}$, number of siliqua $branch^{-1}$, number of siliqua $plant^{-1}$, number of seed $siliqua^{-1}$, and yield m^{-2} did not differ

Table 1: Average of yield and other yield indicators of black gram, *kharif*, 2010

Treatment/ Characters	Plant height (cm)	No. of branches $plant^{-1}$	No. of pods $plant^{-1}$	No. of seeds pod^{-1}	1000 seed wt (g)	pod length (cm)	Yield m^{-2} (kg)
Shasyagavya (5%)	170.42	6.06	40.90	6.73	3.92	4.80	$0.09^{b,c}$
Shasyagavya (10%)	169.50	5.53	38.50	6.86	4.27	5.50	$0.10^{a,b}$
Shasyagavya (20%)	171.90	8.23	44.06	7.06	4.15	4.84	0.11^{a}
Kunapajala (1%)	123.16	5.20	47.06	6.80	4.10	4.72	$0.10^{b,c}$
Kunapajala (3%)	181.96	5.45	43.36	6.66	4.01	4.67	$0.10^{b,c}$
Kunapajala (5%)	171.20	6.53	44.50	6.63	4.15	5.05	0.11^{a}
Kunapajala (10%)	164.40	6.80	46.86	7.33	4.21	5.01	0.11^{a}
Control	166.80	5.56	35.66	6.16	3.87	4.62	0.09^{c}
Grand Mean	164.92	6.17	42.61	6.78	4.08	4.90	0.10
CD (p=0.05)	52.26	2.09	11.00	0.72	0.29	0.82	0.01

Treatments having same superscripts are non-significantly different (p>0.01)

Table 2: ANOVA for yield indicators of mustard during *rabi*, 2011

Source of variance	df	Plant height (cm)	No. of branch $Plant^{-1}$	No. of siliqua $branch^{-1}$	No. of siliqua $plant^{-1}$	No. of seed $siliqua^{-1}$	Thousand seed wt. (g)	Yield m^{-2} (g)
Treatment	7	116.03	1.67	1.57	247.20	5.23	0.52^{**}	1714.14
Error	14	138.69	1.70	2.63	262.87	6.76	0.01	1042.21

$^{**}p$<0.01

Table 3: Average of yield and other yield indicators of Mustard, *rabi,* 2011

Treatment	Plant height (cm)	No. of branch $plant^{-1}$	No. of siliqua $branch^{-1}$	No. of siliqua $plant^{-1}$	No. of seed $siliqua^{-1}$	1000 seed wt (g)	Yield m^{-2} (g)
Shasyagavya (5%)	131.74	6.47	8.4	88.2	42.87	$2.44^{a,b\dagger}$	117.32
Shasyagavya (10%)	127.25	4.93	6.4	68.27	40.4	2.56^{a}	74.91
Shasyagavya (20%)	128.11	5.47	6.27	70.2	40.53	1.48^{d}	75.10
Kunapajala (1%)	136.81	7.2	7.6	91.33	42.67	1.89^{c}	100.06
Kunapajala (3%)	135.07	6.13	7.33	79.2	44.13	$2.32^{a,b}$	132.17
Kunapajala (5%)	130.15	5.33	6.4	67.73	42.27	2.27^{b}	94.18
Kunapajala (10%)	130.33	5.93	7.13	73.73	43.47	$2.32^{a,b}$	110.02
Control	116.34	6.6	7.13	71.93	41.73	1.52^{d}	62.25
Grand mean	129.47	6.00	7.08	76.32	42.25	2.1	95.75
SE(d)	9.61	1.06	1.32	13.23	2.12	0.11	26.35
CD (p=0.05)	20.62	2.28	2.84	28.39	4.55	0.25	56.54

significantly among treatments (Table 3).

The mean 1,000 seed weight was maximum (2.56 g) for *Shasyagavya* (10%) and minimum (1.5 g) for control. Notably, *Kunapajala* (3%) exhibited better result for most of the characters as compared to other treatments. The results were in conformity with earlier findings (Somasundaran, 2003; Sreenivasa, 2005). The beneficial effects of these liquid manures on soil and plant health can be attributed to the presence of organic carbon, beneficial microbes (Soliappan, 2002), and growth hormones. Note that, in black gram increased leaf area and nodulation could be the key factors for high yield, as indicated by Sangeetha and Thevanthan (2010). Effect of carrier materials with respect to microbial count over a three-month storage period differs significantly ($p<0.01$) among each other (Table 4). The post-hoc analysis revealed that charcoal was the best carrier followed by glycerol (Table 5). Therefore, we concluded that charcoal based preparation of *Shasyagavya* and *Kunapajala* may be used to increase the shelf life of these bio-inoculums.

In the present study, the higher average bacterial and fungal counts as compared to any commercially available biofertilizer (1×10^8 CFUs ml^{-1}) were clearly evident (Table 6). The decrease in microbial populations followed the same trend in all treatments.

Sudden rise of average total microbial counts [bacterial ($50x10^8$

Table 4: ANOVA for different bio-inoculums prepared with two different carrier materials

Source of variance	df	Mean of square	*p*-value
Treatment	2	57174.83	0.002**
Error	13	5548.56	---

**$p<0.01$

Table 5: Post Hoc tests of different carrier materials with respect to total microbial count

Treatment	Total microbial count
Control	33^b
Glycerol	37^b
Charcoal	72^a

Same superscripts are non-significantly different ($p>0.01$)

Table 6: Mean count of total bacteria and total fungus in different carrier based preparation

Days	Control		Charcoal		Glycerol	
	Total Bacteria ($x10^8$)	Total Fungus ($x10^5$)	Total Bacteria ($x10^8$)	Total Fungus ($x10^5$)	Total Bacteria ($x10^8$)	Total Fungus ($x10^5$)
17	74.77±16.09	101.55±16.09	117.66±19.71	75.66±16.09	78.67±16.09	8.00±16.09
22	43.78±12.15	98.11±12.15	238.00±14.88	143.11±12.15	40.00±12.15	17.22±12.15
24	118.99±21.32	171.77±21.32	35.50±26.12	226.33±21.32	130.33±21.32	103.67±21.32
29	63.33±5.08	1.89±5.80	80.83±7.10	38.33±5.80	1.55±5.80	1.55±5.80
31	110.00±17.99	62.22±17.99	4.00±22.03	132.78±17.99	69.11±17.99	5.66±17.99
36	59.11±9.98	0.88±9.98	7.67±12.22	20.66±9.98	55.77±9.98	1.55±9.98
38	102.33±21.93	1.66±21.93	64.17±26.85	33.33±21.98	121.44±21.93	2.68±21.93
43	75.55±15.11	2.00±15.11	51.83±18.51	22.99±15.11	114.44±15.11	6.88±15.11
45	37.11±8.75	6.44±8.75	50.16±10.72	447.44±8.75	47.66±8.75	1.55±8.75
50	3.00±8.58	14.44±8.58	16.00±10.50	90.88±8.58	16.77±8.58	14.33±8.58
52	17.00±15.07	5.66±15.07	19.00±18.46	186.77±15.07	91.44±15.07	11.55±15.07
57	51.44±14.11	9.00±14.11	127.00±17.28	79.00±14.11	15.11±14.11	25.11±14.11
59	32.11±34.39	1.22±34.39	70.83±42.12	115.00±34.39	108.33±34.39	5.66±34.39
64	11.53±11.71	3.00±11.71	45.17±14.34	37.66±11.71	2.11±11.71	2.00±11.71
66	6.99±14.98	2.44±14.98	98.83±18.35	79.66±14.98	43.77±14.98	7.55±14.98
73	28.66±16.00	3.33±16.00	19.17±19.60	30.33±16.00	56.33±16.00	64.67±16.00
78	28.66±16.00	3.33±16.00	19.17±19.60	30.33±16.00	56.33±16.00	64.67±16.00
80	34.33±29.18	18.89±29.18	124.16±35.74	15.00±29.18	78.22±29.18	16.55±29.18
85	22.55±5.70	5.77±5.70	22.33±6.98	12.77±5.70	83.22±5.70	23.00±5.70
87	11.22±7.78	18.55±7.78	18.00±9.53	9.55±7.78	45.00±7.78	3.42±7.78
92	15.44±2.68	2.66±2.68	11.33±3.28	8.78±2.68	0.33±2.68	2.66±2.68
94	1.00±3.54	1.44±3.54	8.33±4.33	2.66±3.54	16.78±3.54	3.33±3.54

CFUs) + fungal (447x10^5 CFUs)] in charcoal based preparations were found after 45 days of decomposition. Average maximum bacterial counts in control (118x10^8 CFUs), charcoal based preparations (238x10^8 CFUs), and glycerol based preparations (130x10^8 CFUs) were found on 24th, 22nd, and 24th days of decomposition. Moreover, average maximum fungal counts in control (171x10^5 CFUs), charcoal based preparations (47x10^5 CFUs), and glycerol based preparations (103x10^5 CFUs) were found on 24th, 25th, and 24th days of decomposition. The specific microbes *Azotobactor*, *Azospirillum*, PSB, *Pseudomonas*, *Rhizobium* were counted at 10th day of decomposition for *Shasyagavya*, 25th day of decomposition for *Kunapajala*, and 90th day of decomposition for both *Kunapajala* and *Shasyagavya*. Table 7 showed significant decrease in bacterial CFUs in both bio-inoculums except *Azospirillum* and PSB in *Shasyagavya* and *Pseudomonas* in *Kunapajala*. Note that, the initial 10th day of decomposition *Azotobactor* and *Rhizobium* CFUs were higher in *Shasyagavya* than *Kunapajala*. In contrast, PSB and *Azosprillum* CFUs were higher in *Kunapajala*. However, after 90th day of decomposition all microbes under study were higher both in *Kunapajala* than *Shasyagavya* except *Rhizobium*. The presence of different beneficial microbes in bio-inoculums

Table 7: Mean Count of different microbes and their pair wise test of significance

Microbes		Before (mean)	After (mean)	t value
Azotobactor	*Kunapajala*	25.22±1.6	8.00±2.34	6.55**
	Shasyagavya	32.89±9.21	1.44±0.38	3.46**
Azospirillum	*Kunapajala*	3.2±0.57	1.00±0.37	3.26*
	Shasyagavya	0.22±0.14	0.78±0.22	1.89
PSB	*Kunapajala*	5.56±2.28	0.33±0.17	2.30*
	Shasyagavya	3.00±1.06	1.00±0.5	1.44
Pseudomonas,	*Kunapajala*	21.44±4.4	13.33±5.22	0.94
	Shasyagavya	26.44±5.69	3.00±0.41	4.28**
Rhizobium	*Kunapajala*	13.22±2.48	3.56±0.6	3.71**
	Shasyagavya	15.67±1.6	3.55±0.6	6.04**

**p<0.01, *p<0.05

(*Shayasgvya* and *Kunapajala*, in our case) agreed with the findings of Soliappan (2002) who observed beneficial microbes in *Panchagavya*, another liquid bio-inoculum.

This present study was intended for testing the capability of Vedic liquid bio-inoculums for increasing field-crop yield. Besides, carrier based preparations of both the bio-inoculums reflected adequate potentials for increasing their shelf life.

4. Conclusion

In black gram, *Shasyagavya* 10 and 20% and *Kunapajala* 5 and 10% showed better yields. Highest yield was recorded with *Shasyagavya* 20% (0.11 kg m^{-2}). In mustard, the only yield indicator which significantly varied among treatments was 1,000 seed weight. The average 1,000 seed weight was maximum (2.56 g) in *Shasyagavya* 10% spray and minimum (1.5 g) in control. It is worth noting that *Kunapajala* (3%) exhibited better result for most of the characters as compared to other treatments. Among the two carriers studied, charcoal performed better than glycerol. Moreover, we concluded that carrier based preparations could be stored for at least three months without compromising with quality.

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