



Impact of organic techniques of seed crop management on seed yield and quality in rice

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Abstract: A study was conducted at the Department of Seed Science and Technology, Tamilnadu Agricultural University, Coimbatore in June - July season of two different years to find out suitable organics for enhanced productivity of rice cv ADT 43 for organic seed production. The results revealed among the organic soil application of neem cake (1786 kg ha⁻¹) along with 3 per cent panchakavya foliar spray maximized the yield along with yield attributing characters (plant height, total number of tillers hill⁻¹, productive tillers hill⁻¹, chlorophyll content, panicle length) and resultant organic seed quality characters. However, the yield was higher with basal nutrients applied as inorganic (3537 kg ha⁻¹ in initial and 4352 kg ha⁻¹ in confirmation), which was on par with neem cake + panchakavya (3500 kg ha⁻¹ in initial and 4315 kg ha⁻¹ in confirmation), GLM + azolla (3380 kg ha⁻¹ in initial) and GLM + azolla + panchakavya (4213 kg ha⁻¹ in confirmation) treatments and sprayed with panchakavya at vegetative, flowering and maturity. These findings are highly useful for paddy organic seed production programme.

Keywords: Organic manures, Organic seed production, Quality seeds, Rice

INTRODUCTION

Rice (*Oryza sativa* L.) is the important world's staple food, particularly in South Eastern countries, while in India 70 per cent of the population depends on rice for their feeding. During the year 2010-11, rice with 94.01 million tonnes of production contributed to 40.5% of the total foodgrain production of the country (Anonymous, 2011). Venkataramani, (2002) also expressed that Asian people consume 92 per cent of the 90 per cent global rice production. India is the largest country with rice cultivated area of 44.97 million hectares and holds the second position in production (85.5 million tonnes) next to china and contributes 7.53 per cent of the world's total rice production.

In India, the green revolution undoubtedly helped to tide over the food crisis during the last four decades. Use of chemical fertilizers is one of the major factors for increasing the food production from 50 million tonnes to 200 million tonnes. Chemical fertilizers are the immediate source of nutrients in soils. Consumption of nitrogenous (N), phosphatic (P) potassic (K) fertilizers has increased from 1.1 million tones in 1966-67, the year preceding the green revolution to 27.7 million tonnes in 2011-12 (Anonymous, 2013). Continuous usage of fertilizers enhanced the demand for fertilizers to the tune of about 28 million tonnes from the current level of 17 million tonnes and

pesticides to 1.5 lakh tonnes as against current usage of 0.8 lakh tones that started expressing their ill effects with advances in periods. In spite of increased use of costly inputs, it is not certain whether we could meet the challenge of feeding the people to desired extent with the right quality of safe food. At this juncture, a keen awareness has sprung on the adoption of organic farming as a remedy to cure the ills of modern chemical agriculture. Organic agriculture is environmental friendly ecological production system that promotes and enhances biodiversity, biological cycle and biological activities. It is based on minimal use of off-farm inputs and management practices that restore, maintain and enhance ecological harmony. The principal guidelines for organic production are to use materials and practices that enhance the ecological balance of natural systems and integrate the parts of the farming systems into an ecological holistic system. Organic agriculture practices cannot ensure that products are completely free from residues, however, methods are used to minimize pollution of air, water and soil reported by Mary, (2007). The primary goal of organic agriculture is to optimize the health and productivity of interdependent communities of tiring soil, plant, animals and people. Use of organic manures in one form or the other though inherent in Indian farming has advantages like nutrient conservation, slow release, improvement of soil physical conditions resulting in higher crop yields. For

efficient nutrient management in a cropping system basis, the use of available organic resources such as Farmyard manure (FYM), compost, biogas slurry, green manure, green leaf manure, sewage sludge, urban waste, farm waste and crop residues should necessarily dovetailed for increasing soil productivity. Keeping in view of the nutrient needs of the crop, use of biofertilizers and microorganisms also could be adopted (Krishnappa *et al.*, 1993). Since rice being cultivated throughout the year, quality seed production plays a vital part to supply seeds in time at reasonable cost. Seed production in rice varieties involves application of large quantities of inorganic inputs in the field as well as on the foliage of the crop to facilitate production of good quality seed. Hence, seed production using organic means is getting momentum now a days. As per the stipulations of International Federation of Organic Agriculture Movements (IFOAM), sowing organic seed has become mandatory for organic agriculture since 2003. Nutrition to mother crop plays a significant role in improving the yield and quality of seed. Maximum yield is a constantly moving target because of continuing technological advance. Organic nutrient management has more often been used as low and locally available input sustainable agriculture by maintaining soil fertility (Mader *et al.*, 2002). The present study was therefore initiated to study the effect of mother crop nutrition in relation to organics and to compare with the inorganic inputs on seed yield and quality in rice cv. ADT 43 in the June – July season of 2003 as initial and 2004 as confirmation trial

MATERIALS AND METHODS

The experiment was designed in Randomized Block Design with three replications during June – July season for consequent two years (initial and confirmation). The area were ploughed and puddled well adopting RBD with three replication, the plots of size 3.25 x 3.25 m (net plot size 3 x 3 m) were segregated and the basal application of nutrients in different form of organic viz., (T₁) Neem cake (1786 kg ha⁻¹), (T₂) Biogas slurry (5555 kg ha⁻¹), T₃ - Vermicompost (3333 kg ha⁻¹), T₄ -GLM (Green Leaf Manure) (3641 kg ha⁻¹) + *Azolla* (1000 kg ha⁻¹), T₅ – FYM (Farm Yard Manure) (12500 kg ha⁻¹) were applied based on the inorganic nitrogen recommended for the crop. Each of the above set of treatment were also sprayed with three per cent panchakavya (T₆ - T₁ + Panchakavya, T₇ -T₂+ Panchakavya, T₈ - T₃ + Panchakavya, T₉ - T₄ + Panchakavya, T₁₀ - T₅+ Panchakavya,) at vegetative, flowering and seed maturation stages. These organic treatments were also compared with (T₁₁) inorganic nutrient source @100 : 50 : 50 N P K kg ha⁻¹ as per the recommendation of CPG, (1999). Twenty five day old seedlings organically produced seedlings (applied with FYM only) were transplanted after root dipping in 2 per cent

Pseudomonas and transplanted at the spacing of 15 x 10 cm. During the growth period, based on need the plant protection measures were taken with organic products such as Neem based products (3 ml / lit) (Neem oil) and *Pseudomonas* for plots evaluated for organic farming, while for T₁₁, the inorganic nutrient source monocrotophos (2 ml/lit) was sprayed. The panchakavya stock solution was prepared using 5 kg of Cowdung, 3 litres of cow's urine, 2 litres, of cow's milk, 2 litres of cow's curd and 1 litre of cow's clarified butter / ghee as per Natarajan (1999) and were diluted to three per cent for the spray. During crop growth, observations on plant and yield attributes like plant height, days to 50 per cent flowering, leaf folder incidence, number of tillers, number of productive tillers, panicle length, chlorophyll (Yoshida *et al.*, 1972), total number of spikelets panicle⁻¹, number of filled seeds panicle⁻¹, number of ill-filled seeds panicle⁻¹, seed yield plant⁻¹, seed yield plot⁻¹, computed seed yield ha⁻¹. The resultant seeds were also evaluated for seed quality attributes like seed recovery, seed to husk ratio, seed hardness (Viswanathan *et al.*, 1997), 100 seed weight (ISTA, 1999), seed germination (ISTA, 1999), drymatter production (ISTA, 1999) and vigour index (Abdul-Baki and Anderson, 1973). The seeds were also evaluated for field emergence (%) after thirty days of sowing and the seedlings were measured for the vigour parameters such as drymatter production (ISTA, 1999), vigour index (Abdul-Baki and Anderson, 1973). In addition the seed biochemical attributes like total sugars (Hodge and Hofreiter, 1962), protein content (Piper, 1966), ATPase (Unbreit *et al.*, 1964), alpha – amylase (Simpson and Naylor, 1962) and dehydrogenase activity (Kittock and Law, 1968). The data gathered were evaluated for their significant difference at 5 per cent probability as per Panse and Sukhatme, (1999).

RESULTS AND DISCUSSION

Plant height referred as an index of plant growth, was maximum in neem cake + panchakavya during initial trial, while during confirmation trial, inorganic treatment was the best, but was followed by neem cake + panchakavya (Table 1). Natarajan (2002) has also reported that organic manure application enhanced the rice plant growth attributes. Foliar application of panchakavya enhanced the absorption of nutrients, thus increasing the plant height (Sebastian, 2005 and Srimathi *et al.*, 2013). Early flowering was noticed in plots applied with neem cake + panchakavya which were on par with the recommended practice of inorganic treatment (Table 1) in both the trials. Early flowering might also be due to early accomplishment of initial stages and correspondingly all other stages of growth, owing to the cumulative effect of both soil and foliar nutrition and also presence of GA and other growth promoting substances in panchakavya (Saritha *et al.*, 2013). Similar advancement of flowering by organic

Table 1. Effect of organic seed crop management on plant height, Number of tillers, Days to 50 per cent flowering and productive tillers in rice cv. ADT 43

Treatments	Plant height (cm)		Number of tillers hill ⁻¹		Days to 50 per cent flowering		Number of productive tillers hill ⁻¹	
	Initial trail	Conformation trail	Initial trail	Conformation trail	Initial trail	Conformation trail	Initial trail	Conformation trail
T ₁ -Neem cake	72.5	68.7	8.9	12.7	77	81	11.2	13.3
T ₂ -Biogas slurry	62.7	62.6	6.7	10.8	78	81	9.0	11.7
T ₃ -Vermicompost	64.3	66.3	9.3	11.7	81	83	10.7	13.1
T ₄ -GLM+azolla	71.7	66.5	10.6	12.8	77	81	11.8	13.2
T ₅ -FYM	66.4	64.1	7.1	11.0	78	81	9.3	12.4
T ₆ -T ₁ + panchakavya	74.5	76.8	10.9	13.7	74	79	12.0	14.2
T ₇ -T ₂ + panchakavya	70.8	66.4	9.0	12.9	78	81	11.3	12.9
T ₈ -T ₃ + panchakavya	66.3	66.4	8.2	12.5	77	79	11.0	12.7
T ₉ -T ₄ + panchakavya	66.7	66.6	9.2	13.5	79	80	11.3	13.7
T ₁₀ -T ₅ + panchakavya	68.2	67.5	8.5	12.3	78	81	10.9	12.7
T ₁₁ - Inorganic nutrients	72.8	76.9	11.0	13.9	74	79	12.4	14.3
SEd	0.561	0.363	0.561	0.363	1.024	0.570	0.330	0.363
CD (P=0.05)	1.171	0.756	1.171	0.756	2.052	1.190	0.688	0.757

Table 2. Effect of organic seed crop management on panicle length, total number of spikelets panicle⁻¹ filled and ill filled seeds panicle⁻¹ in rice cv. ADT 43

Treatments	Panicle length (cm)		Total number of spikelets panicle ⁻¹		Filled seeds (%) panicle ⁻¹		Ill filled seeds (%) panicle ⁻¹	
	Initial trail	Conformation trail	Initial trail	Conformation trail	Initial trail	Conformation trail	Initial trail	Conformation trail
T ₁ -Neem cake	18.3	19.5	115	123	81.4	87.0	18.6	13.0
T ₂ -Biogas slurry	16.4	19.5	95	117	76.8	85.3	23.2	14.7
T ₃ -Vermicompost	18.4	18.2	115	95	74.7	86.3	25.3	13.7
T ₄ -GLM+azolla	19.0	19.7	116	118	82.0	85.0	18.0	15.0
T ₅ -FYM	17.8	19.2	94	106	82.5	86.0	17.5	14.0
T ₆ -T ₁ + panchakavya	19.0	21.0	126	135	85.5	89.3	14.5	10.7
T ₇ -T ₂ + panchakavya	18.3	19.4	104	116	78.9	83.7	21.1	16.3
T ₈ -T ₃ + panchakavya	18.3	19.2	106	126	84.4	83.0	15.6	17.0
T ₉ -T ₄ + panchakavya	18.1	20.9	105	112	81.6	89.2	18.7	10.8
T ₁₀ -T ₅ + panchakavya	18.4	19.2	104	111	80.6	85.0	19.4	15.0
T ₁₁ - Inorganic nutrients	19.5	21.6	119	129	80.3	78.0	20.2	22.0
SEd	0.329	0.342	2.230	4.577	1.267	1.804	0.676	0.943
CD (P=0.05)	0.686	0.712	4.623	9.492	2.628	3.740	1.402	1.955

Table 3. Effect of organic seed crop management on Chlorophyll total (mg g^{-1}) and seed yield in rice cv. ADT 43

Treatments	Chlorophyll total (mg g^{-1})		Seed yield plant ⁻¹ (g)		Seed yield plot ⁻¹ (kg)		Seed yield ha ⁻¹ (kg)	
	Initial trail	Conformation trail	Initial trail	Conformation trail	Initial trail	Conformation trail	Initial trail	Conformation trail
T ₁ -Neem cake	2.955	3.347	2.40	4.88	2.90	3.33	3222	3704
T ₂ -Biogas slurry	2.843	3.250	1.91	4.15	2.63	2.99	2917	3319
T ₃ -Vermicompost	2.627	2.873	1.88	3.61	2.55	2.81	2833	3120
T ₄ -GLM+azolla	2.953	3.237	2.67	4.47	3.04	3.35	3380	3722
T ₅ -FYM	2.633	2.817	2.08	3.99	2.75	2.99	3056	3319
T ₆ -T ₁ + panchakavya	3.116	3.790	2.70	5.33	3.15	3.88	3500	4315
T ₇ -T ₂ + panchakavya	2.975	3.062	2.22	4.55	2.80	3.80	3111	3556
T ₈ -T ₃ + panchakavya	2.976	3.073	2.09	4.39	2.81	3.18	3120	3537
T ₉ -T ₄ + panchakavya	2.927	3.563	2.30	5.26	2.95	3.79	3278	4213
T ₁₀ -T ₅ + panchakavya	3.080	3.110	2.15	5.05	2.84	3.12	3157	3463
T ₁₁ - Inorganic nutrients	3.195	3.807	2.81	5.81	3.18	3.92	3537	4352
SEd	0.079	0.073	0.093	0.269	0.074	0.104	123.017	115.017
CD (P=0.05)	0.163	0.151	0.193	0.562	0.154	0.216	256.610	239.922

Table 4. Effect of organic seed crop management on leaf folder incidence (%), seed recovery (%), seed to husk ratio and seed hardness (kg) in rice cv. ADT 43

Treatments	Leaf folder incidence (%)		Seed recovery (%)		Seed to husk ratio		Seed hardness (kg)	
	Initial trail	Conformation trail	Initial trail	Conformation trail	Initial trail	Conformation trail	Initial trail	Conformation trail
T ₁ -Neem cake	19	10	97.5	95.3	4.29	4.31	13.56	12.85
T ₂ -Biogas slurry	22	14	96.3	95.9	3.93	4.24	12.66	11.93
T ₃ -Vermicompost	23	18	97.4	96.8	3.88	4.19	15.45	14.25
T ₄ -GLM+azolla	20	15	97.5	95.4	4.12	4.29	13.76	12.63
T ₅ -FYM	22	16	97.3	95.5	3.99	4.22	12.73	11.99
T ₆ -T ₁ + panchakavya	14	9	98.1	97.0	4.32	4.49	15.65	14.37
T ₇ -T ₂ + panchakavya	16	15	97.6	95.6	4.10	4.24	15.62	14.12
T ₈ -T ₃ + panchakavya	17	15	97.1	95.2	4.06	4.23	13.77	12.99
T ₉ -T ₄ + panchakavya	18	13	97.9	96.8	4.11	4.34	14.84	14.00
T ₁₀ -T ₅ + panchakavya	20	13	97.8	95.8	4.07	4.35	14.12	13.32
T ₁₁ - Inorganic nutrients	30	22	97.3	93.8	3.93	4.24	13.74	12.97
SEd	1.530	1.362	0.384	0.452	0.053	0.019	0.309	0.283
CD (P=0.05)	3.191	2.841	0.796	0.936	0.109	0.039	0.642	0.590

Table 5. Effect of organic seed crop management on 100 seed weight (g), germination, drymatter production (g 10 seedlings⁻¹) and vigour index in rice cv. ADT 43.

Treatments	100 seed weight (g)		Germination (%)		Drymatter production (g 10 seedlings ⁻¹)		Vigour index	
	Initial trail	Conformation trail	Initial trail	Conformation trail	Initial trail	Conformation trail	Initial trail	Conformation trail
T ₁ -Neem cake	1.51	1.53	93 (74.66)	95 (77.08)	0.105	0.112	2953	3088
T ₂ -Biogas slurry	1.45	1.52	92 (73.57)	93 (74.66)	0.102	0.108	2767	2967
T ₃ -Vermicompost	1.49	1.52	92 (73.57)	90 (71.57)	0.103	0.100	2809	2847
T ₄ -GLM+azolla	1.50	1.53	94 (75.82)	95 (77.08)	0.107	0.106	2992	3058
T ₅ -FYM	1.48	1.51	90 (71.57)	89 (70.63)	0.102	0.108	2822	2813
T ₆ -T ₁ + panchakavya	1.52	1.55	95 (77.08)	98 (81.87)	0.110	0.117	3132	3249
T ₇ -T ₂ + panchakavya	1.50	1.53	93 (74.66)	93 (74.66)	0.105	0.111	3168	3032
T ₈ -T ₃ + panchakavya	1.50	1.55	93 (74.66)	93 (74.66)	0.107	0.106	3055	3008
T ₉ -T ₄ + panchakavya	1.50	1.52	92 (73.57)	95 (77.08)	0.107	0.108	3015	3128
T ₁₀ -T ₅ + panchakavya	1.49	1.53	95 (77.08)	98 (81.87)	0.106	0.109	3052	3177
T ₁₁ - Inorganic nutrients	1.49	1.49	90 (71.57)	89 (70.63)	0.107	0.106	2892	2845
SEd	0.009	0.007	0.678	1.885	0.001	0.002	26.433	54.063
CD (P=0.05)	0.019	0.015	1.407	3.932	0.002	0.004	54.819	112.121

(Figures in parentheses indicate arcsine values)

Table 6. Effect of organic seed crop management on field emergence (%), drymatter production (g 10 seedlings⁻¹), vigour index and total sugar ($\mu\text{g g}^{-1}$) in rice cv. ADT 43

Treatments	Field emergence (%)		DMP (g 10 seedlings ⁻¹)		Vigour index		Total sugar ($\mu\text{g g}^{-1}$)	
	Initial trail	Conformation trail	Initial trail	Conformation trail	Initial trail	Conformation trail	Initial trail	Conformation trail
T ₁ -Neem cake	74 (59.34)	75 (60.00)	0.425	0.503	1757	1838	75.95	77.94
T ₂ -Biogas slurry	65 (53.75)	63 (52.54)	0.480	0.543	1675	1447	73.02	75.29
T ₃ -Vermicompost	74 (59.34)	69 (56.17)	0.314	0.434	1573	1348	73.23	74.88
T ₄ -GLM +azolla	77 (61.34)	78 (62.03)	0.328	0.631	1755	1624	74.94	78.01
T ₅ -FYM	75 (60.00)	74 (59.34)	0.422	0.652	1798	1474	73.53	75.35
T ₆ -T ₁ + panchakavya	88 (69.73)	87 (68.87)	0.682	0.787	2503	2262	77.57	80.63
T ₇ -T ₂ + panchakavya	75 (60.00)	75 (60.00)	0.530	0.659	1992	1403	75.53	77.36
T ₈ -T ₃ + panchakavya	73 (58.69)	72 (58.05)	0.523	0.542	1701	1697	74.94	77.57
T ₉ -T ₄ + panchakavya	80 (63.43)	76 (60.67)	0.518	0.553	1982	1760	77.27	79.62
T ₁₀ -T ₅ + panchakavya	81 (64.16)	77 (60.67)	0.495	0.537	1914	1794	76.96	78.69
T ₁₁ -Inorganic nutrients	64 (53.13)	62 (51.94)	0.579	0.684	1640	1643	74.34	76.97
SEd	2.258	0.967	0.012	0.006	13.493	49.166	0.523	0.625
CD (P=0.05)	4.684	2.017	0.026	0.012	28.146	102.560	1.088	1.296

(Figures in parentheses indicate arcsine values)

Table 7. Effect of organic seed crop management on seed protein content, ATPase activity ($\text{m mol pi g}^{-1}\text{hr}^{-1}$), Alpha - amylase activity (cm) and dehydrogenase activity (OD) in rice cv. ADT 43.

Treatments	Protein content (%)		ATPase activity ($\text{m mol pi g}^{-1}\text{hr}^{-1}$)		Alpha - amylase activity (cm)		Dehydrogenase activity (OD)	
	Initial trail	Conformation trail	Initial trail	Conformation trail	Initial trail	Conformation trail	Initial trail	Conformation trail
T ₁ -Neem cake	8.72	8.22	0.833	0.647	0.83	1.03	0.128	0.175
T ₂ -Biogas slurry	8.30	8.02	0.800	0.673	0.75	0.85	0.129	0.181
T ₃ -Vermicompost	8.61	8.00	0.817	0.527	0.59	0.82	0.128	0.163
T ₄ -GLM+azolla	8.70	8.30	0.853	0.680	1.03	1.07	0.128	0.182
T ₅ -FYM	8.68	8.04	0.833	0.467	0.80	0.95	0.120	0.145
T ₆ -T ₁ + panchakavya	8.91	8.52	0.887	0.760	1.05	1.26	0.139	0.197
T ₇ -T ₂ + panchakavya	8.56	8.17	0.823	0.660	0.69	1.05	0.127	0.176
T ₈ -T ₃ + panchakavya	8.71	8.21	0.827	0.537	0.78	1.08	0.138	0.165
T ₉ -T ₄ + panchakavya	8.92	8.24	0.800	0.630	0.76	1.13	0.128	0.166
T ₁₀ -T ₅ + panchakavya	8.82	8.22	0.870	0.770	0.70	1.14	0.128	0.204
T ₁₁ - Inorganic nutrients	8.51	8.33	0.817	0.693	0.90	1.06	0.130	0.179
SEd	0.079	0.034	0.019	0.031	0.035	0.051	0.002	0.006
CD (P=0.05)	0.163	0.070	0.040	0.063	0.072	0.105	0.004	0.013

manure + panchakavya in green gram, maize and sunflower were reported by Somasundram (2003) and Shakuntala *et al.* (2012) in rice.

Total number of tillers varied significantly in all stages (vegetative, flowering and maturity) on account of treatments. Inorganic plots registered the maximum number of tillers and productive tillers which was on par with neem cake + panchakavya (Table 1). Increase in plant height and number of tillers was mainly due to N as reported by De Datta (1981) in rice and in addition to involvement of certain growth substances like IAA (Sen and Bose, 1959) in rice. Application of organic in combination with inorganic fertilizers or biofertilizers or micronutrient have recorded the more number of productive tillers in rice as reported by Hattb (1995). Inorganic treatment and neem cake + panchakavya were again on par in registering maximum panicle length (Table 2). Panicle length even though controlled partly by genetic character that was influenced by nutrition as reported by Matsushima, 1980).

The other yield components like, total number of spikelets panicle⁻¹, filled seeds panicle⁻¹ were the highest in neem cake + panchakavya (Table 2) because of balanced supply of nutrients through out the growth period and proper physiological partitioning from source to sink. By virtue of the ability to provide the nutrients in a steady manner, organics would have increased the filled seeds as compared to inorganic treatment. The maximum chlorophyll content was recorded in inorganic treatment (Table 3).

Chlorophyll is important nitrogen containing compound of the green plants (Mishra and Srivastava, 1983). Neem cake + panchakavya also showed beneficial effect in chlorophyll, which was on par with inorganic fertilizers. The seed yield plant⁻¹, seed yield plot⁻¹ and computed seed yield were maximum in inorganic plot (3537 kg ha⁻¹ in initial trail and 4352 kg ha⁻¹ in confirmation trail), which was on par with neem cake + panchakavya (3500 kg ha⁻¹ in initial trail and 4315 kg ha⁻¹ in confirmation trail), GLM + azolla (3380 kg ha⁻¹ in initial trail) and GLM + azolla + panchakavya (4213 kg ha⁻¹ in confirmation trail) treatments (Table 3). The yield level attained in inorganic might be due to the immediate availability of nutrients to the plants. Quantity of organics was calculated on equal nitrogen basis. However, inorganic plot received P and K at a dose of 50 kg each per hectare respectively. Organics might not be in a position to make available this much quantity of P and K to the plants. However, some of the organically treated plots also performed on par with inorganic treatment due to other bioactive compounds available in organics. Application of neem cake + panchakavya, GLM + azolla and GLM + azolla + panchakavya evoked response to a greater level as that of inorganic fertilizer application.

Organic matter increased the availability of unavailable plant nutrients by enhancing the biochemical activity

of soil microorganisms. Koyama (1975) opined that even under heavy nitrogen application about 68 per cent of N absorbed by rice was from soil N and humus is an important source of N in soil. The organic source of the treatment might have improved the availability of micronutrients well by binding and protecting them from losses. The bound nutrients will be released for assimilation by plants. Beneficial effects of panchakavya on yield have been reported by Sridhar *et al.* (2001) in rice, Somasundaram (2003) in maize, green gram and sunflower, Kumaravelu and Kadamban (2009) in greengram and Padmapriya *et al.* (2010) in *Gymnema sylvestre*. It is also supported by the presence of low leaf folder incidence in neem cake + panchakavya applied plot and it was higher in inorganic nutrients (30% in initial trail and 22% in confirmation trail) (Table 4).

Seed quality attributes *viz.*, seed to husk ratio, seed hardness and 100 seed weight of size graded seeds (1.5 mm x 19 mm slotted hole sieve) were significantly influenced by organic manures. Percentage recovery of seeds upon grading with 1.5 mm x 19 mm slotted hole sieve were higher in most of the organic treatments (Table 4). Higher seed hardness, seed to husk ratio and 100 seed weight were maximum in neem cake + panchakavya (Table 4 and 5). In general, seeds harvested from organic plots recorded higher hardness than inorganic plot (Table 4). This might probably be due to availability of additional growth promoting substances in the organics in addition to major nutrients. Another reason could be that the ready availability would have enabled the plant to absorb more nitrogen resulting in increased succulence of cell wall causing reduced hardness in the seeds of inorganic plots. Chandrgiram *et al.* (1987) reported that the highest seed hardness in wheat was recorded in control treatment (unfertilized plot). Similar effect of organic on 1000 seed weight was reported by Kenchaiah (1997) in rice.

In any seed production activity, achieving high level of germination is the prime objective. As per minimum seed certification standards rice seeds should possess at least 80 per cent germination. In this study not only organically produced seed but also seed produced from inorganic treatment registered a germination level of above 80 per cent. However, inorganic seeds had 5 and 8 per cent lesser germination during initial and confirmation trail, respectively than the best organic combination of neem cake + panchakavya (Table 5). Better germination of seeds of the neem cake + panchakavya treatment might be because of increased fillness as revealed from seed to husk ratio and 100 seed weight. Biochemical estimations involving protein content, ATPase activity, alpha-amylase, total sugars and dehydrogenase showed the superiority of neem cake + panchakavya treatment, which again would have been the reason for higher germination (Krishnasamy and Seshu, 1990).

Seed quality, apart from genetic and physical purity, includes viability, health, structural soundness, size and vigour, all of which may influence the performance of a seed. Seedling vigour measured through dry matter production and vigour index was maximum in neem cake + panchakavya (Table 5). This again would have been the result and effect of higher seed weight, protein content and enzyme activity present in this treatment. Field emergence is the ultimate measure of seed vigour (Tonkin, 1969). The superior quality seeds produced in neem cake + panchakavya conformed with higher field emergence per cent, dry matter and vigour index in the field emergence test (Table 6). The reason for the favourable effect of neem cake + panchakavya might be due to higher 100 seed weight and better biochemical attributes.

The biochemical attributes like total sugar, protein, ATPase and alpha-amylase activity were higher in neem cake + panchakavya (Table 6 and 7). Kenchaiah (1997) reported improvement of protein due to neem cake application in rice. Increase in protein content due to panchakavya spray was reported by Somasundaram (2003) in maize, green gram and sunflower and Sebastian (2005) in sunflower. Dutta (1979) had amply demonstrated in rice, the positive association of viability and vigour with dehydrogenase activity. The dehydrogenase activity significantly differed among treatments where in neem cake + panchakavya registered maximum activity.

Conclusion

It was concluded that there was no much significant difference between inorganic and neem cake + panchakavya 3 percent spray treatment. But seed quality parameters viz., seed germination, seed filling and field emergence was significantly maximum in organic treatment than inorganic treatment. In addition to above, the neem cake + panchakavya treatment would not cause any problem to the soil, water and to the rice consumer. Because of this property and for sustaining the paddy seed production neem cake and panchakavya treatment was the best when compared to rest of the treatments. Hence, the finding would be highly useful for organic paddy seed production.

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