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Effect of nutrient coating on seedling vigour, nutrient uptake and yield of rice (*Oryza sativa*)

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ABSTRACT

Pot and field experiments were conducted at Annamalainagar to evaluate the effect of seed coating with bio-digested slurry, zinc sulphate, *Azospirillum*, phosphobacteria and phytohormone in rice (*Oryza sativa* L.). Result of pot culture study showed that seed coating in combination with bio-digested slurry, zinc sulphate, *Azospirillum*, phosphobacteria and phytohormone improved the seedling characteristics such as plumule length, radicle length, biomass and seedling vigour. Nitrogen uptake was increased by 7.4% at seedling stage (30th day). Coating of seeds in combination with nutrients enhanced the growth and yield attributes. Seed coating in this combination increased the grain yield by 6.4% over uncoated seeds. Uptake of N, P, K and Zn was also enhanced by various coating treatments.

Key words: Nutrient Coating, Seedling vigour, Nutrient uptake, Rice, Yield

Seed coating is a technique of applying needed inputs such as organic, inorganic nutrients, biofertilizers and pesticides on the seeds themselves in an effort to provide a self sustaining seed unit with an improved micro-environment for germination and seedling development. Coating materials improve the germination ability and increase seedling emergence, especially in the sub-optimal range, and also regulate transport of water to seed and embryo, and act as a water reservoir that is able to release or bind additionally the water to certain limits (Mucke, 1987). Seed coating provides an opportunity to package effective quantities of materials such that they can influence the seed or soil at the seed-soil interface (Scott, 1989).

The effectiveness of nutrient coatings also vary depending on several factors such as soil type, time of sowing, type of coating, and the soil fertility and texture. The incorporation of nutrients in seed coating provides a unique opportunity to supply each sown seedling with an accurately controlled quantity of nutrients that may be preferentially available to the sown crops and less available to any neighbouring weeds (Scott, 1989). Beneficial effects of seed coating

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with organic nutrients (Jaundri, 1989), inorganic nutrients and biofertilizers (Jeyabal *et al.*, 1992) have been reported by many researchers.

Bio-digested slurry is good source of nutrients, containing 1.53% N, 0.81% P_2O_5, 0.78% K_2O and traces of zinc, iron, copper and manganese (Jeyabal *et al.*, 1992) and numerous active substances like enzymes and vitamins (Ye Zhicheng, 1991). Not much research has been done on nutrient coating with integration of organic, inorganic and biofertilizers. Hence, the present investigation is aimed to evaluate the effect of seed coating with a combination of nutrients and phytohormone in rice.

MATERIALS AND METHODS

A series of experiments were conducted at Annamalai University, Annamalainagar to evaluate the effect of seed coating with bio-digested slurry, zinc sulphate, biofertilizers and phytohormone in rice (*Oryza sativa*). Pot culture experiment was carried out in 1994 to study the effect of seed coating on seedling characteristics. Based on the encouraging results, field experiments were conducted in two seasons viz., *kharif* (June to October, 1994) and *rabi* (October to February, 1994-95) seasons to evaluate the effect of seed coating on growth parameters, yield attributes, nutrient uptake and yield of rice. Soil was clay (Udic Chromustert) with pH 7.4-7.5, EC 0.34-0.36 dS/m, organic carbon 0.42-0.43% and available N, P, K and Zn 175-192, 20.5-21.7, 230-275 and 0.62-0.69 kg/ha, respectively.

The bio-digested slurry contained about 93 to 94% moisture, and was suitable for seed coating. Biofertilizers viz. *Azospirillum (Azospirillum lipoferum)* and phosphobacteria *(Bacillus megaterium* var. *phosphaticum)* each at 2% (w/w of seed) were used for both the experiments. The rice variety was ADT 38. The treatments comprised seed coating in bio-digested slurry alone (T_1), digested slurry + *Azospirillum* (T_2), digested slurry + *Azospirillum* + phosphobacteria (T_3), digested slurry + *Azospirillum* + phosphobacteria + zinc sulphate (T_4), digested slurry + *Azospirillim* + phosphobacteria + zinc sulphate + kinetin (T_5)/gibberellic acid (T_6) and uncoated (T_7). Recommended dose of N, P_2O_5 and K_2O at 100 : 50 : 50 kg/ha was applied as urea, single superphosphate and muriate of potash, respectively. The entire single superphosphate was applied as basal. The nitrogen and potassium were applied in three equal splits i.e. basal, 25 and 55 days after planting. The experiments were laid out in randomized block design with four replications.

The seeds were initially coated with gum arabic (1% w/w of seeds) and dried in sun for 20 minutes to facilitate binding of coating materials to the seed coat. Zinc sulphate 2%, 100 ppm kinetin 5% and 100 ppm gibberellic acid 5% were thoroughly mixed with fresh digested slurry (50% w/w of seeds) as per the treatment schedule. Seeds already coated with gum arabic were uniformly mixed with the above coating medium and sun-dried for 6 hours to pre-treated moisture content of the seeds. Coated seeds were inoculated with *Azospirillum* and phosphobacteria each 2% and shade dried for 30 minutes and the seeds were sown within an hour of inoculation. Length of the plumule and radicle was measured individually 3rd day after germination. Vigour index and seedling biomass were determined at 15th day.

RESULTS AND DISCUSSION

Seedling characters

Seedling characters viz., plumule length, radicle length, shoot length and vigour index were improved by different seed coating treatments. Root length was significantly increased by zinc sulphate coating. Coating in combination with all the nutrients (bio-digested slurry + *Azospirillum* + phosphobacteria + zinc sulphate) increased root length by 8.0% over uncoated (Table 1). In the coated seeds, availability of zinc near seed soil interface could make it easily available to the roots. It increases enzymatic activities and absorption of water by the plants (Lindsay, 1974). Greater absorption of zinc in the roots would have favoured the formation of stronger/healthy roots. Further, as the soil was also low in zinc content, inclusion of zinc sulphate in the coating medium had a pronounced effect on seedling characters. Coating in combination with bio-digested slurry, biofertilizers and zinc sulphate gave the highest N uptake of 2.77 g/plant at seedling stage (30th day), which was 5.7 and 7.4% higher than coating with digested slurry alone and uncoated seeds, respectively. The greater root, shoot and seedling vigour by seed coating observed in the present study might have influenced the nutrient uptake in the seedling stage.

Growth and yield attributes

Seed coating in combination with bio-digested slurry and biofertilizers (*Azospi-rillum* and phosphobacteria) produced taller plants than that of uncoated seeds. Addition of either zinc sulphate or phytohormone in the coating medium was not effective (Table 2). Highest number of tillers were recorded with seed coating in combination with bio-digested slurry, biofertilizers, zinc sulphate and gibberellic acid, which gave 412 tillers/m^2 compared to 397 tillers/m^2 in uncoated seeds. Inclusion of *Azospirillum* in the coating medium enhanced tiller number over coating with digested slurry alone. But phosphobacteria were not effective. Coating in digested slurry alone was not effective in tiller number. Coating of seeds in bio-digested slurry, biofertilizers and zinc sulphate gave higher LAI than coating in bio-digested slurry alone. Inclusion of biofetilizers in the coating medium increased LAI.

Seed coating in combination with bio-digested slurry, biofertilizers, zinc sulphate and gibberellic acid registered the highest number of panicles, being 4.9% more than uncoated seeds. Zinc sulphate had a significant effect on panicle number.

Table 1. Effect of seed coating on seedling characteristics of rice

Treatment	Plumule length (cm)	Radicle length (cm)	Shoot length (cm)	Root length (cm)	Biomass (g)	Root vigour (15 day)	Shoot vigour (15 day)	Seedling vigour	N uptake at 30 days (g/plant)
T_1	2.27	4.57	12.47	8.37	2.65	738	1099	234	2.62
T_2	2.20	4.70	12.43	8.68	2.73	733	1048	230	2.64
T_3	2.33	4.73	12.60	8.50	2.72	728	1079	233	2.69
T_4	2.80	4.67	14.60	9.07	3.21	762	1227	270	2.77
T_5	2.77	5.13	15.83	9.03	3.30	780	1368	285	2.68
T_6	2.87	5.17	15.77	8.97	3.20	787	1384	281	2.65
T_7	2.23	4.10	12.03	8.40	2.50	727	1041	216	2.58
CD (P = 0.05)	0.24	0.34	0.57	0.38	0.12	29.2	48.3	16.2	0.05

Grain and straw yields

Seed coating exerted a marked influence on grain and straw yields (Table 3). Seed coating in combination with bio-digested slurry, zinc sulphate, *Azospirillum*, phosphobacteria and gibberellic acid recorded a

Table 2. Effect of seed coating on growth attributes in rice

Treatment	Plant height at active tillering stage (cm)			Number of tillers/m^2			Leaf area index at flowering stage		
	Kharif	*Rabi*	Mean	*Kharif*	*Rabi*	Mean	*Kharif*	*Rabi*	Mean
T_1	39.93	41.50	40.72	398.0	398.3	392.2	5.18	5.13	5.15
T_2	40.57	42.00	41.28	409.7	404.7	407.2	5.22	5.16	5.19
T_3	40.93	41.87	41.40	406.3	404.3	405.3	5.25	5.21	5.23
T_4	39.93	42.37	41.15	407.0	409.3	408.2	5.32	5.22	5.27
T_5	40.67	43.03	41.85	413.7	412.7	413.2	5.33	5.23	5.28
T_6	41.83	42.70	42.27	412.0	407.3	409.7	5.34	5.28	5.31
T_7	39.97	40.70	40.33	398.7	395.7	397.2	5.14	5.10	5.12
Mean	40.55	42.02	–	406.5	404.6	–	5.25	5.19	–

	Plant height CD (P = 0.05)	Tiller number CD (P = 0.05)	Leaf area index CD (P = 0.05)
Treatment	0.88	6.69	0.054
Season	0.47	NS	0.025
Interaction NS	NS	NS	

Table 3. Effect of seed coating on panicle number and yield of rice

Treatment	Number of panicles/m^2			Grain yield (t/ha)			Straw yield (t/ha)		
	Kharif	*Rabi*	Mean	*Kharif*	*Rabi*	Mean	*Kharif*	*Rabi*	Mean
T_1	307.7	305.3	306.5	5.93	5.63	5.78	7.24	7.27	7.25
T_2	310.3	307.3	308.8	5.98	5.59	5.78	7.27	7.37	7.32
T_3	311.3	308.0	309.7	6.04	5.62	5.83	7.41	7.51	7.46
T_4	319.3	311.3	315.3	6.07	5.65	5.86	7.45	7.51	7.48
T_5	322.7	320.7	321.7	6.19	5.86	6.02	7.50	7.61	7.56
T_6	321.0	320.7	320.8	6.10	5.91	6.01	7.61	7.58	7.60
T_7	305.7	304.3	305.0	5.79	5.53	5.66	7.12	7.17	7.14
Mean	314.0	311.1	—	6.02	5.68	—	7.37	7.43	—

	Panicle number CD (P = 0.05)	Grain yield CD (P = 0.05)	Straw yield CD (P = 0.05)
Treatment	4.88	0.23	0.11
Season	2.61	0.12	0.06
Interaction	NS	NS	NS

Table 4. Effect of seed coating on crop nutrient uptake (kg/ha) of rice

Treatment	Nitrogen			Phosphorus			Potassium			Zinc		
	Kharif	*Rabi*	Mean	*Kharif*	*Rabi*	Mean	*Kharif*	*Rabi*	Mean	*Kharif*	*Rabi*	Mean
T_1	114	108	111	16.5	15.7	16.1	107	103	105	0.22	0.25	0.24
T_2	121	117	119	16.9	16.7	16.8	112	106	109	0.23	0.25	0.24
T_3	111	105	108	17.8	17.2	17.5	106	100	103	0.24	0.24	0.24
T_4	119	115	117	18.0	17.6	17.8	110	106	108	0.23	0.27	0.25
T_5	117	113	115	18.2	18.0	18.1	99	97	98	0.25	0.25	0.25
T_6	122	118	120	17.7	17.3	17.5	107	103	105	0.26	0.24	0.25
T_7	108	109	106	16.3	15.7	16.0	98	94	96	0.24	0.22	0.23
Mean	116	112	—	17.3	16.9	—	106	101	—	0.24	0.25	—

	N uptake CD (P = 0.05)	P uptake CD (P = 0.05)	K uptake CD (P = 0.05)	Zn uptake CD (P = 0.05)
Treatment	7.38	0.71	NS	0.006
Season	3.61	NS	NS	0.003
Interaction	NS	NS	NS	NS

grain yield of 6.02 t/ha, being 6.4% higher than that of uncoated seeds. Coating of seeds in combination with nutrients and phytohormone increased the straw yield by 6.0% over uncoated seeds. Higher grain and straw yields in the coating treatments might be due to root colonization of soil bacteria, greater seedling vigour and higher uptake of water and minerals in the early stage of crop growth. Naturally, the crop with vigorous early growth would have the tendency to utilize the resources earlier and consequently to produce favourable growth and yield components, ultimately leading to greater grain yield.

Nutrient uptake

Coating of seeds in combination with bio-digested slurry, biofertilizers, zinc sulphate and kinetin increased the N uptake by 14 kg/ha over uncoated seeds (Table 4). *Azospirillum* addition to bio-digested slurry increased the N uptake by 8 kg/ha over coating in bio-digested slurry alone. Increased nitrate accumulation in inoculated plants as a consequence of colonisation of bacteria and bacteria and bacterial reductase activity in roots (Rao *et al.,* 1983) and availability of nitrogen to the plants due to fixation by these bacteria (Bashan and Levanony, 1990) might have enhanced mineral uptake, especially N. Presence of organic matter in the form of bio-digested slurry would have increased the activity and multiplication of *Azospirillum*. In addition to *Azospirillum* and bio-digested slurry, inclusion of phosphate solubilising microorganism (phosphobacteria) enhanced the P uptake by 1.5 kg/ha in coating treatments. Reported effect of phosphobacteria in solubilising the insoluble phosphate to available form to the crop by excretion of organic acids (Subba Rao, 1983) might have increased P uptake. Zinc included treatments exerted marked positive influence on zinc uptake. Addition of phosphobacteria in the coating medium enhanced the zinc uptake by 8.7% over uncoated seeds. Coating in bio-digested slurry alone had no effect on zinc uptake. The study clearly indicated that seed coating in combination with organic, inorganic nutrients and biofertilizers is a good pre-sowing low cost technique for increasing the rice productivity.

REFERENCES

Bashan, Y. and Levanony, H. 1990. Current status of *Azospirillum* inoculation technology: *Azospirillum* as a challenge for agriculture. *Canadian Journal of Microbiology* **30**: 591-608.

Jaundri. K.S. 1989. Evaluation of certain agro-industrial wastes as seed pelletants under adverse soil pH conditions. *Biological Wastes* **28** : 233-236.

Jeyabal, A., Kuppuswamy, G. and Lakshmanan, A.R. 1992. Effect of seed coating on yield attributes and yield of soyabean (*Glycine max* L.). *Journal of Agronomy and Crop Science* **169** : 145-50.

Lindsay, W.L. 1974. Zinc in soils and plant nutrition. *Advances in Agronomy* **24** : 141-181.

Mucke, D. 1987. The regulation of water transport in pelleted sugar beet seed. *Journal of Agronomy and Crop Science* **161** : 79-83.

Rao, V.R., Nayak, D.N., Charyulu, P.B.B.N. and Adhra, T.K. 1983. Yield response of rice to root inoculation with *Azospirillum*. *Journal of Agricultural Sciences* **100** : 689-691.

Scott, J.M. 1989. Seed coatings and treatments on their effects on plant establishment. *Advances in Agronomy* **42** : 43-83.

Subba Rao, N.S. 1983. Phosphate solubilisation by soil microorganisms. *Advances in Agricultural Microbiology* (Ed. N.S. Subba Rao). Oxford and IBH, New Delhi, pp. 295-303.

Ye Zincheng, 1991. Utilization of biogas slurry to soak seed has achieved a remarkable results. *Biogas Forum* **2** : 46-48.