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Effect of nutrient-management options and plant growth regulators on growth and yield of late-sown winter season rice (*Oryza sativa*) under aberrant weather conditions

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ABSTRACT

A field experiment was conducted at Agricultural College and Research Institute, Madurai, during 1997–98 and 1998–99 for improving rice (*Oryza sativa* L.) productivity in late winter season due to delayed release of water in the Periyar Vaigai command through nutrient and plant-growth regulators. Application of N and K in 4 splits (skipping basal) + nutrient mixture foliar spray + *Sesbania rostrata* intercrop + silica-solubilizing bacteria (SSB) significantly increased all the growth parameters, yield attributes, grain (6,461 kg/ha) and straw (8,279 kg/ha) yields of rice. Among the plant growth regulators, foliar spraying of Triacontanol @ 2 ppm at 35 and 65 days after transplanting significantly recorded higher grain (6,325 kg/ha) and straw (8,274 kg/ha) yields. This was followed by 20 ppm Benzyladenine and *Albizia amara* leaf extract.

Key words : Rice, Late *rabi*, Nutrient mixture, *Sesbania rostrata*, SSB, Triacontanol, Benzyladenine, *Albizia amara* extract

As the rice contributes 41.5% of the total foodgrain production, the food security of India depends on the capacity to achieve sustained improvement in the productivity and profitability of rice farming.

Water is becoming scarce in irrigation commands because of many reasons like erratic and unpredictable behaviour of monsoon and growing demand of water from other sectors. In the event of late onset of South–West monsoon, the rainy season is started late. This ultimately results in delayed transplanting of winter rice. Under such late winter conditions, the weather conditions are not conducive for the growth of rice. The aberrant weather conditions such as low temperature and insufficient light result in subsequent reduction in uptake and mobility of nutrients in plants. To overcome the problem of low light intensity and impaired uptake and mobility of nutrients, evolving suitable eco-techniques will go a long way to sustain the rice production in this area.

MATERIALS AND METHODS

A field experiment was conducted during the late winter seasons of 1997–98 and 1998–99 at Agricultural College and Research Institute, Madurai. The soil was sandy clay loam in texture, belonging to Ustifluents series having pH 7.2, EC 0.35 d S/m, low in available N (162.4 kg/ha), medium in available P (13.4 kg/ha) and high in available K (290 kg/ha). The experiment was laid out in factorial randomized block design with 3 replications. The treatments consisted of 2 factors, viz. nutrient management and plant-growth regulators. The nutrient- management practices comprised M_1, recommended dose of N and K (150 and 50 kg/ha) in 3 splits, viz. 50% basal, 25% at after active tillering and 25% at panicle initiation; M_2, application of N and K in 4 splits, viz. 16.7% at 7 days after transplanting, 33.3% at 21 days after transplanting, 33.3% at 55 days after transplanting and 16.7% at 65 days after transplanting; M_3, M_2 + foliar spraying of nutrient mixture (0.5% $ZnSO_4$+02% $CuSO_4$+1% muriate of potash + 1% diammonium phosphate at tillering, active tillering and panicle initiation); M_4, M_3+ intercropping of *Sesbania rostrata* incorporated at 45 DAT; M_5, M_4 + silica-solubilizing bacteria (SSB) @ 2 kg/ha. The plant growth regulators comprised S_1, no spray; S_2, 5% *Albizia amara* leaf extract (at 35 and 65 DAT); S_3,2 ppm Triacontanol; S_4, 20 ppm Benzyladenine.

Medium-duration rice variety 'ADT 39'

Table 1. Growth parameters of late winter rice as influenced by nutrient and plant growth regulators (pooled mean)

Treatment	Plant height (cm)*	Number of tillers**	Leaf-area index**	Dry-matter* (kg/ha)
Nutrient management				
M_1	75.7	9.9	5.20	12,256
M_2	79.1	10.5	5.42	12,637
M_3	88.6	10.8	6.09	14,139
M_4	91.2	12.0	6.28	14,349
M_5	95.0	13.6	6.49	14,735
CD (P=0.05)	3.0	0.8	0.35	210
Plant growth regulators				
S_1	79.0	10.3	5.42	12,181
S_2	84.8	11.0	5.80	13,425
S_3	92.7	12.2	6.38	14,605
S_4	87.2	11.4	5.99	13,726
CD (P=0.05)	2.7	0.7	0.32	174

Details of treatments are given in text
*At harvest; ** at following

was used for the study. Entire P (50 kg/ha) fertilizer was applied basal in the form of single superphosphate. Twenty-five days old seedlings of *Sesbania rostrata* were transplanted in the spacings provided at 1.5 m intervals and incorporated 45 days after transplanting. The SSB (*Bacillus* sp.) was applied basal @ 2 kg/ha. The foliar sprays of nutrient mixture, leaf extract and growth-regulators were imposed as per the treatment schedule.

RESULTS AND DISCUSSION

Growth parameters

The nutrient and plant-growth regulators significantly influenced the growth parameters, viz. plant height, number of tillers, leaf-area index (LAI) and dry-matter production. Application of N and K in 4 splits + foliar spraying of nutrient, mixture + intercropping of *S. rostrata* with SSB recorded significantly higher values for growth characters over the recommended practice of N and K in 3 splits (Table 1). The reason that can be attributed is the enhanced nutrient uptake and thus the mobility with increased soil fertility status. Intercropped *S. rostrata* under decomposition have solubilized the soil native P and K in addition to its green biomass to the tune of 18.4 to 19.6 kg N/ha which led to the balanced nutrition and to the production of taller plants, more number of tillers, high leaf-area index and dry-matter production (Diack, 1986). Increase in plant height, leaf area, dry-matter production might be due to the increase in cell division, cell elongation and expansion caused by silica nutrition (Ashoka Rani *et al.*, 1997).

Among the plant-growth regulators, spraying of 2 ppm Triacontanol recorded significantly higher values for growth parameters, followed by 20 ppm Benzyladenine and 5% *Albizia amara* leaf extract over no spray. This is due to the action of growth regulators in accelerating photo-phosphorylation in the chloroplasts (Chen *et al.*, 1980). The Benzyladenine delayed the leaf senescence by delaying the chlorophyll loss (Daniel *et al.*, 1991).

Yield attributes and yield

Application of N and K in 4 splits + foliar spraying of nutrient mixture + intercropping of *S. rostrata* along with SSB produced significantly more number of tillers (15.1%), increased filled grains/panicle (11.8%) and test weight (6.6%) over the recommended practice of N and K in 3 splits which led to higher grain and straw yields, followed by application of N and K in 4 splits + foliar spraying of nutrient mixture + intercropping of *Sesbania rostrata.*

The positive role of adding green-manure along with 4 splits of N and K and nutrient spray is well exhibited through the increase in the grain yield by 2.8% over 4 splits + nutrient spray and as high as 17.0% over 3 splits (Table 2.) Addition of green-manure benefited the rice crop through increased N availability in soil as seen from the higher uptake by rice crop (Srividya, 1991) and efficient utilization of mineralized N from the incorporated *Sesbania rostrata* (Solaippan and Veerabadran, 1997).

The contribution of SSB towards the increase in grain yield of late winter rice was significantly substantiated. The basal addition of SSB @ 2 kg/ha along with 4 splits of N and K, foliar spraying of nutrient mixture and

Table 2. Yield attributes and yield of late winter rice as influenced by nutrient and plant-growth regulators (pooled mean)

Treatment	Panicles/ m^2	Filled grains/ panicle	Test weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)
Nutrient management					
M_1	344	75	19.8	5,193	7,045
M_2	358	78	20.3	5,435	7,201
M_3	372	79	20.7	6,080	8,059
M_4	384	83	21.0	6,256	8,088
M_5	405	85	21.2	6,461	8,279
CD (p=0.05)	16	3	0.4	114	156
Plant growth regulators					
S_1	355	77	19.9	5,419	6,162
S_2	365	79	20.3	5,799	7,626
S_3	403	83	21.3	6,328	8,274
S_4	386	82	20.9	5,979	7,736
CD (P=0.05)	17	8	0.3	121	160

addition of *S. rostrata* increased the rice grain yield by 205 kg/ha (3.2%) over no SSB application. The plausible reasons for the SSB increasing grain yield of the late winter rice was attributed to erectness of leaves with high silica content (3.4%) contributed to efficient photorespiration, carbon assimilation and promotion of new root growth (Gaussman, 1962), improvement in oxygen supply to roots by increasing the volume and rigidity of the gas channels (Ponnamperuma, 1964), better translocation of P from source to sink (Cheng *et al.*, 1973). Moreover, the yield increase after silica application is largely attributed to the advantage gained in grain-filling and grain weight (Murali Kannan, 1996).

Among the plant growth-regulators, foliar spraying of Triacontanol @ 2 ppm significantly increased the rice grain yield by 909 kg/ha (14.4%) over no spray. This was followed by Benzyladenine and *Albizia amara* leaf extract. The grain yield increase was 560 kg/ha (9.4%) in Benzyladenine and 380 kg/ha (6.6%) in *Albizia amara* spray over the control.

It can be concluded that application of N and K in 4 splits (skipping basal) + foliar spraying of nutrient mixture + intercropping of *S. rostrata* + SSB was the best nutrient-management practice for obtaining the maximum yields of late winter rice and for mitigating the effect of low temperature and light intensity prevailing during late winter season, foliar spraying of Triacontanol @ 2 ppm or 20 ppm Benzyladenine is advocated for getting the higher grain yields of rice.

REFERENCES

Ashoka Rani, Y., Narayanan, A., Saraswathi Devi, D. and Subramamma, P. 1997. The effect of

silica application on growth and yield of rice plants. *Annals of Plant Physiology* **11**: 123–128.

Chen, N.K. 1980. Effect of light and temperature on growth and fertility of rice. *Plant Physiology* **1** : 15–18.

Cheng, W.Y., Heitz, A. and Deville. 1973. The effect of silica on sugarcane growth in pure nutrient solution. *Journal of Science of Food and Agriculture* **24** : 113–115.

Daniel, O. Caldiz, Jose Bettroano, Laura, V. Fernandez, Santiago J. Sarandon and Carlos Favorett. 1991. Effect of foliar applied benzyladenine on grain yield and grain protein in wheat. *Plant Growth Regulation* **10** : 197–204.

Diack, M. 1986. *Sesbania rostrata* as green manure for rice. (In) *Proceedings of Workshop, on Biological Improvement of the Soil Fertility, the IFS- CRDI-ORTOM*, held during 15–19 March 1986 at Dakar, Senegal.

Gaussmann, W. 1962. Investigations on the effect of silica on uptake of phosphorus and other nutrients. *Phosphosaure* **22** : 223–241.

Murali Kannan, N. 1996. 'Biodissolution of silicate, phosphate and potassium by silicate solubilising bacteria in rice ecosystem.' M.Sc. (Agriculture) Thesis, Tamil Nadu Agricultural University, Coimbatore, India, (unpublished).

Ponnamperuma, F.N. 1964. On The mineral nutrition of rice plant. (In) *Symposium, International Rice Research Institute,* Johns Hopkins Press, Balimore, Maryland. pp. 295–328.

Solaippan, V. and Veerabadran, V. 1997. Effect of green manure intercropping on rice. *Madras Agriculture Journal* **84** : 369–370.

Srividya, P.G. 1991. 'Green manure intercropping and its effect on growth, yield and nitrogen economy of low land transplanted rice–rice cropping system.' M.Sc. (Agric.) Thesis, Tamil Nadu Agricultural University, Coimbatore, India (Unpublished).