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Effect of crop fortification with pulse sprout extract on crop growth and seed yield in rice var Co 48

Jayanthi M.[1,2]*, R. Umarani[1,3] and V. Vijayalakshmi[1,4]

[1]Department of Seed Science and Technology, TamilNadu Agricultural University, Coimbatore-641 003, India.
[2]Department of Seed Science and Technology, Adhiparasakthi Agricultural, Horticultural College and Research Institute, G.B. Nagar, Kalavai, Vellore, TamilNadu – 632 506, India.
[3]Department of Seed Science and Technology, Forest College and Research Institute, Tamil Nadu Agricultural University, Mettupalayam – 641 301, India.
[4]Department of Seed Science and Technology, Agricultural College and Research Institute, Madurai – 625 104, India.

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Rice is the staple food for over half of the Indian population, hence great emphasis has to be laid on ways and means to fortify seeds organically for better seed vigour. Seed fortification is one of the important seed invigoration treatment. Germinated grains are good sources of ascorbic acid, riboflavin, choline, thiamine, tocopherols and pantothenic acid which increases the nutritional quality. Extract has been prepared from the sprouted pulses. Foliar spray is a very easy way to supply valuable nutrients to plants. With this background, an experiment was conducted in 2008 to study the effect of crop fortification with pulse sprout extract on crop growth and seed yield in rice seeds. Field experiment was conducted with the treatments which include foliar spray of rice crop with 3, 5 and 7% of horse gram sprout extract and 7, 9 and 11%, respectively of cowpea sprout extract and crop without foliar spray served as control. The observations made on crop growth and yield factors such as plant height (cm) at maturity stage, Dry matter production (g plant^{-1}), No. of tillers plant^{-1}, No. of productive tillers plant^{-1}, Chlorophyll content, Panicle length (cm), No. of seeds panicle^{-1}, 1000 Seed weight (g) and seed yield. Among these treatments foliar spray with 3% horse gram sprout extract recorded the highest yield of 4324 kg/ha whereas control recorded seed yield of 3603 kg/ha.

Key words: Rice crop, pulse sprout extract, foliar spray, Horse gram and cowpea.

INTRODUCTION

Rice is the major staple food for more than two billion people in Asia and one-third of the calorific intake of nearly one billion people of Africa and Latin America. The uninterrupted and disproportionate use of chemical fertilizers over a longer period of time has resulted in deterioration of soil health and reduced yield. To maintain long–term food production there is a need for sustainable agricultural practices. This is one of the aims of organic farming and consumers are prepared to pay higher prices for certified organic products. In many developing countries agriculture is still largely based on low inputs, because farmers cannot afford the high costs of chemical fertilizers and pesticides. For such farmers, organic farming can provide a better economic alternative because the advantages are twofold; i) the inputs are of lesser cost and ii) the produces fetch higher price. Sprouting has often been proposed as a useful and easy process for improving nutritional quality of legume seeds (Vidal-Valverde et al., 2002). Hence it was hypothesized that application of the nutrient extract from the sprouted

*Corresponding author. E-mail: mjayanthi8@gmail.com.

Table 1. Effect of foliar spray with pulse sprout extract on growth attributes of rice variety CO 48.

Treatment and concentration	Plant height (cm)	Dry matter production (g plant^{-1})	No. of tillers plant^{-1}	No. of productive tillers plant^{-1}	Chlorophyll content
Control	95.5	34.0	18.9	17.6	27.8
Horse gram 3%	108.1	66.3	21.6	20.4	34.7
Horse gram 5%	106.6	62.5	20.9	20.1	33.1
Horse gram 7%	105.9	60.0	19.4	18.3	33.1
Cowpea 7%	105.5	58.9	19.2	18.3	32.6
Cowpea 9%	105.4	54.1	19.2	18.1	32.0
Cowpea 11%	102.93	37.4	19.2	18.0	29.46
Mean	104.27	19.77	19.77	18.6	32.5
		Critical difference, CD (0.05)			
T	0.40	1.13	0.43	0.40	0.68
C	0.40	1.13	0.43	0.40	0.68
TXC	0.70	NS	0.74	0.70	1.18

pulses in the form of crop fortification will enable better crop growth and productivity of rice. Horse gram and cowpea are the low cost and easily available pulses in Tamil Nadu. Plant feeding with foliar spray has become more and more accepted as an improved method of feeding plants. Nutrient uptake via the foliage may be much faster as compared to soil nutrition (Kannan, 2010). The application of foliar fertilizer is the quickest way to deliver the nutrients to the tissues and organs of the crop (Saira et al., 2011). With these ideas, an attempt was made to explore the effect of seed fortification with pulse sprout extract on crop growth, seed yield and quality in rice seeds.

MATERIALS AND METHODS

The study was conducted in rice variety CO 48. Seeds of rice obtained from Paddy Breeding Station, Tamil Nadu Agricultural University, Coimbatore was used for the study. The seeds were cleaned before conducting the studies. Two field trials was conducted at Wet lands, Tamil Nadu Agricultural University, Coimbatore; First trial during September 2007 to January 2008 and confirmation trial raised during January 2008 to April 2008 by adopting Factorial Randomized Block Design with three replications and a plot size of 2 × 8 m with the spacing of 20 × 15 cm adopting 530 plants/plot. Horse gram and cowpea pulse sprout extract were used for crop fortification. Horse gram and cowpea seeds were soaked overnight and incubated in a wet cloth for 12 h to enable sprouting. 100 g of sprouts were ground in a mixer-grinder using ice cubes from 100 ml of water. The ground substance was squeezed through cloth bag and 100 ml extract of 100% concentration was obtained. The three concentrations *viz*; 3, 4, 5% horse gram sprout extract and 7, 9, 11% cowpea sprout extract were explored as foliar spray to field trials for evaluating their effect on crop growth and productivity of direct wet seeded rice var Co 48. Foliar spray was applied at two stages viz; vegetative (50 Days After Transplanting) and flowering stage (75 Days After Transplanting). The following observations were made on crop growth and yield factors such as plant height (cm) at maturity stage, Dry matter production (g plant^{-1}), No. of tillers plant^{-1}, No. of productive tillers plant^{-1}, Chlorophyll content, Panicle length (cm), No. of seeds panicle^{-1}, 1000 Seed weight(g) and seed yield. For confirmation another trial was taken with two best concentrations of horse gram and cowpea extracts along with the control. The data obtained from experiments were analyzed by the 'F' test for significance following the method of Factorial Randomized Block Design as described by Panse and Sukhatme (1985). Wherever necessary, the percent values were transformed to angular (Arc-sine) values before analysis. The critical differences (CD) were calculated at 5% probability level. The data were tested for statistical significance.

RESULTS AND DISCUSSION

The results of Tables 1 and 2, which are the observations taken in first field trial raised during September 2007 to January 2008 are discussed. Significant differences were found due to foliar application of pulse sprout extract. The nutrient solutions are more effective when applied as foliar spray rather than through soil, where complex chemical reactions are often a great interference. It has been observed that the foliar sprays of zinc, iron, copper and molybdenum are often more effective than soil application, because these elements are not highly soluble in the soil (Sarma et al., 2005). The advantages of foliar fertilizers were more noticeable under growing conditions restricting the incorporation of nutrients from the soil, as reported by Verma et al. (2000). Hence it was decided to take up foliar spray with horse gram and cowpea sprout extract in two stages viz; vegetative stage (50 Days After Transplanting) and flowering stage (75 Days After Transplanting) at three levels of concentrations. The horse gram sprout extract was sprayed at 3, 5 and 7% levels while cowpea was sprayed at 7, 9 and 11% concentrations. The concentrations were fixed based on the results of seed fortification experiment obtained from the lab experiment wherein the horse gram

Table 2. Effect of foliar spray with pulse sprout extract on yield attributes of rice variety CO 48.

Treatment and concentration	Panicle length (cm)	No. of seeds panicle^{-1}	1000 Seed weight (g)	Seed yield (g plant^{-1})	Seed yield (g m^{-2})	Seed yield (kg ha^{-1})
Control T_0	23	159.0	16.3	11.1	363	3603
Horse gram 3%	24.6	206.2	17.3	12.8	436	4324
Horse gram 5%	24.6	203.7	17.3	12.3	420	4180
Horse gram 7%	23.5	202.2	17.3	11.8	407	4035
Cowpea 7%	24.3	196.3	17.0	11.6	402	4026
Cowpea 9%	24.4	172.8	16.9	11.5	396	3963
Cowpea 11%	23.2	167.6	16.8	11.3	390	3903
Mean	24.0	186.8	16.9	11.6	351	3915
Critical difference, CD (0.05)						
T	0.52	4.00	0.55	0.14	5.28	47.28
C	0.52	4.00	NS	0.14	5.28	47.28
TXC	NS	6.93	NS	0.245	9.15	81.9

was more effective in lower concentrations compared to cowpea sprout extract.

Observations were made on plant height (vegetative and maturity stages), number of tillers /plant^{-1} (vegetative and maturity stages), dry matter production (g plant^{-1}), number of productive tillers plant^{-1} (vegetative and maturity stages), chlorophyll content (vegetative and maturity stages), panicle length (cm), number of seeds panicle^{-1}, 100 seed weight (g), seed yield (g plant^{-1}) and seed yield (g m^{-2}) besides seed yield (kg plot^{-1}) from which the seed yield (kg ha^{-1}) was computed. The results obtained are discussed here in. The plant height (cm) recorded at maturity stages revealed that plant was increased from 95.5 cm (control) to 108.1 cm by spraying horse gram 3% extract; however spraying of cowpea 11% extract recorded only 102.9 cm which was the lowest among the crop fortification sprays. Similarly, the dry matter production (g seedlings-^{1}) also recorded only 34 g which nearly doubled when sprayed with horse gram 3% extract (66.3 g) however all other sprays resulted in better values compared with the control. The total dry matter accumulated at different growth stages invariably determine the yield potential of crops as it supplies the required metabolites to the filling sink and hence the size and strength of sink which forms the economic yield together determine the harvest index of the crop (Velu, 2002).

At maturity stage, the number of tillers plant^{-1} as well as number of productive tillers plant^{-1} was 14 and 16% higher in horse gram 3% extract. The chlorophyll content was also found to be enhanced due to foliar spray as revealed by 25% increase with horse gram 3% extract over control. The improvement was also found in panicle length (24.6 cm), number of seeds panicle^{-1} (206.2), 1000 seed weight (17.3 g) over control which obviously resulted in higher seed yield as recorded plant^{-1} (12.8 g), m^{-2} (436 g), plot^{-1} (6.98 kg) and ha^{-1} (4324 kg). The percentage increase in seed yield ha^{-1} recorded by spraying horse gram 3% extract was 20 over control. Velu (2002) reported that lack of photosynthetic activity at the time of seed filling, limiting sink capacity and improper translocation leads to poor seed filling and ultimately resulted in more hollow seeds and deplete the production considerably. The lower chlorophyll content was recorded in control hence, could have resulted in lower seed yield.

In order to confirm the effect of crop fortification with pulse sprout extract, the foliar spray of horse gram 3 and 5%, and cowpea 9 and 11% were practiced at two concentration levels which were found to be superior in the previous field experiment. Between the two pulse sprouts, horse gram was found to be superior to cowpea. Horse gram pulse sprout extract was superior at both levels viz; 3 and 5% compared to cowpea (9 and 11%). The control seeds recorded the values 79.34, 23.72, 22.76, 18.29, 101.15 and 3.75 for plant height (cm), number of tillers (plant^{-1}), number of productive tillers (plant^{-1}), panicle length (cm), number of seeds (panicle^{-1}) and seed yield (kg m^{-2}) respectively (Table 3). The percentage increase recorded over control by horse gram 3% extract was 6, 21, 17, 12, 39 and 22, respectively. This improvement in seed yield (kg ha-^{1}) rose to the tune of 22% over control for the variety CO 48.

Pulse sprouts are a rich source of enzymes viz; α-amylase activity, phytase and other digestive enzymes and protein water soluble vitamins such as Thiamin, Niacin, Vitamin A, B complex and vitamin C, minerals and soluble sugars (Uriyo, 2000; Vidal Valverde et al*.,* 2002; Oloyo, 2003). Shinde and Bhilare (2003) have reported even small quantites of nutrients applied through foliage 2-3 times at different growth stages of crops would meet out the nutrient requirements of the crops and thus productivity could be enhanced with low input cost. He

Table 3. Effect of foliar spray with pulse sprouts extract on growth and yield attributes of rice variety CO 48.

Treatment and concentration	Plant height (cm)	No. of tillers plant^{-1}	No. of productive tillers plant^{-1}	Panicle length (cm)	No. of seeds panicle^{-1}	Seed yield (g m^{-2})	Seed yield (kg ha^{-1})	1000 seed weight (g)
Control T_0	79.34	23.72	22.76	18.29	101.15	375	3753	17.5
Horse gram 3%	83.78	28.64	26.66	20.43	140.84	458	4578	19.5
Horse gram 5 %	83.56	25.18	24.46	19.35	130.05	428	4281	19.4
Cowpea 9 %	80.82	21.84	18.44	19.17	129.84	412	4118	18.8
Cowpea 11 %	79.14	17.34	15.86	18.57	121.56	394	3938	17.3
Mean	81.32	23.34	21.63	19.16	124.69	400.5	4005.5	18.33
Critical difference, CD (0.05)								
T	2.08	0.60	0.56	0.48	3.14	9.86	98.70	0.557
C	NS	0.49	0.46	0.39	2.56	9.86	98.70	NS
TXC	NS	0.85	0.79	NS	4.44	13.95	139.58	NS

also pointed out that foliar application of fertilizers is becoming more prevalent as practice in agricultural crop production, because it is more purposefully, and potentially more friendly to the environment in contrast to soil fertilization (Kuepper, 2003). Improvement in accumulation of biomass on seed due to other selected chemicals may be attributed due to increased source activity by delaying the senescence during grain filling period. Jaskulski (2007) shows the positive economic effect of foliar fertilization in growing vegetables, having a direct impact on increasing yield.

Spraying with $ZnSO_4$ registered maximum hundred seed weight of 2.048 g as compared to 2.010 g in control. Similar effect of Zinc on seed weight was reported by Balakrishnan and Natarajarathinam (1996) in rice. Improvement in seed weight might be due to better translocation and accumulation of food reserves on the seeds. Foliar application of Phosphorous through Di Ammonium Phosphate at critical stages of crop growth is effectively absorbed by the crop and translocated more efficiently to the developing pods for proper filling of grains which is very well reflected in the higher values obtained for different yield attributes (Elizabeth et al., 1998). Foliar application of P with growth regulators increased the NPK uptake, yield attributes and yield in green gram (Kalita et al., 1989). Dinesh (2005) reported that foliar spray of a chelated solution of micronutrients and gibberellic acid @ 2.5 l/ha and gibberellic acid @ 50 ppm both proved effective in improving seed yield of Berseem. Foliar application of mineral nutrients increases the seed yield of various forage crops (Hazra and Sinha, 1996).

Conclusion

The field experiments on crop fortification through foliar spraying at vegetative and flowering stage has proved that pulse sprout extracts irrespective of concentrations could improve the seed yield. However maximum improvement in seed yield and quality can be realized by spraying horse gram 3% extract. The yield enhancement may be due to the presence of bioactive substances in sprouted horse gram and cowpea extracts were found effective towards yield maximization in rice seeds.

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