Asian Journal of Crop Science

ISSN 1994-7879

science alert
http://www.scialert.net

ANSInet
an open access publisher
http://ansinet.com

Asian Journal of Crop Science 5 (4): 444-451, 2013
ISSN 1994-7879 / DOI: 10.3923/ajcs.2013.444.451

Effect of Seed Fortification with Pulse Sprout Extract on Crop Growth and Seed Yield in Rice Seeds

M. Jayanthi, R. Umarani and V. Vijayalakshmi
Department of Seed Science and Technology, TamilNadu Agricultural University, Coimbatore-641 003, India

Corresponding Author: M. Jayanthi, Department of Seed Science and Technology, TamilNadu Agricultural University, Coimbatore-641 003, India

ABSTRACT

Rice is the staple food for over half of the Indian population, main 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 invigouration treatment. Germinated grains are good sources of ascorbic acid, riboflavin, choline, thiamine, tocopherols and pantothenic acid which increases the nutritional quality. Extract has prepared from the sprouted pulses. With these background, an experiment was conducted during 2008 to study the effect of seed fortification with pulse sprout extract on crop growth and seed yield in rice seeds. Field experiment was conducted with the treatments include fortification of rice seeds with 2 and 3% of horse gram sprout extract and 4 and 5% of cowpea sprout extract and dried back to original moisture content and untreated seeds served as control. The observations made on crop growth and yield factors such as field emergence (%), plant height (cm) at vegetative and maturity stages, 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 2% horse gram sprout extract recorded the highest yield of 3951 kg ha^{-1}. 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.

Key words: Rice seeds, pulse sprout extract, 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 two fold (1) the inputs are of lesser cost and (2) the produces fetch higher price. Sprouting has often been proposed as a useful and easy process for improving nutritional quality of legume seeds. Hence, it was hypothesized that application of the nutrient extract from the sprouted pulses in the form of seed 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. Seed fortification treatment mainly supplies nutrient to the seed to germinate into vigorous seedlings. 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

Materials: The study was conducted in rice variety CO 43. 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. Field trial was conducted at Wet lands, Tamil Nadu Agricultural University, Coimbatore during 2008. Horse gram and cowpea pulse sprout extract used for seed fortification.

Methods: Horse gram and cowpea seeds were soaked overnight and incubated in a wet cloth for 12 h to enable sprouting. A 100 g of sprouts were ground in a mixer-grinder by using ice cubes from 100 mL of water to prepare extracts of 100% concentration. The rice seeds var Co 43 were soaked in varied concentrations of both horse gram and cowpea sprout extracts for 12 h. Later, the seeds were dried back to original moisture content under shade. Untreated seeds were maintained as control. Field trial was conducted during January, `08 with three replications and a plot size of 2×8 m. The fortified rice var Co43 seeds were directed seed under wetland conditions. The field emergence was recorded and required thinning was done to maintain the spacing of 20×15 cm. The following observations were made on crop growth and yield factors such as field emergence (%), plant height (cm) at vegetative and maturity stages, 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.

Statistical analysis: The data obtained from experiments were analyzed by the 'F' test for significance following the method 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

According to Table 1 among the fortification treatments evaluated, control recorded the lowest field emergence (61.0%). Among the treatments, horse gram 2% recorded the highest emergence (80.7) which was followed by 3% (78.7) and it was on par with cowpea 4% (78.7%). No significant difference was observed for the field emergence in the interaction between the treatment×concentration. Significant differences were found in plant height due to seed fortification treatments. Among the different treatments, the plant height was maximum recorded in horse gram 2% in both vegetative (83.1 cm) and maturity stages (101.1 cm), it was followed by cowpea 4% (82.0 cm) and horse gram 3% (80.2 cm) at vegetative stage. At maturity stage, the maximum of 100 cm was recorded by horse gram 3% and cowpea 4%. The minimum plant height was recorded by control and at both vegetative (77.6 cm) and maturity stages (91.7 cm), respectively. The statistical analysis revealed that significant differences were found in dry matter production due to seed fortification treatments. Control recorded the minimum dry matter production of 9.05 g at vegetative and 27.1 g at maturity stages, respectively. Among the different treatments, the maximum dry matter production was recorded by horse gram 2% extract in both

Table 1: Effect of seed fortification with pulse sprouts extract on growth attributes of rice variety Co 43

		Plant height (cm)			Dry matter production (g plant^{-1})		
		Stage			Stage		
Treatment and coucentration	Field emergence (%)	Vegetative	Maturity	Mean	Vegetative	Maturity	Mean
Control	61.0 (51.35)	77.6	91.7	84.6	9.05	27.100	18.0
Horse gram							
2%	80.7 (64.15)	83.1	101.8	92.4	12.8	38.400	25.6
3%	78.7 (62.72)	80.2	100.0	90.1	10.6	32.000	21.3
Cowpea							
4%	78.7 (62.72)	82.0	100.0	91.0	10.0	32.600	21.3
5%	75.7 (60.66)	79.4	98.4	88.9	10.6	32.300	20.4
Mean	74.9 (61.12)	80.5	98.4		10.6	32.500	
C.D.(0.05)							
T	1.89	20.05	2.16		0.270	0.736	
C	1.54	1.68	1.77		0.220	0.601	
T×C	NS	NS	NS		0.382	10.042	

Figures in Parenthesis are arcsine values

Table 2: Effect of seed fortification with pulse sprout extracts on productive attributes of rice variety Co 43

	No. of tillers plant^{-1}			No. of productive tillers plant^{-1}			Chlorophyll content		
	Stage			Stage			Stage		
Treatment and coucentration	Vegetative	Maturity	Mean	Vegetative	Maturity	Mean	Vegetative	Maturity	Mean
Control	16.20	17.50	16.8	11.1	15.40	13.2	25.8	35.800	30.8
Horse gram									
2%	19.20	20.90	20.0	12.4	19.70	16.0	28.0	39.200	33.6
3%	17.90	19.80	18.8	12.0	18.00	15.0	27.4	36.600	32.0
Cowpea									
4%	18.60	20.80	19.7	12.1	18.60	15.3	27.8	38.600	33.2
5%	17.90	19.70	18.8	12.0	17.20	14.6	27.4	36.600	32.0
Mean	17.96	19.74		11.92	17.78		27.28	37.360	
C.D.(0.05)									
T	0.45	0.50		0.303	0.45		0.69	0.955	
C	0.37	0.40		NS	0.36		NS	0.780	
T×C	0.64	0.70		NS	0.63		NS	1.350	

vegetative (12.8 g) and maturity stages (38.4 g) followed by horse gram 3% extracts 10.6 g at vegetative stage. In maturity stage, it was followed by 4% cowpea extract as 32.6 g. The datas of accoding to Table 2 No. of tillers per plant significantly differed due to fortification treatments. Control recorded the minimum number of tillers per plant at both vegetative (16.2) as well as maturity stages (17.5). Among the different treatments, the maximum number of tillers registered by horse gram 2% extract at both vegetative (19.2) and maturity stages (20.9)and it was followed by cowpea extract 4% at vegetative (18.6) and at maturity (20.8) stages. Significant difference was observed in number of productive tillers dueto fortification treatments. Control recorded the minimum number of productive tillers plant at both vegetative as well as maturity

Table 3: Effect of seed fortification with pulse sprout extracts on yield attributes of rice variety Co 43

Treatment and concentration	Panicle length (cm)	No. of seeds panicle^{-1}	1000 seed weight (g)	Seed yield			
				g plant^{-1}	g m^{-2}	kg plot^{-1}	kg ha^{-1}
Control T_0	20.5	87.30	16.700	10.4	342.0	5.48	3426.00
Horse gram							
2%	22.4	163.20	19.600	12.2	395.0	6.32	3951.00
3%	21.8	125.20	18.600	11.6	377.0	6.03	3770.00
Cowpea							
4%	22.3	162.70	19.500	22.3	162.7	19.50	22.30
5%	21.6	123.40	18.100	21.6	123.4	18.10	21.60
Mean	22.0	143.60	19.000	22.0	143.6	19.00	22.00
C.D.(0.05)							
T	0.55	3.35	0.047	0.50	15.03	0.24	150.30
C	NS	2.74	0.038	0.40	12.27	0.19	122.72
T×C	NS	4.75	0.066	0.70	21.25	0.33	21.2.56

stages as 11.1 and 15.4, respectively. Among the different treatments, the maximum number of productive tillers registered by horse gram 2% extract at both vegetative (12.4) and maturity stages (19.7) and it was followed by cowpea extract 4% which recorded 12.1 at vegetative and 18.6 at maturity stages. Total chlorophyll content was significantly influenced by seed fortification treatment. Among the treatments, horse gram 2% recorded the highest total chlorophyll content of 39.2 and 28.0 at vegetative and maturity stage, respectively. The lowest chlorophyll content was recorded by control (35.8) and (25.8) at both vegetative and maturity stages, respectively. Among the concentration no significant difference was observed between the concentrations and the interaction of treatment×concentration for chlorophyll content. The seed fortification treatments varied significantly from each other. According to Table 3 among the treatments, horse gram 2% recorded the maximum panicle length (22.4 cm) which was on par with cowpea 4% (22.3 cm). They were followed by horse gram 3% (21.8 cm) and cowpea 4% (21.6 cm). The minimum panicle length was observed in control recorded (20.5 cm). Significant variations were observed in number of seeds per panicle due to the seed fortification treatment. Among the treatments horse gram 2% recorded the maximum number of seeds 163.2, it was on par with cowpea 4% (162.7) followed by horse gram 3% (125.2) and cowpea 5% (123.4). They were on par with each other. The minimum number of seeds panicle^{-1} was observed in control recorded (87.3). Significant differences were observed among the treatments. The highest value was recorded by horse gram 2% (19.6 g) which was on par with cowpea 4% (19.5 g), it was followed by horse gram 3% (18.6 g). The minimum value recorded by control (16.7 g). A significant variation in single plant yield was observed due to seed fortification treatment. Among the treatments, horse gram 2% recorded the maximum seed yield (12.2 g), followed by cowpea 4% (11.3 g). The lowest seed yield recorded by control (10.4 g). Significant results were obtained for seed yield sq.m^{-1}. Among the treatments, horse gram 2% recorded the highest seed yield (395 g), followed by cowpea 4% (370 g). The lowest seed yield recorded by control (342 g). Significant difference was found in seed yield plot^{-1}. Among the treatments, horse gram 2% recorded the maximum seed yield (6.32 kg). The minimum seed yield recorded by control (5.48 kg). Highly significant variation was observed in seed yield ha^{-1}. Among the treatments, horse gram 2% recorded the highest seed yield (3951 kg) while the lowest seed yield recorded by control (3426 kg).

DISCUSSION

The results revealed that irrespective of the pulse sprout all the treatments recorded better performance compared to control. The control seed recorded the lowest field emergence of 61 while horse gram 2, 3% and cowpea 4 and 5% pulse sprout extract 81, 79, 76 and 79, respectively. This may be due to nutritional quality increased in pulse sprouts which is used for seed fortification. Augustin and Klein (1989) reported that the content of phosphorous, potassium, zinc and copper increased significantly as result of germination in various legumes. Similar results was reported by Martin-Cabrejas *et al.* (2007) the remarkable increase in sodium content which increases the nutritional qualities of the sprouted legumes.

Seed fortification with micronutrients viz., manganese sulphate, ferrous sulphate, zinc sulphate, ammonium chloride, ammonium molybdate, potassium chloride, potassium dihydrogen phosphate, magnesium sulphate, borax and ammonium sulphate in three concentrations viz., 0.5, 0.75 and 1.0% were proved to be better than control in terms of speed of germination, germination percent, root length (cm), shoot length (cm), dry matter production (g seedlings^{-10}) as well as vigour index (Marimuthu, 2007). Grzywnowicz-Gazda (1982) reported that soaking of spring barley seeds in B, Mn, Mo, Zn, Fe, Mg either individually or in mixture for 24 h increased the trace element concentration in the grain. The seed treatment was also found to increase the germination capacity, growth and dry matter production of barley seedlings when compared with untreated control. Nitrogen containing compound might have stimulated the germination by increasing the seed cytokinin content, occurring naturally in seeds which interacted with growth inhibitors and enhance the metabolic process, leading to higher germination (Khan, 1980). FaShui *et al.* (1996) noticed the increased germination rate, seed vigour, seedling fresh weight, seedling height and root length when maize seeds were soaked in solution of 0.3% $CaCl_2$, 0.1 per cent $ZnSO_4$ either individually or in combination.

Seed fortification with molybdenum as a Sodium molybdate, Zinc sulphate and Manganese sulphate @ 0.1, 0.2 and 0.2%, respectively, recorded maximum seed physiological quality attributes in laboratory (Natesan, 2006). The sulphur in zinc sulphate given as fortification was found to increase the level of vitamins, biotins and thiamins and its coenzymes (Srimathi and Malarkodi, 2000). The overall performance of the treatments underscore that manganese sulphate (1.0%), ferrous sulphate (0.75%) and ammonium molybdate (0.75%) can well serve as seed fortification agent to increase the seed vigour of rice seeds.

During seed fortification, the first phase of germination ends with completion of imbibition process and hence, the time taken from sowing to emergence is much reduced reported by Hegarty (1970). Fortification of seed increased the field germination of corn by promoting embryo growth (Zubenko, 1959). The improvement in field emergence due to fortification could also be ascribed to activation of cells which results in the enhancement of mitochondrial activity leading to the formation of more high energy compounds and vital biomolecules which were made available during the early phase of germination observed by Dharmalingam *et al.* (1988). These initial changes culminate in enlargement of the latent embryo. The probable reason for higher germination in fortified treatment could be due to greater hydration of colloids, higher viscosity and elasticity of protoplasm, increase in bound water content, lower water deficit, more efficient root system (May *et al.*, 1962) and increased metabolic activity (Joseph and Nair, 1989). It might also be due to enhanced metabolic activity resulted in early germination as stated by Joseph and Nair (1991). Studies. Thus it is obvious that, the presence of bioacitve substances in sprouted horse gram and cowpea extracts viz., amino acid, vitamins and minerals could have resulted in fortification of rice seeds as corroborated by earlier reports.

The seed fortification treatments influenced the plant height both at vegetative and maturity stages. The maximum plant height was recorded by horse gram 2% which recorded 83.1 and 101.8 cm in vegetative and maturity stages which was followed by 5% cowpea extract which recorded 82 and 100 cm, respectively. Similarly the number of tillers and productive tillers recorded at both the vegetative and maturity stages ascertained that seed treatment with both horse gram and cowpea had augmenter effects on the growth and productivity of rice plants. The increment recorded was maximum with horse gram 2% extract which recorded 12 and 28% over control at vegetative and maturity stages, respectively.

The chlorophyll content of the plants grown out of fortified seeds were estimated both at vegetative and maturity stages. The seed fortification with 2% horse gram extract was found to boost the chlorophyll content of the plants to the highest level at both vegetative and maturity stages. The increase recorded over control was 9 and 8% over control, respectively. It was closely followed by cowpea 5% extract which could improve the chlorophyll content up to 8% over control in both stages.

The effect of the seed fortification treatments with pulse sprout extracts were found to be profound on the yield attributing factors viz., panicle length (cm), number of seeds per panicle and 1000 seed weight. The control plants could record the lowest values for panicle length (20.5 cm), number of seeds per panicle (87.3) as well as 1000 seed weight. (16.7 g). from these values, the seed fortification with horse gram 3% extract could improve the values to 22.4 cm, 163.2 and 19.6 g, it was followed by 5% cowpea extract which recorded 22.3, 162.7 and 19.5 g which were at par with each other.

The improvement with yield attributing factors that were enabled by seed fortification with pulse sprout extract obviously resulted in higher seed yield. The seed yield were analysed at single plant and per square meter and computed to per plot and per hectare. The control seeds recorded the lowest levels of 10.4, 342 g, 5.48 and 3426 kg at plant $^{-1}$, square meter^{-1}, plot^{-1} and hactare^{-1}. The horse gram 2% extract recorded 12.2, 395, 6.32 and 395, respectively. The improvement was upto 17, 16, 15 and 15% over control, respectively. Similarly, cowpea 5% extract could record 9, 8, 8 and 8% over control.

The seed vigour extended due to fortification of rice seeds with pulse sprout extracts had resulted in better plant growth as reflected in plant height, increased chlorophyll content and higher number of productive tillers. Besides the growth factors the yield attributing factors viz., panicle length (cm), number of seeds per panicle and 1000 seed weight were also found to improved. This could have been due to higher photosynthetic rate enable by the high chlorophyll content recorded in the plants raised from the pulse sprout extract fortified seed. The seed yield increase in finger millet was attributed to maintenance of high leaf area index and chlorophyll stability index and less proline content by Kalarani *et al.* (2001). Seed yield increase in rice was supported by the favorable high value for the physiological parameters like germination, field emergence, vigour index, total dry matter production, chlorophyll stability index and proline content at different stages of crop growth (Thandapani and Subarayalu, 1986). This might be due to the combined effect of fortification and coating which might have enhanced the nutrient uptake and thereby increased the dry matter production. The increase in dry matter production due to the above said treatment in the present study is in accordance with the report of Periyathambi and Palaniyappan (1981) and Selvaraju (1992) in sorghum and Rangasamy *et al.* (1993) in agricultural crops.

CONCLUSION

The field experiment was laid with rice seeds fortified with cloth bag squeezed extract of horse gram @ 2 and 3% and cowpea 4 and 5% where dry seeds served as control. The maximum plant height was recorded by horse gram 2% which recorded 83.1 and 101.8 cm in vegetative and maturity stages which was followed by 5% cowpea extract which recorded 82 and 100 cm, respectively. Similarly the number of tillers and productive tillers recorded at both the vegetative and maturity stages ascertained that seed treatment with both horse gram and cowpea had augmenter effects on the growth and productivity of rice plants. The seed fortification with 2% horse gram extract was found to boost the chlorophyll content of the plants to the highest level at both vegetative and maturity stages. The control seeds recorded the lowest seed yield levels of 10.4, 342 g and 3426 kg at plant $^{-1}$, square meter^{-1}and hactare^{-1}, respectively while the horse gram 2% extract recorded 12.2, 395, 6.32 and 395, respectively.

REFERENCES

Augustin, J. and B. Klein, 1989. Nutrient composition of raw, cooked, canned and sprouted legumes. Legumes. Chem. Technol. Human Nut., 3: 187-217.

Dharmalingam, C., K. Paramasivam and V. Sivasubramanian, 1988. Seed hardening to overcome adversity. The Hindu, November 16(Wed.).

FaShui, H., M. ChengCang, W. XuMing and J. GuangMing, 1996. Effect of ca^{2+} and zn^{2+} on seed vigour and some enzyme activities during seed germination of maize. Plant Physiol. comm., 32: 110-112.

Grzywnowicz-Gazda, Z., 1982. The response of spring barley to seed treatment with trace elements and magnesium. Acta Agraria et Silvestria Agraria, 21: 65-78.

Hegarty, T.W., 1970. The possibilities of increasing field establishment by seed hardening. Hort. Res., 10: 59-64.

Joseph, J.K. and N.R. Nair, 1989. Effect of seed hardening on germination and seedling vigour in paddy. Seed Res., 17: 188-190.

Joseph, K. and N.R. Nair, 1991. Studies on the effect of soil moisture content and seed soaking on the germination of legumes. Legume Res., 14: 153-154.

Kalarani, M.K., R. Sivakumar, M. Vanangamudi and K.B. Sujatha, 2001. Effect of seed soaking treatments in late sown finger millet under rainfed condition. Madras Agric. J., 88: 509-511.

Khan, A.A., 1980. The physiology and biochemistry of seed dormancy and germination. In: In: The Physiology and Biochemistry of Seed Dormancy and Germination, Khan, A.A., (ed), North Holland Publishing Company, Amsterdam, New York, Pages: 127.

Marimuthu. A., 2007. Comprehensive seed enhancement technique for direct sown rice (*Oryza sativa*.L.) cv CO 43. M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore.

Martin-Cabrejas, M.A., M.F. Diaz, Y. Aguilera, V. Benitez and E. Molla, 2007. Influence of germination on the soluble carbohydrates and dietary fibre fractions in non-conventional legumes. Food. Chem., 107: 1045-1052.

May, L.H., E.J. Milthorpe and F.L. Mithorpe, 1962. Pre-sowing hardening of plants to drought. An appraisal of the contributions by P.A. Genkel. Field Crop Abstr., 15: 93-98.

Natesan, P., 2006. Designing integrated seed treatment in blackgram (*Vigna mungo* (L).Hepper) for irrigated and rainfed ecosystem. Ph.D. Thesis, Tamil Nadu Agricultural University, Coimbatore.

Panse, V.G. and P.V. Sukatme, 1985. In: Statistical Methods for Agricultural Workers. ICAR Publication, New Delhi, India pp: 327-340.

Periyathambi, C. and S.P. Palaniyappan, 1981. Effect of premonsoon sowing, depth of seed placement and seed hardening on total drymatter production, growth and yield components of rainfed sorghum. Madras Agric. J., 68: 100-104.

Rangasamy, A., S. Purusothaman and P. Devasenapathy, 1993. Seed hardening in relation to seedling quality characters of crop. Madras Agric. J., 80: 535-537.

Selvaraju, K., 1992. Studies on certain aspects of seed management practices for seed production under moisture stress condition in sorghum cv. CO 26 (*Sorghum bicolor* (L.) Moench). M.Sc. Thesis, Tamil Nadu Agricultural University, Coimbatore, India.

Srimathi, P. and K. Malarkodi, 2000. Influence of nutrient pelleting on seed yield of soybean cv. CO 1. Indian Agric., 44: 79-82.

Thandapani, V. and M. Subarayalu, 1986. Effect of presowing seed treatment with chemicals and growth regulators for drought tolerance and yield of cotton (*Gossypium hirsutum* L.). under rainfed condition. Madras Agric. J., 73: 668-675.

Zubenko, V.K.H., 1959. The effect of preplanting hardening of seeds against drought on the productivity of corn in late plantings. Plant Physiol., 6: 341-343.