Effect of Brown Manuring and Different Levels of Nutrients on Growth and Yield Attributes of Aerobic Rice (*Oryza sativa* L.)

Abstract

A field experiment was conducted during *kharif* season of 2019 to assess the Effect of brown manuring and different levels of nutrients on growth and yield attributes of aerobic rice (*Oryza sativa* L.) at Crop Research Centre, Dr Rajendra Prasad Central Agricultural University, Pusa, Bihar. This experiment was conducted in randomized block design (factorial) with sixteen treatment combinations replicated thrice using the rice variety "Abhishek" as a test crop. The experimental results indicated that higher values of growth parameters viz. Plant height (109cm), tillers/m^2 (355), dry matter production **(**969g/m^2**)** and crop growth rate (12.2g/m^2/day**)** were observed in rice + brown manuring treatment (B_2) as compared to rice without brown manuring (B_1) at harvest. While among the nutrient levels, treatment F_8- 70 kg/ha phosphorous and 50 kg/ha potassium as split recorded significantly higher growth parameters (tillers/m^2, dry matter production and crop growth rate), yield attributes (panicles/m^2, grains/panicle), grain yield, while remaining at par with treatment F_4 -60 kg/ha phosphorous and 50 kg/ha potassium as split. Plant height, panicle length and test weight remained unaffected by any of these treatments. However, the interaction effect of both the factors did not significantly influence any of the parameters.

Keywords

Brown manuring, aerobic rice, knockdown.

1. Introduction

Ever since the beginning of agriculture, Cereals have been the premium source of diet for the man kind as they are rich in carbohydrates. A major cereal crop, Rice (*Oryza sativa* L.) is known to be a highly dominant grain crop worldwide. 21 % of human per capita energy along with 15 % protein per capita has been supplied by rice universally, being a constituent of major proportion of daily diet in many South-East Asian countries (irri.org). 60 per cent of population of earth lives in Asia, which contributes to 92 per cent of rice production in the world with an overall rice consumption of 90%. Countries like India, China, Bangladesh, Indonesia, Thailand

and Vietnam collaboratively account to maximum production which is three quarters more compared to world rice production according to IRRI ("International Rice Research Institute"). In conventional puddled transplanted system, huge quantity of irrigation water is utilized for puddling. Although puddling is effective in controlling weeds, improving nutrient as well as water availability and facilitating transplantation and quick establishment of seedlings, it can adversely affect the physical properties of soil like poor structure of soil by breaking capillary pores and destroying soil aggregates that in turn leads to the creation of hard-pan, forming problems in establishing and development of succeeding crops. Considering high labour wages in the traditional rice production, low water availability, high cost of cultivation and low returns, "Direct Seeded Rice" is preferable. Aerobic rice can be successfully raised with half of the water required as against puddled-transplanted rice in summer and entirely on rainfall in wet season with good rainfall distribution. Aerobic rice can save water to the tune of 45 to 55 per cent in summer season and even higher in *kharif* season as compared to continuous submerged crop (Gandhi *et al*., 2012).

Nitrogen fertilization is most crucial in improving the yield and quality of rice crop. Application of phosphatic fertilizers is important in aerobic rice compared to rice in flooded fields because dry aerobic soil can reduce the indigenous supply of phosphorous (irri.org). Potassium fertilizers applied at panicle initiation stage significantly increases the grain quality & yield (Wong ***et al*.,** 2004). Applying potassium either through KCl or $KClO_3$ in three equal split doses applied as basal dose, at panicle initiation and flowering stages could be suggested as a strategy of potassium management for yield maximization in aerobic rice (Babu *et al*., 2018).

Brown manuring (BM) technique has the advantage of supplementing all nutrients with crop and, is also beneficial for weed control and soil resources development. Procedure of brown manuring literally signifies a 'zero-till' form of green manuring, where a post-emergence herbicide is administered on BM to naturally decompose it without soil incorporation or ploughing till the residues decompose itself on the soil targeting to add organic manure into the soil besides weed suppression by the shade effect produced by brown manure crop. Chlorophyll is lost from the leaves which were subjected to spray of herbicide in order to desiccate hence, leaves tend to change to brown in colour. This method helps the field by adding up to 35 kg/ha Nitrogen**,** dry matter**,** managing broad leaved weeds along with developing the yield of grain up to 4 -5 q/ha because of OM addition into soil. On lighter soils prone to erosion this practice shall be preferred. Along with adding organics to soil, BM helps to enhance the soil properties **(**physical**,** chemical and biological**).**

2. Materials and Methods

The field experiment conducted during *kharif* period of 2019 at the RPCAU, Pusa, Bihar. The soil of the experimental field was calcareous in nature containing 26 % free $CaCO_3$, sandy loam in texture, alkaline in nature with a pH of 8.3 and EC 0.49 dSm^{-1}. The soil contained low in organic carbon (0.45 %), available nitrogen (243kg ha^{-1}) and potassium (112 kg ha^{-1}), while medium in available phosphorus (11kg ha^{-1}). The experiment was conducted in factorial randomised block design with sixteen treatment and replicated three times (Table-1). Abhishek variety of rice was sown according to the date decided in the treatment, planted with a spacing of 20 cm (RR), with the seed rate of 40 kg ha^{-1}. The treatment details include factor one as system of cultivation with two treatments B_1- Rice alone and B_2 - Rice + Dhaincha (BM). Factor two include different levels of phosphorus (P) and potassium (K) fertilizers with combinations F_1 - P 60 K_B 40 (P_2O_5 @ 60 kg/ha and K_2O @ 40kg/ha as a complete basal dose); F_2 - P 60 K_B 50 (P_2O_5 @ 60 kg/ha and K_2O @ 50kg/ha as a complete basal dose); F_3 - P 60 K_S 40 (P_2O_5 @ 60 kg/ha and K_2O @ 40kg/ha as split application); F_4 - P 60 K_S 50 (P_2O_5 @ 60 kg/ha and K_2O @ 40kg/ha as split application); F_5 - P 70 K_B 40 (P_2O_5 @ 70 kg/ha and K_2O @ 40kg/ha as a complete basal dose); F_6 - P 70 K_B 50 (P_2O_5 @ 70 kg/ha and K_2O @ 50kg/ha as a complete basal dose); F_7 - P 70 K_S 40 (P_2O_5 @ 70 kg/ha and K_2O @ 40kg/ha as split application) and F_8 **-** P 70 K_S 50 (P_2O_5 @ 70 kg/ha and K_2O @ 50kg/ha as split application). (Note: BM indicates Brown manuring with dhaincha @ 40 kg/ha seed rate and knock down at 25 DAS using a post-emergence herbicide, K_B indicates basal application of 100% Potassium (K), K_S indicates split application of 100% K (60% as basal dose and 40% top dressing during panicle initiation stage of the crop. Along with these treatments the recommended dose of nitrogen (RDN) applied @ 140 kg N/ha). All recommended agronomic practices (weeding, hoeing, pesticides, irrigation etc.) were kept uniform for all the treatment and were carried out throughout the growing season, when required. During the experiment observations were recorded using the standard procedure for each parameter.

3. Results and discussion

3.1 Crop growth rate (g/m^2/day)

The figures calculated pertaining to Crop Growth Rate (CGR) at all the growth stages (0-25, 25-50, 50-75 DAS and 75 DAS -at harvest) are furnished in the table 1. A clear data appraisal in from table here under denotes improvement in crop growth rate from 0-25 DAS up to 50-75 DAS which decreased later on as the crop age increased gradually while reaching the physiological maturity stage. At 0-25 DAS, neither brown manuring nor different levels of nutrients indicated their effect on this factor in aerobic rice. It was non-significant irrespective of the treatments applied. At 25-50 DAS, it was observed that significantly higher crop growth rate was found with brown manuring (7.37g/m^2/day) compared to rice alone (5.91 g/m^2/day). Among the eight nutrient management treatments, F_8 (7.24 g/m^2/day) resulted in highest CGR which was statistically on par with F_5 (6.86 g/m^2/day), F_6 (7.06 g/m^2/day) and F_7 (7.11 g/m^2/day). At 50-75 DAS, brown manured plots (16.85 g/m^2/day) resulted in markedly lesser CGR compared to rice alone (17.58) but different doses of phosphorous and potassium failed in producing any changes in CGR. Both factors under study gave significant results with respect to CGR at harvest. Significantly greater CGR was recorded with brown manuring treatment whereas among nutrients, F_8 treatment i.e., 70 kg P_2O_5 & 50 kg K_2O as split resulted in highest CGR (12.72 g/m^2/day) which was at par with F_6 (11.62 g/m^2/day) and F_7 (12.43 g/m^2/day) but superior than other treatments. Phosphorous and potassium possess a crucial role in photosynthesis of any plant. Potassium plays a positive part in metabolic activity of the plant that leads to increase in photosynthesis and thereby increases dry matter production. Hence, the growth indices like CGR was higher in treatments where K fertilizer was applied in split as observed by Jinger *et al*. (2018).

Table-1: Effect of brown manuring and different levels of nutrients on crop growth rate

Treatments	Crop growth rate (g/m^2/day)			
	(0-25) DAS	(25-50) DAS	(50-75) DAS	(75DAS) -At harvest

Factor A: System of cultivation				
B_1(rice alone)	0.81	5.91	17.58	11.21
B_2(rice+sesbania)	0.79	7.37	16.85	12.20
SEm (±)	0.01	0.09	0.25	0.15
CD (P=0.05)	NS	0.2	0.7	0.4
Factor B: Different levels of phosphorous and potassium				
F_1 (P60 K_B 40)	0.77	5.94	16.37	10.73
F_2 (P60 K_B 50)	0.79	6.32	16.95	10.93
F_3 (P60 K_S 40)	0.78	6.25	16.75	11.73
F_4 (P60 K_S 50)	0.79	6.38	16.61	12.01
F_5 (P70 K_B 40)	0.82	6.86	17.52	11.47
F_6 (P70 K_B 50)	0.82	7.06	17.82	11.62
F_7 (P70 K_S40)	0.81	7.11	17.73	12.43
F_8 (P70 K_S 50)	0.82	7.24	17.93	12.72
SEm (±)	0.02	0.18	0.50	0.30
CD (P=0.05)	NS	0.5	NS	0.8

Interaction(B*F)	NS	NS	NS	NS

3.2 Number of panicles/m^2 and Panicle length (cm)

Effect caused by brown manuring and differed levels of nutrients on yield attributes and yield is given in the table-2. Recorded data exhibited that brown manuring treatment did not produce significant results in panicle length after a clear perusal. However, slightly longer panicle length was observed with brown manuring compared (21.38cm) to rice without brown manuring (21.15cm). Among the different levels of nutrients none of the treatments significantly affected the panicle length. It was found non-significant however, among eight treatments highest panicle length (21.55cm) was recorded with F_8 treatment while the lowest panicle length (21.05cm) was seen in F_1 treatment with marginal differences through other fertilizer doses. The both brown manuring and nutrient levels resulted in significant Number of panicles produced in a unit area. The no. of panicles produced in brown manuring (285) were significantly superior over rice alone treatment (268). Whereas among the various levels of phosphorous and potassium, F_8 treatment (297) resulted in increasing panicle numbers significantly while being statistically in comparison related to F_4, F_5, F_6 and F_7. Highest number of panicles per m^2 might be attributed to lot of effective tillers/m^2 produced as an outcome of BM and Paddy crop receiving additional supply of N**,** P and K nutrients as for gradual decomposition of brown manure caused higher intake of nutrients also better availability for longer duration resulting in higher yield attributes as observed by Yadav *et al***. (**2011).

3.3 No. of grains in a panicle

A clear appraisal of data (Table-2) indicated that number of filled grains produced per panicle were significantly influenced by the present treatments. Brown manuring (98) produced outstandingly more grain production compared to no brown manuring (92). Gradual release of nitrogen due to incorporation of dhaincha relatively throughout the primordial initiation, flowering alongside grain filling phases helped to increase the number of spores budding on stigma that resulted in increased amount of spore germination on stigma which in turn enhanced the amount of filled grains in a panicle. The results stated here were found to be in agreement to the outcome of Mohioddin *et al*. (2014) and Chaudhary ***et al*.** (2011).Whereas 70kg phosphorous and 50kg potassium in split application (100) resulted in highest number of grains/panicles which was, significantly superior over F_1 viz. 60 kg phosphorous & 40 kg potassium as basal (90) but the other treatments did not provide significant results. The most elevated estimations of growth characteristics acquired with the use of phosphorus showed signs of improvement in yield qualities which might be likely because of more ingestion and usage of accessible phosphosrous for absorption and utilization by plants, by and large improvement of "source-sink relationship", which thus upgraded the yield characteristics of aerobic rice (Sharma *et al*.**,** 2009). Utilization of K brought about better plant development and dry matter yield. Adjusted supply of N, P and K was liable for higher photosynthesis, metabolic action and cell division, which therefore expanded development and yield qualities as detailed by Vijayakumar (2017). Comparable discoveries as per the current examination were given by Awan *et al*. (2007).

3.4 Test weight (g)

Values regarding test-weight did not seem to have any significant variation because of the brown manuring or nutrient management treatments. However slightly higher test weight was observed with brown manuring in rice (21g) whereas rice without brown manure showed lower test weight (20g). Among the nutrient levels, non-significant results were seen although F_8 treatment showed slightly higher test weight than others. The interaction results too remained non-significant.

3.5 Grain yield (q/ha)

Grain yield obtained through brown manuring (42.79 q/ha) was significantly superior over yield from rice alone plots (40.64 q/ha). Rice grown along with brown manure yielded 5.29% higher grain than rice without brown manuring. Fundamentally more grains could be achieved from B_2-rice with dhaincha contrasted with rice alone, which had significant differences which may have come about because of the higher estimations of yield properties, for example, number of panicles/m^2, panicle length, grains in panicle and weight of 1000 grains. Comparable outcomes were recorded by Samant (2017) and Singh *et al*. (2009). The residues of brown manure (dhaincha) acted as mulch increasing the availability of moisture which would have contributed to increase in yield attributes and finally leading to enhanced grain & straw yield (Yadav *et al*., 2010). Comparison of effect of different nutrient levels on grain yield indicated that F_8 treatment gave significant results by producing 43.79q/ha which was significant over F_1 treatment but at par with all others. The difference was to the tune of 8.72%. The vital role taken up by potassium in improving the yield attributes significantly increased the grain yielding capability of the crop. As a consequence of split application of K, a greater number of filled grains in a panicle and higher panicle length were observed. The production of yield attributes and grain yield exhibited a strong positive correlation. Aforesaid findings have similarity to the results given by Arivazhagan *et al.* (2004)

Table: 2. Effect of brown manuring and various nutrient levels on the yield attributes and grain yield.

Treatments	Number of panicles /m^2	Panicle length (cm)	No. of grains in a panicle	Test weight. (g)	grain yield (q/ha)
Factor A: System of cultivation					
B_1(rice alone)	268	21.15	92	20	40.64
B_2(rice + sesbania)	285	21.38	98	21	42.79
SEm (±)	5.2	0.4	1.8	0.4	0.69
CD (P=0.05)	15.0	NS	5.4	NS	2.0
Factor B: Different levels of phosphorous and potassium					
F_1 (P60 K_B 40)	258	21.05	90	20	39.55
F_2 (P60 K_B 50)	261	21.07	93	20	40.37
F_3 (P60 K_S 40)	259	21.22	96	20	40.96
F_4 (P60 K_S 50)	270	21.24	96	21	41.56
F_5 (P70 K_B 40)	279	21.20	96	21	41.79

F_6 (P70 K_B 50)	288	21.25	96	21	42.57
F_7 (P70 K_S40)	293	21.53	98	21	43.16
F_8 (P70 K_S 50)	297	21.55	100	21	43.79
SEm (±)	10.4	0.83	3.77	0.80	1.39
CD (P=0.05)	30.2	NS	10.9	NS	4.0
Interaction(B*F)	NS	NS	NS	NS	NS

4. Conclusion

It can be concluded that brown manuring and implementation of 140kg N**,** 60kg P_2O_5 and 50kg K_2O as split found beneficial in terms of growth and yield attributes for aerobic rice. Along with that Aerobic rice could be one of the best alternative technology that can save 30 to 40 per cent of water compared to traditional lowland cultivation.

5. References

Arivazhagan, K., Revichandran, M., 2005. Interaction effect of nitrogen and potassium on yield and yield attributes in rice Cv. IR 20 Advances in Plant Sciences 18, 425- 427.

Awan, T. H., Manzoor, Z., Safdar, M. E., Ahmad, M., 2015. Yield response of rice to dynamic use of potassium in traditional rice growing area of Punjab. Pakistan Journal of Agricultural Science 44(1), 130-135.

Babu, A., Hattab, O., Aruna, L., Mohan, R., 2018. Effect of sources, split and foliar application of KCl and KClO3 on uptake of potassium in aerobic rice. Journal of Pharmacognosy and Phytochemistry 7(4), 1954-1957.

Bahmaniar, M. A., Ranjbar, G. A., Ahmadian, S. H., 2007. Effects of N and K applications on agronomic characteristics of two Iranian and landrace rice (Oryza sativa L.) cultivars. Pakistan Journal of Biological Sciences 10(6), 880-886.

Chaudhary, S. K., Marahatta, S., Chaudhary, M., 2018. Performance of dry direct seeded rice and weeds on Sesbania brown manuring as compared to farmers' practice and chemical control method. International Journal of Applied Sciences and Biotechnology 6(3), 265-269.

Gandhi, R. V., Rudresh, N. S., Shivamurthy, M., Hittalmani, S., 2012. Performance and adoption of new aerobic rice variety MAS 946-1 (Sharada) in southern Karnataka. Karnataka Journal of Agricultural Sciences 25(1), 5-8.

Jinger, D., Dhar, S., Dass, A., Sharma, V. K., Joshi, E., Vijayakumar, S., Gupta, G. (2018). Effect of silicon and phosphorus fertilization on growth, productivity and profitability of aerobic rice (Oryza sativa). *Indian Journal of Agricultural Sciences 88*(10), 1600-1605.

Mohioddin, M. G., Ramana, M. V., Sridevi, S., Reddy, A. P. K., 2014. Influence of integrated nitrogen management on yield components and yield of scented rice (Oryza sativa L.). The journal of research ANGRAU 42(2), 65-68.

Samant, T.K., 2017. A study on effect of brown manuring on growth, yield, economics and soil fertility in direct seeded rice. Journal of Bio Innovation 4, 643.

Sharma, S.N., Prasad, R., Shivay, Y.S., Dwivedi, M.K., Kumar, S., Kumar, D., 2009. Effect of rates and sources of phosphorus on productivity and economics of rice (*Oryza sativa*. L) as influenced by crop-residue incorporation. Indian Journal of Agronomy 54(1), 42–46.

Singh, G., Sharma, D.P., Singh, A.K., Malik, R.K., 2009. Evaluation of resource conservation technologies in rice-wheat cropping system. Conservation Agriculture experiment at CSSRI, India.

Vijayakumar, S. 2017. Potassium management in aerobic rice (*Oryza sativa L.*) – wheat (*Triticum aestivum L.)* cropping system. Ph.D Thesis, Indian Agricultural Research Institute, New Delhi, India.

Yadav, G.S., Shivay, Y.S., Kumar., 2011. Effect of mulching and iron nutrition on productivity, nutrient uptake and economics of aerobic rice (Oryza sativa L.). Indian Journal of Agronomy 56(4), 365-372.