



Plant Growth Analysis of Basmati Rice (*Oryza sativa* L.) as Affected by Application of Different Organic Nutrient Sources Under System of Rice Intensification

Narinder Panotra ^{a*}, Vikas Sharma ^a, M. Iqbal Jeelani ^b, Ritika Gupta ^c and Yamini Raut ^c

^a Organic Farming Research Centre, Chatha, Sher- e - Kashmir University of Agricultural Sciences and Technology of Jammu, Jammu and Kashmir, India.

^b Faculty of Basic Science, Sher- e - Kashmir University of Agricultural Sciences and Technology of Jammu, Jammu and Kashmir, India.

^c Faculty of Agriculture, Sher- e - Kashmir University of Agricultural Sciences and Technology of Jammu, Jammu and Kashmir, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJAEES/2022/v40i1031145

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/90728>

Original Research Article

Received 20 June 2022
Accepted 13 August 2022
Published 16 August 2022

ABSTRACT

Field experiments were conducted for four consecutive *Kharif* season of 2017-2020 at Organic Farming Research Centre, Sher-e- Kashmir University of Agricultural Sciences and Technology of Jammu, Chatha, located at 32° 66' North latitude and 74° 79' East longitude with an altitude of 356 meters above mean sea level in the Shiwalik foothills of North-Western Himalayas. The mean annual rainfall of the experimental site is 1198.2mm of which 70-75% rainfall is received from June to September. The soil of the experimental site was sandy clay loam in texture, slightly alkaline in reaction, medium in organic carbon, available phosphorus and potassium but low in available nitrogen. The experiment was laid out in split plot design with three replications. The experiment consisted of 05 (five) organic nutrients sources treatments with two crop establishment methods.

The results showed that there were maximum plant growth characters of organic Basmati 370 like plant height, number of tillers, number of productive tillers, root length, number of roots, root volume, biological yield etc after using vermicompost @ 3.0 t ha⁻¹ followed by FYM @ 8 t ha⁻¹ under SRI method. In addition, SRI method was found to be effective in reducing pest and disease incidence, shortening crop rotations and improving plant conditions. It was found from the study that among the various treatments of organic nutrient sources, the highest (132.13 q/ha) biological yield of basmati 370 was recorded with the application of vermicompost @ 3t/ha which was statistically at par the application of FYM @ 8t/ha (130.20q/ha) respectively under SRI method.

Keywords: Organic nutrient sources; organic basmati rice; plant growth attributes; SRI.

1. INTRODUCTION

Rice farming is the primary source of income for millions of people around the world, and some Asian and African countries rely heavily on it for foreign exchange gains and government revenue. More than 80% of people in Asia live upon rice, and their primary food security is entirely dependent on the amount of rice produced in the region [9]. India has the greatest rice-growing region in Asia, accounting for 29.4 percent of the global total, but it also has the lowest yield. Due to social, biological, and technological failures, traditional paddy cultivating regions are in the worst possible shape. Due to India's ever-increasing population, there is a growing demand for rice [2]. Indian rice contributes for 20% of global rice output. It is the world's second-largest rice producer. Small and marginal farmers (land holdings of less than 2 hectares) dominate Indian agriculture, accounting for 82 percent of the overall farmer population. Agriculture accounts for 49 percent of the overall population's output [3,4]. Rice is India's most significant cereal food crop, accounting for around 24% of the country's gross planted area. It produces 42% of the country's total food grain output and 45% of the country's overall cereal production [5].

By 2025, in Asia 17 million hectares of irrigated rice land may face "physical water shortage" and 22 million hectares may face "economic water scarcity." Water available for rice is getting scarce year to year due to increased competition from industrial, urban sectors and from commercial crops. Decreased inflows in major delta systems of the state and predicted climate changes are likely to accentuate the water crisis in the state, warrants the need for exploring of water saving alternatives in rice farming. The conventional rice production systems of transplanted rice by farmers not only leads to wastage of water but also causes environmental degradation and reduces fertilizer use efficiency.

System of Rice Intensification (SRI), a new method of rice establishment practice, has the potential to improve water and land productivity in irrigated rice [6]. SRI is a novel rice growing system that uses a comprehensive package of procedures to increase rice yield while using less seed, water and manures [7].

The use of organic farming techniques to grow crops has increased in popularity in recent years, resulting in increased consumer demand for organically grown produce and a genuine desire on the part of many growers to maintain or improve the soil [8]. Now, organic products generally fetch a higher price than conventional products [9], motivating growers to grow crops organically. The increased consumer demand appears to be driven primarily by the belief that organically grown produce is safer and more nutritious to eat than produce grown conventionally [10]. In addition, it should be recognized that organic nutrient sources can vary significantly in terms of nutrient availability. It may be more meaningful to compare different organic nutrient sources or rates within an organic system to determine the effect on soil and produce quality compared to conventional nutrient sources in a conventional system. However, it is necessary that the present study has been carried out by using of organic nutrient sources in Basmati rice to achieve sustainable crop yield and better organic production without affecting soil fertility.

2. METHODOLOGY

Field experiments were conducted for four consecutive *Kharif* season of 2017-2020 at Organic Farming Research Centre, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Chatha, located at 32° 66' North latitude and 74° 79' East longitude with an altitude of 356 meters above mean sea level in the Shiwalik foothills of North-Western Himalayas. The mean annual rainfall of the

Chart 1. List of conventional methods

Particulars	SRI method	Convention method
Variety	Basmati 370	Basmati 370
Seedlings transplant	09-12 days old with two leaves / hills	25-30 days old with five to ten leaves/ hills
Spacing	25 X 25 cm ²	20 X 15 cm ²
Gap filling & thinning	Necessary to maintain optimum plant population	Not done
Plant protection	Need based timely spraying	Improper measures
Irrigation	Soil was kept moist	Flooding method

experimental site is 1198.2mm of which 70-75% rainfall is received from June to September. Jammu is located in sub-tropical zone bestowed with hot and dry early summers followed by hot and humid monsoon season and cold winters. The soil of the experimental site was sandy clay loam in texture, slightly alkaline in reaction, medium in organic carbon, available phosphorus and potassium but low in available nitrogen. A total experiment area of 5.0 m X 4.0 m in every year was fixed. The experiment was laid out in split plot design with three replications. The experiment treatments comprised of 05 (five) different organic nutrient sources viz; Zero, FYM @ 6t/ha, FYM @ 8t/ha, VC (Vermicompost) @ 2t/ha, VC @ 3t/ha and two crop establishment methods. SRI nursery was prepared with raised bed duly applying FYM and VC as affine layer on the bed. Pre-sprouted seeds were sown @ 5.0 kg/ha. Proper leveling was done before planting. 09-12 days old single seedlings were transplanted at spacing of 25 x 25 using seedling per hill, water management was done by maintaining saturation up to panicle initiation (PI) stage.

Other package of practices was adopted to raise the crop as per the recommendations. For recording observations on various agronomical traits, five plants in each plot were selected at random and labeled. After the crop reached its physiological maturity, the crop was harvested manually by sickle, close to ground level, and the entire above-ground biomass was removed from the field. The observation on growth parameters viz., plant length (cm), number of hill/ tillers, root length (cm) were recorded. The yield data were collected at crop maturity stage and experimental design used in this study was RCBD and statistical analysis was done utilizing R software.

3. RESULTS AND DISCUSSION

3.1 Plant Growth Analysis

The result presented in Table 1 showed that the significantly plant height, higher no. of tillers/plant

and productive tillers/plant at the time of harvest were recorded at 3t/ha vermicompost and 8t/ha FYM application. As result of high photosynthetic and hormonal activity, the meristematic growth in the apical region resulted in the sufficient elongation of the plants owing to 3t/ha vermicompost and 8t/ha FYM application. The different level of treatment measures exhibited significant variation in respect to growth parameters. Higher plant height 165.17 and 164.13cm were recorded where application 3t/ha vermicompost and 8t/ha FYM under SRI method due to proper manure supply to the plant which resulted shoot up plant growth by better establishment of roots and rapid cell division.

Higher no. of tillers/plant and productive tillers/plant (39.00 and 37.00) (36.67 and 33.67) were recorded in the application of 3t/ha vermicompost and 8t/ha FYM respectively under SRI method. The higher no. of tiller might be due to proper spacing, timely transplanting, young & healthy seedling and water management.

Similarly, the maximum panicle length in cm (30.83 & 29.80) and no of grain per panicle (169.67 & 166.00) were recorded 3t/ha vermicompost and 8t/ha FYM application under SRI method because SRI facilitates the efficient use of recourses such as proper nutrients, solar radiation, water use capacity, photosynthetic rate in the growth stage.

3.2 Root Growth Analysis

For measuring the impact of different treatment on the root growth of the organic basmati 370 no. of root, root length and root volume are useful parameters. The data on no. of root, root length and root volume at different stages presented in Table 2 clearly indicates that the no. of root, root length and root volume significantly varied in different treatments at various growth stages of organic basmati 370. At 60 DAT, amongst different organic nutrient treatments, highest No of roots per plant, root length (cm) and root

Table 1. Effect of organic nutrient sources on plant growth attributes of basmati 370 at harvest

Treatment	Dose	Plant height	No. of Tiller/plant	Productive tillers/plant	Panicle Length (cm)	No. of Grains/Panicle
E ₁ F ₀	Zero	120.93	15.00	9.67	13.36	94.67
E ₁ F ₁	6t FYM	149.50	31.33	27.67	25.23	145.33
E ₁ F ₂	8t FYM	164.13	37.00	33.67	29.80	166.00
E ₁ F ₃	2t VC	156.07	32.67	29.67	27.70	150.33
E ₁ F ₄	3t VC	165.17	39.00	36.67	30.83	169.67
E ₂ F ₀	Zero	103.21	8.00	5.33	12.73	89.67
E ₂ F ₁	6t FYM	118.33	12.33	9.00	18.22	103.00
E ₂ F ₂	8t FYM	125.63	13.67	11.33	19.52	114.67
E ₂ F ₃	2t VC	120.13	12.67	10.33	19.17	108.33
E ₂ F ₄	3t VC	128.83	14.33	12.00	19.73	119.33
SE (m)		3.45	1.32	1.11	0.78	4.61
C.D(p≤0.05)		11.02	2.55	3.47	1.36	7.99

volume per plant of basmati 370 were recorded (97.33, 17.87 & 185.88) 3t/ha vermicompost and (95.77, 16.80 & 179.33) 8t/ha FYM application respectively under SRI method (Table 2). SRI method was performed increased root growth due to rich and healthier conditions of soil moisture, better root respiration and proper spacing while continues flooding method under convention method was affected the soil redox potential.

Root growth at time of harvest presented in Table 2. No of roots per plant, root length (cm) and root dry weight per plant (mg) were higher recorded (338.22, 33.44 and 322.89) in the application of 3t/ha vermicompost which were statistically at par with application of 8t/ha FYM (335.11, 31.44 and 318.22) under SRI method due to better organic nutrients management, roots received their nutrients requirement more adequately, proper space for roots and canopy

growth throughout the cropping cycle of organic basmati rice. SRI method developed larger, deeper and healthy root system as compared to convention method.

The biological yield was positively associated with various nutrient management practices. The higher 1000-Grain Weight (g) was recorded (23.06 and 22.75 g) in the application of @ 3t/ha vermicompost and 8t/ha FYM respectively under SRI method (Table 3). Higher biological yield was observed under SRI method due to wider spacing (25x25 cm), more number of tillers, length of panicle, number of panicles, number of roots, roots length. Further, proper nutrient management and vegetative growth resulted the maximum biological yield was recorded (132.13 q/ha) with application of 3t/ha vermicompost followed by application of 8t/ha FYM (130.20q/ha) respectively under SRI method.

Table 2. Effect of organic nutrient sources on root growth of basmati 370

Treatment	Dose	No. of roots/ plant		Root length (cm)		Root volume/plant	
		At 60 DAT	At Harvest	At 60 DAT	At Harvest	At 60 DAT	At Harvest
E ₁ F ₀	Zero	22.00	31.99	10.77	15.66	77.55	97.66
E ₁ F ₁	6t FYM	87.22	327.77	14.37	27.00	169.22	234.00
E ₁ F ₂	8t FYM	95.77	335.11	16.80	31.44	179.33	318.22
E ₁ F ₃	2t VC	93.00	330.88	14.67	30.44	171.11	293.33
E ₁ F ₄	3t VC	97.33	338.22	17.87	33.44	185.88	322.89
E ₂ F ₀	Zero	7.93	19.55	7.83	12.22	41.55	77.22
E ₂ F ₁	6t FYM	56.77	76.55	10.37	18.11	94.66	134.89
E ₂ F ₂	8t FYM	64.33	88.22	11.30	20.88	100.78	183.55
E ₂ F ₃	2t VC	60.55	81.33	10.59	19.11	97.55	176.77
E ₂ F ₄	3t VC	66.11	97.55	12.44	21.89	105.89	194.28
SE (m)		1.47	2.55	0.88	1.04	2.72	4.98
C.D (p≤0.05)		3.22	4.01	1.03	2.77	5.61	10.17

Table 3. 1000-grain weight, biological yield and harvest index as influenced by crop establishment methods

Treatment	Dose	1000-Grain Weight (g)	Biological Yield (q/ha)	Harvest Index (%)
E ₁ F ₀	Zero	14.22	77.85	25.05
E ₁ F ₁	6t FYM	21.35	118.64	27.71
E ₁ F ₂	8t FYM	22.75	130.20	28.22
E ₁ F ₃	2t VC	22.49	124.53	27.88
E ₁ F ₄	3t VC	23.06	132.13	28.27
E ₂ F ₀	Zero	10.04	57.89	25.29
E ₂ F ₁	6t FYM	17.92	81.28	25.35
E ₂ F ₂	8t FYM	18.14	101.64	26.35
E ₂ F ₃	2t VC	18.11	94.02	25.49
E ₂ F ₄	3t VC	18.39	103.92	26.59
SE (m)		0.93	2.17	0.11
C.D(p≤0.05)		2.01	5.43	1.03

Harvest index (%) is the ratio of grain to total biological yield. The higher (28.27) harvest index was recorded with application of 3t/ha vermicompost which was at par (28.22) application of 8t/ha FYM under SRI method.

4. CONCLUSION

The benefits of organic nutrient sources on the physical, chemical and biological properties of soils are clearly evident from the literature, although careful management is necessary to avoid potential environmental impacts. The findings of this study showed that the application of 3t/ha vermicompost which was at par application of 8t/ha FYM under SRI method. The SRI method is superior in terms of higher number of tillers, length of panicle, number of panicles, number of roots, roots length, higher grain, straw and biological yield, higher profitability of organic basmati-370 than the convention method.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

- Shankar R, Bhattacharjee A, Jain M. Transcriptome analysis in different rice cultivars provides novel insights into desiccation and salinity stress responses. *Sci Rep.* 2016;6:23719
- Devi KS, Ponnarasi T. An economic analysis of modern paddy production technology and its adoption behavior in Tamil Nadu. *Agric. Econ. Res. Rev.* 2009;22:341-347.
- Baruah KK, Gogoi B, Gogoi P. Plant physiological and soil characteristics associated with methane and nitrous oxide emission from rice paddy. *Physiol Mol Biol Plants.* 2010; 16:79–91.
- Borah L, Baruah KK. Physiological and anatomical variations in three rice (*Oryza sativa* L.) genotypes for transport and emission of methane. *Clim Change Environ Sustainability.* 2015;3: 58–70.
- Lakra N, Kaur C, Anwar K, Singla-Pareek SL, Pareek A. Proteomics of contrasting rice genotypes: identification of potential targets for raising crops for saline environment. *Plant Cell Environ.* 2018; 41:947–969.
- Kumar Anand and Singh NK. Heterosis and combining ability in hybrid rice. *Ann Pl Soil Res.* 2004;6(2):148-151.
- Uphoff N, Fasoula V, Iswandi A, Kassam A, Thakur AK. Improving the phenotypic expression of rice genotypes: Rethinking “intensification” for production systems and selection practices for rice breeding. *Crop J.* 2015;3(3): 174–189.
- Dimitri C, Greene C. Recent growth patterns in U.S. Organic Foods Market. *Agricultural Information Bulletin No. 777, Economic Research Service, U.S. Department of Agriculture, Washington, D.C;* 2002.

9. Oberholtzer L, Dimitri C, Jaenicke EC. Evidence on importing organic products into the United States: Consumer interests and international trade. Unpublished manuscript; 2010.
10. Lockie S, Lyons K, Lawrence G, Mummery K. Eating 'Green': Motivations Behind Organic Food Consumption in Australia. *Sociologia Ruralis*. 2002; 42(1):23-40.

© 2022 Panotra et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:
<https://www.sdiarticle5.com/review-history/90728>