Plant growth analysis of Basmati rice (*Oryza sativa* L.) as affected by application of different organic nutrient sources under System of Rice Intensification

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 32^0 66' North latitude and 74^0 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) respectivelyunder SRI method.
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Keywords: Organic nutrient sources, organic basmati rice, plant growth attributes, SRI.

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 (Shankar*et al* 2016). 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 (Devi andPonnarasi 2009). 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 (Baruah *et al* 2010; Borah and Baruah 2015). 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 (Lakra *et al.* 2018).

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 (Kumar and Singh 2004).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 (Uphoff *et al.* 2015).

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 (Dimitri and Greene, 2002). Now, organic products generally fetch a higher price than conventional products (Oberholtzer et al., 2010), 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 (Lockie et al., 2002). 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 thatthe present study has been carried outby using of organic nutrient sources in Basmati rice to achieve sustainable crop yield and better organic production without affecting soil fertility.

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 32^0 66' ' North latitude and 74^0 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. 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.

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

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 stageand experimental design used in this study was RCBD and statistical analysiswas done utilizing R software.

Results & Discussion

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 recorded3t/ha vermicompost and 8t/ha FYM application under SRI method because SRI facilities the efficient use of recourses such as proper nutrients, solar radiation, water use capacity, photosynthetic rate in the growth stage.

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_1F_0	Zero	120.93	15.00	9.67	13.36	94.67
E_1F_1	6t FYM	149.50	31.33	27.67	25.23	145.33
E_1F_2	8t FYM	164.13	37.00	33.67	29.80	166.00
E_1F_3	2t VC	156.07	32.67	29.67	27.70	150.33
E_1F_4	3t VC	165.17	39.00	36.67	30.83	169.67
E_2F_0	Zero	103.21	8.00	5.33	12.73	89.67
E_2F_1	6t FYM	118.33	12.33	9.00	18.22	103.00
E_2F_2	8t FYM	125.63	13.67	11.33	19.52	114.67

E_2F_3	2t VC	120.13	12.67	10.33	19.17	108.33
E_2F_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($p \leq 0.05$)		11.02	2.55	3.47	1.36	7.99

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 3 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 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-3). 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-3. 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 of8t/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.

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_1F_0	Zero	22.00	31.99	10.77	15.66	77.55	97.66
E_1F_1	6t FYM	87.22	327.77	14.37	27.00	169.22	234.00
E_1F_2	8t FYM	95.77	335.11	16.80	31.44	179.33	318.22
E_1F_3	2t VC	93.00	330.88	14.67	30.44	171.11	293.33
E_1F_4	3t VC	97.33	338.22	17.87	33.44	185.88	322.89
E_2F_0	Zero	7.93	19.55	7.83	12.22	41.55	77.22
E_2F_1	6t FYM	56.77	76.55	10.37	18.11	94.66	134.89
E_2F_2	8t FYM	64.33	88.22	11.30	20.88	100.78	183.55
E_2F_3	2t VC	60.55	81.33	10.59	19.11	97.55	176.77
E_2F_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 ($p \leq 0.05$)	3.22	4.01	1.03	2.77	5.61	10.17

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. Higherbiological 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.

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.

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_1F_0	Zero	14.22	77.85	25.05
E_1F_1	6t FYM	21.35	118.64	27.71
E_1F_2	8t FYM	22.75	130.20	28.22
E_1F_3	2t VC	22.49	124.53	27.88
E_1F_4	3t VC	23.06	132.13	28.27
E_2F_0	Zero	10.04	57.89	25.29
E_2F_1	6t FYM	17.92	81.28	25.35
E_2F_2	8t FYM	18.14	101.64	26.35
E_2F_3	2t VC	18.11	94.02	25.49
E_2F_4	3t VC	18.39	103.92	26.59
SE (m)		0.93	2.17	0.11
C.D($p \leq 0.05$)		2.01	5.43	1.03

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.

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